LETTER

OF THE

SECRETARY OF THE TREASURY,

COMMUNICATING

The Report of the Superintendent of the Coast Survey, showing the progress of that work during the year ending November 1, 1857.

JANUARY 5, 1858.—Referred to the Committee on Commerce. Motion to print referred to the Committee on Printing.
MARCH 3, 1858.—Report in favor of printing.
MARCH 23, 1858.—Ordered to be printed.

Resolved, That in addition to the usual number of copies of the report of the Superintendent of the Coast Survey Office for the year 1857, there be printed six thousand two hundred copies; twelve hundred of which for the use of the Senate, and five thousand copies thereof for distribution by the Superintendent of the Coast Survey, under the direction of the Secretary of the Treasury; that the same be printed and bound with the plates in quarto form, and that the printing of said plates shall be done to the satisfaction of the Superintendent of the Coast Survey.

TREASURY DEPARTMENT,
January 4, 1858.

SIR: I have the honor to submit, for the information of the Senate, a report made to the Department by Professor A. D. Bache, Superintendent of the United States Coast Survey, showing the progress of that work during the year ending November 1, 1857, and the accompanying map, prepared in the Coast Survey Office, in accordance with an act of Congress approved March 3, 1853.

This report would have been transmitted to Congress in December last, in accordance with the law, but for the adjournment of that body, which was not anticipated.

With great respect, your obedient servant,

HOWELL COBB,
Secretary of the Treasury.

Hon. J. C. BRECKINRIDGE,
Vice President of the United States and President of the United States Senate.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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This project currently includes the imaging of the full text of each volume up to the "List of Sketches" (maps) at the end. Future online links, by the National Ocean Service, located on the Historical Map and Chart Project webpage (http://historicals.ncd.noaa.gov/historicals/histmap.asp) will includes these images.

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January 13, 2003

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ERRATA

In Coast Survey Report for 1855.

Page 349 : Table I, column 3, 2d line from bottom, for **12*h*, 12*m*.** read **12*h*. 6*m*.**

Page 351 : Table II, subtract **6*m*.** from quantities in last column.

Page 351 : Table III, 4th column, 4th line, for **10.0** read 11.0.

Page 353 : Strike out line 6.

Page 354 : Tables IV and V, subtract 6*m*. from all the quantities in the columns headed from 0 to 7.

Page 354 : Line 10, from bottom, for 13*h*. 3*m*. read 12*h*. 57*m*.

Page 354 : Line 9, from bottom, for 25 0 read 24 54.

Page 354 : Line 9, from bottom, for 1 0 read 0 54.

Page 354 : Line 5, from bottom, for 20 read 14.

Page 354 : Line 4, from bottom, for 24 21 and 0 21, read **24*h*. 15*m*.** and 0 15.

Page 358 : Table X, line 7, for 1.1, 1.5, and 0.6, read 1.9, 2.4, and 1.7.

Page 379 : Line 13, for Jan José read San José.

Page 379 : Line 18, for that mountain, read Mount Diablo.

Page 379 : Line 7, from bottom, for commence read commences.

Page 379 : Line 3, from bottom, for Benardino read Bernardino.

Page 380 : Line 10, insert a comma after "direction."

Page 380 : Line 9, for suggests read suggest.

Page 382 : Line 6, for Benardino read Bernardino.

Page 387 : Line 17, for practically read economically.

Page 388 : Line 25, for Sancelito read Saucelito.

Page 392 : Line 24, for of the boring shells, read of boring shells

Page 392 : Line 26, for granite read granitic.

Page 394 : Line 21, from bottom, for anti-clinal read anticlinal.

Page 394 : Line 2, from bottom, for were read was.

Page 395 : Line 1, for Quarternary read Quaternary.

Page 395 : Line 12, for primogenius read primigenius.

Page 395 : Line 19, for exudes read exude.

Page 395 : In the foot note, for practical read practicable.

Page 396 : Line 16, for former read older.

In Coast Survey Report for 1856.

Page 325 : Line 18, for investigation read investigator.

Page 327 : Line 20, from below, for thenics read thermics, and for meteorology read metrology.

In Coast Survey Report for 1857.

Page 1 : Line 1, for OFFICE read STATION.

Page 144 : Line 26, for 1855 read 1850.

Page 182 : "Key West—over northwest channel bar," "Low water of spring tides," for 17.7 read 11.7.

Page 183 : "Santa Cruz harbor—anchorage," in 5th column of figures, for 26.6 read 25.7.

Page 183 : "San Francisco harbor—on the bar," in 6th column of figures, for 36.4 read 37.4; and "At best wharves," in 6th column, for 23.4 read 24.4.

Page 190 : Line 26, for covered read curved.

REPORT.

COAST SURVEY OFFICE, BANGOR, MAINE,
November 3, 1857.

SIR: In compliance with the law of 1853, and with the regulations of the Treasury Department, I have the honor to present my report on the progress of the Coast Survey of the United States during the past year, or from November 1, 1856, to the same date in 1857.

The survey has been in progress, in its field or office work, during the past year, in all the States and Territories of the Atlantic, Gulf of Mexico, and Pacific coasts, where it is not essentially completed.

Since the commencement of the work, the extensive coasts of Florida and Texas, and of California, and Oregon and Washington Territories, have been added to the Union.

I propose to retain the same division for this report as of the one immediately preceding it. The general divisions are three in number—the introduction, the description of operations, and the appendix.

I. The introduction gives a general notice of the progress of the survey, with references to more detailed accounts of the operations in the second and third parts of the report. The estimated progress for the next year, on the same scale as for several years past, is next given, with the estimates necessary to insure that progress.

Any change in the means furnished, will, of course, change the rate of advance, and, as there is a certain definite amount of coast to be surveyed, will change the date of completion of the work. The present scale of progress is a more economical one than a smaller scale, as has frequently been shown. It is estimated that, with the same means provided for the last two years, the field work on the Atlantic and Gulf coasts may be essentially completed in nine to eleven years.

II. The second part of the report gives a detailed account of the work in the field and afloat, and of the office work, arranged under the head of geographical sections, numbered from one to eleven, beginning at the northeastern extremity of the United States, and passing to the southward and westward on the Atlantic and Gulf of Mexico, and from the southward on the Pacific coast to the northward and westward. Each section forms a chapter of the report, and the operations are subdivided according to the class to which they belong and the officer conducting them. The statistics reported by the several chiefs of parties are given in these chapters, and indicate, in a general way, the progress made. A brief reference to the progress of the section, and to the several operations described in the chapter, precedes each chapter.

III. The appendix is subdivided as follows: 1. *Field, hydrographic, and office details*, included in general lists, showing the distribution of the parties along the coast; the names of army and navy officers attached to the work; items of information communicated in reply to applications made within the year; the statistics of field and office work; the detached surveys made on the

Western Coast; the developments and discoveries made in prosecuting the regular hydrography; tables giving tidal data and depths at port entrances of the United States, for the use of navigators; reports upon the work executed in the several divisions of the office; lists of the original topographical and hydrographic sheets deposited in the archives; and lists of geographical positions determined from recent data furnished by the field work. 2. *Special operations and scientific discussions*, relative to longitude, latitude, astronomical and geodetic methods, magnetism, tides, currents, and winds. 3. *Local surveys*, comprising reports on the survey of special localities, their topographical features and resources. 4. *Miscellaneous scientific matters*, including descriptions of instruments and methods employed in the work, and papers relating to it. 5. *Miscellaneous correspondence*, in reference to matters incidental to the operations of parties engaged in the field. 6. *Light-house matters.*

The report is preceded by a table of contents, and an alphabetical index.

The first part of the introduction will be confined to statements concerning the progress and estimates; the second, to details and remarks on the operations in field and office.

GEOGRAPHICAL SECTIONS—ESTIMATES OF PROGRESS AND OF COMPLETION.

The limits of the geographical sections into which, for convenience, the coast has been subdivided, with the best estimate which I can make of relative progress, are given below, estimated upon the present resources and regular rate of progress. As a general rule, unless when the character of particular localities, as the Nantucket shoals and Florida reefs, for example, requires a different course, the sections should make a similar general progress, so as to be finished at the same time. This condition would have been readily fulfilled had the survey been begun in each at one date, and the scale of the work been at once raised to meet it with the determination to continue it. As the work was commenced at very different periods, so now the sections are at different stages of advance; but, by pushing those begun later, they have in a degree overtaken the others, so as to make the date of completion much less irregular than might be supposed.

SECTION I. *From Passamaquoddy bay to Point Judith, including the coast of the States of Maine, New Hampshire, Massachusetts, and Rhode Island.*—This section is more than half (six-tenths) done, and may be finished, the triangulation in eight years, and the topography and hydrography in from ten to twelve. This will, however, require close management to accomplish, and the most favorable use of the resources. The primary triangulation will be finished in say three years, and the number of the other parties may then be increased. The triangulation was begun in this section in 1843.

SECTION II. *From Point Judith to Cape Henlopen, including the coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.*—This is essentially completed. A part of the rivers and some revision work remain, all of which will be completed incidentally as parties are available for other portions of the work.

SECTION III. *From Cape Henlopen to Cape Henry, including the coast of part of Delaware, Maryland, and part of Virginia*, is more than three-fourths (eight-tenths) done, and the remaining operations are generally of a class resembling those of the last section, and, with certain leading ones steadily provided for, will be executed as parties are available. The climate in this and the preceding section favors this arrangement, which is, besides, under the circumstances, the most economical. This section is characterized by the importance of its great interior bay, the Chesapeake. The triangulation was begun in 1842.

SECTION IV. *From Cape Henry to Cape Fear, including part of the coast of Virginia and North Carolina.*—This section is rather more than half done, including the land and water work. The preliminary triangulation of the outer coast is finished, and more than one-third of the interior triangulation. The topography of the coast and of more than two-thirds of the interior sounds is done. The triangulation of Pamplico sound, with its rivers, with average success, will take five years, but there is at present no party available for it. The hydrography should be completed in seven to ten years at the present rate. The most dangerous parts of this coast have been done, and, if there were a special object in doing so, this section could easily be pushed to completion earlier; but three others will need the resources more, in order to bring them up to time.

SECTION V. *From Cape Fear to the St. Mary's river, including part of the coast of North Carolina, and the coast of South Carolina and Georgia.*—This section is nearly half (four-tenths) done. With the number of parties now engaged there, it may be completed in seven years. The triangulation was begun in 1849. It will probably be expedient, after a few years, to diminish the number of parties in this section, applying the means to others which have made less progress.

The progress in these five Atlantic coast sections is, on the average, nearly two-thirds towards completion, estimating in due proportion all the operations.

SECTION VI. *From St. Mary's river to St. Joseph's bay, including the eastern and part of the western coast of Florida, and the Florida reefs and keys.*—This section is about one-fourth done, if we estimate by extent, and more if we take the importance of the work executed into consideration, and, if the present rate of appropriation is continued, can readily be finished in ten years. If not, it may be difficult to bring the work on the main coast to a close as early as the other sections. The character of that essential work, however, is so much changed by the line across the head of the peninsula, permitting the substitution of a small secondary triangulation, that it may come out earlier than I now suppose. Two or three years hence I can form a better estimate. The line across the peninsula can be done, at the present rate of appropriation, probably in two years.

SECTION VII. *From St. Joseph's bay to Mobile bay, including part of the coast of Florida and Alabama.*—This was the last section commenced, and it is perhaps between one-sixth and one-fifth done. It will require additional force to push it through in ten to twelve years. This may probably be had, as the Atlantic sections require fewer parties to bring them to a close; but I cannot foresee positively yet. Good progress has been made since we commenced this work in 1852; and there are three centres of operation—near Pensacola, near Apalachicola and St. Mark's, and near Cedar keys. If we had means to employ a steam vessel here throughout the season, there would be no doubt of the completion of this section with the others. The topography and hydrography are simple in their character generally.

SECTION VIII. *From Mobile bay to Vermilion bay, including the coast of Mississippi and part of Louisiana.*—This was the first commenced on the Gulf, and is between one-third and one-half done. There are two centres of operation; and with the present means, there can be no difficulty in essentially completing the work within ten years. To do this, the parties must, however, be kept steadily at work in the section, and cannot be spared for work in those adjacent.

SECTION IX. *From Vermilion bay to the southwestern boundary, including part of the coast of Louisiana and coast of Texas.*—This section was commenced soon after Section VIII, and the coast has less of detail work needed than any other on the Gulf. It is now more than one-third done, and can readily be finished with the present force in ten years. A less force, however, will not accomplish it; and, indeed, there may be a new centre of operations necessary at the northern end of the section, requiring additional means to be furnished. These sections on the Gulf are very expensive, compared with those on the Atlantic, in regard to the subsistence of parties and the means of transportation; and the fact must be considered in estimating for them from data derived chiefly from the Atlantic sections. Taking all the operations into consideration, the Gulf sections are nearly one-third done, and can, at the present rate of appropriation, be completed in from ten to twelve years by close economy and thorough efficiency of arrangement. Nothing less will do.

GENERAL STATEMENT OF PROGRESS.

A reference to the map, (Sketch No. 64,) which shows the sheets projected for preliminary and general coast charts of the United States, will enable me to describe intelligibly the present condition of progress on the Atlantic and Gulf coast, and to show the limits of the geographical sections, and give an estimate of progress connected with each.

The work is certainly more than half done on the Atlantic and Gulf coast, and the appropriations now made, secure every year a much more considerable rate of progress than in the average of the past years. Notwithstanding the increased cost of supplies of every kind, the rate of progress has been more than kept up in proportion to the means expended. When the survey was upon a small scale very little division of labor was practicable, and the change of the parties from north to south, according to season, could not be made to advantage.

If the plan now in successful operation for several years is carried out without interruption, the essential completion of the Atlantic and Gulf work within the time already named (ten to twelve years) is almost certain. This is, of course, more to the interest of commerce and navigation and of the government than to that of the persons engaged in the work. The credit of taking part in a great work successfully completed will, however, if I understand their spirit, more than repay them for the more short-lived character of their positions. Up to this time I have always had the most cordial support of the officers of the survey in the extension of the work, though obviously diminishing by many years the duration of the work.

Fifty-three base lines, ten principal, and forty-three preliminary, have been measured on different parts of the coast. Upon these rests the triangulation which is now continuous from Mount Desert, in Maine, to Shallotte inlet, south of Cape Fear, in North Carolina; stretching over more than ten degrees of latitude, and as many of longitude, including the coast of ten States and the greater part of the coast of two others. Then, with an interval of about seventy miles, it extends along the coast of South Carolina and Georgia with two gaps, which this season will fill, to Ossabaw entrance. It covers, on the coast of Georgia, Sapelo entrance, and St. Simon's and Brunswick harbor; St. Mary's, Georgia; and Fernandina harbor, and St. John's river, Florida. It is continuous from Virginia key, Cape Florida, to the Marquesas, west of Key West, completing the connexion of the outer keys and reefs of south Florida. On the western coast of Florida it extends from Crystal river to beyond Cedar keys; over Ocilla river entrance; St. Mark's harbor; from East Pass through St. George's and St. Vincent's sounds, including Apalachicola harbor; St. Andrew's bay and Pensacola harbor and approaches. On the coast of Alabama and Mississippi, it crosses Mobile bay and the approaches; Mississippi sound and part of Lake Pontchartrain, connecting Mobile and

New Orleans. On the coast of Louisiana, Chandeleur sound to Isle au Breton sound; Isle Dernière and Caillou bay; Atchafalaya and part of Côte Blanche bays. On the coast of Texas, Galveston entrance and East and West bays, and the coast to include Matagorda bay, and the entrance to the Rio Grande. On the coast of California, the main triangulation is complete from north of Sonoma mountain to south of Monterey bay, and the secondary triangulation connected with this along the coast line is nearly completed. Secondary triangulation has been made at San Diego; near San Pedro; along the Santa Barbara coast, and on the Santa Barbara islands; in San Francisco, San Pablo, Suisun, Ballenas, Drake's, and Tomales bays. The river entrances of the coast of Oregon have been surveyed, and Columbia river triangulated to Astoria. On the coast of Washington Territory, Shoalwater bay, Washington sound, Admiralty inlet, and parts of Puget's Sound and Hood's canal have been triangulated.

Where the main triangulation did not afford the requisite facilities for progress, preliminary triangulations have been executed in advance of them, to serve as a basis for the detailed work, and to be verified in turn.

The topography, giving the coast-line and so much of the shores as may be essential to recognition by the mariner, and to give the nearest land communication, has been kept generally within one season of the triangulation. The hydrography has followed closely in turn. The in-shore hydrography is nearly continuous along the coast from Cape Neddick, in Maine, to Ocracoke, in North Carolina, with gaps, which two or three seasons will probably fill. Kennebec entrance and part of Casco bay, in Maine, are, besides, done. The difficult off-shore work towards George's bank has made good progress, and the broken ground of the Nantucket shoals has been completely sounded. The hydrography of the coast of North Carolina is in vigorous progress, being complete from Hatteras to Portsmouth, beyond Ocracoke; from Cape Lookout to south of Beaufort, and at Cape Fear and approaches. The in-shore work on the coast of South Carolina is nearly complete; Winyah bay and Georgetown harbor are done, and the soundings are complete from Winyah bay to Tybee entrance. On the coast of Georgia, Tybee entrance and Savannah river, to the head of Argyle island, are finished; also St. Simon's entrance, Turtle river, and Brunswick harbor, to the north end of Blythe island, and St. Mary's entrance. Reconnaissances have been made of St. Andrew's sound and Doboy entrance. On the coast of Florida, Fernandina harbor is completely surveyed, and St. John's entrance and river, to Jacksonville. The hydrography of the Florida reef is complete from near Cape Florida to Rodriguez bank, and from Loggerhead key to the Marquesas, and Key Biscayne bay has been sounded out. There is a reconnaissance of Tampa bay. The hydrography is complete from Waccasassa point to Cedar keys, inclusive; of Ocilla river entrance; of St. Mark's harbor; St. Andrew's bay, and Pensacola entrance and harbor. The hydrography is complete of Mobile bay, Mississippi sound, and coast outside of the chain of islands, and westward into Lake Borgne, and of part of Chandeleur sound.

Much off-shore hydrography has been done in connexion with this in-shore work, and both classes of hydrography keep close upon the triangulation and topography. There is a reconnaissance of the passes of the Mississippi. The hydrography of part of Caillou bay, behind Isle Dernière, is complete, and that of Atchafalaya bay is in progress. Galveston bay and entrance are complete, and East and West bays in part finished. The in-shore work of the coast of Texas is nearly done between Galveston and Matagorda entrances. There is a reconnaissance of Aransas pass, and a survey of the Rio Grande entrance.

On the Western Coast, San Diego bay and harbor, Cortez bank, San Clemente anchorage, Santa Catalina harbor; the coast of Santa Barbara channel, between Point Duma and San Buenaventura; Prisoners' harbor, Cuyler's harbor, Santa Barbara, San Luis Obispo, Coxo, and Monterey harbors; San Pedro, San Francisco, San Pablo, and Suisun bays, and Mare Island strait, have been sounded out. Ballenas and Drake's bays; Haven's anchorage, Mendocino City harbor, Shelter cove, Humboldt harbor, and Trinidad bay, Crescent city and Ewing harbors, Umpquah river, Columbia river entrance, Shoalwater bay, Gray's harbor; Neè-ah harbor, New Dungeness, and False Dungeness, in the Strait of Fuca; Canal de Haro and Rosario strait and approaches; Blakely harbor; and in Admiralty inlet, Puget's sound, and Hood's canal; Port Townshend, Port Ludlow, Port Gamble, Olympia and Steilacoom harbors, and Bellingham bay, have been surveyed in a preliminary way, and charts have been published.

The field work is now so far done that it is easy to see that a few years more must bring it to a close on the Atlantic and Gulf coasts, if a steady progress at the present rate is secured by the usual appropriations.

It is much more easy now, upon the Atlantic coast, to state what remains to be done than what has been done. Filling up a gap of seventy miles on the coast of Maine, of seventy miles on the coast of North and South Carolina, of seventy-five miles on the coast of Georgia, and of three hundred and forty miles on the coast of Florida, would give a continuous triangulation, either main or secondary, from Quoddy Head to Cape Florida.

The time of completion of the work is merely a question of the means furnished, for we have now, not only trained officers steadily, actively, and intelligently working in their several spheres of duty, but many in inferior grades who are quite ripe for higher occupations. The survey is essentially a temporary work, and its whole organization is adapted to that idea. It has thus the advantage of adapting the number and qualities of its employees to the amount and kind of work, and is able to recognize the principle of promotion by merit, for which the quantity and quality of the work furnish a mathematical basis.

The resources being applied from year to year to the varying state of relative progress in the different operations, the progress for a given extent of coast is determined by the scale of appropriation.

A comparison of the relative progress, in the earlier stages of the work, showed clearly that it was more economical to conduct it upon a large scale than upon a small one. The division of labor, and facilities for working on different parts of the coast during different seasons of the year, produce the chief part of this economy. The sooner the facilities of a survey can be presented to a growing commerce and navigation the better. The extent of the coast being determined, economy and utility both indicate that the appropriations should be such as to push the work vigorously to completion.

A recent reinvestigation of the question of economy has shown me that for an increase, in 1855, of appropriation, from the average of 1844 to 1849, of two and three-tenths, the work done in the field is two and six-tenths, and in the office upwards of three, showing the economy of the larger scale as amounting to some eighteen per cent.

The charts have kept pace with the field work, preliminary ones being published for each year's work, in advance of the elaborate finished maps. The principal dangerous localities on the coast have been surveyed, and charts published in advance of connected work; thus, of the Nantucket and Monomoy shoals, Hatteras shoals, the Frying Pan and Cape Fear shoals, Cape

Roman shoals, Canaveral shoals, and others. The same course has been taken in regard to localities affording facilities for commerce and navigation, and nearly half the harbors and most of the important inlets of the coast have been surveyed, and charts of them have been published. Every season, as the hydrographic work comes in, a preliminary chart is drawn and engraved, and the engraved plate is added to, year by year, by the electrotype process. This is done according to a project determined beforehand, as early as the limits of the coast are known with sufficient precision.

Charts of two hundred and thirty-five harbors, inlets, shoals, sounds, bays, and portions of the coast and rivers, have been drawn, engraved, and published. The number of maps, charts, and sketches drawn within the year, or now in progress, (as will be seen by reference to Appendix No. 22,) is ninety-five; and the number engraved, or yet in hand, is eighty-four. Of these, twenty-nine are first class maps, twenty-six are preliminary charts, and twenty nine are sketches and diagrams.

The list of published maps, charts, and sketches, (Appendix No. 22,) shows that one hundred and forty-eight sheets may be had of the general disbursing agent of the Coast Survey, and of local agents in the principal marts of commerce. Within the year seventy sheets have been published, including those with the report of 1856. The number of copies distributed under the act of Congress and regulation of the Treasury Department within the year is nineteen thousand seven hundred and ninety-five.

PROGRESS DURING THE YEAR 1856-'57.

The general distribution of the parties, and the progress made by each one, is stated in tabular form in Appendix No. 1. By the help of the map of the coast, (Sketch No. 64,) this progress of the work in the field and afloat can be minutely followed by referring to the table. This progress to November 1, 1857, may be briefly stated as follows:

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.—(Sketches Nos. 1 and 2.)*—A base of verification of between five and six miles in length has been measured on Epping Plains, Washington county, Maine, and the ends have been permanently marked. Astronomical and magnetic stations have been occupied at Bangor and Calais, Maine, at which telegraphic differences of longitude by the American method, latitude, and the magnetic elements, have been determined. The astronomical station at Bangor has been finally connected with the primary triangulation in the vicinity. The secondary triangulation has been extended eastward on the Sheepscot river to Wiscasset, over Townsend and Linican bays, including the Damiscove islands, near the entrance of Kennebec river. The topography of the shores of the Kennebec has been extended northward to include Bath, and of those of Casco bay from Cape Small Point towards Harpswell, and from the mouth of Yarmouth river to join with work in the vicinity of Portland. The shores of most of the islands in Casco bay have been surveyed. The topography of the shores of Plymouth harbor, extending northward from Back river, near Duxbury, has been completed. Revision work has been done near Provincetown, Massachusetts. The hydrography of the Kennebec river has been carried northward to the upper limits of Bath; that of the eastern end of Casco bay has been executed between Cape Small Point and the meridian of Ragged island. The off-shore work between the coast of Massachusetts and George's bank and beyond George's has made good progress, as also the in-shore soundings north of Cape Ann towards Portsmouth, N. H. Additional hydrography has been executed in Martha's Vineyard sound. The tidal observations at Boston navy yard have been continued, and the currents have been specially investigated in Nantucket and Martha's Vineyard sounds.

The following maps and charts have been drawn this year: Kennebec river entrance, scale $\frac{1}{30000}$; Annis Squam and Ipswich harbors, $\frac{1}{20000}$; seacoast of Massachusetts, from Scituate to Saughkonnet river, R. I., $\frac{1}{200000}$; Provincetown harbor, $\frac{1}{50000}$; Eastern Series, Nos. 2 and 3, $\frac{1}{80000}$; Monomoy shoals, (additions,) $\frac{1}{0000}$; and harbor of Wood's Hole, Mass., $\frac{1}{20000}$. The following drawings are in progress: Seacoast from Cape Neddick to Scituate harbor, $\frac{1}{200000}$; coast chart from Portsmouth to Cape Ann, $\frac{1}{80000}$; from Cape Ann to Scituate, $\frac{1}{80000}$; from Scituate to Nausett, $\frac{1}{0000}$; and the general coast chart from Cape Ann to Point Judith. The engraving has been completed during the year of: Seacoast of Massachusetts, No. 1, as preliminary; Plymouth harbor; Boston harbor, (new edition;) and Monomoy Shoals, (additions;) and progress has been made on the plates of: Seacoast of Massachusetts, as a finished map; Ipswich and Annis Squam harbors; Muskeget channel; and Eastern Series, Nos. 1 and 2.

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.—(Sketches No.* 11–15.*)*—Some additional triangulation in New York harbor has been done; the triangulation of Hudson river has been extended from Poughkeepsie northward to above Roundout. The topography of the islands in New York harbor, of the shores of New Jersey, opposite New York, from Bergen Neck to Guttenberg, and of the shores from Throg's Neck to Harlem river, has been executed. Some hydrography of revision has been executed near New York, and the soundings of the Hudson river have been extended above Newburgh. This work was generally in prosecution of the regular operations of the section, the aid from the New York commissioners having ceased in April. Tidal observations have been continued at New York, and the tides and currents at Hell Gate have been further investigated. Drawings have been completed of a comparative chart of the Hudson river from Albany to New Baltimore, 1852–'53–'56, $\frac{1}{20000}$; and of Long Island Sound, No. 3, south side, $\frac{1}{80000}$; New York bay and harbor, $\frac{1}{80000}$; and Hudson river, from the entrance to Sing Sing, have been in progress in the Drawing Division. The engraving of the following plates has been completed during the year: South side of Long Island, No. 2; middle and south side of Long Island, No. 3; and the engraving of New York harbor, $\frac{1}{80000}$, (new edition,) is now in progress.

SECTION III. *Coast of Delaware, Maryland, and part of Virginia.—(Sketches Nos.* 16–25.*)*—The triangulation of the Patuxent river has been extended from Setterley Point upwards to Benedict; that of York river, Virginia, has been completed to the junction of the Mattaponi and Pamunkey rivers, at West Point; that of the Curratoman has been completed; and that of James river has been extended nearly to Newport News. The triangulation of Potomac river has been commenced. The topography of the seacoast of Virginia near Wallop's island, has been executed, and the plane table work on the shores of the Rappahannock has been carried downwards to Parrott's island, including also the shores of the tributaries near the mouth of the river. The shore-line of both sides of York river has been traced nearly to West Point. The hydrography of the Rappahannock has been completed; York river has been sounded out from its mouth to West Point. The hydrography of St. Mary's river, Maryland, and of James river from the mouth of the Chickahominy to City Point has been completed, and progress has been made in the hydrography of Patuxent river. The tidal observations at Old Point Comfort have been continued.

Two sheets of the Rappahannock river, $\frac{1}{20000}$, from Fredericksburg to Port Royal, have been drawn, as also the charts of Hampton Roads, $\frac{1}{40000}$; and Norfolk harbor, $\frac{1}{10000}$. The following drawings are in progress: Chesapeake bay, series Nos. 3, 4, 5, and 6, $\frac{1}{80000}$; York river entrance, $\frac{1}{60000}$, and James river, $\frac{1}{40000}$, from Richmond to City Point. The engraving of Patapsco river, Rappahannock river from Fredericksburg to Port Royal, and thence to Occupacia creek, as preliminary, has been completed, and that of Patapsco river as a finished map, Chesapeake bay, $\frac{1}{80000}$, Nos. 1, 2, and 3; Rappahannock river, Nos. 3 and 4 as finished; York river entrance and Hampton Roads are now in progress.

SECTION IV. *Coast of Virginia and of part of North Carolina.—(Sketches Nos.* 25—29.)—The triangulation from Currituck sound has been connected with Cape Henry light-house. The small triangulation of the ocean shore is connected with that of the Cape Fear, being executed from Topsail Inlet southward. Topography connected with these two triangulations has been executed. In-shore soundings were carried from Cape Lookout twenty miles southward along the coast, and Beaufort bar has been resurveyed. The hydrography of Hatteras and Ocracoke Inlets and their approaches, and of part of Pamplico sound has been executed, and the Cape Fear bar and channels re-examined. The following drawings have been completed: Beaufort harbor entrance, $\frac{1}{20000}$; Cape Fear entrances, (additions to lower sheet,) $\frac{1}{30000}$; Cape Fear entrances, (comparative chart,) $\frac{1}{20000}$; and the finished map of Albemarle sound, No. 1, $\frac{1}{80000}$, has been in progress. The engraving of Cape Fear river from Federal Point to Wilmington, and seacoast of North Carolina, from Hatteras to Ocracoke, has been completed; and that of the following plates is in progress: Cape Fear entrances, Albemarle sound, Nos. 1 and 2, $\frac{1}{80000}$, and chart of Beaufort harbor, (new edition.)

SECTION V. *Coast of part of North Carolina and of South Carolina and Georgia.—(Sketches Nos.* 31—37.)—The secondary triangulation has been carried from Lockwood's Folly to Shallotte Inlet, on the coast of North Carolina; on that of South Carolina, Winyah bay has been connected with Charleston, and the connection of St. Helena sound with Tybee entrance is nearly completed. The triangulation of the coast of Georgia has been extended southward from the Savannah river over Wassaw and Ossabaw sounds, and up the Ogeechee river. The topography connected with the triangulation described in North Carolina has been executed. The wharf lines at Charleston have been resurveyed. Wadmelaw island, the lower part of Dawho river, parts of the Pon Pon and South Edisto rivers, and of Fenwick's, Pine, and other islands in the vicinity, and the shores of the Ashepoo river, and part of St. Helena sound have been completed. The topography of Sapelo entrance and river, on the coast of Georgia, to Sutherland's Bluff, and of Turtle river and Blythe island, of St. Mary's river and approaches, and of part of Cumberland island, has been completed. Surveys of the proposed sites for bases on Cumberland and Sapelo islands have been made. Astronomical and magnetic observations have been made at Savannah—the former for the determination of the longitude of Fernandina. The in-shore hydrography has been carried from Cape Roman to Charleston, and off-shore soundings have been made and the currents observed off the same coast. Maffitt's channel has been re-examined. Supplementary hydrography has been executed at St. Simon's entrance, Georgia, and in Brunswick harbor and Turtle river. Tidal observations with the self-registering gauge have been continued at Charleston. Drawings have been made of the charts of St. Mary's bar and Fernandina harbor, $\frac{1}{20000}$; a comparative chart of the same, 1843 and 1857, $\frac{1}{20000}$; St. Simon's sound and Brunswick harbor, $\frac{1}{40000}$; additions have been made to the chart of Charleston harbor, $\frac{1}{30000}$; to that of Maffitt's channel, $\frac{1}{30000}$; and to North

Edisto river, $\frac{1}{50000}$. The charts of St. Helena sound, $\frac{1}{40000}$, and seacoast of South Carolina, from Cape Roman to Tybee, Georgia, $\frac{1}{200000}$, are in progress. The engraving has been completed of the following charts: Charleston harbor, (additions,) Maffitt's channel, (comparative chart,) North Edisto entrance, (new edition,) and St. Mary's bar and Fernandina harbor, (comparative chart.) A new progress sketch has been engraved for the section, and the engraving of the seacoast of South Carolina, from Cape Roman to Savannah, is now in progress.

GULF STREAM.—Incidental observations have been made off Nantucket, and along the axis of the stream from the Tortugas to Chesapeake entrance; and also in the inner warm band from south of Cape Cañaveral to near Cape Fear. Additions have been drawn and engraved for the Gulf Stream chart, $\frac{1}{5000000}$.

SECTION VI.—*Coast, reefs, and keys of Florida.—(Sketches No.* 39 *and* 40.*)*—The longitude of Fernandina has been determined by chronometer differences from Savannah. The line across the Florida peninsula, from Fernandina to Cedar keys, has been explored and found practicable for a connecting triangulation; the opening of lines has been begun, and some progress made in observing the angles. This triangulation connects the work on the Atlantic and Gulf of Mexico. The secondary triangulation of the Florida keys and reefs has been completed by a junction between the two series—one proceeding eastward from the Stirrup keys to Lower Matecumbe, and the other southward and westward from Point Charles to the same line. The topography of part of Cumberland sound and St. Mary's river, of Fernandina harbor and its approaches and connections has been completed. The outer shore line of Key Largo, and of Upper and Lower Matecumbe, and Lignum Vitæ keys has been traced, and the markings into quarter sections made for the Land Office. The topography and marking for the Land Office of the Stirrup keys, Burnt key, Raccoon key, the Water keys, and others north of the Pine islands, of Big Pine key, the Torch keys, New Found Harbor keys, and others in the vicinity, and of Cape Sable prairie and its vicinity, have been executed. The hydrography of St. Mary's entrance and approaches has been completed. The St. John's bar has been resurveyed. The hydrography of the Florida reefs has been carried eastward from East Bahia Honda beyond Loggerhead key. Tidal observations have been made at Cape Florida, Indian key, Key West, and Tortugas, with self-registering gauges. A section of the Florida channel, from Key West to Havana, has been sounded. A drawing of St. John's river, $\frac{1}{25000}$, from Brown's creek to Jacksonville has been made, and charts of the Florida reef, $\frac{1}{200000}$ and $\frac{1}{80000}$, have been in progress. The engraving of St. John's river, No. 1, from the entrance to Brown's creek, and No. 2, from Brown's creek to Jacksonville as preliminary has been completed; and the preliminary chart of Florida reefs and St. John's river, No. 2, as finished, are now in progress.

SECTION VII. *Part of the western coast of Florida.—(Sketches No.* 44—45.*)*—The triangulation of the peninsula of Florida has been carried eastward from Waccasassa river to Crystal river; that of St. George's sound, Apalachicola bay, and St. Vincent's sound has been completed from Dog island westward to Indian pass. A preliminary base has been measured with rods at Cedar keys. The triangulation of Escambia bay from Red bluff to Garçon point has been extended towards Warrington on Pensacola bay. Topography, in connection with the Florida peninsula triangulation, has been executed; that of St. George's island and sound, including the vicinity of Apalachicola, has been completed. The hydrography of Waccasassa bay has been continued, and that of Pensacola entrance and approaches completed.

The following drawings have been made: Waccasassa bay, $\frac{1}{50000}$; St. Mark's river, $\frac{1}{30000}$; and additions have been made to the chart of St. Andrew's bay, $\frac{1}{40000}$. The engraving of

Apalachicola river is in progress, and a new progress sketch of the section has been drawn and engraved.

SECTION VIII. *Coast of Alabama, Mississippi, and part of Louisiana.—(Sketches No.* 47—51.)—Telegraphic differences of longitude have been determined between Montgomery, Alabama, Lower Peach Tree, and Mobile, for the connection of Washington and New Orleans. The latitude and magnetic elements at those stations have been determined. Azimuth observations have been made at East Pascagoula, and magnetic observations at Barrel key on Chandeleur sound. The secondary triangulation has been extended southward from Cat island over Chandeleur sound. A preliminary base site has been selected for the triangulation of Mississippi delta, and the last named work is begun. A preliminary base has been measured at Point au Chevreuil and the triangulation from Atchafalaya has been advanced into Côte Blanche bay. Topography has been executed in connection with these several triangulations, and also in the southwestern part of Lake Borgne. The hydrography of Mississippi sound has been completed, and that of Chandeleur sound has been commenced. Lines of deep sea soundings have been run from Pensacola to the Chandeleur islands, thence to the mouth of the Mississippi, and thence to the Tortugas. Drawings have been made within the year of Mississippi City harbor, $\frac{1}{40000}$; St. Louis bay, $\frac{1}{30000}$; Grand Island pass and Pearl river entrance, $\frac{1}{40000}$; and sketches have been made showing lines of deep sea soundings in the Gulf of Mexico. The drawing of the coast chart of Mississippi sound, $\frac{1}{80000}$, from Round island to Grand island; and preliminary coast chart, $\frac{1}{200000}$, from Cat island to Lake Pontchartrain is now in progress. The engraving of the following plates has been completed: Sea coast of part of Alabama and Mississippi; profiles of deep sea soundings in the Gulf of Mexico, and sketches to illustrate the phenomena of winds and tides. Plates for the charts of Mississippi sound, $\frac{1}{80000}$, Nos. 1 and 2, and Biloxi bay, as a finished map, are in progress.

SECTION IX. *Coast of part of Louisiana and coast of Texas.—(Sketches No.* 53—54.)—The triangulation has been completed of Matagorda and Lavacca bays, and a reconnaissance pushed ahead of the work southward to Aransas. The topography in connection with this has been finished in Matagorda bay, and nearly completed in its dependencies. Soundings have been made at the bar and entrance of Matagorda bay, and a deep sea line run, extending fifty miles from the entrance.

The drawing of a finished map of Galveston bay, $\frac{1}{80000}$, and preliminary chart of the coast of Texas from Galveston, southward, has been in progress. A chart within the same limits, and one of the entrance to Galveston bay, $\frac{1}{40000}$, have been engraved during the year.

SECTION X. *Coast of California.—(Sketches Nos.* 56—61.)—Astronomical and magnetic observations have been made at Rincon Point, near San Francisco, and on Tomales bay. The primary triangulation has been extended northward from San Francisco bay, and the secondary from Point Reyes, northward, to Bodega bay, and including Tomales bay. A tertiary triangulation has been made on the eastern side of San Francisco bay, from Contra Costa station to Red hill. The positions of the new light-house and others in San Francisco entrance have been determined. The triangulation of the shores of Santa Barbara channel has been extended westward from San Fernando nearly to Santa Clara river, and that of Santa Cruz and San Nicolas islands has been completed. San Francisco city has been resurveyed. The topography of the main shores of San Francisco bay has been completed. A plane table reconnaissance has been made of Petaluma and Napa creeks, from their entrances in San Francisco bay to the head of navigation. The topography of the main of Santa Barbara channel has been extended from Point Conversion, eastward, to Point Duma.

The hydrography of the eastern entrance to Santa Barbara channel, and of Monterey bay, between Santa Cruz harbor and Point Pinos, has been completed. In-shore soundings were made along the coast between Point Año Nuevo and Point Miramontes, and the hydrography of San Francisco bay and Karquines Strait was completed. The shore of Santa Barbara channel has been re-examined for a light-house site. Tidal observations have been kept up at the permanent stations, San Diego and San Francisco. The following maps and charts have been drawn during the season: Cortez Bank, $\frac{1}{80000}$; San Clemente anchorage, $\frac{1}{20000}$; eastern entrance to Santa Barbara channel, $\frac{1}{80000}$; San Diego bay, $\frac{1}{40000}$; San Francisco entrance, $\frac{1}{400000}$; San Antonio creek, $\frac{1}{20000}$; and Mare Island strait, $\frac{1}{30000}$. The drawing of the finished maps of Monterey bay, $\frac{1}{60000}$; San Francisco bay, $\frac{1}{80000}$; and San Pablo bay, $\frac{1}{60000}$, is now in progress. The following plates have been completed: Entrance to San Francisco bay, as preliminary, and vicinity of Anacapa and part of Santa Cruz island. The engraving of entrance to San Francisco bay, as finished; San Diego bay; eastern entrance to Santa Barbara channel; San Antonio creek; and San Pablo bay, is in progress.

SECTION XI. *Coast of Oregon and Washington Territories.—(Sketch No.* 63.)—The triangulation has been extended into the southern part of Admiralty inlet from Bainbridge island, and signals erected to continue the work into Puget's Sound. A general reconnaissance has been made and the triangulation begun in Port Orchard. Transit observations were made within the season at Point Pully, W. T. Topography has been executed at the entrance of Hood's canal, and on the shores of Admiralty inlet, in the vicinity of Point No Point. The hydrography of Semiahmoo harbor, W. T., has been executed. The self-registering tide-gauge at Astoria has been kept in operation. Drawings have been made of Port Townshend base; Apple Cove, $\frac{1}{20000}$; and of a new progress sketch of the section. The engraving of Shoalwater bay, (additions;) New Dungeness harbor; Port Ludlow; Port Gamble; Olympia harbor; Steilacoom harbor; Bellingham bay; and Blakely harbor, has been completed within the present surveying year.

The following list contains the titles of maps, preliminary charts, and sketches accompanying this report, arranged in geographical order. Letters for reference stand in the margin to distinguish the several sections—A corresponding to Section I, B to Section II, and so on. The miscellaneous diagrams are placed at the end, and numbers on the maps and sketches themselves correspond with those attached to the list given at the end of this report.

1.—A. Progress sketch, Section I, (primary triangulation.)
2.—A *bis*. Progress sketch, Section I, (topography and hydrography.)
3.— Epping base, (profiles and cross sections.)
4.— Kennebec river entrance.
5.— Seacoast of Maine, New Hampshire, and part of Massachusetts.
6.— Annis Squam and Ipswich harbors.
7.— Boston harbor.
8.— Seacoast of southern part of Massachusetts.
9.— Provincetown harbor.
10.— Harbor of Wood's Hole.
11.—B. Progress sketch, Section II.
12.— South side of Long Island, (middle sheet.)

13.— South side of Long Island, (eastern sheet.)
14.— New York bay and harbor, (preliminary chart.)
15.— New York bay and harbor, (comparative chart.)
16.—C. Progress sketch, Section III.
17.— Chesapeake bay, Sheet No. 4.
18.— Chesapeake bay, Sheet No. 5.
19.— Chesapeake bay, Sheet No. 6.
20.— Rappahannock river from entrance to Punch Bowl.
21.— Rappahannock river from Punch Bowl to Occupation creek.
22.— York river entrance, Virginia.
23.— Hampton Roads and Elizabeth river.
24.— Norfolk harbor.
25.—D. Progress sketch, Section IV.
26.— Seacoast of North Carolina from Cape Hatteras to Ocracoke inlet. } On one plate.
27.— Seacoast of North Carolina from Cape Lookout to Bogue inlet, N. C. }
28.— Hatteras and Ocracoke inlets, North Carolina.
29.— Beaufort harbor, North Carolina.
30.— Beaufort harbor, (comparative chart.)
31.—E. Progress sketch, Section V.
32.— Entrances to Cape Fear river.
33.— Cape Fear entrances, (comparative chart.)
34.— Seacoast of South Carolina from Cape Roman to Savannah river.
35.— Bull's bay and Roman inlet, (harbors of refuge.)
36.— St. Helena sound.
37.— St. Simon's sound and Brunswick harbor.
38.— St. Mary's river and Fernandina harbor.
39.—F. Progress sketch, Section VI, upper part.
40.—F *bis.* Progress sketch, Section VI, Florida Keys.
41.— St. John's river entrance, (comparative chart.)
42.— Florida reefs, (preliminary chart.)
43.— Legaré anchorage, (additions and changes.)
44.—G. Progress sketch, Section VII.
45.— Apalachicola river entrance.
46.— Pensacola harbor entrance and approaches.
47.—H. Progress sketch, Section VIII.
48.— Mobile bay; $\frac{1}{80000}$.
49.— Seacoast of part of Alabama and Mississippi.
50.— Mississippi City harbor.
51.— St. Louis bay and Shieldsboro' harbor.
52.— Grand Island pass.
53.—I. Progress sketch, Section IX.
54.— Seacoast of Texas from Galveston to Matagorda.
55.— Entrance to Matagorda bay.
56.—J. Progress sketch, Section X, lower part.
57.—J *bis.* Progress sketch, Section X, upper part.

58.— San Diego bay.
59.— Eastern entrance to Santa Barbara channel.
60.— Monterey bay.
61.— Mare Island straits.
62.— San Antonio creek.
63.—K. Progress sketch, Section XI.
64.— Project limits for charts $\frac{1}{200000}$ and $\frac{1}{400000}$.
65.— Co-tidal lines, Atlantic coast, curves of equal height of tides, and sailing lines.
66.— Winds of the western coast, (diagram.)
67.— Diagrams illustrating chronometric results for longitude between Savannah, Georgia, and Fernandina, Florida.
68.— Diagrams illustrating loss of magnetism.
69.— Apparatus for measuring preliminary base lines.
70.— Sands' specimen tube for deep-sea bottoms; Massey's indicator; and Burt's sounding nipper.
71.— Modification of Brooks' sounding apparatus.
72.— Trenchard's and Mitchell's tide gauges.

ESTIMATES.

In my report of last year I remark: "As the prices of all commodities and of labor increase in our country, the amount of work which we can execute for a given appropriation is, of course, diminished. The present scale of the appropriations does not quite meet this increase, and may fall so far short of it as to require a new appeal in regard to it. This I shall, of course, avoid, if it is at all possible. The expenses of the parties in the sections on the Gulf of Mexico are also considerably greater than on the Atlantic coast."

In accordance with the spirit of those remarks, I prepared (October 19, 1857) the annual estimates, to be presented for the examination of the Secretary of the Treasury, with the usual explanatory letter which I now embody here, omitting only the general statement of progress of the work, already given in this report:

"The estimates provide for the scale of progress heretofore approved by the Treasury Department and by Congress. The items are the same as for the last two years, with two exceptions. The estimate needed for fuel and quarters, and for transportation for officers of the army serving on the work, in consequence of a surplus from the former estimates, is less than heretofore; and the withdrawal of the naval engineers, hitherto detailed for the Coast Survey steamers, requires an estimate for the pay of steam engineers.

"The progress upon which these estimates are based is stated under the head of the several sections of the Atlantic, Gulf, and Pacific coasts, and the sums estimated are the least which can insure the amount of work stated. They include, as usual, the office as well as field-work, and are intended to keep the former as near the latter as practicable."

"The past year has, owing to peculiar circumstances, not determined the question of insufficiency of the western coast appropriation, referred to in my last annual report, and I have therefore not advised an increase."

"The line across the Florida peninsula proves very practicable, and will be of great advantage to the survey, connecting the main triangulation of the Atlantic and Gulf of Mexico, and preventing the necessity of reliance upon the small triangulation across the Florida peninsula for such a purpose. As a measure of economy, it is also of great advantage. It is possible that the sum now asked may nearly or quite complete this work."

"Several of the older vessels of the survey require more thorough repairs than can be given from the current resources, and provision is made therefor by an item in the estimates."

"The estimates, which are hereto appended in detail, show the progress proposed to be secured by them during the fiscal year 1858–'59."

These estimates suppose the same aid from the War, Navy, and Interior Departments, as heretofore. Should any part of this be withheld, the proportionate progress must, of course, be less. The table shows, in parallel columns, the estimates for the next fiscal year, and the appropriation of the present year :

Object.	Fiscal year 1858-'59.	Fiscal year 1857-'58.
For survey of the Atlantic and Gulf coast of the United States, (including compensation to superintendent and assistants, and excluding pay and emoluments of officers of the army and navy, and petty officers and men of the navy employed on the work,) per act of March 3, 1843	*Estimated.* $250,000 00	*Appropriated.* $250,000 00
For continuing the survey of the Western Coast of the United States, per act of September 30, 1850	130,000 00	130,000 00
For continuing the survey of the Florida reefs and keys, (excluding pay and emoluments of officers of the army and navy, and petty officers and men of the navy employed on the work,) per act of March 3, 1849	40,000 00	40,000 00
For running a line to connect the triangulation on the Atlantic coast with that on the Gulf of Mexico, across the Florida peninsula, per act of March 3, 1843	15,000 00	15,000 00
For publishing the observations made in the progress of the survey of the coast of the United States, per act of March 3, 1843	15,000 00	15,000 00
For repairs of the Crawford, Madison, Mason, and George M. Bache, and other sailing schooners used in the survey, per act of March 2, 1853	15,000 00	15,000 00
For fuel and quarters, and for mileage or transportation for officers and enlisted soldiers of the army serving in the Coast Survey, in cases no longer provided for by the Quartermaster's Department, per act of August 31, 1852	5,000 00	10,000 00
For pay and rations of engineers for seven steamers used in the hydrography of the Coast Survey, no longer supplied by the Navy Department	*12,800 00	

* Included last year in estimates of the Navy Department.

The following estimates for the field and office work to be executed during the next fiscal year were presented to the department in my communication of October 19 :

ESTIMATES IN DETAIL FOR THE FISCAL YEAR 1858–'59.

For general expenses of all the sections, namely : rent ; fuel ; materials for drawing, engraving and printing, and ruling forms ; binding ; transportation of instruments, maps, and charts, and for miscellaneous office expenses ; and the purchase of new instruments, books, maps, and charts $19,000

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.* FIELD-WORK.—To continue the primary triangulation in *Maine*, east of *Mount Desert*, and to make the necessary observations for longitude, latitude, and azimuth, and magnetic observations ; and to connect the base on *Epping plains* with the triangulation ; to extend the secondary triangulation eastward from *Kennebec river;* to continue the topography of the eastern and western portions of *Casco bay*, that of *Kennebec river*, and of *Cape Cod bay* below *Manomet;* to continue the hydrography of *Casco bay*, and to extend that of the *Kennebec river* to above *Bath;* to continue the general hydrography of the coast of *New Hampshire* and southern portion of *Maine;* to continue the deep-sea work off the coast of *Massachusetts*, between it and *George's Bank*, and beyond *George's;* to continue observations of tides and currents in the section, completing those of *Nantucket sound*, and to take the views required for charts. OFFICE-WORK.—To make the computations required; to complete the drawing of coast charts from *Portsmouth* to *Cape Ann;* from *Cape Ann* to *Scituate;* and of the finished map of *Portland harbor;* to continue the coast chart from *Scituate* to *Nausett;* the general coast chart from *Cape Ann* to *Point Judith*, and seacoast chart of part of *Maine*, *New Hampshire*, and *Massachusetts;* to draw the finished map of *Kennebec river* and the sketches of the section; to commence the engraving of *Provincetown harbor;* eastern series No. 3, and the general coast chart No. 2; to continue that of *Portland harbor* and eastern series No. 2; to complete that of the seacoast of *New Hampshire* and part of *Massachusetts;* eastern series No. 1, and harbor of *Wood's Hole;* and to engrave the preliminary sketches of the section, will require........................ $41,000

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and Delaware.* FIELD-WORK.—To continue the triangulation, topography, and hydrography of *Hudson river*, and the topography and hydrography near *New York harbor and bay;* to execute work of verification in the section; and to continue the observations of tides and currents. OFFICE-WORK.—To make the necessary reductions and computations; to commence the drawing on $\frac{1}{80000}$ of a coast chart from *Sandy Hook* to *Cape May;* to continue the drawing of *New York bay and harbor*, and the lower sheet of *Hudson river;* and to complete the drawings of sketches of the section; to commence the engraving of *New York harbor*, $\frac{1}{80000}$, new edition; to complete that of *Hudson river*, lower sheet; and to engrave the preliminary sketches of the section, will require.................................... 8,000

SECTION III. *Coast of Delaware, Maryland and Virginia.* FIELD-WORK.—To continue the astronomical and magnetic observations required in the section; to complete the triangulation of the *Patuxent river*, and to continue that of the *Potomac;* to continue the topography of the *York* and *James rivers*, and to commence that of the *Potomac river;* to continue that of the outer coast of *Maryland* and *Virginia*, and to complete that of the shores of *Chesapeake bay;* to continue the off-shore hydrography of the section, and execute the soundings in *Patuxent river;* to complete the hydrography of *James river*, and commence that of the *Potomac*, and to continue the tidal observations in the section. OFFICE-WORK.—To make computations required by the field-work; to commence the drawing of the coast chart from *Cape Henlopen* to *Little Machipongo Inlet*, and maps of the *Patuxent*, *St. Mary's*, and *James river entrance;* to continue the *Chesapeake bay series*, Nos. 3, 4, 5, and 6; to complete the upper sheet of *James river;* sheets Nos. 3, 4, 5, and 6 of *Rappahannock river*, and the sketches of the section; to commence the engraving of *Chesapeake bay*, Nos. 4, 5, and 6, and *Rappahannock river*, Nos. 5 and 6; to continue that of *Chesapeake bay*, Nos. 2 and 3; and to complete *Chesapeake bay*, No. 1, and *Hampton Roads*, and engrave the preliminary sketches of the section, will require.. 25,000

SECTION IV. *Coast of Virginia and North Carolina.* FIELD-WORK.—To make astronomical and magnetic observations at *Cape Fear entrance;* to continue the triangulation of *Pamplico sound*, and to measure bases of verification; to close the secondary triangulation between *Cape Hatteras* and *Cape Fear;* to complete the topography north of *Currituck sound* and south of *Stump inlet;* to continue the outer hydrography south of the line of *Virginia* and *North Carolina*, south of *Ocracoke*, and south of *Beaufort;* to continue observations of the tides and currents, and of the *Gulf Stream.* OFFICE-WORK.—To commence the drawing of a coast chart of the vicinity of *Cape Fear;* to continue the coast chart of *North Carolina* from *Cape Lookout to Cape Fear*, and from *Cape Hatteras to Cape Lookout;* to complete the drawing of *Albemarle sound* Nos. 1 and 2, and the sketches of the section; to complete the engraving of Albemarle sound Nos. 1 and 2, *Beaufort harbor*, new edition; seacoast of *North Carolina* from *Cape Lookout to Bogue inlet*, and to engrave the preliminary sketches of the section, will require...... $26,000

SECTION V. *Coast of North and South Carolina and Georgia.* FIELD-WORK.—To extend the triangulation in *North Carolina*, and topography connected with it, from near *Shallotte inlet* southward; the primary triangulation of the coast of *South Carolina* north and east of *Wando river* and *Long Island*, and the secondary triangulation up the rivers; to measure supplementary bases on the coast of *Georgia* or *South Carolina;* to continue the triangulation between *St. Simon's* and *Sapelo* rivers, and between *Sapelo* and *Ossabaw;* to commence the triangulation of *Doboy* and *Altamaha sounds* and approaches, and of the *Altamaha river;* to continue the topography connected with these triangulations; to continue the hydrography of *Broad river* and its tributaries, and the off-shore hydrography of the coast of *South Carolina;* to complete the hydrography of *Wassaw*, *Ossabaw*, and *St. Catharine's sounds* and their connections, and to commence that of *Doboy* and *Altamaha sounds;* to continue tidal observations and investigations of the *Gulf Stream* in this and the preceding sections. OFFICE-WORK.—To make the necessary computations; to continue the drawing of the coast chart of *South Carolina* in the vicinity of *Charleston;* to complete the chart of *St. Helena sound*, drawings of *Sapelo entrance*, *Wassaw*, and *Ossabaw inlets*, and the sketches of the section; to complete the engraving of seacoast of *South Carolina* from *Cape Roman to Savannah*, *Savannah river*, *St. Helena sound*, *St. Simon's bar*, and *Brunswick harbor*, and to engrave the preliminary sketches of the section, will require 36,000

SECTION VI. *Reefs, Keys, and Coast of Florida.*—(See estimates of appropriation for those special objects.)

SECTION VII. *Western Coast of Florida.* FIELD-WORK.—To continue the triangulation and topography southward from *Crystal river* and north from *Cedar Keys;* the triangulation eastward on *Appalachee bay* towards *St. Mark's*, and the topography eastward from *St. George's sound;* the triangulation and topography eastward in *East bay*, near *Pensacola;* to make the necessary astronomical and magnetic observations in the section; to continue the hydrography in connection with the triangulation and topography, and the deep-sea work of the *Gulf coast;* to make the necessary tidal and current observations. OFFICE-WORK.—To make the computations and reductions from field-work; to continue the drawing of a chart of *Pensacola harbor*, of *Apalachicola entrance* and approaches, to make additions to that of *Waccasassa bay*, and to the progress sketches of the section; to continue the engraving of the chart of *Pensacola harbor*, and of *St. George's sound* and entrances, and engrave the preliminary sketches of the section, will require.. $36,000

SECTION VIII. *Coast of Alabama, Mississippi, and Louisiana.* FIELD-WORK.—To complete the triangulation of *Chandeleur sound* and islands, and to continue that of *Isle au Breton sound;* to continue that of the *Mississippi delta*, and to extend it westward; to continue that of *Côte Blanche bay;* to continue the topography connected with these several triangulations; to continue determinations for longitude, and the astronomical and magnetic observations necessary in the section; to continue the hydrography of *Chandeleur sound* and *approaches*, of the *Mississippi passes*, and of *Atchafalaya bay* and approaches; to continue the deep-sea soundings off this section of the *Gulf coast.* OFFICE-WORK.—To make the reductions and computations; to commence a drawing of *Atchafalaya bay;* to continue the series of coast charts of *Mississippi sound* to the entrance of *Lake Pontchartrain*, the seacoast chart of *Mississippi* and part of *Louisiana*, and to draw the sketches of the section; to complete the engraving of *Mississippi sound* No. 1; seacoast of part of *Mississippi* and *Louisiana, St. Louis bay* and *Shieldsboro' harbor;* to continue that of *Mississippi sound* No. 2, and to commence No. 3, and engrave the preliminary sketches of the section, will require............. 33,000

SECTION IX. *Coast of part of Louisiana and Texas.* FIELD-WORK.—To complete the minute reconnaissance of the coast, and to extend the main and secondary triangulations from *Matagorda entrance* southward and westward; to complete the topography of *Matagorda bay* and its dependencies, and of the coast south of *Cavallo Pass;* to continue the in and off shore hydrography near *Matagorda bay*, and between *Galveston* and *Matagorda bays*, and to continue the requisite tidal observations. OFFICE-WORK.—To make the necessary computations; to commence the drawing of a coast chart of the vicinity of and including *Matagorda bay;* to complete that of the chart of *Galveston bay* and vicinity, coast chart from *Galveston to Matagorda*, and the sketches of the section; to continue the engraving of entrance to *Matagorda bay*; to complete that of the seacoast of *Texas* from *Galveston to Matagorda*, and to engrave the preliminary sketches of the section, will require.. 26,000

Total for the *Atlantic coast* and *Gulf of Mexico*, excluding estimates for the *Florida reefs and keys*, and for the *Western coast*................................ 250,000

The estimates for the *Florida reefs, keys and coast*, and for the *Western coast of the United States* are intended to provide for the following progress:

SECTION VI. *Reefs, keys, and coast of Florida.* FIELD-WORK.—To complete the connection of *Key Biscayne* and *Cape Sable* bases, and the triangulation of *Barnes' sound*, and the adjacent main; to commence the main triangulation, if practicable; to make the requisite astronomical observations at *Indian Key*, and to complete the triangulation of *Charlotte harbor* and *Oyster bay;* to complete the topography of the outer keys, and to continue that of the inner, and of the main and *Charlotte harbor* and its vicinity; to complete the hydrography of the *Florida reef*, and to commence the off-shore work; to make the requisite magnetic determinations, and to continue tidal observations in the section. OFFICE-WORK.—To continue the computations required; to make the drawing of a coast chart of the *Florida reefs*, from *Key Biscayne to Marquesas keys*, and additions to the seacoast chart within the same limits; to draw the sketches of the section; to continue the engraving of the preliminary chart of *Florida reefs*, to commence that of the finished charts of *Florida reefs*, and engrave the preliminary sketches of the section, will require $40,000

SECTION X. *Coast of California.* FIELD-WORK.—To continue the main triangulation of the coast of *California* from the limits of the previous year, westward and southward, and to execute the secondary and tertiary work of the coast on *Tomales* and *Drakes' bays*, south of *Monterey*, and in the dependencies of *San Francisco bay;* to continue, if practicable, the main triangulation of the *Santa Barbara channel*, and the connection of its islands with the main; to complete the topography of *Sacramento river*, and of such other dependencies of *San Francisco bay* as are yet unfinished; to continue that of the coast of *California*, south of *San Francisco* entrance and south of *Monterey;* if practicable, to continue the topography of the shores of *Santa Barbara channel;* to complete the off-shore soundings near *San Francisco* entrance, and north and south of it; to continue the tidal observations; to make the requisite magnetic observations, and to prepare views for the projected charts. OFFICE-WORK.—To make computations as required by the field-work; to continue the drawing of the chart of *San Francisco bay* and vicinity, and the sketches of the section; to complete the engraving of *San Diego bay*, *Monterey bay*, *San Francisco bay entrance*, *San Pablo bay*, and engrave the preliminary sketches of the section. Also, for operations in

SECTION XI. *Coast of Oregon and Washington Territories.* FIELD-WORK.—To continue the triangulation of *Washington Sound*, or of *Puget's Sound* and *Hood's Canal*, from the limits of 1857, and the topography and hydrography of their dependencies; to make such astronomical and magnetic determinations as may be necessary, and to continue the tidal observations of the section. OFFICE-WORK.—To make the required computations and reductions from field-work, and to draw and engrave the preliminary charts of such harbors in *Puget's Sound*, *Hood's Canal, or Washington Sound*, as may be surveyed, and the preliminary sketches of the section, will require 130,000

For running a line to connect the triangulation on the Atlantic coast with that on the Gulf of Mexico, across the Florida peninsula, per act of March 3, 1843 15,000

For publishing the observations made in the progress of the survey of the coast of the United States, per act of March 3, 1843 15,000

For repairs of the Crawford, Madison, Mason, or George M. Bache, and other sailing schooners, used in the survey, per act of March 2, 1853 15,000

For fuel and quarters, and for mileage or transportation, for officers and enlisted soldiers of the army serving in the Coast Survey, in cases no longer provided for by the Quartermaster's Department, per act of August 31, 1852 5,000

For pay and rations of engineers for seven steamers used in the hydrography of the Coast Survey, no longer supplied by the Navy Department $12,800

In a communication from the Treasury Department, received by me after these estimates were sent, but before they had reached the department, I was advised that, "In view of the existing embarrassed financial condition of the country, and the greatly diminished receipts from revenue, it becomes incumbent on the department to bring down the estimates for all works under its control to the lowest figure possible.

"It will be expected, therefore, that you will reduce your estimates accordingly, applying the amounts asked for to such portions of the work as are indispensably necessary."

To meet this view of the department, I made a supplementary communication, (October 21,) stating that, "Under the view entertained in your letter of the 14th, if the measure meet your approval, the publication of the records and results of the Coast Survey might be suspended during the next fiscal year, and the estimates for that purpose be omitted for that year. This would diminish the estimates of my letter of October 19 by $15,000.

"If a further reduction is necessary, I would advise that $5,000 be taken from each of the following items: For the line across the Florida peninsula; for repairs of vessels; and for fuel and quarters of army officers employed on the survey. These will make a further reduction of $15,000, and a total reduction of $30,000. I hope, however, that the first named reduction may suffice.

"A contraction of the scale of the work is not an economical process, as has been shown by comparisons of the survey in former years on different scales. Omitting to complete operations which are begun and in progress, will lead to much loss and waste. The signals are temporary, and the operations must follow each other closely to be conducted with economy."

DEVELOPMENTS AND DISCOVERIES.

The general list is given in Appendix No. 8. That of the year is not as large as usual. It includes—

1. Temple's Ledge, near Cape Small Point, Maine.
2. Changes in the vicinity of Provincetown harbor, (Cape Cod.)
3. The decrease of depth, with general permanence of form of George's Bank, off the coast of Massachusetts.
4. A shoal spot near Little George's Bank.
5. The study of the tidal currents of the Vineyard and Nantucket sounds.
6. The tidal currents of Hell Gate.
7. Least water on the Hell Gate rocks determined by dragging.
8. Notice of the changes in New York bay and harbor.
9. York river, Virginia, noticed as a harbor.
10. Changes at Hatteras and Ocracoke inlets, North Carolina.
11. Changes on the bar of Beaufort, North Carolina.
12. Changes of the Cape Fear bars and channels.
13. Rules for navigators in regard to the tidal currents of the coast.
14. Heights of the tides of the Atlantic coast.
15. A shoal inside of the entrance to Amelia river, Florida.
16. Allen's Bank, Admiralty inlet, Washington Territory.
17. Winds of the Western coast of the United States.

Notices of these developments and discoveries are given in this introduction, in the body of the report, and in the Appendix, as follows: The position of Temple's Ledge; of the shoal near Little George's; changes at East harbor, (Cape Cod;) and the particulars in regard to George's Bank, will be found under the head of hydrography in Section I, and in the Appendix, Nos. 9—12; and a notice of the current observations in the Vineyard and Nantucket sounds is given in the introduction, and a report in regard to them in the Appendix, No. 35. Notices of the tidal currents of Hell Gate, and of the changes in New York harbor, are also given in this introduction, and in the same Appendix; and the depths upon the Hell Gate rocks, in Section I, and in Appendix No. 13. York River harbor is described under Section III. The changes at Hatteras and Ocracoke inlets, Beaufort, North Carolina, and Cape Fear, in Section IV, and in the Appendix, Nos. 15, 16, and 17. The rules for navigators, in regard to tidal currents, are noticed in the introduction, and given in detail in Appendix, No. 20. The subjects of the heights of the Atlantic coast tides, and of the winds of the Western coast, are stated in Appendix No. 33 and No. 36, and noticed in this introduction. The position of Allen's Bank is given in Appendix No. 19.

DEPTHS OF HARBOR BARS, CHANNELS, ETC.

The table of depths contained in my last annual report has been revised and extended, according to the latest tidal results, and is republished in Appendix No. 21.

SAILING DIRECTIONS.

Preliminary arrangements are making for the printing of the sailing directions, notices of dangers, &c., compiled from the records of the Coast Survey, under the act of Congress making appropriation for publishing the records and results of the survey. The volume now in preparation will contain directions for entering ninety-three harbors, and for seventeen bays, sounds, &c.

MAPS AND CHARTS.

In my report of last year I explained, succinctly, the character of the different maps and charts of the coast which had been projected. They were subdivided into coast or in-shore maps and charts, general coast or off-shore charts, and harbor maps and charts, in reference to their uses and positions. In regard to their style of execution, they were subdivided into sketches, preliminary charts, and finished maps and charts. I stated the progress made in these several classes, and especially the efforts in regard to the finished maps, which, requiring first-class engravers, have made extraordinary efforts necessary in procuring them. We have now eight first-class engravers at work, but those who have recently joined the office have not all yet succeeded as fully as is desirable in working up to the style of execution. To meet this, certain changes of style have been necessary, in order not to lose too much time, the result of which is yet an experiment.

The following project for maps and charts, thirty in number, have been submitted and approved during the year, and given to the office for execution:

Kennebec river, Maine; Wood's Hole, Massachusetts; Provincetown harbor, Massachusetts; New York bay and harbor, preliminary and comparative; Rappahannock river, Virginia, lower part, and combination of six sheets; York river, Virginia; Hampton Roads; Norfolk harbor; Beaufort harbor, North Carolina, comparative chart; preliminary coast chart of North and South Carolina, Bull's bay; St. Mary's river, Georgia and Florida; map of reconnaissance from Fernandina to Cedar Keys, Florida, comparative of St. John's river, Florida; Waccasassa bay, Florida; Apalachicola river, Florida; Pensacola harbor; Mississippi city; St. Louis bay and Shieldsboro' harbor, Mississippi; Grand Island Pass and Pearl river, Louisiana; Galveston bay, Texas; entrance to Matagorda bay, Texas; San Diego bay, California; Monterey bay, California; entrance to Santa Barbara channel, California; San Antonio creek, California; and Mare Island strait, California. Of these, six are preliminary, and twenty-four are harbor charts.

The coast-line is now generally known with sufficient accuracy to render it practicable to prepare projects for a general series of maps according to the scales, and for the objects heretofore adopted. These projects have been taken up from time to time, and laid down again for want of more precise materials to be furnished in the progress of the survey, or for more thorough and mature study after preliminary examinations and discussions.

The three classes of maps and charts, of which the study has been resumed, are the preliminary seacoast charts on the scale of $\frac{1}{000}$; the general coast charts or off-shore charts on the scale of $\frac{1}{400000}$, and the finished coast maps (in-shore) on the scale of $\frac{1}{80000}$. The first and second named series have been approved, subject merely to alteration in the details, and the third, after modification, has been retained for further study. The several sheets of these different classes of maps and charts form, of course, part of the series. The series of harbor charts is additional to those just referred to. The general classification of the maps and charts resulting from the survey has been given in my report for 1856.

PRELIMINARY SEACOAST CHARTS.

These useful charts have been growing as the work advanced, but the subject was hardly, until recently, mature for projects for a general series. Under my immediate direction, Mr. A. Boschke has presented a plan, which is favorably improved, in which the whole coast of the Atlantic and Gulf of Mexico is given in thirty-two chart projects on the scale of $\frac{1}{2000000}$, or about three miles to the inch. These will give the shore-line, and all the in-shore, and part of the off-shore hydrography, and they will, as far as practicable, be a series, so that consecutive sheets may be mounted together and form continuous charts, suitable for the office or counting room, while the separate sheets will be used upon the table, or be bound in an atlas. The coast of Maine, from Eastport to Portland, is given in one series of two sheets; New Hampshire and part of Massachusetts, to include Cape Cod and the Nantucket shoals, in two sheets; Massachusetts, Connecticut, New York, and New Jersey, from Nantucket to Barnegat, in two sheets; New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina, from Fire island to Cape Lookout, in four sheets; North Carolina, South Carolina, Georgia, and Florida, from Cape Hatteras to the St. John's river, in five over-lapping sheets—the first embracing Cape Hatteras and Cape Lookout, the second Cape Lookout and Cape Fear, the third Cape Fear and Cape Roman, the fourth Cape Roman and Tybee entrance, the fifth Tybee and the St. John's; Florida peninsula in three series—the first in three sheets, extending from the St. John's to Cape Florida; the second in two sheets, from Cape Florida to the Tortugas; the third in three sheets, from Cape Roman to St. Mark's; Florida, Alabama, Mississippi, and Louisiana, from St. Mark's to New Orleans, in three sheets; Louisiana and Texas, from the passes of the Mississippi to Galveston, in three sheets; Texas, from Galveston to Corpus Christi, in two sheets; and Texas, from Corpus Christi to the Rio Bravo del Norte, in one sheet.

The details of the limits of these sheets will, of course, be carefully studied as the work advances. Materials are already collected for beginning eighteen of them; for nearly completing five; for completing six; leaving parts of the coast untouched by the survey in but three.

Of these charts, twelve have been already commenced, and will grow from year to year as the work continues, the sheets being joined by the electrotype process. Eight of the charts are nearly or quite completed, falling into the systematic arrangement. In some cases these charts will, perhaps, be omitted in favor of the finished charts already executed.

GENERAL COAST CHARTS, OR OFF-SHORE CHARTS.

This series has been the subject of repeated study by different assistants, and the last project of Mr. Boschke has seemed to me so successful that I have adopted it for general guidance in the office, subject to such modifications in details as the progress of the work may require. It gives the coast of the Atlantic and Gulf of Mexico in sixteen sheets. Of these, the Atlantic series is comprised in nine sheets, for which there are materials for beginning the whole in the office, and I propose to publish on this scale, and as preliminary with the reports of the year, by lithography, stone engraving or transfer, such portions of these charts as are finished from time to time, referring them by their numbers to the complete charts. The limits of the Atlantic series and its progress are as follows:

No. I. *Quoddy Head to Cape Cod*, Eastport to Provincetown, (seacoast of Maine, New Hampshire, and part of Massachusetts.)

II. *Cape Ann and Jeffries Bank to Gay Head and Davis Shoal*, including George's Bank and the Nantucket shoals, (seacoast of Massachusetts and part of Rhode Island.)

III. *Gay Head to Cape Henlopen*, including Long Island Sound and New York bay, (seacoast of part of Massachusetts and Rhode Island, Connecticut, New York, New Jersey, and part of Delaware.)

IV. *Cape May to Currituck*, (seacoast of part of New Jersey and Delaware, of Maryland, Virginia, and part of North Carolina.)

V. *Currituck to Cape Fear*, including the Wimble, Hatteras, Cape Lookout, and Cape Fear shoals, (seacoast of North Carolina.)

VI. *Ocracoke to Charleston*, (seacoast of part of North and South Carolina.)

VII. *Winyah bay to the St. John's river*, (seacoast of part of South Carolina, of Georgia, and of part of Florida.)

VIII. *St. John's river to Cape Florida*, (seacoast of Florida.)

Of these No. III has been published; materials are in the office for nearly completing Nos. II and IV, for more than half of the land work and hydrography of No. VII, for the land work and portions of the hydrography of No. V, for two-thirds of the land work and portions of the hydrography of No. VI, for a third of the land work and a portion of the hydrography of No. I, and No. VIII is the only one for which there is a mere beginning in materials collected.

Directions have been given for the execution of the drawings of this series, and for arranging all the preliminary details of their progress. Several of the charts have already been begun.

INFORMATION FURNISHED.

The regulations of the Treasury Department authorize the communication of information from the archives to parties applying for it, the easy condition being that due credit is given to the Coast Survey for the information in any use which may be made of it, and that the expense of furnishing it is defrayed by the parties desiring it. A special application for authority to communicate is made by the Superintendent to the Secretary of the Treasury in each case, but this authority has not been refused. The list of information furnished, stating the names of the persons to whom it has been supplied, is given in Appendix No. 5. It contains eighty-one cases of greater or less importance.

LISTS OF TOPOGRAPHICAL AND HYDROGRAPHIC SHEETS.

In connection with the matter just referred to, and in part to facilitate applications for information, but also for the convenience of the Coast Survey itself, and to bring up the lists communicated to Congress by the Secretary of the Treasury in 1849, complete lists of the topographical and hydrographic sheets have been made out, and are appended to this report, (Appendix Nos. 23 and 24.) They show the localities and limits of the sheets, the scale, date, by whom executed, and the numbers by which they have been registered in the office, for reference. These lists contain, respectively, six hundred and eighty and six hundred and thirty-two titles.

A list of the capes, headlands, &c., surveyed on the western coast of the United States, will be found in the Appendix (No. 6.)

GEOGRAPHICAL POSITIONS.

Every two years the geographical positions determined in the course of the survey are published for the use of geographers, surveyors, navigators, and others. In the Appendix to the present report, No. 25, nine hundred and five additional positions are furnished, including points in Sections I to XI, inclusive of the coast. The progress sketches show the location of these points, the latitudes and longitudes of which, with the bearings and distances from each other, are given in the tables. The whole number of positions now published amounts to five thousand five hundred and sixteen.

LONGITUDES.

Longitudes by the telegraphic method.—These have made due progress during the past year by the addition of the lines Montgomery—Mobile, Alabama, and Bangor—Calais, Maine, to the former results. We were disappointed in reaching New Orleans, in consequence of the necessity for an intermediate station between the first two named cities. A detailed account of this work is given under the head of Sections I and VIII, to which it belongs. The southern connection is also referred to in Appendix No. 27.

There is now completed a chain of telegraphic longitudes from Calais, in Maine, and upon the St. Croix river to Mobile, in Alabama. It consists of the following links, determining the differences of longitude of important stations: Calais—Bangor, Maine; Bangor—Cambridge, Massachusetts; Cambridge—New York; New York—Philadelphia; Philadelphia—Washington; Washington—Petersburg, Virginia; Petersburg—Wilmington, North Carolina; Wilmington—Columbia, South Carolina; Columbia—Macon, Georgia; Macon—Montgomery, Alabama; Montgomery—Lower Peach Tree, Alabama; Lower Peach Tree—Mobile; Baltimore—Washington; Petersburg—Raleigh, North Carolina; Raleigh—Columbia South Carolina; Columbia—Charleston, South Carolina; Charleston—Savannah, Georgia, have also been determined by the same method. This gives a series of differences of longitude of very great value, unrivalled in any foreign survey, and obtained by methods originating and perfected in the United States Coast Survey. It is admitted by scientific men who have examined these methods and those applied since their adoption in Europe, that we are still far ahead of our cotemporaries in the application of this admirable method for longitudes. We expect, in the next season, to reach New Orleans and to push the determinations between Washington and New Orleans by the western telegraph routes. We have already determined Washington—Pittsburg; Pittsburg—Cincinnati; Pittsburg—Hudson, Ohio; and Pittsburg—St. Louis, in this way. The original idea was, to use the continuous line to connect Washington and New Orleans, but the imperfect insulation prevents this, and the introduction of repeaters, which answer perfectly the purpose of transmitting messages and renders imperfect insulation of much less consequence in the ordinary communications of the lines, is an effectual bar to accurate longitude determinations. In consequence of this, we have been forced to the incidental determination of several points of great interest in the geography of the country, and, by connecting latitude and magnetic determinations with those for longitude, we have been enabled, without additional expense of any moment, to give the complete geographical determinations of those localities. The longitude connexion now embraces fourteen and a half degrees of latitude, and twenty and three-quarters of longitude, and a distance, in an air-line, of fifteen hundred miles.

The report of Dr. B. A. Gould, in charge of the telegraph operations, is given in Appendix No. 27. While having charge of the southern telegraph work, Dr. Gould has been chiefly occupied in discussing the results of former observations, and in preparing them for publication; and the results of some telegraph operations are nearly ready for the printer. Among the interesting results of the discussion of telegraph longitudes, the variation of a signal given by tapping on the telegraph key from the mean is shown to be not very different from the variation in observation by the eye and ear of the best observers. The increase made of observations in a given time, the greatly diminished effort needed by the observer, the less necessity for experience and practice, and the decidedly smaller personal equation, constitute the great gain in the electro-magnetic method of observing over the ordinary method of astronomical observation. Another curious result which seems to come out from this discussion is, that the velocity of transmission of a signal is not the same when sent against and with the direction of the galvanic current. A special report gives full details of the discussion.

Longitudes by Solar Eclipses, Occultations of Pleiades and Moon Culminations.—The special researches of Professor Peirce upon this interesting subject have been noticed, and the progress made is stated in his able report in Appendix No. 29. A tribute is paid to the lamented S. C. Walker, to whom the merit is justly awarded of clearly pointing out the line of research needed for perfecting the longitude problem and of grappling with some of its most difficult details. The use of solar eclipses and the probable limit of accuracy of results derived from them is clearly stated, and the special researches and computations that are necessary and have been commenced by Professor Pierce, with the assistance of Dr. C. H. F. Peters, are briefly but distinctly recapitulated. The arrangements for observing the occultations of the Pleiades, as suggested by Professor Peirce, have been steadily prosecuted under his direction.

The predictions of the occultations of March 1, August 12, November 2, and December 27, 1857, were made and projected by Dr. Peters, and distributed to astronomers, in various parts of the United States and in Europe, from the Coast Survey office. Great attention has been paid, especially by astronomers of this country, to the suggestions of observation of these occultations, and prompt replies to the letters relating to them have been received.

Owing to the unfavorable state of the weather returns were received from only five stations, in March, and two in August. The occultations of November 2, were observed at eight places in the United States; in western Europe, where they were also visible, the state of the weather prevented observations.

Considerable progress has been made in collecting the data for the computation of past observations. The new triangulation of the Pleiades, which it is supposed will be made with the heliometer of the Dudley Observatory, will complete the means of using the data thus in process of collection.

The beginning and end of the solar eclipse of March 25, were observed by Assistant George Davidson, at San Francisco, California, and his results forwarded to the office.

Professor W. C. Bond reports from the Cambridge Observatory, for the use of the survey, thirty moon culminations, seventeen occultations of stars by the moon, and a number of transits of certain bright points on the moon's disc. His report, which contains interesting remarks, is given in Appendix No. 28.

Longitude by Chronometers.—The longitude of Fernandina being required for the air line triangulation across the head of the Florida peninsula, and no telegraphic line having been yet established between Savannah and that port, it was necessary to determine the difference of longitude by the transportation of chronometers as the next best resource under the circumstances. A memoir, showing the nature of the operations and the method of reduction and results, is given in Appendix No. 30. It is modified from a paper read before the American Association for the Advancement of Science, in which the incidental questions of personal equation and the like were deemed of more interest than those now more prominently stated as appropriate to this report. The superiority of the telegraph method of determining longitudes could not be better indicated than by comparison with the labor bestowed to obtain these results, and the rough approximation finally reached as compared with the corresponding time and accuracy of the method by telegraphic signals.

This determination of the longitude of Fernandina shows that the best charts are out some eight miles in this important position.

LATITUDE BY THE ZENITH TELESCOPE.

In 1851, I read at the Cincinnati meeting of the American Association for the Advancement of Science a paper containing an account of Talcott's method for observing latitude by the zenith telescope, then in full use in the Coast Survey, and by the kindness of the secretary was furnished with copies, which were distributed to the assistants of the Coast Survey and others. This original and excellent method is now adopted in the survey in preference to any other, and the form into which the observations and reductions have settled down is described in a clear report by Assistant Charles A. Schott, chief of the computing division, shown in Appendix No. 31. The report shows: (1) the principle of the method; (2) the modes of determining the value of the micrometer of the instrument, with tables for recording the observations and for facilitating the computations requisite; (3) the mode of determining the value of the level used with the telescope with form of record and computation; (4) the correction for refraction, with a table of corrections; (5) the reduction to the meridian with tables; (6) the rules for selecting the pairs of stars; (7) the errors in the determination of the micrometer value; (8) method of correcting for micrometer from the observations themselves; (9) method of discussion of the results of observation, forms of record and computation.

EPPING BASE.

A paper giving a resumé of the operations in grading and measuring this important base of verification is contained in the Appendix, (No. 26,) and is illustrated by a topographical sketch of the site, length and cross sections of the base. Views were taken by the photograph, showing the principal stages in the measurement, the signals at the ends, &c. Some of the principal details of this work are given in the chapter headed Section I.

LOSS OF MAGNETISM BY MAGNETS USED IN OBSERVATION.

Appendix No. 32 contains a report by Assistant Charles A. Schott on the loss of magnetism in the several magnets used by the assistants of the Coast Survey in their observations, illustrated by a diagram, (Sketch No. 68.) The history of each magnet is traced, and the magnetic moments at different periods, after reduction to a standard temperature, are compared. The gradual loss of magnetism is found to be well represented by a hyperbola; but from its capricious character, as shown by the different cases, the determinations of the magnetic moment made during the observations are to be preferred, in obtaining the several results, to the moment deduced from the general discussion.

This paper may be considered as supplementary to those on the change of the magnetic elements of the earth, published in my annual reports of 1855 and 1856.

TIDES, TIDAL CURRENTS, AND WINDS.

Tidal observations and reductions.—An interesting report, from Assistant L. F. Pourtales, in charge of the tidal division, showing the progress made in the observations and in the reductions during the past year, is given in Appendix No. 34. The permanent tide-gauges are at Charlestown, Massachusetts; Brooklyn, New York; Old Point Comfort, Virginia; and St. Mary's, Georgia, on the Atlantic; and at San Diego and San Francisco, California; and Astoria, Oregon, on the Western Coast. The object and progress of the observations at Tappahannock, of those at the Florida reefs and others, are distinctly stated. The earthquake record at Tahiti upon the self-registering gauge, loaned to the exploring expedition of Commander John Rodgers, U. S. N., connects itself with similar disturbances upon the gauges at Astoria, San Francisco, and San Diego, which had been previously received, but of which we could make no use from the relative positions of the stations, and our ignorance of the place of origin of the disturbance. As far as I have yet been able to study the subject, the Tahiti observations will enable us to clear up the whole matter.

The difficulty of the subject of tidal predictions requires to be studied before it can be fully appreciated. Twice I have supposed we were on the point of success in preparing prediction tables, and twice have found that our progress was not yet up to that point. Rough tables we could issue, but not such as the materials in our hands would justify. The subject is one of constant and anxious effort.

Tide tables and tidal currents along the sea coast.—These have been revised to date, and are given in Appendix No. 20. The additional matter, prepared by authority of the Treasury Department for Mr. G. W. Blunt, and drawn from the study of the co-tidal lines of the coast, will be found of interest to navigators. The generalization in regard to the tidal currents near the shore, between the port of New York and any southern Atlantic port, is a very simple one. That "for all practical purposes of coasting, the succession of tides, and, of course, of the tidal currents of ebb and flood, will be the same as if the navigator remained stationary." The sailing lines from New York to southern and eastern ports are given on Sketch No. 65, and tables show the succession of tides on these lines off various ports. The distance of the cold wall of the Gulf Stream, off ports south of New York, from the Gulf Stream chart of the Coast Survey, is also shown by a table.

The continuous tidal observations on the Pacific coast have led to a closer knowledge of the changes in the diurnal inequality of the tides, and the tables have been corrected accordingly. As a first approximation, the changes before and after the period of the moon's greatest declination were arranged; but the differences in the two periods being now well made out, the tables have been extended so as to show these for a given number of days both before and after this period.

Heights of tides of the Atlantic coast.—The generalizations which I have made in regard to the tides of the Atlantic coast were, by permission of the Treasury Department, presented to the American Association for the Advancement of Science, in a paper which is transferred to the Appendix, No. 33. Diagrams on Sketch No. 65 are referred to in the paper, and the model described in it is deposited in the Coast Survey office, at Washington.

As a technical memory these generalizations will be of interest to navigators. They refer to three great physical divisions of the coast of the United States—the great southern bay, from Cape Florida to Cape Hatteras; the middle bay, from Cape Hatteras to the eastern part of Nantucket, (Siasconsett;) and the eastern bay, from Siasconsett to Cape Sable, (Nova Scotia.) The tide wave entering each of these bays increases in height as it runs towards the head of the bay. Thus, from Cape Florida and Hatteras (great southern bay) to Savannah and Port Royal, the tide increases in height from one and a half and two feet to seven feet. From Cape Hatteras and Siasconsett (or, more accurately, Weweeder) to the coast of New Jersey and New York, (middle bay,) the tide rises and falls one foot two inches, and two feet to nearly five feet (four feet eight inches) at Cape May, New Jersey, and Sandy Hook, though with less regularity than in the great southern bay. From Siasconsett and Cape Sable it rises from two feet two inches and four feet four inches to fifty feet at Shadwood point, on the Bay of Fundy.

The same rule applies to the bays in which the tide wave enters directly, as Massachusetts bay, Long Island sound, New York bay, and Delaware bay; but does not apply to Chesapeake bay, where, on account of the smallness of the opening and the immediate expansion and change of direction at right angles to itself by the tide wave, the height rapidly diminishes after entering.

This generalization conforms to an established principle, though it could not, of course, be made out without tidal observations of similar number and frequency to these embraced in the Coast Survey investigations.

Whether the eastern bay is only a part of a larger bay between Nantucket and the Newfoundland banks, or whether the Cape Sabie tide of four feet four inches has a different origin, can only be established by observation. The question goes to show the difficulty of limiting physical observations by strict geographical and national boundaries.

Tides and tidal currents of Hell Gate.—These observations were made upon the plan of those at Sandy Hook, and in New York bay and harbor, and the Kills. They consisted of observations, at short intervals, of the height of the tide and direction and force of the current at particular stations, and of special observations of eddies, of the limits of moving water, and the like. These were made, under my immediate direction, by Sub-assistant Henry Mitchell, and with signal ability on his part. They confirm the previously acknowledged excellence of the observations of Commander Charles H. Davis, United States navy, and the careful nature of those of Lieutenants Porter and Goldsborough. The resulting charts of time, direction, and velocity of tidal currents, are complete, and the curves of tides, but as the whole subject presents materials for close study, and these results will come in as an essential part of the work when it takes its final shape, I have thought it best to postpone their publication to that time, and at present to give merely Mr. Mitchell's statement of the observations made, and of tables, diagrams, and results presented.—(Appendix, No. 35.) If the tables and charts were now appended to this report they would be separted from the final deductions, or must be presented a second time.

The generalizations will, I am confident, be found useful to navigators, as well as in the great question of rendering this access to New York harbor a safe one.

Winds of the Western Coast of the United States.—The deductions from observations of the force and direction of the wind in connection with the permanent tidal observations at Astoria, San Francisco, and San Diego, are embodied in a paper read by me before the American Association for the Advancement of Science, by authority of the Treasury Department, and placed in the Appendix (No. 36.) The diagrams (Sketch No. 66) which accompany the paper convey at once to the eye the general facts deducible from the observations, and better than they can be conveyed in words, the mind seizing readily for itself the principal inferences. One series of diagrams, which represents the daily changes from hourly observations, I have been obliged to omit as too expensive for publication. The results are stated in the form of inferences in regard to day and night winds, and the winds at different seasons.

The very simple regimen of the winds on the Pacific coast is expressed in the two following rules: (1.) Westerly winds greatly prevail, showing a regular flow of the air at the surface of the earth from the sea to the land. (2.) There is a general absence of easterly winds, showing the absence of a return current at the surface. The philosophy of these two deductions is obvious, hinging upon the difference of temperature of the ocean and land. When the easterly winds blow at all, it is, as a rule, during the winter, and the northeast, and more frequently in the morning than in the afternoon hours of the day. It would be unnecessary repetition to state the less general conclusions of the paper referred to as it stands in the appendix. I may venture to express the hope that these deductions will not be found useless to those men of science who are engaged in studying so carefully and zealously the climate and meteorology of our country.

This discussion will be extended to the results of other years, by which valuable comparisons must be obtained, and the generalizations of the year 1855 be tried by the observations of other years.

RECORDS AND RESULTS.

In my report of last year I noticed the progress made in the preparation of the material for volumes for which a special appropriation has been made by Congress.

The order of publication of such a work during the actual progress of operations is, of a necessity, chronological, while ultimately an arrangement of volumes according to subjects or different classes of work appears the most desirable. To delay the publication until the final completion of the operations of the survey would greatly increase the difficulties arising from imperfect statements, when, in most cases, the appeal to personal recollection would have become unsafe or impossible.

The design has therefore been so to arrange the work, according to a general scheme embracing all the various operations of the survey, that the matter contained in the annual volumes may ultimately be re-arranged according to subjects, uniting operations of certain classes into separate volumes.

The work of the year 1849 has been selected to form the context of the first volume of GEODESY, as embracing operations of every class, and therefore calculated to give a full view of the operations of the Coast Survey. It will give detailed accounts of the measurement of a principal base line and of some preliminary bases; of observations of angles for primary, secondary, and tertiary triangulation; of observations of latitude with the zenith sector and with the zenith telescope; of observations of azimuth and of time. The description of instruments and of methods of observation and reduction will form a necessary and valuable portion of the first volume.

Having arranged the general features of the work after much consultation, I have entrusted the execution of the details to Assistant J. E. Hilgard, who has had charge of the work of publication, and the greatest portion of whose time and attention during the past year have been devoted to this subject.

The preparation of a volume giving an account of the CHRONOMETRIC EXPEDITIONS FOR ASCERTAINING THE LONGITUDE BETWEEN CAMBRIDGE AND LIVERPOOL, mentioned in my report for 1856 as being in the hands of Prof. G. P. Bond, has been completed. The following is a brief sketch of its contents:

1. *Introduction.*—Reference to results of expeditions of 1849 and 1851; recognition of the change of temperature as the principal disturbing influence. Plan for a new expedition in 1855, in which the elimination of the effects of temperature changes is to be an object of special attention. General arrangements, arrangements for preserving uniform temperatures: for comparison of chronometers with stand and clocks.

2. *Description of instruments.*—Transits, clocks, registers, chronometers, thermometers, chronometric thermometer. Apparatus for ascertaining temperature coefficients.

3. *General account of the several voyages.*

4. *Determination of time at Cambridge.*—Methods of observation and reduction. Determination of instrumental constants and corrections, personal equations. Tables of resulting clock errors. Appendix I, giving record and reduction of transits, observed at Cambridge.

5. *Determination of time at Liverpool.*—Same details as preceding chapter. Appendix II, giving record and reductions of transits, observed at Liverpool.

6. *Comparison of chronometers.*—Method employed, and probable error of comparison, by striking the key of an electro-magnetic apparatus in concert with the beats, and recording them thus on the spring-governor sheet graduated by the clock. Appendix III, giving the record of comparisons.

7. *Computation of longitude.*—Development of method employed. Table of chronometer errors on which the longitude directly depends.

8. *On the probable errors and relative weights of determinations of longitude.*

9. *On the influence of changes of temperature.*—Difficulties of ascertaining their effect on the rates of chronometers. Experiments with chronometric thermometer. Process of ascertaining the temperature of best compensation, and the coefficients of temperature for the several chronometers. Tables of *temperature trials.*

10. *Corrections to longitude due to temperature changes.*

11. *Final results for longitude.*—Table of results for longitude by each chronometer for the several voyages. Final result.

Satisfactory progress has been made in the preparation of a volume to contain the results for telegraphic longitudes, obtained since 1852. This work is in charge of Dr. B. A. Gould, jr., and reference is made to it in his report of the season, Appendix No. 27.

A volume containining the EXPLORATIONS OF THE GULF STREAM, prepared by the Superintendent, with the assistance of Prof. A. G. Pendleton, United States navy, is nearly completed ; a part of it is in the printer's hands, and the diagrams are engraved. The general arrangement of this volume is as follows :

1. *Introduction*, giving the general scope of the work and a historical narrative of previous research.

2. *Narrative of cruises*, giving the principal objects, occurrences, &c.

3. *Discussion of instruments*, and instrumental corrections.

4. *Tables and curves*, giving the record of observed depths, temperatures, nature of bottom, &c., and a graphical representation of the observations.

5. *Results*, giving a full dicussion of the observations, and the conclusions deduced from them.

The volume of SAILING DIRECTIONS for the coast of the United States, the collection of material for which was referred to in my last report, has made progress, and is now undergoing the scrutiny of experienced hydrographic officers previous to its publication. The form of publication has been carefully studied and matured.

The plan of this volume is to embody the hydrographic information brought out in the progress of the Coast Survey, in reference to the harbors, dangers, places of refuge, and sailing lines along our coast, and it will, of course, receive additions and modifications as the work will extend to localities, of which hitherto no surveys, or hydrographic reconnaissances only, have been made. It gives for each harbor a general hydrographic description, sailing directions for entering or leaving, the positions and marks of dangers ; light-houses and beacons, currents and titles, geographical positions and variations of the compass, forming a companion and commentary to the charts published by the Coast Survey.

The preparation of copy of the work of 1849 having in 1856 reached a condition which made it probable that the stereotyping of a volume could proceed without interruption, and the forms of the principal classes of work having been previously studied and determined upon, the work of stereotyping was commenced about the close of the year.

A contract had been made in the preceding October, under the law of 1852 and authority of the Treasury Department, with Mr. E. O. Jenkins, of New York, at whose establishment the work has been done.

The work has averaged three pages per day, great care being required in perfecting the manuscript copy for the printer, which is prepared, page for page, with all typographical details duly arranged.

To insure correctness, the proofs are read with the original records and revised reductions, as well as with the copy used by the compositor. Second proofs are duly examined, before the pages are cast, and proof impressions from the stereotype plates are finally re-examined, with the original records, by a person who has not before read them, and who checks the arithmetical operations appearing on the face of the page.

It is estimated that the printing of the geodetic volume, in progress, may be commenced by January or February next, and that it will be ready for publication in May or June following.

SPECIAL SURVEYS.

I have given, in the Appendix, extracts from reports on surveys in various special localities, as in No. 40, from the report of Assistant A. M. Harrison, on the survey of Cumberland and Amelia islands, the former for the site of a base line; from that of Lieut. A. W. Evans, U. S. A., on the survey of the sites for a base line on Sapelo Island, Georgia, Appendix No. 39; that of Captain J. H. Simpson, U. S. Topographical Engineers, on the air-line across the head of Florida peninsula, Appendix No. 41; that to the Commissioner of the General Land Office, on the survey and marking of the Florida keys, with extracts from the reports of the surveying officers, Sub-assistants C. T. Iardella and S. A. Wainwright, and Mr. F. W. Dorr, Appendix No. 42; that of Assistant W. E. Greenwell, on the survey of the islands off the Western Coast, for the Land Office, Appendix No. 44; and the report of Sub-assistant W. M. Johnson, on the topography of the shore of Santa Barbara channel, Appendix No. 43.

In regard to the surveys for the Land Office, I would observe that one year more of the appropriation would finish the work of the Florida keys, and main immediately connected with them, and that the fruits of the preliminary work on the Western islands, which has been very difficult, are now beginning to be gathered, and in two years more would be fully so. I should regret extremely the necessity for suspending either of these works. It is not possible that in any other way can the keys and main of Florida, or the islands off the Western Coast and main be connected, or that it would repay the Land Office to organize and fit out parties for this special geodetic work, which, it will be recollected, was recommended by the Executive and Congress, for the land surveys on the Western Coast in 1852.

The triangulation across the Florida peninsula will save much time, labor, and expense in connecting the main triangulation of the Atlantic coast, and that of the Gulf. An appropriation of the amount of that of last year will probably enable us to complete this work.

A reconnaissance of Bull's bay, thirty miles northeast of Charleston, and a survey of North Edisto entrance, about twenty-five miles southeast of that city, pointed to these harbors as harbors of refuge for vessels unable to pass Charleston bar in northeast or southwest gales. Charts were published for this purpose, showing easy entrances in both cases, and giving the necessary sailing directions.

Last year a new chart of the North Edisto was given, showing slight changes in the position of the bar, but the same depth of water.

Assistant C. O. Boutelle, who has entered both of these harbors during the past year, calls attention to the neglect of them, and gives an instance in which, by running into North Edisto, a vessel might probably have been saved from wreck. I would, therefore, again draw the attention of pilots and navigators to these important harbors of refuge. Bull's bay entrance gives thirteen feet at mean low water, and North Edisto twelve feet.

The instructions of this year include nearly all the inlets on the coast of Section V, not heretofore covered by the operations of the survey. The combined triangulation and topography of the northern end of the section will be brought nearly or quite to the North Carolina line, completing the preliminary work of the coast of that State.

RESURVEY OF NEW YORK BAY AND HARBOR.

This important work was begun under the direction of the President of the United States, and upon application of the Commissioners on Harbor Encroachments of New York, in 1855, and continued by that of the Secretary of the Treasury in the following years. The arrangement, made under authority of the Executive of the United States, was of mutual advantage to the government and to the State of New York. It was of great interest to commerce and navigation that the changes in New York bay and harbor should be known. The former survey was made twenty years ago, and considerable changes were known, from partial resurveys in different localities, to have occurred. It was important to the plans for the defence of the harbor that these changes should be ascertained. It was also desirable that the most improved methods of survey should be applied to this harbor, the great source of revenue to the United States. The harbor commissioners of New York estimate that this survey would have cost them four to five years in time, and five hundred and thirty thousand dollars in money, (see their report to the legislature of New York, March 31, 1857, senate document New York State, No. 149,) and report that the expenditure upon it, and upon the maps connected with it, as fifty-five thousand dollars and two years of time. Deducting the cost of special maps, which would not have been required by the United States, the amount by which the cost of this necessary work is diminished to the government is not less than thirty-five thousand dollars.

The obvious value of the results obtained and reported were such as to induce the legislature of the State of New York to request the Superintendent of the Coast Survey to complete the physical survey of the harbor, so that the results might not only be adapted to purposes of navigation but to the study of the changes in progress.

The disastrous result of the continued growth of Sandy Hook into the main ship channel, its progress having been for the last century at the rate of nearly "a sixteenth of a mile in twelve years," and "large areas, over which twenty years ago there were twenty and forty feet water," being "now dry ground," needs no exaggeration to give it importance.

A comparative map, founded upon the surveys of 1835 and 1855, developed and illustrated the changes in bay and harbor, on the bars, and in the channels. The report of the advisory council to the commissioners, consisting at the time of General Totten, chief engineer of the United States, and myself, upon this chart, is given in Appendix No. 37; and I note here a few of the results derived from it to show their importance, and to invite an examination of the document itself for many others, and for the details of these.

The progress of Sandy Hook is discussed and explained, and the mode of controlling it is shown. False Hook channel (Sandy Hook) is found to have deepened a foot and a half; the bar at its southern entrance, seaward, has deepened one foot, (from twenty-one to twenty-two feet at mean low water,) and the bulk-head which closed its northern entrance has disappeared. *Eighteen feet can now be safely carried through this channel* at mean low water. In twenty years a million and a half cubic yards of sand have been removed from this channel. *The average depth of the main ship channel has changed but little.* Great changes have taken place on the western shores of Coney island and of Long Island, and in the position and forms of the inlets on the south side of Long Island. "*In general, there has been a movement to the northward and eastward of all the channels and shoals* of New York bar." Flynn's Knoll is an exception. "While this movement has gone on, *the channels have generally increased in depth, and the shoals have diminished in extent.*" From the channels the enormous amount of three millions of cubic yards is estimated to have been actually removed, or shifted in position. The outer bar has become more uniform in depth, Gedney's channel being slightly improved, and the North and South channels having coalesced and forming a better entrance than when they were separate. The Swash channel has widened and deepened; the bar at its southern entrance, which had only twenty feet upon it, has now twenty-three feet. The East channel has improved, and the bar at its eastern entrance has diminished in width.

At the entrance to the Narrows, Lieut. Comg. Craven discovered a shoal which was not on the former chart. The examinations in New York upper bay, in Newark bay, the Hudson river, East river to Throg's Neck, have each developed matters of considerable interest.

EXPERIMENTAL INQUIRIES.

Experiments have been made during the past year by Mr. Mathiot, in continuation of those on actinic engraving, and on reductions by photography; by Mr. J. M. Batchelder, on the expansion and contraction of highly callendered paper; on the use of backed paper for printing maps and charts; on the compression of sea water and some other liquids by pressure, and the effect of temperature in compression, as applied to Saxton's sounding instrument; on the use of vulcanized India rubber in a compression sounding apparatus; on Leonard's dynamometric log for the way of vessels and rate of currents; and on iridium surface copper plates. The callendered paper was found to act very irregularly. The backing spoiled the impressions of the fine charts, especially the work representing marshes and sanding. The great effects of temperature on the Saxton instrument, and the binding by changes of temperature, showed that it required important modifications to make it a proper sounding instrument. Leonard's log has received important modifications in its details, and will be further tested.

The iridium surface plate is promising, not so much as affording a complete protection to the copper as for facility. It is still under trial.

INSTRUMENTS AND APPARATUS.

Appendix No. 45 contains a description, by Assistant J. E. Hilgard, of an apparatus for measuring preliminary base lines. It is essentially the same as described in my last report, with some improvements in the mechanical details suggested by the experience of last year, and ensuring greater convenience and dispatch in its use.

A combination with the deep-sea sounding apparatus devised by Commander B. F. Sands, U. S. N., with Burt's sounding nipper and Massey's indicator, as used by him in last season's work, is shown on Sketch No. 70. The floating bag, with nipper attached, secures a vertical cast, while the indicator registers the depth, and the specimen tube brings up a portion of the bottom, the line being relieved from the weight of the deep-sea lead by its detachment in the manner shown in the drawing.

The alleged objection to Brooke's sounding apparatus, from the turning of the spindle, is obviated in a modification used by Lieut. Comg. O. H. Berryman, U. S. N. The change suggested is represented in Sketch No. 71.

These improvements have been applied in the soundings taken by the officers who report them.

The sounding apparatus proposed by Lieut. E. B. Hunt, corps of engineers, assistant in the Coast Survey, (Appendix No. 47,) acts by balancing the water column of the depth to be ascertained, by a column of mercury or other pressure gauge, the pressure acting through air.

An instrument for testing the proposed method by experiment has been constructed under the direction of Mr. J. M. Batchelder, and experimental trials made by Lieut. Comg. W. G. Temple, U. S. N., in New York harbor, seem to promise success in its practical application, (Appendix No. 48.)

A form of tide-gauge suggested by Lieut. Comg. S. D. Trenchard, U. S. N., assistant in the Coast Survey, consisting of a float and counterpoise connected by a graduated belt, is described in Appendix No. 49. The instrument is represented in Sketch No. 72.

Sub-Assistant Henry Mitchell has invented a spar tide-gauge for observations on the open seacoast, which promises to be useful, and will be further tested under his direction. The description of it is given in Appendix No. 50, and a drawing in Sketch No. 72.

INDEX OF SCIENTIFIC REFERENCES.

In 1855, Lieut. E. B. Hunt, U. S. Engineers, proposed to the American Association for the Advancement of Science to have prepared, under its auspices, an index of scientific references, following out the admirable index of Dr. Thomas Young, and bringing it down to the present date. This subject was one of those which early attracted the attention of the Secretary of the Smithsonian Institution, Professor Henry, and in regard to which he communicated with the British Association for the Promotion of Science. On his proposition they addressed the Royal Society, inviting co-operation in this undertaking, judged worthy of the best abilities in its execution. Subsequently, Lieut. Hunt proposed to the American Association a system for the abbreviation of titles in connection with this index, showing the variety which existed in abbreviations by different authors, and the desirableness of uniformity. The want of such an index of matters connected with the Coast Survey operations and studies has been severely felt by all those who have been desirous of knowing what progress has been made in a subject of investigation, or whether certain methods, instruments, and appliances are new, or have been proposed or used.

Lieut. Hunt suggested that an index of such matters was within the compass of his own labors, and began at once its preparation. In prosecuting this work, some seven thousand volumes have been examined, and thirty-five thousand titles extracted. In his report of progress for the past year, (Appendix No. 51,) Lieut. Hunt states that it is probable one thousand more volumes must be examined before proceeding to the classification of the titles for publication. In this work he has persevered zealously, though his Coast Survey duties have been merely incidental, as his chief time has been necessarily given to duties under the Engineer Department and Light-house Board, in the construction of fortifications and light-houses.

I have twice, recently, had occasion to use this index in its incomplete form, by calling upon Lieut. Hunt for references to subjects which it was important to look into without delay. In both cases the references were very copious. This work, I regret to say, will be interrupted during the winter by Lieut. Hunt's orders to Fort Taylor at Key West, but the chief engineer has consented that he resume it next summer. It is a work requiring a peculiar combination of qualities to execute well.

OFFICERS OF THE ARMY.

The names, rank, and date of attachment to the survey of officers of the army serving upon it is given in Appendix No. 2. Captain M. L. Smith, U. S. Topographical Engineers, and

Lieutenant Thomas Wilson have been detailed within the year. Captain Smith is in charge of the Coast Survey office.

The number of officers attached to the work on the 1st of November is the same as last year, namely, eleven.

OFFICERS OF THE NAVY.

The number of officers of the navy attached to the Coast Survey on the 1st of November, 1857, was thirty-one, being twenty-two less than at the same date of the year before, (1856,) and twenty-eight less than on the 1st of September, 1855. The number of assistant engineers was but five; and notice was given in July of the intention to withdraw the whole of the naval engineers from the work, in consequence of the exigencies of the naval service.

In no year have so many experienced officers been withdrawn from this service. Commander H. S. Stellwagen, and Lieutenants John J. Almy, T. A. M. Craven, Richard Wainwright, S. D. Trenchard, and John C. Febiger have been relieved. These officers have all served acceptably; and the loss of their experience will be severely felt in the next season's operations. In connection with the hydrography last executed by them, I have expressed my opinion of their services—a small return for their arduous labors.

The withdrawal of the naval engineers has brought the expense of running our vessels upon the appropriations for the year which was not calculated for. For the next year there is an item in the estimates to cover this. It is proposed to attach steam engineers, selected by the hydrographic chiefs, to the vessels while in commission, keeping one for repairs and care of the machinery while the vessel is laid up.

LIGHT-HOUSE MATTERS.

Examinations of sites.—The system of lighting the coast has now reached an order and method which make hap-hazard appropriations for lights so rare that the number of calls upon the Coast Survey for examinations of lights in localities of doubtful utility has very much diminished. The few examinations made during the past year, only two in number, are referred to under the head of Sections I and X, and the detailed reports are presented in the Appendix Nos. 56 and 57. The result of a third examination (ordered in Section XI) has not yet been reported.

The number of cases proposed for examination in 1851 was forty-three.

Aids to navigation.—As the hydrography advances, various aids to navigation are recommended by the surveying officers. There have been seven cases of such recommendations during the past year, viz: of a buoy for the flat ground near the Salvages, Cape Ann, Massachusetts; a buoy for the northern edge of the middle ground near Cape Henry, Virginia; buoys for the main ship channel, and for the slue at Beaufort, North Carolina; for St. Simon's bar, Georgia; at St. Mary's and Amelia rivers, Florida; and a beacon at Love key, Florida reef. These several recommendations have been referred to the Light-house Board through the Treasury Department. The reports containing them are given in the Appendix Nos. 60 to 65.

OBITUARIES.

Two of the youngest members of our surveying corps have died within the year, and both from the exposure incident to their duties. Both well deserved, and have received, special notices in connection with the work in Section I and Section VI, in which they were engaged.

One of the oldest and most faithful tidal observers, too, has died within the year, and his services are referred to under the head of tidal observations in Section I.

MISCELLANEOUS.

The Coast Survey officers frequently have it in their power to render acceptable assistance to vessels in distress. I have, in previous reports, given many instances of this in which their services were duly acknowledged.

During the past year Commander W. T. Muse, in the surveying steamer Hetzel, relieved the ship Manlius, of Boston, when in a sinking condition off Cape Henry; two of his lieutenants and a crew being sent on board of her. In testimony of their appreciation of this service, the owners of the vessel presented, through the Treasury Department, to Lieutenants R. D. Minor and Bayard E. Hand, U. S. N., each a gold chronometer watch, and forwarded at the same time a contribution in money, which was divided amongst the crew engaged in the relief of their ship. The reports of Commander Muse and Lieutenant Minor and the letter of the owners of the Manlius are given in Appendix No. 53.

For a similar service, stated in Appendix No. 69 of my report of last year as having been rendered to the British barque Adieu, the British government forwarded, for presentation to Lieutenant Commanding S. D. Trenchard, a valuable sword.

A special act, passed at the last session of Congress, authorized the reception of these by the officers for whom they were intended.

By request of the United States consul, at Nassau, New Providence, Lieutenant Commanding J. K. Duer, U. S. N., assistant Coast Survey, in the surveying schooner Varina, took on board the crew and steerage passengers of the ship Julia Howard, wrecked on the Bahamas, landing the former at Havana, and the latter at Pensacola. The report of Lieutenant Commanding Duer, and the letters of the United States consuls at Nassau and Havana are given in Appendix No. 54.

Assistance in saving government property at Pensacola from destruction by fire, incidentally rendered by the hydrographic parties of Commander B. F. Sands and Lieutenant Commanding J. K. Duer, will be referred to under the head of hydrography, in Sections VII and VIII.

I now proceed to give a detailed statement of the work executed in the field arranged under the heads of the several sections on the Atlantic, Gulf of Mexico, and Western Coast.

In each, the operations in triangulation, topography, and hydrography will be noticed in geographical order, preceded by a summary of the office work executed at the office in Washington.

SECTION I.

FROM PASSAMAQUODDY BAY TO POINT JUDITH, INCLUDING THE COAST OF THE STATES OF MAINE, NEW HAMPSHIRE, MASSACHUSETTS, AND RHODE ISLAND.—(SKETCH A, NOS. 1 AND 2.)

The progress in this section has been very good. The large development of shore-line, which is much beyond any possible calculation from ordinary maps, prior to the time of the Coast Survey, and the great extent of comparatively shoal sea off this coast, when taken in connection with the short season for work in the eastern part of the section, makes it a subject of great solicitude with me. I am confident that a continuance of the present resources, and a proper application of them according to the systematic steps already laid down, will bring the work here to a close nearly as soon as in the other sections. I estimate for the operations an average period of, say ten years; the triangulation closing first and the hydrography last. This coast changes so little, that whatever is done on the seacoast will remain of authority for a long period of years, and only some of the harbors will require resurvey and careful watching in their changes.

The operations in this section during the past season have been as follows:

1. Astronomical and magnetic observations at Bangor and Calais, including telegraphic longitudes and latitudes.
2. The measurement of a base of verification on Epping plains, Maine, with the new Coast Survey apparatus.
3. Triangulation eastward from the Kennebec river.
4. Topography of the shores of the Kennebec to Bath, Maine.
5. Topography of Cape Small point, Maine, and its extension westward to Harpswell.
6. Topography of the islands and main of Casco bay, eastward from the Presumpscot.
7. Topography of Plymouth harbor and its approaches.
8. Hydrography of the Kennebec river, Maine, from the entrance to Bath.
9. Hydrography of Casco bay, Maine.
10. In-shore hydrography north and south of Newburyport, Massachusetts.
11. Off-shore soundings eastward from the coast of Massachusetts to beyond George's bank.
12. Deep-sea soundings off the coast, and special surveys.
13. Tides and currents of Martha's Vineyard and Nantucket sounds.
14. Observations at a permanent tidal station.
15. Light-house examinations.

There can be no doubt, on even looking at this list, that the number of parties employed, and the character of their employment, has been in proportion to the importance of this section of the survey, and to the large commercial and navigating interests of which it is the home.

Office work.—The following drawings have been completed within the surveying year: Kennebec river entrance, scale $\frac{1}{30000}$; Annis Squam and Ipswich harbors, $\frac{1}{20000}$; seacoast of Massachusetts, from Scituate to Saughkonnet river, Rhode Island, $\frac{1}{200000}$; Provincetown harbor, $\frac{1}{50000}$; eastern series, Nos. 2 and 3, $\frac{1}{80000}$; Monomoy shoals, (additions,) $\frac{1}{40000}$; and harbor of Wood's Hole, $\frac{1}{20000}$.

The following are now in progress: Seacoast from Cape Neddick to Scituate harbor, $\frac{1}{200000}$; coast chart from Portsmouth to Cape Ann, $\frac{1}{80000}$; from Cape Ann to Scituate, $\frac{1}{80000}$; from

Scituate to Nausett, $\frac{1}{80000}$; and the general coast chart from Cape Ann to Point Judith. In the engraving division, plates have been completed of seacoast of Massachusetts, No. 1, as preliminary; Plymouth harbor; Boston harbor, (new edition,) and Monomoy shoals; and the following plates are in progress: seacoast of Massachusetts, as a finished chart, Ipswich and Annis Squam harbors, Muskeget channel, and eastern series, Nos. 1 and 2.

Astronomical and magnetic observations.—The erection of buildings near the Coast Survey station, on Thomas' Hill, in Bangor, during the past year, made it necessary to occupy that station this season in order to render available the longitude results there obtained in 1851-'2, by the late Professor Sears C. Walker, assistant in the Coast Survey.

Upon the completion of the measurement of the Epping base, my party was reorganized, and transferred to Bangor for astronomical work, in connection with which it was desirable, at the same time, to fix the geographical position of some point, near the eastern boundary of the United States, which might hereafter be connected with the triangulation of the coast. The charge of this party was assigned to Assistant George W. Dean, who, with Sub-Assistant Stephen Harris, and Mr. Julius Kincheloe, as aid, proceeded to Calais and made the necessary arrangements for executing the work.

The erection of an observing station, in connection with other arrangements at Bangor, was satisfactorily executed, under the direction of Sub-Assistant Edward Goodfellow, during my absence at Washington.

Upon my return to Bangor, early in September, observations were at once commenced for determining the personal equation between Mr. Dean, Mr. Goodfellow, and myself; after which Mr. Dean returned to Calais, and the exchange of star signals for determining the difference of longitude, by the electro-magnetic method, was satisfactorily commenced on the evening of the 18th.

Some very interesting results in regard to personal equation were had, which, however, require careful discussion and study before presenting them.

The weather proving favorable for the work, star signals were exchanged on four nights, between the 18th and 26th, when Mr. Dean returned to Bangor, and a second series of observations were made for ascertaining the personal equation between the observers; upon the completion of which Mr. Goodfellow proceeded to Calais and continued the observations at that station until the 26th of October, when the operations for the season were closed.

At the special request of Professor Jack, of Frederickton, New Brunswick, who visited Calais for the purpose of witnessing our methods of operating, star signals were exchanged on one night between Frederickton and Calais; Professor Jack conducting the operations at the former station, and Mr. Goodfellow at the latter.

The telegraph lines between Bangor and the eastern stations were in excellent condition, and the experiments for differences of longitude proved highly satisfactory. Through the courtesy of James Eddy, esq., general superintendent for the American Telegraph Company, the lines were placed at the disposal of the Coast Survey, after the regular business hours, 9 p. m., and all messages relating to the experiments were, at all times, sent free. The local superintendents, Messrs. Bedlow and Stevens, also the operators at the several stations upon the lines, extended every facility for the successful prosecution of the work.

Mr. Dean officially acknowledges, in appropriate terms, the facilities extended to the Coast Survey by the trustees of the Calais Academy, who cheerfully accorded to him the privilege of establishing a Coast Survey station in the academy grounds.

During the progress of the astronomical observations at Bangor, the angles necessary for connecting the geodetic station with Mount Harris and Mount Waldo were measured by Assistant C. O. Boutelle.

The following statistics exhibit in brief the work executed by the parties at Bangor and Calais, betwen September 1 and October 26.

At Bangor two hundred and ninety-three observations were made for determining the local time and instrumental corrections; forty-one circumpolar stars were observed for ascertaining the equatorial intervals of the threads; and two hundred and twenty-five stars were observed by the electro-magnetic method, on seven nights, in connection with the station at Calais, for determining the difference of longitude between these stations. The instrument used in making these observations was a forty-six inch transit, made by Troughton & Simms, (C. S. No. 6,) which has for several years been used for similar observations.

Latitude observations.—The observations for latitude were made by Sub-Assistant Goodfellow and Mr. Dean, and consisted of two hundred and fifteen observations upon forty-one pairs of stars, with the zenith telescope, C. S. No. 5. The value of one revolution of the micrometer of the instrument was determined by one hundred and sixty observations upon the circumpolar star, 51 *Cephei,* near its eastern elongation. Thirty observations were made with the micrometer upon a distant mark for ascertaining the value of the divisions of the level scale upon the telescope. The stars observed for latitude were, as far as practicable, selected from the Greenwich Twelve-Year Catalogue.

Magnetic observations.—The magnetic observations were made near the geodetic station by Sub-Assistant Stephen Harris, aided by Mr. Henry W. Bache, and consisted of one hundred and ninety-five, for declination, during four days; two sets for horizontal intensity and moment of inertia, and five sets for dip. The latter observations were made at different localities in the vicinity of the geodetic station, but no differences were obtained which indicated local attraction. The instruments used were declinometer D. 22 (C. S. No. 1) and dip-circle C. S. No. 4.

Meteorological observations.—The usual meteorological journal was in charge of Mr. Henry W. Bache, one of the aids in my party. One hundred and seventy observations for temperature, and an equal number for determining the evaporating point were recorded. One hundred and seventy readings of the barometer (Greenwich, No. 910, and Dent's aneroid, No. 8,580) were also noted, with general remarks upon the winds, clouds, and other conditions affecting the state of the atmosphere in the immediate locality of the station.

Mr. A. T. Mosman aided in the longitude experiments, and read off the chronographic sheets for clock and azimuth corrections and equatorial intervals.

At Calais, two hundred and eighteen observations were made for determining the clock and azimuth corrections, and two hundred and eleven stars were observed for differences of longitude by the electro-magnetic method, in connection with the Bangor station, by Assistant G. W. Dean, and Sub-Assistant Edward Goodfellow.

Latitude observations.—The latitude was determined by Sub-Assistant Stephen Harris from one hundred and eighty-six observations, upon forty-four pairs of stars, with zenith telescope No. 4, C. S. For ascertaining the value of the micrometer, one hundred and sixty-five observations were made upon Polaris, near its eastern elongation. The arc value of the level divisions upon the telescope was determined by seventy-five observations upon a collimater, which was adjusted to a sidereal focus.

Magnetic observations.—The magnetic observations were made at a point about one hundred and fifty metres south of the astronomical station by Sub-Assistant Harris, aided by Mr. Julius Kincheloe, and consisted of one hundred and ninety-four readings for declination, on four days, three complete sets for horizontal intensity and moment of inertia, and four sets for dip.

Mr. Kincheloe also assisted in the longitude experiments, and read off the chronographic sheets for instrumental corrections.

Meteorological observations.—The usual meteorological journal was kept, in which were recorded one hundred and fifty readings of a standard barometer, and corresponding readings of the thermometers for temperature and evaporating point.

The observing station at Calais was erected by Thomas McDonnell, artificer in the Coast Survey.

Assistant Dean and Sub-Assistant Goodfellow are under instructions to organize parties for the telegraphic determination of longitude between Mobile and New Orleans.

Sub-Assistant Harris has been assigned to the party of Assistant J. E. Hilgard in Section VIII.

Measurement of a base of verification on Epping plains, Maine.—The preparation of the site selected on Epping plains, Washington county, Maine, as a base for verifying the primary triangulation in this section was begun by Assistant C. O. Boutelle, in the autumn of last year, at which time a topographical survey of the line was made by Lieutenant J. C. Clark, U. S. A., assistant.

In the spring of the present year the work was resumed; the line carefully marked out, levelled, and grades established at the beginning of each slope throughout its length. These preparations were completed early in July, and I immediately commenced the preliminary comparisons necessary to determine the length of the bars used in the apparatus. The comparisons were made with Saxton's pyrometer, the same apparatus which has been employed for the purpose at various bases in the survey. Its essential parts consist, as heretofore, of two stone pillars, one to support an abutting screw, and the other a mirror; a third pillar supporting a reading telescope and a paper scale, upon which, as reflected in the mirror, the different lengths of the measuring bars and standard are recorded. Twenty-three sets of comparisons were made before commencing the measurement, at temperatures ranging from 60 to 72 degrees Fahrenheit, each set consisting of one reading of each measuring bar, and two readings of the standard.

The measurement was begun at the western end of the base on the 20th of July, and continued, with the interruption of nearly a week by reason of bad weather, until the 3d of August. Allowing an average of ten hours to a day, the actual number of working days employed in the measurement would be six and three quarters. The greatest number of tubes measured in a single day was two hundred and eighty-one or 1·05 miles. For three consecutive days the rate of progress was rather more than a mile per day. After the measurement twenty sets of comparisons were made between the bars and the standard, at temperatures ranging between 60 and 75 degrees of Fahrenheit. The length of the base uncorrected for inclination of the bars is 8718·64 metres or five miles and four-tenths. The point marking the western end of the line is cut into a solid ledge of rock. That marking the east end is secured by a heavy stone monument.

The chief peculiarity of this base, as distinguished from other primary bases in the work, arose from the necessity of employing heavy grades to overcome the great irregularities of the surface. The line measured and profiles of the base are represented on Sketch No. 3. A detailed description of the site, of the means employed in the measurement, and comparisons of the progress, with the statistics of other primary bases, are contained in Appendix No. 26.

As more considerable slopes were to be measured on this line than upon those heretofore measured in the Coast Survey, elaborate observations were made at the office, under my direction, by Assistants J. E. Hilgard, Joseph Saxton, and Mr. J. M. Batchelder, to test the base apparatus as to flexure or motion upon a slope, and as to the length upon a slope, the constancy of which with varying inclinations depends upon the form of the bed upon which the stem carrying the knife edge traverses. These were very difficult and laborious, but in the end quite satisfactory.

I was assisted in this measurement by Professor Rogers, of the University of Pennsylvania, who volunteered for the purpose, by Assistant Dean, Sub-Assistants Goodfellow, Sullivan, and Harris, and by Mr. T. McDonnell; Professor Fraser, of the University of Pennsylvania, was also present at the early part of the measurement, and Dr. Gould near its close.

The operation attracted a very large number of visitors from the surrounding country, who cheered us by the interest they took in the work.

Two monuments of granite were placed perpendicular to the base, on the north side, at the distances of thirty-six and seventy-two metres, respectively, from the eastern terminus. These are each 3.5 feet long, by a foot square, and are surrounded by wooden curbs each a foot and a half square. Copper bolts were driven into the tops of each block and wedged, and a line perpendicular to the base at its eastern terminus passes through the copper bolts at the intersection of crosses cut upon the head of each.

The monument marking the eastern terminus is of white marble, 1.64 foot square, and 3.28 feet in height. This rests upon a block of granite (Sketch No. 3) 3.5 feet square and 2.5 feet thick, bedded on a foundation a foot in depth and five feet square. A plinth for the western monument, seen in Diagram No. 3, was cut from the rock in place at that terminus.

Sections through the eastern and western ends of the base are also shown on Sketch No. 3. The levels marked on the diagrams were referred to a zero assumed as 100 feet below the bench mark near the eastern terminus. The tidal observations thus far made indicate that this zero line is 145.4 feet above the plane of mean level of the sea. This gives for the eastern a height of 254.7 feet above the sea, for the summit of the base 277.7 feet, and for the western terminus 238.4 feet.

Triangulation eastward from Kennebec river, Mainé.—This work was resumed under the direction of Lieutenant A. W. Evans, U. S. A., assistant in the Coast Survey, on the 7th of August, by his party in charge of Sub-Assistant B. Huger, jr., in the schooner Hassler. Six stations of the previous year were re-occupied, and observations completed at them. The triangulation covers the towns of Westport, Edgecombe, Booth bay and Southport, Monterey bay, Sheepscot river to Wiscasset, Townsend and Linican bays, and the Damiscove islands. Points were established throughout the limits of the work for the uses of a topographical party. The whole number of positions correctly fixed by a triangulation is forty-five. Sub-Assistant J. A. Sullivan, who had been engaged in the grading of the base site on Epping Plains, joined the party on the 14th of August, and assisted until the close of the season. The stations of the previous year were visited by Mr. G. E. Humphries, the aid in the party, and secured under the direction of Sub-Assistant Huger. The following are the statistics of the work:

Stations occupied	11
Objects observed on	87
Horizontal angles measured	226
Number of observations	1,344

Twenty-one vertical angles were measured at four stations, upon eighteen objects, by two hundred and ninety observations with the theodolite. The heights of all the prominent signals were determined.

Mr. Humphries, the aid of the party, was unfortunately drowned in the Kennebec river on the 20th of August, by the upsetting of a boat in which he was returning from Bath, where he had been sent on duty. The energy which he had previously shown in aiding the operations is favorably mentioned in the report of Lieutenant Evans.

Work was discontinued on the 4th of October, and immediate preparations were made for the return of the party in the schooner Hassler to the coast of Georgia. Sub-Assistant Huger then proceeded to commence triangulation work on the eastern coast of the Florida peninsula, and Sub-Assistant Sullivan joined the party of Captain J. H. Simpson, U. S. Engineers, assistant in charge of the air-line triangulation between Fernandina and Cedar Keys, Florida.

The records of horizontal angles and descriptions of signals used in prosecuting the triangulation of Kennebec river have been deposited by Lieutenant Evans in the Coast Survey office.

Topography of shores of Kennebec river, Maine.—The shore line of this river, and principal features along the banks, have been surveyed by the party of Sub-Assistant W. S. Gilbert. The lower limit of this topographical sheet, the details of which were furnished, from time to time throughout the summer, to the hydrographic party, is Cox's Head, near the entrance, where it connects with a sheet executed last season by Assistant I. Hull Adams. The plane-table work was extended upwards beyond Bath, and includes both shores of the river. Assistant Adams directed the operations of this party at the outset of the season. The work was concluded by Sub-Assistant Gilbert on the 1st of October, and is comprised in the follow-detail:

Shore line	55 miles.
Square miles of topography	7 "

Mr. Adams was employed during the remainder of the season in inking his sheets of work executed in Section III. The party of Sub-Assistant Gilbert is now about to take the field in Section VIII.

Topography of Cape Small Point, Maine.—The plane-table work in this immediate vicinity, remaining unfinished at the end of last season, has been completed by Sub-Assistant C. T. Iardella. His sheet embraces the lower part of the western side of Small Point peninsula, and joins on the east with a sheet of the previous year, executed by Assistant I. Hull Adams. It also includes, on the westward, part of Great island, Bear island, Malaga island, Horse island, and a number of detached ledges and smaller islands lying in the entrance to Casco bay. The topography of the main shore was extended from Cape Small upwards to Phipsburg.

Sub-Assistant Iardella also completed the details of a topographical sheet commenced by Assistant S. A. Gilbert in 1854, and connecting on the westward with his own of the present year. Rogue island, Jenny island, Long Ledge, Mark island, and others lying east and north of Ragged island, were surveyed.

The statistics of work are as follows:

Miles of shore-line traced	46
Miles of roads	$8\frac{1}{2}$
Area surveyed, (square miles)	9

Mr. F. F. Nes accompanied the party as aid.

The following is an extract from the report of Mr. Iardella:

"New Meadows river, which divides Great island from the main land, is ten miles in length by three in width, and averaging in depth from twenty to thirty-six fathoms. It is a fine harbor for coasting vessels, being well protected at its entrance by Bear island, and Horse and Malaga islands."

The preparations of Mr. Iardella are now well under way for resuming the topography of the Florida keys.

Topography of shore and islands in Casco bay, Maine.—This work has been continued by Assistants A. W. Longfellow and A. S. Wadsworth, on sheets commenced by the former in previous seasons. The main shore-line of the western side of Casco bay has been traced northward and eastward from Presumpscot river to Parker's Point, at the mouth of Yarmouth river. On the islands lying south and west of a line joining Parker's Point, and the outer extremity of Harpswell neck, the plane-table work consisted of filling in the topography of Great Jebeig island, (the largest in the bay,) and the survey of Little John's, Green, Crow, Goose nest, Stockman's, Eagles, Upper Flag, Haskell's, and Great and Little Mark islands. The last five lie off the southwest end of Harpswell neck, commonly called Potts' Point.

The schooner Meredith was used for transportation, and is about to be transferred with the party, to resume work in Section V.

Mr. Clarence Fendall was attached during the year as aid in the party of Assistant Longfellow.

Topography of Plymouth harbor, Massachusetts.—The topography between Back river, north and east of Duxbury, and extending northwards towards Scituate, has been executed by the party of Assistant A. M. Harrison, completing the survey of the shores of Plymouth harbor. The plane-table work was carried back, towards the interior, about two miles. The character of the country embraced is varied, requiring care and minuteness in the execution of the field-work.

Sub-Assistant Charles Ferguson and Mr. W. H. Dennis were attached to the party of Assistant Harrison. The work was commenced on the 10th of August, and closed on the 24th of September. The party has since been engaged in inking the topographical sheets.

A synopsis of statistics is thus given in the concluding report:

Shore-line surveyed	$10\frac{1}{2}$	miles.
Creeks, &c	35	"
Roads	$13\frac{1}{2}$	"
Area of country, (square miles)	6	

The surveying schooner Peirce was used by the party for transportation, and is now fitting out for duty in Section V.

Assistant R. M. Bache has inked, and returned to the office, his topographical sheet of Back river and vicinity, executed in 1855.

Topographical resurvey of Provincetown harbor, Cape Cod, Massachusetts.—My attention having been called to the progressive changes in this vicinity, a careful resurvey of the shores of the northern extremity of the peninsula of Cape Cod was made by Assistant H. L. Whiting, extending from the Highland light around to Race Point light, and continued from thence to include the inner shore of the harbor at Provincetown. The work was carried down on the inside shore of the peninsula to Pond village, nearly opposite to the Highland light. About twenty miles of shore line were reviewed in this examination. This work was executed after the middle of October, and closed the operations of Mr. Whiting for the season. He reports that the general line of the shore has undergone but few alterations since the survey of 1849. Important local changes, however, have occured, which in his opinion seriously threaten the interests connected with the preservation of East harbor. His report, in detail, giving the results of the resurvey will be found in Appendix No. 10.

Hydrography of Kennebec river, Maine.—The hydrographic party of Lieut. Comg. Stephen D. Trenchard, U. S. N., assistant in the Coast Survey, resumed work on the 30th of August at Cox's Head, within the entrance where the soundings of last season were terminated. Proceeding upwards in the river the hydrography was executed to the upper limits of the city of Bath, shore line being furnished by the plane-table party of Sub-Assistant Gilbert, and during part of the time employed by Assistant I. Hull Adams.

The deficiencies in the hydrography off Seguin island, White Ledge, and Herron island, have also been filled in. The additional soundings made off Herron island develop ledges not shown upon the chart of last year. The anchorage without the river being unsafe, the schooner Gallatin was kept inside, and the work reached each day in boats.

A preliminary chart of Kennebec river (Sketch No. 4) shows the combined results of the topography and hydrography executed within the year.

The great strength of the tide in the Kennebec rendered soundings impracticable, except in the slack water, and the regular progress of the work was in consequence much interrupted.

In the execution of the hydrography, one hundred and forty-two miles were run in sounding, six hundred and fifty-two theodolite and sextant angles were observed, and ten thousand eight hundred and sixty-three soundings made in from one to thirty fathoms water. The tides were observed at six temporary stations between the entrance and Bath.

Lieut. Comg. Trenchard's hydrographic sheet of the coast between Annis Squam and Ipswich, Massachusetts, and the sheet of Kennebec entrance executed last year, have been deposited in the archives.

Hydrography of Casco bay, Maine.—The work of sounding has been continued at the entrance of the bay, by Lieut. Comg. W. G. Temple, U. S. N., assistant in the Coast Survey, in the steamer Corwin. His sheet joins on the east at Cape Small Point, with one of the Kennebec entrance, executed last year by Lieut. Comg. Trenchard. The hydrography of Casco bay was carried westward from Cape Small Point to the meridian of Ragged island, and to an equal distance southward, including about thirty-three square miles in the soundings. One hundred and fifty-one miles were run in making twelve hundred and ten casts of the lead. Angles were observed, for hydrographic purposes, at three hundred and fifty-eight stations, and seven hundred and forty-three angles were recorded.

Within the limits of his hydrographic sheet a ledge, in thirty feet water, was discovered by Lieut. Comg. Temple. It seems to have been unknown to the pilots and fishermen of the vicinity. The position of the ledge was communicated to the Department shortly after its discovery. It lies five and a half nautical miles W.SW. $\frac{3}{4}$ W. (W. $\frac{1}{4}$ S. per compass) from Seguin light-house. The cross-bearings for finding it are given with Appendix No. 9.

Examination of Jordan's rock, near Portland light, and of a shoal in the inner harbor.—The presence of the hydrographic vessels at work during the summer and autumn to the eastward, in the commodious harbor of Portland, having suggested to the Board of Trade of that city the opportunity for a re-examination of Jordan's rock, and of a bank lying in the inner harbor off Union wharf, my attention was called to the subject, and the desired resurvey was made by the party of Lieut. Comg. S. D. Trenchard, in the schooner Gallatin, temporarily in command of Lieut. F. A. Roe, U. S. N., assistant in the Coast Survey.

A number of detached boulders, only two of which projected as much as a foot, were found imbedded in the bank making out from the Cape Elizabeth shore. The positions of several of these, varying from one to two feet in diameter, were determined by Lieut. Roe. He considers the present buoy in that locality well placed, and advises that vessels should not go inside of it.

Jordan's rock was found to be an unbroken ledge, extending about two hundred and fifty yards southward and eastward from the buoy which has been placed at its northern extremity. The surface of the rock is quite uneven, the lead frequently slipping off into water two or three feet deeper than that first found in sounding. Lieut. Roe recommends that a large buoy be placed a little to the northward and eastward of the present one. He remarks that there is plenty of sea room between it and the opposite side of the channel.

The position of Jordan's rock was carefully determined anew by Lieut. Roe, and the soundings in both examinations above mentioned were made under very favorable circumstances.

In-shore hydrography north and south of Newburyport, Massachusetts.—In the latter part of the season Lieut. Comg. Rodgers extended the in-shore hydrography of the coast of Massachusetts from Londoner shoal, near Thatcher's island, (Cape Ann,) northward, beyond Newburyport harbor, to the Isle of Shoals, near Portsmouth. During the progress of this work, he determined the position of a sunken ledge near Straitmouth island. The ledge has only twelve feet water on it, surrounded by ten fathoms. Its existence is known to very few persons, and has even been doubted by mariners living in its immediate neighborhood. The flat ground to the northward and westward of the Salvages was also examined, and as little as two feet water found in places on it. The recommendation of Lieut. Comg. Rodgers for a buoy to mark this dangerous ledge has been forwarded through the department to the Light-house Board.—(Appendix No. 60.)

The following is a summary of the statistics:

Miles run in sounding	1,914
Number of angles recorded	4,036
Number of soundings	11,730

The records of the hydrographic work of last year, including journals and duplicates of soundings, angles, and tidal observations, made in Nantucket and Martha's Vineyard Sounds, have been completed and placed in the office.

Off-shore soundings, eastward from Massachusetts bay.—In continuation of the deep sea work executed last year to the eastward of Cape Cod peninsula, Lieut. Comg. C. R. P. Rodgers, U. S. N., assistant in the Coast Survey, with the steamer Bibb, resumed at Cape Ann and carried a line due east to the meridian 66° 30′ W. The line then passed southward to the latitude of George's bank, and was extended westward to Stellwagen's bank, in a course generally parallel to that carried out. A second line was run off-shore, from a point three miles south of the Highland light, on Cape Cod peninsula, to the same meridian, and thence carried southward and northward, alternately, so as to traverse the vicinity southward and eastward of George's bank, with five lines of soundings parallel and at equal distances from each other. Two other lines running eastward and westward, after considerable progress had been made, were interrupted by gales.

The lines run were about ninety miles in length, and very nearly fill the spaces left in the off-shore soundings of previous seasons.

On my application through the Department, the revenue cutter Morris was placed at the disposal of Lieut. Comg. Rodgers, and was used for a new examination of George's bank.

"The position of the shoalest water seems to be the same as it was when surveyed by Capt. Wilkes twenty years ago. The least depth found by us was thirteen feet at low water—two feet less than the least found in the examination made in 1837." The character of the bottom on George's bank is described in a report from Lieut. Comg. Rodgers, given in Appendix No. 11.

In the vicinity of Little George's bank, a small shoal with only thirty feet of water on it was discovered by this party about ninety miles from the nearest land. Its true position is given in Appendix No. 12.

Lieut. Comg. Rodgers makes special mention of the efficiency with which Captain Whitcomb, of the revenue cutter Morris, co-operated in the examination of George's shoal.

Deep sea soundings.—On the outward passage of Lieut. Comg. O. H. Berryman, U. S. N., assistant Coast Survey, in the steamer Arctic, for special duty directed by the Department, a line of soundings was run in July along the inner edge of the Gulf stream. From a position southeast of the Nantucket shoals, in latitude 40° N., this line was carried in a direction parallel with the general trend of the coast to a position in latitude 44° N., a little to the east of Sable island. Specimens were brought up from depths varying from five hundred to fourteen hundred and forty fathoms.

In *February* last I was directed by the Treasury Department to have certain incidental surveys made by this party in aid of the Telegraph Company's operations, who had been so liberal to the Coast Survey. These were satisfactorily executed by Lieut. Comg. Berryman, and the charts resulting from them have been forwarded to the office and communicated to the company. This incidental work, which has added little to the cost of the party, is but a small return for the gratuitous use of the telegraph lines, which the Coast Survey has enjoyed through all the lines of the United States, and which have been presented to it by this company, so that, had the cable been successfully laid, we could at once have availed ourselves of the transmission of signals to it, to connect America and Europe in longitude by telegraph. One set of signals transmitted to and fro would have done more than all the astronomical observations yet made, and the chronometer results observed, to give a satisfactory longitude.

On his return, Lieut. Comg. Berryman was successful in obtaining soundings along a line carried southward from Halifax, N. S., to the parallel of 38° N. latitude. The soundings were found to deepen very suddenly a little above the latitude 42°. At the greatest depth, which occurred in latitude 38° N., longitude 68° W., the line parted after bottom had been reached in 2,987 fathoms.

Tides and currents.—In continuation of a series of observations conducted under my immediate direction, Sub-Assistant H. Mitchell placed tide-gauges at Monomoy, Falmouth, Menemsha, and No Man's Land, in the vicinity of Nantucket and Vineyard sounds, and has secured a large amount of valuable data bearing upon the development of the interferences known to exist in the tides of this part of the coast.

In connection with these, fifty current stations were occupied by three divisions of his party, working simultaneously. These stations were so arranged as to furnish the necessary data for a chart of co-current lines, embracing the two sounds and their approaches. Mr. Mitchell made also a physical study of the shoals, their causes and type curves. A detailed account of the operations as conducted by Mr. Mitchell will be found in Appendix No. 35.

The permanent tidal station at the dry dock of the Charlestown navy yard, Massachusetts, was kept up until the 1st of August by Mr. Isaac Williams, whose punctuality and faithfulness have already been alluded to in former reports. Since his death, which occurred in August, the gauge has been in charge of Mr. Thomas E. Ready, whose previous connection with Mr. Williams tends to confirm the expectation that the observations will be continued with a like degree of care and attention.

Light-house examination.—In accordance with directions given by the Department, a re-examination has been made of the point of rocks at Westport, Massachusetts, in order to determine the expediency of erecting a light-house there. This duty was executed by Lieut. Comg. C. R. P. Rogers, U. S. N., assistant Coast Survey. His report, with the conclusions reached in his examination of the vicinity, will be found in Appendix No. 56.

SECTION II.

FROM POINT JUDITH TO CAPE HENLOPEN, INCLUDING THE COAST OF CONNECTICUT, NEW YORK, NEW JERSEY, PENNSYLVANIA, AND PART OF DELAWARE.—(SKETCH B, No. 11.)

The outstanding work in this section has occupied one triangulation party during the season, two topographical parties during part of the season, (one a double party,) and two hydrographic parties during part of the season, besides which special investigations of tide and currents have been made during parts of the season, and the regular tidal observations in New York harbor have been kept up. A portion of this work is new, and a part belongs to essential work of verification. It was all provided for in the estimates and directions of the Treasury Department, the supplies from the New York Commissioners on Harbor Encroachments having ceased. The mutually advantageous connection of the Coast Survey and Harbor Commissioners has been referred to in the introduction to this report at some length. The Superintendent of the Coast Survey has been requested by the legislature of the State to complete the physical survey of the harbor and the Commissioners' map, but no special appropriation has yet been made for the purpose of defraying the expenses.

The report in regard to changes in New York bay and harbor by the Chief Engineer of the United States and Superintendent of the Coast Survey, acting as advisory counsel to the Commissioners, is given in Appendix No. 37. The wharf lines for the harbor and bay of New York, recommended by the Commissioners on Harbor Encroachments on the report of their advisory counsel, based upon the Coast Survey maps and results, were adopted by the legislature of New York, putting the crowning action to one of the most useful and successful operations ever executed by the survey, or for which it has furnished the materials. The preservation of this noble harbor, so important to the resources of the government and to the prosperity of our country, from further encroachment in the future, is thus assured, while the interesting and encouraging result is made known that the entrance to the bay has not deteriorated within the last twenty years in depth of water and regimen of channels; and a reasonable expectation is held out that by physical investigations of the tides and currents of the bay and harbor the causes of change may be so ascertained as to place them under efficient control for all future time.

Office-work.—Within the year drawings have been completed of a comparative chart of Hudson river between Albany and New Baltimore, 1852–'53 and '56, on the scale $\frac{1}{20000}$, and of a chart of Long Island sound, No. 3, (south side,) $\frac{1}{80000}$. The engraving of the same sheet and of Long Island sound, No. 2, adjoining, has been completed, and the drawing and engraving of a new edition of the chart of New York harbor, $\frac{1}{800}$, are in progress at the date of this report.

Triangulation of Hudson river.—The connected triangulation of this river has been continued upwards from the vicinity of Poughkeepsie. Assistant Edmund Blunt was engaged in this work from the 8th of August until late in November, and closed operations for the season at Station Burhanes, a short distance above Tunnel Point. The extent of the river course included in triangulation within the limits stated is about seventeen miles. A series of small triangles confined within the banks, but connected with the chain passing up the river, will furnish ample means for the execution of the topography.

Mr. Blunt was assisted during the season by Lieutenant A. H. Seward, U. S. A., assistant Coast Survey, and Sub-Assistant G. H. Bagwell. The statistics of work are thus reported:

Primary stations occupied	10
Secondary stations occupied	70
Series observed on primary signals	189
Series observed on secondary signals	724
Number of observations	9,018

The area embraced in the triangulation is about forty-seven square miles. Six volumes, containing duplicates of the measurements for horizontal angles, and another with descriptions of the stations and signals used on the Hudson river, have been furnished by Assistant Blunt, and deposited in the office.

Topography of the environs of New York harbor.—The party of Assistant H. L. Whiting, during the entire season, and two others under his general direction in the field, have been engaged in filling in the supplementary details necessary to complete the resurvey of New York harbor.

Assistant Whiting resumed work on the 22d of April, and completed, in detail, the survey of the northwest part of Staten Island, which had been interrupted by severe weather at the close of last season. The party was then transferred to Hoboken, New Jersey, and executed a regular plane-table survey of the west side of Hudson river, from below Jersey city to a point opposite Spuyten Duyvel creek. The work in this vicinity was carried inland, so as to embrace all the topographical details of Jersey city and Hoboken and the high land back of them. The *Palisades* form the principal feature on the two sheets of work executed in this locality.

The statistics of plane-table work executed on the western side of New York harbor by the party of Mr. Whiting are as follows:

Shore-line surveyed	16 miles.
Creeks	5 "
Marsh line	9 "
Roads	61 "
Area in square miles	14 "

The party of Mr. John Mechan commenced on the 1st of July, at the limit reached by Mr. Whiting, in 1856, in Bergen neck, (about three miles from its southern point,) and extended the topography northward to a junction with the sheet first noticed as containing the survey of Jersey city. The work was comprised within an average breadth of three-quarters of a mile, between the shore-line of New York harbor on the east and the plank road at its western limit.

On completing the sheet just described, Mr. Mechan took up a second, commencing at 155th street, (New York city,) and supplied the details embraced in the northern part of Manhattan island, extending to Spuyten Duyvel creek: "The island in this part is so wooded that very few opportunities occurred of determining the position of the plane-table by the three-point problem. The thickly studded details, houses, roads, gardens, fields, and villages, were mostly secured by traverses of the plane-table, and carefully verified by the severest tests."

A third sheet, on a scale of $\frac{1}{5000}$, containing Governor's, Ellis', and Bedloe's islands, was also executed by Mr. Mechan before the middle of October.

He thus reports the statistics of the work done by his party:

Shore-line surveyed	28 miles.
Roads	$34\frac{1}{2}$ "
Creeks	6 "
Area in square miles	10 "

The party of Mr. F. W. Dorr filled in, with the requisite details, a sheet extending from Throg's neck, on East river, to High Bridge, on Harlem river.

Under the direction of Mr. Whiting, the aid in his party, Mr. C. Rockwell, made a detailed survey of Ward's and Randall's islands, the North and South Brother, and Ricker's island, in East river. The statistics of this work comprise about ten miles of shore-line, within three square miles of area.

In reference to the character of the plane-table surveys completed under his direction, Assistant Whiting observes: "that executed by Mr. Mechan was detailed and difficult, and was accurately and closely surveyed."

"The work from Throg's neck to High Bridge was executed by Mr. Dorr in a most creditable and accurate manner. The sheet containing the islands, surveyed by Mr. Rockwell, is also a fine specimen of work."

"The topographical surveys just completed are sufficiently in detail to answer all the purposes to which they could be applied. The representations are characteristic and expressive."

Assistant Whiting left his own party, in charge of Mr. Rockwell, in the middle of October, and engaged in a resurvey of Provincetown harbor in Section I.

Mr. Mechan has resumed plane-table work in Section IV, and Mr. Dorr is completing arrangements for continuing the survey of the Florida keys.—(Section VI.)

Two plane-table sheets of the work executed by Mr. Mechan, between Macomb's dam and Spuyten Duyvel creek, and between Communipaw and Palmispaw, have been inked and returned to the office.

Hydrography of New York harbor and approaches.—The supplementary work of the present season was executed by the party of Lieut. Comg. W. G. Temple, United States navy, assistant in the Coast Survey, with the steamer Corwin. Newtown creek was sounded out, and East river, from the mouth of the creek to a line crossing Blackwell's island at the penitentiary.

The hydrography of Hell Gate and its approaches from the eastward was also executed, and that of Little Hell Gate; Harlem Kills; and the connecting passages to the eastward of Randall's island.

The least depth of water on the several rocks at Hell Gate was determined by *sweeping.* "One of the large sounding boats was laid broadside to the current, nearly at slack water, having a loaded pole, twenty-four feet long, suspended by lead lines from the bow and stern. The boat was then allowed to drift slowly over the rocks, the pole being always kept so as to touch the bottom. At the instant of finding the shoalest water, the position of the boat was carefully determined, and the operation was repeated until the whole vicinity had been thoroughly swept."

The soundings, when reduced to mean low water, gave the following results:

Depth on Pot rock	18 feet.
Depth on Way's reef	13 "
Depth on Sheldrake's rock	17 "
Depth on Frying Pan	9½ "
Depth on Heel Tap rock	10 "

Lieut. Comg. Temple also sounded out Spuyten Duyvel creek, from King's Bridge to the Hudson river. The statistics of the work are:

Miles run in sounding	25½
Number of soundings	1,715
Stations for angles	99
Angles observed	690

After the completion of this work, the party in the steamer Corwin was engaged in the hydrography of Casco bay, as stated under the preceding section.

The channel of the East river, to the westward of College point, was re-examined by Lieut. Comg. Temple and found to be somewhat improved in depth since the older survey.

A thorough search was made by the party in the steamer Corwin for the site of a wreck alleged to have been lodged in the lower bay, and around which it was supposed that sand might be accumulating. Numerous lines of soundings were run over the spot in question, which had previously been marked by a buoy. Only a small portion of the wreck was found remaining, but it did not appear that any shoal formation had commenced. Lieut. Comg. Temple's report is given in Appendix No. 14.

The new form of sounding apparatus suggested by Lieut. E. B. Hunt, Corps of Engineers, assistant Coast Survey, the application of which, in practice with some necessary modifications in regard to details, had been arranged for by Mr. J. M. Batchelder, was tested in the channel near the navy yard. I subjoin in Appendix No. 48 a communication from Lieut. Comg. Temple, giving the result of the trials made, and comparisons between, the soundings determined by the water pressure and those obtained at the same time by the ordinary lead line. Having previously witnessed the performance of the apparatus in still water, in which the agreement of the results was remarkably close, it may be inferred from those given in the report of Lieut. Comg. Temple that, with some further modification, the method may be adapted to soundings generally in any ordinary depth of water.

The hydrographic chart of East river, between Hell Gate and Throg's Neck, the details of which were executed by the party of Lieut. Comg. Craven, has been completed and deposited in the archives.

Hydrography of Hudson river.—The regular survey of this river was continued by the hydrographic party of Lieut. Comg. Richard Wainwright, U. S. N., assistant Coast Survey, until the time of his detachment from the work. Soundings were commenced at Fort Montgomery and extended up the river. In the middle of August the schooner Nautilus was put in charge of Lieut. Comg. James H. Moore, U. S. N., assistant, and the work prosecuted upwards as far as the railroad station, above Newburg, a distance by the river course of about fifteen miles and a half above Fort Montgomery. The survey was retarded by bad weather in October.

The deepest water found is abreast of Fort Montgomery, (28 fathoms,) and in the bend of the river, between West Point and Cold Spring, ranging from 36 to 28 fathoms. After passing Cold Spring, the water gradually shoals to Newburg bay, where the depth ranges from 7 to 9 fathoms. The channel here, as in the northern part of the "Race," is on the western side of the river.

Soundings were discontinued on the 7th of November. The following is a synopsis of the statistics:

Miles run in sounding	252¼
Signals established	27
Angles determined	2,025
Number of soundings	19,767

Three tidal stations were occupied for hydrographic purposes.

The original hydrographic sheet of the Hudson, between New Baltimore and Albany, together with records of angles, soundings, and tidal observation made by the party of Lieut. Comg. Wainwright in 1854, 1855, and 1856, have been deposited with duplicates in the office.

Lieut. Comg. Moore is now about to prosecute the hydrography in Section V, assigned to Lieut. Comg. S. D. Trenchard a short time previous to the detachment of that officer.

Tides.—The self-registering observations of tides at Governor's Island, New York harbor, were suspended during the winter, and replaced by observations on a common box-gauge at the Atlantic Dock ferry, in Brooklyn.

The self-registering tide-gauge was replaced on the 1st of May, and put under the charge of Mr. R. T. Bassett.

A special series of observations on the tides and currents at Hell Gate was conducted by Sub-Assistant H. Mitchell during the early part of the spring and summer.

The object and scope of these investigations are stated in his report, which will be found in the Appendix, No. 35.

SECTION III.

FROM CAPE HENLOPEN TO CAPE HENRY, INCLUDING THE COAST OF PART OF DELAWARE, MARYLAND, AND PART OF VIRGINIA.—(SKETCHES C, Nos. 16—24.)

The body of the triangulation, nearly three-fourths of the topography, and quite four-fifths of the hydrography of this section are complete. The operations of the past year have included the triangulation of the Patuxent river, which is nearly completed; of the branches of the Rappahannock, completed; of York river, which is completed from the mouth to West Point; and of James river, which is nearly complete from Richmond to Chesapeake bay. The topography of the seacoast of Virginia has made further progress; the shore-line and topography of the immediate shores of the Rappahannock river, and of its tributary, Curratoman river, have been completed, and the topography of York river is nearly finished. The hydrography of Patuxent river has made considerable progress; that of the Rappahannock and its lower tributaries has been completed. That of the York river has been executed from the mouth to West Point, the junction of the Pamunkey and Mattaponi rivers; and that of the James river has been completed to within nine miles of City Point.

The details of all these surveys will be found in this chapter. The only large piece of work remaining in this section is the survey of the Potomac river, for which there are two bases: one near the entrance, and the other near the head of tide, in the vicinity of Washington and Georgetown, both connected with the main triangulation of the coast.

Office-work.—Drawings have been made, or are in progress, of the following sheets, viz: Rappahannock river from Fredericksburg to Port Royal; Hampton Roads; Norfolk harbor; Chesapeake bay series; York river and James river, upper part; the engraving of Patapsco river as a finished map; Chesapeake bay $\frac{1}{300000}$, Nos. 1, 2, and 3; Rappahannock river, Nos. 3 and 4, as finished. York river entrance and Hampton Roads are now in progress.

Triangulation of Patuxent river, Maryland.—Lieutenant J. P. Roy, U. S. A., assistant, after completing work in another locality in this section, made in May a general reconnaissance on both sides of the Patuxent river in the vicinity of Setterly Point, where the triangulation, carried upwards from the entrance, had terminated in 1846. Not recognizing the stations before occupied, he laid out a series of triangles above the limit of the work of that year, extending from Leonard's creek to a point about five miles above Benedict. The chain thus projected is provisionally independent of that coming from the entrance of the river, but a proper connection will be made with it in the coming season. Fifteen stations were erected in the prosecution of the work, and the angles were measured by sixteen hundred observations. This duty was commenced on the 13th of May, and continued till the 5th of July, when Lieutenant Roy returned to the office. The limits of the triangulation are shown in Sketch No. 16. Duplicates of the descriptions of signals erected in the present season have been furnished by Lieutenant Roy, and deposited in the archives of the section.

Triangulation of Potomac river, Virginia.—This work was commenced in the summer, by Mr. Farley, in the vicinity of Alexandria. Seven stations were occupied, and eight hundred and sixteen observations made.

Triangulation of St. Mary's river, Maryland.—Immediately after the completion of the hydrography of this river, which will be presently described, Assistant John Farley determined the stations and signals used in making the soundings. Ten stations were occupied in the triangulation, and in its connection with the Potomac river, and fourteen hundred and twenty-eight observations were made in the measurement of angles.

Triangulation of Curratoman river, Virginia.—The triangulation of Curratoman river, a tributary of the Rappahannock, which falls in on the north side of that river a few miles above its entrance into Chesapeake bay, was carried, by Assistant John Farley, from Gray's Point and Station "Whiting," (see Sketch No. 16,) on the south side of the Rappahannock, and opposite the mouth of the Curratoman, upwards to the steamboat wharf at Merry Point.

This work checks the preliminary triangulation previously executed of the vicinity by the plane-table party of Assistant I. Hull Adams, on the basis of which the shores of Curratoman river and Carter's creek were completed during the season. Assistant Farley occupied fourteen stations, and made twelve hundred and ten observations in completing the triangulation of the Curratoman. He then proceeded with the work on James river.

Triangulation of York river, Virginia.—At the date of my report of last year, Lieutenant J. P. Roy, U. S. A., assistant, having reached Yorktown on the 20th of October, was engaged in completing the triangulation of the river above Purtan island, where his operations closed on the advance of the previous summer.

Sixteen stations were occupied, and fourteen new triangles laid out, and measured by one thousand six hundred and eight observations. The work was carried above West Point to Glass island, on the Mattaponi, and to Taylor's Quarter, on the Pamunkey river. The data furnished by the triangulation were subsequently used by the hydrographic party, as will presently be noticed. Lieutenant Roy closed operations on the 8th of December, and before taking the field again in this section deposited at the office sketches and descriptions of the signals erected on York river, and two volumes containing the records of horizontal angles measured.

The collector at Yorktown kindly loaned a custom-house boat to facilitate the progress of the party. At the opening of the present surveying year a considerable part of the triangulation of York river remained for execution. This, as already noticed, has been completed, and the results of the concluding operations of the hydrographic party are shown in the preliminary chart (Sketch No. 22) accompanying this report.

Triangulation of James river, Virginia.—This work was advanced from its former limits in the direction of Chesapeake bay, during the months of October, November, and December, of last year, by the party of Assistant John Farley. Twenty-one stations were occupied below the mouth of Chickahominy river, and the triangulation is now complete nearly to Newport News. About four thousand angular measurements were made in the extension of the work. The records of horizontal angles observed on James river, and descriptions of the signals used in the triangulation, have been completed and deposited at the office.

It is expected that a connection will be made early in the ensuing season between the series on James river and the triangulation of Chesapeake bay. The two stations adjacent to Newport News (see Sketch No. 16) have been partly occupied by Assistant Farley; but his attention was turned, before completing them, to work on the Rappahannock and on the Potomac, near Alexandria. Notice having been given of the intended removal of the cupola of the Theological Seminary, which had been used as a station in the triangulation of the Potomac, it was necessary to complete the connections with that station in the course of the summer. Sixteen stations were occupied in the triangulation of the James river, and seven on the Potomac in the neighborhood of Washington and Alexandria. The number of angles measured during the season was one hundred and sixteen, in which five thousand two hundred and sixty-four observations were recorded.

Topography on the seacoast of Virginia.—This work has been continued by Mr. N. S. Finney, northward from Wallop's island, where his sheet joins with the one last executed by Assistant G. D. Wise. The party of Mr. Finney took the field at the end of July, and steady progress was made until the 25th of September, the weather being uniformly good for field operations. The topography executed embraces all the shore-line and details of the north end of Wallop's island, the marsh islands in Chincoteague bay, and the southern, and part of the western, side of Chincoteague island. The shore line of the main was also traced from Snead signal, where the work of Assistant Wise terminated in 1856, northward and eastward to the boundary line between Virginia and Maryland, beyond Long Point. The limits of the topographical sheet are represented on Sketch No. 16. Mr. Finney thus reports the statistics of his plane-table work:

Miles of shore line surveyed	91
Miles of road	9
Area included in topography, (square miles)	16

The progress was somewhat retarded by sickness in the party; all the hands engaged being, by turns, attacked with ague and bilious fever.

Before returning to the office, Mr. Finney determined and secured a sufficient number of points to serve for the plane-table work of next season in the vicinity.

Mr. J. L. Tilghman served as aid in the topographical party, and efficiently assisted in the duties of the season.

Mr. Finney has inked his sheet and deposited it in the office. His preparations have since been made for returning to carry on the topography of the shores of Waccasassa bay, in Section VII.

Topography of Rappahannock and Curratoman rivers, Virginia.—The preliminary topography of the Rappahannock river, which has been for several successive seasons in progress between Fredericksburg and the entrance into Chesapeake bay, was completed during the year by the party of Assistant I. Hull Adams. At the date of my last annual report, it had been extended downwards on the immediate shores of the river to a point above the mouth of La Grange creek.—(See Sketch No. 16.) The work was this season carried in the direction of the river, to a junction with the sheet executed near the entrance, by Assistant John Seib. Sketch No. 16 represents the limits and proportions of the various sheets, which require, however, in many cases, filling up of interior details. The work of the season lies immediately adjacent to the mouth of Curratoman river, the shores of which were surveyed on a separate sheet. Above the Curratoman, the topography was resumed at Stations "Jones" and "Spindle," respectively, on the north and south banks of the Rappahannock, and pushed southward and eastward a distance of rather more than eighteen miles, to a station below Parrott's island, falling on the sheet of Assistant Seib. The width of the part of the river included in this plane-table work varies between two and three miles. La Grange, Robinson's, and Urbana creeks, were surveyed in connection with the shores of the main river, the work being carried up the last mentioned stream two miles and a half above its mouth, and including the town of Urbana and the topography intervening between it and Robinson's creek. Field operations were suspended during winter, and resumed on the 1st of May at Beach Point and Bailey's Bluff, below the mouth of Urbana creek. Proceeding from thence in the direction of the river towards its entrance, the shores of the Rappahannock were traced to Toll's Point at the mouth of Curratoman river. The sheet of the Curratoman extends about six miles above its entrance into Rappahannock river, and includes its several branches known as Taylor's creek, Eastern branch, and Whitehouse creek. From Curratoman Point, the work was carried down the Rappahannock, and in its course embraces the shores of Carter's creek on the north side, and Meachim's, Lockley's, and Mill creeks on the south side of the main river.

"The Curratoman river is about two miles and a half in width at its entrance, but diminishes to a quarter of a mile at Merry Point, a distance of five miles and a half from its mouth."

"At Merry Point a landing has been built and steamboats stop there in passing to and from Fredericksburg and Baltimore."

The statistics of the season's work at the Rappahannock are as follows:

Shore lines surveyed	101 miles.
Roads	3 "

Sub-Assistant Charles Ferguson was attached to the topographical party. The plane-table work was completed in the field on the 29th of June, when the surveying schooner J. Y. Mason, which had been used for transportation, returned with the party to Baltimore, and Assistant Adams was engaged in office-work and in field-work, in Section I, during the summer.

The recent sheets of the survey of the Rappahannock river were inked during the summer, and have been registered in the Coast Survey office.

Topography of York river, Virginia.—A plane-table sheet, executed by Assistant John Seib in 1855, included the mouth of this river, and its shores, to within three miles of Yorktown. The topography was resumed on the 21st of August, by the party of Mr. Seib, and continued with a view to the completion of the survey before the close of the season. Progress was reported on the 1st of October, at which time sixty miles of the shore-line had been traced in carrying the work upward, to the immediate vicinity of Bigler's mill, about seventeen miles from the mouth of the river. The plane-table work includes the details within a border varying in width, from a quarter to half a mile along the banks.

Mr. W. S. Edwards aided Mr. Seib in the topography, and in inking his sheets of previous work.

At the close of the surveying season, the plane-table work on York river had reached a point only a short distance below the junction of the Pamunkey and Mattaponi rivers.

Hydrography of Patuxent river, Maryland.—From points furnished in the recent work of triangulation, before noticed, the soundings in this river have been extended from the entrance to Leonard's creek by the party of Commander W. T. Muse, U. S. N., assistant Coast Survey, in the surveying steamer Hetzel. This work was executed towards the close of the season, the party having been previously engaged in three localities of Section IV. The statistics are thus given in a summary report from Commander Muse:

Miles run in sounding	182
Number of soundings	14,374
Number of sextant angles	848
Tidal observations recorded	430

In connection with the soundings, twelve high and ten low waters were recorded.

Commander Muse remarks that the facilities at the entrance of the Patuxent are such as to invite commercial enterprise: "Vessels of any size can enter and be well protected. Higher up the channel is sufficiently deep, but too narrow for vessels of large size."

Hydrography of St. Mary's river, Maryland—This work has been executed in advance of the topography, by the hydrographic party of Commander Muse. A proper junction was made with the soundings of the Potomac river, to which it is a tributary.

After a remark similar to that quoted in reference to the Patuxent, Commander Muse observes: "The largest vessels can enter the St. Mary's river with ease, and be well protected. Its short distance from Chesapeake bay would enable vessels to leave in the severest winters, while others remain blocked in ice at most of our large cities. At convenient distances the river is indented by bays, which admit of vessels remaining at anchor to load and unload, without interfering with the main channel."

The following are statistics of the hydrographic survey of the St. Mary's:

Miles run in sounding	135
Number of soundings	8,748
Number of sextant angles	562
Tidal observations recorded	163

For purposes connected with the reduction of soundings, four high and five low waters were observed.

The work here under notice was executed in November. Following in strict geographical order, it will presently be seen that the operations of this party were resumed at the usual period of the season, in charge of Lieut. Comg. J. J. Almy, U. S. N., who was relieved by Commander Muse in July. Further duty executed under the command of the last named officer will be stated under the head of Section IV.

Hydrography of Rappahannock river, Virginia.—This work, in which steady advance has been made since its commencement, by the party of Lieut. Comg. Richard Wainwright, U. S. N., assistant Coast Survey, has been completed within the season just closed.

The surveying schooner Nautilus, with the hydrographic party, reached her station from the Hudson, on the 22d of November, near the upper limit of the topographical sheet last executed by Assistant I. Hull Adams in 1856, (Sketch No. 16;) and the soundings were continued from that point down the Rappahannock to the mouth of Urbana creek, and up the channel of that stream beyond the town of Urbana. A month had been spent in the work, when further progress was stopped by the ice, and the operations were suspended until spring.

On the 6th of May Lieut. Comg. Wainwright took up the soundings below Urbana creek, and pushed the survey towards the entrance, following closely, and keeping pace, throughout the season, with the topographical party then at work on the shores. The shore line of Curratoman river having been furnished by Assistant Adams, that branch of the Rappahannock was also included in the hydrography.

Sketch No. 20 presents in the form of a preliminary chart the details of the work referred to, and shows its connection with the hydrography of Chesapeake bay.

The following is an abstract of the statistics:

Miles run in sounding	329
Number of soundings	23,663
Angles observed	329

Three tidal stations were occupied for purposes connected with the reduction of soundings.

The survey of the Rappahannock was completed on the 22d of June, when Lieut. Comg. Wainwright transferred his party to Section II, and resumed the hydrography of Hudson river.

In May, notice was received from the Navy Department that this excellent officer would be detached from the Coast Survey, and in August the orders detaching him were received. His career upon the Coast Survey has been one of remarkable success, industry, and steady perseverance, leading to a thoroughness in the completion of work not to be exceeded. He has labored throughout the year, changing place with the season, and has kept his office-work close up to that afloat, leaving nothing at loose ends. In beginning a piece of work he steadily looked to its completion, having in view always the finished result, and never being satisfied with desultory or irregular and intermitting effort. These qualities, and his experience, rendered him one of the most valuable officers upon the survey, and his loss will be proportionably felt. The command of this party has been assigned to Lieutenant J. H. Moore, U. S. N., assistant.

Hydrography of York river, Virginia.—Following the triangulation which was completed shortly after the close of the last surveying year, the party of Lieut. Comg. J. J. Almy, U. S. N., assistant in the Coast Survey, commenced the hydrography of the river at its entrance into Chesapeake bay. The work was vigorously prosecuted after the opening of the season, and by the 3d of July the soundings had embraced the whole of York river, from its mouth to the junction of its two principal branches—the Pamunkey and Mattaponi rivers, at West Point.

Of the two hydrographic sheets containing the results of the season, the first in order of execution contains the soundings between the entrance and Bigler's Mill, a distance of about sixteen miles. The second, those between West Point and the upper limit of the sheet just referred to, making together a length of thirty-five miles of river work completed and plotted within the season. During the latter part of the period occupied in soundings, Lieut. Comg. Almy was necessarily absent from his party, and the hydrographic operations afloat were, in the interval, conducted by Lieut. Robert D. Minor, U. S. N. The zeal and efficiency of that officer, in his connection with the various interests of the work, have been specially mentioned in the various reports made from time to time by Lieut. Comg. Almy, and deserve especial notice here. Nearly all the hydrography of the river was executed in the boats of the steamer Hetzel. The following is a synopsis of the statistics:

Miles run in sounding	439
Number of soundings	28,047
Sextant angles for hydrographic positions	1,849

Thirty-three high tides and twenty-nine low tides were observed in the course of the work, and twelve hundred and eighty tidal observations made for reducing the soundings. Lieut. Comg. Almy thus remarks upon the capacity of York river:

"No one can look at the chart of the lower part of York river, from the entrance up to Yorktown, without pronouncing it a harbor of the first class. There is no bar at the mouth of this river, and the least water to be passed over in entering it is thirty-three feet at low-tide, near the tail of York Spit, in Chesapeake bay. After passing this the water deepens to six, seven and eight fathoms, increasing in passing up the channel to eleven and twelve fathoms abreast of Yorktown, where the shore is very bold, and wharves carried out a distance of fifty feet would strike four and a half and five fathoms water. The channel of the river is more than a mile in width, and with a few buoys aud beacons judiciously placed, the heaviest line-of-battle ships could beat up or down the river without the least difficulty."

"Yorktown is situated about thirty nautical miles from the entrance of the river into Chesapeake bay. The location is elevated, and it could be easily fortified at moderate expense against attack either by land or water. It affords a harbor sufficient for the largest navy and commercial marine, and next to Newport, Rhode Island, it is, in my judgment, the safest and the most commodious harbor in the United States."

The preliminary chart of York river, resulting from the work of the season, accompanies this report as Sketch No. 22.

At the conclusion of the survey of York river, Lieut. Comg. Almy was detached from duty on the Coast Survey, and the hydrographic party in the steamer Hetzel was placed in charge of Commander W. T. Muse, U. S. N., assistant.

The records of soundings made in connection with previous surveys in this and the adjoining southern section, together with duplicates and records of angles and tidal observations, have been received and deposited in the archives of the office.

The recommendation of Lieut. Comg. Almy for a buoy to be placed near Cape Henry, was communicated for transmission to the Light-house Board. It will be found in the Appendix No. 61.

In the detachment of Lieut. Almy the Coast Survey loses another of its most efficient officers.

Always at work with a purpose, he has made a broad mark upon the hydrography of the coast of Maryland, Virginia, and North Carolina. His zeal and industry were never at fault, and his success was thus always to be counted on. His watchful care for the interests of commerce and navigation connected with his work was not to be surpassed. His ripe experience cannot soon or readily be replaced.

Hydrography of James river, Virginia.—This work was resumed on the return of the hydrographic party of Lieut. Comg. J. N. Maffitt, U. S. N., assistant in the Coast Survey, from duty in Section V. In previous seasons the soundings had been extended from the entrance of the James river to the mouth of the Chickahominy. Early in July Lieut. Comg. Maffitt took up the work at Dancing Point, and carried it to a point within nine miles of the junction, beween the Appomattox and James rivers, at City Point, before the close of the season.

The tides were observed in James river while the soundings were in progress. A summary of the statistics is thus given in the season's report:

Miles run in sounding	360
Angles determined	1,374
Number of soundings	10,575

Tidal observations.—The permanent self-registering observations at Old Point Comfort have been continued during the year under the charge of Mr. M. C. King. The self-registering tide-gauge, established last year at Tappahannock, was kept in operation (with a few interruptions by ice during the winter) until July, so as to obtain the regimen of the river during a whole year.

SECTION IV.

FROM CAPE HENRY TO CAPE FEAR, INCLUDING THE COAST OF PART OF VIRGINIA AND NORTH CAROLINA.—(SKETCH D, No. 25.)

The progress in this section, anticipated in my reports of last year, and of the year before, has been realized, and the plan for completing the work of the section, developed in the latter report, has been steadily pursued. The preliminary small triangulation is now connected from Cape Henry to Cape Fear, and the topography of the ocean shores is nearly done between the same limits. The peculiarities of the work on different parts of this coast require different modes of strengthening this preliminary work, or of substituting other connected triangulation in its place. All this has been carefully studied by the light of the preliminary work, which serves as a very complete reconnaissance. Two hydrographic parties have been employed on the outer coast, in Hatteras and Ocracoke inlets, and on Beaufort bar, during portions of the year, making such progress as the stormy character of the season permitted.

Cape Fear bar has been re-examined. Nearly half of the in-shore hydrography on the ocean coast of this section is done, and the principal shoals and inlets have been sounded out. It will be easy by steady progress, as I have before stated, to finish the work of this section at the same time with that of Section III, to the north, and Section V, to the south of it. In this section there remain the triangulation and topography of the shores of Pamplico sound and of its rivers, the rectification of the coast triangulation, a part of the topography between the head of Currituck sound and Cape Henry, and a small space between Stump and Topsail inlets. Any interruption to the successive operations would be disastrous among the moving sands of this coast, where it is difficult to preserve station points for any length of time, and where the topographical outline is subject to such changes. To these changes, as having an important bearing upon the future condition of this important part of the coast of the United States, I must again call attention. The inroads of the ocean are steady.

Office-work.—Drawings of Beaufort harbor, Cape Fear river, (lower sheet,) and Cape Fear entrances, (comparative chart,) have been completed within the year, and the finished map of Albemarle sound, No. 1, has been in progress. The engraving of Cape Fear river, from Federal point to Wilmington, and seacoast of North Carolina, from Hatteras to Ocracoke, has been completed, and the following plates are in progress: entrances to Cape Fear river, Albemarle sound, Nos. 1 and 2, and Beaufort harbor, (new edition.)

Triangulation and topography in the vicinity of Cape Henry, Virginia.—In the progress of the triangulation, which had been brought by the party of Assistant J. J. S. Hassler, northward from the head of Currituck sound, a reconnaissance was made of the desert tract intervening between it and Cape Henry, and practicable lines for the connection of that work with the triangulation of Chesapeake bay were approximately determined. During the present surveying season the efforts of Assistant Hassler were directed to the opening of avenues between the stations selected, and, in consequence of the extreme inclemency of the season, this proved to be a work of unusual difficulty. Operations were begun early in December. Under favorable circumstances of weather, the natural obstacles to be encountered by the party in penetrating through swamps heavily timbered with gum, cypress, and oak, would have retarded progress, but to these were superadded impediments which have rarely interfered with the operations of the section. For continued periods during the winter the forest was covered with snow, which materially obstructed the advance of work on the lines, and the consequent fogs, added much to the difficulties experienced in making the subsequent observations. Preliminary measurements were made from two stations connecting with Cape Henry light-house, and at these six hundred and ten observations were recorded. Final measurements being hindered from time to time during the period allotted for work, Assistant Hassler executed a plane-table survey of the region lying immediately south of Cape Henry, the limits of which will be seen on Sketch No. 16.

The character of the tract, represented on his topographical sheet, is swampy, and much indented by small bays. It comprises fifteen miles of shore-line, and twenty-one miles of road. Assistant Hassler reports that the degree of cold experienced in the winter has been unprecedented in this section: "Ice accumulated to the height of ten feet along the beach south of Cape Henry. Nearly all the wild fowl in the vicinity, many of the fishes, and some of the cattle were frozen to death." Computations have been made of the geographical positions determined by the observations of Assistant Hassler.

The records, in duplicate, of angular measurements made in the work near Cape Henry, with descriptions of the signals erected, have been deposited in the office.

Triangulation on the outer coast of North Carolina, extending to Cape Fear.—On closing operations, referred to as being then in progress, under Section II, in my last annual report, the parties of Assistant A. S. Wadsworth resumed, at Topsail inlet, the joint duty of triangulation and topography, and pushed the work southward and westward in the direction of Cape Fear. The coast series (a preliminary triangulation) is now complete from Cape Henry to Federal Point light-house, and by two triangles projected on Cape Fear river, by Assistant Wadsworth, it connects with the triangulation of that river and with the coast chain of Section V. The extent of coast in a direct line, embraced in the work of the season, is about twenty-eight miles. Sketch No. 25 represents the scheme of triangles completed, and its connection with the work below Cape Fear. The following is an extract from the report of Assistant Wadsworth :

"The obstacles to progress were considerable on approaching the head of the sound. The woods approach the beach abruptly, and were of such a character as to require the use of very small triangles, in order to avoid the dense swamps ; cutting was necessary for each side of the small triangles, excepting those following the beach. The lines were opened through timber nearly valueless by reason of the difficulty of access to it."

"The weather was very unfavorable throughout the season, and particularly so after the close of March."

"The triangulation covers an area of thirty-three and a half square miles. Forty-five stations were occupied and forty-eight objects observed on in the work."

"The Gambey theodolite, C. S. No. 13, was used in the measurements, and one hundred and thirty-eight angles were determined by five thousand and three observations."

The party took the field on the 1st of December, and closed on the 25th of April.

After the completion of the triangulation, Assistant Wadsworth engaged a vessel for the purpose, and revisited the coast between Cape Fear and Beaufort, North Carolina. He examined the stations previously occupied, and found them generally secure. This review of the work was made with reference to the selection of sites for bases of verification.

Mr. J. L. Tilghman was attached to the triangulation, partly as aid, and rendered efficient service in the reconnaissance and other duties connected with the work.

Field-work was concluded on the 3d of May, at which time Assistant Wadsworth proceeded to the office, and was assigned to topographical duty in Section I.

Records of the horizontal angles and descriptions of the signals erected between Rich inlet and Cape Fear were completed during the summer, and have been deposited in the office.

Topography of Hatteras inlet, North Carolina.—After completing the plane-table survey, which will be noticed next in its proper geographical order, Mr. John Mechan, on being detached from the party of Assistant A. S. Wadsworth, proceeded to Hatteras inlet, and traced the shore-line necessary for the uses of the hydrographic party to be assigned to duty in that locality. Four miles of coast-line were determined, in connection with the adjacent topography and shore-line of the sound. An island known as "Shell Lumps," lying four miles from the entrance to the inlet, the sand shoals in the sound, and the channel buoys, were also determined in position and represented on the plane-table sheet.

Such of the stations formerly occupied in the vicinity as could be recognized were examined and secured by Mr. Mechan. He reports as an instance of the rapid changes to which the neighboring coast is liable, that "West inlet signal, which was erected in 1853 upon a sand-hill within the high water line, stands now two hundred and eighty-three metres seaward in the ocean."

"Hatteras inlet is making an easterly advance, and recently a small inlet has opened a quarter of a mile westward of it, which will probably be merged into the main opening. Fishing shoal, lying at the interior mouth of the inlet, is assuming the character of a sand island, while the sand shoals immediately north of it, formerly bare at neap low water, are now visible only at extremely low equinoctial ebbs. The accumulation of sand on Fishing shoal seems to be, as it were, the complement of this decrease."

Topography of Ocracoke inlet, North Carolina.—Previous to the execution of the work detailed under the last head, Mr. John Mechan commenced a plane-table survey at a point two miles north of the entrance to Ocracoke inlet, and, following the outer coast southward, traced the shore-line to the entrance, and below it, until abreast of the village of Portsmouth, including on the sheet the corresponding shore-line of Pamplico sound, the adjacent islands, the new light-house on Beacon island, the channel light-boat, and the running buoys. The data thus obtained in this locality and at Hatteras inlet were furnished to the hydrographic party operating in this section, but the unusually stormy character of the season, which had much hindered the field-work, made it impracticable to execute soundings along the coast beyond harbor entrances.

Five and three-quarter miles of coast-line were traced by Mr. Mechan at Ocracoke inlet, and an aggregate of nearly twenty-five miles of interior shore-line in that vicinity and at Hatteras inlet, before referred to.

The following remarks occur in his special report made at the close of the season:

"With the exception of the closing of the small inlet south of Amity shoal, some advance of Ocracoke inlet to the southward, and the steady encroachment of the ocean observed along the entire coast of North Carolina, I have found little change in the high water contour as compared with the survey of 1853. This inlet, however, must be subject to exterior changes. The beach which flanks it for a league on each side is a sandy flat, devoid of vegetation, and of such low profile as to be submerged by the ocean during heavy southerly gales."

The work in this vicinity was commenced by Mr. Mechan on the 4th of May, and, in connection with that at Hatteras, completed by the 24th of that month. After turning in at the office his plane-table sheets he was assigned to topographical duty in Section II, and was so employed until the close of the surveying season.

Topography of the coast of North Carolina above Cape Fear.—This work was carried on jointly with the triangulation, the details of which have been already given, by a party under the direction of Assistant A. S. Wadsworth. Beginning a short distance above Rich inlet, and following within the limits traced in the triangulation, Mr. John Mechan executed all the shore-line and topographical details included between it and Federal Point, at Cape Fear entrance. His first sheet was commenced on the 27th of December, and during the season four others connecting with it were completed. These embrace the shores of Topsail sound, Barren inlet, Middle and Masonboro sound and inlet, Myrtle sound, and the numerous intricate passages through the adjacent swamps. An extent of coast stretching twenty-eight miles southward and westward, and terminating at Federal Point, is represented on the connected sheets. Within this space three hundred and ten miles of shore-line were run.

"The marshes which compose the greater part of the sheets are very intricate and difficult of access, being in many places overflowed at half tide, miry, and full of quicksands. In topography the general character is the same as on the other sounds south of Pamplico, except that the main land is more thickly inhabited, and consequently presents more surface for detailed work."

Assistant Wadsworth thus concludes his report upon the duty executed by the plane-table party under his direction:

"Mr. Mechan, notwithstanding the unfavorable weather, succeeded, by perseverance, in keeping this work so far advanced that on closing the triangulation the topography had joined that of Cape Fear river, thus completing the coast from Topsail inlet to the upper limit of Section V. He then proceeded under special instructions to Ocracoke inlet."

The topographical sheets have been inked and registered with others of the present season in the Coast Survey office.

A party is now about to be organized for plane-table duty in Section VI, the charge of which has been consigned to Mr. Mechan. About ten miles of topography yet remaining between Stump inlet and New inlet, on the coast of North Carolina, will be traced by Mr. Mechan before proceeding to Florida.

Hydrography of Hatteras inlet, North Carolina.—A survey has been made of this inlet by the party of Commander W. T. Muse, U. S. N., assistant in the Coast Survey, with the surveying steamer Hetzel. The soundings were confined generally within the limits of the examination made in 1852.

In the opinion of Commander Muse, the bar of Hatteras inlet has probably shifted since the former survey. Other remarks bearing upon the character of the inlet as a harbor are given in extracts from his report, Appendix No. 15.

The following are statistics of the survey :

Miles run in soundings	48
Number of soundings	3,962
Number of theodolite angles	544
Tidal observations recorded	310

Six high and seven low waters were observed for hydrographic purposes.

Hydrography of Ocracoke inlet, North Carolina.—This inlet has also been re-examined by the party of Commander Muse within the season. The work was attempted in July, but was deferred by the unfavorable weather which then prevailed along the coast of North Carolina.

The result of the resurvey shows that the depth of water on the bar has decreased at least two feet since 1852.

Commander Muse concludes from his examination that the present channel must eventually become useless; but thinks there are indications of an opening to the northward and eastward of it. Some extracts from his report on the survey are contained in Appendix No. 15. A synopsis of the statistics is thus given in his general report :

Miles run in sounding	168
Number of soundings	1,524
Number of sextant angles	726
Tidal observations recorded	869

For reducing the soundings, seventeen high waters and twenty low waters were observed.

Hydrography of Pamplico sound, North Carolina.—In connection with the resurvey of Ocracoke inlet, the hydrography of Pamplico sound was extended eastward and westward a distance of eighteen miles abreast of the entrance, and carried about twelve miles northward, the limit of work in that direction reaching somewhat beyond the middle of the sound.

This duty was executed by the party of Commander Muse, who thus reports the statistics :

Miles run in sounding	125
Number of soundings	10,726
Number of theodolite angles	1,396
Number of sextant angles	164
Tidal observations recorded	407

High water was observed in ten instances, and low water in eight, in connection with the hydrographic operations.

The party at the outset of the season was in charge of Lieut. Comg. J. J. Almy, U. S. N.

He was relieved on the 9th of July by Commander Muse, previous to the commencement of operations for the season in this section. The subsequent labors of the hydrographic party in the steamer Hetzel have been stated under Section III.

Hydrography southward from Cape Lookout, including Beaufort harbor, North Carolina.—The surveying steamer Bibb, after refitting at New York, left that port on the 7th of March, with the hydrographic party of Lieut. Comg. C. R. P. Rodgers, U. S. N., and on the 10th arrived at Beaufort. "Soundings could not be commenced until the 23d of March, in consequence of very bad weather and the shifting character of the sand hills on Bogue and Shackleford banks, by which many of the marks left by the triangulation parties had become obliterated. Much annoyance was also experienced throughout the whole season by the frequent prostration of signals erected by us for hydrographic purposes."

"Every available moment was improved for prosecuting the work, and, with much difficulty, and some hazard, we succeeded in extending the survey from Cape Lookout, twenty miles westward towards Bogue inlet." The soundings were carried off-shore about fourteen miles to the southward, the outside limit ranging parallel with the coast. Twenty-seven lines were run in that direction, and crossed by others at right angles. Several traverse lines of soundings were also made within the limits of the sheet.

In connection with the regular hydrography of the coast, Lieut. Comg. Rodgers made a careful resurvey of Beaufort bar and anchorage, and developed the changes which have taken place since the survey made by Lieut. Comg. J. N. Maffitt, U. S. N., assistant, in the surveying year of 1853–'54. The results obtained by the last named officer are given in detail in Appendix No. 14 of my report for that year. Appendix No. 16 of this report contains extracts from a communication made by Lieut. Comg. Rodgers on completing the re-examination. His recommendations therein contained, in regard to buoys, have been transmitted through the Department to the Light-house Board. (Appendix No. 62.)

The following is an abstract of the hydrographic statistics:

Number of miles of soundings plotted	742
Number of sextant angles recorded	4,066
Theodolite angles measured	909
Total number of soundings	22,658

The steamer Bibb returned to New York on the 9th of May, and the office-work of the party was completed as soon afterwards as practicable.

Two sheets, containing the results of this season's operations in the section, have been filed in the office.

A chart showing by comparison the changes, developed by Lieut. Comg. Rodgers, since the former survey, accompanies this report. (Sketch No. 30.)

In the course of the summer new boilers were provided for the Bibb, and that vessel was continued in charge of Lieut Comg. Rodgers, for the hydrographic duty which has been described as executed by his party in Section I.

Re-examination of Cape Fear bars and entrances.—A complete hydrographic resurvey of this vicinity was made in December by Lieut. Comg. J. N. Maffitt, U. S. N., assistant in the Coast Survey. The result of his observation showed, in comparison with the survey made in 1851, that "for all essential purposes of navigation the old main bar channel has ceased to exist." Remarkable changes were also noted as having occurred in the entire locality south of Bald Head Point. In his report Lieut. Comg. Maffitt says: "Where, in 1851, nine, ten, and eleven feet could be found in the channel, only five, four, and three feet can at present be obtained at mean low water. On spring tides, and with a northwesterly wind, this old channel is in many places a wash."

Lieut. Comg. Maffitt suggests the prolongation of the western Bald Head jettee, for deepening the channel, and cites, in support of that opinion, the improvement since 1852 of the slue, to which my attention was drawn in a personal examination of the main bar.

Slight changes only were found in the western channel, and the middle ground is reported as not having materially changed since the last survey.

At New inlet the shore-line was found to be much altered, and the Federal point channel narrowed, nearly closed, and shifted to the northward. The report of Lieut. Comg. Maffitt, showing in detail the results of comparisons made between the recent survey and that of 1851, is given at length in Appendix No. 17.

SECTION V.

FROM CAPE FEAR TO THE ST. MARY'S RIVER, INCLUDING PART OF THE COAST OF NORTH CAROLINA, AND THE COAST OF SOUTH CAROLINA AND GEORGIA.—(SKETCH E, No. 31.)

The same number of parties has been employed in this section this year as during the last, and the progress has been very considerable. The parties have been distributed as follows: One astronomical party between Savannah and St. Mary's; two triangulation parties, one (a double party) between Winyah bay and Charleston, and between St. Helena and the head of Calibogue sound, and one between Tybee and Ossabaw, Georgia; two combined triangulation and topographical parties between the Cape Fear and Shallotte inlet, North Carolina, and at Sapelo inlet and Brunswick harbor; one topographical party on Edisto island and vicinity, and on the shores of St. Helena sound; two hydrographic parties, one on the coast of South Carolina, between Cape Roman and Charleston, and the other on the coast of Georgia, in St. Simon's sound, Turtle river, and Brunswick harbor. Besides these, a topographical party has been at work, in part in this section, on the St. Mary's river and approaches, and Cumberland island, also for short periods, for revision work, near Charleston, and in surveying the sites for bases on Cumberland and Sapelo islands.

I have already, in the introduction to my report, called attention again to Bull's bay and North Edisto entrances, as harbors of refuge well situated in regard to Charleston.

Of the eight inlets on the coast of Georgia, between Tybee and St. Mary's, a reconnaissance has been made of two, Doboy and St. Andrew's; a complete survey of one, St. Simon's; and the operations are in part completed in four others, Wassaw, Ossabaw, St. Catharine's, and Sapelo. Provision has been made for continuing these during the coming surveying season.

A preliminary chart of St. Simon's sound and Brunswick harbor has been drawn, and engraved on a scale of $\frac{1}{40000}$; additions have been made to the chart of Charleston harbor, $\frac{1}{30000}$; to the comparative chart of Maffitt's channel, $\frac{1}{5000}$; the drawing of St. Helena sound, $\frac{1}{40000}$; and seacoast of South Carolina, from Cape Roman to Tybee island, Georgia, has been in progress.

The engraving has been completed of the following charts: Charleston harbor, (additions;) Maffitt's channel, comparative chart; North Edisto entrance, new edition; and the engraving of a chart of the seacoast of South Carolina, from Cape Roman to Savannah, is in progress.

Astronomical and magnetic observations at Savannah, Georgia.—The difference of longitude between Savannah and Fernandina, Florida, was determined in the early part of the season under my immediate direction. For this purpose ten chronometers were rated and passed by regular trips of the steamers to and from Fernandina, observations for time and chronometer comparisons being made at the astronomical stations selected at the two places, respectively. This determination was of special importance in consequence of the discrepancies in the best charts as to the longitude of Fernandina, now rising into renewed consequence as one of the termini of the air-line railroad across the peninsula of Florida, and from its connection with the triangulation across the same peninsula to unite the work on the Atlantic and Gulf coasts.

At Savannah, observations were commenced March 25, and closed on the 30th of April. The transits of two hundred and thirty-seven stars were observed on seven wires each, with transit No. 3, C. S., of forty-five inches focal length. I was assisted in the operations by Assistant Charles A. Schott, who was temporarily relieved from the charge of the computing division for this duty, and had charge of the operations at Fernandina.

A statement of the connected observations now detailed will be made under Section VI. Elaborate observations were made for personal equation, for the effect of temperature on the chronometers, and others, which, with the modes of discussion, will be found noted in the papers in the Appendix No. 30.

Assistant Schott, aided by Mr. J. E. Blankenship, determined the magnetic elements at Savannah, using magnetometer No. 6, by Jones, and the dip circle No. 9, by Barrow. The dip was determined by two needles, their polarity being reversed for half the number of observations, and the magnetic intensity was ascertained in the usual way by deflections and vibrations. Records of the observations made by my party have been completed by Assistant Schott in duplicate, and filed with the archives in the Coast Survey office. The usual meteorological journals were kept up in connection with the observations.

The records of observations made for latitude and magnetic elements at Macon, Georgia, by Assistant G. W. Dean, in 1855, have been received and deposited in the office, together with journals of the meteorological readings kept there and at De Rosset, N. C., and Columbia, S. C., in the following season.

The operations for telegraphic longitudes which, for several successive seasons, have been noticed in my annual reports under this section, having been extended beyond its geographic limits, will be found described with the work executed in Section VIII.

Triangulation and topography of the coast westward from Lockwood's Folly, North Carolina.— This work was resumed on the 26th of January at the limit reached last year, and has been extended westward by the party of Assistant C. P. Bolles. Many natural obstacles to progress in the field occur in this part of the coast. The triangulation is based upon a reconnaissance of the region made in 1851 by Major H. Prince, U. S. A., then assistant in the Coast Survey.

Assistant Bolles, in a summary report, thus refers to the work commenced in a former season under his charge at Cape Fear. I give it in more than usual detail as being an excellent exposition of the method of working in a case involving much difficulty, and when the usual routine of triangulation cannot be followed to advantage.

"Before extending the secondary chain of triangles to the westward of Cape Fear river, it was deemed expedient to re-measure all the angles in the series connecting Smith's Island base with the mouth of the river, and in order to insure greater accuracy four additional stations were established in that vicinity."

"Taking advantage of the open country over Elizabeth and Dutchman creeks, the next step was to extend a net of triangles along their banks to Ash Swamp and the Georgetown road, respectively."

"By selecting lines requiring the least cutting, as pointed out clearly by this preliminary survey, the points on Elizabeth creek were readily connected with others favorably situated along the seashore, and thus the secondary chain was gradually developed as far as Ash Swamp. The tertiary series, in conjunction with the secondary, will also serve a useful purpose in facilitating the extension of the primary work."

"A range of almost impenetrable swamps runs parallel to the coast, tending to confine the secondary triangulation to a narrow belt, and therefore some modification of the plan before adopted became necessary. This was accordingly made, and the result gives exact information in regard to the most advantageous sites for points of observation, the limits of the triangulation, and also the data necessary for topographical purposes, and thus both divisions of the party were enabled to keep pace with each other."

"The most conspicuous sand dunes on the shore were selected as sites for signals, and their relative positions determined by the theodolite and chain. In the course of the measurement the lines of high and low water on the seashore, and the range or groups of dunes, were carefully traced."

"A line was at the same time marked out by reconnaissance direct from a signal on a Sand hill near the swamp, and by means of it all the topographical features, crossings of roads, and houses in the vicinity, were correctly located. This was adopted as a triangle side, (see Sketch No. 31,) after examination made with the view of changing its direction so as to require the least cutting.

"A second line connecting with the first was traced out in the same way, and the triangle was completed in the selection of a third line to combine with the others the conditions most desirable in respect of practicability, economy of labor in preparing for observations, and in the requisites for plane-table work.

"In this manner several triangles were projected before avenues were opened between the stations, so that, if it became necessary to alter the direction to adapt the scheme more advantageously to the circumstances of the country, this might be done without loss."

"The plan here detailed enabled me to extend four triangles on two bases through the narrow belt of country between Ash swamp and the seashore. These are sufficient for topographical and hydrographic purposes.

"Having reached Lockwood's Folly river, the next step was to find the width of the belt of country enclosed by the chain of swamps west of it. This information was obtained by tracing a line from Holden (see Sketch No. 31) towards Stansbury swamp and its branches, and by making such an angle with the line to N. Galloway as would meet another at the swamp if run from N. Galloway parallel to the coast, in the supposed direction of the swamp."

"The triangle deduced from this reconnaissance defined the position of the main branch of the swamp, and furnished a base for the chain afterwards extended to the western side of the river. Fulford was then brought into the connection, and another reconnaissance line traced from Lancaster westward. This last line showed clearly the necessity for a gradual reduction in the size of triangles to be laid out between Lockwood's Folly and Shallotte inlet."

"The auxiliary work was carried on always with a view to the development of the topography, as well as to serve the purposes of reconnaissance for the secondary triangulation, besides giving, incidentally information of the positions of such obstacles as would materially retard progress in laying out a series of main triangles."

The party of Assistant Bolles was first organized for the work below Cape Fear, in December, 1854, and disbanded in the following May, after completing the survey from Smithville to Ash swamp, and re-measuring the angles between Smith's Island base and Smithville.

The work was resumed in December, 1855, but operations in the field were delayed until the succeeding month in consequence of extreme cold weather.

The party continued the work until May, 1856, having completed the triangulation and topography as far westward as Lockwood's Folly river.

Sub-Assistant G. H. Bagwell assisted in all the operations of the first two seasons, and in the last Mr. W. S. Edwards served as aid to the party. In the early part of the present surveying season, Assistant Bolles made a resurvey of the shore-line adjacent to New inlet and the Cape Fear entrance to correspond with the resurvey by the hydrographic party. The regular work was resumed about the middle of January, and discontinued in May. The shore-line was traced to Shallotte inlet westward, and the topography is complete to Bacon's inlet, within a short distance of the opening first named.

The triangulation now extends fifteen miles westward from Smithville, and reconnaissance has been made for work about five miles beyond this.

In the measurement of angles, ninety-nine objects were observed upon by five thousand five hundred and sixty-five repetitions with a six-inch Brunner theodolite. The statistics of plane-table work are thus given by Assistant Bolles:

Seashore traced	20½	miles.
Shore-line of sound and creeks	66¼	"
Cleared and fast land surveyed	53½	"
Roads	54½	"
Swamp	28½	"

Mr. O. Hinrichs aided Assistant Bolles during the present season, and his zeal and successful application to duty are mentioned in terms of praise in the report.

Few tracts along the Atlantic sea board present greater obstacles to the advance of field work than the vicinity of the coast below Cape Fear. To accomplish the results thus far obtained, the parties of Assistant Bolles tracked the wilderness in many directions an aggregate distance of two hundred and twenty-three miles, and encountered severe labor in cutting and clearing avenues for the triangle sides.

In closing his report, Assistant Bolles expresses obligations to residents of Brunswick county, through whose land some of the avenues in his work were opened, for courtesies shown, and for the spirit of liberality evinced in facilitating the progress of the operations.

Four topographical sheets result from the plane-table surveys made. Assistant Bolles was employed during the summer in inking them and in the computations of the triangulation.

Secondary triangulation, coast of South Carolina.—This work has been continued under the charge of Assistant C. O. Boutelle, to whom the surveying schooner Petrel was assigned at the opening of the present year, for transportation. The vessel reached Charleston on the 7th of December, and the remainder of that month was occupied in preliminary field arrangements for prosecuting the work of two parties—one of which, under the general direction of Mr. Boutelle, was conducted by Sub-Assistant B. Huger, jr.

The first work of the party was the secondary triangulation of the coast towards Bull's bay. "The new light-house on Fort Sumter afforded a good connection with the primary and secondary triangulation of the coast, and it was accordingly occupied and connected by observations with the well determined stations, Charleston Light, Circular Church, and Breach Inlet."

"By the 9th of January, having carried the work as far as it could be done advantageously from Charleston harbor, the party in the Petrel moved to Dewee's inlet. Mr. Huger had made a reconnaissance upon the main land, and a couple of days' examination along the sea-coast enabled us to lay out a connected scheme of triangles up to Dewee's inlet. The weather was cold and blustering beyond any previous experience in the section, but both parties labored zealously in erecting signals and opening avenues for observation on the lines of connection. At the close of the month the triangulation had been extended northward and eastward over Long Island, Dewee's, and Caper's island, and to the upper shore of Price's inlet."

During the month of February the work was carried forward over Bull's island and through Bull's bay to Cape Roman by the parties working jointly.

"Bull's bay we found to be a large sheet of shallow water intersected with numerous narrow channels leading from the creek entering the bay, but suitable only for navigation by light draught vessels."

"A very fine harbor of refuge is made by the northeastern end of Bull's island with a safe and easy entrance from sea by night or day, and about four feet more water than at Charleston bar. Although the Coast Survey chart of this entrance was published in 1850, and a light-house has since that time been erected here, I cannot ascertain that the pilots have, in any instance, taken vessels in for refuge."

A sufficient number of stations having been occupied to furnish the hydrographic positions required for use in the party of Lieut. Comg. J. N. Maffit the triangulation was left in charge of Mr. Huger, and Assistant Boutelle proceeded to Georgetown. On making a reconnaissance for the secondary work between Cape Roman and Wihyah bay it was found that both ends of the South island base, measured in 1853, had been washed away. The site of its southern terminus was reproduced by observing from adjacent stations, and a line established between it and station "Lowdnes," lying to the southward and westward, for connecting the series pushed in that direction by Mr. Huger.

"A succession of gales and rain storms, in the month of March, greatly impeded our progress, subjecting us to much discomfort and some peril, as we were obliged to land directly upon the sea beach in the surf, instead of reaching our stations from interior waters in the usual manner. We found greater difficulty of access to the shore in this quarter than in any other north of Charleston, and much time was lost in consequence.

"The reconnaissance was made, signals erected, and some of the stations occupied by the 12th of March, when we returned to Bull's bay."

"Sub-Assistant Huger was retarded in his work by the same blustering weather which had caused so much delay in the operations of my party and by the labor of opening a difficult line upon the main land side.

"Both parties engaged in the measurement of angles when it was possible, and by the 17th of March all the stations resting on Bull's bay had been occupied. Mr. Boutelle then proceeded in the schooner Petrel to continue his triangulation southward from St. Helena sound.

"Mr. Huger continued the secondary triangulation from Cape Roman with a view to its connection with that executed at Winyah bay in 1853, but alternate gales and the prevalence of smoke so hindered his operations as to prevent the completion of the necessary observations. His party returned to Charleston on the 7th of May."

"The work from Charleston to Georgetown light proceeds for a distance of forty-six miles through an unbroken series of eleven quadrilaterals in which both diagonals have been observed. This is the most symmetrical chain of triangles yet obtained upon the southern Atlantic coast, and no other part of the coast of South Carolina affords equal facilities for its prosecution. In the progress of the work forty-one stations have been occupied, and five hundred and ninety-eight angles measured upon five hundred and fifty objects, by five thousand seven hundred and seven observations. One primary tripod and scaffold, twenty-seven secondary signals, and twenty-two of the third order have been erected, and the triangulation has determined the position of eighty-eight points for the use of the topographical and hydrographic parties."

In reference to the extension of the primary triangulation northward and eastward from Charleston, Assistant Boutelle observes: "I do not apprehend serious difficulty in carrying the primary work from Charleston to Winyah bay. The stations along the sea board are already intervisible, and the interior ones may be made so by judicious and careful reconnaissance along the openings formed by the Wando river and Owendaw creek. The diagonal lines must cross and recross the belt of pine forest extending from Haddrell's Point to the Santee river, and great care will be required in projecting lines so as to avoid intervening buildings on both sides of the belt."

The party of Assistant Boutelle, in the schooner Petrel, was detained at Charleston by head winds until the 25th of March, and advantage was taken of the interval to re-occupy some of the stations of the original triangulation of Charleston harbor, made in 1849, connecting with the general triangulation of the coast and the new central station upon Fort Sumter. Five stations were thus occupied, and four hundred and thirty observations made in the measurement of thirty-six angles. On the approach of favorable weather the schooner left Charleston, and Mr. Boutelle met me, by appointment, at Savannah, where preliminaries were arranged for grading and preparing the site for a base of verification in Section I. These being completed, the secondary triangulation was taken up at the head of Calibogue sound. Several stations were occupied in this vicinity, and others established for continuing the work northward across Port Royal entrance. Bad weather coming on, Mr. Boutelle proceeded to the closing stations of his last year's work on St. Helena sound, and erected signals necessary for extending the triangles to a junction at Broad river with the series attempted from the upper limit of the triangulation of Calibogue sound. A succession of gales and unfavorable weather prevented the completion of observations. Twelve stations in all were occupied, at which sixty-seven angles were measured by eight hundred and twenty-six observations.

"The bases *Station island—Parry*, *Parry—Dorr*, and *Dorr—Oyster*, (Sketch No. 31,) serve, respectively, to carry the triangulation up Beaufort, Broad, and Colleton rivers. Another chain of secondary triangulation passing up Morgan island and Coosa river will meet that of Beaufort, and still another chain will cross between St. Helena and Ladies' island, striking Beaufort river about five miles below the town. These will furnish points for a minute topographical survey of the country between Beaufort and the ocean."

The party of Mr. Boutelle was broken up on the 5th of May. By agreement with the mayor of Charleston, the schooner Petrel was left at that port to be used until the next approach of the season for work in this section as a quarantine guard ship, and to be then returned in the condition in which the vessel was delivered for that purpose.

Mr. F. P. Webber and Mr. G. E. Humphries served as aids in the two triangulation parties.

Assistant Boutelle and Sub-Assistant Huger were subsequently engaged at different localities in Section I, as stated under that head.

Two volumes containing the duplicates of records of horizontal angles measured in South Carolina have been deposited by Mr. Boutelle in the office.

Secondary triangulation and reconnaissance of Wassaw and Ossabaw sounds, Georgia.—Some delay occurred, in beginning the work assigned in this section, to the party of Lieutenant A. W. Evans, U. S. A., assistant, in consequence of damage to his vessel, the schooner Hassler, on the passage to Savannah. The necessary repairs having been made, Lieutenant Evans commenced operations on the 3d of January by making a compass reconnaissance and erecting third order signals along the Great and Little Ogeechee rivers, Vernon river, the shores of Ossabaw sound, Odingsell creek, and the outlet of the Romerly marshes, and on Wilmington river, Wassaw island and sound, and Tybee river, to connect with stations of the triangulation completed on the Savannah river. As soon as a sufficient number of signals had been erected, the measurement of horizontal angles was begun at the stations on Ossabaw sound. The winter and early part of the spring proved to be unexampled in severity, and many hinderances incident to unfavorable circumstances of the weather retarded the field-work. Fogs and haze prevailed until May. That month and the following were more favorable, and good progress was made until the close of the season.

"In prosecuting the triangulation, a good connection was made with the work of Assistant A. W. Longfellow on Romerly marshes, and his signals, which were all found standing, were of great service, particularly in the neighborhood of Wassaw sound. The work in that vicinity was taken up on completing the measurements at Montgomery and on the Ogeechee river, and I was successful in making a series of large triangles, which connect a base of the Savannah triangulation with Wassaw sound, Romerly marsh, and Ossabaw sound."

Lieutenant Evans accompanied me in April in an examination of the sites for a base on Sapelo island, originally pointed out by the reconnaissance of Assistant James S. Williams. I left, in his charge, the execution of the work to Mr. H. S. Du Val, aid to the party, who was to make a plane-table survey of the base sites and vicinity on Sapelo island, (Appendix No. 39.) This survey was satisfactorily executed, and a report made upon it after the close of the season. Sketch No. 31 shows the scheme of triangulation referred to in this section.

The following is an abstract of the statistics of the triangulation:

Signals erected	54
Stations occupied, (first and secondary)	22
Stations of third order occupied	10
Number of angles measured	468
Number of observations	3,229

Eighty points falling within the limits of the work were determined in position.

Lieutenant Evans mentions in terms of warm commendation the services of his aid, Mr. Du Val, in executing the plane-table reconnaissance on Sapelo island.

Reference will be made under the head of topography to the plane-table survey of the shores of Sapelo river, by Assistant A. W. Longfellow, within the present year.

The party of Lieutenant Evans was engaged during the summer in continuing the triangulation of Kennebec river, mention of which has been made under Section I. It is about to be reorganized to resume work on the coast of Georgia, southward from Savannah entrance.

Topography of Charleston, S. C.—A resurvey of the wharf lines and of the additions made since 1848 was in part executed between May 12th and the end of June, by Mr. W. S. Edwards, who was detached for that special duty from the party of Lieut. Comg. J. N. Maffitt, then engaged in prosecuting the hydrography of the section.

The wharf lines along the Ashley and Cooper rivers were traced, and the alterations which have been made were marked on the sheet. In prosecuting this duty Mr. Edwards chained a distance of forty-seven miles and a half in the various streets of the city, measured an aggregate length of three miles of wharf line, and traced six miles of shore.

The data contained on his topographical sheet, with that to be obtained next season, will be used in the new edition of the chart of Charleston harbor.

Topography of Wadmelaw island and river, and parts of Dawho and South Edisto rivers, S. C.—The work in this vicinity has been completed by the party of Assistant John Seib, and an additional plane-table sheet has been commenced for the extension of the survey of the shores of St. Helena sound.

The party sailed from Baltimore on the 15th of November in the surveying schooner Wave, and was met on the 27th by Assistant Seib at Charleston, where the vessel was detained by unfavorable weather until the 4th of December.

Assistant Seib joined in his first sheet with the limits reached in a previous year by Assistant G. D. Wise, and continued the topography along the main road and seacoast to South Edisto river, where his work of last season terminated. The two sheets then under way are completed, and now embrace the shores of Wadmelaw river from the North Edisto to stations in the triangulation of Assistant C. O. Boutelle, (see Sketch No. 31,) part of Wadmelaw island, parts of Togodo and McCloud creeks on the main land, the lower part of Dawho river, Russell's creek, on Edisto island, and the topography between these creeks and rivers, and extending to the main road on Edisto island. Part of the Pon Pon, and the greater part of South Edisto river, with Jehossee and Edisto islands, Fenwick's, Pine, and Otter islands, the intermediate topography and the shores of the Ashepoo river from St. Helena sound to a point about a mile above Fenwick's island, are also included in the completed work of the season.

On a third sheet commenced by Assistant Seib, a part of the shore-line of St. Helena sound has been traced. In reference to the character of the topography represented on his finished sheets, Assistant Seib observes: "The surface is low and almost level; the highest point on Edisto island is elevated about fifteen feet above tide, and occurs near its middle. The slopes are mostly gradual towards the marshes, and steep on or near the water courses.

"The entire work includes a group of islands and extensive marshes, difficult to traverse in the vicinity of the salt water, but more solid when above its reach."

"Much of the land in this locality has been recently laid out in rice plantations. The most extensive of these is on Jehossee island, which is now intersected by nearly twelve miles of canal, cut to admit the water to, or drain it from, the rice fields."

A synopsis of plane-table statistics is thus given in the report of the season's operations:

Shore-line surveyed	182 miles.
Roads surveyed	38 "
Area included in topography	57 square miles.

Work in the field was discontinued on the 5th of May, and after receiving some necessary repairs at Charleston the schooner Wave returned to Baltimore, and the party was discharged.

Assistant Seib inked his two sheets of completed work during the summer, and after returning them to the office engaged in the topography of York river, which has been noticed under Section III. His arrangements are now in progress for an early return to this section.

Topography of Sapelo sound and shores of Sapelo river, Georgia.—Following the triangulation of this vicinity, described in my last annual report, Assistant A. W. Longfellow commenced the topography on the 13th of December, and prosecuted it with such interruptions only as were occasioned by the inclement weather, which prevailed generally on the southern coast, until the 22d of March, when his attention was directed to another locality, as will be hereafter noticed.

"The results obtained in the vicinity of Sapelo sound and mapped comprise one hundred and thirty-four miles of shore-line and three miles of road, within an area of thirty-seven square miles. The limits of the sheet (Sketch No. 31) extend from east to west thirteen miles and a half, and from north to south nine miles, and include fourteen miles in extent of the channel of inland navigation. On the south it traverses the western side of St. Catharine's sound through Johnson's creek, crosses the sound on a south course towards Blackbeard island, thence west to the northern or High Point of Sapelo island, from which it passes up the broad and shallow channel of Mud river to Tea Kettle creek, communicating with Doboy sound. The outer, or ocean shores of the islands were also run to the limits of the sheet, the map showing two and seven-tenths miles on Blackbeard, and five and five-tenths miles on St. Catharine's island."

"The survey extends from the entrance westward through the sound and up Sapelo river, a distance of eleven miles and a half, to a point a mile above Sutherland's bluff."

The following remarks in reference to the surface and other features are also extracted from the report of Assistant Longfellow:

"The topography has the usual character of the southern coast, the sea islands being sand banks, protected on the ocean side by a series of parallel ridges thrown up by the action of the sea and the winds, and running generally with the trend of the coast. The level portions form the plantations which produce sea island cotton. These subside inland into extensive marshes, intersected by innumerable creeks, through which passes the remarkable channel of inland navigation, before alluded to, extending from South Carolina to Florida."

"The entrance to Sapelo sound is more than a mile in width at high water, and lies between St. Catherine's island on the north and Blackbeard island on the south."

The hydrography of the sound, including Sapelo river, as far as the plane-table survey has been carried westward, will be commenced and, if practicable, completed, early in the ensuing surveying season.

Topography of Brunswick harbor, Georgia.—As the proposed site for a naval depot, attention having been directed to Blythe island, in the immediate vicinity of Brunswick, Assistant Longfellow was instructed to make a detailed survey of its shores and interior, upon a scale double the size of that first intended. This duty was commenced on the 24th of March, and completed on the 29th of April. "It consists of the minute survey of Blythe island, called for by special instructions; the extension of the shore-line of Turtle river with its branches, to a point seven miles above Brunswick, at the head of Blythe island; the shore-line of Brunswick harbor and of the channel thence to Blythe island; and a survey of Academy creek to the outlet of the Altamaha canal."

"The number of miles of shore-line run was sixty-two, and of roads six miles. The area included by the survey is about sixteen square miles."

"Blythe island upland extends from north to south four miles, and has an average width of nearly a mile. The measured area is three and one-tenth square miles, equal to nineteen hundred and eighty-four acres. Including its marsh extensions, the total length of the island is six miles. The marsh at the southern end has an area of five hundred and ninety-five acres."

"Turtle river bounds the island on the east. Its western side is irregular in outline and difficult of access, the marsh and creeks there being much broken. Except in the old plantation fields it is covered with a growth of small pines of little value."

Data requisite for the uses of the hydrographic party of Lieut. Comg. S. D. Trenchard, U. S. N., assistant, were furnished by Assistant Longfellow in the progress of his work. He has also furnished descriptions of the signals employed in the triangulation of the Romerly marshes, and completed and turned in duplicates of his triangulation of St. Simon's sound and Brunswick harbor.

Mr. Clarence Fendall served as aid in this party during the season. Assistant Longfellow specially refers to his intelligent and efficient services.

The schooner Meredith was used for the transportation of the party during the season, returning to the north in May, and being employed in the plane-table work at Portland, mentioned under its proper head in Section I.

Preparations are now making to resume work on the coast of Georgia.

Hydrographic resurvey of Cape Fear bar and New inlet, North Carolina.—Before resuming the regular outside hydrography of this section, at the beginning of the present surveying year, Lieut. Comg. J. N. Maffitt, U. S. N., assistant in the Coast Survey, made a thorough re-examination of the bars and channels at Cape Fear entrance. The surveys made in this locality in 1851 and 1852 were taken by him as the bases of comparison, and the results were presented in a special report, a copy of which is given in Appendix No. 17. The Sketch No. 33 shows distinctly the changes which have taken place. The main bar has shoaled, and the western channel is now the main entrance. The pocket observed in 1852 as affording the rudiment of a new channel through the main bar has improved, extending still nearer to the ocean than formerly.

In the resurvey at Cape Fear the soundings were extended about ten miles and a half abreast of the western bar and main ship channel, and carried inside as far as a line joining Bald Head light-house and Fort Caswell.

The hydrography executed at New inlet comprises the space two miles seaward from Federal point, and extending southward and westward, to include the entrance, beyond Zeek's island.

A synopsis of the statistics of this work is thus stated in the general report of Lieut. Comg. Maffitt:

Miles run in sounding	506
Number of angles determined	1,832
Number of soundings	27,143

Hydrography of the coast of South Carolina.—The in-shore soundings necessary for the completion of the coast chart between Cape Roman and the entrance to Charleston harbor have been executed by the party of Lieut. Comg. Maffitt. The limits of this work include the entrance to Bull's bay, and a belt of hydrography extending evenly southward and westward along the coast to a distance seaward of about ten miles.

Two surveying vessels, the schooners Crawford and Bancroft, were employed in this service, and while thus engaged, on the 4th of January, the first named vessel was blown from her station off Bull's island in a furious storm which prevailed along the coast. By extraordinary exertions Lieut. Chandler, the officer in charge of the Crawford, kept the vessel afloat during twenty-four days of unusually tempestuous weather, and finally succeeded in reaching Smithville, North Carolina, with loss of sails, one of the surveying boats, and considerable damage to the hull of the schooner. To the energy of Lieut. Chandler and the excellent conduct of the crew must be attributed the preservation of the vessel, which, before making port, had been leaking badly.

The hydrography of the immediate coast, from Cape Roman to Tybee Light, is now complete. Considerable progress has also been made in the off-shore soundings of this vicinity, and in the investigation of the normal current at stations distant twenty miles from the land. The completion of the off-shore work was prevented by bad weather. Supplementary lines, requisite to the completion of the deep-sea hydrography, will be run on the next return of the vessels of the party to the section.

The statistics of the work are as follows:

Miles run in executing in-shore work	1,821
Number of angles determined	4,776
Number of soundings	50,856
Miles run in deep-sea soundings	810
Number of soundings (off-shore)	2,374
Number of specimens of bottom	277

During the progress of the hydrographic work in this section, Maffitt's channel was re-examined, and supplementary soundings were executed off and within the entrance to St. Helena sound, completing the hydrographic survey of that locality.

As additional to the statistics of the regular work, the following is a summary of that last referred to:

Miles run in sounding	636
Angles determined	1,533
Number of soundings	14,411

The unusual severity of the weather interfered with the progress of work generally in the southern sections; but the statistics presented as the result of the operations of this party fall but little below the average of past seasons.

At the approach of summer, Lieut. Comg. Maffitt proceeded with the vessels of his party and prosecuted the hydrography of James river, Virginia, mention of which has been made in its proper place, under Section III.

Hydrography of Brunswick harbor, Georgia.—Supplementary work necessary to complete the chart of St. Simon's sound and its dependencies was executed within the season by the party of Lieut. Comg. S. D. Trenchard, U. S. N., assistant in the Coast Survey. Turtle river was sounded from a point above the town of Brunswick to the head of Blythe island. The points requisite for the uses of the hydrographic party were furnished by Assistant A. W. Longfellow. Careful tidal observations were made in connection with the soundings.

The statistics of the hydrography are as follows:

Miles run in sounding	69
Theodolite and sextant angles	437
Number of soundings	7,425

The surveying schooner Gallatin was employed in the work at Brunswick, and after its completion proceeded to Section VI; under which head will be mentioned the subsequent operations of the hydrographic party.

A recommendation, made by Lieut. Comg. Trenchard, for the placing of two additional buoys to mark the line of best water in entering St. Simon's sound, was communicated to the Department in the usual manner for transmission to the Light-house Board, (see Appendix, No. 63.) Eight volumes, containing records of the soundings and tidal observations made at Brunswick and St. Simon's sound, have been deposited in the archives by Lieut. Comg. Trenchard. He has also completed and returned the three hydrographic sheets of that locality commenced in 1856. The additional data obtained in the present year, including the topography executed by the party of Assistant Longfellow, appear, in the preliminary chart of St. Simon's sound and Brunswick harbor, as No. 37 of the sketches accompanying this report.

Tides.—The permanent self-registering tide-gauge at the custom-house wharf, Charleston, has been kept in operation by Mr. W. R. Herron with great regularity.

Observations of tides, for short periods, were also made in connection with the hydrographic work at Brunswick, Jekyl island, and Turtle river, Georgia. A series of observations were conducted during three months at a station near St. Simon's light-house, to verify the results obtained during the previous season on Jekyl island. The comparison showed that they were entirely satisfactory, and that the obstruction of the low water wave, off the mouth of the creek where the gauge was placed, had caused the discrepancy in the results of Mr. G. Würdemann in 1855, and those of Lieut. Comg. Trenchard in 1856.

GULF STREAM.

The observations, for the most part, of the past season, have been incidental ones. Commander B. F. Sands, U. S. N., assistant Coast Survey, returning from the Gulf of Mexico, ran a line on the inner warm band of the Coast Survey chart, carrying depths from a hundred and fifty-six to twenty-five fathoms, from about the latitude of Cape Canaveral to within fifty miles south of Cape Fear, where bad weather and leaky boilers put a stop to the observations. A line was run, but under unfavorable circumstances, by Lieut. Comg. Craven, from Havana to Key West, soundings for temperature being taken at various depths to four hundred fathoms. Bottom was reached at that depth about seventy nautical miles from Havana, and the lowest temperature observed at that depth was about 48° Fahrenheit.

Lieut. Comg. O. H. Berryman made several efforts to run a line across the Gulf Stream, after its divided trend to the eastward, as shown by the Coast Survey chart. In his last voyage, on a line from Halifax towards the Bermudas, he had reached a position south of 39° north latitude, when, all his sounding line and wire being expended, he was forced to return, with the loss of several instruments. There has not been time yet to study these results, but extremely low temperatures seem to have been reached, as low, if the indications of the thermometers can be trusted, as 19° Fahrenheit. The greatest depth reached was 2,987 fathoms, (3.4 miles,) when 3,040 fathoms of line were out. The temperature appears to have been 25° Fahrenheit. This very difficult section of the Gulf Stream yet remains to be explored.

A continuous line of soundings for temperature was run in the axis of the stream, from the Tortugas to the Chesapeake entrance, by Lieut. Comg. J. C. Febiger, on his return from Section IX, in the surveying schooner Arago. The observations were made at the surface, and at depths of fifteen fathoms, and show, conclusively, what I had before inferred from the comparative results of the different sections, that the Gulf Stream water varies in temperature irregularly at different parts of the axis of the stream ; depending, probably, upon the temperature of the air on the Gulf of Mexico, so that a more southern point at particular times may have a lower temperature than a more northern.

The ease with which the axis of the stream was tracked, by using the Coast Survey chart, was quite remarkable.

SECTION VI.

FROM ST. MARY'S RIVER TO ST. JOSEPH'S BAY, COAST OF FLORIDA, AND INCLUDING THE FLORIDA REEFS AND KEYS.—(SKETCH F. Nos. 39 AND 40.)

The triangulation of the Florida reefs and keys has been rendered continuous this season from Virginia key (Cape Florida) to the Marquesas, anticipating by a season the result stated in my last report. When the connection is completed of the triangulation with the Cape Sable base by which the two bases, the one at Key Biscayne, and the other at Cape Sable, will be brought to bear upon the lengths of the same sides, we shall be able to determine whether this triangulation shall be accepted as final or must be further strengthened, or be considered only secondary to a main series. In any case an astronomical station is needed about the middle of the work, and it may be that this is all that will be requisite to make the geodesy complete. Two more seasons will close the topography of the keys, if the same means be furnished during the second as are now available for the first.

Two or three seasons also of continuous effort will complete the hydrography of this, the most dangerous, part of the coast. The effect of the knowledge already spread in regard to it, and of the examinations which have furnished data for the erection of signals, beacons, and lights, in diminishing the risks of navigation, is admitted by those who have observed the wrecks and disasters of former and recent years. Including the work upon the main, as well as upon the keys and reefs, eleven parties have been employed during the past season, viz: triangulation parties, one on the air line from Fernandina to Cedar keys, and two between Point Charles and Stirrup key; five topographical parties, viz: one on Amelia island and its vicinity, two upon the keys between Key Largo and Plover key, and one on the northern part of the group known as the Pine keys and on the main near Cape Sable ; a hydrographic party during a brief part of the season in Fernandina harbor and its approaches, and another during the season on the reef, the latter party having a steam vessel. Sixty-nine miles in extent, following the sides of the triangles in the reckoning, have been completed, and six hundred and sixteen miles of shore line, exclusive of creeks and interior passages. A line of soundings for temperature has been made across the Gulf from Key West, and tidal observations with self-registering instruments have been kept up at five stations.

The details of these various operations, which have employed the skill, energy, and industry of a number of capable officers, will be found in this chapter.

With a continuation of the means appropriated for work in this section during the past three years the triangulation of the whole section could be completed in from five to seven years. The topography could be kept closely up to it, say within one season, and the hydrography within some two seasons of the triangulation.

Cutting off the small triangulation of Florida peninsula from the main series of the coast is a most important step, and there now appears to be no reasonable doubt that it can certainly be done, and with a moderate outlay of expenditure. The open character of the route between the St. Mary's and Cedar keys will permit the opening of avenues for the sides of the triangles at a moderate expense. As a measure of economy and of efficiency there can be no doubt of the very great advantage of the air-line across the head of the peninsula. If the small triangulation around the peninsula must be so strengthened as to connect the work on the Atlantic and Gulf of Mexico, the expense would be very greatly increased, and the time of its execution would be much prolonged. Under the present conditions it becomes a comparatively rapid and inexpensive work.

Office-work.—The drawing and engraving of the sheets of St. John's river have been completed, and the drawing of a chart of the Florida reefs from Carysfort light southward is in progress.

Astronomical observations at Fernandina, Florida, for differences of longitude, and magnetic observations.—The operations of the party organized under my immediate direction, for the determination of the longitude of Fernandina, Amelia island, Florida, have been referred to under Section V, the observations being made in connection with others at Savannah, Georgia.

During the month of April two sets of chronometers, five in each set, were sent and returned by the regular steamers in their passages between Savannah and Fernandina, eight interchanges in all being thus made. The chronometers were compared by the method of coincidences.

At the station on Amelia island, transit No. 10 was mounted and adjusted for use on the 1st of April. Between that date and the 27th of April, the transits of 147 stars over nine wires each were observed; with the exception of the determination for personal equation, these observations were made by Assistant Charles A. Schott. In addition to these, thirty-three sets of chronometer comparisons for longitude were made.

The transit used has a magnifying power of thirty-five and a focal length of twenty-six inches. Chronometer, Hutton, No. 311, was employed for time in noting the observations. At the commencement and near the close of operations several determinations were made of the personal equation of the observers at the two stations. The observations necessary for instrumental corrections were made and applied in the usual manner.

Observations were continued at Savannah and Fernandina at the same time—by myself at the former, and by Assistant Schott at the latter place.

Towards the close of the operations the observers changed places. Messrs. J. H. Toomer, J. E. Blankenship, and D. Hinkle, served as aids in the party. The last named aid accompanied the chronometers in their transit between the stations, and made the comparisons generally. The usual meteorological observations were recorded at both stations.

As soon as practicable after the return of the party to the office the results obtained by observation were computed. One of the best existing maps was found to be in error nine miles in the longitude assigned to Fernandina. The determination now made is dependent on the telegraphic longitude of Savannah, observed in 1851.

Assistant Schott, aided by Mr. Blankenship, made observations for magnetic declination, dip, and intensity, at the geodetic station at Fernandina, on the 6th, 10th, and 20th of April. The station chosen is about a third of a mile north of the observatory. Magnetometer No. 6 and dip circle No. 9 were used. Mr. Schott also verified the direction of the meridian line traced by Sub-Assistant E. Goodfellow, on Amelia island, in 1856.

Five volumes original, and four others in duplicate, containing the records of chronometer comparisons, observations for time, and the magnetic elements, with the usual meteorological records, have been completed by my party, and are deposited in the archives of the office.

On concluding the operations at Fernandina my party returned to the office, and immediate preparations were made for work in Section I, the details of which have been given in their proper place. Assistant Schott was at that time re-assigned to the charge of the computing division, which, during his temporary absence, had been conducted by Assistant J. E. Hilgard.

A paper on the method employed in determining the differences of longitude between Savannah and Fernandina will be found in Appendix No. 30.

Reconnaissance and triangulation for air-line measurement between Fernandina and Cedar Keys, Florida.—This work, for which a special appropriation has been made, was commenced by Captain J. H. Simpson, U. S. Topographical Engineers, assistant in the Coast Survey, on the 8th of December. Starting from a camp near Loftin's creek, about ten miles from Fernandina, with the necessary equipment, the party were occupied twenty-one days in traversing the route of the railroad and adjacent country in the direction of Cedar Keys. The entire distance travelled in the reconnaissance was four hundred and twenty-nine miles.

Having completed his review of the whole line and come to conclusions favorable to the practicability of a triangulation across, Captain Simpson repaired to the office, and, after a personal conference, returned to Fernandina and proceeded to open the lines between the stations which he had selected as points for triangulation in order to test the cost of cutting. The progress thus made will be seen by reference to Sketch No. 39. Stations were erected for the completion of four triangles, in which the conditions most desirable for accuracy were sought and obtained. The triangle sides average about six miles and a quarter in length. A preliminary connection was made between the series commenced and two stations in the triangulation of Lieutenant A. W. Evans, U. S. A., on Cumberland sound. Captain Simpson carried his work southward and westward in the direction of Cedar Keys, and closed for the season on the 7th of April at a station established on Dunn's creek, west of Nassau marsh, distant about thirteen miles from Fernandina.

The timber growth encountered in opening the lines for observation consisted principally of pine and cypress, chiefly the former. An aggregate extent of fifty miles was prepared in the reconnaissance by cutting, for the measurements subsequently made.

Captain Simpson was aided throughout the season by Thomas Baltzell, jr. and Mr. G. B. Maynadier. Their promptitude and effectiveness in the discharge of duty and thorough co-operation in all the interests connected with the work are highly commended in the report made by Captain Simpson at the close of the season.

Captain Simpson acknowledges also the courtesies extended to him by Messrs. Finegan & Co., of the Florida railroad, and Mr. Daniel Callahan, contractor, in the assistance afforded to the party in transporting the camp equipage. The liberality of these gentlemen in declining any charge for the services rendered merits this public expression of my thanks.

Captain Simpson returned to the office at the end of April, and turned in the records of his triangulation, with a map and notes of the reconnaissance. His report describes minutely the character of that part of the Florida peninsula which falls within the limits of his operations. The extracts from it, given in Appendix No. 41, will be found interesting as bearing upon the local resources yet to be developed by the projected connection between Fernandina and Cedar keys.

The work of triangulation in the direction of the last mentioned point is about to be resumed by Captain Simpson under the appropriation made by the last Congress.

Triangulation of the Florida keys.—In the continued survey for the General Land Office, two triangulation parties, and three others engaged with the plane-table, kept the field during the period allotted for work at the south.

The party of Lieutenant A. H. Seward, U. S. A., assistant in the Coast Survey, reached its station in the schooner Graham on the 28th of December. Early in January the triangulation was resumed at Point Charles, and carried southward and westward to a station on Matecumbe key, where it joins with the work of Lieutenant J. C. Clark, whose operations will be next referred to in their geographical order. The series of triangles determined by Lieutenant Seward includes stations on the outside shore of Key Largo, Dove key, Tavernier, Indian key, and Lower Matecumbe. Several of the beacon signals recently erected on the reef were also observed upon, in addition to others lying outside of the keys.

The distance between the limits of the work of this party, (Sketch No. 40,) executed during the present surveying year, is about twenty-five miles.

Mr. C. B. Baker served as aid in the party, and his efforts in the discharge of duty are commended by Lieutenant Seward.

Six repetitions were made in the measurement of each angle. The instrument used was the ten-inch Gambey theodolite C. S. No. 15.

The statistics of work are thus mentioned in the season's report:

Signals erected	29
Stations occupied	26
Number of sets of repetitions	1,137
Single observations in measurements	6,822

The triangulation covers an area of eighty-three square miles.

Previous to the commencement of operations Lieutenant Seward completed and deposited at the office his journal in duplicate of the work of last season, with sketches and descriptions of the stations then occupied. Since his return from this section he has turned in also the records of horizontal angles and descriptions of the signals observed on during the present year.

The triangulation executed by Lieutenant Seward in 1856 has been reported upon from the Computing Division of the office as being satisfactory in connection with the work of Sub-Assistants Rockwell and Sullivan of that date. A very satisfactory agreement was also found on comparing the computed lengths of the triangle sides as derived respectively from the preliminary bases at Key West and Bahia Honda.

Lieutenant Seward has been engaged during the summer in the triangulation of Hudson river under the direction of Assistant Edmund Blunt, and is under instructions to complete the connection of the Cape Sable and Key Biscayne bases.

The records of observations made in the course of the season's operations, together with the computed results of the triangulation of the Florida keys, have been received and deposited in the archives of the section.

A second triangulation party, conducted by Lieutenant J. C. Clark, U. S. A., assistant, in the schooner Bowditch, commenced a series of triangles on the 5th of January at Stirrup key, the eastern limit of previous work executed by Lieutenant Seward, and extended it northward and eastward over the Stirrup keys, Grassy key, Long key, and numerous small patches of keys between Eagle cove and Lower Matecumbe. At the locality last mentioned the series joins with the triangulation executed within the season by that officer. The connection is now complete along the entire outer line of keys lying between Cape Florida and the Marquesas to the westward of Key West.

Lieutenant Clark found the season generally unfavorable for observations. The extent embraced in the triangulation by his party is nearly twenty-nine miles, the limits and details of which will be seen on Sketch No. 40.

Mr. F. W. Alexander served as aid during the season. Twenty-five signals were observed upon in the measurement of seventy-five angles comprised in the series. The following are the statistics of the work in detail:

Signals erected	21
Stations occupied	13
Number of observations	3,585

The volumes containing the original records made in the measurement of horizontal angles, descriptions of the signals, results of computations for triangle sides, &c., have been sent to the office for deposit by Lieutenant Clark. Some remarks extracted from his report, having reference to the local facilities for navigation afforded in the vicinity of Long key and Grassy key, are given in Appendix No. 42.

The operations of the party were closed on the 22d of May, when Lieutenant Clark returned to the north, and the schooner Bowditch was laid up at New York.

Arrangements are now nearly complete for work by this party on the Florida peninsula.

Topography of Cumberland sound, and of St. Mary's and Amelia rivers, with their tributaries.—On closing the plane-table work in the vicinity of New York bay at the end of the last surveying year, the party of Assistant A. M. Harrison proceeded in the schooner Benjamin Peirce to Fernandina, and commenced the topography of Cumberland sound, and its dependencies, on the 5th of December. The weather proved unusually stormy and inclement in that vicinity, but operations in the field were continued throughout the full season, and terminated on the 5th of June.

Four topographical sheets, containing the shore-line of numerous intricate water courses, tributary to Cumberland sound, were completed before the return of the party, and have since been put in ink and deposited in the archives of the office. The limits of these will be found severally marked on Sketch No. 31. First in order of execution, Assistant Harrison projected a sheet which includes the entrance of the sound and adjacent parts of Cumberland and Amelia islands, the entrance to St. Mary's river, part of Tiger island, and Amelia river from its mouth upwards to Kingsley's Cut. Other sheets, connecting with that just alluded to, extend the survey to a point three miles above, and including the town of St. Mary's, together with the shores of North river and Burrell's creek, in Georgia. On the Florida side of the boundary, the same sheets embrace the whole of Bell's river, Jolly river, and Lanceford creek, with numerous intersecting branches of the first mentioned streams occurring on the upper part of Tiger island.

The towns of Old and New Fernandina, the Atlantic terminus of the Florida railroad, are represented on the sheet which contains a part of Amelia island. The contents of the several sheets are stated in detail in the report of Assistant Harrison, extracts from which I have placed in the Appendix, (No. 40.) A tracing from the sheet first described was furnished by him at the request of the Florida railroad company. As preliminary to the operations of the party engaged under my immediate direction at Fernandina, Mr. Harrison also made an examination, and submitted a plan, which met my approval, for connecting the astronomical station with the triangulation of Lieutenant A. W. Evans executed in 1856.

Having conducted the operations of his party in the field during five months of the season, Assistant Harrison returned north, in consequence of the condition of his health, in the early part of May, after which the plane-table work was continued by his principal aid, Mr. W. H. Dennis. Under the direction of Assistant Harrison, a minute survey was made by him of the site proposed for a base line on Cumberland island. Four lines of levels were run in executing this duty. A strip, embracing a quarter of a mile in breadth, and extending throughout the entire length of the projected site, is represented on one of the topographical sheets. In reference to the services of Mr. Dennis, Assistant Harrison remarks:

"The duties assigned to him, of whatever kind, have been performed faithfully and promptly. He has cheerfully co-operated in the work, and has proved himself a valuable acquisition to the party."

Mr. J. A. Da Costa also served as aid during the season, and his efforts in the prosecution of the work, which met many hindrances in the unfavorable character of the winter and spring, are well spoken of by Assistant Harrison.

The plane-table work included in the four sheets was completed by the 5th of June, at which time Mr. Dennis rejoined Assistant Harrison with the schooner Peirce for topographical duty in the vicinity of Plymouth, Massachusetts, reference to which has been made under Section I.

The following statement of statistics, contained in the report of Assistant Harrison, is referable to the work executed in the vicinity of Fernandina and St. Mary's.

Sheets.	Shore-line.	Creeks, &c.	Inland marsh line.	Roads.	Area.
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Square miles.*
No. 1	$37\frac{1}{3}$	$84\frac{1}{4}$	$28\frac{1}{2}$	$9\frac{1}{4}$	20
No. 2	$52\frac{1}{8}$	$238\frac{3}{4}$	$30\frac{7}{8}$	$27\frac{2}{3}$	$32\frac{1}{2}$
No. 3	$6\frac{1}{4}$	$10\frac{1}{8}$	4	$3\frac{1}{4}$	$2\frac{7}{8}$
No. 4	....	....	....	$8\frac{1}{4}$	$2\frac{3}{4}$
Total	$95\frac{1}{2}$	$333\frac{1}{8}$	$63\frac{3}{8}$	$48\frac{1}{2}$	$58\frac{1}{8}$

In reporting upon the work executed, Assistant Harrison expresses his obligations to Lieut. G. W. Custis Lee, U. S. Corps of Engineers, in charge of Fort Clinch, for assistance, and to Mr. Nightingale, of Cumberland island, for courtesies extended to himself and party while employed in that vicinity.

Topography of the Florida keys.—A plane-table party, additional to the two which have been regularly employed in the survey for the General Land Office, was organized at the close of the last year, and a corresponding advance has been made in the progress of the work undertaken.

The party of Sub-Assistant S. A. Wainwright resumed operations on Key Largo on the 16th of January, and had fixed in place eighty section posts when the increase of Indian hostilities in the vicinity made it, in his opinion, inexpedient to carry on work beyond the immediate reach of the outer shore, his party being without means of defence. His party was therefore transferred to Point Charles, and commencing there with the plane-table, the outer shore-line of the key was traced to its southern extremity. The work executed falls within the triangulation carried on at the same time by Lieut. A. H. Seward, the details of which have been given under their proper head. The outside shore-lines of Upper and Lower Matecumbe keys were also traced within the season. Including creeks and passages between the keys, and the outline of water courses intersecting the fast land of Key Largo, one hundred and twenty miles of shore-line, and six square miles of interior were surveyed by the party. The limits of the work are represented on Sketch No. 40. Thirty-seven of the quarter section posts put down were of iron, and forty-three of wood. They were all marked in the usual manner as being at the intersections, or intervening between the meridians and parallels. The points requisite for the plane-table work were furnished by Lieut. Seward.

The surveying schooner J. W. Bailey was used for transportation by the party of Mr. Wainwright, and at the close of the season was laid up at Baltimore.

Appendix No. 42 contains remarks bearing on the quality and value of the keys in the vicinity of Key Largo, extracted from the report of Sub-Assistant Wainwright. The work will shortly be resumed in that locality.

The second party employed in the topography of the Florida keys was conducted, as in the two previous surveying seasons, by Sub-Assistant C. T. Iardella. His operations commenced on the 3d of January, and embraced the plane-table survey, and marking of a number of keys lying westward of Bahia Honda harbor. These fall principally within the triangulation completed by Sub-Assistants Rockwell and Sullivan in 1856.

Three plane-table sheets finished within the year, inked, and returned to the office by Sub-Assistant Iardella, present in detail the survey and subdivision of the following named keys: *Ramrod* key, *Big Torch*, *Little Torch*, *Big Pine*, and *No Name* keys; *New-found harbor; Little Pine* key; *Pye's Harbor* key; *Annette*, *Big Spanish*, *Little Spanish*, *Crawl*, *H we's*, and *Mayo's* key; the *Johnson keys; Flat* key; *West Bahia Honda*, and *East Bahia Honda*. Full details, in reference to the quality of soil and timber growth occurring on the keys just enumerated, are given in the report of Mr. Iardella, which I have placed in the Appendix, (No. 42.) The number and character of the quarter section posts put down for the General Land Office will also be found in his report.

The surveying schooner Agassiz, which had been reassigned for the use of the party, arrived in the harbor of Key West at the usual time for resuming work at the outset of the season. Mr. S. J. Hough, attached to the party as aid, accompanied the vessel, but was seized with fever a few days after reaching port, and died on the 14th of December. He had served throughout the previous season in the party of Sub-Assistants Rockwell and Sullivan, in the triangulation of the Florida keys in the vicinity of Key West, and during the former year in my own party in Section I. In these employments, and as connected with the party of Sub-Assistant Iardella, his faithfulness in the discharge of duty had commended him to favorable notice. The untimely loss of Mr. Hough was replaced by the assignment of Mr. G. U. Mayo, who joined the party in February, and continued in it until the close of the season. Notwithstanding the adverse circumstances which occasioned delay in commencing the work, the amount of detail presented in plane-table sheets is beyond the average for the working season, and in its character and quality is highly creditable to the energy of Sub-Assistant Iardella. The statistics comprise one hundred and ninety miles of shore-line, within an area of thirty-one square miles.

Operations were discontinued for the season on the 3d of May, when the schooner Agassiz was transferred to the north and laid up at Baltimore.

After inking his sheets of work executed in this section, Sub-Assistant Iardella was assigned to topographical duty on the shores of Casco bay, and made the survey described under that title in Section I. His preparations are now in progress for an early return, to resume work on the Florida keys.

The additional party detailed for service in this section was entrusted to Mr. F. W. Dorr, whose experience in the field, under the direction of Assistant H. L. Whiting, had qualified him to conduct its operations. Mr. Dorr reached Key West on the 10th of January, and in the following week joined the surveying schooner Dana, which had been assigned for the transportation of his stores and instruments. His topographical sheets comprise surveys made in three separate localities, which will be noticed in the usual geographical order. Points within the triangulation of Lieutenant Clark having been furnished by that officer, Mr. Dorr took up and completed the survey of Key Vacas, referring the junction of his sheet to the limit reached by Assistant I. Hull Adams in a former year. His work in that vicinity was carried eastward, and includes Boot key, the Stirrup keys, Fat Deer key, Bamboo key, and a number of small intervening patches. Remarks concerning the relative positions and character of the several keys, included in the sheet now under notice, will be found in Appendix No. 42, which contains extracts from Mr. Dorr's report upon the work of the season. The location of the sheet is eastward of Bahia Honda harbor, and wholly within the triangulation of Lieutenant Clark, already mentioned under this section.

A second sheet was projected, to include the unsurveyed keys lying northward and westward, and immediately adjacent to the work of Sub-Assistant Iardella. Mr. Dorr's sheet of that vicinity comprises the topography of *Burnt* key, *Knock'em down* key, *Budd* key, *Michael's* key, *Raccoon* key, the *Water* keys, the *Eastern* and *Western Content* keys, and *Harbor* key, together with numerous smaller ones not distinguished from each other by local names. The report of Mr. Dorr, (in Appendix No. 42,) will be found to contain information relative to the size and surface peculiarities of the keys included in this sheet. All the firm land embraced in his surveys was subdivided into quarter sections. The first sheet represents the positions of sixty-seven, and that last mentioned of eighty-nine quarter section stakes, which were placed in the progress of his work at the intersections of the meridians and parallels, and marked, respectively, M. P. or MP.

An attempt was made, at the outset of the season, to commence the topography of Cape Sable, but the presence of hostile Indians at the extremity of the Florida peninsula made it expedient to defer that work until the advance of spring.

Mr. Dorr began, in the middle of March, a plane-table sheet, to include the base at Cape Sable, and the extremity of the peninsula southward of a line joining Northwest cape and the "Upper Crossing," opposite to the Oyster keys. His survey in this neighborhood requiring a second sheet, the shore-line between Palm Point and Northwest cape was traced and represented on it. Sandy key, lying southward and eastward of Cape Sable, is included in the topographical work executed in this vicinity. Fifty-two quarter section stakes were placed and marked for the purposes of the General Land Office, with letters to designate their location on the meridians or parallels. The limits of the four topographical sheets returned to the office by Mr. Dorr are represented on Sketch No. 40. His operations were discontinued for the season on the 16th of May. The local features of that part of the peninsula of Florida over which his work extended are given in Appendix No. 42. Mr. Dorr's report contains the following summary of statistics, derived from the several plane-table surveys completed by him in this section:

Shore-line surveyed	$210\frac{1}{2}$	miles.
Outline of wood and marsh traced	69	"
Total area included	73	square miles.

This large season's work is represented in excellent style upon Mr. Dorr's plane-table sheets.

At the close of the season allotted for work at the south the party returned north, and Mr. Dorr was assigned to duty in the vicinity of New York. Preparations are now in progress for his return to prosecute the survey, and marking of the Florida keys, in conjunction with the party which has been heretofore engaged in that service.

The Commissioner of the General Land Office has been furnished with copies, in triplicate, of the sheets completed within the season by Sub-Assistant Iardella and Mr. Dorr. My report addressed to him, and extracts from the field reports, giving the details of progress made in the survey within the present year, will be found in Appendix, (No. 42.)

Hydrography of St. Mary's bar, and of the entrance to Cumberland sound.—A very careful re-examination has been made of the soundings executed last season by the party of Lieut. Comg. S. D. Trenchard, U. S. N., assistant in the Coast Survey. Some of the lines run in the present year extend over the localities included in last season's operations, and no change was found in the comparison made. The bar seems, however, to have deepened slightly, and the change detected there is thus referred to in the report of Lieut. Comg. Trenchard:

"The thirteen and a half feet ridge, which extended across the channel, now appears broken, forming a middle ground, with a channel of over fourteen feet on either side." His recommendation, that a buoy be placed on the middle ground referred to, has been communicated, through the Department, to the Light-house Board, (Appendix No. 64.)

"In the prosecution of the work the lines of soundings were carefully verified, every precaution being taken to develop the line of best water, by making the soundings as close as possible. The positions of the buoys were determined and laid down on the chart. The bar has been sounded out, in company with the St. John's pilots, on two separate occasions, and the result shows no depth greater than that assigned by our present survey. The soundings were mostly made in boats during very light winds or calm weather, between the 21st of February and the 11th of March." Additional soundings were also made in Cumberland sound and at the entrance of the St. Mary's river; the operations of the party in the surveying schooner Gallatin having commenced there early in January. The hydrography of Amelia river and its tributaries and Fernandina harbor was also completed within the season. The limit to which the work was carried seaward from the entrance into Cumberland sound will be seen by reference to Sketch No. 31.

In connection with the hydrography of the bar, the tide register at the entrance was observed every five minutes. From the 10th to the 17th of April simultaneous observations were made at the bar and at Fort Clinch with reference to the intervals between the times of high water. The result of the comparison made is thus stated by Lieut. Comg. Trenchard:

"Time of low water at Fort Clinch, thirty-one minutes later than at St. Mary's bar."

"Mean duration of slack water (ebb) at Fort Clinch, fifteen minutes."

"Greatest difference between times of low water at Fort Clinch and bar, one hour; least, ten minutes."

"The observations were made during favorable weather, and the tide, during their continuance, was not influenced by wind."

Simultaneous observations were also made between the 17th and 20th of June, at the bar and at Fort Clinch, for the purpose of detecting any difference which might exist in the rise and fall. Comparisons made of the records by Lieut. Comg. Trenchard showed no appreciable difference between the respective heights of the water at the two stations. The gauge used at the bar was placed just within the entrance buoy.

The shore-line requisite for the hydrography of Amelia river was furnished by Assistant A. M. Harrison.

I have communicated, in the usual form, to the Light-house Board the recommendation of Lieut. Comg. Trenchard, for replacing the entrance buoy at St. Mary's by one of the first class.—(Appendix No. 63.)

While the schooner Gallatin was at anchor near the northern point of Amelia island, in February, she was driven on shore by the swell and northeast wind, the ring of the anchor giving way. Fortunately the vessel sustained no injury, and with the valuable assistance rendered by Lieut. G. W. Custis Lee, United States Corps of Engineers, in charge of Fort Clinch, and by others, Lieut. Comg. Trenchard was enabled to get her afloat by the 25th, and resume the regular work of the season.

The hydrographic sheets of the St. Mary's bar, entrance to Cumberland sound and Fernandina harbor, containing the work of the present season, have been received and filed with the archives of the office. Lieut. Comg. Trenchard returns the following report of statistics:

Miles run in sounding	293
Number of soundings	13,700
Number of angles observed	642

A comparative chart has been prepared showing the results of the successive surveys made at the St. Mary's entrance by the party of Lieut. Comg. Trenchard.

Ten volumes, containing the original records of soundings, angles, and tidal observations connected with the work, have been deposited in the office.

Supplementary hydrography at the entrance of St. John's river, Fla.—After completing the work last noticed, Lieut. Comg. Trenchard commenced, on the 21st of May, a resurvey of the bar of St. John's river, and extended the hydrography seaward, and from the entrance upward to a junction above Mayport Mills, with his work of 1855. This resurvey was made by request and at the cost of the Engineer Department. Soundings were carried southward to a line abreast of St. John's flag; northward to Talbot island, and a mile within Fort George inlet. The following is an extract from the report of Lieut. Comg. Trenchard: "The soundings on the bar have been made with great care, and as close as it was possible to plot them. The least depth on the bar at mean low water, running the pilot's line in, is eight and a half feet."

Observations were made with reference to the tides and currents in connection with the hydrography.

The work was completed on the 13th of June, and the results are shown in the following statistics:

Miles run in sounding	165
Number of soundings	11,250
Number of angles observed	873

In prosecuting operations in this and in the preceding section, Lieut. Comg. Trenchard occupied seven current stations. One permanent and eight temporary tidal stations were established, three hundred and thirty-seven high waters were observed, and three hundred and twenty-eight low waters recorded.

The chart of the entrance to St. John's river has been completed and deposited in the office.

Lieut. Co'mg. Trenchard returned from this section at the close of June, and, after refitting the Gallatin at New York, engaged in the hydrography of Casco bay, in the vicinity of Portland. His chart of St. John's river entrance is now in the office.

Hydrography of Florida Reefs.—This work was continued by the party of Lieut. Comg. T. A. Craven, U. S. N., assistant in the Coast Survey, in the steamer Corwin. The vessel left New York on the 25th of January, and commenced the operations of the season on the 7th of February, at a line extending southward and eastward from East Bahia Honda. The hydrographic sheet falls chiefly within the limits of the topographical survey made within the season by Sub-Assistant C. T. Iardella. Soundings were extended to a distance of rather more than nine miles in a direction generally southward from the line of outer keys. The limit reached in a westerly range is beyond Loggerhead Key, nearly seventeen miles and a half from East Bahia Honda. A sheet previously executed there joins with the work now under notice.

While engaged in the regular hydrographic work on the reef, Lieut. Comg. Craven ran a line of soundings, in connection with observations for temperatures, between Havana and Key West, the results of which have been referred to under the head *Gulf Stream.* The following are statistics of the work of his party:

Miles run in sounding	945
Number of soundings	33,560
Number of angles measured	5,124

A tidal station was occupied, and a full series of observations recorded at a current station.

The operations were brought to a close on the 15th of May.

Two hydrographic sheets of work, previously executed by the party, have been plotted within the year and deposited in the archives.

In order to save the time of the triangulation and topographical parties engaged on the keys, in passages to and from Key West for supplies of wood and water, an arrangement was made with Lieut. Comg. Craven, and the requisites were regularly furnished to them by the Sophia, the tender of the hydrographic party.

The recommendation of Lieut. Comg. Craven, for the erection of a permanent beacon on Looe Key, (Appendix No. 65,) was communicated to the department for transmission to the Light-house Board.

Lieut. Comg. Craven was detached from Coast Survey duty shortly after his return from this section. The loss of his services is one of the most severe of those which the survey has had to sustain during the past year. His natural qualities as a hydrographer have been ripened by a large experience, and there is no part of his profession in which he is at fault. In the regular routine of sounding, and in the more difficult and delicate investigations of the Gulf stream, and of tides and currents, he is equally at home. His industry, perseverance and zeal are not to be surpassed, and have rendered successful in his hands the difficult exploration of the Gulf Stream, the soundings of the Florida reefs and coast, and the minute hydrography of New York bay and harbor and its approaches. Always prompt himself, he has inspired the officers of his party with his own zeal, and has thus always had around him cheerful and active co-laborers. The selection of this officer to conduct the exploration of the Atrato route for an interoceanic canal removes him to a higher field of duty, and is a just reward for the faithfulness and efficiency of his service in the Coast Survey. Lieutenant Craven was replaced, as chief of a hydrographic party, by the assignment of Lieut. Comg. W. G. Temple.

New boilers were provided for the steamer Corwin during the summer, and have been put in place since the return of the vessel from service in Casco bay. The arrangements of the party are now in progress for resuming the hydrographic work on Florida reef.

Tidal observations.—The self-registering tide-gauge at Fort Clinch was kept in successful operation during the season as a permanent station.

Observations of short period for hydrographic purposes were made at New Fernandina, Fla., at the outer bar of the St. Mary's river, and also in the St. John's river, at Pilots' wharf, and Mayport mills.

Four self-registering tide-gauges were established by Mr. Gustavus Würdemann on the Florida keys, viz: at Cape Florida, Indian Key, Key West, and Tortugas. These are still in operation under Mr. Würdemann's supervision.

SECTION VII.

FROM ST. JOSEPH'S BAY TO MOBILE BAY, INCLUDING PART OF THE COAST OF FLORIDA AND ALABAMA.

(SKETCH G, No. 44.)

This is only the third year for which we have had an appropriation for this section of the coast. The same number of parties has been regularly employed as last year, namely, two in triangulation, two in topography, and one in hydrography; besides which, the occasional services of another have been had in triangulating and measuring a preliminary base. Being still cramped in regard to means, each of two of the vessels for transportation were necessarily assigned to two parties, in a degree retarding the progress of the separate operations. The season has not been altogether favorable; but, as the parties were early in the field, the amount of work has been greater than that of last year. The localities of survey have been Pensacola and its approaches; St. George's sound and the approaches to Apalachicola and Waccasassa bay. We should have a combined triangulation and plane-table party to keep up the extension of the work begun at St. Andrew's bay.

The details of the several operations in these localities will now be given. The following drawings have been completed: Waccasassa bay, $\frac{1}{50000}$; St. Mark's river, $\frac{1}{30000}$; addition to St. Andrew's bay, $\frac{1}{40000}$. The engraving of Apalachicola river entrance is in progress.

Triangulation of Waccasassa bay, east of Cedar keys, Fla.—There being no vessels disposable for the transportation of two separate parties, and the state of progress and the nature of the work permitting the triangulation and topography to go on together without material inconvenience, the two operations were joined under the direction of Sub-Assistant G. H. Bagwell and Mr. N. S. Finney, and the schooner Joseph Henry was assigned to the united parties. Various delays occurred which prevented the vessel from reaching Cedar keys until late in January. During February and March the weather proved very unfavorable for field operations, but Mr. Bagwell succeeded in making the reconnaissance required for the triangulation and in determining a sufficient number of points to keep the plane-table party at work.

Beginning at Grassy Point, (see Sketch G,) Sub-Assistant Bagwell re-occupied several of the stations erected in the previous season by Sub-Assistant B. Huger, jr., and carried a series of triangles southward and eastward along the main on the eastern side of Waccasassa bay to the entrance of We-thlocco-chee river, and thence in the same general direction to Shell Point, beyond the entrance to Crystal river. It was found impracticable to make connections in the chain of triangles by stations on the peninsula, in consequence of the difficulty of access to the shore.

"Throughout the season much delay was occasioned by the necessity of being far removed in the vessel from the ground of operations, and the impossibility of reaching many of the points, even in small boats, except at high water."

To the extract just quoted from his report, Sub-Assistant Bagwell adds: "The country over which the work extends consists chiefly of low marsh, overflowed at ordinary high tide, shifting bars, and shell reefs, from one to three miles distant from the main shore.

"Operations were closed on the 27th of May, and the statistics of the work executed up to that time are as follows:

"Stations established	12
"Stations occupied	14
"Number of signals determined	18
"Number of angles measured	89
"Number of single observations	3,096
"Area of triangulation in square miles	89

"Eight sets of observations, of six repetitions each, were made to each angle, the sets being observed forward and backward alternately, beginning with new readings of the instrument."

"The station points were well secured with screw piles and granite blocks, the former being used in every case where the soil was loose, as on the reefs, or liable to change."

Mr. N. S. Finney, in charge of the topographical party, co-operated in the triangulation work executed.

Sub-Assistant Bagwell has been occupied during the summer in the party of Assistant Edmund Blunt, engaged in the triangulation of Hudson river, and will shortly return to continue the work in the vicinity of Crystal river, Florida.

Triangulation of Apalachicola harbor and western part of St. George's sound, Florida.—This triangulation was continued by Sub-Assistant S. C. McCorkle, who had charge of it during the previous year. The schooner Belle, assigned to his party for transportation, was lost in passing along the coast from Pascagoula upon a shoal not laid down upon any chart, in the vicinity of Crooked island, near St. Andrew's bay, retarding the commencement of work, and requiring the party to find transportation in the schooner Franklin during the former part of the surveying season. The schooner Belle was so old, being one of those turned over by the Quartermaster's Department at the close of the Mexican war, that she was soon broken up after grounding. The crew were unharmed, and the instruments and equipments were landed safely.

In consequence of this delay Sub-Assistant McCorkle was unable to commence observations until the 26th of December. He had previously visited the stations occupied in the preceding season and replaced the signals, then erected, which had been nearly all blown down by the gale of August, 1856. Some difficulty was experienced also in obtaining materials for signals, the pine timber bordering the coast having been, in great measure, destroyed by the action of salt water.

Mr. McCorkle reports in reference to the condition of the station points themselves: "They were generally found in a good state of preservation. Some, requiring additional security, were attended to as far as practicable. The water, during the prevalence of a gale, rises as much as ten feet, and washes away the ground in some places fifteen or twenty, rendering the positions used in this vicinity very uncertain, and no ordinary precautions will answer for maintaining permanence in the stations."

The distance of the triangulation points in advance of the topography making it inconvenient to work from the vessel of the topographical party, a vessel was hired on the 1st of March for the remainder of the season, the party being discharged at the close of May.

The triangulation was resumed at Cat Point station, on Godley's Bluff, and carried directly westward over East bay, Apalachicola harbor, and St. Vincent's sound and island to the western outlet of the sound at Indian Pass. Signals used in the triangulation were erected on St. George's and St. Vincent's islands. From the position first occupied the work was also pushed eastward through St. George's sound to a line connecting the station adjacent to Turkey Point with the eastern end of Dog island.

"The season proved very unfavorable; December and January were fair working months, but the extreme cold weather towards the end of that period greatly retarded field operations; during February and March it was almost impossible to carry on the work in consequence of fogs and smoke, except at very brief intervals."

Sketch No. 44 presents a scheme of the triangulation executed. Nineteen tripod signals and five of the ordinary kind were erected by the party during the season, eighteen stations were occupied and seventy-six angles determined with the six-inch Gambey theodolite, C. S. No. 55. One thousand six hundred and eight observations were made in the measurement of angles.

Mr. Eliab H. Wells was attached to the party as aid, and his aptitude and zeal in the discharge of duty are referred to in terms of praise by Sub-Assistant McCorkle.

The necessary computations and duplicates of the field records were made after the return of the party and the volumes containing them have been placed in the office.

Sub-Assistant McCorkle thus refers to the local resources of that part of the coast of Florida included in the range of work:

"In my opinion the channel of Apalachicola river can be deepened without great cost, and when done it will open to the country one of the most valuable timber ports to be found on the coast. The shores of the Chattahoochee and Flint rivers abound with timber equal to any in the world."

"During the present season more than eighty thousand bales of cotton have been shipped from this port." Arrangements will be made with a view of executing, if practicable, the hydrography of Apalachicola harbor early in the season now commencing.

Triangulation of Pensacola harbor, Florida.—This work has been continued by the party of Assistant F. H. Gerdes, by a reconnaissance for the main series of triangles. Several stations were occupied for the secondary triangulation of Escambia bay, and the angles formed at Garçon Point, Red Bluff, and Emanuel Point, with stations selected for the main and secondary work, were measured.

The early part of the season was occupied by Assistant Gerdes in the measurement of a preliminary base, at Cedar keys, to be connected with the triangulation executed by Sub-Assistant G. H. Bagwell, reference to which has already been made.

The statistics of the work near Pensacola are as follows:

Signals erected	8
Additional signals selected	5
Stations occupied	5
Angular measurements	324

Assistant Gerdes was subsequently engaged in triangulation and topographical duty at two localities, in Section VIII, which will be hereafter noticed. In the course of the summer he completed a duplicate of the observations made, and descriptions of signals used, in the work at Pensacola. These, together with his computation of the results of the triangulation, have been placed in the archives.

Topography of the eastern shore of Waccasassa bay, Florida.—This was executed by Mr. N. S. Finney, whose party, as already stated, was united with that of Sub-Assistant Bagwell, in charge of the triangulation. The plane-table sheets are connected with those made a year ago by Assistant Harrison.

"The topography executed embraces all the shore-line, outline of forest, islands, shell-bank, hammocks, and details of every description, lying between the Waccasassa and Wethlocco-chee rivers, excepting a few small islands and shell reefs near the mouth of the last named river, which the time appointed for closing work did not admit of including. The sheets included We-thlocco-chee and Mangrove bays, Turtle creek, and Waccasassa river as far up as the head of steamboat navigation, or three miles from its mouth."

"The Waccasassa reefs were also surveyed, and the shore-line of the Gulf was traced to the distance of two miles northward of the entrance to Waccasassa river."

In connection with the work assigned to Mr. Finney, he assisted in the erection of signals for the triangulation, in reconnaissance for stations, and the measurement made by Assistant F. H. Gerdes of the preliminary base at Cedar Keys.

The following are statistics of the plane-table work, which was discontinued on the 26th of May:

Miles of shore-line surveyed	151
Miles of forest outline	10

Sub-Assistant Bagwell furnished the points requisite for topographical purposes, and co-operated thoroughly in the duties jointly assigned to the parties.

The following extract from Mr. Finney's report refers to the tract included between the Waccasassa and We-thlocco-chee rivers:

"The character of the country is such that I was obliged to dispense with the chain altogether, and carry on the work entirely by intersections; the surface being soft and broken marsh, very much cut up and traversed by innumerable small creeks and bayous. As a matter of necessity, the plane-table and instruments were transferred from station to station in the boat. There was great difficulty also in finding stations sufficiently firm, and, in consequence, most of those occupied were in water from one to three feet deep."

After inking and depositing his sheets in the office, Mr. Finney was assigned to duty in Section III. In conjunction with the party of Sub-Assistant Bagwell, his preparations are now well advanced for resuming work, in continuation of that of last season, in the vicinity of Crystal river, Florida.

Topography of St. George's sound, including the shores of Apalachicola harbor, Florida.—As part of the duty assigned to Assistant Geo. D. Wise in the preceding year, some progress had been made in the survey of the shores of St. George's sound, as noticed in my last annual report. His party arrived at Apalachicola on the 29th of November, and, before closing for the season, executed the topography of the delta of the Apalachicóla, the shores of St. George's sound, including Apalachicola bay, and the greater part of St. Vincent's sound. The plane-table survey of the vicinity is now complete from Indian Pass, eastward, through St. George's sound, to Dog Island light-house, a distance of about forty miles.

The schooner Franklin was used by the party of Assistant Wise for transportation, and, during two months at the commencement of the season, by the party of Sub-Assistant S. C. McCorkle also.

Mr. Wise thus reports the statistics of his work, the sheets of which have been inked and turned into the office:

Shore-line surveyed	170 miles.
Road-line	4 "
Area included in topography	41 square miles.

"Most of the season was unfavorable for topographical work on account of high winds and the unusual degree of cold. Thick fogs also prevailed for weeks at a time."

By request, Assistant Wise made preliminary soundings on the bar, and furnished E. K. Dodge, esq., a map of the mouth of Apalachicola river.

On the 23d of May the operations of the party were closed, and the vessel laid up in Apalachicola river.

The report of Assistant Wise contains the following remarks on the commercial facilities of Apalachicola: "The town is of considerable importance, shipping yearly some ninety thousand bales of cotton. Its trade is principally with New York and Liverpool. Semi-monthly lines of steamers run to New Orleans and Key West, and there is almost daily communication with the interior by the river boats as far as Columbus, Ga., a distance of three hundred and eighty miles."

"It is very desirable for the future prosperity of Apalachicola that the bar at the mouth of the river, which prevents vessels drawing over five feet from coming to the wharves, should be removed. As the distance requiring dredging is short, this could be done at small expense. The bar has been formed by deposits from the river, and it is of very light material."

Assistant Wise was employed during the summer in office-work.

Mr. F. F. Nes served as aid in the topographical party throughout the season.

Three plane-table sheets, resulting from the work in Apalachicola bay and St. George's sound, have been inked, and registered with the archives of the section.

Hydrography of Waccasassa bay, Florida.—Supplementary soundings for the chart of Waccasassa bay were made during the season by the party of Lieut. Comg. J. K. Duer, U. S. N., assistant in the Coast Survey.

The eastern limit of the work, as will be seen by reference to Sketch No. 44, is about ten miles due south of Waccasassa Point. From this line the hydrography was continued westward to a junction with the work of last year.

The duty assigned to the hydrographic party included Pensacola harbor as well as this locality. The supplementary soundings eastward of Cedar keys were commenced on the 23d of March. The hydrography was continued from that date, with no interruptions excepting from bad weather, until the 15th of April, when the hydrography already described was finished, and operations were resumed in Pensacola bay.

The statistics of the additional work executed eastward of Cedar keys are thus stated in the summary report of Lieut. Comg. Duer:

Number of angles determined	379
Miles run in sounding	371
Number of soundings	41,832

Tidal observations were made at three stations in connection with the hydrography.

The surveying schooner Varina was employed under Lieut. Comg. Duer in the work here noticed, and in that of Pensacola, which comes next in regular geographical order.

Hydrography of Pensacola bay entrance and approaches.—The party of Lieut. Comg. Duer sailed from New York in the surveying schooner Varina on the 8th of November, and commenced the hydrography of Pensacola bay and its approaches early in the following month. Many hindrances and interruptions were experienced in the general prevalence of fogs and easterly storms throughout the season. By a diligent use, however, of the means afforded in intervals of good weather, satisfactory progress has been made.

The sheet projected for Pensacola bay is now in the office. It contains soundings from Santa Rosa island northward and eastward as far up the bay as Emanuel Point, and the hydrography of the approaches in a direction southward and westward to a limit about eight miles outside of the entrance. The work here was closed on the 11th of May. The statistics are as follows:

Number of angles determined	1,458
Miles run in sounding	1,522
Number of soundings	42,742

Four tidal stations were established, at which observations were taken for use in the hydrographic reductions.

On the southern passage from New York, at the outset of the season, the schooner Varina touched at New Providence, and at the request of the United States vice consul at Nassau Lieut. Comg. Duer received on board his vessel the crew and steerage passengers of the American ship *Julia Howard*, which had been, a short time previous to his arrival, lost on the Bahama banks. No provision existing at the consulates to meet such cases, the destitute passengers, and such of the crew as desired it, were taken in the Varina to Pensacola. The correspondence relative to the action of Lieut. Comg. Duer is given in Appendix No. 54.

In February Lieut. Comg. Duer was applied to for assistance by the consignees of the schooner *Georgia*, stranded some days previously about thirty miles from Pensacola. The party proceeded in the Varina to the wreck, and united in the efforts made to relieve her, but these proved unavailing without the employment of means inconsistent with the duties of the season.

While the hydrographic work at Pensacola was in progress a fire occurred at Fort Pickens; the officers and crew of the Varina promptly co-operated in the measures taken to stop the destruction of property, and the service so rendered by the party was acknowledged in a communication addressed to Lieut. Comg. Duer by Captain John Newton, of the Corps of Engineers, commanding the harbor.

The schooner Varina, shortly after her return to New York at the close of the season, was temporarily exchanged with the Navy Department for the steamer Arctic.

SECTION VIII.

FROM MOBILE BAY TO VERMILION BAY, INCLUDING THE COAST OF MISSISSIPPI AND PART OF LOUISIANA.

(SKETCH H, No. 47.)

The same number of parties has been employed in this section as during the previous year, and with the same organization. It has been found quite economical to connect the operations for topography and triangulation in one party, under the circumstances of ground and climate in the section.

There are two parties thus organized, and a third topographical party is required to keep the topography up with the triangulation. The hydrographic party in a steam vessel nearly keeps pace with the land work. The triangulation of the section is quite half done, the topography and hydrography more than one-third. At the present rate of progress six or seven years will complete the triangulation of this section, and the topography and hydrography will be but a few years behind the triangulation. The work of this season has included—

1. Longitude determinations by telegraph between Montgomery, Alabama, and Mobile, with latitude and magnetic observations connected with them.
2. Secondary triangulation and magnetic observations on the coast of Louisiana.
3. Marking of the terminus of Dauphine island base.
4. Reconnaissance and triangulation of the Mississippi delta.
5. Measurement of a preliminary base at Pt. au Chevreuil, and triangulation of Côte Blanche bay, Louisiana.
6. Topography of the shores of Lake Borgne.
7. Topography of the main and islands of Chandeleur sound.
8. Topography of Côte Blanche bay, Louisiana.
9. Hydrography of Mississippi and Chandeleur sound.
10. Deep-sea soundings of the Gulf of Mexico.

The necessary details in reference to these operations are given in this chapter. The progress has been entirely satisfactory, taking into view the means furnished. The work in the office has consisted of the computation of the field-work; of drawings of Mississippi City harbor, St. Louis bay, and Grand island Pass, and Pearl river entrance; the drawing of the coast chart of Mississippi sound, from Round island to Grand island, and chart from Cat island to Lake Pontchartrain, has been in progress; the chart of part of the coast of Alabama and Mississippi has been engraved, and the chart of Mississippi sound, Nos. 1 and 2, and Biloxi bay, (as a finished map,) are now in progress.

The rough chart of the Gulf of Mexico, between the mouth of the Mississippi and Key West, which accompanies this report, gives a capital general idea of the form and character of the bottom in this great bay. The curves show the extent of the gentle slope from the shores to the abrupt descent to a great depth, and the shading shows the material of which the bottom is composed, the mud, the sand, the mud and sand, and, towards the Florida keys, the coral. This map, with its sections, when completed, will give a full idea of the physical geography of this portion of the Gulf. A line run from the entrance of Matagorda bay, (Section IX,) nearly at right angles to the general direction of the coast, about fifty nautical miles in length, shows a gradual slope to sixty-eight fathoms, the depth at its extremity.

We were disappointed in the expectation of being able to complete the telegraph work between Washington and New Orleans last season, as the state of the lines required us to make an intermediate point between Montgomery and Mobile. The connection between Mobile and New Orleans only remains to be made to finish this longitude line, unsurpassed, for length, in any part of the world, between Calais, in Maine, and New Orleans, in Louisiana.

Longitude determinations by Telegraph, between Montgomery and Mobile, Ala. Astronomical observations.—The chain of telegraphic longitudes between Washington and New Orleans has this season been extended to Mobile, by the party of Dr. B. A. Gould, jr., assistant, the operations of which were, as heretofore, conducted by Assistant G. W. Dean.

We expected certainly to have reached New Orleans this season, but the state of the telegraph lines has prevented it.

Arrangements for longitude experiments were completed early in November, and Sub-Assistant Edward Goodfellow proceeded to Mobile in charge of the party and instruments; Mr. Dean then passing on to New Orleans, for the purpose of erecting a suitable observatory upon the site selected by Dr. Gould last season for determining the longitude of that city.

Having accomplished this duty, Assistant Dean took charge of the telegraph station at Montgomery on the 1st of December. The astronomical instruments were adjusted in position, and the telegraph apparatus placed in good working order for finding the difference of longitude between Montgomery and Mobile. On the 7th of that month efforts were made, but without success, to exchange signals between the two cities without the use of the repeater at Lower Peach Tree, which, however efficient for ordinary messages, destroys the accuracy of the longitude determination.

Between December and the following March a large number of experiments were made with different arrangements of the batteries, but the imperfect insulation and connections of the line at that time could not be overcome. The reports of Mr. Dean satisfied me that the experiments had been conducted with care and good judgment, and accordingly in March I directed him to establish an intermediate station at Lower Peach Tree, near the Alabama river, in order to complete the work to Mobile before the close of the season. The instruments at Mobile in charge of Mr. Goodfellow were transferred to Lower Peach Tree about the middle of March, and from that date until the 11th of June the observations advanced rapidly to completion.

At Montgomery six hundred and seventy-five observations were made upon one hundred and sixty-five stars, with the C. S. transit No. 6, for determining the clock error, azimuth and collimation corrections to the transit instrument. One hundred observations were made upon eighteen well ascertained circumpolar stars, for thread intervals, and the inequalities of the transit pivots were determined with the riding level of the instrument, by the usual method.

At Lower Peach Tree station four hundred and ninety-six observations were made upon one hundred and fourteen stars, with the C. S. transit No. 8, for clock and instrumental corrections. For thread intervals fifty-three observations were made upon eighteen circumpolar stars, at upper and lower culminations. The inequalities of the transit pivots were determined in the usual manner.

The latitude of the station at Lower Peach Tree was determined by Sub-Assistant Goodfellow, from ninety-five observations upon twenty-two pairs of stars, with the zenith telescope C. S. No. 5.

At Mobile eight hundred and ten observations were made with transits Nos. 6 and 8, for time and instrumental corrections. The thread intervals were determined by one hundred and twelve observations, upon twenty-four circumpolar stars, and one hundred stars were observed on for the personal equation between Mr. Dean and Mr. Goodfellow.

The latitude of the Mobile station was determined by Sub-Assistant Goodfellow, from two hundred and fifty-seven observations, upon forty-three sets of stars, with zenith telescope C. S. No. 5. The value of the micrometer was obtained from ninety observations upon Polaris, near its western elongation, and the level divisions were determined from observations upon a collimator.

In the determination of difference of longitude between Montgomery and Lower Peach Tree, signals were exchanged on eight different nights, the observers changing places after four successful nights' observations, for the purpose of eliminating the effect of personal equation. Two hundred and twenty-two stars were used for the telegraphic observations.

The difference of longitude between Peach Tree station and Mobile was obtained by exchanging signals upon two hundred and thirty stars, on seven nights, the observers replacing each other after four successful nights, as in the previous campaign.

Assistant Dean acknowledges his particular obligations to Brevet Major P. G. T. Beauregard, Corps of United States Engineers, and J. N. Jennings, esq., of New Orleans, for aid rendered in the erection of an astronomical station in that city.

The officers connected with the telegraph line over which the experiments were made, in the past season, extended all the facilities for working in their power, and the courtesies of Mr. J. C. Butler, superintendent of the line, are especially acknowledged in the reports of the assistants who conducted the operations.

Magnetic observations.—At Lower Peach Tree, Ala., the magnetic elements were determined by Assistant G. W. Dean, while the operations for telegraphic longitudes were in progress; one hundred and twenty-five observations were made for variation on three different days with declinometer No. 22, by Jones, (C. S. No. 1;) two sets for horizontal intensity and moment of inertia, on two days; and two sets for dip, with the ten-inch Barrow dip-circle, (C. S. No. 4.)

Magnetic determinations were also made by Sub-Assistant Edward Goodfellow, in the public square at Mobile, consisting of one hundred and eighty observations, on four days, for variation; three sets for horizontal intensity and moment of inertia, on three days; and four sets for dip, with the same instruments used at Lower Peach Tree. A meridian line was traced in the public square, and permanently marked, by Sub-Assistant Goodfellow, with marble monuments furnished by the city authorities of Mobile, at whose request the line was established.

The meterological conditions of the atmosphere were recorded in connection with the various observations made at the longitude and magnetic stations. Messrs. Julius Kincheloe and McLane Tilton served as aids in the longitude parties, and rendered valuable assistance in the operations of the season.

The volumes containing the registers of observations, and computations of the places of stars used, have been received from Assistant Dean.

Sub-Assistant Goodfellow has completed and sent to the office, together with the original record, a duplicate of the latitude observations made at Mobile, and the computation derived from the data contained in them. Since the close of operations in this section at the approach of summer, Assistant Dean and Sub-Assistant Goodfellow have been engaged with my party in Section I.

Under favorable circumstances, it is hoped that the arrangements already made for prosecuting the telegraphic work in the coming season will enable the parties to complete the observations necessary on the line connecting Mobile and New Orleans, and thus complete the longitude connection of Washington and New Orleans.

Secondary triangulation on the western shore of Chandeleur sound, La.—This work, in connection with the primary triangulation of Mississippi sound, has been advanced westward by the party under the direction of Assistant J. E. Hilgard.

The attention of Assistant Hilgard being required at the office in the arrangement of details for the volumes of Records and Results, the operations of his party were executed by Sub-Assistant Stephen Harris, aided by Mr. R. E. Halter, and during part of the season by Mr. J. S. Harris.

Beginning at the opening of the season at the stations Cat island and Cat Island light, (see Sketch No. 47,) the work was extended southward, and now joins at Freemason's key the triangulation of the Chandeleur islands.

In the prosecution of the secondary triangulation, one hundred and five angles were measured at eighteen stations, by six hundred and fifty-two sets of observations of six repetitions each, with the ten-inch theodolite, C. S. No. 79, and six-inch No. 84.

The area covered by the triangulation is two hundred and fifty square miles.

The surveying schooner Twilight was in the service of the party of Assistant Hilgard for transportation throughout the season.

Before proceeding to Chandeleur sound, Sub-Assistant Harris made a local triangulation in Mobile to connect the telegraphic longitude station with the spire of the Episcopal church in that city, one of the points in the main triangulation of this section.

Originals and duplicates of the observations recorded, in the primary and secondary triangulation of Mississippi sound and Lake Borgne, in 1855, together with descriptions of the signals used in that work, and records of the observations for azimuth at Cat island, have been furnished within the season and placed with the archives in the office.

Magnetic observations.—At Barrel Key station, on the western side of Chandeleur sound, observations were made during the progress of the work of triangulation and topography, by Sub-Assistant Stephen Harris. The magnetic declination, dip, and horizontal intensity were determined with declinometer, C. S. No. 2, and the ten-inch dip circle by Barrow, C. S. No. 8.

Dauphine Island base.—Since the measurement of the base on Dauphine island, in 1847, the site has been repeatedly visited by Assistants F. H. Gerdes and J. E. Hilgard, in passing to and from the ground of their work in the Gulf Sections. Inspection has been made from time to time, and the condition of the marks, intended to be permanent at the termini, reported, and the results have been stated, from time to time, in my reports.

The hurricane of 1855 having destroyed the monument at the west end of the base, a new set of marks were made by Assistant Hilgard from points marked during the measurement of the base undisturbed by the hurricane. For further security, reference marks were made by Assistant Gerdes, and a screw pile was inserted in the prolongation of the line, below the surface, in a vertical position, filled, covered, and marked. In the opinion of Mr. Gerdes it will keep its place so long as the island itself remains.

On completing this duty, Assistant Gerdes proceeded with his regular work in this section and in the prosecution of that described under Section VII.

Reconnaissance and triangulation of Mississippi delta, Louisiana.—After completing the work just described, Assistant F. H. Gerdes proceeded to the mouth of the Mississippi river, and made a general reconnaissance, with the object of commencing the triangulation of the delta within the season.

Regarding as so many stations to be occupied, the light-houses at the entrances of the delta, the scheme of triangles projected extends upwards from the outer passes of the Mississippi, and includes the several arms of the delta and the main river as high up as Fort St. Philip.

The site for a preliminary base was selected and surveyed by Assistant Gerdes. "Its location is on the eastern shore of the main river, just above the head of the Passes, on a very narrow strip of pasture land, running close along the bank, and bounded on the eastern side by marshes and the water known as Bay Rondo."

"The ground during a dry season is as hard as a gravelled road, perfectly level and free from all but very trifling obstructions. It much resembles the site of the base at Cape Sable, and presents the advantage of being always hard and not subject to be affected by ordinary showers of rain."

"From end to end the line measures approximately 4,950 metres," (3·1 miles.)

The location of the site is nearly central on the ground at present embraced in the field operations, as will be seen on Sketch No. 47. A topographical sheet, executed by Assistant Gerdes, includes the shores of the rivers in the immediate vicinity of the base, and the junction of the three principal outlets of the Mississippi.

The statistics of work are as follows:

Stations occupied	9
Preliminary observations made at	5
Angles recorded	888
Area in square miles	70
Shore-line traced, (miles)	10

Mr. Gerdes reports as probable that the site chosen may be found to possess the conditions requisite for a primary base line, and by reason of the general instability of the neighboring surface this fact will, if verified by subsequent examination, materially conduce to the means for securing accuracy in the work. The connections desirable with the triangulation are reported by Assistant Gerdes as being entirely practicable.

Probably no tract of equal extent, included in the operations of the survey, presents so many natural obstacles to progress in the field as the delta of the Mississippi. The light-houses at the outer passes serving as points will opportunely aid in the work, and it is supposed that a station carried to the height of forty feet, at the junction of the mouths with the main body of the river, would enable the observer to complete measurements upon all the points connected with the triangulation of the delta. Facilities for the erection of stations, so common elsewhere, are in this district almost entirely wanting. Assistant Gerdes remarks: "A greater scarcity of foothold I have never experienced, and, but for the light-houses, I would regard the work as altogether impracticable, without the employment of extraordinary means for its execution."

"The use of the plane-table in the prosecution of topography will, in all probability, be found impossible."

Having adjusted his scheme for triangulation, Mr. Gerdes occupied successively fourteen stations of the second order, at nine of which he completed the angular measurements. Preliminary observations were made at the remaining stations. The computations resulting from the work have also been made by the party and sent to the office.

Mr. C. H. Boyd served as aid under the direction of Assistant Gerdes.

While the work here referred to was in progress a division of the party was detailed for the continuance of the triangulation and topography beyond Atchafalaya bay, as will be presently noticed.

Measurement of preliminary base at Point au Chevreuil and triangulation of Côte Blanche bay, La.—Necessary comparisons were made at the office, of the apparatus intended for use in the measurement at Point au Chevreuil, and on their completion the bars were packed and directed to Assistant Gerdes, who was then engaged in the triangulation and reconnaissance noticed under the last head. The vessel, however, in which they were despatched was unfortunately wrecked on the Bahamas, near Nassau, and the apparatus was lost. On receiving from the office a new set of bars, Mr. Gerdes proceeded at once to Atchafalaya bay, and made preparations for the measurement of the base at Point au Chevreuil, the approximate length of which had been determined by repeated chaining in the previous year.

The base was measured without any interruption. Two days were occupied in preparing the line, and five were employed in the measurement. Mr. Gerdes reports that the contact slides, devised by Assistant J. E. Hilgard and attached to the apparatus, worked very well in use.

After making the computations and reductions for inclination and applying the necessary temperature corrections, the resulting length was found to be 3,473.9 metres, (about 2.2 miles.) Mr. Gerdes was assisted in the measurement by Sub-Assistant J. G. Oltmanns, who subsequently prosecuted the triangulation of Côte Blanche bay, based on a reconnaissance made previous to the return of Assistant Gerdes to the site of his work at the mouth of the Mississippi river.

From a connection with stations occupied last season in the vicinity of Point au Chevreuil the triangulation was pushed northward and westward into Côte Blanche bay. The limit reached in the work, as far as completed in that direction, coincides with a line joining the northeastern extremity of Marsh island with Malony's Point.—(See sketch No. 47.)

The reconnaissance made by Assistant Gerdes will furnish also the means for carrying the triangulation into the upper part of the bay in the ensuing season.

The statistics of the work executed by Sub-Assistant Oltmanns are as follows:

Stations established or selected	23
Stations occupied	7
Angles recorded	1,027

A duplicate of the record made in the measurement of the preliminary base, at Point au Chevreuil, has been received from Assistant Gerdes.

Topography of shores of Lake Borgne, La.—The plane-table party heretofore employed in this vicinity was organized at the usual date for resuming work by Assistant R. M. Bache. A sheet was commenced by him intended to include a part of the northern shore of Lake Borgne, contiguous to Shell Point and Alligator Point, but after some progress had been made in its execution he was compelled to leave the field in consequence of declining health, and Sub-Assistant W. S. Gilbert was detailed to conduct the party operations until the close of the season.

Mr. Gilbert completed the sheet begun by Assistant Bache, and laid out two others. The one immediately adjoining that just mentioned commences at Alligator Point, and comprises almost the entire shore-line and adjacent topography of the southwestern extremity of Lake Borgne. The details are thus stated by Sub-Assistant Gilbert: "That part of the country was included lying between Fort Wood and Proctorville. The work was carried back about a mile and three quarters from the shore at Proctorville, nearly to the same distance back from Martello Castle, somewhat less in the vicinity of Battery Bienvenue, and from thence to Fort Wood, a fringe of about a mile and a half in breadth was executed and represented on the sheet."

"The shores of the lake, and as far back as the sheet extends, with the exception of the site of Proctorville, and a few shell banks in the vicinity of Martello Castle, are composed of very soft marsh, intersected by numerous bayous and lagoons, which connect with each other and with the lake on both sides of the peninsula known as Proctor Point."

"The banks of these bayous are covered with cane, ranging from five to nine feet in height, which, by obstructing the view, rendered the survey very difficult."

"Early in May a third sheet was commenced, which takes in the shore lying between Proctorville and Point aux Marchettes. The detailed work was carried back to distances varying between half a mile and a mile from the general shore-line. The character of the topography here is similar to that before described, except that there are a few trees on the banks of the intervening bayous. Having determined their positions by lines from the shore, I was enabled to check on them as points, when it was impracticable to use the positions furnished in the triangulation."

Sub-Assistant Gilbert highly commends the efficiency and zeal manifested by the aid in his party, Mr. Rufus King, jr. The schooner G. M. Bache was taken in charge by Mr. Gilbert on the 9th of February, for transportation, and at the close of the season was laid up at Pascagoula. Work was discontinued on the 1st of June, at which time the three topographical sheets comprised the following statistics:

Shore-line surveyed	242 miles.
Area included in detail	62 square miles.

The sheets were inked soon after the return of Sub-Assistant Gilbert from this section and registered in the office.

Assistant R. M. Bache has completed and turned in two sheets of the Rigolets and Pearl river island and vicinity, executed by him respectively in 1855 and 1856.

Late in July Mr. Gilbert commenced and prosecuted the duty noticed under the head of topography in Section I. His preparations will be made early for the continuation of the work in Section VIII.

Topography of western shores of Chandeleur sound, La.—In the intervals unfavorable to the measurement of angles, plane-table work was carried on by the party of Assistant Hilgard within the limits of the secondary triangulation of the western side of Chandeleur sound.

A sheet, represented on Sketch No. 47, was completed, and another, joining it and extending in the direction of the Mississippi delta, was in progress when the operations were brought to a close by the advance of summer. One hundred and sixty-two miles of shore-line were traced and transferred to the sheets within an area of twenty square miles. The completed sheet has been inked and placed in the office.

The surface of the country surveyed is marshy and intersected by numerous shallow bayous.

On returning to the north, Sub-Assistant Harris was attached to my party, and assisted in the operations described under Section I. He is about to return and prosecute the triangulation in Chandeleur sound, under the direction of Assistant Hilgard.

Topography of Côte Blanche bay, La.—In connection with the triangulation of Assistant Gerdes, and from points furnished in its progress, Sub-Assistant Oltmanns executed a plane table survey of the shores of Côte Blanche bay, including that part of Marsh island which fell within the bounds of the triangulation.

Point au Chevreuil, Malony's Point, and the intervening topography of the eastern part of the bay, are represented on the sheet. The statistics connected with its details are as follows :

Shore-line surveyed	26 miles.
Area (square miles)	13 "

The parties under the direction of Assistant Gerdes kept the field until the close of the season. Sub-Assistant Oltmanns reported at the office, but his health was so much impaired as to render it inexpedient to assign him to duty at the north.

Assistant Gerdes was occupied during the summer in office-work depending upon his observations made in this section and on the western shore of the Florida peninsula. He has since completed and returned to the office two topographical sheets containing the work last executed on C te Blanche and Atchafalaya bays.

Hydrography of Mississippi sound.—Commander B. F. Sands, U. S. N., assistant Coast Survey, in charge of the hydrographic party in the surveying steamer Walker, sailed from Philadelphia on the 19th of November. On the way south incidental soundings were attempted, but unfavorable weather in the vicinity of Cape Hatteras prevented the accomplishment of any satisfactory results. The efforts of Commander Sands, made with the same object later in the season, were, however, successful, and the results obtained have been referred to under another head.

A succession of gales was experienced on the passage, and after coaling at Key West the Walker was delayed some time for necessary repairs to the boilers, which, having been a long time in use, had become much worn. Some further delay occurred at Pensacola, from which port the vessel finally sailed for her station on the 1st of February, and on her arrival the regular operations of the party were resumed. The hydrography of Mississippi sound was continued from the limits of former work, and is now complete to the westward as far as Grassy island, at the entrance into Lake Borgne. The space included in the soundings made this season lies north of the range of islands bordering the southwestern part of the sound, and extends to a line midway between them and the northern shore at the entrance of Bay St. Louis. A resurvey was also made of a portion of the work previously executed off Pass Christian. The duty thus far noticed was accomplished by the end of April. Commander Sands then proceeded to Pensacola for a supply of coal and provisions, and on his return ran a line of soundings S.SW. from the bar of Pensacola, a distance of thirty miles, and thence to Chandeleur sound. The hydrography was resumed at Chandeleur north, and carried by the 25th of May westward about ten miles across the northern end of the sound, and southward nearly to the latitude of Rescue Hill. Sketch No. 47 represents the hydrographic limits of the sheet of this locality, and also that containing the work done in Mississippi sound. On the completion of the two sheets just noticed, Commander Sands carried a line of soundings from a position ten miles east of Chandeleur light, southward and westward along the islands, to the delta of the Mississippi, at Pass à l'Outre, and from thence shaped a course for the NW. Pass, at Key West harbor. The results obtained are thus stated in his report :

"I succeeded in running the line, having good weather, and in obtaining soundings and portions of the bottom at every cast, by means of an improvement recently devised, and attached to my apparatus, for bringing up specimens, a drawing and description of which (Appendix No. 46, Sketch No. 70) accompanies this report. The instrument was entirely successful in practice, and renders the work of sounding, at the greatest depths, comparatively an easy operation. The rod with specimen tube attached and Massey's indicator, weighing but five or six pounds, admits of the use of the smallest lead-line, and is hauled in by hand with perfect ease."

"The deepest sounding made on the passage to Key West was at 1,511 fathoms, registered by the indicator with 2,070 fathoms of line out, and an ample specimen of light blue mud was brought up. The preceding cast showing but 370 fathoms, and my meridian observation placing the vessel further north than the position intended, I hauled to the southward, and the greater depth, as just described, was obtained, showing the abruptness of the northern plateau and leading to the inference of a greater depth further south, say along a line extending from South Pass to the Tortugas."

In my last report I remarked upon the sudden change of depth from the plateau as a general fact, and threw out some suggestions in regard to its connection with the cause of the low temperatures at considerable depths. At the bottom the temperature in the month of May was 38° Fahr., the air being 78° and the surface water 77½°.

After taking in a supply of coal at Key West, Commander Sands returned to the north, and, on the homeward passage of the steamer, executed a fourth line of soundings, which has been remarked upon in a former part of this report, in reference to the Gulf Stream.

The following is a synopsis of the work executed during the season by the hydrographic party:

Localities.	Number of angles.	Miles run in sounding.	Number of casts.
South side of Mississippi sound	1,380	729	52,377
Off Pass Christian	433	202¾	15,064
Chandeleur sound	231	156	7,990
Line from Pensacola to Chandeleur sound		144½	35
Line from Chandeleur to Pass à l'Outre		60	25
Line from Pass à l'Outre to Key West		540	38
Total	2,044	1,832¼	75,529

The chart of Mississippi sound and Pass Christian has been plotted and registered in the office.

Before commencing the operations in this section, Commander Sands had sent to the office twenty volumes containing the original records of soundings made in the work of last year, a volume of observations in determining angles, another of tides observed, and thirteen diagrams, in duplicate, of current observations made in 1855.

While detained at Pensacola, assistance was rendered by Commander Sands, with the men and boats of the steamer Walker, on the occasion of a fire which happened at Fort Pickens on the night of the 20th of January. On the day following the accident, a communication was addressed to him by Captain John Newton, corps of U. S. engineers, commanding the harbor of Pensacola, in acknowledgment of the obligation to the officers and crew, who, in conjunction with the hydrographic party in the C. S. schooner Varina, had promptly repaired to the scene of disaster.

The steamer Walker was refitted with new boilers at Philadelphia during the summer, and has been re-assigned for use of the hydrographic party, to continue the work in this section.

SECTION IX.

FROM VERMILION BAY TO THE BOUNDARY, INCLUDING PART OF THE COAST OF LOUISIANA, AND THE COAST OF TEXAS.—(SKETCH I, No. 53.)

The same number of parties have been at work here during the past season as during the year before, and I see no reason to change the estimate which I made in my report of 1856 of the time of completion of the section. The proportionate progress during the past year has been reached in the land work, and only fell short in the hydrography by one of those untoward changes in the organization of the party to which I have before referred as so often interfering with the progress of the survey in this section. Five years, or less, will carry the triangulation to the Rio Grande, if prosecuted with the means now devoted to it; and the topography is of such a character, that one party continuing work with the triangulation, and another acting independently, are sufficient to keep up the plane-table work. There will then remain the extension of the triangulation from Galveston bay to Vermilion bay, on the coast of Louisiana.

These remarks suppose that the present triangulation may suffice for main work. If this proves not to be the case, a few years must be added to the estimate. A hydrographic party with a sailing vessel is also sufficient to keep pace with the land work, the soundings being unusually uniform along the coast. We are, however, again to be retarded this year by a change in the chief of the party, and this will, of course, tell upon the progress.

The details to be given in this chapter will show the completion of the triangulation of Matagorda bay, and of its dependencies; the completion of the greater part of the topography of the bay, and of the hydrography of the entrance and part of the interior, together with some off-shore soundings, giving a general idea of the slope of the bottom of this part of the Gulf of Mexico. These subjects will be taken up in turn.

Office-work.—The drawing of a finished map of Galveston bay, $\frac{1}{30000}$, has been in progress; the preliminary chart of the coast of Texas, from Galveston southward, has been drawn and engraved, and also a new edition of the entrance to Galveston bay, $\frac{1}{40000}$.

Triangulation of Matagorda bay and its dependencies, Texas.—This work was resumed, after the completion of the office-work of last year, by the party of Assistant S. A. Gilbert, who continued his operations in the field until its final completion on the 20th of June. The topography was prosecuted by him in connection with the triangulation.

Assistant Gilbert found the season more than usually favorable for field-work, and succeeded in finishing the triangulation of the bay and its dependencies, including Lavacca and Espiritu Santo bays, and in extending the scheme for completion quite across the entrance of San Antonio bay, lying between that last mentioned and Aransas. Before the close of the season stations had been occupied within thirty miles of Aransas Pass.

As represented in Sketch No. 53, the triangulation has been completed to the line Espiritu Santo ——— Rahal, in the direction of Aransas.

"The whole number of stations occupied was eight, from which we observed upon and determined twenty-four signals, and other conspicuous objects. At all the stations we were obliged to observe from scaffolds, elevated twenty to thirty feet above the ground, in order to see over the high rolls of the prairie, the cane grass that grows in swampy places, and the bushes fringing the shores. These scaffolds required to be made very steady, as a strong breeze generally blows when it is clear enough to observe, and there is no protection against its force. The difficulty of transportation renders the carrying of the lumber for them tedious and very laborious."

During the progress of the work, conducted by Assistant Gilbert, points were furnished to the hydrographic party, in charge of Lieut. Comg. J. C. Febiger, for the execution of work which will be referred to presently.

Mr. Charles Hosmer was attached to the triangulation party as aid. He assisted, also, in the topography, and, under the direction of Mr. Gilbert, in inking the sheets.

A volume containing the records of horizontal angles measured in the triangulation of Matagorda bay has been deposited in the archives of the section.

Topography.—The plane-table work on the shores of Matagorda bay and its branches was carried on by Assistant Gilbert in connection with his own triangulation. Some difficulty was experienced in the field in consequence of drought and the necessity of using unwholesome water; but the unusual degree of coolness for that latitude favored operations generally, and good progress has been made in the work. Nearly the whole of the topography of Matagorda bay has been completed. The portion remaining to be yet executed comprises a part of Lavacca bay, in the vicinity of Gallinipper Point.

Assistant Gilbert thus reports the statistics of his plane-table sheets:

Shore line surveyed	158 miles.
Roads	$15\frac{1}{2}$ "
Area of topographical sheets	90 square miles.

Of the three sheets completed, one, embracing the inner shore of Matagorda bay, between seven-mile station and Live Oak bayou, was begun in the previous year. Assistant Gilbert traced in, on the second, the western shore of Carankaway bay and the shores and interior in the vicinity of Sand Point. It was then taken up by Sub-Assistant M. Seaton, in charge of a separate topographical party in this section, and completed. The third sheet embraces the shores of Lavacca bay and the continuation of its western shore beyond Pass Cavallo light-house, at the entrance to Matagorda bay.

"The general character of the country is prairie; along the shores of the bays the land is subject to overflow at very high tides; but, at a distance of ten or fifteen miles from the Gulf, the shores of the bays are fronted by bluffs rising from fifteen to thirty feet high, with frequent patches of timber, especially near the streams."

"Matagorda island is mostly low, but ridges, or 'rolls,' rising from eight to ten feet above the Gulf, extend throughout its entire length. Immediately along the Gulf shore some sand hills occur, varying in height between five and thirty feet."

"The soil of the island is fertile; but high winds prevail constantly during spring and summer. All kinds of garden vegetables grow in great perfection and abundance.

"Fruit trees generally, and the peach and fig, thrive very well in sheltered localities; but the chief attention is given to the raising of cattle, mules, and sheep."

"The towns of Lavacca, Indianola, and Saluria come within the limits of this season's work. At the two first named considerable business is done in forwarding and receiving goods and produce, passing and returning between the coast and the upper country. Regular lines of sailing packets connect with New York and New Orleans, and two lines of steamships run to and from the last named city.

"Saluria may become a place of much importance, if plans which have been projected for the improvement of the bays are carried out."

Assistant Gilbert prosecuted his operations until the 20th of June in a vessel hired for the purpose at Saluria. Before leaving the section he executed a reconnaissance for the extension of the work in the coming season to Aransas.

The three topographical sheets resulting from the labors of the party in the vicinity of Matagorda and Lavacca bays were inked during the summer, and have been registered in the office.

The party of Assistant Gilbert will shortly be reorganized to extend the triangulation and topography of the coast of Texas southward and westward, in the direction of Aransas pass.

A second party, detailed for topographical duty on the shores of Matagorda bay, was conducted by Sub-Assistant M. Seaton. He reached the field on the 13th of January, and commenced a sheet at Olive Point, to include the whole of Trespalacios bay, above the entrance, and West Turtle bay, with the streams running into both. The southwestern limit of his work comprises also the eastern shores of Carankaway bay.

"An abrupt bluff, from six to eight feet in height, composed of a species of marl, shells, and black mud, forms the shore on either side of Well Point, and the edge of the bluff is covered with low matted bushes."

"A well of excellent water occurs in this vicinity, and also wood for fuel, articles very scarce in that region. The prairie is generally high and slightly undulating, with occasional depressions of wet ground, which abound in wild fowl."

The plane-table survey, made by Sub-Assistant Seaton, was extended upwards from the head of the bay, and embraces the shores of Trespalacios river for about a mile above its entrance.

"There is a shallow bar at the mouth of the river which is a serious hindrance to navigation, for vessels drawing more than two and a half or three feet. After passing this obstruction bold water is found for many miles up. Several large creeks, in former years, were the outlets for large quantities of cotton and sugar, but the trade seems to have been directed into other channels."

In addition to the sheet completed by Mr. Seaton, some details were placed by him on one previously commenced by Assistant Gilbert, to include the vicinity of Indianola and Lavacca. The statistics of work done in the field are thus reported by Sub-Assistant Seaton:

Shore-line surveyed	83	miles.
Marsh-line traced	75	"
Creeks and bayous	32	"
Roads	5½	"
Area surveyed, (square miles)	81½	

Mr. R. E. Evans was attached as aid to the party of Mr. Seaton, and his cheerful and faithful discharge of duty in the field are specially referred to in the season's report.

Operations were closed on the 15th of May. Sub-Assistant Seaton completed the inking of his sheet, after returning from the section, and deposited it at the office.

Preparations are now well advanced for resuming the topographical work at the opening of the coming season.

Hydrography of the bar and entrance to Matagorda bay, Texas.—The hydrographic party which has been heretofore engaged in this section was reorganized, at the usual time for resuming work, and continued under the command of Lieut. Comg. E. J. De Haven, U. S. N., assistant in the Coast Survey.

After the necessary preparations, the surveying schooner Arago sailed from Philadelphia, and, in a passage of ordinary duration, reached the ground of work, off Matagorda peninsula. On the way south, Lieut. Comg. De Haven suffered much in the failing of his eyesight, but proceeded, in the hope of being able to direct the hydrographic operations of his party. His expectation was not realized, and towards the end of January he requested to be relieved from the charge of the duties assigned

Lieut. Comg. John C. Febiger was detailed for the service, and having relieved the officer at first in charge, and received the requisite data, furnished by the triangulation party, he projected a sheet to embrace the entrance and a portion of the lower part of Matagorda bay. The bar near the entrance was sounded, and will be laid down on the completed chart. Four current stations were used, and tidal observations made for the hydrographic reductions. Soundings were extended to the distance of four miles outside from Decros Point, and from the limit in that vicinity five miles southward and westward, to a line beyond the light-house a few miles below Saluria, on the southern side of the entrance to the bay. A space, including about six miles square, lying inside of Matagorda peninsula, was also sounded, in connection with the work on the bar.

Efforts made by Lieut. Comg. Febiger, soon after his arrival in the section, to obtain lines of off-shore soundings were not successful. A line was, however, subsequently run from the outer buoy at Matagorda bar, on a southeast course, (magnetic,) and specimens of bottom were obtained at depths ranging from four to sixty-eight fathoms; the soundings on this line were carried to a distance of rather more than fifty miles. Work was commenced by the party in charge of Lieut. Comg. Febiger on the 24th of March, and terminated on the 19th of May. The following is an abstract of the statistics of the regular hydrography:

Miles run in sounding	520
Number of soundings	31,290
Angles determined	1,249

The operations of the party were retarded by the unfavorable character of the weather and by the loss of one of the working boats.

On returning northward, soundings for temperatures were made by Lieut. Comg. Febiger in the axis of the Gulf Stream, which service has been referred to, under that head, in a former part of this report.

Very shortly after the arrival of the schooner Arago at Philadelphia, Lieut. Comg. Febiger was detached from duty on the Coast Survey, and the office-work of the party was executed under the direction of Lieut. W. T. Glassell, U. S. N., who had assisted during the season in the hydrographic work at Matagorda entrance.

The chart of the bar, and part of the bay included in the soundings, has been forwarded by that officer to the Coast Survey office, with duplicates of the records and seven specimens of bottom taken from the bar at Matagorda.

I had hoped to retain the services of Lieutenant Febiger as chief of a hydrographic party. He had been trained in the school of hydrography of Lieut. Comg. Craven, and had earned a most enviable reputation as his executive officer. His promptness in repairing to Texas, and his success in taking up the work in the midst of the season's operations, gave earnest of his future usefulness. I much regretted his detachment, and endeavored to induce the Navy Department to withdraw it, but without effect.

SECTIONS X AND XI.

SECTION X.—FROM THE SOUTHERN BOUNDARY AT SAN DIEGO TO THE FORTY-SECOND PARALLEL, INCLUDING THE COAST OF CALIFORNIA.—(SKETCH J, NOS. 56—57.)

The land-work in these two sections has made excellent progress, but the hydrography has been, in a degree, retarded by the call for the services of the hydrographic party, under the law of 1856, for transportation, and other aids, to the Commissioner of the Northwestern Boundary of the United States. All the work that zeal and industry could accomplish, under the circumstances, has been executed. The details are given under the following heads for Section X:

1. Astronomical and magnetic observations at San Francisco and Tomales bay.
2. Triangulation of Santa Barbara islands and adjacent coast.
3. Primary and secondary triangulation north of San Francisco bay.
4. Tertiary triangulation on the shores of San Francisco bay.
5. Topography of main of Santa Barbara channel.
6. Topography of San Francisco bay.
7. Hydrography of Monterey bay and Santa Barbara channel.
8. Hydrography of San Francisco bay.
9. Tidal observations.
10. Light-house examination.

The work done in Section XI is mentioned under the following:

1. Triangulation of Admiralty inlet, W. T.
2. Topography of Admiraly inlet and Hood's canal.

It will be seen that we are about to realize the results desired by the Land Office in the connection of the islands off the Santa Barbara channel with the main. Should the appropriation for this special work be cut off, the parties engaged in it must necessarily also be cut off, and the operations be stopped for the present in favor of the more important work to the northward. Two years more would probably complete all that is desired here, beyond the regular progress of the survey.

It would be premature to attempt yet an estimate of the time of completion of these two sections, seeing that the data are necessarily so insufficient for the purpose. The amount of shore-line shown by detached surveys would probably not be so much in excess, as proved to be the case on the Atlantic side, and yet on particular parts of the coast, as near San Francisco entrance, any estimate from the ordinary charts must have fallen very much below the truth, as shown by the detached surveys.

Office-work.—The following maps, charts, and sketches of *Section X* have been drawn during the year: San Diego bay, Cortes bank, San Clemente anchorage, eastern entrance of Santa Barbara channel, San Francisco entrance, San Antonio creek, and Mare Island strait. Finished maps of Monterey bay, San Francisco bay, and San Pablo bay have been in progress. The engraving of the following plates has been completed: Anacapa and part of Santa Cruz island; entrance to San Francisco bay, as preliminary, and the engraving of San Diego bay; eastern entrance to Santa Barbara channel; entrance to San Francisco bay, (finished chart.) San Antonio creek and San Pablo bay are now in progress.

Section XI.—Drawings have been made of Port Townsend base and Apple cove. The engraving has been completed of Shoalwater bay, (additions,) New Dungeness harbor, Port Ludlow, Port Gamble, Olympia harbor, Steilacoom harbor, Bellingham bay, and Blakely harbor.

Astronomical observations.—Although the computed predictions of the occultations of the Pleiades on the 1st of March, which had been sent to Assistant George Davidson from the office, did not arrive until after their occurrence, he had made all requisite preparations to observe them at San Francisco with the C. S. transit No. 2, and zenith telescope No. 3, and succeeded in obtaining no less than twenty-two immersions of the stars of that group, with transits of the moon and moon culminating stars on the two following nights.

Mr. Davidson also computed the times of beginning, ending, and phases of the solar eclipse of March 25th, noting the instant of both contacts by actual observation.

One hundred and eighteen transits in all were observed in connection with the eclipse and occultations.

Magnetic observations.—In order to make his observations of the solar eclipse of March at San Francisco as complete as possible, Assistant Davidson set up the magnetometer, and obtained results showing the changes in the magnetic declination. A full series of meteorological observations was made at the same time.

During the rainy season Mr. Davidson visited Tomales bay, and completed a series of satisfactory observations for absolute magnetic declination at the previous station there, then occupied by the party of Assistant G. A. Fairfield. No reliable results were obtained for inclination with the dip circle used.

The results obtained in these several observations, with duplicates of the records, have been received at the Coast Survey office.

On various occasions during the year Assistant Davidson furnished, by request, the geographical positions of light-houses in this and the adjoining section, with notes, tracings, and information relative to other points on the coast, desired by the officer in charge of the light-house service, Major Hartman Bache, U. S. Topographical Engineers.

The party left San Francisco on the 1st of April in the surveying brig Fauntleroy, and the regular operations of the season, conducted under charge of Mr. Davidson, will be stated with notices of the work in Section XI.

Triangulation. Santa Barbara islands and adjacent coast of California.—This work has been continued, and good progress has been made in it, by the party under the charge of Assistant W. E. Greenwell, in the surveying schooner Humboldt.

On the main the triangulation has been extended from San Fernando to Conejo station, near the coast, and lying between Point Duma and the Santa Clara river. Reconnaissance has been made in addition, and signals erected for carrying a chain of triangles in the same direction, between the main and the islands of Santa Cruz and San Miguel, quite through the Santa Barbara channel to Point Conception. The scheme proposed is given on Sketch No. 56.

The difficulties attending the triangulation of the main and neighboring islands, to which allusion has been made in my previous reports, have been in a great measure overcome by the energy of Assistant Greenwell, whose efforts in its accomplishment have been untiring. His party has spent the entire surveying year in the field.

The triangulation of Santa Cruz island, which was in progress at the close of last season, has been completed, and that of San Nicolas, lying at some distance from it to the southward, has also been executed.

Some interesting remarks on the character of the islands forming the Santa Barbara group, and the views of Mr. Greenwell in reference to the practicability of completing their survey, will be found in Appendix No. 44.

Mr. P. C. F. West served as aid in the triangulation party, and is commended in the report of Assistant Greenwell for willing and intelligent co-operation in all the interests of the work under his charge.

The field report contains the following summary of statistics:

Signals erected for primary triangulation	8
Signals erected for secondary triangulation	38
Primary stations occupied	2
Secondary stations occupied	35
Number of observations	5,939

The eight-inch Gambey theodolite, C. S. No. 44, was used by Mr. Greenwell in the measurement of angles.

Violent shocks of earthquake occurred on the 9th of January while the triangulation and topographical parties were engaged on the shore of Santa Barbara channel. Assistant Greenwell, in charge of the triangulation, was then at San Fernando Station, (see Sketch No. 56,) and Sub-Assistant Johnson at work with his plane-table party in Sycamore valley, a few miles westward of Point Duma. Reports received from both of these gentlemen agree as to the time of commencement of the earthquake at twenty-four or twenty-five minutes past eight o'clock in the morning. Between that time and eleven o'clock of the same night, nine shocks in all were recorded by Mr. Johnson, and four by Mr. Greenwell. The shocks felt at Sycamore valley in the morning were all within the space of twenty-four minutes from the beginning; those in the evening commenced at half-past eight o'clock and recurred at intervals until forty minutes past ten. At San Fernando, three shocks occurred in the morning between *3h. 25m.* and *9h. 31m.*, and one in the afternoon at *4h. 49m.* Mr. Johnson's camp was thirty miles eastward of the town of San Buenaventura, and, having occasion to visit that place in connection with the delivery of supplies which had been forwarded from San Francisco, he left Sycamore valley soon after the last shock was felt in the morning of the 9th, and reached San Buenaventura in the evening. His observations on the effect produced by the earthquake along his route are thus described in his report: "We forded the Santa Clara river six miles from its mouth. The stream in itself is insignificant, but its bed is from a half to three-quarters of a mile wide from bank to bank; and here I met with the first evidences of the terrible power exerted by the convulsion of nature so recently felt. Long cracks were visible in the bed of the river, many of them being six or eight inches across, and extending in a direction SE. and NW. These openings must have been at first considerably wider, for many of them had evidently been filled with water from the river, as on either side of the cracks lay a ridge of wet sand.

"These appearances were visible as far as I could see up and down the bed of the river. Near the mouth of the river the cracks were longer and wider. Persons residing within a mile of the entrance say that the water was thrown out from the cracks as high as six feet, and that large blocks of earth sank several feet below the former level, and there remain."

After the arrival of Mr. Johnson at San Buenaventura, shocks were felt there generally coincident with those recorded by the party at Sycamore valley during his absence.

In reference to the first shock felt at San Fernando, Assistant Greenwell says: "The earth was in fearful agitation, with undulations so quick and rapid as to make it almost impossible to stand. The sensation was very much like that felt on the deck of a small vessel in a heavy chopped sea." He adds, in regard to changes of relative position, which might have been expected in the immediate vicinity: "I was interested to know whether my signals remained unchanged; but in subsequent measurements no differences could be detected in the angles."

At San Fernando, the earthquake wave seemed to travel from east to west. In Sycamore valley, the direction was judged to be from the southeast, ranging upwards with the trend of the coast.

The particulars of the earthquake of January 9 have been furnished for the archives of the Smithsonian Institution.

Earthquake shocks recurred at intervals during the month of January at Mr. Johnson's camp, on Santa Barbara channel. His journal contains notes of the time and attendant phenomena of one on the 10th, two on the 11th, one on the 15th, three on the 16th, one on the 17th, and one on the 28th of that month. These shocks produced no action upon the ocean which could be detected upon the tide-gauges at San Diego or San Francisco.

Primary and secondary triangulation north of San Francisco bay, Cal.—The primary work in charge of Assistant G. A. Fairfield has been extended to Point Reyes, in connection with the secondary triangulation. The secondary work on Tomales bay has been completed and carried northward to include also Bodega bay. At the date of his last report of progress, Assistant Fairfield was engaged in endeavors to connect his triangulation of Point Reyes with that previously executed by Sub-Assistant Rodgers, on Ballenas bay. Field operations, at stations along the coast, have been very much retarded by the prevalence of dense fogs. In reference to prospective work Assistant Fairfield remarks: "The indications now are that we shall have an early and severe winter; in which case I anticipate being able to execute more of the primary work than during the past two years, which have been exceedingly unfavorable to the progress of the triangulation."

The signals observed on during the season were erected by Mr. C. B. Ellis, the aid of the party.

A magnetic station, established and occupied in the course of the season by Assistant G. Davidson, was connected by Mr. Fairfield with his secondary triangulation.

The following are statistics of the main and secondary work:

Number of signals erected	21
Stations occupied, (including one primary station)	17
Angles observed and determined	122
Number of observations	1,828

Tertiary triangulation on the shore of San Francisco bay, Cal.—As a basis for his plane-table work of the Contra Costa, Sub-Assistant A. F. Rodgers laid out a chain of small triangles extending from the station, marked Contra Costa (1) on the Sketch No. 57, to Red Hill, in a direction nearly southeast from it. Ten stations were occupied with the Würdemann theodolite, C. S. No. 38, and sixteen points determined and plotted on the topographical sheet.

Sub-Assistant Rodgers also made a small triangulation at the entrance of San Francisco bay, and determined the positions of the light-houses on Point Bonita, Fort Point, Alcatraz island, and the position of the selected site at Point Lobos.

The records of the triangulation made on the Contra Costa have been sent to the office.

Topography of main shore of Santa Barbara channel, Cal.—The plane-table work done in the present year was commenced at Point Conversion by the party of Sub-Assistant W. M. Johnson, and continued eastward along the coast to Point Duma. It is comprised on two sheets, the first extending from the place of beginning to the *Cañada de Isique*, and embracing a rough and difficult tract.

"The part of the coast range represented on this sheet has an average altitude of twelve hundred feet above high water, the mountains springing directly from the water line."

On the second sheet, which includes the coast between *Cañada de Isique* and Point Duma, the topography undergoes a slight change in character. A strip of table-land, about a hundred and fifty yards wide, commences at the *Cañada*, and gradually increases in breadth in the direction of Point Duma, where it is several miles in extent. The average elevation of this table-land is about two hundred feet. Five miles eastward of Point Duma the hills again come down boldly to the shore.

At the last date received from Sub-Assistant Johnson, his party was at work two miles west of Point Duma. The following is a summary of the season's statistics:

Shore-line of topographical sheets	$20\frac{1}{2}$ miles.
Area of country surveyed	1,889 "

Mr. C. M. Bache served as aid in the party, and assisted Mr. Johnson in both the field and office work throughout the year. Transportation was furnished by Assistant W. E. Greenwell in the surveying schooner Humboldt.

An original topographical sheet, executed between Point Año Nuevo and Punta del Bolsa, by Sub-Assistant Johnson, in 1854, has been inked and deposited in the archives.

The character of that part of the coast of Santa Barbara channel surveyed during the year is well described in extracts from the report of Mr. Johnson, Appendix No. 43.

Topography of San Francisco bay, Cal.—This work has been vigorously prosecuted within the year by two parties under the charge of Sub-Assistant A. F. Rodgers, and the survey of the shore-line is now complete. The localities embraced in the concluding operations lie at the southeastern extremity of the bay, below a line joining Guano island and Contra Costa, (1,) and in the vicinity of San Francisco city. Seven topographical sheets in all have been completed during the season, of which five contain in connection the shore-line, creeks, and water courses of the lower part of the bay, and two the shores of the Golden Gate, San Francisco city, and the western shore of the bay from the city southward beyond Point Avisadera.

Commencing at the Upper Contra Costa, the first sheet executed comprises, in addition to the eastern shore and numerous intricate streams, a survey of Union City. A second sheet reaches to the extremity of the bay, and includes the shores of Coyote creek and its tributaries; Ravenswood and Alvise are contained on the third sheet, with the shore-line and water courses occurring between those two towns. The work continued from Ravenswood upwards, along the western side of the bay, is comprised on two sheets, one of which includes Redwood city and the shores of San Francisco bay to Guano island.

The marginal shore-line of the bay within the limits just described is much broken by small creeks and more considerable streams, all of which are represented in the details of the topography.

In order to secure the largest result in field-work practicable within the season, a second party was organized by Sub-Assistant Rodgers, and placed in charge of Mr. David Kerr, who had served as aid for several years in the topographical party, and previously in the triangulation party engaged in the work on San Francisco bay.

The survey of the main shores of San Francisco bay was completed in March, and Mr.

Rodgers commenced a resurvey of San Francisco city, to include the additions made since 1852. This work was continued during the summer, and is probably complete at this date. Progress had also been made on a plane-table sheet, embracing the shores of the entrance to the bay.

The following are the statistics of the work executed by the parties in charge of Sub-Assistant Rodgers:

Sheets.	Shore-line.	Creeks and ponds.	Roads.	Area.
	Miles.	*Miles.*	*Miles.*	*Square miles.*
No. 1	25.6	229.3	13.6	25
No. 2	21.2	196.6		12
No. 3	55.1	266.5	2.5	24.5
No. 4	5	19	5	2
No. 5	43.4	307	1.5	25
No. 6			10	
No. 7	10		100	11.5
Total	160.3	1,018.4	132.6	100

Tracings from the sheets of the southern part of the bay were furnished by Mr. Rodgers in February and March to the hydrographic party then engaged in sounding.

While the topographical work was in progress Sub-Assistant Rodgers made reconnaissances along the shores of Napa and Petaluma creeks. In reference to the first he reports that "the principal impediment to its navigation is a reef of rocks between Suscol ferry and the town of Napa, which is situated higher up the stream. These extend across the channel, and close the passage to any boat of more than one foot draught of water. Snags are brought down by the winter freshets, and these also are hindrances to the navigation."

The following remarks result from his observations made along the shores of Petaluma creek:

"Petaluma must soon reach a position of no little comparative importance in the list of California cities, if rapid development is the invariable result of extraordinary advantages of location; and, under the influence of capital and labor, its progress during the last year affords ground for the supposition. The town is situated at the head of navigation, in the channel through which passes to market most of the produce of the valleys of Petaluma, Bodega, Santa Rosa, and Sonoma, fertile fields for agricultural enterprise. Their resources are only beginning to unfold, though every day attracting more attention.

"At low water the channel of Petaluma creek is very narrow in places, though free from rocks or snags, and generally of sufficient depth for ordinary steamboat traffic."

Two original sheets of previous topographical work, executed by Mr. Rodgers on the shores of San Francisco bay, have been received within the year and deposited in the office.

Hydrography of Monterey bay and Santa Barbara channel.—At the close of the last surveying season the hydrographic party of Commander Alden was engaged in Monterey bay and completed the soundings north of Point Pinos, including the entire bay, and extending to a line three miles west of Santa Cruz harbor. The in-shore hydrography of the coast between Point Año Nuevo and Point Miramontes, and soundings at the eastern entrance of Santa Barbara channel, abreast of Point Hueneme, were also completed before laying up the vessels for the winter. Fifty-seven specimens of bottom taking in the soundings of Monterey bay, sixteen at and near Point Hueneme, and nine from the vicinity of Pigeon Point have been sent to the office, with twenty-two specimens secured last season in the survey of San Diego bay. Commander Alden has also sent, for deposit in the office, four hydrographic sheets, containing the soundings of San Diego bay, his chart of Monterey bay in four sheets, and sheets of the work executed in Santa Barbara channel, and on the coast north of Point Año Nuevo. He thus refers to a peculiarity observed in the hydrography of Monterey bay. "It will be perceived, by referring to the general chart of the bay, that there is a deep sub-marine valley, or "gulch," directly in the middle of it, wide at the mouth, (taking the fifty fathom curve,) but narrowing very much as it approaches the shore, where deep water is found close to the very beach, and we discovered that this was the only practicable landing throughout the exposed portions of the bay."

In reference to Santa Barbara channel, Commander Alden also remarks: "It will be seen by the chart of the east entrance of Santa Barbara channel that there is a similar characteristic off Point Hueneme, where the deep water approaches the shore, and where we also found the best landing. In other words, we landed on the point without difficulty, while the bight inside of it, and to *leeward*, was clearly impracticable."

At the close of summer Commander Alden returned to the Atlantic coast on leave, and the party was assigned to the command of Lieutenant Richard M. Cuyler, United States navy, his experienced senior assistant.

Hydrography of San Francisco bay, Cal.—The southern part of the bay, which remained at the close of last season, has been sounded by the hydrographic party in charge of Commander James Alden, United States navy, in the steamer Active and schooner Ewing. The greater parts of the months of March, April, and May were spent in this work. Hydrographic points and the shore-line requisite were furnished, as needed, by Sub-Assistant A. F. Rodgers. The hydrography of San Francisco and San Pablo bays is now complete.

Commander Alden thus reports the season's statistics of his party:

Miles run in sounding	597
Angles measured	2,217
Number of soundings	28,134

A line of soundings was run by the steamer Active, and a section of the bottom between the Golden Gate and the Farallones obtained by Commander Alden.

The resulting chart and twenty-two specimens of bottom taken along the line have been received at the office. In reference to these soundings, Commander Alden observes: "I also noticed that two of the casts show reddish specks something similar in character to the soundings inside of the bar, (at the Golden Gate;) but as they are so remote, and the water so much deeper, I hardly think that mistakes could possibly occur."

The hydrographic sheet concluding the survey of San Francisco bay, and the chart of the Straits of Karquines, have been deposited in the Coast Survey office.

Deep-sea temperatures.—On the passage northward of the surveying brig Fauntleroy, a line was started by Assistant Davidson off Haven's anchorage, and carried northward and westward to latitude 39° 19′ N.; longitude 128° 32′ W. Twelve soundings were made, during such intervals as the weather would permit, for temperature at the surface, at ten, fifty, a hundred, and two hundred fathoms depth. The lowest temperature (46.2 degrees) was observed in two hundred fathoms at the in-shore extremity of the line, the corresponding temperature at ten fathoms being 56°.5, and at the surface 60°.4.

Tides.—The three permanent tidal stations, San Diego and San Francisco, Section X, and that at Astoria, in Section XI, continued to give very satisfactory results under the charge of Lieutenant N. F. Alexander, of the Corps of Engineers, until the time of his transfer by the Engineer Department to the Atlantic coast.

On the 2d of August the gauges were placed in charge of Lieutenant G. H. Elliot, with the concurrence of the Chief Engineer, to whose courtesy the survey is indebted for regular tidal observations since the withdrawal of the officer who had been regularly in charge.

A few days' observations, made by Sub-Assistant A. F. Rodgers, at Alvisa, near the southern extremity of San Francisco bay, have proved of interest. Three stations in the bay have been occupied for periods of about a month in connection with the hydrographic work.

At Alvisa the spring tide occasionally rises to a height of more than thirteen feet.

Sub-Assistant Rodgers observes: "That there is frequently a difference of more than an hour between San Francisco and Saucelito in the changes and actual times of high and low water, and that the tides of Napa creek and Karquines strait differ as much as an hour and a half. There is no duration of slack water in the change from flood to ebb in Karquines strait, and the other turn is very slow."

Light-house examination.—A concluding report has been made by Commander James Alden, U. S. N., assistant in the Coast Survey, in regard to the necessity for a light on the main of the Santa Barbara channel, Cal. The conclusions arrived at in his last examination, and reasons therefor, are stated in Appendix No. 57.

SECTION XI.

FROM THE FORTY-SECOND PARALLEL TO THE NORTHWESTERN BOUNDARY, INCLUDING THE COAST OF OREGON AND WASHINGTON TERRITORIES.—(SKETCH K, No. 63.)

Astronomical observations.—Assistant George Davidson set up the C. S. transit No. 7 at Point Pully, Admiralty inlet, W. T., for the purpose of making observations to connect with occultations. Two transits of the moon and twenty of standard and moon culminating stars were observed, but at the predicted time of the occultations the sky was clouded. The occultations of the Pleiades in August and September could not be observed at Point Pully in consequence of the dense smoke and cloudy weather which prevailed in the vicinity of the astronomical station.

The notice of sixteen occultations made in the last season by Mr. Davidson at Port Townshend, W. T., was not received in time to admit of being mentioned in my annual report for 1856.

Triangulation of Admiralty inlet, W. T.—This work has been extended southward from its former limits by Assistant Davidson.

His party left San Francisco, where the rainy season had been occupied in office-work, on the 1st of April, in the surveying brig Fauntleroy. The vessel encountered a succession of heavy northwest gales during fifteen days, and was compelled to return for repairs after unsuccessful efforts to reach any harbor north of San Francisco. These having been made without delay, the party reached its site of work without further detention, accompanied by Sub-Assistant J. S. Lawson, and was soon after joined by Mr. Davidson, the condition of whose health would not admit of taking passage in the vessel at the time of her departure.

Mr. Lawson carried forward the reconnaissance in Admiralty inlet, pushing it southward from the line Dolphin Point—Brace Point, and erecting signals for the triangulation and for topographical work.

Assistant Davidson resumed his reconnaissance at Point Defiance, carried it through Colvos Passage to the line Hornet—Upper Steilacoom, in Puget's sound, southward; and also made a preliminary examination of Port Orchard, westward of Bainbridge island.

Over a hundred signals were erected for the means of triangulation. The angular measurements were then commenced and prosecuted with various interruptions until the 1st of August, when it was found quite impracticable to continue them in consequence of the smoke from great fires, the season having been unusually dry. The work of triangulation executed within the season, as will be seen by reference to Sketch No. 63, is comprised between the south end of Bainbridge island and the line Point Pully—Point Heyer.

As incidental to his regular work, Assistant Davidson made a close reconnaissance for sketching in the shore-line adjacent to his stations, observing by single pointings upon three hundred and two objects for that purpose.

The following is a synopsis of the season's statistics:

Number of stations occupied	26
Number of angles measured	141
Number of observations, (direct and reversed)	6,072

Early in August Mr. Davidson attempted to co-operate, under my instructions, with the Northwest Boundary Commission, but was again taken ill and forced to remain under medical treatment during the remainder of that month. In September he commenced at Point Wilson the connection of the triangulation of Admiralty inlet with that of the southern shore of the Strait of Juan de Fuca. The stations at Point Partridge and Ross were occupied by Sub-Assistant Lawson for connecting the light-house at New Dungeness with the triangulation. He also erected signals on the Gulf of Georgia for extending the triangulation to the line Patos—Point Whitehorn.

A few observations were made by Assistant Davidson for vertical angles upon Mount Hood, of the Cascade range—upon Mount Ellinor, of the Olympus range, and upon the "Brothers." The geographical position of the first not being well determined, no computation can yet be made of its height from the observations. Mount Ellinor is stated to be 6,312 feet and the "Brothers" 6,897 feet in height.

Forty-six volumes, consisting of the original records of observations made in the triangulation of Rosario strait, Canal de Haro, and Admiralty inlet, and duplicates of the observations for azimuth at Point Hudson, and of those connected with the azimuth, magnetic, and other observations at Port Townshend, New Dungeness, and Admiralty inlet, have been forwarded by Mr. Davidson within the year, and deposited in the archives of the C. S. office, with descriptions of the signals used in Admiralty inlet and in the triangulations of New Dungeness and Port Discovery.

The continued ill health of Assistant Davidson rendering his return to the Atlantic coast advisable, he returned to San Francisco in October, and reported at the office in Washington at the end of the following month.

Topography.—In June, Assistant Davidson, in charge of the land-work in this section, detached Sub-Assistant J. S. Lawson from his triangulation party for plane-table work on the shores of Admiralty inlet. The topography was resumed at the entrance of Hood's canal and prosecuted to a connection with Port Ludlow on the west, and around Foulweather Bluff to

Point No Point on the main shore of the inlet, on the east. The two sheets executed have been inked and turned in at the office. They embrace twelve miles of shore-line, and include an area of rather more than four square miles. The country represented is covered with a dense growth of fir, and an almost impenetrable undergrowth.

Assistant Davidson has also sent to the office two maps of reconnaissance made in the western part of the Strait of Fuca and in the Gulf of Georgia, and a third showing the progress of the triangulation in this section.

Sub-Assistant Lawson returned to the Atlantic coast with Mr. Davidson, in November.

During the progress of his triangulation work in Admiralty inlet, Assistant George Davidson, in the surveying brig Fauntleroy, discovered and partially sounded out a ten-fathom bank off the northern entrance to Colvos Passage. It lies a short distance southward and eastward from Blake island. Mr. Davidson has named it Allen's bank, and I have placed it under that title in the list of developments of the year.

Hydrography.—At the request of the Department of State, and by direction of the Treasury Department, the surveying steamer Active, and hydrographic party in charge of Lieut. Comg. Richard M. Cuyler, U. S. N., assistant in the Coast Survey, have been placed at the disposal of the commissioner of the northwestern boundary, Archibald Campbell, Esq The preliminaries connected with the duties assigned to the commissioner have kept the vessel in employ, and but little regular hydrography has been added to the work of the section.

Towards the end of the season, Lieut. Comg. Cuyler found means to commence soundings in Semiahmoo bay, lying on the forty-ninth parallel, and on the eastern side of the Gulf of Georgia. The work was retarded by rainy weather and smoke, but the hydrography of the inner harbor was completed at the middle of September.

The tides of the bay were observed for two lunations in connection with the soundings.

On being advised by the boundary commissioner that the services of the steamer Active would not be further needed by him until the opening of next season, Lieut. Comg. Cuyler sailed in September for San Francisco, where the vessel will receive the repairs necessary to fit her again for duty.

OFFICE-WORK.

The Coast Survey office has been, since January 20, 1857, under the charge of *Captain M. L. Smith, U. S. Topographical Engineers,* with occasional intervals, during which it was under the charge of *Lieut. A. P. Hill,* U. S. Army, who relieved Captain H. W. Benham, of the Corps of Engineers, on the 1st of November, 1856, and directed in the office operations until January.

The lucid report of Captain Smith, Appendix No. 22, gives a full account of the progress of the office-work, arranged under the heads of the different divisions, and referring, when necessary, to the sub-reports of the officers in charge of them. A reference to these reports dispenses with the necessity for more than a brief summary of the work of the several divisions of the office.

1. Computing Division.—This efficient division has been continued under the charge of *Assistant Charles A. Schott,* and, during his absence on field service for a short time, was under that of *Assistant J. E. Hilgard.* The great amount of systematic labor performed by the employees of this division, is shown in the report of the assistant in charge of the office, and of the division.

The memoirs contributed to this report by Mr. Schott and others, in the preparation of which he assisted, are given in the Appendix Nos. 30, 31, and 32.

Of the several computers attached to the division, *Assistant T. W. Werner* has been employed in reductions of primary and secondary triangulation and geographical positions; *Mr. Eugene Nulty* on astronomical azimuths, and transits in connection with occultations of the Pleiades, and in reductions for chronometric longitudes; *Mr. James Main* on magnetic observations and azimuths; *Mr. G. Rumpf* on geographical positions and triangulations; *Mr. John Wiessner* on the adjustments of triangulations and second reduction for latitude; *Mr. J. E. Blankenship* in the discussion of magnetic results and reductions of triangulation; *Mr. John T. Hoover* served as clerk in the division, and assisted in miscellaneous computations; *Mr. D. Hinkle* was engaged in the early part of the season in reducing triangulations. He afterwards served with my party in Section I; and, on the close of operations, was transferred to duty connected with the publication of records and results. *Mr. T. F. Herbert* and *Mr. L. Daser* assisted temporarily in the preparation of geographical positions for publication in this report; and *R. Freeman* was employed in copying.

2. TIDAL DIVISION.—This division, under the charge of *Assistant L. F. Pourtales*, has furnished all the tidal data required for the charts and tables, and has continued the discussion of the observations under my immediate direction, as stated in the introduction to this report.

Mr. R. S. Avery has continued the discussion of the Boston tidal observations. *Mr. C. Fendall* was engaged in graphical decompositions when assigned to field duty at the end of November, 1856. *Mr. G. C. Blanchard* has been principally engaged in reading off and reducing observations from self-registering tide-gauges, and in other ordinary reductions and copying. *Mr. R. E. Evans* in decompositions and reductions. *Mr. C. M. Yulee* in similar duties until his resignation on the 1st of July. *Mr. G. B. Vose* during the early part of the season assisted in discussing the Boston tides, and in miscellaneous computations. *Mr. R. T. Bassett* was engaged in ordinary reductions until the end of April, when he took charge of the tidal station at New York. *Mr. S. Walker* has been employed in graphical decompositions, and *Mr. G. B. Maynadier* in miscellaneous reductions. The meteorological observations turned in have been, as heretofore, tabulated by *M. Thomas*.

3. DRAWING DIVISION.—The gratifying fact is stated by the assistant in charge of the office, that this division has during the past year gained upon the field-work. It has been under the charge of Lieutenant J. C. Tidball, U. S. A., and now consists of eleven draughtsmen, a clerk, and four persons employed chiefly in tracing.

The interesting remarks of Captain Smith, Appendix No. 22, in regard to the economy of labor from separating the field-work, and drawing from each other, should be referred to in this connection. Of the persons employed, *Assistant W. M. C. Fairfax* has been, as heretofore, employed on fine topographical and hydrographic reductions; *Assistant M. J. McClery* on first-class topography, and additions to the Congress map; *Mr. Joseph Welch* on topography until the beginning of illness, which caused his death in February. *Mr. J. J. Ricketts* has been engaged in hydrographic reductions and verifications; *Mr. F. Herbst*, until his resignation in March, was employed on the light-house map; *Mr. L. D. Williams* was occupied on general coast charts and drawings of sketches; *Mr. A. Balbach* on hydrographic reductions; *Mr. A. Lindenkohl* on topography, projects and progress sketches; *Mr. W. P. Schultz* has made chart reductions and projections for original sheets; *Mr. L. Daser* was engaged on hydrographic reductions until his transfer to the computing division in August; *Mr. W. T. Martin* has been engaged in topographical drawing, and on diagrams for the last annual report; *Mr. A. Strausz*, from the 10th of September, was employed in hydrographic drawing; *Mr. P. Witzel* has been engaged on comparative charts, progress sketches, and projections; *Mr. W. Wagner* was employed until May in the reduction of topography; *Mr. F. Fairfax* has reduced the topography and hydrography necessary for additions to certain charts and sketches; *Mr. W. Fairfax* was engaged on sketches and tracings until June; *Mr. A. Schoepf* and *Mr. E. Hergesheimer* have worked by contract on preliminary charts; *Mr. B. Hooe* has been continued on tracings; *Mr. S. B. Linton* and *Mr. W. T. Bright* have been practiced on reductions, and also employed in tracing; *Mr. H. McCormick* and *Artificer J. A. Campbell* have been engaged in tracings, the former until the first of April, when he left the office.

4. ENGRAVING DIVISION.—Twenty-one engravers have been employed during the year in this division, nine of whom are of the first class. The division has been under the charge of Lieutenant Rufus Saxton, U. S. A. The programme for the year included six first-class maps and numerous preliminary charts and sketches, and has been executed, with certain changes pointed out in Captain Smith's report. Forty plates were completed during the year, and twenty-nine are in progress. The office estimates that during the coming year some ten first-class maps, and sixty-eight to seventy preliminary maps, charts, and sketches may be executed. A complete list of the maps and charts of the survey is given in Appendix No. 22, and includes two hundred and fifty-eight sheets.

The following are the names and occupations of the engravers:

Mr. G. McCoy has engraved the work of first-class topography and views; *Mr. John Knight*, titles, notes, general lettering, and the soundings on first-class charts; *Mr. F. Dankworth* has continued the engraving of outlines and topography; *Mr. A. Rollé* has been engaged on fine topography; *Mr. J. Enthoffer* on engraving, and *Mr. A. Blondeau* in etching topography; *Mr. A. Sengteller* has engraved topography and sand, and *Mr. G. B. Metzeroth* has engraved and etched on copper and steel, and executed views on sketches; *Mr. W. Phillips* joined the office in June, and has been employed on topographical engraving; *Mr. J. V. N. Throop* has engraved titles, notes, and soundings; *Mr. A. Maedel*, topography and lettering; *Mr. J. C. Kondrup*, outlines, topography, and notes on charts; *Mr. H. S. Barnard*, the sanding on plates, and miscellaneous work; *Mr. E. A. Maedel* joined the office on the 1st of April, and has been chiefly employed in letter engraving; *Mr. W. Langran*, besides miscellaneous work, has engraved titles, notes, and soundings; *Mr. W. Ogilvie* and *Mr. A. Petersen* have executed outlines, general lettering, and soundings; *Mr. J. J. Knight* was engaged on plates of preliminary charts and sketches until the 1st of August, when he left the office; *Mr. S. W. Bradley* had recently completed his apprenticeship, and was engaged in general lettering until near the time of his death, which occurred on the 1st of July; *Mr. R. F. Bartle* completed his apprenticeship in May, and has been employed upon preliminary charts and sketches; apprentices *F. W. Benner*, *W. A. Thompson*, and *E. Sipe* have been employed in the engraving of progress sketches, and in the practice necessary to their improvement in the art.

I have had frequent occasion to notice the devotion to duty of *Mr. Edward Wharton*, engaged as assistant in directing the details of the engraving division.

5. ELECTROTYPE DIVISION.—*Mr. George Mathiot* and two assistants have executed the entire work of this division during the present year, including the experimental researches in photography, and engraving by phototype, which Mr. Mathiot has executed himself. The application of photography as a substitute for drawing in the reduction of maps has made good progress and yielded excellent experimental results; but we are not as far advanced in the actual practical application as a substitute for drawing as the British Ordnance Survey.

I shall hope that even before this report is published we may have reached the point desired in this important application.

6. MISCELLANEOUS.—(*a*) *Printing.* Some changes, stated in Appendix No. 22, have taken place in regard to this part of the work, and it has been placed under the more immediate charge of *Lieut. A. P. Hill*, U. S. A. Twenty-two thousand two hundred and forty-two copies of maps, charts, sketches, and diagrams have been printed during the year. The printing is now executed by *Mr. John Rutherdale.*

(*b*) *Distribution of maps and reports.*—During the year, nineteen thousand seven hundred and ninety-five impressions of maps, charts, and sketches have been distributed, or turned over to sale agents, or for use in the office, within the past season. The titles and numbers are stated in Appendix No. 22. *Mr. V. E. King* has been continued in charge of the map room, and of distributing the Coast Survey reports—attending to clerical duties in the office when not thus occupied. Six thousand and eighty-three copies of the report of 1855, and thirteen hundred and twenty-five of those of 1851 to 1854, inclusive, have been distributed under act of Congress, chiefly to associations and persons connected with navigation and commerce, science, and the public service. Notwithstanding this large list, applications are daily received for copies of the report of 1855, and frequent ones for the earlier volumes, to complete sets. Those prior to 1851 are out of print; a very limited edition having been ordered by Congress.

(*c*) *Library and Archives.*—These have been continued in charge of *Mr. C. B. Snow*, who represents in his report the inconvenience resulting from the limited space which the office affords for the library and records. During the calender year, 1857, three hundred and eighty-nine volumes have been added to the library, of which one hundred and sixty were presented by foreign governments and scientific societies at home and abroad.

(*d*) *Instrument shop.*—This part of the office, under the charge of *Mr. J. Vierbuchen*, has turned out a large amount of work during the year, of which a detailed list is given in Appendix No. 22. It includes the making as well as repairing of instruments.

(*e*) The work in the *carpenters' shop*, under the charge of *Mr. A. Yeatman*, is also stated in detail in Appendix No. 22.

Lieutenant A. P. Hill, U. S. A., has served as general assistant to Captain M. L. Smith in the office, replacing him during his absence, and at all times relieving him of many onerous details, and has rendered most acceptable service in this position. The assistant in charge acknowledges especially the services of Mr. A. W. Russell, the principal clerk in his office.

The services of *Assistant J. E. Hilgard*, in charge of the publication of records and results; of *Assistant L. F. Pourtales*, in charge of the tidal researches; of *Lieut. E. B. Hunt*, in charge of the preparation of a scientific index of geodetic and kindred matters; of *Prof. A. G. Pendleton*, in charge of the Gulf Stream records and results; and of his successor, *Prof. W. P. Trowbridge*, have been noticed in the introduction to this report, their work being under my immediate direction.

Lieut. W. D. Whiting, U. S. N., who served as chief of the hydrographic division of the office, was relieved in March last, and the exigencies of the naval service have not permitted the assigment of a successor. The details have been adjusted by the assistant in charge of the office and Lieutenant Hill, with the aid of a hydrographic draughtsman. It is hoped that the detail of an experienced hydrographic officer for this important position may soon be obtained.

Mr. J. M. Batchelder has conducted acceptably various experimental inquiries in connection with the field and office work of the survey during the year ; notices of the more important of which have been given in the introduction.

I have had more than usual cause, during the past year, to give expression to my sense of the services of *Samuel Hein, esq.*, general disbursing agent of the survey. A more zealous and efficient officer it would be impossible to find. His method and industry in keeping the various and complicated accounts of the work are very remarkable, and while he never loses sight of economy, he avoids the extreme of crippling the operations of the work by injudicious interference with the lawful expenditures of the parties.

To my principal clerk, *W. W. Cooper, esq.*, I would again accord acknowledgments for his able and devoted services.

Respectfully submitted by

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX.

APPENDIX No. 1.

Distribution of the parties of the Coast Survey upon the coasts of the United States during the surveying season of 1856–'57.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION I.				
From Passamaquoddy bay to Point Judith, including the coast of Maine, N. Hampshire, Massachusetts, and Rhode Island.	No. 1	Astronomical, telegraphic, and magnetic observations.	A. D. Bache, Superintendent; Geo. W. Dean, assistant; Edward Goodfellow, sub-assistant; Stephen Harris, sub-assistant; J. Kincheloe, aid; A. T. Mosman, aid.	Observations for time and telegraphic exchanges of star signals for difference of longitude between Bangor and Calais, Me.; determinations for latitude and magnetic elements at both stations. (See also Sections V, VI, and VIII.)
	2	------------------	C. O. Boutelle, assistant; J. A. Sullivan, sub-assistant.	Grading and preparation of site on Epping plains, Me., for a base of verification. (See also section V.)
	3	Geodetic	A. D. Bache, Superintendent; Geo. W. Dean, assistant; Edward Goodfellow, sub-assistant; Stephen Harris, sub-assistant; J. A. Sullivan, sub-assistant.	Measurement of primary base on Epping plains, near Columbia, Washington county, Me., to verify the triangulation of the northeastern coast of the Atlantic States. (See also Sections V, VI, and VIII.)
	4	Secondary and tertiary triangulation.	Lieut. A. W. Evans, U. S. A., assistant; Benjamin Huger, jr., sub assistant; J. A. Sullivan, sub-assistant, (part of season;) G. E. Humphries, aid, (part of season.)	Triangulation of Sheepscot river, Me., extended from former limits eastward to Wiscasset, and over Townsend and Linican bays, and the Damiscove islands. (See also Section V.)
	5	Topography	W. S. Gilbert, sub-assistant; Rufus King, jr., aid.	Plane-table survey of shores of Kennebec river, extending from Cox's Head upward to Bath, Me. (See also Section VIII.)
	6	Topography	C. T. Iardella, sub-assistant; F. F. Nes, aid.	Survey of western side of Cape Small Point peninsula, and of Great island and other islands and ledges in its vicinity. (See also Section VI.)
	7	Topography	A. W. Longfellow, assistant; C. Fendall, aid.	Shore-line of Casco bay completed eastward from Portland to Parker's Point, and topography of islands lying west of a line joining Yarmouth entrance and Harpswell Point. (See also Section V.)
	8	Topography	A. M. Harrison, assistant; Chas. Ferguson, sub-assistant; W. H. Dennis, aid.	Shores of Plymouth harbor, Mass., completed from Back river, near Duxbury, and extending northward towards Scituate. (See also Section VI.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION I—(Continued.)	No. 9	Topography	H. L. Whiting	Resurvey of shore-line at northern extremity of Cape Cod peninsula. (See also Section II.)
	10	Hydrography	Lieutenant Commanding S. D. Trenchard, U. S. N., assistant.	Hydrography of Kennebec river from Cox's Head to Bath, and examination of Jordan's rock, Portland harbor. (See also Section V.)
	11	Hydrography	Lieutenant Commanding W. G. Temple, U. S. N., assistant.	In-shore soundings at the entrance of Casco bay extended westward from Small Point peninsula to the meridian of Ragged island. (See also Section II.)
	12	Hydrography	Lieutenant Commanding C. R. P. Rodgers, U. S. N., assistant.	Lines of off-shore soundings run eastward between Cape Ann and Cape Cod, and southward outside of George's bank to latitude 40° 30′ N.; in-shore hydrography extended from Londoner shoal (Cape Ann) northward beyond Newburyport, Mass. Supplementary hydrography in Martha's Vineyard sound, and examination of Westport harbor, Mass., for light-house site. (See also Section IV.)
		Tidal observations		Observations continued at the permanent station in Boston dry dock.
	13	Tides and currents	H. Mitchell, sub-assistant; G. B. Vose, aid; Jas. Gilliss, aid.	Nantucket and Vineyard sounds. (See also Section II.)
SECTION II. From Point Judith to Cape Henlopen, including the coast of Connecticut, New York, and New Jersey, and shore of Pennsylvania and Delaware.	No. 1	Secondary triangulation.	Edmund Blunt, assistant; Lieut. A. H. Seward, U. S. A., assistant; G. H. Bagwell, sub-assistant, (part of season.)	Triangulation of Hudson river, from Poughkeepsie to station Burhances, above Rondout.
	2	Topography	H. L. Whiting, assistant; J. Mechan, aid; F. W. Dorr, aid; C. Rockwell, aid.	Supplementary topography of northern part of Staten island; west side of Hudson river, from Bergen Neck to Guttenberg, including Jersey city and Hoboken; northern part of Manhattan island; from High Bridge to Throg's Neck; Governor's island; Bedloe's; Ellis'; Ward's; Randalls; North and South Brother, and Riker's island.
	3	Hydrography	Lieutenant Commanding W. G. Temple, U. S. N., assistant.	Soundings in Hell Gate, and supplementary hydrography in Harlem river, Spuyten Duyvel creek, and the channels near Blackwell's island. (See also Section I.)
	4	Hydrography	Lieutenant Commanding Rich'd Wainwright, U. S. N., assistant, (part of season;) Lieutenant Commanding James H. Moore, U. S. N., assistant.	Hydrography of Hudson river continued from Fort Montgomery to the vicinity of Newburgh, N. Y.
	5	Tides and currents	H. Mitchell, sub-assistant; G. B. Vose, aid; Jas. Gilliss, aid.	Observations in Hell Gate and its vicinity, East river. (See also Section I.)
		Tidal observations		Observations continued on self-registering gauge at Governor's island, New York harbor, and with staff gauge at Atlantic Ferry dock, Brooklyn.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION III.				
From Cape Henlopen to Cape Henry, including the coast of part of Delaware, and the coast of Maryland and Virginia.	No. 1	Se ondary triangulation.	Lieut. J. P. Roy, U. S. A., assistant.	Triangulation of Patuxent river, Md, extended from Setterley Point, upward, to stations above Benedict.
	2	Secondary triangulation.	Lieut. J. P. Roy, U. S. A., assistant.	Triangulation of York river, Va, completed, including the mouths of the Mattaponi and Pamunkey rivers.
	3	Secondary triangulation.	John Farley, assistant......	Triangulation of Curratoman river, a tributary near the entrance of Rappahannock river, Va.
	4	Secondary triangulation.	John Farley, assistant; J. P. Farley, aid, (part of season.)	Extension of triangulation downward on shores of James river, Va., to stations adjacent to Newport News. Triangulation commenced on Potomac river, at Alexandria, Va.
	5	Topography	N. S. Finney; J. L. Tilghman, aid.	Plane-table survey of sea coast of Virginia, and inner shore of Chincoteague island, completed between Wallop's island and Maryland boundary. (See also Section VII.)
	6	Topography	I. Hull Adams, assistant; Charles Ferguson, sub-assistant.	Plane-table survey completed of shores of Rappahannock river, Va., between La Grange creek and Parrott's island, including Urbanna, Curratoman, Carter's creek, and others intervening.
	7	Topography	John Seib, assistant; W. S. Edwards, aid, (part of season.)	Topography of shores of York river, from its entrance, upward, to Bigler's Mill. (See also Section V.)
	8	Hydrography	Commander Wm. T. Muse, U. S. N, assistant.	Hydrography of Patuxent river, Md., from Leonard's creek, upward, to Benedict. Hydrography of St. Mary's river, Md. (See also Section IV.)
	9	Hydrography	Lieutenant Commanding R. Wainwright, U. S. N., assistant.	Hydrographic survey of Rappahannock river, Va., completed to entrance into Chesapeake bay, including sounding of Curratoman river. (See also Section II.)
	10	Hydrography	Lieutenant Commanding J. J. Almy, U. S. N., assistant.	Soundings completed in York river, Va., from its entrance into Chesapeake bay to the junction of Mattaponi and Pamunkey rivers, at West Point.
	11	Hydrography	Lieutenant Commanding J. N. Maffitt, U. S. N., assistant.	Hydrography continued upward in James river, Va., from the mouth of Chickahominy river to near City Point. (See also Section V.)
		Tidal observations .	....	Observations continued with self-registering gauge at Old Point Comfort, Va.
SECTION IV.				
From Cape Henry to Cape Fear, including part of the coast of Virginia and coast of North Carolina.	No. 1	Secondary triangulation and topography.	J. J. S. Hassler, assistant...	Preparation of lines for observation and preliminary measurements at stations connecting with Cape Henry lighthouse; plane-table survey of the vicinity of Cape Henry.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION IV—(Continued.)	No. 2	Triangulation	A. S. Wadsworth, assistant; J. L. Tilghman, aid.	Triangulation completed on outer coast of North Carolina from Topsail inlet southward and westward to Cape Fear. (See also Section I)
	3	Topography	A. S. Wadsworth, assistant; John Meehan, aid.	Plane-table survey completed of sea coast of North Carolina between Topsail inlet and Cape Fear. (See also Sections I and II.)
	4	Hydrography	Commander Wm. T. Muse, U. S. N., assistant.	Resurvey of Hatteras inlet and Ocracoke inlet, N. C., and hydrography of Pamplico sound, connecting with Ocracoke. (See also Section III.)
	5	Hydrography	Lieutenant Commanding C. R. P. Rodgers, U. S. N., assistant.	In-shore soundings completed along the coast of North Carolina from Cape Lookout westward twenty miles, and extending fourteen miles southward; resurvey of Beaufort bar and harbor, N. C. (See also Section I.)
SECTION V.				
From Cape Fear to St. Mary's river, including the coast of S. Carolina and Georgia.	No. 1	Astronomical and magnetic observations.	A. D. Bache, Superintendent; C. A. Schott, assistant; J. H. Toomer, aid; J. E. Blankenship, aid; David Hinkle, aid.	Transits observed at Savannah, Ga., in connection with chronometer determination of difference of longitude between Savannah and Fernandina, Fla.; observations for magnetic declination, dip, and intensity. (See also Sections I and VI.)
	2	Secondary triangulation.	C. O. Boutelle, assistant; Benj. Huger, jr., sub-assistant; F. P. Webber, aid; G. E. Humphries, aid.	Secondary triangulation and erection of signals for connection between Charleston harbor and Winyah bay; triangulation continued on coast of South Carolina between St. Helena sound and Calibogue sound. (See also Section I.)
	3	Secondary triangulation and topography.	C. P. Bolles, assistant; O. Hinrichs, aid.	Secondary triangulation of coast of North Carolina completed from Lockwood's Folly westward to Shallotte inlet, and reconnaissance made for extension of work; plane-table survey finished westward within coast triangulation to Bacon's inlet, and shore-line traced beyond to Shallotte inlet.
	4	Secondary triangulation and reconnaissance.	Lieut. A. W. Evans, U. S. A., assistant; H. S. Du Val, aid.	Triangulation of coast of Georgia, commenced between Savannah river and Great Ogeechee river, to include Wassaw and Ossabaw sounds; signals erected for extension of work; topographical reconnaissance of Sapelo island, Ga., for primary base site. (See also Section I.)
	5	Topography	W. S. Edwards	Resurvey of wharf lines at Charleston, S. C., and details determined of additions made since previous survey.
	6	Topography	John Seib, assistant	Completion of plane-table survey of shores of Wadmelaw river; part of Wadmelaw island; the lower part of Dawho river and intervening creeks; parts of the Pon Pon and South Edisto rivers; Fishing creek, dividing Fenwick's, Pine, and other islands; the Ashepoo river, and part of St. Helena sound, S. C. (See also Section III.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION V—(Continued.)	No. 7	Topography	A. W. Longfellow, assistant; Clarence Fendall, aid.	Sapelo sound and approaches, and Sapelo river from its entrance to above Sutherland's bluff, with part of the outer shores of St. Catharine's and Blackbeard islands. Topography of Turtle river, Ga., to the head of Blythe island; detailed survey of Blythe island complete, and of Brunswick harbor with the shores of adjacent channels. (See also Section I.)
	8	Hydrography	Lieutenant Commanding J. N. Maffitt, U. S. N., assistant.	Resurvey of entrances to Cape Fear river, N. C.; in-shore hydrography southward from Cape Roman, including the entrance to Bull's bay, S. C., and extending to Charleston harbor entrance; off-shore soundings from coast of South Carolina; resurvey of Maffit's channel, and supplementary hydrography at the entrance of St. Helena sound. (See also Section III.)
	9	Hydrography	Lieutenant Commanding S. D. Trenchard, U. S. N., assistant.	Supplementary hydrography of St. Simon's bar and sound, and of Turtle river at Brunswick, Ga. (See also Sections I and VI.)
		Tidal observations		Observations continued with self-registering gauge at Charleston, S. C.
GULF STREAM		Hydrography	Commander B. F. Sands, U. S. N., assistant; Lieut. Com'g. J. C. Febiger, U. S. N., assistant.	Soundings in the inner warm band of the Gulf stream, extending from within 60 miles of Cape Fear, southward, to Cape Canaveral, Fla. (See also Section VIII.)
SECTION VI.				
From St. Mary's river to St. Joseph's bay, including the eastern and part of the western coast of Florida peninsula, with Florida reef and keys.	No. 1	Astronomical and magnetic observations connected with chronometric expedition.	A. D. Bache, Superintendent; C. A. Schott, assistant; J. H. Toomer, aid; J. E. Blankenship, aid; David Hinkle, aid.	Transit observations for time at Fernandina, and determination of longitude by chronometers; observations for magnetic declination, dip, and horizontal intensity. (See also Sections I and V.)
	2	Reconnaissance and triangulation.	Capt. J. H. Simpson, U. S. Topographical Engineers, assistant; Thos. Baltzell, jr., aid; J. Maynadier, aid.	Stations erected and occupied in the vicinity of Fernandina, Fla., for air-line connection by triangles across the Florida peninsula to Cedar keys.
	3	Triangulation	Lieut. A. H. Seward, U. S. A., assistant; C. B. Baker, aid.	Triangulation of outer keys on Florida reef, extended southward and westward from Point Charles to Lower Matecumbe. (See also Section II.)
	4	Triangulation	Lieut. J. C. Clark, U. S. A., assistant; F. W. Alexander, aid.	Triangulation of outer keys on Florida reef, extended southward and westward from Lower Matecumbe to Pigeon key, including Long key, Grassy key, and the Stirrup keys.
	5	Topography and reconnaissance.	A. M. Harrison, assistant; W. H. Dennis, aid; J. A. Da Costa, aid.	Plane-table survey of Cumberland sound, including Fernandina harbor; parts of Amelia and Cumberland islands; St. Mary's, and Amelia rivers; North river, Burrell's creek, and the town of St. Mary's, Ga.; Jolly river, Bell's river, Lanceford creek, and the towns of Old and New Fernandina, Fla.; reconnaissance and survey of site for base line on Cumberland island. (See also Section I.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION VI—(Continued.)	No. 6	Topography	S. A. Wainwright, sub-assistant.	Outer shore-line traced, and interior of Key Largo marked in quarter sections for General Land Office; outer shores traced of Upper and Lower Matecumbe, and of Lignum Vitæ key, Florida reef.
	7	Topography	F. W. Dorr	Survey and marking of the Stirrup keys, and others adjacent, eastward of Bahia Honda harbor, Florida reef: Burnt key, Raccoon key, the Water keys, and others lying northward of the Pine keys; shore line traced, and survey of the interior of Florida peninsula in the vicinity of Cape Sable; surveys marked in quarter sections for the General Land Office. (See also Section II.)
	8	Topography	C. T. Iardella, sub-assistant; S. J. Hough, aid, (part of season;) G. U. Mayo, aid, (part of season.)	Big Pine key, the Torch keys, Newfound Harbor keys, and numerous adjacent keys, surveyed and marked in quarter sections for the General Land Office. (See also Section I.)
	9	Hydrography	Lieutenant Commanding S. D. Trenchard, U. S. Navy, assistant.	Supplementary hydrography of Cumberland sound, and of St. Mary's river, and Amelia river and its tributaries; soundings completed at the entrance of St. John's river, Fla., extending to Mayport Mills, and including re-examination of St. John's bar. (See also Sections I and V.)
	10	Hydrography	Lieutenant Commanding T. A. Craven, U. S. Navy, assistant.	Hydrography of Florida reef continued westward from East Bahia Honda, and extended beyond Loggerhead key.
	11	Tidal observations.	Gustavus Würdemann	Observations at Cape Florida, Indian key, Key West, and Tortugas.
SECTION VII. From St. Joseph's bay to Mobile bay, including part of the western coast of Florida and the coast of Alabama.	No. 1	Triangulation	G. H. Bagwell, sub-assistant.	Triangulation extended on the western coast of Florida peninsula, from Waccasassa river, eastward, to Crystal river. (See also Section II.)
	2	Triangulation	Spencer C. McCorkle, sub-assistant; E. H. Wells, aid.	Triangulation of St. George's sound, Apalachicola bay, and St. Vincent's sound completed from Dog island, southward and westward, to Indian Pass.
	3	Triangulation	F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant; C. H. Boyd, aid.	Measurement of preliminary base at Cedar keys, Fla. Triangulation continued in Escambia bay from Red Bluff and Garçon Point, and extended southward towards Warrington, on Pensacola bay. (See also Section VIII.)
	4	Topography	N. S. Finney	Topography from Grassy Point, including entrance to Waccasassa river, Fla., continued eastward to We-thlocco-cheo river, with survey of intermediate creeks and reefs. (See also Section III.)
	5	Topography	George D. Wise, assistant; F. F. Nes, aid.	Plane-table survey of shores of St. George's island and sound, including the city and vicinity of Apalachicola, Fla.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION VII—(Continued.)	No. 6	Hydrography	Lieutenant Commanding J. K. Duer, U. S. Navy, assistant.	Soundings continued southward from Grassy Point, Waccasassa bay, Fla., and westward to limits of previous work; hydrography of Pensacola entrance and approaches completed.
SECTION VIII.				
From Mobile bay to Vermilion bay, including the coast of Alabama and Mississippi, and part of the coast of Louisiana.	No. 1	Astronomical, telegraphic, and magnetic observations.	Dr. B. A. Gould, jr., assistant; George W. Dean, assistant; Edward Goodfellow, sub-assistant; J. Kincheloe, aid; McLane Tilton, aid.	Telegraphic difference of longitude between Montgomery, Ala. — Lower Peach Tree, and Lower Peach Tree—Mobile, Ala. Observations for latitude at Lower Peach Tree, and determination of magnetic elements at all the stations. (See also Section I.)
	2	Astronomical and magnetic observations.	J. E. Hilgard, assistant; Stephen Harris, sub-assistant; Jos. S. Harris, aid, (part of season;) R. E. Halter, aid.	Observations for azimuth at East Pascagoula, Miss., and for magnetic declination, dip, and horizontal intensity at Barrel key, western side of Chandeleur sound.
	3	Secondary triangulation and topography.	J. E. Hilgard, assistant; Stephen Harris, sub-assistant; Jos. S. Harris, aid, (part of season;) R. E. Halter, aid.	Extension of secondary triangulation southward from line Cat island—Bayou Pierre, along eastern side of Mississippi delta, and connecting with triangulation of Chandeleur islands. Topography from Isle au Pied extended southward beyond Barrel key, La.
	4	Triangulation, reconnaissance, and topography.	F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant; C. H. Boyd, aid.	Securing western terminus of Dauphine island base. Survey of site for preliminary base at Mississippi delta; triangulation commenced, and reconnaissance made for extension of work upward. (See also Section VII.)
	5	Triangulation and topography.	F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant; C. H. Boyd, aid.	Measurement of preliminary base at Point au Chevreuil and triangulation of Côte Blanche bay from the entrance to Malony's point, opposite Marsh island. Topography of eastern shore of Côte Blanche bay completed within same limits. (See also Section VII.)
	6	Topography	R. M. Bache, assistant, (part of season;) W. S. Gilbert, sub-assistant; Rufus King, jr., aid.	Plane-table survey of shores of southwestern part of Lake Borgne, extending to Shell point and Point aux Marchette. (See also Section I.)
	7	Hydrography	Commander B. F. Sands, U. S. N., assistant.	Hydrography completed in southwestern part of Mississippi sound; re-survey of Pass Christian, and hydrography commenced in the northern part of Chandeleur sound. Lines of deep-sea soundings in the Gulf of Mexico, viz: from Pensacola to Chandeleur sound, thence to the delta of Mississippi river; and from Pass à l'Outre to Key West. (See also Gulf Stream.)
SECTION IX.				
From Vermilion bay to the southwestern boundary, including part of the coast of Louisiana and the coast of Texas.	No. 1	Triangulation and topography.	S. A. Gilbert, assistant; Charles Hosmer, aid.	Triangulation completed in Matagorda and Lavacca bays, and reconnaissance made for extension of work southward and westward on the coast of Texas to Aransas. Topography nearly completed on the shores of Matagorda and Lavacca bays, including surveys of Indianola, Lavacca, and Saluria.

APPENDIX No. 1.—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION IX—(Continued.)	No. 2	Topography	Malcolm Seaton, sub-assistant; R. E. Evans, aid.	Plane-table survey of shores of Tres-palacios, Turtle, and Caranckaway bays, dependencies of Matagorda bay, Texas.
	3	Hydrography	Lieut. Commanding E. J. De Haven, U. S. N., assistant, (part of season;) Lieut. Commanding John C. Febiger, U. S. N., assistant.	Soundings on the bar, at the entrance and inside, including the southwestern part of Matagorda bay. Off-shore line of soundings, carried southeast from the bar at Matagorda entrance. (See also Gulf Stream.)
SECTION X. Western coast of the United States, from the southern boundary to the forty-second parallel, including the coast of California.	No. 1	Astronomical and magnetic observations.	George Davidson, assistant; James S. Lawson, sub-assistant.	Transit observations at Rincon Point, San Francisco, Cal.; occultations and moon culminations observed for longitude. Magnetic declination determined at Rincon Point and at primary station on Tomales bay, Cal. (See also Section XI.)
	2	Primary and secondary triangulation.	G. A. Fairfield, assistant; C. B. Ellis, aid.	Extension of primary triangulation northward from San Francisco bay. Secondary triangulation continued from Point Reyes northward to Bodega bay, and including Tomales bay, Cal.
	3	Triangulation	Aug. F. Rodgers, sub-assistant; David Kerr, aid.	Tertiary triangulation of southeastern shore of San Francisco bay, from Contra Costa (1) to Red Hill station; determination of light-house positions at Alcatraz island, Point Bonita, Fort Point, and of site selected at Point Lobos.
	4	Triangulation	W. E. Greenwell, assistant; P. C. F. West, aid.	Triangulation on the shore of Santa Barbara channel, Cal., extended from San Fernando, westward, nearly to Santa Clara river; triangulation of Santa Cruz and San Nicolas islands completed.
	5	Topography	W. M. Johnson, sub-assistant; C. M. Bache, aid.	Plane-table survey of main shore of Santa Barbara channel, from Point Conversion, eastward, to Point Duma.
	6	Topography	Aug. F. Rodgers, sub-assistant; David Kerr, aid.	Resurvey of city of San Francisco and environs; supplementary topography at Point Lobos and Alcatraz island; plane-table survey of shores of southern arm of San Francisco bay completed from Contra Costa station (1), southward, to the head of navigation, including Union City and the village of Alvise, thence northward to Guano island, including Ravenswood village and Redwood city; reconnaissances of Petaluma and Napa creeks from their entrances into San Francisco bay to the head of navigation.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION X—(Continued.)	No. 6	Hydrography	Commander James Alden, U. S. N., assistant; Lieutenant Commanding R. M. Cuyler, U. S. N., assistant.	Hydrography completed at the eastern entrance of Santa Barbara channel, and of Monterey bay, between Point Pinos and Santa Cruz harbor; in shore soundings extended on the coast between Point Año Nuevo and Point Miramontes, and hydrography completed in San Francisco bay and Karquines strait.
SECTION XI.				
Western coast of the United States from the 42d parallel to the northern boundary, including the coasts of Oregon and Washington Territories.	1	Triangulation and astronomical and magnetic observations.	George Davidson, assistant; James S. Lawson, sub-assistant.	Triangulation of Admiralty inlet, W. T., south of line Restoration—Battery, to Point Pully—Point Heyer, thence to Point Prospect in Colvos passage, and to the entrance of Port Orchard; reconnaissance and erection of signals from triangulation, southward, to Ketron island, in Puget's Sound, beyond Steilacoom; transit observations made at Point Pully for connection with occultations. (See also Section X.)
	2	Topography	James S. Lawson, sub-assistant.	Plane-table survey at entrance of Hood's canal, and part of the western shore of Admiralty inlet, extending beyond Point-No-Point, W. T.
	3	Hydrography	Lieutenant Commanding R. M. Cuyler, U. S. N., assistant.	Soundings in Semiahmoo bay, W. T., and completion of hydrography of the inner harbor; tides observed.
SECTIONS X, XI.	--------	Tidal observations.	Lieutenant N. F. Alexander, U. S. Engineers, (part of season;) Lieutenant G. H. Elliot, U. S. Engineers.	Charge of permanent tidal stations at San Diego and San Francisco, (Section X,) and Astoria, (Section XI.)

APPENDIX No. 2.

List of Army officers on Coast Survey duty March 1, 1857.

Officers.	Rank.	Date of attachment.
James H. Simpson	Captain topographical engineers	June 24, 1856
Martin L. Smith	Captain topographical engineers	December 9, 1856
Joseph C. Clark, jr	First lieutenant 4th artillery	January 7, 1854
Ambrose P. Hill	First lieutenant 1st artillery	November 23, 1855
John C. Tidball	First lieutenant 2d artillery	September 6, 1854
Augustus H. Seward	First lieutenant 5th infantry	December 11, 1851
Edward B. Hunt	First lieutenant engineers	May 5, 1851
Rufus Saxton	First lieutenant 4th artillery	December 25, 1855
James P. Roy	First lieutenant 2d infantry	October 7, 1853
Judson D. Bingham	First lieutenant 2d artillery	March 22, 1856
Andrew W. Evans	First lieutenant 7th infantry	November 10, 1852

APPENDIX No. 2 bis.

List of Army officers on Coast Survey duty September 1, 1857.

Officers.	Rank.	Date of attachment.
James H. Simpson	Captain topographical engineers	June 24, 1856
Martin L. Smith	Captain topographical engineers	December 9, 1856
Joseph C. Clark, jr	First lieutenant 4th artillery	January 7, 1854
Ambrose P. Hill	First lieutenant 1st artillery	November 23, 1855
John C. Tidball	First lieutenant 2d artillery	September 6, 1854
Augustus H. Seward	First lieutenant 5th infantry	December 11, 1851
Edward B. Hunt	First lieutenant engineers	May 5, 1851
Rufus Saxton	First lieutenant 4th artillery	December 25, 1855
James P. Roy	First lieutenant 2d infantry	October 7, 1853
Andrew W. Evans	First lieutenant 7th infantry	November 10, 1852
Thomas Wilson	First lieutenant 5th infantry	May 26, 1857

APPENDIX No. 3.

List of Navy officers on Coast Survey duty March 1, 1857.

Vessel.	Locality of service.	Officers.	Rank.	Date of attachment.
	Office work, Section I	Henry S. Stellwagen	Commander	October 22, 1852
	Office work, Section II	John Lee Davis	Lieutenant	November 24, 1854
		W. T. Truxton	do	July 19, 1854
Steamer Hetzel	Section III	John J. Almy	Lieutenant commanding	March 12, 1851
		R. D. Minor	Lieutenant	April 19, 1855
		C. W. Flusser	do	February 28, 1857
		A. C. Izard	Passed midshipman	February 25, 1857
		C. F. Fahs	Passed assistant surgeon	do
Schooner Nautilus	Section III	Richard Wainwright	Lieutenant commanding	January 31, 1848
		George H. Bier	Lieutenant	February 10, 1857
		Thos. O. Selfridge	Passed midshipman	January 10, 1857
Steamer Bibb	Section IV	C. R. P. Rodgers	Lieutenant commanding	July 7, 1855
		S. B. Luce	Lieutenant	May 18, 1854
		K. R. Breese	do	July 10, 1855
		A. E. K. Benham	do	February 12, 1857
		Henry Wilson	do	December 8, 1856
		De Grasse Livingston	do	July 8, 1856
		H. O. Mayo	Passed assistant surgeon	December 10, 1856
Schooners Crawford and Bancroft.	Section V	John N. Maffitt	Lieutenant commanding	May 9, 1843
		J. H. Moore	Lieutenant	January 22, 1857
		Charles P. McGary	do	March 5, 1857
		R. Chandler	do	July 10, 1855
		D. L. Braine	do	October 28, 1855
Schooner Gallatin	Sections V, VI	S. D. Trenchard	Lieutenant commanding	March 1, 1853
		F. A. Roe	Lieutenant	February 21, 1856
		J. J. Cornwell	do	July 29, 1856
		Robt. L. May	do	do
Steamer Vixen	Gulf stream	O. H. Berryman	Lieutenant commanding	October 20, 1856
		Isaac G. Strain	Lieutenant	November 8, 1856
		J. P. K. Mygatt	do	February 25, 1857
Steamer Corwin	Section VI	T. A. Craven	Lieutenant commanding	November 27, 1850
		W. G. Temple	Lieutenant	June 5, 1855
		Jas. H. Rochelle	do	July 11, 1855
		W. M. Gamble	do	September 18, 1855
		E. K. Owen	do	December 4, 1855
		T. B. Steele	Passed assistant surgeon	October 8, 1856
Schooner Varina	Section VII	John K. Duer	Lieutenant commanding	August 1, 1855
		S. L. Breese	Lieutenant	October 11, 1854
		C. E. Hawley	do	October 8, 1856
		R. Boyd, jr	Passed midshipman	do
		James Laws	Assistant surgeon	October 3, 1856

APPENDIX No. 3—Continued.

Vessel.	Locality of service.	Officers.	Rank.	Date of attachment.
Steamer Walker	Section VIII	B. F. Sands	Commander	May 14, 1850
		W. T. Muse	do	February 27, 1857
		Thos. Roney	Lieutenant	September 23, 1856
		A. W. Weaver	do	October 15, 1856
		John Irwin	do	do
		C. A. Babcock	Passed midshipman	do
		P. J. Horwitz	Passed assistant surgeon	October 3, 1856
Schooner Arago	Section IX	J. C. Febiger	Lieutenant commanding	December 3, 1851
		W. T. Glassell	Lieutenant	October 1, 1856
		J. G. Maxwell	do	May 12, 1856
		Ashton Miles	Passed assistant surgeon	October 3, 1856
Steamer Active and schooner Ewing.	Sections X and XI	James Alden	Commander	May 18, 1849
		Richard M. Cuyler	Lieutenant commanding	June 20, 1845
		Simeon S. Bassett	Lieutenant	March 17, 1849
		P. C. Johnson	do	July 20, 1854
		J. M. Browne	Assistant surgeon	May 10, 1855
	Office	W. D. Whiting	Lieutenant	July 30, 1853
	Office	A. G. Pendleton	Professor of mathematics	May 8, 1848

APPENDIX No. 3 bis.

List of Navy officers on Coast Survey duty September 1, 1857.

Vessel.	Locality of service.	Officers.	Rank.	Date of attachment.
	Office work, (Sec. III)	John J. Almy	Lieutenant commanding	March 12, 1851
	Office work, (Sec. VII)	John K. Duer	do do	August 1, 1855
	Office work, (Sec. VI)	T. A. Craven	do do	November 27, 1850
	Office work, (Sec. VIII)	B. F. Sands	Commander	May 14, 1850
		Thomas Roney	Lieutenant	September 23, 1856
	Office work, (Sec. IX)	W. T. Glassell	do	October 1, 1856
Steamer Arctic		O. H. Berryman	Lieutenant commanding	October 20, 1856
		J. P. K. Mygatt	Lieutenant	February 25, 1857
		John Irwin	do	October 15, 1856
		A. W. Weaver	do	October 15, 1856
Steamer Corwin	Section I	W. G. Temple	Lieutenant commanding	June 5, 1855
		J. Lee Davis	Lieutenant	November 24, 1854
		J. H. Rochelle	do	July 11, 1855
		W. M. Gamble	do	September 18, 1855
		E. K. Owen	do	December 4, 1855
		T. B. Steele	Passed assistant surgeon	October 8, 1856
Schooner Gallatin	Section I	Stephen D. Trenchard	Lieutenant commanding	March 1, 1853
		F. A. Roe	Lieutenant	February 21, 1856
		J. J. Cornwall	do	July 29, 1856
		R. Boyd, jr.	Acting master	October 8, 1856
Steamer Bibb	Section I	C. R. P. Rodgers	Lieutenant commanding	July 7, 1855
		S. B. Luce	Lieutenant	May 18, 1854
		K. R. Breese	do	July 10, 1855
		A. E. K. Benham	do	February 12, 1857
		Henry Wilson	do	December 8, 1856
		De Grasse Livingston	do	July 8, 1856
		H. O. Mayo	Passed assistant surgeon	December 10, 1856
Schooner Nautilus	Section II	James H. Moore	Lieutenant commanding	January 22, 1857
		George H. Bier	Lieutenant	February 10, 1857
		Thomas O. Selfridge	Acting master	January 10, 1857
Schooners Crawford and Bancroft.	Section III	J. N. Maffitt	Lieutenant commanding	May 9, 1843
		C. P. McGary	Lieutenant	March 5, 1857
		R. Chandler	do	July 10, 1855
		D. L. Braine	do	October 28, 1855
Steamer Hetzel	Section IV	W. T. Muse	Commander	February 27, 1857
		R. D. Minor	Lieutenant	April 19, 1855
		B. E. Hand	do	March 7, 1857
		C. E. Hawley	do	October 8, 1856
		C. F. Fahs	Passed assistant surgeon	February 25, 1857
Steamer Active and schooner Ewing.	Sections X and XI	James Alden	Commander	May 18, 1849
		R. M. Cuyler	Lieutenant commanding	June 20, 1845
		S. S. Bassett	Lieutenant	March 17, 1849
		P. C. Johnson	do	July 20, 1854
		J. M. Browne	Assistant surgeon	May 10, 1855

APPENDIX No. 4.

List of assistant engineers United States Navy, on Coast Survey duty March 1, 1857.

Vessel.	Assistant engineers.	Rank.	Date of attachment.
Steamer Hetzel	Virginius Freeman	Second assistant engineer	January 29, 1857
	W. P. Burrow	Third assistant engineer	February 25, 1857
Steamer Bibb	H. H. Stewart	First assistant engineer	June 1, 1856
	H. Ashton Ramsay	Second assistant engineer	September 17, 1856
Steamer Vixen	W. J. Lamdin	First assistant engineer	September 12, 1856
	Jno. S. Albert	Third assistant engineer	May 15, 1856
Steamer Corwin	T. A. Jackson	First assistant engineer	June 30, 1855
	Jas. F. Lamdin	Second assistant engineer	June 30, 1854
	R. W. McCleery	Third assistant engineer	December 26, 1855
Steamer Walker	F. C. Dade	First assistant engineer	September 23, 1856
	John Hollins	Second assistant engineer	September 23, 1856
	J. M. Harris	Third assistant engineer	October 27, 1854
Steamer Active	N. C. Davis	First assistant engineer	February 22, 1853
	M. P. Jordan	Third assistant engineer	June 20, 1854

APPENDIX No. 4 bis.

List of assistant engineers United States Navy, on Coast Survey duty September 1, 1857.

Vessel.	Assistant engineers.	Rank.	Date of attachment.
Steamer Arctic	Jno. S. Albert	Third assistant engineer	May 15, 1856
Steamer Corwin	R. W. McCleery	Third assistant engineer	December 26, 1855
Steamer Bibb	H. H. Stewart	First assistant engineer	June 1, 1856
Steamer Hetzel	W. P. Burrow	Third assistant engineer	February 25, 1857
Steamer Active	N. C. Davis	First assistant engineer	February 22, 1853

APPENDIX No. 5.

List of information furnished by the Coast Survey during the year 1856–'57, under authority of the Treasury Department.

Date.		To whom communicated.	Information communicated.
1856.			
Nov.	8	Col. Thomas F. Drayton	Tracing of hydrographic survey of Port Royal entrance, S. C.
	8	........do	Tracing of hydrographic survey of Beaufort river, S. C.
	19	G. W. Blunt, Esq	Tracing of southern part of Massachusetts bay, including hydrography off Minot's Ledge.
Dec.	15	Hon. A. Iverson	Tracing of channel of St. Simon's bar and Brunswick harbor, Ga.
	15	........do	Tracing of Brunswick river, Ga.
	20	Hon. M. R. H. Garnett	Tracing of hydrography of James river, from Newport News to Caryville, Va.
	20	........do	Tracing of hydrography of Rappahannock river, in vicinity of "Garnett" Station, Va.
	30	G. W. Blunt, Esq	Tracing of hydrography of part of Hyannis harbor, Mass.
	30	War Department	Tracing of sketch of Admiralty inlet and vicinity, W. T.
	30	........do	Tracing of shore-line of Port Gamble and part of entrance to Hood's canal, W. T.
	30	........do	Tracing of shore-line of Apple Cove, Admiralty inlet, W. T.
	30	........do	Tracing of shore-line of Port Townsend, Admiralty inlet, W. T.
	30	........do	Tracing of shore-line of Murden's Cove, Admiralty inlet, W. T.
1857.			
Jan.	13	Navy Department	Tracing of hydrography of Port Royal entrance and bay, S. C.
	15	Maj. Hartman Bache, Topographical Engineers.	Latitude and longitude of light-houses on the Pacific coast.
	16	P. K. Dickenson, Esq	Copy of a report on the Cape Fear bars, N. C.
	29	Hon. Percy Walker	Tracing of hydrography of Mobile bay, Ala.
	30	E. S. Viele, Esq	Astronomical data for stations in vicinity of New York city.
Feb.	11	G. W. Blunt, Esq	Position of Green island, off Portland harbor, Maine.
	11	G. W. Call, Esq	Tracing of shore-line of St. Mary's river and approaches, Ga.
	12	Light-house Board	Tracing of hydrographic reconnaissance of Point Hueneme and vicinity, Cal.
	13	Hon. J. A. Stewart	Tracing of hydrography of Tangier sound, Md. and Va.
	17	Wm. Ashhurst, Esq	Tracing of Newport and vicinity, R. I.
	18	Amos Davis, Esq	Tracing of hydrography of part of Turtle river, Ga.
	20	D. K. Dodge, Esq	Tracing of Apalachicola river entrance, Fla.
	21	G. W. Blunt, Esq	Tracing of hydrography north of Nantucket island.
	23	Lieut. W. A. Wayne, U. S. N	Tracing of hydrography of Susquehanna river, from Port Deposit to Havre de Grace, Md.
	24	Hon. Robert Toombs	Tracing of hydrography of Turtle river, Ga.
March	5	S. J. Martenet, Esq	Tracing from reduction, scale $\frac{1}{60}$,000, of topography of Chesapeake bay and tributaries, north of the Gunpowder and Sassafras rivers, Md.
	7	U. S. Commissioner on survey of North-western boundary.	Tracings of hydrographic reconnaissance of Rosario straits and Canal de Haro, W. T.
	7	........do ....do	Tracing of Smith's island, W. T.
	7	........do ....do	Tracing of hydrographic reconnaissance of Bellingham bay, W. T.
	7	........do ....do	Tracing of triangulation sketch of Canal de Haro and entrance of Rosario straits, W. T.
	19	A. Dudley Mann, Esq	Depth of water from the capes of the Chesapeake to Norfolk, Richmond, and West Point, Va.
	19	A. Dudley Mann, Esq	Depth of water in the channels leading to cities of New York and Philadelphia.
	19	........do	Certain distances in Chesapeake bay.
	25	Lieut. C. B. Comstock, Corps of Engineers	Geographical position of certain stations in the vicinity of Baltimore, Md.
	26	Capt. Wm. F. Lynch, U. S. N	Tracing of Petersburg and vicinity, Va.
	28	Light-house Board	Tracing of hydrography of Hudson river from Van Wie's bar to Winnie's old dam, N. Y.
April	2	Lieut. Wm. H. Murdaugh, U. S. N	Tracing of shore-line of Eastern bay, Md.
	3	Boston Board of Trade	Tracing of Stellwagen's bank, Massachusetts bay.
	6	Hon. R. W. Habersham	Tracing of hydrography of Broad river, S. C.
	10	Hon. D. L. Yulee	Tracing of sketch of St. Mary's bar, (showing comparisons of surveys of 1855–'56,) Fla.
	22	Pilot Commissioners of port of New York	Tracing of channel of Long Island Sound from Throg's Point to North Brother.
	23	H. W. Allen, Esq	Tracing of Castleton bar and vicinity, Hudson river, N. Y.
May	29	W. C. Johnson, Esq	Specimens of sea-bottom for microscopic examination.
	29	Light-house Board	Tracing of hydrography of Beaufort harbor, S. C.

APPENDIX No. 5—Continued.

Date.		To whom communicated.	Information communicated.
1857.			
June	3	G. W. Blunt	Copy of sailing directions for St. Mary's sound, Ga.
	5	President Florida Railroad Company	Tracing of topography of Cumberland sound and Fernandina harbor, Ga.
	13	G. P. Elliott, Esq	Tracing of hydrography of Port Royal entrance, S. C.
	19	Light-house Board	Tracing of hydrography of North river in the vicinity of Tarrytown, N. Y.
	29	G. W. Adams, Esq	Tracing of shore-line of the Atlantic, south of Delaware bay, and of the Gulf of Mexico.
	30	Pilot Commissioners of port of New York	Tracing of North river from Robbin's reef to Hoboken, N. J.
	30	do do	Tracing showing depth of water north of the "Brothers" to Morris' dock, East river, N. Y.
July	3	Charles Copley, Esq	Tracing of off-shore soundings, approaches to Nantucket shoals, Mass.
	7	Hon. Wm. Ballard Preston	Tracing of hydrography of Norfolk harbor, Va.
	7	do	Tracing from preliminary chart of Hampton roads, Va.
	7	do	Tracing of York river entrance, Va.
	9	Charles Copley, Esq	Tracing of hydrography of Cape Cod bay, Mass.
	9	do	Tracing of deep-sea soundings, Gulf of Mexico, in 1854, 1855, and 1856.
	9	do	Tracing of hydrography of Nantucket sound, Mass.
	9	do	Tracing of hydrographic reconnaissance of Rio Grande entrance, Texas.
	9	do	Tracing of hydrography of Kennebec river entrance, Me.
	13	Light-house Board	Maps (three series) of Atlantic, Gulf, and Pacific coasts of United States, showing positions of light-houses.
	20	do	Tracing of Cumberland channel, St. Mary's entrance, Ga
	20	Hon. D. L Yulee	Tracing of Way key, Fla.
	28	Capt. H. W. Benham, Corps of Engineers	Tracing of Clarke's Point and vicinity near New Bedford, Mass.
August	2	John Henderson, Esq	Tracing of topography of Talbot county, Md.
	6	James Ryan, Esq	Distance between Constable's Point and Caven's Point, coast of New Jersey.
	8	J. C. Brevoort, Esq	Tracing of Jamaica bay, N. Y.
	8	do	Tracing of topography of Cow bay, Long Island Sound.
	11	G. W. Blunt	Longitude of astronomical station at Fernandina, Fla.
	14	do	Tracing of hydrographic survey of St. Mary's bar and Fernandina harbor, Fla.
	14	do	Sailing directions for Cumberland channel.
	15	J. G. Kohl, Esq	Shore-line of western coast of United States.
Sept.	26	Lieut. J. J. Almy, U. S. N	Tracing of Hampton roads and Elizabeth river to Norfolk, Va.
	29	James Regan, Esq	Lengths of sides of two triangles in vicinity of Bergen Point, N. J.
October	14	Hon. W. Cost Johnson	Tracing of hydrography in vicinity of Point Lookout, Chesapeake bay.
	15	John Overman, Esq	Bearing and magnetic variation at Capitol, Washington city, and at Point Lookout.
	16	Capt. J. G. Foster, Corps of Engineers	Tracing of Wilkins' Point and vicinity, N. Y.
	17	Capt. J. G. Benton, Ordnance	Tracing of triangulation of part of Hudson river, N. Y.
	31	Light-house Board	Tracing of Pensacola entrance, Fla.

APPENDIX No. 6.

List of capes, headlands, islands, harbors, and anchorages on the western coast of the United States, of which either topographical, hydrographic, preliminary, or complete surveys have been made, or maps, charts, or sketches issued to date of report of 1857.

Names, in geographical order.	Character of survey.	Published.
CAPES AND HEADLANDS.		
Point Loma	Complete survey	Sketch
Point Pedro	do	do
Point Fermin	do	do
Point Hueneme	Topographical and hydrographic survey	
Buenaventura Mission	do do	
Point Conception	Topographical survey	Sketch
Point Pinos	Complete survey	do
Point Año Nuevo	Topographical and hydrographic survey	do
Point San Pedro	Complete survey	
Point Lobos	do	Sketch
Point Bonita	do	do
Ballenas Bluff	do	
Point Reyes	do	Sketch
Point Adams	do	do
Cape Disappointment	do	do
Cape Flattery	Topographical survey	do
ISLANDS.		
Los Coronados islands	Topographical survey	
Anacapa island	Complete survey	Map
Santa Cruz island, east end of	do	do
Farallones islands	Topographical survey	Sketch
Alcatraz island	Complete survey	do
Yerba Buena island	do	do
Angel island	do	do
Mare island	do	do
Sand island	do	do
Smith's island	do	do
Cypress island, part of	Topographical survey	
HARBORS AND ANCHORAGES.		
San Diego harbor	Complete survey	Sketch
San Clemente anchorage, southeast end of island	Hydrographic survey	do
San Clemente anchorage, northeast end of island	do	do
Catalina harbor	do	do
San Pedro harbor	Topographical and hydrographic survey	do
Santa Barbara channel, part of eastern entrance	do do	
Smugglers' cove, Santa Cruz island	Complete survey	Sketch
Prisoners' harbor, Santa Cruz island	Hydrographic survey	do
Cuyler's harbor, island of San Miguel	do	do
Santa Barbara anchorage	Complete survey	do
Coxo harbor	Topographical survey	do

APPENDIX No. 6—Continued.

Names, in geographical order.	Character of survey.	Published.
HARBORS AND ANCHORAGES—Continued.		
San Luis Obispo harbor	Hydrographic survey	Sketch
San Simeon harbor	do	do
Monterey harbor	Complete survey	do
Sanquel cove	do	
Santa Cruz harbor	do	Sketch
Point Año Nuevo harbor	Topographical and hydrographic survey	do
San Francisco harbor	Complete survey	Preliminary chart
Mendocino City harbor	Hydrographic survey	Sketch
Shelter cove	do	do
Crescent City harbor	do	do
Port Orford, or Ewing harbor	Topographical and hydrographic survey	do
Grenville harbor	Hydrographic survey	do
Nee-ah harbor	Topographical and hydrographic survey	do
False Dungeness	Hydrographic survey	do
New Dungeness	Complete survey	do
Port Townshend	do	do
Port Ludlow	do	do
Mats-Mats, or Boat harbor	do	do
Port Gamble	do	do
Apple cove	Topographical survey	
Murden's cove	do	
Blakely harbor	Hydrographic survey	Sketch
Steilacoom harbor	do	do
Olympia harbor	do	do
BAYS.		
San Diego bay	Complete survey	Sketch
False bay	Topographical survey	
Monterey bay	Complete survey	Sketch
San Francisco bay	Topographical survey	
San Pablo bay	Complete survey	Preliminary chart
Ballenas bay	do	
Sir Francis Drake's bay	Preliminary survey	Sketch
Tomales bay	Topographical survey	
Humboldt bay	Hydrographic survey	Sketch
Trinidad bay	do	do
Shoalwater bay	do	do
Duwamish bay	do	do
Strawberry bay	Topographical survey	
Bellingham bay	Hydrographic survey	Sketch
REEFS AND BANKS OR SHOALS.		
Cortez bank	Hydrographic survey	Chart
Duxbury reef	Complete survey	Sketch, (on chart of San Francisco bay.)

APPENDIX No. 6—Continued.

Names, in geographical order.	Character of survey.	Published.
STRAITS AND ENTRANCES.		
San Diego entrance	Complete survey	Sketch
San Francisco entrance	do	Preliminary chart
Karquines straits	Topographical survey	Preliminary chart, (on chart of San Pablo bay.)
Mare Island straits	Complete survey	Preliminary chart, (on chart of San Pablo bay.)
Umpquah River entrance	Hydrographic survey	Sketch
Columbia River entrance	Complete survey	Preliminary chart
Admiralty inlet	Reconnaissance	Sketch
Canal de Haro and Straits of Rosario	do	do
RIVERS.		
Santa Clara river	Topographical survey	
Salinas river	do	
Pajaro river	do	
San Antonio creek	Complete survey	
Petaluma creek	Topographical and hydrographic survey	Preliminary chart, (on chart of San Pablo bay.)
CITIES AND TOWNS.		
San Diego	Complete survey	Sketch
Santa Barbara	do	do
City of Monterey	do	do
City of San Francisco	do	Map
Oakland city	do	
San Antonio	do	
Vallejo	do	On chart of San Pablo bay
City of Benicia	do	do do

APPENDIX No. 7.

Statistics of field and office work of the Coast Survey.

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	Total.
Reconnaissance—															
Area, in square miles	9,642	1,140	3,739	1,830	2,950	3,940	10,159	3,280	3,512	1,706	1,708	795	1,487	4,072	49,950
Parties, number of	15	2	4	5	5	7	7	4	4	6	5	13	7	5	89
Base lines—															
Primary, number of	1	....	....	....	1	1	1	1	....	....	2	....	2	....	9
Secondary, number of	2	....	1	....	2	1	3	3	3	4	4	2	8	8	43
Length of, in miles	19¼	16	6½	....	9¼	13	9¾	17½	2	4½	18½	3¾	24¼	9½	154⅛
Triangulation—															
Area, in square miles	9,076	795	2,166	1,185	1,903	2,952	4,091	2,097	2,465	1,703	3,089	2,701	2,729	2,793	39,745
Extent of coast line, miles	310	....	....	....	....	....	149	305	117	224	154	313	375	370	2,317
Extent of shore line, miles	3,215	....	....	....	....	....	620	902	694	900	888	1,577	1,270	1,010	15,287
Horizontal angle stations	750	120	80	197	120	98	204	157	184	223	224	204	410	544	3,515
Points determined	1,183	147	148	372	194	227	....	....	307	446	346	388	584	1,240	6,195
Vertical angle stations	15	2	5	7	3	1	18	13	22	14	7	89	6	1	203
Elevations determined	44	12	7	46	44	1	....	....	53	66	9	127	6	12	508
Parties, number of	24	5	7	10	8	10	21	18	14	18	16	18	20	20	209
Astronomical stations—															
For azimuth	9	8	2	2	3	3	4	4	6	6	9	5	4	2	67
For latitude	9	8	5	3	8	2	5	8	8	17	20	6	4	6	109
For longitude	1	1	....	2	3	3	5	6	7	18	21	4	1	1	73
Longitude stations, permanent	....	1	1	2	1	1	1	2	5	5	5	4	3	1	32
Parties, number of	6	3	2	2	3	3	10	5	6	4	7	7	6	4	68
Magnetic stations	....	14	21	28	19	6	11	9	10	8	13	9	8	23	179
Parties, number of	....	2	3	3	6	3	8	4	2	5	9	6	5	3	59
Topography—															
Area, in square miles	6,292	163	567	647	730	585	352	292	568	601	551	523	532	721	13,054
Length of shore line, miles	7,582	521.7	913.6	1,302.7	1,781	1,405	955	768	722	1,301	1,468	1,613	1,356	1,861	23,550
Length of roads, in miles	12,905	691.1	1,023.8	1,157.6	1,241	916.7	264	....	....	....	....	....	....	787	22,002
Parties, number of	....	....	....	....	....	....	11	11	12	15	14	15	14	32	124
Hydrography—															
Parties, number of	....	....	....	....	....	....	9	10	10	9	10	11	11	20	90
Soundings, number of	808,147	120,827	125,173	220,402	228,402	255,398	265,824	264,323	371,660	288,375	305,377	162,454	526,875	439,614	4,382,851
Soundings in Gulf Stream for temperature	....	....	....	681	....	729	....	24	21	....	....	260	137	137	1,989
Tidal stations occupied	108	16	24	40	34	28	32	27	26	56	100	71	104	103	769
Tidal parties, number of	....	2	5	5	4	5	12	11	7	5	6	4	3	17	86
Current stations occupied	....	27	....	....	....	....	28	44	41	21	89	10	84	84	628
Current parties, number of	....	....	....	....	....	....	....	2	3	3	3	2	1	2	16
Specimens of bottom	1,327	2,257	89	100	338	678	286	292	305	252	105	34	253	161	6,477
Topographical maps, original	166	14	16	21	28	20	20	21	38	29	34	47	77	45	576

Hydrographic maps, original	127	9	8	20	20	19	12	13	47	25	49	57	60	58	524
Reductions from original sheets	15	9	15	16	17	13	7	24	208	174	133	128	168	39	155
Sketches made in field and office	311	24	33	32	29	48	....	....						125	602
Total number of manuscript maps	619	59	72	89	94	100	42	72	255	228	216	232	305	267	2,643
Records of triangulation, original volumes	97	12	17	23	17	32	38	40	33	33	64	46	79	96	627
Records, astronomical observations, original vols	17	10	11	10	16	22	69	30	41	48	29	88	35	12	438
Records, magnetic observations, original volumes	4	2	1	6	7	4	3	5	5	7	6	4	33	13	100
Records, duplicates of the above	27	26	32	32	44	49	19	23	45	73	76	84	139	101	770
Computations, number of volumes	78	25	17	21	26	23	57	24	40	72	101	91	109	99	783
Hydrographic volumes, original—															
Soundings and angles	188	22	26	152	54	154	134	172	213	206	183	66	332	197	2,099
Duplicates of the above	28	2	5	4	11	11	12	12	16	27	15	7	26	27	203
Tidal and current, original	127	23	47	51	44	40			114	139	123	70	196	110	12,64
Duplicates of the above	....	23	47	51	44	40	63	62	385	132	114	79	87	100	1,111
Tidal reductions, volumes	....	46	94	102	88	80			22	26	6	81	60	52	445
Total volumes of original records	566	191	297	452	351	456	395	424	914	763	717	616	1,096	807	8,045
Library, number of volumes	....	....	....	....	....	655	95	590	333	171	273	155	250	389	2,911
Engraved plates of maps, number	5	2	3	5	3	5	11	10	6	3	4	....	8	4	69
Electrotyped plates, number	....	....	....	....	1	7	6	25	18	23	47	77	50	69	323
Published maps, number of	....	4	1	3	3	8	9	6	6	5	5	9	1	6	66
Printed sheets of maps distributed	....	169	416	1,708	1,104	2,923	1,848	326	5,649	5,799	8,042	5,195	5,392	8,858	47,429
Printed sheets of maps with sale agents	....	....	880	1,686	4,981	5,016	1,506	3,115	5,168	6,866	4,375	3,232	2,577	2,898	42,400
Instruments, cost of	....	....	....	....	....	....	$8,326	$4,652	$4,603	$3,835	$5,296	$5,402	$3,958	$5,369	$41,441

APPENDIX No. 8.

General list of coast survey discoveries and developments to 1856, *inclusive.*

1. Determination of the position of a sunken rock, on which the steamer Daniel Webster struck, in Casco bay, on the evening of the 13th of October, 1856.

2. Determination of the dimensions of Alden's Rock, near Cape Elizabeth, Maine, 1854.

3. Determination of rocks off Marblehead and Nahant, 1855.

4. A rock (not on any chart) in the inner harbor of Gloucester, Massachusetts; discovered in 1853.

5. A bank, ninety miles eastward of Boston, with about thirty-six fathoms of water, probably a knoll connected with Cashe's ledge, but with deep water between it and the ledge, 1853.

6. Boston harbor; Broad Sound channel thoroughly surveyed, and marks recommended, 1848.

7. Several rocks in the fair channel way in Boston harbor entrance, 1854.

8. A bank, (Stellwagen's Bank,) with ten and a half to fourteen and a half fathoms of water on it, at the entrance to Massachusetts bay, and serving as an important mark for approaching Boston and other harbors, 1854.

9. Extension of Stellwagen's Bank to the southward and eastward some sixteen or seventeen square miles, enclosed by the twenty-fathom curve, 1855.

10. A dangerous sunken ledge (Davis' ledge) to the eastward, and in the neighborhood of Minot's ledge, 1854.

11. Development of a reef extending between Minot's and Scituate light, 1856.

12. A sunken rock, with only six feet on it at low water, off Webster's Flag Staff, Massachusetts bay, 1856.

13. A dangerous rock, near Saquish Head, entrance to Plymouth harbor, 1856.

14. Three rocks determined in position, partly bare at low water, off Manomet Point, Massachusetts bay, 1856.

15. Determination of a very dangerous rock off Indian Hill, and four miles southward of Manomet Point, Massachusetts bay, with as little as six feet water on it, 1856.

16. Probable connection of George's Bank and the deep sea banks north and east of Nantucket, 1855.

17. Non-existence determined of "Clarke's Bank" and "Crab Ledge," laid down on certain charts as distinct from an immense shoal ground off Cape Cod peninsula, 1856.

18. Nantucket shoals; Davis' New South shoals, six miles south of the old Nantucket south shoals, in the track of all vessels going between New York and Europe, or running along the coast from the eastern to the southern States, or to South America; discovered in 1846.

19. Two new shoals, north and east of Nantucket, discovered in 1847.

20. Six new shoals near Nantucket; the outermost fourteen and a half miles from land, and with only ten feet water; discovered in 1848.

21. McBlair's shoals, off Nantucket, discovered in 1849.

22. The tidal currents of Nantucket shoals and the approaches, 1854.

23. Davis' Bank, Nantucket shoals, discovered in 1848, and survey finished in 1851.

24. Fishing Rip, a large shoal extending north and south, about ten miles to the eastward of Davis' Bank, and thirty miles from Nantucket, with four and a half fathoms; surveyed in 1852.

25. A ridge connecting Davis' New South shoal and Davis' Bank; found in 1853.

26. A small bank or knoll, with but five fathoms on it, about five miles east of Great Rip, with twelve fathoms between it and Davis' Bank and Fishing Rip, the water gradually deepening outside of it to the northward and eastward, beyond the limits of the series of shoals.

27. Discovery of Edwards' shoal, one mile and seven-eighths southward of Nantucket light-boat, 1855.

28. Examination of the interference tides of Nantucket and Martha's Vineyard sounds, 1855.

29. Contraction of the inlet at the north end of Monomoy island, and opening of new entrance to Chatham harbor, 1853.

30. Muskeget channel, surveyed by Lieutenant C. H. Davis in 1848 and Lieutenant C. H. McBlair in 1850.

31. Discovery of two shoal spots, with twelve and thirteen feet water, eastward from Great and Little Round shoals, Nantucket sound, 1856.

32. Determination of two shoal spots near the northern extremity of Davis' Bank, with fourteen and eighteen feet water, 1856.

33. Further development of Edwards' shoal, three-fourths of a mile from the Southern Cross Rip, Nantucket sound, 1856.

34. Shoal sand ridges discovered northward of Great Point light, Nantucket sound, 1856.

35. Important changes in geographical feature at the southeastern end of Martha's Vineyard, Muskeget channel, 1856.

36. Numerous rocks in Martha's Vineyard sound, Long Island sound, and the various bays and harbors connected with them.

37. The tidal currents of Long Island sound, 1854.

38. The currents of the great bay between Massachusetts, Rhode Island, Connecticut, New York, and New Jersey, 1855.

39. Gedney's channel into New York bay, having two feet more water than the old channels. Had the true depth of this channel been known in 1778, (then probably existing, as seen by comparing old and new charts,) the French fleet under Count D'Estaing would have passed into the bay and taken the assembled British vessels.

40. The changes in New York harbor, near New York city, between 1845 and 1856.

41. Increase of depth in Buttermilk channel, ascertained and made known in 1848, by survey of Lieutenant D. D. Porter, United States Navy.

42. Shoal in the main ship channel of New York harbor, 1855.

43. The tides of Hudson river, 1856.

44. Sandy Hook. Its remarkable increase traced from the surveys of the topographical engineers and others, and by several successive special surveys made between 1844 and 1856.

45. Delaware bay; Blake's channel at the entrance, discovered in 1844; open when the eastern channel is closed by ice. This discovery has served to develop strikingly the resources of that portion of Delaware.

46. Blunt's channel, in Delaware bay.

47. Changes in the Delaware, near the Pea Patch.

48. The true extent and position of the dangerous shoals near Chincoteague inlet, Virginia, 1852.

49. Metomkin inlet, Virginia, shoaling from eleven to eight feet in the channel during 1852.

50. Two channels into Wachapreague inlet, Virginia; one from the northward and the other from the eastward, both with seven feet water at low tide, 1852.

51. A shoal half a mile in extent, not put down on any chart, $5\frac{1}{2}$ miles east from the north end of Paramore's island, Virginia; it has but four fathoms water on it and nine fathoms around it, 1852.

52. Great Machipungo inlet, Virginia; found to have a fine wide channel with eleven feet water on the bar at low ebb, and fourteen at high tide; good anchorage inside in from two to eight fathoms; the best harbor between the Chesapeake and Delaware entrances, 1852.

53. Two shoals near the entrance to the Chesapeake, one of $4\frac{3}{4}$ nautical miles SE. by E. from Smith's Island light-house, with seventeen feet water upon it; the other E. by S. nearly $7\frac{3}{4}$ miles from the same light, with nineteen and half feet upon it, 1853.

54. Only three feet water upon the "Inner Middle," the shoal part of the Middle Ground, west of the "north channel," at the Chesapeake entrance, 1852.

55. A twenty-five fathom hole $2\frac{1}{2}$ miles W.SW. from Tazewell triangulation point, eastern shore of the Chesapeake; all other charts give not more than sixteen fathoms in this vicinity.

56. A shoal at the mouth of the Great and Little Choptank, in Chesapeake bay, 1848.

57. The bars in Rappahannock river, 1855.

58. The general permanence of the Bodkin channel, and shoals in its vicinity, at the entrance of the Patapsco river, between 1844 and 1854.

59. A shoal (New Point shoal) in Chesapeake bay, with sixteen feet water on it, southeast from New Point Comfort light-house, off Mobjack bay, 1854.

60. Re-examination of York Spit, Chesapeake bay, and least water determined (nine feet,) 1855.

61. A reconnaissance of the Wimble shoals, near Nag's Head, coast of North Carolina, 1854.

62. Sub-marine range of hills beyond the Gulf Stream, tracked from Cape Florida to Cape Lookout, 1855.

63. Deep water found on Diamond shoal, and a dangerous nine feet shoal off Cape Hatteras, 1855.

64. A new channel, with fourteen feet water, into Hatteras inlet, formed during the year 1852, which is better and straighter than the old channel.

65. The well ascertained influence of prevailing winds in the movement of the bars at Cape Fear and New Inlet entrances, and the gradual shoaling of the main bar; the latter fact being of great importance to the extensive commerce seeking this harbor, 1853.

66. Changes in the main Western and New Inlet channels in Cape Fear, 1855.

67. Frying Pan shoals, off Cape Fear, North Carolina; a channel of $2\frac{1}{2}$ fathoms upwards of a mile wide, distant eleven nautical miles from Bald Head light-house, across the Frying Pan shoals. A channel extending from three to four miles from the point of Cape Fear to 8 or $8\frac{1}{2}$ miles from it, with sufficient water at low tide to allow vessels drawing from nine to ten feet to cross safely. A channel at the distance of fourteen nautical miles from Bald Head light-house, one mile wide, with $3\frac{1}{2}$ to seven fathoms water on it. The Frying Pan shoals extend twenty nautical miles from Bald Head light-house, and 16, 17 and 18 feet water is found 17 and 18 nautical miles out from the light, 1851.

68. Shoaling of Cape Fear river bar thoroughly examined for purposes of improvement, 1852.

69. The general permanence in depth on the bar of Beaufort, North Carolina, with the change of position of the channel, 1854.

70. Changes at the entrance of Winyah bay and Georgetown harbor, and the washing away of Light-House Point, at the same entrance, 1853.

71. Maffitt's new channel, Charleston harbor, with the same depth of water as the ship channel, 1850.

72. The changes in Maffitt's channel, Charleston harbor, South Carolina, from 1852 to 1856.

73. Changes in the main ship channel, Charleston harbor, 1855.

74. Changes in the channels at the entrance of Charleston harbor, 1852.

75. The remarkable discovery of continuous deep-sea soundings off Charleston, and of soundings in the depth of between four and five hundred fathoms beyond the Gulf Stream, 1853.

76. Development of the changes affecting the entrance to North Edisto river, S. C., 1856.

77. Discovery of a new channel between Martin's Industry (shoal) and the southeast breakers, Port Royal entrance, S. C., 1856.

78. Discovery of cold water at the bottom of the ocean below the Gulf Stream, along the coasts of North and South Carolina, Georgia, and Florida, 1853.

79. The discovery of the cold wall, alternate warm and cold bands, and various other features of the Gulf Stream, especially such as concern its surface and deep-sea temperatures and its distribution relative to the shore and bottom of the ocean.

80. Various facts relative to the distribution of minute shells on the ocean bottom, of probable use to navigators for recognizing their positions.

81. Examination of Doboy, St. Simon's and Cumberland entrances, 1855.

82. Hetzel shoal, off Cape Canaveral, Florida, 1850.

83. Temperature of 34° beneath the Gulf Stream, thirty-five miles east of Cape Florida, at a depth of three hundred and seventy fathoms, 1855.

84. A harbor of refuge, (Turtle harbor,) to the northward and westward of Carysfort light-house, Florida reef, with a depth of water of twenty-six feet at the entrance, 1854.

85. A new passage, with three fathoms water, across Florida reef to Legaré harbor, under Triumph reef, (latitude 25° 30′ N. longitude 80° 03′ W.,) which, if properly buoyed, will be valuable as a harbor of refuge.

86. A safe rule for crossing the Florida reef near Indian Key, 1854.

87. A new channel into Key West harbor, 1850.

88. Co-tidal lines for the Atlantic coast of the United States, 1854.

89. Isaac shoal, near Rebecca shoal, Florida reef, not laid down on any chart, 1852.

90. Channel No. 4, a northwest entrance into Cedar Key's bay, 1852.

91. Directions for entering the harbor from Crystal River offing, western coast of Florida peninsula, 1856.

92. Mobile bay entrance bar, in 1832, only seventeen feet at low water could be carried over it; in 1841, it had nineteen, and in 1847, it had twenty feet and three quarters, as shown by successive surveys, 1847.

93. The diminution, almost closing, of the passage between Dauphine and Pelican islands, at the entrance of Mobile bay, 1853.

94. Horn Island hancnel, Mississippi sound.

95. The removal of the East Spit of Petit Bois island, in the hurricane of 1852, opening a new communication between the Gulf and Mississippi sound, and the rendering of Horn Island pass more easy of access by the removal of knolls, 1853.

96. The accurate determination of Ship shoal, off the coast of Louisiana, in connexion with the site for a light-house, 1853.

97. An increase of depth of water on the bar of Pass Fourchon, Louisiana, 1854.

98. Deep-sea soundings in the Gulf of Mexico, 1855–'56.

99. Tidal phenomena of the Gulf, 1855.

100. The changes at Aransas Pass, Texas, as bearing on the question of a light-house site, 1853.

101. Co-tidal lines of the Gulf of Mexico, 1856.

102. On the effect of wind in disturbing the tides of the Gulf of Mexico, 1856.

103. Development of a bar at the entrance of San Diego bay, California, 1856.

104. A shoal inside of Ballast Point, San Diego bay, with only twelve and a half feet of water; not laid down on any chart, 1852.

105. The determination of the position and soundings on Cortez Bank, off the coast of California, 1853.

106. Complete hydrographic survey and determination of a point of rock on Cortez shoal, 1856

107. Determination of Uncle Sam Rock, 1855.

108. Investigation of the currents of Santa Barbara channel, 1856.

109. Red sand, marking the inner entrance to the Golden Gate, 1855.

110. Channel sounded out between Yerba Buena and the Contra Costa, San Francisco bay, 1855.

111. Further development of the extent of Commission Rock, San Pablo bay, 1856.

112. Changes in the channel entrance of Humboldt bay or harbor, California, 1852 and 1853.

113. South channel, Columbia river, surveyed and made available to commerce, 1851.

Changes of channels, their southward tendency, and a new three fathom channel from Cape Disappointment, due west, to open water, Columbia entrance, 1852; further changes, 1853.

114. The depth of water on the bars at the entrance of Rogue river and Umpquah river, Oregon, 1853.

115. A shoal at the the entrance to the straits of Rosario, Washington Territory, giving good holding ground in thirty-three feet, 1854.

116. Boulder reef, northwest of Sinclair island, Rosario strait, partly bare at unusually low tides, and surrounded by kelp, 1854.

117. Belle Rock, in the middle of Rosario strait, Washington Territory, visible only at extreme low tides, 1854.

118. Entrance Rock, at the entrance of Rosario strait, 1854.

119. Unit Rock, in the Canal de Haro, Washington Territory, 1854.

120. A five fathom shoal in the strait of Juan de Fuca, between Canal de Haro and Rosario strait, 1854.

121. The non-existence of two islands at the northern entrance of Canal de Haro, laid down on charts, 1854.

122. The non-existence of San Juan island, usually laid among the Santa Barbara group, 1854.

123. Tides of San Diego, San Francisco and Astoria, 1854.

124. Co-tidal lines of the Pacific coast, 1855.

125. Various surveys and charts of small harbors on the Pacific, and a continuous reconnaissance of the entire western coast and islands adjacent, a great part of which was imperfectly known.

ADDITIONAL LIST FOR 1857.

1. Temple's Ledge, near Cape Small Point, Maine.
2. Changes in the vicinity of East Harbor, (Cape Cod.)
3. The decrease of depth, with general permanence of form of George's Bank off the coast of Massachusetts.
4. A shoal spot near Little George's Bank.
5. The study of the tidal currents of the Vineyard and Nantucket sounds.
6. The tidal currents of Hell Gate.
7. Least water on the Hell Gate rocks, determined by dragging.
8. Notice of the most recent changes in New York bay and harbor.
9. York river, Virginia, as a harbor.
10. Changes at Hatteras and Ocracoke inlet.
11. Changes on the bar of Beaufort, N. C.
12. Changes of the Cape Fear bars and channels.
13. Rules for navigators in regard to the tidal currents of the coast.
14. Heights of the tides of the Atlantic coast.
15. A shoal inside of the entrance to Amelia river, Florida.
16. Allen's Bank, Admiralty Inlet, W. T.
17. Winds of the western coast of the United States.

APPENDIX No. 9.

Letter of the Superintendent to the Secretary of the Treasury, communicating the discovery of a ledge off Cape Small Point, Maine, by Lieut. Comg. W. G. Temple, U. S. N., assistant in the Coast Survey.

BANGOR, MAINE, *September* 16, 1857.

SIR: I have the honor to report to you that during the operations of the present season on the coast of Maine the hydrographic party under the charge of Lieut. Comg. Wm. G. Temple, U. S. N., assistant in the Coast Survey, discovered a new ledge, which does not appear upon any chart yet published, and is unknown to any of the pilots or fishermen in the vicinity. It has a depth of thirty feet on it at mean low water, and lies W. S. W. ¾ W. (W. ¼ S. per compass) from Seguin light-house, distant five and a half (5½) nautical miles, in latitude 43° 41′ north and longitude 69° 52′ west. I propose to call it "Temple's Ledge," after the discoverer.

I would respectfully request authority to publish this communication in the usual form, as a notice to mariners.

Very respectfully, yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

Cross bearings for finding Temple's Ledge.

Bring the southern end of Fuller's (or Glover's) Rock on with the northern end of Seguin island, and the eastern ends of Brown Cow and Mark island (flag tree) in range.

APPENDIX No. 10.

Report of Assistant H. L. Whiting on the topographical resurvey of Provincetown harbor, Mass., and development of changes of shore line in its vicinity.

WEST TISBURY, MASS., *December* 15, 1857.

DEAR SIR: I report herewith the result of my resurvey of Provincetown harbor, Cape Cod. A careful resurvey of the entire shore of the Cape has been made from the Highland light in Truro, continuing around the outside shore to the Race Point light, thence to Long Point light and along the inner shore of the harbor, including a resurvey of the wharves and shore line at Provincetown, and extending past East Harbor to Pond village in Truro, nearly opposite to the Highland light. This work comprises about twenty miles of shore line.

The general changes in the actual shore line are not remarkable; in fact, the general line of the shore is almost what it was in 1849. The wind has gradually blown away the sand hills, however, and the effect has been to drive the sand in upon the Cape. At Race Point considerable change has taken place. The opening of Race Run has worked nearer to the Point, and the action of the storms and the sea has been such as to beat in the beach. The shore has also considerably altered in shape, showing some change in the action of the currents and tide.

The opening at Lance's harbor (so called) between Race Point and Long Point has closed, and for an extent of two and a half or three miles the beach has been driven in from a hundred to three hundred feet.

At Long Point the sand has accumulated and the solid fence, which was built some years since from the main beach of Long Point or "Wood End" to the small sand spit or island upon which the light-house stood in 1849, has caused quite a strip of beach to be thrown up on either side of it, so that now the highest tides never overflow it. During the last summer a crop of beach grass was started upon this ridge of sand. Not only along the fence—an increased deposit of sand seems to have been made at the extremity and on the outside shore of Long Point.

From Long Point no change seems to have occurred along the town shore excepting about East Harbor inlet. This has changed considerably, and a strong tidal current through the opening is wearing away the shores of the creek and lagoon called East Harbor. I am informed that a great quantity of sand is carried out by the ebb tide and deposited in the main harbor, and that the flats and shoal water in this part of the harbor are constantly increasing. There has certainly been much shifting of sand about the inlet. The main channel of the creek has changed its course in one place, and cut into a drift sand hill, about forty feet in height, some three hundred feet since the survey of 1849.

The most important change, however, as regards the probable consequences, if means are not taken to prevent them, is in the outside beach opposite the "head of the meadow," a tract of marsh through which the East Harbor creek winds. This marsh extends nearly to the outside shore, leaving only a low and narrow strip of beach connecting the high ground of Truro with the peninsula of Provincetown.

Opposite to the marsh and lower portion of beach the sea has encroached more from the outside than at any other place between the Highland light and Race Point. There is one point at which a cove of marsh made up from the inside, and in 1849 came within about three hundred feet of the outside shore. The beach here was, however, about forty feet high, presenting a bluff of sand towards the outside shore. This beach is now only about a hundred feet wide and from twelve to fifteen feet high. The sea, I believe, broke over it during a violent storm last winter.

The difference of the level of tide between the outside and inside of the peninsula at the same time is very considerable, perhaps not less than four or five feet even at the mouth of East Harbor, and at the "head of the meadow" probably the *whole tide*, so that if the sea should once form a channel through the beach it would flow into the creek and rush through into the harbor with great force. The effect would be most disastrous to the harbor, such as probably to change its character, or perhaps entirely destroy it. * * * * Attention should be given to the condition of this shore *at once*, and the importance urged of immediate measures to guard against the consequences of the sea breaking through this narrow strip of beach. * * * * * * *

Very respectfully, yours,

HENRY L. WHITING,
Assistant Coast Survey.

Prof. A. D. BACHE,
Superintendent Coast Survey.

APPENDIX No. 11.

Letter to the Secretary of the Treasury, communicating extracts from a report by Lieutenant Commanding C. R. P. Rodgers, U. S. N., assistant Coast Survey, in relation to the gradual decrease in the depth of water on George's Bank.

BANGOR, MAINE, *October* 17, 1857.

SIR: I have the honor to communicate to the Department the result of a development made by Lieutenant Commanding C. R. P. Rodgers, U. S. N., assistant in the Coast Survey, showing a gradual decrease in the depth of water on the shallowest part of George's shoal, off the coast and eastward of Cape Cod peninsula. The examination was made under favorable circumstances, on the 10th of September, and the results are thus reported by Lieutenant Commanding Rodgers:

"George's shoal seems to consist of narrow sand ridges (like those at the entrance of Nantucket sound) lying parallel to each other, in a direction generally north and south, though some incline to the eastward and westward. The tide rushes across them with great violence."

"We kept the steamer over the crests of these ridges, and, aided by our experience of last year, probably found the most shallow spot, where the soundings, reduced to mean low water, show a depth of only thirteen feet, or two feet less than the least found in the year 1837. The least water found differed only some seconds, either in latitude or longitude, from that found by Captain Wilkes, in his examination of the shoal twenty years ago."

I would respectfully request authority to publish this communication, as a notice to mariners.

Very respectfully, yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 12.

Letter of the superintendent to the Secretary of the Treasury, communicating the discovery of a small shoal southward and westward of Little George's Bank, by Lieutenant Commanding C. R. P. Rodgers, U. S. N., assistant in the Coast Survey.

BANGOR, MAINE, *September* 12, 1857.

SIR: I have the honor to report that, on the 28th of August, a small shoal lying southward and westward of Little George's Bank, off Cape Cod peninsula, was discovered by Lieutenant Commanding C. R. P. Rodgers, U. S. N., assistant in the Coast Survey.

A storm prevailing at the time, the hydrographic party engaged in the steamer Bibb was unable to anchor, but passed repeatedly over the shoal, finding only six fathoms on its crest, which is very small, and a depth of twenty fathoms surrounding it. Its approximate position, determined under the circumstances just referred to, is latitude 41° 10′ 48″ N., longitude 68° 25′ 48″ W.

In bearing up for Gloucester harbor during the storm the mainmast of the Bibb was lost, but will be replaced without delay, and the earliest opportunity taken to re-examine and verify the position of the shoal.

I would respectfully request authority to publish this communication in the usual form, as a notice to navigators.

Very respectfully, yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 13.

Report of Lieutenant Commanding W. G. Temple, U. S. N., assistant Coast Survey, stating the results of an examination made to determine the least water on the rocks at Hell Gate, East river, New York.

COAST SURVEY STEAMER CORWIN,
New York, September 18, 1857.

SIR: I have to report that the operation of "*sweeping,*" in order to determine the least water on the several rocks of Hell Gate, has been satisfactorily accomplished by the party under my command.

The results, when reduced to mean low water, will not differ materially from the following:

On Pot Rock	18	feet.
On Way's Reef	13	"
On Sheldrake Rock	17	"
On Frying Pan	9½	"
On Heel Tap Rock	10	"

The process adopted was to lay one of our large sounding boats broadside to the current at nearly slack water, with a loaded pole twenty-four feet in length suspended horizontally by lead lines from the bow and stern, and in that position to allow her to drift slowly over the rocks, always keeping the pole just touching the bottom. At the instant of finding the shoalest water the position of the boat was carefully determined, and the operation was repeated until the whole vicinity had been thoroughly *swept*.

I feel confident that the results will show the least water that can be found in that locality.

Respectfully,

WM. G. TEMPLE,
Lieut. Com'g U. S. N., Assis't Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 14.

Report of Lieutenant Commanding W. G. Temple, U. S. N., assistant Coast Survey, on the examination of a locality in New York bay, containing a portion of wreck.

COAST SURVEY OFFICE,
Washington, D. C., December 4, 1857.

SIR: In accordance with your directions I have visited New York, and made inquiry of several persons relative to a wreck lodged in the lower bay. Having obtained the information requisite, I proceeded to the spot and swept carefully over every foot of ground within a hundred yards of the buoy which has been placed to mark the site.

From this examination I am able to reiterate the substance of my former report, that no bank whatever exists in that vicinity, but a small portion of the wreck, not more than eight or ten feet in extent, remains at a distance of about twenty yards southeast from the buoy. A loose spar is attached to this fragment, and at slack low water it may be seen "watching" as a buoy. During the strength of the tide this spar is carried under, so that vessels drawing not more than fifteen or eighteen feet might touch it in passing over the spot, giving the impression that no more than that depth of water covered the solid part of the wreck. This impression, however, would be erroneous, as there is a depth of twenty-three feet at mean low water, and the soundings deepen at once to thirty-three feet all around it.

Respectfully,

WM. G. TEMPLE,
Lieut. Com'g U. S. N., Assis't Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 15.

Extracts from the report of Commander W. T. Muse, U. S. N., assistant in the Coast Survey, relative to changes at the bars of Hatteras and Ocracoke inlets, N. C.

NOVEMBER 25, 1857.

DEAR SIR: * * * * * * * * * *

The bar at Hatteras inlet has probably shifted a little. There is a small harbor inside, in which vessels can find anchorage in two fathoms water, well secured from heavy seas, but not at all sheltered from the wind. Between this harbor and Pamplico Sound there is an extensive bulkhead, over which vessels drawing more than seven feet cannot always pass. Were this cut through it might close again in the course of a month, and might also injuriously affect the bar. * * * * * * * * * * *

The water on the bar at Ocracoke has decreased at least two feet since the last survey, (1852.) That gives eleven feet, but we were unable, with the greatest care, to find more than nine feet. In order to be as accurate as possible, one of the pilot boats was employed, with a crew of pilots, under a strong desire to find my first impression wrong, but without avail.

The fears in regard to the filling up of the channel, of which there are some indications at present, will probably be realized at no distant day. It would be a matter of great regret if a convenient access to the sea should be denied to the rich back country, as its inhabitants have begun in earnest to develop its resources, which go to show that as an agricultural district it is perhaps not excelled. Nature, while it seems to sport with their hopes and fears, will probably never debar them from direct communication with the ocean. If the present channel closes, I think there are indications that another would open more to the northward and eastward.

I am satisfied that science might devise some expedient for opening and maintaining a seaward communication for this country. * * * * * * *

Very respectfully, your obedient servant,

W. T. MUSE,
Commander U. S. N., Assis't Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 16.

Extracts from the report of Lieutenant Commanding C. R. P. Rodgers, U. S. N., assistant in the Coast Survey, showing the results of a resurvey of the bar and anchorage at Beaufort, N. C.

U. S. SURVEYING STEAMER BIBB,
Navy Yard, New York, May 20, 1857.

SIR : * * * * * * * * * * *

The greatest depth that can be carried into the harbor of Beaufort, N. C., through the main channel at mean low water, is now, as it was in 1854, fifteen and a half feet; but since that year the bar has extended towards the westward, while the southern breakers lie further to the north ; so that we found from three to six feet water where the survey of 1854 shows from twenty to twenty-three feet. The deepest water is now nearer the Shackleford Bank.

The whole of the main channel, from the bar to the anchorage, has become narrowed, and off the southwest end of Shackleford Bank there is at present from four to fourteen feet, where in 1854 the soundings gave from twenty-seven to thirty feet.

A new channel across the breakers of 1854 seems to be forming to the westward of the main ship channel, from which it turns at the southwest end of Shackleford, and runs into the open sea, in a direction a little to the westward of south. Through it ten and a half feet may now be carried at low water.

In 1854 there was a slue to the northward and westward of it, through which eight feet could be carried, but this is now entirely closed by breakers with from three to seven feet water, where there was a depth of more than twenty feet three years ago.

It seems probable that this new channel will deepen, and it is not unlikely that it may at some future day become the chief entrance to the harbor.

* * * * * * * * * * * *

I am, very respectfully, your obedient servant,

C. R. P. RODGERS,
Lieutenant U. S. N., Assistant Coast Survey.

Professor A. D. BACHE,
Superintendent U. S. Coast Survey, Washington, D. C.

APPENDIX No. 17.

Report of Lieutenant Commanding J. N. Maffitt, U. S. N., Assistant Coast Survey, showing the result of a re-examination of the bars and entrances to Cape Fear river, North Carolina.

UNITED STATES SCHOONER CRAWFORD,
Charleston, December 19, 1856.

SIR: I herewith enclose a tracing showing the result of the re-examination of the Cape Fear bar, made in accordance with your instructions of September last. From a comparison of the present survey with that of 1851 it would appear that the progressive deterioration of this bar within the period of five years included within the recent and previous examination by the Coast Survey, and for an interval prior, as derived from other authority, has at length reached such a point that, for all essential purposes of navigation, the old main bar channel has ceased to exist.

The eighteen feet curve, from abreast of Bald Head Point, extends five hundred and eighty yards less to seaward than it did in 1851. The twelve feet curve has contracted, in the same direction, sixty-six yards. The Fingers have become connected with Marshall's shoal, and where, in 1851, there was nine, ten, and eleven feet in the channel, but five, four, and three feet at present can be obtained at mean low water. On spring tides, and with a northwesterly wind, this old channel is in many places awash. This entire locality has undergone a total change, and the accumulation of sand is so great that, in all probability, with the continuance of existing causes, the channel will not resume entirely the former passage way to the sea. The deterioration of this bar is, by the pilots and others, now erroneously attributed to the construction of the Bald Head jettees, whereas their erection has already supplied a most important desideratum for protecting the shore of this important locality. So long as a turning point, like Bald Head, is subjected to the abrasion of the current and the consequent transportation of its sand to different parts of the channel, there can be no permanency in its direction or capacity. The security of this point will, undoubtedly, in time, insure the opening of a better and more direct channel. In fact, such are the present indications, as the pocket, or slue, which attracted your attention in 1852, has improved, and now manifests a still greater tendency to communicate freely with the ocean. If I might hazard a suggestion, it would be decidedly in favor of the immediate prolongation of the western Bald Head jettee, with a view of restoring the ancient limits of that point and deflecting the ebb current through what appears a more natural channel, such as is exhibited by Wimble's chart of 1738. The closing of New Inlet would, of course, be an important auxiliary. I incline to the opinion that the present condition of the main bar may be, in part, accounted for by the rapid washing away of Bald Head Point, thereby changing the direction of the channel more to the eastward, and the ebb current, freighted with sand, has, at certain points, (the Fingers, for instance,) encountered an ocean current, which, after an easterly blow, is very rapid to the westward, over Frying Pan shoals. At this point of meeting the ebb is exhausted and the deposit occurs. Of course, the greater the abrasion at Bald Head, the greater the deflection of the channel from its natural course, the more the tidal current would be diffused, and consequently the less would be its scouring power.

The pocket, or slue, has made seaward, and, as it *demonstrates*, through the narrowest part of the bar. An opening here would seem to give promise of a good and safe channel, such as existed in the same place in 1738, prior to the opening of New Inlet and wearing away of Bald Head. The further extension of the jettees towards this opening would unquestionably insure the result desired. It is certain that no injury can be occasioned to the bar by the experiment proposed. The valuable commerce of Wilmington, and interests connecting through that city with a large and wealthy section of the State, demand that prompt attention be given to the improvement of the Cape Fear entrance.

The Coast Survey chart of 1852 gives the following differences on the old bar, as compared with the present examination: The eighteen feet curve has contracted seaward four hundred and ninety yards; the twelve feet curve in the same direction eleven yards; and in the channel way, for instance, where the outer buoys were located with seven, eight, nine, and ten feet between them, but five, four, and three feet *now* exist at mean low water, which change, as compared with the chart of 1851, shows the deterioration to be progressive but irregular. The slue, in 1851, had a *mean* depth of six feet, and the distance from its inner six feet curve to its outer six feet curve was nine hundred and eighty-four yards. The twelve feet curves (outer and inner) were then separated by a distance of fifteen hundred and eighty-six yards. In 1852 an evident improvement had commenced, as will be observed, from the fact that the distance between the inner and outer six feet curves was but four hundred and five yards, a *difference at once* in s *favor* of five hundred and eighty yards, in reference to this particular curve of six feet. The twelve feet curve had not changed, as shown by comparison of the charts of 1851 and 1852. It will be seen by the present chart (1856) that this slue has *continued* to *improve in general capacity* since 1852, the distance between the outer and inner six feet curves being now only two hundred and fourteen yards; and the twelve feet curves are separated by only nine hundred and eighty-four yards, giving thus an extension of the water passage seaward of considerable importance. Reeper's shoal, on its east side, is generally bare at low water. It assists in confining the ebb current to its work of dredging out the slue, and serves at the same time as a breakwater against the influence of the heavy easterly waves; the "Middle Ground" affording the same facilities on the west side. As the *direction* of this anticipated outlet over the narrowest part of the bar is not in positive opposition to the coast ebb and flood current, a deposit, such as has occurred in the old main channel, could not reasonably be anticipated, for the increased capacity of the ebb current by the closing of the new inlet, and all the dredging resources of the river thus concentrated would, as a natural consequence, force the entire bar further seaward into deeper water.

The western channel has undergone but little change. Its present capacity is ten feet at mean low water. On the Rip there is a depth of eight feet, but its fluctuations in direction and depth are very frequent.

Changes occur almost monthly, the Rip being particularly subject to the influence of southerly gales. The pilots are forced to give constant attention, in consequence of its variable character. I am convinced that no improvement could be made in this locality offering the slightest hope of permanency.

The "Middle Ground" has not changed materially since the last survey. The shore line at Bald Head has kept pace with the "jettees," and the "wattling" to the eastward has fulfilled the purpose designed in the accumulation of sand, and the consequent extension seaward of the high water mark.

New Inlet.—The shore line about this inlet has changed remarkably since my former survey, and should be retraced by the plane table. Where the wharf at Zeek's island now stands the Coast Survey chart of 1851 gives fifteen feet ; and so rapid was the accumulation of sand soon after the wharf was constructed, that it ceased to be of use for the landing of materials required for the closing of the slues, and an extension some fifty-five yards further into the channel became necessary. The shore line followed the wharf, and now there is but four feet depth at its outer end. On the Federal Point side, opposite to Zeek's island wharf, the shore has made to the southward some two hundred and twenty yards. New Inlet has narrowed since 1851 about three hundred and seventy-five yards.

The closing of the inlets to the southward of Zeek's island has been successfully accomplished, and the ebb and flood entirely shut off from those former passage ways, the result of which is to feed New inlet with an additional amount of flood. The pilots have conceived the idea that the closing of the two small inlets has been of marked benefit to New Inlet bar. Be that as it may, the bar has certainly undergone noticeable changes, and has increased one foot in mean depth since 1852. The entire channel has shifted to the northward five hundred and fourteen yards since 1851. It now runs where the Middle Ground was in 1851 and 1852. Carolina shoal has followed the shifted channel, and extends eastwardly two hundred and seventy-three yards further than in 1851. The W.S.W. point of the Middle Ground has been washed away for about three hundred and ninety-four yards, and where depths of five and six feet occurred in 1851, twenty and twenty-one feet can now be found.

Federal Point channel has narrowed until it is nearly closed, and at the same time shifted to the northward. New Inlet channel is now, in its narrowest part, between the six feet curves, two hundred and eighty-four yards wide ; in 1851 it was only one hundred and sixty-four yards. In 1851 the narrowest part of the channel, abreast of Zeek's island wharf, from six feet curve to six feet curve, was three hundred and thirty-two yards. At present, in the narrowest part of the same locality, the distance is, from six feet curve to six feet curve, one hundred and ninety-seven yards.

The bulkhead athwart the mouth of New Inlet has undergone some few changes, none, however, of consequence, excepting a prolongation of the southern spit of about one hundred and sixty-four yards, thus lapping entirely the mouth of New Inlet. In reference to the very decidedly improved state of this bar, I am inclined to think it due only to the continuance of recent strong southerly winds; for I have long observed that when the wind blows with violence from the northward and eastward, New Inlet bar decreases in depth, while the western channel and Rip improve. With a continuance of strong southerly winds the converse of this has always been apparent.

I am, very respectfully, your obedient servant,

J. N. MAFFITT,

Lieut. Comg. U. S. Navy, and Assistant Coast Survey.

Prof. A. D. BACHE,

Superintendent U. S. Coast Survey, Washington.

APPENDIX No. 18.

Letter to the Secretary of the Treasury, communicating the discovery and position of a shoal inside of the entrance to Amelia river, Florida, reported by Lieut. Comg. S. D. Trenchard, U. S. N., Assistant in the Coast Survey.

PHILADELPHIA, *November* 25, 1857.

SIR: I have the honor to transmit extracts from a report made by Lieut. Comg. S. D. Trenchard, U. S. N., Assistant in the Coast Survey, relative to the existence of a shoal within the entrance of Amelia river, Florida.

"There is but eight feet upon it at mean low water. It is situated three-quarters of a mile from the entrance of the river, and bears from the centre of Old Fernandina, about northwest, (true,) half a mile distant.

"The examination made of Amelia river in 1855 exhibited shoaler water in this spot than in the channel, and this circumstance induced me last season to inquire of the Fernandina pilots. The existence of the shoal was unknown to them.

"The river, from its entrance to a point above Old Fernandina, was re-examined, the soundings being made closer than in the first survey; but as my chart of the St. Mary's was but recently completed, I found, on a more critical examination of the sheet, even less water than I had supposed." * * * * "I would suggest that the shoal be at once buoyed.

"Measures should be taken for its removal, as, being in mid-channel, its existence would prove a serious obstruction to the navigation of the river."

I would respectfully request that a copy of this letter may be furnished to the Light-house Board.

Very respectfully yours,

A. D. BACHE,

Superintendent U. S. Coast Survey.

Hon. HOWELL COBB,

Secretary of the Treasury.

APPENDIX No. 19.

Extract from a report made to the Superintendent, by Assistant George Davidson, communicating the discovery of a bank near the northern entrance to Colvos Passage, Admiralty Inlet, W. T.

SAN FRANCISCO, CALIFORNIA, *November* 1, 1857.

DEAR SIR: * * * * * * * * *

In the early part of the season I discovered a ten-fathom bank off the northern entrance to Colvos Passage, Admiralty Inlet, W. T. It lies to the southward and eastward of Blake's island,

and its existence having been questioned since calling your attention to the subject in July last, I partially sounded out its locality. The results obtained are represented on a drawing which has been forwarded to the Coast Survey office.

* * * * * * * *

Very respectfully yours,

GEORGE DAVIDSON,
Assistant Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 20.

TIDE TABLES.

For the use of navigators, prepared from the Coast Survey observations, by A. D. Bache, Superintendent.

[Furnished, by authority of the Treasury Department, to E. & G. W. Blunt, New York, and revised January, 1857.]

The following tables will enable navigators to ascertain the time and height of high and low water in some of the principal ports in the United States. The results are approximate, the observations being still in progress, but they may safely be used for practical purposes. The number of places of observation, and the time during which many of them have been made, are steadily on the increase as the Coast Survey advances.

The tides of the coast of the United States, on the Atlantic, Gulf of Mexico, and Pacific, are of three different classes. Those of the Atlantic are of the most ordinary type, ebbing and flowing twice in twenty-four hours, and having but moderate differences in height between the two successive high waters or low waters—one occurring before noon, and the other after noon.

Those of the Pacific coast also ebb and flow twice during twenty-four hours, but the morning and afternoon tides differ very considerably in height; so much so that at certain periods a rock which has three feet and a half water upon it at low tide, may be awash on the next succeeding low water. The intervals, too, between successive high and successive low waters may be very unequal.

The tides of ports in the Gulf of Mexico, west of Cape St. George, ebb and flow, as a rule, but once in twenty-four hours, or are single-day tides. At particular parts of the month there are two small tides in the twenty-four hours. The rise and fall in all these ports is small. East of Cape St. George the rise and fall increases; there are two tides, as a rule, during the twenty-four hours, and the daily inequality, referred to in the Pacific tides, is large.

These peculiarities require a different way of treating the cases, and in some of them separate tables.

I propose to enable the navigator to find, from the Nautical Almanac and the following tables, the time and height of high and low water at any date within the ordinary range of difference produced by winds and other variable circumstances. I will endeavor to divest the matter of unfamiliar technical expressions as far as practicable, though, for shortness sake, some such terms may be employed after defining them. The discussion of the Gulf tides has not been carried so far as to enable me to present the results in as definite a form as the others.

As is well known, the interval between the time of the moon's crossing the meridian (moon's transit) and the time of high water at a given place is nearly constant; that is, this interval varies between moderate limits, which can be assigned. The interval at full and change of the moon is known as the establishment of the port, and is ordinarily marked on the charts. As it is not generally the average of the interval during a month's tide, it is a less convenient and less accurate quantity for the use of the navigator than the average interval which is used on the Coast Survey charts, and is sometimes called the "mean" or "corrected establishment."*

The following table gives the principal tidal quantities for the different ports named in the first column, where they are arranged under specific heads. The third column of the table gives the mean interval, in hours and minutes, between the moon's transit and the time of high water next after the transit; the fourth, the difference between the greatest and least interval occurring in different parts of the month, (lunar.) A simple inspection of this column will show how important it is to determine these changes in many of the ports where they amount to more than half an hour, or to more than fifteen minutes, for the average interval.

The fifth, sixth, and seventh columns refer to the height of the tide. The fifth gives, in feet, the average rise and fall, or average difference between high and low water. The sixth gives the greatest difference, commonly known as the rise and fall of spring tides; and the seventh the least difference, known as the rise and fall of the neap tides.

The average duration of the flood, or rising tide, is given in the eighth column; of the ebb, or falling tide, in the ninth; and of the period during which the tide neither rises nor falls, or the "stand," in the tenth. The duration of flood is measured from the middle of the stand at low water to the middle of the stand at high water, so that the whole duration from one high water to the next, or from one low water to the next, should be given by the sum of the numbers in the eighth and ninth columns.

At most of these places given in the list, a mark of reference has been established for the height of the tide. I have omitted the description of these marks, (except in the following localities,) as of no particular interest in this connection.

BENCH-MARKS.

Boston.—The top of the wall or quay, at the entrance to the dry dock in the Charlestown navy yard, is fourteen feet $\frac{76}{100}$ (or 14.76 feet) above mean low water.

New York.—The lower edge of a straight line cut in a stone wall, at the head of a wooden wharf on Governor's island, is thirteen feet $\frac{97}{100}$ (13.97 feet) above mean low water. The letters U. S. C. S. are cut in the same stone.

Old Point Comfort, Va.—A line cut in the wall of the light-house, one foot from the ground, on the SW. side, is eleven feet (11 feet) above mean low water.

Charleston, S. C.—The outer and lower edge of embrasure of gun No. 3, at Castle Pinckney, is ten feet $\frac{13}{100}$ (10.13 feet) above mean low water.

* This term was introduced by the Rev. Dr. Whewell, who has done so much for the investigation of the laws of the tides.

TABLE I.

Tide table for the coast of the United States.

PORT.	STATE.	INTERVAL BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION.		
		Mean interval.	Difference between greatest and least interval.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Coast from Portland to New York.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*h. m.*
Portland	Maine	11 25	0 44	8.8	10.0	7.6	6 14	6 12	0 20
Portsmouth	N.H.	11 23	53	8.6	9.8	7.2	6 22	6 7	21
Newburyport	Mass	11 22	50	7.8	9.1	6.6	5 16	7 9	24
Salem	Mass	11 13	50	9.2	10.6	7.6	6 19	6 6	6
Boston Light	Mass	11 12	35	9.3	10.9	8.1	6 20	6 6	15
Boston	Mass	11 27	44	10.0	11.3	8.5	6 13	6 13	9
Plymouth	Mass	11 19	51	10.2	11.4	9.0	6 13	6 17	29
Wellfleet	Mass	11 5	1 13	11.2	13.2	9.2	6 6	6 17	15
Provincetown*	Mass	11 22	40	9.2	10.8	7.7	6 16	6 10	21
Monomoy	Mass	11 58	....	3.8	5.3	2.6	6 25	5 59	36
Nantucket	Mass	12 24	37	3.1	3.6	2.6	6 23	5 44	9
Hyannis	Mass	12 22	....	3.2	3.9	1.8	6 44	5 41	9
Edgartown	Mass	12 16	....	2.0	2.5	1.6	6 51	5 29	24
Holmes' Hole	Mass	11 43	31	1.7	1.8	1.3	6 41	5 21	12
Tarpaulin Cove	Mass	8 4	49	2.3	2.8	1.8	6 9	6 17	34
Wood's Hole, north side	Mass	7 59	53	4.0	4.7	3.1	6 51	5 31	38
Wood's Hole, south side	Mass	8 34	45	1.6	2.0	1.2	5 17	7 10	59
Menemsha Bight	Mass	7 45	....	2.7	3.9	1.8	6 14	6 14	4
Quick's Hole, north side	Mass	7 31	1 15	3.7	4.3	2.9	6 31	5 54	39
Quick's Hole, south side	Mass	7 36	1 10	3.1	3.8	2.3	6 29	5 55	40
Cuttyhunk	Mass	7 40	49	3.5	4.2	2.9	6 31	5 54	39
Kettle Cove	Mass	7 48	1 0	4.3	5 0	3.7	6 17	6 4	29
Bird Island Light	Mass	7 59	45	4.4	5.3	3.5	6 51	5 58	....
New Bedford Entrance, (Dumpling Rock)	Mass	7 57	41	3.8	4.6	2.8	6 50	5 33	42
Newport	R. I.	7 45	24	3.9	4.6	3.1	6 21	6 3	23
Point Judith	R. I.	7 32	46	3.1	3.7	2.6	6 12	6 10	1 0
Block Island	R. I.	7 36	41	2.8	3.5	2.0	6 23	6 2	5
Montauk Point, L. I.	N. Y.	8 20	1 11	1.9	2.4	1.8	6 17	6 7	31
Sandy Hook	N. Y.	7 29	47	4.8	5.6	4.0	6 10	6 15	16
New York	N. Y.	8 13	46	4.3	5.4	3.4	6 0	6 25	28
Tarrytown	N. Y.	9 57	58	5.5	4.0	2.7	6 6	6 20	43
Long Island Sound.									
Watch Hill	R. I.	9 0	23	2.7	3.1	2.4	6 35	5 56	14
Stonington	Conn	9 7	30	2.7	3.2	2.2	6 15	6 10	25
Little Gull Island	N. Y.	9 38	1 7	2.5	2.9	2.3	6 1	6 21	37
New London	Conn	9 28	52	2.6	3 1	2.1	5 56	6 26	22
New Haven	Conn	11 16	1 8	5.8	6.6	5.1	6 24	6 5	....
Bridgeport	Conn	11 11	1 3	6.5	8.0	4.7	6 1	6 7	....
Oyster Bay, L. I.	N. Y.	11 7	51	7.3	9.2	5.4	6 8	6 24	....
Sands' Point, L. I.	N. Y.	11 13	31	7.7	8.9	6.4	5 55	6 30	14
New Rochelle	N. Y.	11 22	32	7.6	8.6	6.6	5 51	6 35	12
Throg's Neck	N. Y.	11 20	39	7.3	9.2	6.1	5 50	6 33	43
Coast of New Jersey.									
Cold Spring Inlet	N. J.	7 32	51	4.4	5.4	3 6	6 8	6 18	....
Cape May Landing	N. J.	8 19	47	4.8	6.0	4.3	6 11	6 15	20
Delaware bay and river.									
Delaware Breakwater	Del.	8 00	50	3.5	4.5	3.0	6 15	6 6	26
Higbee's, Cape May	N. J.	8 33	43	4.9	6.2	3.9	6 26	6 0	....

* From Major J. D. Graham's observations.

TABLE I—Continued.

PORT.	STATE.	INTERVAL BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION.		
		Mean interval.	Difference between greatest and least interval.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		h. m.	h. m.	Feet.	Feet.	Feet.	h. m.	h. m.	h. m.
Egg Island Light	N. J.	9 4	51	6.0	7.0	5.1	5 52	6 27	....
Mahon's River	Del.	9 52	48	5.9	6.9	5.0	6 11	6 11	....
New Castle	Del.	11 53	....	6.5	6.9	6.6	5 6	6 43	4
Philadelphia	Pa	13 18	48	6.0	6.8	5.1	4 52	7 6	....
Chesapeake bay and river.									
Old Point Comfort	Va	8 17	50	2.5	3.0	2.0	6 1	6 25	....
Point Lookout	Md	12 58	45	1.4	1.9	0.7	5 59	6 19	35
Annapolis	Md	16 38	40	0.9	1.0	0.8	6 11	6 15	32
Bodkin Light	Md	17 42	48	1.0	1.3	0.8	5 23	7 8	....
Baltimore	Md	18 33	43	1.3	1.5	0.9	5 54	6 33	....
James River, (City Point)	Va	14 14	....	2.6	....	....	5 28	6 52	40
Richmond	Va	16 28	....	2.9	....	....	4 52	7 34	....
Coast of North and South Carolina, Georgia and Florida.									
Hatteras Inlet	N. C.	7 4	57	2.0	2.2	1.8	6 7	6 7	50
Beaufort	N. C.	7 26	50	2.8	3.3	2.2	6 11	6 10	42
Bald Head	N. C.	7 26	34	4.3	5.0	3.4	6 18	6 17	31
Smithville, (Cape Fear)	N. C.	7 19	47	4.5	5.5	3.8	6 1	6 26	26
Charleston, (Castle Pinckney)	S. C.	7 13	36	5.3	6.3	4.6	6 36	6 9	33
Fort Pulaski, (Savannah entrance)	Ga	7 20	41	7.0	8.0	5.9	5 49	6 35	26
Savannah, (Dry Dock wharf)	Ga	8 13	51	6.5	7.6	5.5	5 4	7 22	14
Doboy Light-house	Ga	7 33	55	6.6	7.8	5.4	6 2	6 20	....
St. Simon's	Ga	7 43	46	6.8	8.3	5.1	6 10	6 15	20
Fort Clinch	Fla	7 53	1 6	5.9	6.7	5.3	6 9	6 17	....
St. John's River	Fla	7 31	48	4.6	5.5	3.2	5 59	6 26	15
St. Augustine	Fla	8 32	43	4.2	4.7	3.5	6 7	6 19	35
Cape Florida	Fla	8 16	51	1.5	1.7	1.2	6 0	6 25	45
Indian Key	Fla	8 18	49	1.8	2.4	1.2	6 36	5 48	19
Sand Key	Fla	8 40	....	1.2	2.0	0.6	6 31	5 55	13
Key West	Fla	9 22	1 12	1.4	2.3	0.7	6 59	5 25	12
Tortugas	Fla	9 56	1 32	1.2	1.5	0.6	6 43	5 40	....
Tampa Bay, (Egmont Key)	Fla	11 21	1 33	1.4	1.8	1.0	6 36	6 11	43
Cedar Keys, (Depot Key)	Fla	13 15	1 55	2.6	3.2	1.6	6 12	6 13	....
St. Mark's	Fla	13 33	2 0	2.2	2.9	1.2	6 16	6 9	....
Western Coast.									
San Diego	Cal	9 38	1 35	3.7	5.0	2.3	6 22	6 0	30
San Pedro	Cal	9 39	1 48	3.7	4.7	2.2	6 18	6 5	30
Cuyler's Harbor	Cal	9 25	1 2	3.7	5.1	2.8	6 13	6 5	....
San Luis Obispo	Cal	10 8	1 52	3.6	4.8	2.4	6 25	5 58	....
Monterey	Cal	10 22	49	3.4	4.3	2.5	6 31	6 2	35
South Farallone	Cal	10 37	1 16	3.6	4.4	2.8	6 18	6 9	....
San Francisco, (north beach)	Cal	12 6	1 4	3.6	4.3	2.8	6 39	5 51	34
Bodega	Cal	11 17	1 54	3.6	4.7	2.7	6 19	5 59	....
Humboldt Bay	Cal	12 2	1 11	4.4	5.5	3.5	6 19	6 0	....
Port Orford	O. T.	11 26	1 6	5.1	6.8	3.7	6 19	6 7	39
Astoria	O. T.	12 42	1 13	6.1	7.4	4.6	6 3	6 28	33
Neé-ah Harbor	W. T.	12 33	1 28	5.6	7.4	4.8	6 20	6 6	....
Port Townshend	W. T.	3 49	1 3	4.6	5.5	4.0	6 34	5 52	....
Fort Steilacoom	W. T.	4 46	1 6	9.2	11.1	7.2	6 3	6 25	28

NOTE.—The mean interval in column 3 has been increased by twelve hours for some of the ports in Delaware river and Chesapeake bay, so as to show the succession of times from the mouth. Therefore, twelve hours ought to be subtracted from the establishments which are greater than twelve hours, before using them.

The foregoing Table I gives the means of determining, roughly, the time and height of high water at the several ports named. The hour of transit of the moon preceding the time of high water is to be taken from the Almanac, and, the mean establishment being added, the time of high water results. Thus:

Example I.—It is required to find the time of high water at New York on the 5th of November, 1854. The American Almanac gives 0*h.* 0*m.* as the time of transit of the moon on that day. The mean interval for New York, from Table I, column 3, is 8*h.* 13*m.*, which, as the transit was at 0*h.*, is roughly the time of high water.

The moon being full, the height is that of spring tides of column 6, namely, 5.4 feet. If the soundings on the chart are reduced to low water spring tides, 5.4 feet is to be added to them, to give the depth at high water. If the soundings are reduced to mean low water, the rise and fall for mean tides being 1.1 foot less than for springs, the rise or increase of depth will be half of this, or 0.6 of a foot less than 5.4 feet, which is 4.8 feet, or nearly 4 feet 10 inches.

Example II.—Required, the time of high water at Boston on the 23d of January, 1851. From the American Almanac we find the time of the moon's southing, or transit, on that day, 5*h.* 18*m.* a. m., and from Table I the mean interval at Boston dry dock is 11*h.* 27*m.*

We have then	5*h.*	18*m.*	time of transit ;
To which add	11	27	mean interval from Table I.
	16	45	time of high water, or 4*h.* 45*m.* p. m.

If the Greenwich Nautical Almanac is used, add 2*m.* to the time of transit of Greenwich for every hour of west longitude, and its proportional part for less than an hour. It will suffice to take the half hour which may be over any number of hours, as the correction for less than this would be less than one minute, and need not be taken into account. Thus, Boston is 4*h.* 44*m.* west of Greenwich. The correction to be applied to the time of transit of the moon is, for the four hours, eight minutes, and for the 44*m.*, one minute. The time of transit, on the date assumed in the preceding example, is 17*h.* 9*m.* of the 22d, or 5*h.* 9*m.* a. m. of the 23d ; to which add nine minutes, the correction just found, gives 5*h.* 18*m.*, as before ascertained from the American Almanac.

In using the United States Nautical Almanac, in the astronomical part of which the transits of the moon are given for the meridian of Washington, the corrections required may, in this first approximation for the Atlantic coast, be neglected.

To find the time of the next following low water add, from Table I, the duration of ebb tide.

This gives	4*h.*	45*m.*	p. m., time of high water.
	6	13	duration of ebb tide, from Table I.
	10	58	p. m.

By subtracting the duration of flood tide, we obtain the time of the preceding low water, 10*h.* 32*m.* a. m., recollecting that 4*h.* 45*m.* p. m. is the same as 16*h.* 45*m.* reckoned from midnight.

The height of this tide, corresponding to the transit of 5*h.*, will bring it nearly to a neap tide, and the rise and fall obtained from column 7, Table I, is 8.5 feet.

The next following high water may be had by adding to the time of low water the duration of flood, from Table I, thus:

	10*h.*	58*m.*	p. m. time of low water 23d of January.
	6	13	duration of flood, from Table I.
Sum	17	11	or 5*h.* 11*m.* a. m. on the 24th of January.

Or, having found the time of high water, the time of the next following high water may be found by adding the duration of flood and of ebb together, and their sum to the time of high water found, thus :

6*h.*	13*m.*	duration of ebb tide, from Table I.
6	13	duration of flood.
12	26	duration of whole tide.
4	45	p. m. January 23, time of high water.
17	11	or 5*h.* 11*m.* a. m. 24th January, time of the next succeeding high water.

Subtracting the same quantity will give the time of the preceding high water. Thus :

4*h.* 45*m.* p. m.. or 16*h.* 45*m.* from midnight, is the time of high water.

12	26	the duration of flood and ebb.
4	19	a. m. of the 23d for the preceding high water.

The duration of the flood and ebb being reckoned from the middle of one stand or slack water to the middle of the next, the time of beginning of stand of ebb or flood will be found by subtracting half the duration of stand or slack water given by column 10, Table I, from the time of high or low water, and the time of the end of stand of ebb or flood by adding the same. A nearer approximation to the times and heights of high water may be obtained by the use of Tables II and III.

TABLE II.

Interval between the time of moon's transit and the time of high water for different hours of transit, and for several different ports.

Time of moon's transit.	Boston, Mass.	New York, N. Y.	Philadelphia, Penn.	Old Point Comfort, Va.	Baltimore, Md.	Smithville, N. C.	Charleston, S. C.	Ft. Pulaski, Savannah R., Ga.	Key West, Fla.	San Francisco, Cal.
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
0 0	11 38	8 20	1 31	8 33	6 47	7 26	7 38	7 30	9 26	12 5
0 30	11 33	8 18	1 28	8 27	6 42	7 21	7 34	7 25	9 19	11 59
1 0	11 28	8 15	1 25	8 21	6 37	7 16	7 28	7 19	9 12	11 53
1 30	11 24	8 10	1 21	8 15	6 31	7 13	7 22	7 15	9 6	11 47
2 0	11 20	8 6	1 18	8 9	6 26	7 9	7 16	7 11	9 0	11 41
2 30	11 16	8 0	1 14	8 4	6 21	7 6	7 11	7 8	8 55	11 36
3 0	11 13	7 55	1 11	8 0	6 17	7 4	7 7	7 6	8 51	11 33
3 30	11 10	7 52	1 8	7 56	6 13	7 3	7 3	7 5	8 50	11 33
4 0	11 7	7 52	1 6	7 52	6 11	7 2	7 0	7 4	8 49	11 38
4 30	11 6	7 52	1 3	7 49	6 10	7 3	6 58	7 3	8 53	11 46
5 0	11 6	7 53	1 0	7 48	6 10	7 4	6 58	7 4	8 57	11 55
5 30	11 9	7 56	0 59	7 50	6 13	7 6	6 59	7 6	9 7	12 3
6 0	11 13	7 59	0 59	7 53	6 19	7 9	7 1	7 8	9 17	12 11
6 30	11 19	8 5	1 1	8 0	6 25	7 13	7 4	7 12	9 28	12 16
7 0	11 25	8 11	1 7	8 [illegible]	6 32	7 17	7 10	7 16	9 39	12 23
7 30	11 32	8 17	1 15	8 5	6 39	7 23	7 19	7 22	9 45	12 29
8 0	11 38	8 23	1 23	8 24	6 44	7 28	7 28	7 28	9 52	12 34
8 30	11 43	8 27	1 29	8 33	6 49	7 33	7 36	7 34	9 54	12 37
9 0	11 47	8 32	1 34	8 40	6 52	7 37	7 42	7 39	9 56	12 36
9 30	11 48	8 34	1 39	8 45	6 54	7 39	7 45	7 42	9 53	12 34
10 0	11 49	8 35	1 42	8 48	6 53	7 40	7 48	7 43	9 51	12 30
10 30	11 48	8 34	1 43	8 48	6 52	7 40	7 48	7 41	9 45	12 24
11 0	11 47	8 31	1 41	8 46	6 50	7 36	7 46	7 37	9 39	12 17
11 30	11 43	8 25	1 37	8 40	6 48	7 30	7 42	7 34	9 32	12 9

TABLE III.

Showing the rise and fall of tides, and corrections to be applied to determine the height of high water soundings on charts referring to mean low water, and to low water spring tides.

Time of moon's transit.	Boston, Mass.			New York, N. Y.			Philadelphia, Pa.			Old Point Comfort, Va.			Baltimore, Md.			Time of moon's transit.
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	11.2	10.6	11.3	4.9	4.5	4.9	6.3	6.2	6.3	2.9	2.6	2.9	1.5	1.4	1.6	0
1	11.3	10.6	11 3	4.9	4.5	4.9	6.4	6.4	6.5	3.0	2.7	3.0	1.5	1.4	1.6	1
2	11.2	10.5	11.2	4.7	4.4	4.8	6.6	6.5	6.6	2.9	2.7	2.9	1.5	1.3	1.5	2
3	10.6	10.3	11.0	4.3	4.2	4.6	6.6	6.5	6.6	2.6	2.6	2.8	1.4	1.3	1.5	3
4	10.0	10.0	10.7	3.8	4.0	4.4	6.4	6.4	6.5	2.3	2.4	2.7	1.3	1.2	1.4	4
5	9.2	9.7	10.4	3.5	3.8	4.2	6.1	6.2	6.3	2.1	2.3	2.6	1.1	1.1	1.3	5
6	8.8	9.4	10.1	3.3	3.7	4.1	5.7	5.9	6.0	2.0	2.2	2.5	0.9	1.1	1.3	6
7	8.6	9.3	10.0	3.3	3.7	4.1	5.4	5.6	5.7	2.0	2.3	2.5	0.9	1.1	1.3	7
8	8.9	9.5	10.2	3.6	3.8	4.2	5.2	5.3	5.4	2.2	2.4	2.6	1.0	1.2	1.4	8
9	9.4	9.7	10.4	4.0	4.0	4.4	5.4	5.4	5.5	2 1	2.5	2.8	1.1	1.3	1.5	9
10	10.1	10.0	10.7	4.5	4.3	4.7	5.7	5.7	5.8	2.8	2.7	2.9	1.3	1.4	1.6	10
11	10.7	10.3	11.0	4.8	4.5	4.9	6.0	6.0	6.1	3.0	2.8	3.0	1.4	1.4	1.6	11

TABLE III—Continued.

Time of moon's transit.	Smithville, N. C.			Charleston, S. C.			Tybee Entrance, Ga.			Key West, Fla.			San Francisco, Cal.			Time of moon's transit.
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	5.2	4.8	5.1	5.7	5.4	5.7	7.8	7.4	7.8	1.6	1.4	1.6	4 5	4.0	4.4	0
1	5.1	4 8	5.1	5.8	5 4	5.7	7.9	7.4	7.9	1.6	1.4	1.6	3.9	3.7	4.1	1
2	5.0	4.7	5 0	5.6	5.4	5.7	7.6	7.3	7.7	1.5	1.4	1.5	3.7	3.6	4.1	2
3	4.6	4.5	4.8	5.5	5.3	5.6	7.1	7.0	7.5	1.4	1.3	1.5	3.5	3.5	4.0	3
4	4.3	4.4	4.7	5.2	5.2	5.5	6.5	6.7	7.2	1.2	1.2	1.4	3.1	3.3	3.8	4
5	4.0	4.3	4.6	4.9	5.1	5.4	6.1	6.5	7.0	1.0	1.1	1.3	2.8	3.1	3.6	5
6	3.8	4.2	4.5	4.8	5.0	5.3	5.8	6.4	6.8	1.0	1.1	1.3	2.7	3.1	3.6	6
7	3.8	4.1	4.4	4.7	4 .9	5.2	6.0	6.5	6.9	1.0	1.1	1.3	3.0	3.3	3.7	7
8	4.0	4.2	4.5	4.8	5.0	5.3	6.4	6.7	7.1	1.1	1.2	1.3	3.4	3.5	3.9	8
9	4.3	4.3	4.6	4.9	5.1	5.4	6.9	6.9	7.4	1.3	1.3	1.4	3.8	3.6	4.1	9
10	4.7	4.6	4.9	5.2	5.3	5.6	7.4	7.0	7.6	1.4	1.3	1.5	4.0	3.8	4.2	10
11	5 0	4.7	5.0	5.5	5.4	5.8	7.8	7.2	7.8	1.6	1.4	1.6	4.2	3.8	4.3	11

In these, the variations in the interval between the moon's transit and high water are shown for some of the principal ports contained in Table I. These variations of interval depend upon the age of the moon, and as they go through their values in half a lunar month, are known as the half-monthly inequality of interval. The table extends from 0*h*. of transit, midnight of the calendar day, or full of the moon, to 11½ hours. The numbers for "change" of the moon correspond to those of 0 hours, and for 13 hours (or 1 p. m. of the calendar day) to 1 hour, and so on up to 23 hours. The ports for which the numbers are given are designated by the heading of the columns.

The mean interval, it will be seen, does not occur at full and change, but nearly two days afterward, on the Atlantic coast. At Key West it occurs more nearly at full and change, and at San Francisco still more nearly.

The same remark applies to the heights; spring tides occur about two days after the full and change of the moon, and neaps two days after the first and last quarter.

The use of this table of nearer approximation is quite as simple as that of Table I.

Rule to find the time of high water.—Look in the Almanac for the time of moon's transit (or southing) for the date required. In the table corresponding to that time will be found the number to be added to the time of transit.

Example III.—Required the time of high water at New York, October 1, 1856. Using the United States Nautical Almanac, we find the time of moon's transit 1*h.* 24*m.*, astronomical reckoning, or 1*h.* 24*m.* p. m. calendar time. From Table II, we have, under the heading of New York, for 1*h.* 30*m.*, (the nearest number to 1*h.* 24*m.* in the table,) 8*h.* 10*m.*

Thus to	1*h.*	24*m.*,	time of moon's transit,
Add	8	10	interval found from Table III.
The sum,	9	34	p. m., is the time of high water on the 1st of October, 1856.

If the sum of these numbers had exceeded twelve, the tide would have belonged to October 2d, and we must have gone back to the transit of the day before, and computed with it, to obtain the tide of October 1st.

Rule to find the height of high water.—Enter Table III, column 1, with the time of moon's transit. In the column headed with the name of the place, and marked A, will be found the rise and fall corresponding to the time of transit; in column B, the number to be added to soundings on the chart, where the soundings are given for mean low water; in column C, the number to be added to charts of which the soundings are given for low water, spring tides.

In the foregoing example, (III,) the time of transit being between 1 and 2 hours, we find, from Table III, the rise and fall of the tide on the 1st of October, 1856, between 4.9 and 4.7; the number to be added to soundings given for mean low water 4.5 feet, (column B,) and for low water spring tides, (column C,) 4.9 feet.

Having found the time of high water, that of low water may be obtained nearly by adding the duration of ebb from column 9, Table I. The time of the next preceding low water may be found by subtracting the duration of flood from column 8, Table I. The time of the next following high water may be found by adding the duration of both flood and ebb, and of the next preceding high water, by subtracting the same duration of the whole tide.

Example IV.—To find the next high water following that of Example III.

The duration of flood, column 8, Table I, for New York, is 6*h.* 0*m.*; and of ebb, from column 9, is 6*h.* 25*m.*; the sum is 12*h.* 25*m.*

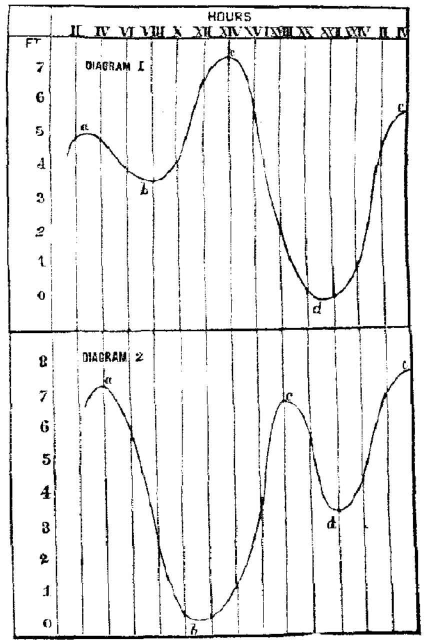
To	9*h.*	34*m.*	p. m., October 1, the time of high water found,
Add	12	25	duration of flood and ebb.
Sum,	21	59,	or 9*h.* 59*m.* a. m. of October 2, the time of the next high water.

TIDES OF THE PACIFIC COAST.

On the Pacific coast there is, as a general rule, one large and one small tide during each day, the heights of two successive high waters occurring one a. m. and the other p. m. of the same twenty-four hours, and the intervals from the next preceding transit of the moon are very different. These inequalities depend upon the moon's declination. They disappear near the time of the moon's declination being nothing, and are greatest about the time of its being greatest. The inequalities for low water are not the same as for high, though they disappear and have the greatest value at nearly the same times.

When the moon's declination is north, the highest of the two high tides of the twenty-four hours occurs at San Francisco about eleven and a half hours after the moon's southing, (transit ;) and when the declination is south, the lowest of the two high tides occurs at about that interval.

The lowest of the two low waters of the day is the one which follows next the highest high water. The nature of these tides will probably appear more plainly from the annexed diagrams. In them the height of the tide is set off at the side on a scale of feet, and the hours of the day are at the top. At XII noon, for example, the tide-gauge marked 6.7 feet. Joining all the heights observed in the twenty-four hours, we have a curve like that marked in the figure. The two high waters are *a* and *c*, and the two low waters *b* and *d*, If *a* is the high water which occurs about twelve hours after the transit of the moon, when the declination is south, the ebb *a b* is quite small, and the high water *a* is much lower than the next high water *c*. If the moon's declination is north, it is the large high water *a* of the second diagram, which occurs next after the transit, and about twelve hours from it.



Tables IV and V give the number to be added to the time of moon's transit, to find the time of high water almost as readily as in the former case. It is one of double entry, the time of transit being, as before, placed in the first column. The number of days from the day at which the moon has had the greatest declination is arranged at the top of the table. Entering the first column with the time of transit, and following the line horizontally until we come under the column containing the days from the greatest declination, we find the number to be added to the time of transit to give the time of high water. If the moon's declination is south, Table IV is to be used ; if north, Table V.

Tables IV to IX, inclusive, have been recomputed, using more complete data for the inequalities above referred to.

TABLE IV.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—						After—							
	6	5	4	3	2	1	0	1	2	3	4	5	6	
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 00	11 49	12 07	12 25	12 43	12 57	13 12	13 20	13 16	13 10	13 02	12 51	12 38	12 21	0 00
0 30	11 43	12 01	12 19	12 37	12 51	13 06	13 14	13 10	13 04	12 56	12 45	12 32	12 15	0 30
1 00	11 37	11 55	12 13	12 31	12 45	13 00	13 08	13 04	12 58	12 50	12 39	12 26	12 09	1 00
1 30	11 31	11 49	12 07	12 25	12 39	12 54	13 02	12 58	12 52	12 44	12 33	12 20	12 03	1 30
2 00	11 25	11 43	12 01	12 19	12 33	12 48	12 56	12 52	12 46	12 38	12 27	12 14	11 57	2 00
2 30	11 20	11 38	11 56	12 14	12 28	12 43	12 51	12 47	12 41	12 33	12 22	12 09	11 52	2 30
3 00	11 17	11 35	11 53	12 11	12 25	12 40	12 48	12 44	12 38	12 30	12 19	12 06	11 49	3 00
3 30	11 17	11 35	11 53	12 11	12 25	12 40	12 48	12 44	12 38	12 30	12 19	12 06	11 49	3 30
4 00	11 22	11 40	11 58	12 16	12 30	12 45	12 53	12 49	12 43	12 35	12 24	12 11	11 54	4 00
4 30	11 30	11 48	12 06	12 24	12 38	12 53	13 01	12 57	12 51	12 43	12 32	12 19	12 02	4 30
5 00	11 39	11 57	12 15	12 33	12 47	13 02	13 10	13 06	13 00	12 52	12 41	12 28	12 11	5 00
5 30	11 47	12 05	12 23	12 41	12 55	13 10	13 18	13 14	13 08	13 00	12 49	12 36	12 19	5 30
6 00	11 55	12 13	12 31	12 49	13 03	13 18	13 26	13 22	13 16	13 08	12 57	12 44	12 27	6 00
6 30	12 00	12 18	12 36	12 54	13 08	13 23	13 31	13 27	13 21	13 13	13 02	12 49	12 32	6 30
7 00	12 07	12 25	12 43	13 01	13 15	13 30	13 38	13 34	13 28	13 20	13 09	12 56	12 39	7 00
7 30	12 13	12 31	12 49	13 07	13 21	13 36	13 44	13 40	13 34	13 26	13 15	13 02	12 45	7 30
8 00	12 18	12 36	12 54	13 12	13 26	13 41	13 49	13 45	13 39	13 31	13 20	13 07	12 50	8 00
8 30	12 21	12 39	12 57	13 15	13 29	13 44	13 52	13 48	13 42	13 34	13 23	13 10	12 53	8 30
9 00	12 20	12 38	12 56	13 14	13 28	13 43	13 51	13 47	13 41	13 33	13 22	13 09	12 52	9 00
9 30	12 18	12 36	12 54	13 12	13 26	13 41	13 49	13 45	13 39	13 31	13 20	13 07	12 50	9 30
10 00	12 14	12 32	12 50	13 08	13 22	13 37	13 45	13 41	13 35	13 27	13 16	13 03	12 46	10 00
10 30	12 08	12 26	12 44	13 02	13 16	13 31	13 39	13 35	13 29	13 21	13 10	12 57	12 40	10 30
11 00	12 01	12 19	12 37	12 55	13 09	13 24	13 32	13 28	13 22	13 14	13 03	12 50	12 33	11 00
11 30	11 53	12 11	12 29	12 47	13 01	13 16	13 24	13 20	13 14	13 06	12 55	12 42	12 25	11 30

TABLE V.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—						After—							
	6	5	4	3	2	1	0	1	2	3	4	5	6	
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 00	12 21	12 03	11 45	11 27	11 13	10 58	10 50	10 54	11 00	11 08	11 19	11 32	11 49	0 00
0 30	12 15	11 57	11 39	11 21	11 07	10 52	10 44	10 48	10 54	11 02	11 13	11 26	11 43	0 30
1 00	12 09	11 51	11 33	11 15	11 01	10 46	10 38	10 42	10 48	10 56	11 07	11 20	11 37	1 00
1 30	12 03	11 45	11 27	11 09	10 55	10 40	10 32	10 36	10 42	10 50	11 01	11 14	11 31	1 30
2 00	11 57	11 39	11 21	11 03	10 49	10 34	10 26	10 30	10 36	10 44	10 55	11 08	11 25	2 00
2 30	11 52	11 34	11 16	10 58	10 44	10 29	10 21	10 25	10 31	10 39	10 50	11 03	11 20	2 30
3 00	11 49	11 31	11 13	10 55	10 41	10 26	10 18	10 22	10 28	10 36	10 47	11 00	11 17	3 00
3 30	11 49	11 31	11 13	10 55	10 41	10 26	10 18	10 22	10 28	10 36	10 47	11 00	11 17	3 30
4 00	11 54	11 36	11 18	11 00	10 46	10 31	10 23	10 27	10 33	10 41	10 52	11 05	11 22	4 00
4 30	12 02	11 44	11 26	11 08	10 54	10 39	10 31	10 35	10 41	10 49	11 00	11 13	11 30	4 30
5 00	12 11	11 53	11 35	11 17	11 03	10 48	10 40	10 44	10 50	10 58	11 09	11 22	11 39	5 00
5 30	12 19	12 01	11 43	11 25	11 11	10 56	10 48	10 52	10 58	11 06	11 17	11 30	11 47	5 30
6 00	12 27	12 09	11 51	11 33	11 19	11 04	10 56	11 00	11 06	11 14	11 25	11 38	11 55	6 00
6 30	12 32	12 14	11 56	11 38	11 24	11 09	11 01	11 05	11 11	11 19	11 30	11 43	12 00	6 30
7 00	12 39	12 21	12 03	11 45	11 31	11 16	11 08	11 12	11 18	11 26	11 37	11 50	12 07	7 00
7 30	12 45	12 27	12 09	11 51	11 37	11 22	11 14	11 18	11 24	11 32	11 43	11 56	12 13	7 30
8 00	12 50	12 32	12 14	11 56	11 42	11 27	11 19	11 23	11 29	11 37	11 48	12 01	12 18	8 00
8 30	12 53	12 35	12 17	11 59	11 45	11 30	11 22	11 26	11 32	11 40	11 51	12 04	12 21	8 30
9 00	12 52	12 34	12 16	11 58	11 44	11 29	11 21	11 25	11 31	11 39	11 50	12 0[illegible]	12 20	9 00
9 30	12 50	12 32	12 14	11 56	11 42	11 27	11 19	11 23	11 29	11 37	11 48	12 01	12 18	9 30
10 00	12 46	12 28	12 10	11 52	11 38	11 23	11 15	11 19	11 25	11 33	11 44	11 57	12 14	10 00
10 30	12 40	12 22	12 04	11 46	11 32	11 17	11 09	11 13	11 19	11 27	11 38	11 51	12 08	10 30
11 00	12 33	12 15	11 57	11 39	11 25	11 10	11 02	11 06	11 12	11 20	11 31	11 44	12 01	11 00
11 30	12 25	12 07	11 49	11 31	11 17	11 02	10 54	10 58	11 04	11 12	11 23	11 36	11 53	11 30

If we disregard the daily inequality, the column headed San Francisco in Table II would give us, as in the examples on the Atlantic coast, the means of determining the time of high water.

Example V.—Required the time of high water at North Beach, San Francisco, California, on the 7th February, 1853.

1st. The time of the moon's transit at Greenwich, from the Nautical Almanac, is 11*h.* 41*m.*; the longitude of San Francisco 8*h.* 10*m.*; requiring a correction of 16*m.* to the time of transit for San Francisco, which is thus found to be 11*h.* 57*m.*

2d. The moon's declination is south, and at the time of transit about two days after the greatest. Entering Table IV, we find 12*h.* (or 0*h.*) of transit, the nearest number to 11*h.* 57*m.* which the table gives; and following the line horizontally until we come to two days after the great declination we find 13*h.* 10*m.*

To 11*h.* 57*m.* time of transit of moon, February 7, San Francisco,
Add 13 10 from column 0*h.* transit, and two days after greatest declination.
The sum 25 7 or 1*h.* 7*m.*, February 8, is the time of high water corresponding to the transit which we took of February 7. If we desire the tide of February 7, we must go back to the moon's transit of the 6th. The example was purposely assumed to show this case.

11*h.* 1*m.* time of transit February 6, 1853.
13 28 number for 11*h.* transit, and one day from greatest declination.
Sum 24 29 time of high water 0*h.* 29*m.* a. m. February 7.

The height of high water.—The height of high water is obtained in a similar manner by the use of Tables VI and VII, entering these in the same way with the time of transit and days from the greatest declination. Table VI is for south declination, and Table VII for north.

Tables showing the numbers to be added to the soundings on charts, referred to the mean lowest low waters of day, to give the depth at high water at San Francisco.

TABLE VI.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—							After—						
	6	5	4	3	2	1	0	1	2	3	4	5	6	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	4.2	4.0	3.8	3.7	3.7	3.6	3.7	3.9	4.0	4.1	4.3	4.6	4.8	0
1	3.6	3.4	3.2	3.1	3.1	3.0	3.1	3.3	3.4	3.5	3.7	4.0	4.2	1
2	3.4	3.2	3.0	2.9	2.9	2.8	2.9	3.1	3.2	3.3	3.5	3.8	4.0	2
3	3.2	3.0	2.8	2.7	2.7	2.6	2.7	2.9	3.0	3.1	3.3	3.6	3.8	3
4	2.8	2.6	2.4	2.3	2.3	2.2	2.3	2.5	2.6	2.7	2.9	3.2	3.4	4
5	2.5	2.3	2.1	2.0	2.0	1.9	2.0	2.2	2.3	2.4	2.6	2.9	3.1	5
6	2.4	2.2	2.0	1.9	1.9	1.8	1.9	2.1	2.2	2.3	2.5	2.8	3.0	6
7	2.7	2.5	2.3	2.2	2.2	2.1	2.2	2.4	2.5	2.6	2.8	3.1	3.3	7
8	3.1	2.9	2.7	2.6	2.6	2.5	2.6	2.8	2.9	3.0	3.2	3.5	3.7	8
9	3.5	3.3	3.1	3.0	3.0	2.9	3.0	3.2	3.3	3.4	3.6	3.9	4.1	9
10	3.7	3.5	3.3	3.2	3.2	3.1	3.2	3.4	3.5	3.6	3.8	4.1	4.3	10
11	3.9	3.7	3.5	3.4	3.4	3.3	3.4	3.6	3.7	3.8	4.0	4.3	4.5	11

TABLE VII.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—							After—						
	6	5	4	3	2	1	0	1	2	3	4	5	6	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	4.8	5.0	5.2	5.3	5.3	5.4	5.3	5.1	5.0	4.9	4.7	4.4	4.2	0
1	4.2	4.4	4.6	4.7	4.7	4.8	4.7	4.5	4.4	4.3	4.1	3.8	3.6	1
2	4.0	4.2	4.4	4.5	4.5	4.6	4.5	4.3	4.2	4.1	3.9	3.6	3.4	2
3	3.8	4.0	4.2	4.3	4.3	4.4	4.3	4.1	4.0	3.9	3.7	3.4	3.2	3
4	3.4	3.6	3.8	3.9	3.9	4.0	3.9	3.7	3.6	3.5	3.3	3.0	2.8	4
5	3.1	3.3	3.5	3.6	3.6	3.7	3.6	3.4	3.3	3.2	3.0	2.7	2.5	5
6	3.0	3.2	3.4	3.5	3.5	3.6	3.5	3.3	3.2	3.1	2.9	2.6	2.4	6
7	3.3	3.5	3.7	3.8	3.8	3.9	3.8	3.6	3.5	3.4	3.2	2.9	2.7	7
8	3.7	3.9	4.1	4.2	4.2	4.3	4.2	4.0	3.9	3.8	3.6	3.3	3.1	8
9	4.1	4.3	4.5	4.6	4.6	4.7	4.6	4.4	4.3	4.2	4.0	3.7	3.5	9
10	4.3	4.5	4.7	4.8	4.8	4.9	4.8	4.6	4.5	4.4	4.2	3.9	3.7	10
11	4.5	4.7	4.9	5.0	5.0	5.1	5.0	4 8	4.7	4.6	4.4	4.1	3.9	11

NOTE.—To use these tables with a chart on which the soundings are referred to mean low water, subtract 1.2 feet from the numbers in the tables.

Example VI.—In Example V, to obtain the height of the tide on February 7, the declination being south, we enter Table VI with 0*h.* of transit, and two days after greatest declination, and find that the tide will be 4.0 feet above the mean of lowest low water, or that 4.0 feet are to be added to the soundings of a chart reduced to the mean of the lowest low waters of each day. If the soundings of the chart were given for mean low water, then 1.2 foot ought to be subtracted from the Tables VI and VII; thus in this example it would be 2.8 feet.

The approximate time of the successive low and high waters of the day will be found by adding the numbers in Table VIII to the time of the first high water already determined. The table gives the numbers for the different days from the greatest declination.

TABLE VIII.

Containing numbers to be added to the time of high water found from tables IV and V to obtain the successive low and high waters.

Days from moon's greatest declination.		South declination.			North declination.			Days from moon's greatest declination.	
		Low water. (Small.)	High water. (Large.)	Low water. (Large.)	Low water. (Large.)	High water. (Small.)	Low water. (Small.)		
		h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*		
Before.	6	5 48	13 00	18 54	5 54	11 57	17 45	6	Before.
	5	5 25	12 28	18 45	6 17	12 32	17 57	5	
	4	5 3	11 50	18 29	6 39	13 10	18 13	4	
	3	4 45	11 16	18 13	6 57	13 44	18 29	3	
	2	4 30	10 46	17 58	7 12	14 14	18 44	2	
	1	4 18	10 18	17 42	7 21	14 42	19 00	1	
	0	4 12	10 00	17 30	7 30	15 00	19 12	0	
After.	1	4 24	10 10	17 28	7 18	14 50	19 14	1	After.
	2	4 34	10 20	17 28	7 08	14 40	19 14	2	
	3	4 49	10 36	17 29	6 53	14 24	19 13	3	
	4	5 6	10 58	17 34	6 36	14 02	19 08	4	
	5	5 24	11 24	17 42	6 18	13 36	19 00	5	
	6	5 51	11 53	17 45	5 52	13 08	18 59	6	

The days from greatest declination are written in the first and last columns of the table. The second, third, and fourth columns refer to south declination, and the fifth, sixth, and seventh to north. The second column gives the number which is to be added according to the declination to the time of high water obtained by means of Tables IV and V, to give the next low water, which is the small low water *b* of Diagram I. The third contains the numbers to be added to the same, to give the second or large high water *c* of Diagram I. The fourth, the numbers to be added to the same, to give the second or large low water *d* of Diagram I. The succeeding columns give the numbers to be used in the same way for north declinations, to obtain the low water *b* (large) of Diagram II, the high water *c* (small) and the low water *d* (small) of the same diagram.

The rise and fall of the same successive tides may be obtained by inspection from Table IX, in which the first column, at the side, contains the time of transit, and the successive columns the numbers corresponding to that time and to the number of days from greatest declination. The arrangement of this table is like that already given.

The numbers for the small ebb tide *a b* of Diagram I, or *c d* of Diagram II, are first given; then those for small low and large high water *b c* of Diagram I, and *d e* of Diagram II; next the large ebb tide *c d* of Diagram I, or *a b* of Diagram II; and lastly, from the large low water to the small high water *d e* of Diagram I, or *b c* of Diagram II.

TABLE IX.

Showing the rise and fall of the several tides corresponding to different hours of transit, and days from greatest declination of the moon, at San Francisco.

Hours of moon's transit.	SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER.												
	Days from moon's greatest declination.												
	Before—							After—					
	6	5	4	3	2	1	0	1	2	3	4	5	6
H.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
0	4.6	4.0	3.3	2.8	2.4	2.0	1.9	2.0	2.3	2.6	3.0	3.7	4.3
1	4.0	3.4	2.7	2.2	1.8	1.4	1.3	1.4	1.7	2.0	2.4	3 1	3.7
2	3.8	3.2	2.5	2.0	1.6	1.2	1.1	1.2	1.5	1.8	2.2	2.9	3.5
3	3.6	3.0	2.3	1.8	1.4	1.0	0.9	1.0	1.3	1.6	2.0	2.7	3.3
4	3.2	2.6	1.9	1.4	1.0	0.6	0.5	0.6	0.9	1.2	1.6	2.3	2.9
5	2.9	2.3	1.6	1.1	0.7	0.3	0.2	0.3	0.6	0.9	1.3	2.0	2.6
6	2.8	2.2	1.5	1.0	0.6	0.2	0.1	0.2	0.5	0.8	1.2	1.9	2.5
7	3.1	2.5	1.8	1.3	0.9	0.5	0.4	0.5	0.8	1.1	1.5	2.2	2.8
8	3.5	2 9	2.2	1.7	1.3	0.9	0.8	0.9	1.2	1.5	1.9	2.6	3.2
9	3.9	3.3	2.6	2.1	1.7	1.3	1.2	1.3	1.6	1.9	2.3	3.0	3.6
10	4.1	3.5	2.8	2.3	1.9	1.5	1 4	1.5	1.8	2.1	2.5	3.2	3.8
11	4.3	3.7	3.0	2.5	2.1	1.7	1.6	1.7	2.0	2.3	2.7	3.4	4.0

From *a* to *b*..Diagram I.
From *c* to *d*..Diagram II.

FROM SMALL LOW WATER TO LARGE HIGH WATER.													Hours of moon's transit.
Days from moon's greatest declination.													
Before—							After—						
6	5	4	3	2	1	0	1	2	3	4	5	6	
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	H.
5.2	5.0	4.7	4.4	4.0	3.8	3.5	3.2	3.3	3.4	3.4	3.5	3.7	0
4.6	4.4	4.1	3.8	3.4	3.2	2.9	2.6	2.7	2.8	2.8	2.9	3.1	1
4.4	4.2	3.9	3.6	3.2	3.0	2.7	2.4	2.5	2.6	2.6	2.7	2.9	2
4.2	4.0	3.7	3.4	3.0	2.8	2.5	2.2	2.3	2.4	2.4	2.5	2.7	3
3.8	3.6	3.3	3.0	2.6	2.4	2.1	1.8	1.9	2.0	2.0	2.1	2.3	4
3.5	3.3	3.0	2.7	2.3	2.1	1.8	1.5	1.6	1.7	1.7	1.8	2.0	5
3.4	3.2	2.9	2.6	2.2	2.0	1.7	1.4	1.5	1.6	1.6	1.7	1.9	6
3.7	3.5	3.2	2.9	2.5	2.3	2.0	1.7	1.8	1.9	1.9	2.0	2.2	7
4.1	3.9	3.6	3.3	2.9	2.7	2.4	2.1	2.2	2.3	2.3	2.4	2.6	8
4.5	4.3	4.0	3.7	3.3	3.1	2.8	2.5	2.6	2.7	2.7	2.8	3.0	9
4.7	4.5	4.2	3.9	3.5	3.3	3.0	2.7	2.8	2.9	2.9	3.0	3.2	10
4.9	4.7	4.4	4.1	3.7	3.5	3.2	2.9	3.0	3.1	3.1	3.2	3.4	11

From *b* to *c*..Diagram I.
From *d* to *e*..Diagram II.

TABLE IX—Continued.

Hours of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.												
	Days from moon's greatest declination.												
	Before—							After—					
	6	5	4	3	2	1	0	1	2	3	4	5	6
H.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*
0	4.4	5.0	5.7	6.2	6.6	7.0	7.1	7.0	6.7	6.4	6.0	5.3	4.7
1	3.8	4.4	5.1	5.6	6.0	6.4	6.5	6.4	6.1	5.8	5.4	4.7	4.1
2	3.6	4.2	4.9	5.4	5.8	6.2	6.3	6.2	5.9	5.6	5.2	4.5	3.9
3	3.4	4.0	4.7	5.2	5.6	6.0	6.1	6.0	5.7	5.4	5.0	4.3	3.7
4	3.0	3.6	4.3	4.8	5.2	5.6	5.7	5.6	5.3	5.0	4.6	3.9	3.3
5	2.7	3.3	4.0	4.5	4.9	5.3	5.4	5.3	5.0	4.7	4.3	3.6	3.0
6	2.6	3 2	3.9	4.4	4.8	5.2	5.3	5.2	4.9	4.6	4.2	3.5	2.9
7	2.9	3.5	4.2	4.7	5.1	5.5	5.6	5.5	5.2	4.9	4.5	3.8	3.2
8	3.3	3.9	4.6	5.1	5.5	5.9	6.0	5.9	5.6	5.3	4.9	4.2	3.6
9	3.7	4.3	5.0	5.5	5.9	6.3	6.4	6.3	6.0	5.7	5.3	4.6	4.0
10	3.9	4.5	5.2	5.7	6.1	6.5	6.6	6.5	6.2	5.9	5.5	4.8	4.2
11	4.1	4.7	5.4	5.9	6.3	6.7	6.8	6.7	6.4	6.1	5.7	5.0	4.4

From *c* to *d*..Diagram I.
From *a* to *b*..Diagram II.

FROM LARGE LOW WATER TO SMALL HIGH WATER.													Hours of moon's transit.
Days from moon's greatest declination.													
Before—							After—						
6	5	4	3	2	1	0	1	2	3	4	5	6	
Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*H.*
3.8	4.0	4.3	4.6	5.0	5.2	5.5	5.8	5.7	5.6	5.6	5.5	5.3	0
3.2	3.4	3.7	4.0	4.4	4.6	4.9	5.2	5.1	5.0	5.0	4.9	4.7	1
3.0	3.2	3.5	3.8	4.2	4.4	4.7	5.0	4.9	4.8	4.8	4.7	4.5	2
2.8	3.0	3.3	3.6	4.0	4.2	4.5	4.8	4.7	4.6	4.6	4 5	4.3	3
2.4	2.6	2.9	3.2	3.6	3.8	4.1	4.4	4.3	4.2	4.2	4.1	3.9	4
2.1	2.3	2.6	2.9	3.3	3.5	3.8	4.1	4.0	3.9	3.9	3.8	3.6	5
2.0	2.2	2.5	2.8	3.2	3.4	3.7	4.0	3.9	3.8	3.8	3.7	3.5	6
2.3	2.5	2.8	3.1	3.5	3.7	4.0	4.3	4.2	4.1	4.1	4.0	3.8	7
2.7	2.9	3.2	3.5	3.9	4.1	4.4	4.7	4.6	4.5	4 5	4.4	4.2	8
3.1	3.3	3.6	3.9	4.3	4.5	4.8	5.1	5.0	4.9	4.9	4.8	4.6	9
3.3	3.5	3.8	4.1	4.5	4.7	5.0	5.3	5.2	5.1	5.1	5.0	4.8	10
3.5	3.7	4.0	4.3	4.7	4.9	5.2	5.5	5.4	5.3	5.3	5.2	5.0	11

From *d* to *e*..Diagram I.
From *b* to *c*..Diagram II.

Example VII.—Thus, in Example VI, the high water of February 7 was found to be 2.8 feet above mean low water. The declination being south, Diagram I applies, and this high water is the small one. To obtain the fall of the next low water, or small low water, we enter Table IX with 0*h.* of moon's transit, and two days after greatest declination in the first part of the table, and find 2.3 feet, which will be the difference in height of this high and low water. Entering with the same transit and day in the second part, we find 3.3 feet, which is the rise of the large high water above the small low water; the difference between 2.3 feet and 3.3, or 1.0 foot, is the difference of height of the two successive high waters.

It is easy to see how, in this way, the soundings of a chart can be reduced to what they would be approximately at all the successive high and low waters. A similar set of tables is in preparation for Key West and some of the other ports on the Gulf of Mexico, where the tides are of the same character.

The tidal observations now in progress on the Pacific will give the means of extending the tables to all the principal ports there.

TIDES OF THE GULF OF MEXICO.

On the coast of Florida, from Cape Florida, around the Peninsula, to St. Mark's, the tides are of the ordinary kind, but with a daily inequality which, small at Cape Florida, goes on increasing as we proceed westward to the Tortugas.

From the Tortugas to St. Mark's the daily inequality is large and sensibly the same, giving the tides a great resemblance to those of the Pacific coast, though the rise and fall is much smaller. Between St. Mark's and St. George's island, Apalachicola entrance, the tides change to the single day class, ebbing and flowing but once in the twenty-four (lunar) hours. At St. George's island there are two tides a day, for three or four days, about the time of the moon's declination being zero. At other times there is but one tide a day, with a long stand at high water of from 6 to 9 hours. From Cape St. Blas, to and including the mouth of the Mississippi, the single day tides are very regular, and the small and irregular double tides appear only for two or three days (and frequently even not at all) about the time of zero declination of the moon. The stand at high and low water is comparatively short, seldom exceeding an hour.

To the west of the mouth of the Mississippi the double tides reappear. At Isle Dernière they are distinct, though a little irregular, for three or four days, near the time of the moon's zero declination. At all other times the single day type prevails, the double tides modifying it, however, in the shape of a long stand of from 6 to 10 hours at high water. This stand is shortest at the time of the moon's greatest declination, sometimes being reduced to but one hour. At Calcasieu the tides are distinctly double, but with a large daily inequality. The rise and fall being small, they would often present to the ordinary observer the same appearance as at Isle Dernière. At Galveston the double tides are plainly perceptible, though small for five or six days, at the time of moon's zero declination. At other times they present the single day type, with the peculiarity that, after standing at high water for a short time, the water falls a small distance and stands again at that height for several hours, then continues to fall to low water. Sometimes it falls very slowly for nine or ten hours following high water, and then acquires a more rapid rate to low water. At Aransas Pass and Brazos Santiago the single day tides prevail. Small, irregular double tides are only perceived for two or three days at moon's zero of declination. At other times there is but one high water in the day, with a long stand of from six to nine hours, during which there are often small irregular fluctuations or a very slow fall.

In the following table the mean rise and fall of tides at the above stations are given.

The highest high and the lowest low waters occur when the greatest declination of the moon happens at full or change; the least tide when the moon's declination is nothing at the first or last quarter.

The rise and fall being so small, the times and heights are both much influenced by the winds, and are thus often rendered quite irregular.

TABLE X.

Rise and fall of tides at several stations on the Gulf of Mexico.

Stations.	MEAN RISE AND FALL OF TIDES.		
	Mean.	At moon's greatest declination.	At moon's least declination.
	Feet.	*Feet.*	*Feet.*
St. George's island, Florida	1.1	1.8	0.6
Pensacola, Florida	1.0	1.5	0.4
Fort Morgan, Mobile bay, Alabama	1.0	1.5	0.4
Cat island, Mississippi	1.3	1.9	0.6
Southwest Pass, Louisiana	1.1	1.4	0.5
Isle Dernière, Louisiana	1.4	2.2	0.7
Entrance to Lake Calcasieu, Louisiana	1.9	2.4	1.7
Galveston, Texas	1.1	1.6	0.8
Aransas Pass, Texas	1.1	1.8	0.6
Brazos Santiago, Texas	0.9	1.2	0.5

TO DETERMINE THE RISE AND FALL OF THE TIDE FOR ANY GIVEN TIME FROM HIGH OR LOW WATER.

It is sometimes desirable to know how far the tide will rise in a given time from low water, or fall in a given time from high water, or to approximate to the time which has elapsed from low or high water, by knowing the rise or fall of the tide in the interval.

If the proportion of the rise and fall in a given time were the same in the different ports, this would easily be shown in a single table giving the proportional rise and fall, which, by referring to table I, showing the rise and fall of the tide at the port, would give the rise and fall in feet and decimals. The proportion, however, is not the same in different ports, nor in the same ports for tides of different heights. The following Table XI, shows the relation between the heights above low water for each half hour for New York and for Old Point Comfort, and for spring and neap tides at each place. Units express the total rise of high water above low water, and the figures opposite to each half hour denote the proportional fall of the tide from high water onward to low water. For example, at New York, three hours after high water, a spring tide has fallen six-tenths (sixty-hundredths) of the whole fall. Suppose the whole rise and fall of that day to be 5.4 feet, (Table I;) then, three hours after high water, the tide will have fallen 3.24 feet, or three feet three inches, nearly. Conversely, if we have observed that a spring tide has fallen three feet three inches, we may know that high water has passed about three hours.

TABLE XI,

Giving the height of the tide above low water for every half hour before or after high water, the total range being taken as equal to 1.

Time before or after high water.	New York.		Old Point Comfort.	
	Spring tide.	Neap tide.	Spring tide.	Neap tide.
h. m.				
0 0	1.00	1.00	1.00	1.00
0 30	0.98	0.98	0.98	0.98
1 0	0.94	0.93	0.95	0.94
1 30	0.89	0.86	0.88	0.87
2 0	0.80	0.72	0.80	0.78
2 30	0.72	0.59	0.70	0.68
3 0	0.60	0.45	0.59	0.57
3 30	0.49	0.31	0.49	0.44
4 0	0.39	0.19	0.37	0.34
4 30	0.28	0.10	0.26	0.22
5 0	0.18	0.02	0.17	0.13
5 30	0.09	0.00	0.08	0.05
6 0	0.05	------------	0.03	0.01
6 30	0.00	------------	0.00	0.00

TIDES IN COASTING.

By observing the times of high and low water along the coast, we find the places at which they are the same. The map of cotidal lines shows that it is high water nearly at the same hour all along our coast, from Sandy Hook to Cape Canaveral; of course, not in the bays and harbors and up the rivers, but on the outer coast. It is high water exactly at the same hour all along the line marked XII seen on the chart, near Sandy Hook, and north and south of Hatteras, and, with small interruptions, at Cape Lookout and Cape Fear, all the way to near Cape Canaveral.

This same line extends eastward to near Block island and south of Nantucket, and then passes away from our coast. At full and change of the moon, along this line, (approximately,) it is high water at XII o'clock, Greenwich time, the local time of high water depending upon the longitude of the place; or, to speak more correctly, in the average of a lunar month, it is high water so many hours after the time of the moon's passing the meridian of Greenwich.

By these lines, called co-tidal lines, we can determine what tidal currents the navigator must expect to meet in coasting, and for this purpose we divide the ports of the coast into two sets—those south and those north of New York.

The sailing lines of coasters bound to southern ports this side of the straits of Florida are marked upon the map, and also of those bound through the sounds to eastern ports, and, outside, to Halifax and European ports.

Vessels to and from ports south of New York.

South of Sandy Hook, New York, the line of XII hours is nowhere more than 18 miles from the coast; that of XI$\frac{3}{4}$ nowhere more than 35 miles; that of XI$\frac{1}{2}$ nowhere more than 48, and of XI nowhere more than 110 miles. The distances of these lines of XII to XI hours (corresponding within four minutes to VII and VI of New York time) from different parts of the coast, is shown in Table A, where the first column gives the name of the place, and the second, third, fourth, and fifth, respectively, the distances of the co-tidal lines of XII, XI$\frac{3}{4}$, XI$\frac{1}{2}$, XI hours. The distances are measured from the ports, on perpendiculars to the co-tidal lines. They may be taken as if measured on the parallel of latitude at all the points for the line of XII hours, and at all between Sandy Hook and Cape Hatteras for the lines of XI$\frac{3}{4}$ and XI$\frac{1}{2}$ hours.

A.

Names of locations.	Distance from coast, measured on perpendicular to co-tidal lines.			
	At XII hours.	At XI$\frac{3}{4}$ hours.	At XI$\frac{1}{2}$ hours.	At XI hours.
	Naut. miles.	*Naut. miles.*	*Naut. miles.*	*Naut. miles.*
Sandy Hook	12	32	53	100
Barnegat	2	29	39	78
Cape May	15	30	46	92
Cape Henlopen	18	33	47	92
Assateague	7	22	36	82
Cape Henry	12	28	43	100
Cape Hatteras		8	20	63
Ocracoke inlet		11	26	71
Cape Lookout		7	18	56
Beaufort entrance	6	15	24	63
Cape Fear		6	16	55
Cape Roman		10	21	67
Charleston light	3	15	27	70
Port Royal entrance	5	17	29	78
Tybee entrance	6	17	31	82
St. Mary's entrance	12	25	40	110
St. John's entrance	17	35	48	
Cape Canaveral	16			
Cape Florida				

The co-tidal lines are in such directions that at 10, 20, and 30 miles from the coast, between Sandy Hook and the St. John's, there is but a variation of seven minutes, and even to Cape Canaveral only of eight minutes. Keeping ten miles from the shore, the coaster would pass from XII hours at Sandy Hook to XI hours 45 minutes at Hatteras, and increase again irregularly to XII hours 7 minutes at the St. John's, as shown more explicitly in the Table B.

These three tracks of 10, 20, and 30 miles are inside of the cold wall of the Gulf Stream, and generally in the cold current, except at Cape Canaveral.

B.

Names of stations.	Co-tidal hour at 10, 20, and 30 nautical miles from the coast, perpendicular to the coast.		
	Ten miles off.	Twenty miles off.	Thirty miles off.
	h. m.	h. m.	h. m.
Sandy Hook	12 0	11 52	11 45
Barnegat	11 52	11 44	11 35
Cape May	12 5	11 53	11 45
Cape Henlopen	12 7	11 57	11 48
Assateague	12 0	11 48	11 37
Cape Henry	12 5	11 48	11 42
Cape Hatteras	11 45	11 30	11 22
Ocracoke inlet	11 47	11 36	11 25
Cape Lookout	11 45	11 30	11 20
Beaufort entrance	11 55	11 38	11 25
Cape Fear	11 38	11 25	11 18
Cape Roman	11 45	11 33	11 24
Charleston light	11 52	11 38	11 25
Port Royal entrance	11 57	11 45	11 32
Tybee entrance	11 55	11 43	11 30
St. Mary's entrance	12 8	11 57	11 47
St. John's entrance	12 7	11 57	11 50
Cape Canaveral	12 8	----------	----------
Cape Florida	13 10	----------	----------

It follows, then, as a general thing, from these two tables, that the coaster, in passing from Sandy Hook to the St. John's, would have the tides the same, within some fifteen minutes, as if he remained at Sandy Hook. So that leaving, for example, at high water, he would, according to the elapsed time, have the ebb and flood alternating every six hours and a quarter, nearly, as if he had remained near Sandy Hook. As the flood tide sets in generally to the northward and on shore, and the ebb tide to the southward and off shore, he would know by the time that elapsed from his departure, and the period of the tide at which he started, what tidal currents he might expect to meet as he passed along the coast. This, of course, is not peculiar to Sandy Hook as a point of departure, but would be true for any of the entrances given in the table, taking care not to mistake the times of tides within for that at the entrance. By referring to George W. Blunt, Esq., I have obtained the tracks of sailing and steam vessels passing from New York to ports south of it, as shown by the lines on the chart accompanying this paper. Tracing these on the map of co-tidal lines, I have determined how the navigator would find the tides as he passes from port to port. The results are shown in the annexed table, (C,) in which the port between which and Sandy Hook the mariner passes, is at the head of the table, and, at the side, the place off which the co-tidal hours will be found, as stated in the table.

C.

Off—	Co-tidal hours on sailing lines between New York and—(measured on parallel of latitudes of places named in first column.)							
	Delaware bay.	Chesapeake bay.	Ocracoke inlet.	Cape Fear.	Charleston.	Savannah.	St. John's.	Cape Florida.
	h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h m.*	*h. m.*	*h. m.*
Sandy Hook	12 5	12 5	12 5	12 5	12 5	12 5	12 5	12 5
Barnegat	11 57	11 57	11 57	11 57	11 57	11 57	11 57	11 57
Cape May	12 10	11 52	11 45	11 45	11 45	11 45	11 45	11 45
Cape Henlopen		11 61	11 43	11 43	11 43	11 43	11 43	11 43
Assateague		11 55	11 33	11 33	11 33	11 33	11 33	11 33
Cape Henry		12 13	11 24	11 24	11 24	11 24	11 24	11 24
Cape Hatteras			11 48	11 48	11 48	11 48	11 48	11 48
Ocracoke inlet				11 42	11 42	11 42	11 42	11 42
Cape Lookout				11 39	11 39	11 39	11 32	11 24
Beaufort entrance				11 39	11 39	11 39	11 32	11 24
Cape Fear					11 36	11 36	11 24	11 0
Cape Roman					11 46	11 46	11 19	
Charleston light						11 52	11 18	
Port Royal entrance						12 3	11 18	
Tybee entrance							11 16	
St. Mary's entrance							11 55	
St. John's entrance							12 10	
Cape Canaveral								
Cape Florida								

Thus, from Sandy Hook to Delaware bay, starting with XII hours 5 minutes, off Barnegat there would be, at the same instant, XI hours 57 minutes, and off Cape May XII hours 10 minutes ; so the navigator would have the same succession of tides, whether he remained at Sandy Hook or passed onward to Delaware bay, or whether he came from Delaware bay to Sandy Hook. So, from Sandy Hook to Charleston, he would find, *at the same instant*, XII hours 5 minutes at Sandy Hook, XI hours 57 minutes off Barnegat, XI hours 45 minutes off Cape May, and so onward upon the parallels of latitude for the several points. *For all practical purposes, then, of coasting, the succession of the tides, and, of course, of the tidal currents of flood and ebb, will be the same as if the navigator remained stationary.* Leaving at low water, he will meet the flood for six hours and 15 minutes, and then the ebb for another 6 hours and 15 minutes, and so on. It is the simplest of all rules that has thus come out of this investigation.

That remarkable change of temperature between the waters of the in-shore cold current and of the warm waters of the Gulf Stream, (occurring in so short a distance that Lieutenant Bache called it the "cold wall,") takes place at distances off the coast of from 170 to 29 miles, (see Table D,) between Sandy Hook and Cape Canaveral, measured from the several points named in the table, at right angles to the direction of the course, or, measured along the parallels of latitude of the points, at distances from 195 to 28 miles between Assateague and Cape Canaveral, (Table D.) The points where the parallels north of Assateague meet this division line have not been accurately determined.

The annexed table (D) shows these distances, measured at right angles and on the parallel.

D.

Distance from coast to "cold wall" of Gulf Stream, off—	Measured at right angles to coast.	Measured on parallel of latitude.
	Naut. miles.	*Naut. miles.*
Sandy Hook	170	------------
Barnegat	135	------------
Cape May	137	------------
Cape Henlopen	137	------------
Assateague	95	195
Cape Henry	92	107
Cape Hatteras	30	31
Ocracoke inlet	53	52
Cape Lookout	53	65
Beaufort entrance	62	------------
Cape Fear	54	97
Cape Roman	57	103
Charleston light	61	95
Port Royal entrance	79	97
Tybee entrance	79	95
St. Mary's	90	87
St. John's	85	82
Cape Canaveral	29	28
Cape Florida	------------	------------

The coasting line of thirty miles keeps inside of the cold wall all the way to Canaveral, and all the routes traced on the chart from Sandy Hook to southern ports are inside of it.

The Gulf Stream lines drawn on the chart show how the route to Bermuda and to the Bahamas cuts the alternate bands of warm and cold water of the Gulf Stream.

Vessels to and from ports east of New York.

The plate shows the sailing lines of vessels bound from New York to eastern ports and to Halifax, outside. The annexed table (E) gives the Greenwich times of high water off the several points named in the first column on the routes to and from the places named in the heading of the table. The distances are measured at right angles to the co-tidal curves.

E.

Off—	Co-tidal hours on sailing lines between New York and—						
	Newport.	N. Bedford.	Nantucket.	Boston.	Portsmouth.	Portland.	Halifax.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Sandy Hook							12 5
Throg's Point	16 16	16 16	16 16	16 16	16 16	16 16	
Fisher s Island	13 48	13 48	13 48	13 48	13 48	13 48	
Block Island	12 16	12 16	12 16	12 16	12 16	12 16	11 30
Monomoy				16 10	16 10	16 10	
Cape Cod				14 35	14 35	14 35	12 15
Cape Ann					15 00	14 40	
Portland						15 30	

In passing from New York to an eastern port, the first great change in the tides and tidal currents is between the East river and Long Island Sound ; the difference between Governor's island and Negro Point, on Ward's island, at the eastern entrance to Hell Gate, is 2 hours and 45 minutes. Between this point and Throg's Point the change is small. The mariner is now in the full tide of the Sound, and between Throg's Point and Fisher's island there is a difference of time of but 2 hours and 20 minutes, the greatest part of which is at the head of the Sound and at its entrance, that is, near Throg's Point and Fisher's island. From off New London to off Sand's Point the difference is but 1 hour and 40 minutes ; so that if the mariner, instead of remaining at Throg's Point, passes onward to Fisher's island, he would lose but half a tide in the whole passage. In other words, he would have the same succession of rise and fall, according to the time elapsed, whether stationary or passing onward within two hours and a half, or less than half a tide. The tidal current lines show that even a less allowance is to be made for the change of current than for the change of tide, the difference in the change of current between Throg's Point and Fisher's island along the middle of the Sound being of no practical importance. Passing out of Long Island Sound, the tidal hours grow earlier, until off Block island that of Sandy Hook is again reached. The co-tidal line of Sandy Hook and Block island being the same, it is the struggle of the same tide through New York bay and the narrow East river and obstructed Hell Gate, and through Fisher's island and Long Island Sound and to Throg's Point. The tidal currents meet near Throg's Point.

The lower part of Narragansett bay has the co-tidal hour XII hours nearly. Buzzard's bay has nearly the same co-tidal hour, the tide-wave reaching the shores at nearly the same time all around the bay. It would be impossible to give in a small compass a minute account of the tides of Martha's Vineyard and Nantucket Sounds. In general, it may be said that as far as Holmes' Hole and Wood's Hole, they resemble those of Block Island Sound, and afterwards those of Monomoy, at the eastern entrance ; but this generalization is unsatisfactory without more details than there is space here to give. In these Sounds takes place the remarkable change of between three and four hours, the great change of our coast, dislocating, as it were, the times of high water at places south and west, and east and north of Nantucket. The whole of this change takes place between the eastern entrance of Nantucket Sound and the western of Martha's Vineyard, giving rise to quite a complex condition of both tides and currents, which it has occupied much time to unravel.

The dominant co-tidal line of our coast, from Block island to Cape Canaveral, is that of XII hours of Greenwich time; that of our eastern coast, from Nantucket to Passamaquoddy, is in general XV hours. Passing out of Nantucket Sound, coasters carry nearly the same co-tidal hour to Cape Cod, and thence vary their time about half an hour in passing to Boston, to Portsmouth, to Portland, or to Passamaquoddy.

It has been long known that the tidal Almanac for Boston might practically be used for eastern ports. Vessels from New York to Halifax, (and New York to Europe,) which keep outside, and should keep well off the Nantucket shoals, and off George's, as shown by the track on the chart, vary their co-tidal hour but little, keeping between the lines of XII and XI½ until quite well on their course and beyond Cape Sable. The same rule will apply to their case as has been given for vessels between New York and a southern port.

APPENDIX No. 21.

Report made to the Superintendent, showing the least water in channel entrances to certain harbors, rivers, and anchorages on the coasts of the United States; prepared by Lieut. W. D. Whiting, and revised by Lieutenants Commanding J. J. Almy and T. A. Craven, U. S. N., assistants in the Coast Survey. Tidal data by Assistant L. F. Pourtales, in charge of Tidal Division.

Places.	Limits between which depths are given.	LEAST WATER IN CHANNEL WAY. Mean. Low water.	Mean. High water.	Spring tides. Low water.	Spring tides. High water.	Authorities. (From Coast Survey data when not otherwise stated.)
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Portland, Maine	From Cape Elizabeth to Portland light	45	53.8	44.5	54.4	1850, '53, and '54.
	*From Portland light to breakwater	36	44.8	35.5	45.4	
	From breakwater to end of Munjoy Point	30	38.8	29.5	39.4	
	From breakwater to anchorage	16	24.8	15.5	25.4	
	Channel way off town and wharves	27	35.8	26.5	36.4	
	From Munjoy to railroad bridge	19.5	28.3	19	28.9	
Portsmouth, N. H	From Whale's Back to Fort Constitution	42	50.6	41.4	51.3	1851.
	From Fort Constitution to the Narrows	51	59.6	50.4	60.3	
	From the Narrows to the city	45	53.6	44.4	54.3	
	Off the wharves	63	71.6	62.4	72.3	
Salem, Mass	Northern ship channel, between Baker's and Misery islands	52	61.2	51.3	61.9	1850 and '51.
	Southern ship channel, passing Halfway Rock, Gooseberry and Eagle islands to the northward, Cat island and Coney island to the southward	28	37.2	27.3	37.9	
	Inside of Salem Neck	19	28.2	18.3	28.9	
Boston, Mass	Main ship channel, between Lovel's and Gallop's island	28.5	38.5	27.8	39.1	1846, '47, '48, and '53.
	Broad Sound, south channel	19.5	29.5	18.8	30.1	
	President's Roads, anchorage	31.5	41.5	30.8	42.1	
	Main ship channel, between Governor's island and Castle island	18	28	17.3	28.6	

*The depth in channel way varies between 6 and 8½ fathoms.

APPENDIX No. 21—Continued.

Places.	Limits between which depths are given.	Least water in channel way. Mean. Low water.	Mean. High water.	Spring tides. Low water.	Spring tides. High water.	Authorities.
		Feet.	Feet.	Feet.	Feet.	
Narragansett bay to Prudence island.	Entering with Boston Neck on port hand. Beavertail and Dutch island lights on starboard hand, passing between Canonicut Point and Hope island	25	28. 9	24. 6	29. 2	Com. Wadsworth, 1832.
	Entering with Beavertail light on the port, and Castle Hill on starboard hand, up to Goat island	60	63. 9	59. 6	64. 2	1848.
	Anchorage southward and westward of Goat island	33	36. 9	32. 6	37. 2	
	Abreast of wharves inside of Goat island	21	24. 9	20. 6	25. 2	
	From Newport harbor, inside of Gull Rocks to Prudence island	31	34. 9	30. 6	35. 2	
	To Mount Hope bay	42	45. 9	41. 6	46. 2	
	To Mount Hope bay, with Cormorant Rock, Sachuest Point on port, and Saughkonnet Point on starboard hand	20	23. 9	19. 6	24. 2	
New York	Gedney's channel	24	28. 8	23. 6	29. 1	From 1835 to 1853 inclusive.
	North channel	22	26. 8	21. 6	27. 1	
	South channel	22. 5	27. 3	22. 1	27. 6	
	Main ship channel, passing Sandy Hook to SW. spit buoy	31	35. 8	30. 6	36. 1	
	Main ship channel, after passing SW. spit buoy on NE. course, one mile up the bay for New York	22	26. 8	21. 6	27. 1	
Arthur's Kill	Anchorage at Perth Amboy	22	26. 9	21. 5	27. 5	1855.
	From anchorage to Woodbridge wharf	22	26. 9	21. 5	27. 5	
	*From Woodbridge wharf to Rossville	13. 5	18. 6	13. 0	19. 2	
	†From Rossville to Chelsea	14	19. 1	13. 5	19. 7	
	‡From Chelsea, in the western channel, to Elizabeth port	13	18. 1	12. 5	18. 7	
	§From Elizabeth port to Shooter's island	6. 5	10. 9	6. 0	11. 5	
Kill van Kull	From Shooter's island to Bergen Point light-house	10	14. 3	9. 5	14. 9	
	From Bergen Point light-house to New Brighton	27	31. 3	26. 5	31. 9	
Newark bay	‖From Bergen Point light-house to the mouth of Hackensack river	7	11. 6	6. 5	12. 2	
Hudson river	From Castle Garden to Manhattanville	32	36. 0	31. 6	36. 8	
	From Manhattanville to Yonkers	27	30. 8	26. 7	31. 3	
	¶From Yonkers to Piermont Ferry	39	42. 6	38. 7	43. 0	1853.
	**From Piermont Ferry to Sing Sing	24. 5	28. 0	24. 3	28. 3	1853.
	From Sing Sing to Haverstraw	26	29. 1	25. 8	29. 8	1853.
	From Haverstraw to Peekskill	27	30. 1	26. 8	30. 8	1854.

* Two bars, each a quarter of a mile, have a less depth than 18 feet.

† A small shoal, with 12 feet, lies in the middle of the kill, opposite the wharf at Blazing Star; and another, with 10 feet, a quarter of a mile to the northward; but deeper water is found on east side of both.

‡ A shoal of 4 feet obstructs the eastern channel, half way between Chelsea and its junction with the main channel.

§ Channel very narrow in the vicinity of Black Beacon.

‖ From Bergen Point light, half way to Newark Bay light-house, 17 feet may be carried.

¶ In a straight line.

** A shoal of 21. 5 feet occurs about a mile below Sing Sing.

APPENDIX No. 21—Continued.

Places.	Limits between which depths are given.	Least water in channel way. Mean. Low water.	Mean. High water.	Spring tides. Low water.	Spring tides. High water.	Authorities.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Delaware bay	*Main ship channel, passing Delaware breakwater	61	64.5	60.4	64.9	
	Off Brandywine light-house	43	46.5	42.4	46.9	
	Main ship channel, passing False Liston's tree to abreast of Bombay Hook light	27.5	33.4	27.3	34.2	
	Blake's channel, along Flogger shoal	13.5	19.4	13.3	20.2	
	Blake's channel, passing Mahon river light	13.5	19.4	13.3	20.2	
	Main ship channel approaching Liston's Point	20	25.9	19.8	26.7	
Delaware river	Main ship channel up to Reedy island	20	26	19.6	26.3	From 1840 to 1844 inclusive.
	Main ship channel, opposite Reedy island light-house	24.5	30.5	24.1	30.8	
	Opposite Delaware City	30	36	29.6	36.3	
	Up to Christiana creek light	20.5	27	20.3	27.2	
	Up to Marcus Hook	20.5	27	20.3	27.2	
	Opposite Chester	24.5	30.7	24.4	31.2	
	Bar off Hog island	18.5	24.7	18.4	25.2	
	Between Greenwich Point and Gloucester Point	31.5	37.5	31.4	38.2	
	From Greenwich Point up to Philadelphia	21.5	27.5	21.4	28.2	
Chesapeake bay	From capes at entrance to Hampton Roads	30	32.5	29.8	32.8	
	Anchorage in Hampton Roads	59	61.5	58.8	61.8	
	From Hampton Roads to Sewall's Point	25	27.5	24.8	27.8	
	South of Sewall's Point, (one mile and a half)	21	23.5	20.8	23.8	
	Up to Norfolk	23	25.5	22.8	25.8	
	From Hampton Roads to James river, entering to the northward of Newport News middle ground	22	24.5	21.7	24.8	1852, '53, and '54.
	From Hampton Roads to James river, entering to the southward of Newport News middle ground	27	29.5	26.7	29.8	
York river, Va	From abreast the tail of York spit up to Yorktown	33	35.5	32.7	35.8	
Elizabeth river, Va	Between Norfolk and navy yard	25.5	28	25.3	28.3	
Hatteras inlet, N. C	Over northern bar	12.5	14.5	12.4	14.6	1850.
	Over southern bar	12.5	14.5	12.4	14.6	
	Over northern bar	12	14	11.9	14.1	
	Over southern bar	14	16	13.9	16.1	
	At the anchorage	21	23.0	20.9	23.1	
	Over bulkhead into Pamplico Sound	6.5	8.5	6.4	8.6	1852.
Ocracoke inlet	Over bar	10.7	13.1	10.5	13.3	
	At anchorage, large	13.5	15.9	13.3	16.1	
	At anchorage, small	7	9.4	6.8	9.6	
	Over bulkhead into Pamplico Sound	6	8.4	5.8	8.6	
Albemarle Sound	From light-boat off Carroon's Point to line joining Powell's Point and shell bank, near the mouth of Currituck Sound	7	------	------	------	1851.
	Thence up the Sound to Martin's Point	5.5	------	------	------	
	From Martin's Point to Trout's Hole, south of Rattlesnake island	5	------	------	------	
North river, N. C	At entrance, and seven miles up from Albemarle Sound	6.7	------	------	------	1850.

* Soundings varying between 10 and 15 fathoms.

APPENDIX No. 21—Continued.

Places.	Limits between which depths are given.	Least water in channel way. Mean. Low water.	Mean. High water.	Spring tides. Low water.	Spring tides. High water.	Authorities.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Beaufort, N. C	Entrance to channel	15.5	18.3	15.3	18.6	1854.
Cape Fear	New inlet bar	7	11.5	6.5	12	1851, '52, and '53.
	*Main ship channel, Cape Fear river	8	12.5	7.5	13	
	Western rip	8	12.5	7.5	13	1856.
	Western bar	10	14.5	9.5	15	
Georgetown, S. C	Entrance to Winyah bay, east and southeast pass	7	10.8	6.7	11.3	1851, '52, and '53.
	Anchorage inside of north island	27	30.8	26.7	31.3	
	Up to Georgetown	9	12.6	8.7	13.1	
Charleston, S. C	Main bar	11	16.3	10.8	17.1	1850.
	North channel	10	15.3	9.8	16.1	
	Maffitt's channel	7	12.3	6.8	13.1	
	Maffitt's channel	11.5	16.8	11.3	17.6	1855.
North Edisto	Over bar at entrance	13	18.8	12.5	19.4	1856.
Port Royal	Channel up to northeast branch	19	26	18.5	26.5	Des Barres, 1777
	South channel	19	26	18.5	26.5	1855.
	Southeast channel	20	27	19.5	27.5	1856.
	East channel	17	24	16.5	24.5	1855.
Tybee entrance	Bar near Tybee island	19	26	18.4	26.5	1851 and '52.
	Tybee Roads	31	38	30.4	38.5	
Savannah	Channel up to city, (Wrecks and Garden Bank)	11	17.5	10.6	18.2	Captain Gilmer, U. S. Engineers.—1856.
St. Simons	Over bar at entrance	17	23.8	16.3	24.5	1855 and '56.
	Entrance to Sound	38	44.8	37.3	45.5	
	Turtle river up to Blythe island*	21	27.8	20.3	28.5	
Doboy bar and inlet	Entrance over bar	15.5	22.1	14.7	22.5	1855.
	Anchorage in Sound	24	30.6	23.2	31	
St. Mary's river	On bar	14	19.9	13.5	20.2	Capt. Mackay, U. S. Topographical Engineers and Coast Survey.—1856.
	Channel up to St. Mary's	19	24.9	18.5	25.2	
St. John's river, Fla	Over bar at entrance	7	11.6	6.5	12	1855.
	Channel passing up towards Jacksonville	23	25.1	22.5	25.5	
Florida reef	Fowey Rock channel; on course S.SW. from five fathoms; light-house bearing NW. by W.	17	18.5	16.8	18.6	
	At anchorage	24	25.5	23.8	25.6	
	Indian Key channel; Indian key bearing NW.	16	17.8	15.7	18.1	
	Anchorage one mile from Indian key	21	22.8	20.7	23.1	
	Bahia Honda channel; west point of Bahia Honda bearing N.NW.	18	19.4	17.7	20	
	Key Sambo channel, between middle and western Sambo	34	35.4	33.7	36	
	Inside the reef, and steering W. by N. for buoy	14	15.4	13.7	16	
Key West	Main ship channel to middle buoy on shoals	27	28.4	26.7	29	1850 and 1851.
	From shoals to anchorage	30	31.4	29.7	32	
	East channel, entering	30	31.4	29.7	32	
	On course N.NW. ½ W., (light on O'Hara's observatory,) and passing between shoals	28	29.4	27.7	30	
	From 14 feet shoals to anchorage	30	31.4	29.7	32	
	At anchorage	27	28.4	26.7	29	
	Rock Key channel	20	21.4	19.7	22	
	Sand Key channel	27	28.4	26.7	29	
	West channel	30	31.4	29.7	32	

* Subject to frequent changes.

APPENDIX No. 21—Continued.

Places.	Limits between which depths are given.	Least water in channel way.				Authorities.
		Mean.		Spring tides		
		Low water.	High water.	Low water.	High water.	
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Key West—Continued	Northwest channel up to abreast N.W. light	15	16.4	14.7	17	
	Over Northwest Channel bar	12	13.4	17.7	14	
Tortugas	Northwest channel	45	46.2	44.8	46.4	1850 and 1851.
	Southwest channel	54	55.2	53.8	55.4	
	East channel	45	46.2	44.8	46.4	
	Anchorage at Garden key	30	31.2	29.8	31.4	1854.
Cedar keys	Channel	10	12.6	9.7	12.9	
St. Mark's	Over bar	11	13.2	10.6	13.5	
	Channel at middle buoy	12	14.2	11.6	14.5	1852.
	Up to Fort St. Mark's	7	9.2	6.6	9.5	
Apalachicola°	Channel	12.5	13.6	12.2	14	
Pensacola°	Over bar, channel	21.5	22.5	22.2	22.7	Colonel Kearney, U. S. Topographical Engineers.—1822.
	From bar to navy yard	28	29	27.7	29.2	
	From navy yard to city	31	32	30.7	32.2	
	Off wharf at Pensacola†	20	21	19.7	21.2	
Mobile bay and river°	Over outer bar	21	22	20.7	22.2	From 1847 to 1852, inclusive.
	Main ship channel to Fort Morgan	36	37	35.7	37.2	
	To the upper fleet	12	13	11.7	13.2	
Ship Island harbor°	Channel	19	20.3	18.7	20.6	
	Northwest channel	19.5	20.8	19.2	21.1	
	Anchorage, Man-of-war harbor	18	19.3	17.7	19.6	
Cat Island harbor°	Ship channel	16	17.3	15.7	17.6	1848.
	South Pass	14	15.3	13.7	15.6	
	Shell Bank channel	15.2	16.5	14.9	16.8	
Mississippi delta°	Pass à l'Outre, North channel	9.5	10.6	9.3	10.7	
	South channel	12	13.1	11.8	13.2	
Northeast Pass*	Over bar, north entrance	9.5	10.6	9.3	10.7	1851.
	Over bar, south entrance	9	10.1	8.8	10.2	
Southeast Pass*	Entering	10	11.1	9.8	11.2	
South Pass*	Channel	8	9.1	7.8	9.2	
Southwest Pass°	Channel	13	14.1	12.8	14.2	
Barataria bay*	Over bar outside of Grand Pass	7.5	8.7	7.2	8.9	1852.
	Grand passage to Independence island	15	16.2	14.7	16.4	
Dernière or Last island°	Channel inside, and north of Ship Island shoal light-ship	27	28.4	26.7	28.8	
	Channel north of Ship shoal, one mile from beach of Dernière island	14	15.4	13.7	15.8	1853.
Sabine Pass*	Across the bar	7.5	9	7.2	9.3	
Galveston bay°	Galveston bay	12	13.1	11.7	13.3	
Aransas Pass*	Aransas Pass	9	10.1	8.7	10.5	
Rio Grande*	Rio Grande	4	4.9	3.8	5	

° The highest tides occur at the moon's greatest declination, and are applied in the column headed "spring tides."
† Varying between 20 and 24 feet.

APPENDIX No. 21—Continued.

Places.	Limits between which depths are given.	LEAST WATER IN CHANNEL WAY. Mean, lowest of day. Low water.	Mean, lowest of day. High water.	Spring tides, lowest of day. Mean. Low water.	Spring tides, lowest of day. Mean. High water.	Spring tides, lowest of day. Moon's greatest declination. Low water.	Spring tides, lowest of day. Moon's greatest declination. High water.	Date.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
San Diego bay	Entrance	27.4	31.5	26.8	32.1	26.3	31.8	1851.
San Diego	Midway between south end of Zuniga shoal and Point Loma light-house, bearing N. 61½ W. by compass, distant nearly a statute mile	20	24.1	19.4	24.7	18.9	24.4	1856.
	Middle Ground light-house, bearing N 67½ W. by compass, distant three-fourths of a statute mile	18	22.1	17.4	22.7	16.9	22.4	1856.
	Midway and nearly in range between Ballast Point and point opposite	22	26.1	21.4	26.7	20.9	26.4	1856.
	Abreast of La Plaza, 160 yards from shore	18	22.1	17.4	22.7	16 9	22.4	1856.
	At end of wharf. (Newtown)	23	27.1	22.4	27.7	21.9	27.4	1856.
San Clemente island, (SE. end.)	About midway between NE. and SW. points at anchorage in deepest bight, 450 yards from shore	40	44.1	39.4	44.7	38.9	44.4	1856.
San Clemente island, (NW. end)	About 200 yards from shore at anchorage	36	40.1	35.4	40.7	34.9	40.4	1852.
Mission San Juan Capistrano.	At anchorage	42	46.1	41.4	46.7	40.9	46.4	1853.
Santa Catalina island, (S. W. side,)	Anchorage in Catalina harbor	21	25.0	20.5	25.5	19 9	25.1	1852.
San Pedro	In range between Point Pedro and half a mile from Dead Man's island	18	22.0	17.5	22.5	16.9	22 1	1852.
Point Duma	Anchorage	54	58.0	53.5	58.5	52.9	58.1	1853.
San Buenaventura	At anchorage half a mile from shore	36	40.1	35.5	40.9	35.0	40.4	1855.
Santa Cruz island	Anchorage, Prisoner's harbor	75	79.1	74.5	79.9	74.0	79.4	1852.
Santa Barbara	Anchorage inside of Kelp, 450 yards from shore	18	22.1	17.5	22.9	17.0	22 4	1852.
San Miguel island	Anchorage, Cuyler's harbor	37	41.1	36.5	41.9	36.0	41.4	1852.
Coxo harbor	Anchorage	30	34.1	29.5	34.9	29.0	34.4	1852.
San Luis Obispo	Anchorage in harbor	33	36.9	32.3	37.4	31.7	37.1	1852.
San Simeon	Harbor anchorage	24	27.9	23.3	28.4	22.7	28.1	1852.
Monterey harbor	Anchorage	42	45.9	41.5	46.2	40.9	45.8	1852.
	Near shore	30	33.9	29.5	34.2	28.9	33.8	1852.
Santa Cruz harbor	Anchorage	27	31.6	26.3	32.3	26.6	31.9	1852.
San Francisco bay	From 4-fathom bank around to southern shore	28	32.2	27.6	32.6	26.9	32 4	1851.
	Anchorage off Rincon Point, 450 yards from shore	66	70.2	65.6	70.6	64.9	70.4	1851.
	Anchorage off Market Street wharf, San Francisco	54	58.2	53.6	58.6	52.9	58.4	1851.
	Off Cunningham's wharf	36	40.2	35.6	40.6	34 9	40.4	1851.
	Off Clark's Point, 450 yards from shore	42	46.2	41.6	46.6	40 9	46.4	1851.
San Francisco harbor	On the bar	33	37.2	32.6	37.6	31.9	36.4	1855.
	At best wharves	20	24.2	19.6	24.6	18.9	23.4	1855.
Mare Island Straits	In mid-channel between Commission Rock and Western shore	25	------	------	------	------	------	1856.
	In mid-channel between navy yard and Vallejo	25	------	------	------	------	------	1856.

APPENDIX No. 21—Continued.

Places.	Limits between which depths are given.	Least water in channel way. Mean, lowest of day. Low water.	Mean, lowest of day. High water.	Spring tides, lowest of day. Mean. Low water.	Spring tides, lowest of day. Mean. High water.	Spring tides, lowest of day. Moon's greatest declination. Low water.	Spring tides, lowest of day. Moon's greatest declination. High water.	Date.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
Ballenas bay	Inside of breakers on Duxbury reef, about a mile from shore	24	28.2	23.6	28.6	22.9	28.4	1853.
Sir Francis Drake's bay	Half a mile inside the point, and 400 yards from shore	17	21.2	16.6	21.6	15.9	21.4	1853.
Bodega bay	Half a mile inside of reef, at anchorage off point, 900 yards from shore	36	40.0	35.4	40.7	34.8	40.4	1853.
Coast	At Haven's anchorage	48						1853.
Albion river	Anchorage at entrance	48						1853.
Mendocino city	Anchorage inside of point	30						1853.
Shelter Cove	Anchorage 500 yards inside of point	22						1853.
Humboldt bay	On bar, half a mile from shore	21	25.8	20.4	26.4	19.7	26.1	1853.
	Main channel	20	24.8	19.4	25.4	18.7	25.1	1851.
Crescent City harbor	Anchorage, half a mile off Crescent City	21	26.2	20.4	26.9	19.7	26.5	1853.
Port Orford or Ewing harbor.	Anchorage, three-fourths of a mile from Tichenor's rock, and half a mile from Battle rock	46	51.7	45.4	52.4	44.7	52.0	1853.
Umpquah river	On bar, opposite mid channel	13						1853.
Columbia river	North channel to Baker's bay	24	30.5	23.4	30.9	22.7	30.6	1852.
	*Entrance into south channel	19	25.5	18.4	25.9	17.7	25.6	1852.
	On bar of south channel	16	22.5	15.4	22.9	14.7	22.6	1853.
Shoalwater bay	On bar	18						1851.
	North channel	22.5	29	21.6	29.5	20.9	29	1853.
	South channel	25	31.5	24.1	32	23.4	31.5	1853.
Grenville harbor	Anchorage, three-quarters of a mile inside of Point Grenville, and same distance from shore	22						1854.
Neé-ah harbor	Anchorage, a mile inside* of Wad-dah island, and 450 yards from shore	36	42.4	34.8	43.0	34.1	42.5	1851.
False Dungeness	Harbor anchorage	54	60					1853.
New Dungeness	Harbor anchorage	45						1855.
Smith's island, (N. side)	Anchorage near Kelp, 450 yards from shore	25						1854.
Bellingham bay		60	67					1855.
	Anchorage, 400 yards SW. of Fitzhugh's wharf	18						1855.
Port Townshend	Anchorage, 400 yards east of custom-house	48	54.4	47.4	54.7	46.3	55.2	1854.
Port Ludlow	Anchorage	36						1855.
Port Gamble	Anchorage	18						1855.
Seattle	Anchorage	20						1854.
Blakely harbor	Anchorage, 450 yards inside of entrance	46		45				1856.
Steilacoom harbor	Anchorage, off Steilacoom creek 400 yards	18	30.0	17.0	30.9	16.1	31.7	1855.
Olympia harbor	Mid-channel, town $1\frac{1}{4}$ mile distant, mission bearing E NE.	11						

* Twenty-one feet may be carried in at mean low water by keeping a little northward and westward, nearer the breakers of the middle sands, and, at the turn, hauling up for Cape Disappointment.

APPENDIX No. 22.

Report of Captain M. L. Smith, U. S. Topographical Engineers, assistant in charge of the Coast Survey office, and extracts from sub-reports of chiefs of the office divisions.

COAST SURVEY OFFICE, *October* 31, 1857.

SIR: In submitting to you the annual reports from the chiefs of the various divisions comprising this office, I take occasion to give a brief summary of their contents, also a few remarks in reference to the operations during the year.

The general design of the office organization being to take up the results as sent in by the field parties, digest and compute them, afterwards delineate on paper, and then, with all the despatch consistent with accuracy, publish to the world, with such directions, data, and conclusions as will be of use—the work will be glanced at in the order received, and pressed through the various divisions.

First in order the triangulation is received, the angles and distances computed, the points then plotted, and returned to the field parties for minute topographical detail, then again plotted on separate sheets and sent for the hydrographic results.

The second return of work is received by the drawing division, changed in scale to suit the nature and extent of locality desired to be embraced in one map or chart, worked up by the draughtsman into the appearance designed for the public; thence it passes to the engraver to be permanently fixed on copper plate for re-production. The plate goes from the engraving to the electrotype room, where a mould or alto is taken, and from the alto a cast or basso produced, which is the duplicate of the engraved plate, and the one used by the printer.

The process by which Coast Survey work is embodied into form through the medium of the office is thus generally indicated, in order that the particular mention of the divisions which constitute it a unit may not seem disconnected and confused.

It will be convenient to retain the general order already indicated, while giving the total of the office work, by presenting a brief summary of the operations of each of its divisions, also to confine remark to the chiefs, referring you for more detailed information to the divisions' reports themselves, herewith submitted.

I beg leave to call attention at this point to the vast amount of work done in the office from year to year, not apparent in the published results of the work, nor in the annual report of its progress.

To illustrate: by law two scales are designated on which the charts of the coast shall be published, viz: $\frac{1}{400000}$ and $\frac{1}{80000}$, or, which is the same thing, on a scale of about six and one-third ($6\frac{1}{3}$) and one and one-fourth ($1\frac{1}{4}$) miles to the inch. Let us suppose the entrance to Savannah river surveyed to include the lower anchorage; on either of the two scales mentioned the survey, when plotted, would be too small and minute to afford that certain guide as to position of lights, land marks, dangers, &c., necessary to enable the mariner to enter with safety and come to a proper anchorage. Hence a chart on a scale differing from either of the two mentioned, and of a size suitable to delineate all that a vessel's safety requires shall be shown, is drawn, engraved and published. The wants of commerce imperatively call for this. At first thought it might be supposed that the office had done with this particular locality with the issue of the chart; this is by no means the case; vessels must come to and leave this anchorage, and it is quite as important to know how to get there from any given point, or how to shape the course from there for any given point, as it is how to sail in after arriving; hence the position of this anchorage relative to other points near must be shown, and conveniently so, too, in order that the eye may take them in.

This necessity calls for a smaller scale, in order that a greater extent of coast may be put within convenient limits, and the same work is reduced a second time, then re-drawn and re-engraved to suit the new case.

Again: it is necessary to show the position of the anchorage with reference to points much more remote, in order that the vessel, while distant many hours, may know how to head so as to take the shortest possible direction. This calls for a scale still more minute, and the office re-produces the entire work again.

This occurs even a fourth time; and when it is stated that the charts on these small scales, on which the labor of years is expended, (for the smaller the scale the more nice and delicate becomes the work on it,) do not appear among the charts, &c., accompanying the annual report, it is readily perceived, as stated, that a large proportion of the labor of the office is not apparent to the casual reader, nor can well be described so as to become so.

Again: take the case of the computing division. Suppose a system of triangulation running along an extent of 400 miles of coast before it becomes practicable to measure a verification base, to fix absolutely the azimuth and the position of the terminating point astronomically, and that these results then disagree with the results of the triangulation, as in all human probability they will; now, it is comparatively easy to compute distances between points, to reduce base measurements and to compute the observations; but who besides the computer himself can estimate the weary pains—taking labor required to go back over hundreds of miles of triangulation, re-compute, re-examine everything again, weigh all the elements and chances of error, compare, adjust, and re-adjust, so that error may disappear and results agree. The same remark will also apply to the designing the form, limits and scale of maps, (termed projects,) requiring in the case of every chart or sketch issued a careful study, so that they may, as far as possible, fulfil every condition of usefulness that can be looked for in them.

The above is not to be understood as admitting or even intimating that in amount of work stated this report will not compare favorably with what has been done during any former year, but to draw attention to the fact that, notwithstanding the details given, many results are obtained and much labor expended that cannot be adverted to.

The general adjustment of force between the different divisions is very satisfactory; no one is too much in advance of the others in its labors; all are moving steadily forward in the track of the field work, and as nearly abreast as the nature of the work and the division of duties will admit of. In point of progress the computing and drawing must lead off, the engraving and publishing close up.

As to the state of advancement of the office relative to the field work, it is impossible to specify the number of weeks or months that separate the two; but it may in general be stated that the office is from one to three years behind.

I am not positive but what this state of things is not only necessary but desirable; opportunity for re-surveys and corrections of mistakes, supplying omissions, &c., is thus afforded, without the office itself being stopped in its progress or losing time in correcting erroneous information.

Computing Division.—The field covered by the labors of this division is necessarily extensive, inasmuch as the primary, secondary, and tertiary triangulation, all astronomical, chronometric, and magnetic observations, base measurements, &c., pass through it for computation, comparison and adjustment, each calculation being made over twice, and even in cases three times, to insure the last degree of accuracy. Patient and constant industry has enabled the division to meet all demands made upon it additional to the field computations, and by applying the check of observations differing in kind, together with that of duplicate and triplicate reductions, the results are given forth with an accuracy that cannot but be reliable and satisfactory.

This division consists of seven persons, under the direction of Assistant C. A. Schott, who with unwearied industry has devoted his time to its superintendence and duties.

With a view to give some indication of its importance, and the care bestowed upon the computations, the following statement* of the number of days spent on each computation is submitted, but, as before mentioned, the labor of the division cannot be summed up. The occupation of the several computers engaged is stated in the annexed report of Assistant Schott.

Tidal Division.—Some changes have occurred in the complement of persons composing this division during the year, but its number has been so maintained as to meet the duties imposed upon it by the office, and at the same time continue the discussion of various tidal and other phenomena, under your direction, as shown by its records of observations.

With the exception of furnishing to this office the tidal data for charts, the labors of the division are directly controlled by the superintendent, to whom the chief assistant, L. F. Pourtales, reports. As the report referred to will be found elsewhere,† a more extended notice of the occupation of this division becomes unnecessary. A general statement will be found annexed to my report.

Drawing Division.—All the topographical and hydrographic work executed by the various Coast Survey parties dotted along the seaboard of the United States is received into this division, reduced in scale, joined together, discrepancies reconciled, and then worked up into the appearance designed for publication. In addition, much labor is consumed in preparing for the field parties the sheets used, and projecting upon them the astronomical and trigonometrical points previously determined. Considerable information also is given forth directly from this division every year, in cases where it is too important to be delayed for engraving by tracings from original drawings.

The division consists of fifteen persons, subject to the immediate direction of Lieutenant J. C. Tidball, U. S. A., and is kept under a rather constant pressure by the wants of field parties calling for information, of the engraving division for work, and by the lithographers in Baltimore, Philadelphia, and New York, by whom a portion of the charts and sketches for the annual report are executed. Still, although the demand upon it is constant, all calls for information and work have been promptly met, and the amount of work reported shows a steady increase upon that of previous years ; also a gradual gain upon the field work.

It is a fact well known and established, that more time is consumed by an isolated party, in working up the results of its own survey, plotting and making the drawings, than is required to make the survey itself and obtain all desired data.

If the Coast Survey, in this respect, shows more rapid progress in the office, it may be regarded as due, solely, to the system established, that the field parties shall be kept in the field, having little or no office duty proper to perform, and that the office party shall be charged with no field duty, but kept steadily employed with its own peculiar duties ; thus enabling the experience and skill gained from day to day to be advantageously applied on each succeeding

*Omitted. †Appendix No. 34.

one. Some few changes in the individual draughtsmen have occurred, but no difficulty was experienced in maintaining the standard of skill, intelligence, and industry. The working force has not materially varied. Four of the draughtsmen have been constantly kept on the $\frac{1}{80000}$ finished charts ; eight others partly on the finished charts and partly on others of a larger scale ; the remainder on maps less highly finished, and on the ordinary drawings and tracings of the office.

I subjoin, with the report of Lieutenant Tidball, a list of maps, charts, and sketches, completed and in progress, as comprising the operations of the division during the past year.

Engraving Division.—It is a matter of necessity that muchinterest should centre around the labors of this division. As the work of the survey has progressed from one step to another, been digested, reduced into form, revised and modified, it finally comes to that point when it is to be given to the public, in a form not only accurate in detail, but practically useful and pleasing to the eye.

The best engravers have consequently been sought, to properly express the valuable labors previously expended on the work, and upon their success must depend, to a very considerable degree, the general success of the work in the estimation of the country.

It is believed that thus far no cause for disappointment exists, and that, both as specimens of art and as faithful representations of the portion of country intended to be delineated, and as giving reliable information to the navigator how to enter the different harbors, and the depth of water he can rely upon as being able to carry in, they are unsurpassed.

The engravers themselves certainly stand high in their art. It has chanced that, since my connection with the office, specimens of work have been submitted by various persons in Europe, with a view to their getting employment here. The inference has naturally been that the applicants were among the most skillful of their class, and certainly no specimen received has been of an order such that, in my opinion, it could not to-day be excelled in this office.

The charge of this division has been under the control of Lieutenant Rufus Saxton, U. S. A., whose management has proved judicious and effective.

The yearly project of work for 1857 proposed the following to be accomplished in engraving, to wit : Plymouth harbor, Muskeget channel, Monomoy shoals, Albemarle Sound, Beaufort harbor, and San Francisco entrance, together with the list of preliminary charts, &c., published in report of 1856. All the work contemplated has been done, with the two exceptions of Albemarle Sound, No. 2, and Muskeget channel ; the former has been delayed in consequence of a small amount of work required to complete it not being in the office ; the latter is still in hand, and reported as requiring at least one year's steady work of an engraver to complete, affording an instance where, with all the experience of the office, it has been found impossible to make an approximate estimate of the time required.

Still the division has not fallen behind even in the number of plates, as the two important charts of Eastern and Middle sheets of south side of Long Island, Boston and Charleston harbors (all of which the yearly prospect of work did not contemplate) have been finished, and contain the changes shown by the most recent surveys. In addition to the first class charts completed, considerable work has been done upon ten others, which it is not possible to show in a report. It can only be apparent to those in the office.

The total number of engravers is twenty-one, most of whom have attended to the work entrusted to them with a commendable spirit of industry and professional ambition. The exceptions to this have not been of such a character as to call for more than a passing notice, and are corrected by the mere knowledge of them.

The various calls made upon the division have been promptly met, and thus far no test of its taste and skill in execution has been too great.

The system of apprenticeship established may be regarded as working well ; the office gets a certain class of work done more cheaply than by other means, and the young men, by learning the art of engraving through the instrumentality of the office, are given the means of earning a future livelihood.

During the coming year it is proposed to complete the following plates, to wit :

The finished first class charts of Eastern series No. 2, Muskeget channel, Annis Squam and Ipswich harbors, Patapsco river, Albemarle Sound, Nos. 1 and 2, Beaufort harbor, (re-survey and new edition,) Mississippi Sound, No. 1, San Francisco bay, San Diego bay, together with seventy-three preliminary maps, charts, sketches, and diagrams.

The following extract from Lieut. Saxton's report contains a summary of the work done in the engraving division during the past year.

"In the engraving division, seven first class maps have been completed during the year, and seventeen have been in progress. Of these last, ten were commenced in former years, and seven in the present year. Twenty second class maps or charts and sketches have been completed during the year, of which sixteen were begun in the present year, and nine of the same class, commenced within the year, are in progress. Thirteen diagrams have been completed. This gives a total of forty plates completed, and of twenty-nine in progress, or of sixty-nine engraved or engraving within the year ending November 1, 1857. The additions and corrections have been so numerous to six of those previously published that they have been re-issued as new editions, and two of those formerly issued in a preliminary form have been completed. The chart of Boston harbor is included in this year's finished list, owing to the various corrections and additions which have been made upon it. In addition to those engraved upon copper, thirteen charts and sketches have been engraved upon stone. The complete list giving the titles of the maps and charts will be found appended to this report. The list of maps, charts, and sketches, up to the present date, which also accompanies the report, includes two hundred and eight titles. Of these, fifty-two are first class or finished maps. Twenty progress sketches, in addition, have been engraved."

Electrotype Division.—From rather an experimental beginning, this division has grown to be one of the most important auxiliaries in getting before the public the results of the survey ; it is to the engraving division what the die is to the seal ; let a plate on which there is engraving but pass into it and that engraving is perpetuated ; deface or destroy the original, it can be re-produced "*ad infinitum*" in the utmost perfection.

Never has the process been carried on with more certainty than during the past year, and the number of plates capable of being produced by the process is only limited by the means placed at the disposal of the electrotypist ; a few years ago it was thought an achievement to produce six perfect plates in a year, now one is produced on an average of every two and a half working days.

In the report of the Superintendent for 1855 a brief description is given of the facility with which work on different copper plates is joined together, by using thin electrotypes of them, which can be readily cut with the scissors, thus fitting the work together, and afterwards producing a new plate by the same process.

It is now practically ascertained that thin electrotypes are all that is necessary ; the stiffness requisite to print from being given by stretching them on steel plates having a smooth surface, and cut to the proper size. As one steel plate, termed a *stretch plate*, will answer for all electrotypes of the same size, it is readily perceived that a great saving of both time and expense will hereafter follow in this division.

The use of thin electrotypes in combination with steel or any substance that will give it the necessary support has led Mr. Mathiot, who is in charge of the division, and to whose experiments and researches it is conceived the Coast Survey owes much, to propose its application to all kinds of printing done from engraved surfaces, other than warped surfaces. The Superintendent's attention is invited to this as a matter of record.

To illustrate by a single example: Calico printing is now done from a steel or copper cylinder on which the desired figures or designs are engraved and stamped at a heavy expense; when this cylinder is too much worn for use there is no method of producing more of the same prints except by engraving a new cylinder at the same expense as the first.

By the use of the thin electrotype plate, which is almost as flexible as paper, the above expense is almost entirely done away with. Instead of engraving on a cylinder, which in the first place is difficult, let the design for the prints be engraved on an ordinary copper plate; from this plate obtain the thin electrotype, which wrap around a smooth prepared cylinder and secure; the engraved steel cylinder, or its equivalent, is now ready; when worn the electrotype wrapping can be replaced any number of times and at the most trifling expense. If the expectations above alluded to prove well founded, it is readily perceived that a complete revolution may be produced in the present limited uses to which printing from copper is put.

The following on this subject is an extract from Mr. Mathiot's report:

"The working of the thin electrotypes has suggested to me the idea of using these plates on a circular bed or roller, and gaining thereby the great advantages of cylinder printing for flat plates. This has often been sought before, but the impossibility of getting a rigid plate to conform accurately to a cylindrical figure has hitherto defeated it. As the thin electrotypes are easily strained over a covered surface, the great desideratum is now attainable. I am about having this matter put to a practical test, and have every hope that the copper-plate printing can thus be executed by steam machinery, and with almost the rapidity of letter-press work."

Printing.—Lieutenant A. P. Hill, U. S. A., in addition to his duties as general assistant in this office, has given more particular supervision to this branch of the work, and reports that both presses were discontinued for a brief space in order to repair the boiler; the small press in addition was not in use for a time, Mr. J. Rutherdale having been taken from it and placed at the large one, in place of Mr. O'Brien, on the 1st of July. A printer for the small press has now been employed and both are in active use.

In consequence of the necessary changes stated above, the number of impressions struck off from the various plates was diminished.

Some improvement has been made in the preparation of the ink used, by which it dries harder and is more adhesive; the lines also come out more clearly defined.

A subjoined list will show the number of impressions taken from the different plates since November 1, 1856.

The *distribution* of maps and Coast Survey Reports has been attended to by Mr. V. E. King, who, when not so occupied, has performed clerical duties in the office. I would refer to his report, hereto annexed, for a statement, in the usual form, of the number of impressions sent from the office.

Archives and Library.—Owing to the number of original sheets constantly received and sent away, and to the continued demand of the office as well as from field parties for information, the keeping of the archives and scientific library attached becomes rather important to the proper working of the Coast Survey.

The system and attention of Mr. C. B. Snow, who is in charge, have afforded every desired facility, and his services have given satisfaction. He reports as follows: "During the past year there has been no change in the arrangement of the archives; the records are in as good order as the limited space will allow, but, in consequence of the increasing number of volumes and the smallness of the room, great inconvenience will be felt if a larger space is not shortly provided."

"To the library there have been added during the year, between January, 1856, and January, 1857, three hundred and eighty-nine volumes, of which one hundred and sixty-one were presented by foreign governments and different scientific societies."

Instrument Shop.—The statement furnished by Mr. J. Vierbuchen, master instrument maker, shows that the following instruments have been made during the year, viz: three plane tables, two compasses for plane tables, the motion work for a plane table, fourteen spring clamps for plane tables, fifteen metre chains, and as many pairs of shoes for chain metre poles, two theodolites, six theodolite stands, four riding levels, four deep-sea thermometers, two eye pieces for theodolites, four beam compasses, four lanterns for transits, two 3-armed protractors, two stands for leveling instruments, a reversing apparatus for transit, a pyrometer for base apparatus, two current metres, two rulers for tide gauge divisions, four tide gauges, three sextants, twelve stands for base apparatus, a set of base rods with sectors, and numerous smaller instruments for use in the field and in the office.

In addition to the above, repairs were made on twenty-three theodolites, twenty-two plane tables, twenty-five sextants, seven surveying and four prismatic compasses, four telegraph registers, two dip circles, seven theodolite stands, fourteen metre chains, six sounding apparatus, (altered for deep-sea indications,) eleven deep-sea thermometers, three levelling instruments, ten beam compasses, and a number of other field and office instruments.

The labors of this branch of the office have been in every way satisfactory. The demand for the deep-sea thermometers has been supplied.

A great variety of work has been done on the base apparatus. All the paper used on the self-registering tide gauges has been cut and rolled. The drawing instruments have been kept in order, and a large amount of miscellaneous work executed during the year. The force employed consists of six mechanics, a blacksmith, and an apprentice.

Carpentry.—I subjoin a statement of the most important work done in the carpenter's shop, under the direction of Mr. A. Yeatman, master carpenter, whose services are very satisfactory:

"There have been made eleven theodolites and plane-table stands; twelve plane-table boards; ten cases with pigeon holes for office records; two large cases, with slides, for copper plates in archives; one large case, with drawers for filing proofs, in engraving division; seven fine cases for theodolites and plane tables; wood work for four new tide gauges; twelve boxes, with inside work, for packing same; two complete sets of stands and boxes for subsidiary base apparatus; one case for dividing engine; painting and numbering upwards of 120 tin cases for original sheets; four covered writing tables for office; one engraver's table; 350 feet of fencing, eight feet high; putting up house for preservation of boxes; seven large drawing boards; one large vat for electrotyping; about 25 boxes for packing valuable instruments, such as transits, heliotropes, plane tables, &c., &c.; one carpenter's bench for shop; one covered desk and table for office;

152 packing boxes ; six large frames, with panels, for backing drawing paper ; one camp table and three camp stools ; with a large variety of miscellaneous work. Repairs have been made to the Coast Survey buildings to a greater extent than in previous years, and all the instruments sent from the office to field and hydrographic parties have been packed."

In closing this report, I take occasion to remark upon the great advantage resulting to the office in having a general assistant, to take the place of the assistant in charge of the office in case of sickness or absence ; also to attend to those special cases requiring more time and attention from the assistant in charge than is consistent with due attention to the general duties of this office.

Lieutenant A. P. Hill, U. S. A., still continues to occupy this position, and the interest, as well as ability, displayed by him in performing the requirements of the office, cannot fail to meet your warmest commendation.

I take pleasure, also, in calling attention to the admirable manner in which the clerical duties of the office are performed by Mr. A. W. Russell. Much of the success met with in any business is due to the proper keeping of books and papers, and the remark is peculiarly applicable to this office, where the duties are various, and papers and accounts numerous and complicated.

Very respectfully, your obedient servant,

M. L. SMITH,
Capt. Top. Eng'rs, Assistant in charge Coast Survey Office.

Professor A. D. BACHE,
Superintendent U. S. Coast Survey.

Report of Assistant Charles A. Schott, in charge of the computing division.

COAST SURVEY OFFICE, *October* 1, 1857.

In compliance with the office regulations, the usual annual report on the condition of the computations and the occupation of the computers during the year past is herewith respectfully submitted.

During my temporary absence from the office, from the middle of March to the end of May, while engaged on field duty, the division was attended to by Assistant J. E. Hilgard. On the last of July Mr. J. E. Blankenship resigned, and the vacancy thereby occasioned has not been filled at the date of this report.

Since no important alterations were made in the general organization of the division, the same being perfectly efficient, it needs no other reference than that to the character and amount of work done by the several computers, of which a detailed statement follows.

As far as the nature of the field work received and the requirements of the office permitted, the general plans and estimates for the year have been adhered to. Particular attention was paid to the revision of the astronomical azimuth and latitude computations ; the adjustment of the triangulations is also claiming more time, in proportion to the increase of the number of connected astronomical positions and the junctions of the separate parts of triangulations. The reduction of the magnetic observations and discussions have been fully kept up to date. The general condition of the astronomical and geodetic reductions is in due conformity with the state of the field work, and the present force of computers is just sufficient to keep it thus balanced. The increase in the field-work occasions no further pressure, as the same is met by the corresponding advantage of the accumulated experience of the computers.

On the 16th of March the Superintendent assigned me to duty in his party, for the determination of the longitude of Fernandina, Fla.; a detailed statement of which will be found elsewhere. On May 29 I again took charge of the division, completed the reduction of the longitude of Fernandina from chronometer transportations, and reduced the magnetic observations at Savannah and Fernandina, 1857. Prior to this field duty I reduced the magnetic declination, dip, and intensity of seventeen stations in Section III, 1857. In December last I was engaged for one week at the Astor Library, New York, in completing the Coast Survey bibliographical index. Besides, a number of reports were submitted to the assistant in charge, amongst them the following: On the junction of the geodetic operations of Sections III and IV and of Section IV with Cape Fear river; on the connection of the Cedar Keys and Waccasassa Bay triangulation; on the latitude and longitude of astronomical station at the mouth of the Rio Grande. I made also a sketch of a hypsometrical equatorial section of the earth's surface, and reduced the Key Biscayne base. All current work for the office and calls from the field parties have been promptly attended to. The geographical positions published in this volume will be found noticed at the end of this report.

Assistant Theodore W. Werner completed the transit and latitude reduction of Humboldt Bay station, Section X, reduced the triangulation of Matagorda Bay of 1856, and Sapelo Sound of 1856, for which latter locality rectangular co-ordinates were computed. He calculated the geographical position of about forty stations near New York, of Assistant Blunt's triangulation. Mr. Werner also reduced the primary and secondary measurements of Assistant Boutelle's triangulation, from Edisto Island to Long Island, S. C., Section V, between 1849 and 1856; a work of considerable labor, including the positions of over two hundred trigonometrical stations. He also completed the reduction of Assistant Davidson's triangulation of Admiralty Inlet, and computed the latitude, longitude, and azimuth of the whole of that triangulation.

Mr. Eugene Nulty made the reduction of the following astronomical azimuths: Of Hurricane Island, Section VII; of Mount Desert, Section I; of Point Hudson, Section XI; of Cat Island, Section VIII; of Yard, Section II, and of Point Pinos, Section X. Mr. Nulty also reduced the latitude of stations Fort St. Mark's and St. Mark's Light, Section VII; of Deer Island, Section VIII; of Hurricane Island, Section VII; of Mount Desert, Section I; of Mobile, Section VIII. Besides some miscellaneous computations, he also reduced transits in connection with occultations of the Pleiades by the moon, made the second reduction of the magnetic observations at Lower Peach Tree, Section VIII, and made considerable progress with the second reduction of the chronometric longitude of Fernandina, Fla.

Mr. James Main made the second reduction of my magnetic observations for declination, dip, and intensity in Section III, 1856; reduced the magnetic observations at Macon and Lower Peach Tree, Section VIII, and at three stations occupied in Section I by the Superintendent's party in 1856. He also made the second reduction of magnetic observations at stations Savannah, Section V, 1857, and Fernandina, Fla., 1857, and performed the computations to show the loss of magnetism of the magnets in use in the survey. Besides some miscellaneous work, Mr. Main prepared some papers of collection of formulæ specially for latitude and azimuth; made the second reduction of the Point Avisadera azimuth, Section X; of the longitude by moon culminations of stations Cape Florida and Sand Key, Section VI; of the longitude by moon culminations, and of that of the astronomical station at the mouth of the Rio Grande, Section IX.

He also revised the latitude computations of stations mouth of the Rio Grande, Fernandina, Fla., and Mount Ragged, Section I. The azimuths at stations Mount Ragged, Section I, and Wilmington, N. C., Section IV, have also been revised.

Mr. G. Rumpf reduced part of Assistant Hassler's triangulation south of Cape Henry; assisted Mr. Hilgard on the reduction of his triangulation in Section VIII; reduced the triangulation and computed rectangular co-ordinates of St. John's river, Section VI, and of Hudson river, below Albany, Section II, 1856. Mr. Rumpf assisted me in the preparation of certain statistics of geodetic operations, and attended to the registers of the geographical positions. He also reduced the triangulation of Lieutenant Seward on the Florida reef, 1856; supplied the L. M. Z. to the Bahia Honda work of 1849; computed the position of some stations in Section I; partly reduced the geodetic operations on the James river, Section III; computed the York river triangulation, Section III; revised the computation of positions in Section V, and made considerable progress with the reduction of Assistant Blunt's triangulation of 1854, 1855, and 1856, in the vicinity of New York, comprising the computation of several hundred positions.

Mr. Jno. Weissner, after his recovery from a severe illness in October and November last, reduced the triangulation east of the Cedar Keys of 1856, Section VII; of Pensacola bay of 1856, Section VII, and of Matagorda bay, Section IX; made an abstract of the horizontal angles at Mt. Saunders and Mt. Desert, by the method of least squares; reduced Lieutenant Evans' secondary triangulation near Cape Small, Section I, 1855–'56; completed the second reduction of the Ewing harbor latitude Section X; performed some miscellaneous computations, and completed the adjustment of the seacoast triangulation of Section IV, north of Bodies island.

Mr. J. E. Blankenship discussed magnetic results under Assistant Hilgard's direction; assisted on the reduction of Section VIII triangulation; computed the triangles and rectangular co-ordinates of the St. Mary's river, Section V; reduced Assistant Wadsworth's triangulation north of Cape Fear of 1856; adjusted the base quadrilateral on Key Biscayne, and performed some miscellaneous computations. He was attached to the Superintendent's party for field duty on the 5th of March, and again reported for duty in the division on the 14th of May. After reducing Lieutenant Clark's triangulation of 1857 on the Florida reef, and connecting with it the Grassy Key work, he resigned on the last of July.

Mr. John T. Hoover, clerk to the division, attended to the correspondence and reports; assisted me in the preparation of various diagrams, illustrating magnetic and astronomical computations; also assisted in the reduction of Assistant Wadsworth's triangulation work of Cape Fear, and on the preparation of the geographical positions published in this report.

Mr. D. Hinkle was temporarily assigned to this division on June 1st; computed the rectangular co-ordinates of the Pensacola bay triangulation, and had made good progress with the reduction of the Atchafalaya and Côte Blanche triangulation, Section VIII, when he was detached, on July 6th, for duty with the Superintendent's party, in Section I.

Messrs. T. F. Herbert and L. Daser were temporarily assigned to the division—the former on August 13th, the latter on the 17th of the same month—to assist me in the preparation of several hundred geographical positions published in this report in continuation of the lists in the reports of 1851, 1853, and 1855. *R. Freeman* was engaged in copying papers required by the office or by field parties.

Report of Assistant L. F. Pourtales, in charge of the Tidal Division.

COAST SURVEY OFFICE, *October* 31, 1857.

The following report on the occupation of the computers in this division during the past year is respectfully submitted:

Mr. R. S. Avery has continued to discuss the Boston tidal observations for the deduction of constants for predictions. A great part of this work was done under the direction of Mr. L. W. Meech.

Mr. C. Fendall made diagrams of type curves of the Gulf of Mexico and graphical decompositions of some of the western coast tides until November 24, when he was detached for field duty.

Mr. G. C. Blanchard has been chiefly engaged in reading off and reducing the observations recorded by the self-registering tide gauges; he has also made other ordinary reductions, and has continued the copying of reports, correspondence, &c., for the division.

Mr. R. E. Evans was attached to this division from November 24 to December 13, and from June 11 to this date, having been attached to a field party in the interval. He finished some of the decompositions of western coast tides commenced by Mr. Fendall, reduced some of the Hudson river tides, and made various ordinary reductions and diagrams. He has also, part of the time, read off the records of the self-registering tide gauges.

Mr. C. M. Yulee made ordinary reductions of the western coast tides, and decomposed the tidal curves of the stations on the Florida reef. He resigned on the 1st of July.

Mr. G. B. Vose was attached to this party until January 30. During that time he was chiefly engaged in assisting Mr. Avery in the discussion of the Boston tides. He made also miscellaneous computations.

Mr. R. T. Bassett joined this division on the 10th of November, and was engaged in ordinary reductions until April 25, when he was detached to take charge of the tidal station at New York.

Mr. S. Walker joined the division from Sub-Assistant Mitchell's party on April 27. He made graphical decompositions of one year's tidal observations at San Diego, and keeps up the decompositions of the Florida reef observations.

Mr. G. B. Maynadier was temporarily employed from July 7 to September 5, making miscellaneous reductions.

The meteorological observations made at the permanent stations of the western coast have been reduced and tabulated as before by *M. Thomas.*

Report of Lieut. J. C. Tidball, U. S. A., in charge of the Drawing Division.

COAST SURVEY OFFICE, *November* 1, 1857.

Since the date of my last annual report, I have continued in charge of this division, in the duties of which I have been assisted by Mr. G. A. Porterfield.

The following statement of work executed by draughtsmen, and the accompanying list of maps, charts, and sketches, completed or in progress, will show the operations of the division during the past year.

Assistant W. M. C. Fairfax has completed the reduction of hydrography of Eastern series, No. 3, $\frac{1}{80000}$; commenced the drawings of coast of South Carolina, in the vicinity of Charleston, $\frac{1}{80000}$; coast of Texas, in the vicinity of Galveston, $\frac{1}{80000}$, and San Francisco bay, $\frac{1}{80000}$; and has been engaged upon the topography of Cape Cod bay, $\frac{1}{80000}$; Chesapeake bay, Nos. 5 and 6, $\frac{1}{80000}$; arrangement of titles and notes of drawings for lithography; specimens of topography, verifications, and projections on copper.

Assistant M. J. McClery has been engaged upon the topography of coast chart, from Portsmouth to Cape Ann, $\frac{1}{80000}$; Massachusetts bay, $\frac{1}{80000}$; Chesapeake bay, No. 4, $\frac{1}{80000}$; additions to the Congress map, $\frac{1}{1500000}$; and specimens of topography.

Mr. Joseph Welch was engaged on the topography of Massachusetts bay, $\frac{1}{80000}$, during part of the months of November and December. The office lost the services of this accomplished topographic draughtsman by his death, which occurred on the 12th of February.

Mr. J. J. Ricketts has reduced the chart of Cortez bank, $\frac{1}{80000}$; completed the hydrography of Eastern series, No. 2, $\frac{1}{80000}$; and Long Island sound, No. 3, (south side,) $\frac{1}{80000}$; and has been employed upon the hydrography of the general coast chart, from Cape Ann to Point Judith, $\frac{1}{400000}$; Chesapeake bay, No. 3, $\frac{1}{80000}$; Florida reefs, $\frac{1}{200000}$; Florida reefs, from Carysfort reef light, southward, $\frac{1}{80000}$; San Pablo bay, $\frac{1}{50000}$; verifications and examinations of hydrographic drawings.

Mr. F. Herbst was employed principally upon the light-house maps, $\frac{1}{600000}$, from the 22d of December until the 7th of March, when he left the office.

Mr. A. Boschke rejoined the office, from special duty, in the month of June, since which time he has been employed on projects, and has had charge of the drawings of the maps of New York bay and harbor, $\frac{1}{20000}$, for the State of New York.

Mr. L. D. Williams has drawn apparatus for the measurement of minor bases; completed additions to Monomoy shoals, $\frac{1}{40000}$; made projection of sphere on copper, and has been engaged upon the charts of the seacoast of Massachusetts, from near Scituate to Saughkonnet river, $\frac{1}{200000}$; seacoast of part of Maine, New Hampshire and Massachusetts, $\frac{1}{200000}$; title and lettering of the light-house maps, and verifications.

Mr. A. Balbach rejoined the office on the 15th of May, from special duty in New York; since which time he has completed the hydrography of San Diego bay, $\frac{1}{40000}$; and has had in hand San Pablo bay, $\frac{1}{50000}$, and New York bay and harbor, $\frac{1}{80000}$.

Mr. A. Lindenkohl has reduced the topography and hydrography of Provincetown harbor, $\frac{1}{60000}$; the topography of San Diego bay, $\frac{1}{40000}$; sketch of San Francisco entrance, showing position of the Farallones, $\frac{1}{400000}$; commenced the topography of Monterey bay, $\frac{1}{60000}$; York River entrance, $\frac{1}{60000}$; and has been employed on the light-house maps, projects and progress sketches.

Mr. W. P. Schultz has made the reduction of St. John's river, from Brown's creek to Jacksonville, $\frac{1}{25000}$; Mississippi City harbor, $\frac{1}{40000}$; compiled the sketch of Gulf of Mexico, $\frac{1}{600000}$; and has been employed on progress sketches, projections for original sheets, projections on copper, and verifications.

Mr. L. Daser joined the office, from the hydrographic party of Comdr. Sands, on the 24th of January. He has reduced the hydrography of St. Mark's river, $\frac{1}{30000}$; and has been employed on the hydrography of Waccasassa bay, $\frac{1}{50000}$; sketch of the Gulf of Mexico, showing lines of deep-sea soundings and profiles of bottom, $\frac{1}{2400000}$, Mississippi sound, No. 2, $\frac{1}{60000}$; seacoast of Mississippi and Louisiana, $\frac{1}{200000}$; and the light-house maps, $\frac{1}{600000}$. He was transferred to the Computing Division on the 17th of August.

Mr. W. T. Martin has drawn diagrams showing injuries to boilers of steamer Hetzel; diagrams illustrating telegraphic apparatus; made additions to the topography of St. Andrew's bay, $\frac{1}{40000}$; and has been employed on the topography of Hudson river, (lower sheet,) $\frac{1}{60000}$; James river, $\frac{1}{40000}$; Albemarle sound, No. 1, $\frac{1}{80000}$; and coast of Texas, in the vicinity of Galveston, $\frac{1}{80000}$.

Mr. A. Strausz joined the office, from the hydrographic party of Lieut. Comg. R. Wainwright, on the 10th of September, and has been engaged on the hydrography of St. Helena sound, $\frac{1}{40000}$.

Mr. P. Witzel has drawn the comparative chart of Hudson river, from Albany to New Baltimore, $\frac{1}{20000}$; the comparative chart of Cape Fear entrance, $\frac{1}{20000}$; eastern entrance to Santa Barbara channel, $\frac{1}{80000}$; San Antonio creek, $\frac{1}{20000}$, and Mare Island straits, $\frac{1}{30000}$; and has been employed on the light-house maps, $\frac{1}{600000}$, progress sketches, and projections.

Mr. W. Wagner was employed in the office from the 21st of October to the 8th of May, during which time he reduced the topography of St. Mark's river, $\frac{1}{30000}$; made additions to the Gulf Stream chart, $\frac{1}{5000000}$; and was employed on the preliminary charts of the seacoast of North Carolina, $\frac{1}{200000}$; seacoast of South Carolina, $\frac{1}{200000}$; seacoast of Texas, $\frac{1}{200000}$; and Kennebec river entrance, $\frac{1}{30000}$.

Mr. F. Fairfax has reduced St. Simon's sound and Brunswick harbor, $\frac{1}{20000}$; completed the topography of Rappahannock river, Nos. 1 and 2, (from Fredericksburg to Port Royal,) $\frac{1}{20000}$; extended the hydrography of Charleston harbor, $\frac{1}{30000}$, to include Rattlesnake shoals; and has been engaged on the upper sheet of James river, $\frac{1}{40000}$, and on sketches.

Mr. W. Fairfax was employed upon the reduction of sketches and on tracings till the 30th of June, when he left the office.

Mr. A. Schoepf has drawn, on contract, the preliminary charts of Hampton Roads, $\frac{1}{40000}$, and Norfolk harbor, $\frac{1}{10000}$.

Mr. E. Hergesheimer has reduced, on contract, the preliminary and comparative charts of St. Mary's bar and Fernandina harbor, $\frac{1}{20000}$.

Mr. A. E. Hartman continued upon projects until the 20th of November, when he left the office.

Mr. G. C. Humphries was temporarily employed in the division during part of the months of February and March upon the light-house maps.

Mr. E. Cordell joined the office, from the hydrographic party of Comdr. Stellwagen, on the 22d of June, and continued until the 17th of July, when he was assigned to duty with Lieut. Comg. Maffitt. During this time he was employed on hydrographic reductions.

Mr. B. Hooe has continued on tracings.

Mr. J. B. Linton has been employed on tracings and practice work, and has reduced Grand Island Pass and Pearl river entrance, $\frac{1}{40000}$; and St. Louis bay and Shieldsboro' harbor, $\frac{1}{30000}$.

Mr. W. T. Bright has been employed on tracings and practice work, and has reduced the harbor of Wood's Hole, $\frac{1}{20000}$.

Artificer J. A. Campbell has been employed on tracings, and in marking the limits of original sheets on the progress sketches of the sections.

Mr. H. McCormick was continued on tracings until the 1st of April, when he left the office.

List of maps and sketches completed, or in progress, during the year ending November 1, 1857, arranged in order of sections.

Name.	Scale.	Description.	Remarks.
SECTION I.—*Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.*			
Progress sketch A	1-600,000		Completed.
Progress sketch A, *bis*	1-400,000		Do.
Kennebec river approaches, and entrance to Adkin's bay, Maine	1-30,000	Preliminary chart	Do.
Seacoast of Maine, New Hampshire, and Massachusetts, from Cape Neddick to Scituate harbor	1-200,000	do	In progress.
Coast of New Hampshire and Massachusetts, from Portsmouth to Cape Ann	1-80,000	Finished map	Do.
Annis Squam and Ipswich harbors, Massachusetts	1-20,000	do	Completed.
General coast chart, from Cape Ann to Point Judith, Massachusetts, and Rhode Island	1-400,000	Finished chart	In progress.
Massachusetts bay, from Cape Ann to Scituate	1-80,000	Finished map	Do.
Seacoast of Massachusetts, from near Scituate harbor to Saughkonnet river	1-200,000	Preliminary chart	Completed.
Cape Cod bay and coast of Massachusetts, from Scituate to Nausett	1-80,000	Finished map	In progress.
Provincetown harbor, Massachusetts	1-50,000	do	Completed.
Eastern series, No. 3, Massachusetts	1-80,000	do	Do.
Monomoy shoals, (additions,) Massachusetts	1-40,000	do	Do.
Eastern series, No. 2, Massachusetts	1-80,000	do	Do.
Harbor of Wood's Hole, Massachusetts	1-20,000	do	Do.
SECTION II.—*Coast of Connecticut, New York, New Jersey, Pennsylvania, and Delaware, north of Cape Henlopen.*			
Progress sketch B, New York bay and Hudson river to Albany	1-400,000		Completed.
Long Island sound, No. 3, (south side)	1-80,000	Finished map	Do.
New York bay and harbor	1-80,000	do	In progress.
Hudson river, lower sheet, from entrance to Sing Sing, New York	1-60,000	do	Do.
Hudson river, from Albany to New Baltimore, New York	1-20,000	Comparative chart, '52-3 to '56	Completed.
SECTION III.—*Coast of Delaware, south of Cape Henlopen, Maryland and Virginia, north of Cape Henry.*			
Progress sketch C	1-400,000		Completed.
Chesapeake bay, No. 6	1-80,000	Finished map	In progress.
Do No. 5	1-80,000	do	Do.
Do No. 4	1-80,000	do	Do.
Do No. 3	1-80,000	do	Do.
Rappahannock river, No. 1, from Fredericksburg to near Moss Neck, Virginia	1-20,000	do	Completed.
Rappahannock river, No. 2, from Moss Neck to Port Royal, Virginia	1-20,000	do	Do.
Rappahannock river, No. 5, from Occupation creek to Punch Bowl, Virginia	1-60,000	do	In progress.
Rappahannock river, No. 6, from Punch Bowl to entrance, Virginia	1-60,000	do	Do.
York river, from entrance to King's creek, Virginia	1-60,000	do	Do.
James river, from Richmond to City Point, Virginia	1-40,000	do	Do.
Hampton Roads and Elizabeth river, from Old Point Comfort to Norfolk, Virginia	1-40,000	Preliminary chart	Completed.
Norfolk harbor, Virginia	1-10,000	do	Do.
SECTION IV.—*Coast of Virginia, south of Cape Henry, and North Carolina, north of Cape Fear.*			
Progress sketch D	1-400,000		Completed.
Albemarle sound, No. 1, from entrance to mouths of Pasquotank and Alligator rivers, inclusive, N. C.	1-80,000	Finished map	In progress.
Seacoast of North Carolina, from Cape Hatteras to Cape Lookout	1-200,000	Preliminary chart	Do.
Beaufort harbor, (additions,) North Carolina	1-20,000	Finished map	Completed.

List of maps and sketches, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION IV—Continued.			
Cape Fear river entrance to Federal Point, (additions,) North Carolina	1–30,000	Finished map	Completed.
Cape Fear river entrance and New Inlet, N. Carolina	1–20,000	Comparative chart, '51 to '56	Do.
Gulf Stream, (extension to Newfoundland banks)	1–5,000,000	Sketch	Do.
Co-tidal lines of Atlantic coast, (additions)	1–10,000,000	do	Do.
SECTION V.—*Coast of North Carolina, south of Cape Fear, of South Carolina, and Georgia.*			
Progress sketch E	1–600,000		Completed.
Seacoast of South Carolina, from Cape Roman to Tybee light	1–200,000	Preliminary chart	In progress.
Coast of South Carolina, vicinity of Charleston	1–80,000	Finished map	Do.
Charleston harbor, (extension showing Rattlesnake shoals,) South Carolina	1–30,000	do	Completed.
North Edisto river, (survey of bar in 1856,) S. C.	1–50,000	do	Do.
St. Helena sound, South Carolina	1–40,000	do	In progress.
St. Simon's sound and Brunswick harbor, Georgia	1–40,000	Preliminary chart	Completed.
Cumberland island base, Georgia	1–100,000	Sketch	Do.
St. Mary's river and Fernandina harbor, Georgia and Florida	1–20,000	Finished map	In progress.
St. Mary's bar and Fernandina harbor, Georgia and Florida		Preliminary chart	Completed.
St. Mary's bar and Fernandina harbor, Georgia and Florida		Comparative chart, '43 to '57	Do.
SECTION VI.—*Coast of Florida, from St. Mary's river to St. Joseph's bay.*			
Progres sketch F, north of Miami river	1–600,000		Completed.
Progress sketch F, No. 2, south of Miami river, including reefs and keys	1–400,000		Do.
St. John's river, upper sheet, from Brown's creek to Jacksonville	1–25,000	Finished map	Do.
Florida reefs from Cape Florida to Tortugas, inclusive	1–200,000	Preliminary chart	In progress.
Florida reefs, No. 2, from Carysfort reef light southward	1–80,000	Finished chart	Do.
SECTION VII.—*Coast of Florida, west of St. Joseph's bay, and Alabama, east of Mobile bay.*			
Progress sketch G	1–600,000		Completed.
Waccasassa bay, Florida	1–50,000	Finished chart	Do.
St. Mark's river, from entrance to town of St. Mark's, Florida	1–30,000	Finished map	Do.
St. Andrew's bay, (additions,) Florida	1–40,000	do	Do.
SECTION VIII.—*Coast of Alabama, west of Mobile bay, Mississippi and Louisiana, east of Vermilion bay.*			
Progress sketch H	1–600,000		Completed.
Gulf of Mexico, from Cape Sable to Rio Grande, (addit's)	1–2,400,000	Sketch showing lines of deep-sea soundings, from Key West to Mississippi delta, and profiles of bottom	Do.
Do do	1–600,000	Sketch	Do.
Mississippi sound, No 2, from Round island to Grand island, Mississippi	1–80,000	Finished map	In progress.
Mississippi City harbor	1–40,000	do	Completed.
Seacoast of Mississippi and Louisiana, from Cat island to Lake Pontchartrain, inclusive	1–200,000	Preliminary chart	In progress.
St. Louis bay and Shieldsboro' harbor, Mississippi	1–30,000	Finished map	Completed.
Mississippi sound, No. 3, from Grand island to Lake Pontchartrain, inclusive, Mississippi and Louisiana	1–80,000	do	In progress.
Grand Island Pass and Pearl river entrance, Mississippi and Louisiana	1–40,000	do	Completed.

List of maps and sketches, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION IX.—*Coast of Louisiana, west of Vermilion bay, and of Texas.*			
Progress sketch J	1-600,000		Completed.
Seacoast of Texas, from Galveston bay, southward	1-200,000	Preliminary chart	In progress.
Coast of Texas, including Galveston bay and vicinity	1-80,000	Finished map	Do.
SECTION X.—*Coast of California.*			
Progress sketch I, No. 1, from San Diego to Point Sal	1-600,000		Completed.
Progress sketch I, No. 2, from Point Sal to Point Reyes	1-600,000		Do.
Progress sketch I, No. 3, from Point Reyes to Point St. George	1-600,000		Do.
San Diego bay	1-40,000	Finished map	Do.
Cortez bank	1-80,000	Finished chart	Do.
Southeast end of San Clemente island anchorage	1-20,000	Sketch	Do.
Eastern entrance of Santa Barbara channel	1-80,000	Preliminary chart	Do.
Monterey bay	1-60,000	Finished map	In progress.
San Francisco bay	1-80,000	do	Do.
San Antonio creek	1-20,000	do	Completed.
Mare Island straits	1-30,000	do	Do.
San Pablo bay	1-50,000	do	In progress.
Western coast of United States, (additions)	1-7,000,000	Sketch showing limits of Alden's reconnaissance.	Completed.
SECTION XI.—*Coast of Oregon and Washington Territories.*			
Progress sketch J, No 1, from Point St. George to Cape Lookout	1-600,000		Completed.
Progress sketch J, No. 2, from Cape Lookout to northwestern boundary	1-600,000		Do.
Port Townshend base, Washington Territory	1-20,000	Sketch	Do.
Apple cove, Washington Territory	1-20,000	do	Do.
Light-house maps of coast of United States, (three series, of six sheets each)	1-600,000		Do.
Boilers of steamer Hetzel		Diagrams showing injuries	Do.
Telegraphic apparatus for difference of longitude		Diagrams illustrating	Do.
Apparatus for measuring minor bases		Sketch	Do.
Polyconic development of sphere		do	Do.

Extracts from the report of First Lieutenant Rufus Saxton, 4th regiment of artillery, United States army, assistant, in charge of the engraving department.

COAST SURVEY OFFICE,
Washington, November 1, 1857.

The charge of this division has remained with me since the date of my last annual report, November 1, 1856. I have been assisted by Mr. Edward Wharton, and it gives me much pleasure to testify to the ability with which he has discharged his duties.

The engraving force now present consists of one chief engraver, *Mr. Geo. McCoy*, seventeen engravers, and three apprentices. *Mr. S. W. Bradley*, a young man of fine promise, has died. He served his apprenticeship in this office, and bid fair to have become one of our best engravers. *Mr. J. J. Knight*, a young man who acquired a knowledge of his art here, has dissolved his connection with the office. As a general rule, the engravers have evinced commendable zeal in the discharge of their duties, and the quantity and quality of their work will, I think, compare very favorably with that of any previous year. Some of the topography and lettering is highly creditable to those who engraved it, and, compared with specimens of work from similar offices abroad, shows that the standard of the art in ours is inferior to none. The charts of the Coast Survey are in great demand, and the extensive use which is made of the information which they contain by those who are in any way connected with the navigation and commercial interest of our country, involves the necessity of extreme accuracy in details. As errors might endanger both life and property, no time or pains is spared to make them as accurate as possible.

Charts which were reported as complete in my last annual report may be again reported, in some instances, as finished this year. This is due for the most part to important changes which have taken place upon the coast, requiring the insertion of subsequent data which could not be estimated for. The above fact will be sufficient to explain any apparent discrepancy between the reports of this and the last year. The engraving of several important first class finished charts has been completed during the year, viz: Plymouth harbor, Boston harbor, Monomoy shoals, south side Long Island, (east,) south side Long Island, (middle,) and Charleston harbor. In addition to the important work which has been done upon the above named maps, the fine first class charts of Patapsco river, Chesapeake bay, No. 1, Chesapeake bay, No. 2, Chesapeake bay, No. 3; Eastern series, No. 1, Eastern series, No. 2; Beaufort harbor, Albemarle sound, No. 1, Albemarle sound, No. 2, and San Francisco bay, have been kept constantly in hand by our first class engravers, and well advanced towards completion. Since the date of my last report, *Mr. George McCoy*, the chief engraver, has re-engraved some fine views upon the charts of Boston harbor and south side of Long Island, and some excellent topography upon the map of Eastern series, No. 2, and south side of Long Island. *Mr. John Knight* has been kept constantly employed engraving the titles, notes, general lettering, and soundings on the first class maps of Boston harbor, south side Long Island, Nos. 2 and 3; Chesapeake bay, Nos. 2 and 3; San Francisco bay and harbor, and other miscellaneous work upon first class maps and charts. For beauty and style of finish, his work is unsurpassed.

Mr. Dankworth has been continued at the engraving of the outlines and topography on the maps of Chesapeake bay. The quality of his work is not excelled in the office.

Mr. Rollê has completed the topography on the map of Boston harbor, and continued the engraving of topography upon the map of Patapsco river, besides miscellaneous work. The beautiful map of Boston harbor, the topography of which was engraved by him, gives the best evidence of his skill.

Mr. Enthoffer has been employed, since he joined the office, engraving the topography upon the maps of Eastern series, No. 2, and south side Long Island, No. 3.

Mr. Blondeau has been employed nearly the entire year in etching the topography of San Francisco bay and harbor.

Mr. Sengteller has engraved the topography on the map of Plymouth harbor, a portion of that of Albemarle sound, No. 1, and the sanding of Rappahannock river. *Mr. Metzeroth* has finished the etching of topography on the steel plate of Beaufort harbor and views of Anacapa island. He also engraved the topography on the plate of the Rappahannock river, No. 2, a portion of that of Albemarle sound, No. 2, and has executed miscellaneous work.

Mr. Phillips joined the office June 8, 1857. He has completed the topography on the plate of Charleston harbor, and engraved a portion of that of Mississippi sound, No. 1.

Mr. Throop has engraved soundings, titles, notes, and general lettering on the following plates, viz: Beaufort harbor, Cape Fear river, (upper,) Tidal Curves Gulf of Mexico, Monomoy shoals, New York bay and harbor, Elec. 7, Rappahannock river, Albemarle sound, No. 1, Maffitt's channel, St. Mary's bar and Fernandina harbor, seacoast of Texas, and miscellaneous lettering. *Mr. A. Maedel* has engraved topography and general lettering upon Cape Fear river (upper and lower,) and Albemarle sound, No. 2. *Mr. Kondrup* has engraved a portion of the outlines of Chesapeake bay, Nos. 1 and 2, and the topography, title, notes, and general lettering of Rappahannock river, No. 1. *Mr. Barnard* has engraved a portion of the sanding on the plates of Albemarle sound No. 1, Monomoy shoals, St. John's river, (lower sheet,) and Charleston harbor, and done some miscellaneous work. *Mr. E. A. Maedel* joined the office on the 1st of April, 1857. He has been principally employed since that time as a letter engraver, and has engraved the title, notes, and general lettering upon the following plates, viz: Rappahannock river, Nos. 2, 3, and 4; lines of deep-sea soundings in the Gulf of Mexico, and telegraphic diagram plate.

Mr. Langran has engraved the titles, notes, soundings, and general lettering of the chart of seacoast of Alabama and Mississippi; title and notes of Steilacoom harbor; notes on Galveston entrance, and done miscellaneous work upon charts and sketches.

Mr. Ogilvie has engraved the outlines, title, notes, soundings, and general lettering upon seacoast of Massachusetts, and miscellaneous work upon charts and sketches.

Mr. Peterson has engraved the title, notes, outlines, topography, soundings, and general lettering upon the two maps of St. John's river, (upper and lower,) besides lettering upon the progress sketches.

Mr. J. J. Knight left this office on the 1st day of August. Up to that date he was employed upon the following plates, viz: Blakely harbor, Bellingham bay, Florida reefs, Shoalwater bay, San Antonio creek, and progress sketches.

Mr. S. W. Bradley engraved the title, notes, and general lettering on the plate of Anacapa island, besides miscellaneous work upon other charts and progress sketches. His death occurred on the first day of July last. *Mr. Bartle* has been employed in miscellaneous work upon the report and progress sketches.

Apprentices *Benner, Thompson, and Sipe* have been employed in the engraving of the progress and other sketches, with such practice as was necessary to improve their knowledge of the art of engraving. It is to be regretted that the number of first class engravers is so small, as there is a much greater amount of important work to be done in this division than can be accomplished within a reasonable time, or as soon as it is desirable that it should be, by the present force employed. This deficiency of engravers has rendered it necessary to resort to lithographing, and in this most undesirable mode have some of the valuable sketches contained in the Superintendent's report been published. For a more detailed account of the work performed, I respectfully refer you to the accompanying list of maps, charts, preliminary charts, and sketches engraved or engraving during the year ending November 1, 1857, arranged in order of sections, and also to the complete list of Coast Survey maps, charts, preliminary charts and sketches engraved, geographically arranged.

List of maps, preliminary charts and sketches engraved or engraving during the year ending November 1, 1857—*arranged in order of sections.*

Name.	Scale.	Description.	Remarks.
SECTION I.			
Progress sketch A	1-400,000		Engraved.
Do ... A *bis*	1-600,000		Do.
Ipswich and Annis Squam harbor	1-20,000	Finished chart	Engraving.
Boston harbor (new edition)	1-40,000	...do	Engraved.
Plymouth harbor	1-20,000	...do	Do.
Monomoy shoals (additions)	1-40,000	...do	Do.
Seacoast of Massachusetts, No. 1	1-200,000	Preliminary chart	Engraving.
Bass river harbor (additions)	1-40,000	Finished chart	Engraved.
Muskeget channel	1-60,000	...do	Engraving.
Eastern series, No 1	1-80,000	...do	Do.
Do ... No. 2	1-80,000	...do	Do.
SECTION II.			
Progress Hudson river triangulation	1-400,000		Engraved.
South side Long Island (middle sheet)	1-80,000	Finished chart	Do.
Do ... do ... (eastern sheet)	1-80,000	...do	Do.
New York harbor (new edition)	1-80,000	...do	Engraving.
SECTION III.			
Progress sketch C	1-400,000		Engraved.
Chesapeake bay, No. 1	1-80,000	Finished chart	Engraving.
Do ... No. 2	1-80,000	...do	Do.
Do ... No. 3	1-80,000	...do	Do.
Patapsco river	1-60,000	...do	Do.
Rappahannock river, No. 1	1-20,000	...do	Engraved.
Do ... No. 2	1-20,000	...do	Do.
Do ... No. 3	1-20,000	Preliminary chart	Engraving.
Do ... No. 4	1-20,000	...do	Do.
York river entrance	1-60,000	...do	Do.
Hampton Roads	1-40,000	...do	Do.
SECTION IV.			
Progress sketch D	1-400,000		Engraved.
Entrance to Cape Fear river	1-30,000	Preliminary chart	Engraving.
Cape Fear river, from Federal Point to Wilmington	1-30,000	...do	Engraved.
Albemarle sound, No. 1	1-80,000	Finished chart	Engraving.
Do ... No. 2	1-80,000	...do	Do.
Beaufort harbor, North Carolina, on steel	1-20,000	...do	Do.
Seacoast, North Carolina, from Hatteras to Ocracoke	1-200,000	Preliminary chart	Engraved.
SECTION V.			
Progress sketch E	1-600,000		Engraved.
Maffitt's channel, comparative chart, (new edition)	1-5,000	Comparative chart	Do.
Charleston harbor (new edition)	1-30,000	Finished chart	Do.
North Edisto river (new edition)	1-50,000	Preliminary chart	Do.
St. Mary's bar and Fernandina harbor, comparative chart	1-20,000	Comparative chart	Do.
Seacoast, South Carolina, from Cape Roman to Savannah	1-200,000	Preliminary chart	Engraving.
SECTION VI.			
Progress sketch F	1-1,200,000		Engraved.
Do ... lower sheet, Florida reefs	1-400,000		Do.
St. John's river, No. 1	1-25,000	Preliminary chart	Do.
Do ... No. 2	1-25,000	...do	Engraving.
Florida reefs	1-200,000	...do	Engraved.
SECTION VII.			
Progress sketch G	1-600,000		Engraved.
Apalachicola river entrance	1-20,000	Preliminary chart	Engraving.

List of maps, preliminary charts, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION VIII.			
Progress sketch H	1-600,000		Engraved.
Mississippi sound, No. 1	1-80,000	Finished chart	Engraving.
Do ......No. 2	1-80,000	......do	Do.
Seacoast of part of Alabama and Mississippi	1-200,000	Preliminary chart	Engraved.
Deep-sea soundings Gulf of Mexico	1-2,400,000	Sketch	Do.
Biloxi bay	1-40,000	Finished chart	Engraving.
Diagrams of heights and luni-tidal intervals of diurnal and semi-diurnal tides in Gulf of Mexico		Diagram	Engraved.
Co-tidal lines, Gulf of Mexico—2 plates	1-10,000,000	Sketch	Do.
Type curves, Gulf of Mexico		Diagram	Do.
Wind curves, Cat island		......do	Do.
SECTION IX.			
Progress sketch I	1-600,000		Engraved.
Seacoast of Texas, from Galveston, south	1-200,000	Preliminary chart	Do.
Entrance to Galveston bay, new edition	1-40,000	Finished chart	Do.
SECTION X.			
Progress sketch J, lower sheet	1-600,000		Engraved.
Do......J, middle sheet	1-600,000		Do.
Do......western coast	1-7,000,000		Do.
Anacapa and east end Santa Cruz island	1-30,000	Preliminary chart	Do.
Entrance to San Francisco bay	1-50,000	Finished chart	Engraving.
San Diego bay	1-40,000	......do	Do.
Eastern entrance to Santa Barbara channel	1-80,000	......do	Do.
San Pablo bay	1-50,000	......do	Do.
San Antonio creek	1-20,000	Preliminary chart	Do.
SECTION XI.			
Pragress sketch K, upper sheet	1-600,000		Engraved.
Shoalwater bay, additions	1-80,000	Preliminary chart	Do.
New Dungeness harbor	1-40,000	Reconnaissance	Do.
Port Ludlow	1-20,000	......do	Do.
Port Gamble	1-20,000	......do	Do.
Olympia harbor	1-20,000	......do	Do.
Steilacoom harbor	1-30,000	......do	Do.
Bellingham bay	1-40,000	......do	Do.
Blakely harbor	1-10,000	......do	Do.
MISCELLANEOUS.			
Map of magnetic declination	1-20,000,000	Sketch	Engraved.
Map of magnetic dip and intensity	1-20,000,000	......do	Do.
Diagram of secular variation of magnetic dip, Atlantic coast		Diagram	Do.
Polyconic development of the sphere		Sketch	Do.
Telegraphic diagram for difference of longitude		Diagram	Do.
Diagram showing injury to boilers of steamer Hetzel		......do	Do.
Apparatus for measuring minor bases		......do	Do.

List of Coast Survey maps, preliminary charts, and sketches engraved—geographically arranged.

1. List of Maps and Charts engraved.

No.	1.	Richmond's island, Maine	$\frac{1}{20000}$
	2.	Newburyport harbor, Massachusetts	$\frac{1}{20000}$
	3.	Gloucester harbor, do.	$\frac{1}{20000}$
	4.	Salem harbor, do.	$\frac{1}{25000}$
	5.	Boston harbor—new edition, 1857, Massachusetts	$\frac{1}{40000}$
	6.	Plymouth harbor, do	$\frac{1}{20000}$
	7.	Monomoy shoals, do	$\frac{1}{40000}$
	8.	Bass River harbor, do	$\frac{1}{40000}$
	9.	Wellfleet harbor, do	$\frac{1}{60000}$
	10.	Nantucket harbor, do	$\frac{1}{20000}$
	11.	Hyannis harbor, do	$\frac{1}{30000}$
	12.	Harbor of Edgartown do	$\frac{1}{20000}$
	13.	Harbors of Holmes' Hole and Tarpaulin Cove, Massachusetts	$\frac{1}{20000}$
	14.	Harbor of New Bedford, Massachusetts	$\frac{1}{40000}$
	15.	General chart of coast from Gay Head to Cape Henlopen	$\frac{1}{400000}$
	16.	Fisher's Island sound, Connecticut	$\frac{1}{40000}$
	17.	Harbor of New London do.	$\frac{1}{20000}$
	18.	Mouth of Connecticut river. do.	$\frac{1}{20000}$
	19.	Harbor of New Haven—new edition, 1852	$\frac{1}{30000}$
	20.	Harbors of Black Rock and Bridgeport, Connecticut—new edition, 1852	$\frac{1}{20000}$
	21.	Harbors of Sheffield and Cawkin's Island, Connecticut—new edition, 1852	$\frac{1}{20000}$
	22.	Huntington bay, New York	$\frac{1}{30000}$
	23.	Oyster bay or Syosset harbor, New York	$\frac{1}{30000}$
	24.	Harbors of Captain's Islands, east and west, New York	$\frac{1}{20000}$
	25.	Hart and City Islands and Sachem's Head harbor, New York	$\frac{1}{10000}$, $\frac{1}{20000}$
	26.	Hell Gate, New York	$\frac{1}{5000}$
	27.	Long Island sound, east	$\frac{1}{80000}$
	28.	Do do middle	$\frac{1}{80000}$
	29.	Do do west	$\frac{1}{80000}$
	30.	New York bay and harbor, and the environs, New York—sheet No. 1	$\frac{1}{30000}$
	31.	Do do do do do No. 2	$\frac{1}{30000}$
	32.	Do do do do do No. 3	$\frac{1}{30000}$
	33.	Do do do do do No. 4	$\frac{1}{30000}$
	34.	Do do do do do No. 5	$\frac{1}{30000}$
	35.	Do do do do do No. 6	$\frac{1}{30000}$
	36.	Do do do do do	$\frac{1}{80000}$
	37.	Western part of south coast of Long Island, New York	$\frac{1}{80000}$
	38.	Middle part do do do	$\frac{1}{80000}$
	39.	Eastern part do do do	$\frac{1}{80000}$
	40.	Little Egg harbor, New Jersey	$\frac{1}{30000}$

No. 41.	Delaware bay and river—sheet No. 1, Delaware	$\frac{1}{80000}$
42.	Do······do·······do··No. 2, New Jersey and Pennsylvania	$\frac{1}{80000}$
43.	Do······do·······do··No. 3	$\frac{1}{80000}$
44.	Harbor of Annapolis and Severn river, Maryland	$\frac{1}{60000}$
45.	Mouth of Chester river, Maryland	$\frac{1}{40000}$
46.	Pasquotank river, North Carolina	$\frac{1}{60000}$
47.	Charleston harbor, South Carolina—new edition, 1856	$\frac{1}{30000}$
48.	Key West harbor and its approaches, Florida	$\frac{1}{50000}$
49.	Mobile bay and entrance, Alabama	$\frac{1}{40000}$
50.	Mobile bay, Alabama	$\frac{1}{80000}$
51.	Cat and Ship Islands harbors, Mississippi	$\frac{1}{40000}$
52.	Entrance to Galveston bay, Texas—new edition, 1856	$\frac{1}{40000}$

2. List of Preliminary Charts and Sketches engraved.

No. 1.	Alden's Rock, Maine	$\frac{1}{1000}$
2.	Eggemoggin reach, Maine	$\frac{1}{20000}$
3.	Portland harbor, Maine	$\frac{1}{20000}$
4.	Portland harbor, (Commissioners' line,) Maine	$\frac{1}{10000}$
5.	York River harbor, Maine	$\frac{1}{20000}$
6.	Portsmouth harbor, New Hampshire	$\frac{1}{20000}$
7.	Annis Squam and Ipswich harbors, Massachusetts	$\frac{1}{20000}$
8.	Stellwagen's Bank—2d edition—Massachusetts	$\frac{1}{400000}$
9.	Boston bay, Massachusetts	$\frac{1}{175000}$
10.	Current chart, Boston harbor, Massachusetts	$\frac{1}{100000}$
11.	Minot's ledge, Massachusettss	$\frac{1}{10000}$
12.	Nantucket shoals, Massachusetts—new edition	$\frac{1}{200000}$
13.	Tidal currents, Nantucket shoals, Massachusetts	$\frac{1}{800000}$
14.	Muskeget channel, Massachusetts	$\frac{1}{60000}$
15.	Sow and Pigs reef, Massachusetts	$\frac{1}{240}$ & $\frac{1}{20000}$
16.	Tidal currents, Long Island, Massachusetts	$\frac{1}{800000}$
17.	Pot rock and Way's reef, New York	
18.	Hudson river, lower sheet, New York	$\frac{1}{60000}$
19.	Buttermilk channel, New York	$\frac{1}{5000}$
20.	Beacon ranges, New York harbor	$\frac{1}{400000}$
21.	Romer shoals and Flynn's knoll, New York	$\frac{1}{40000}$
22.	Changes in Sandy Hook, New Jersey	$\frac{1}{10000}$ & $\frac{1}{40000}$
23.	Seacoast of Delaware, Maryland, and part of Virginia	$\frac{1}{200000}$
24.	Delaware and Chesapeake bays	$\frac{1}{400000}$
25.	Chincoteague inlet, Virginia	$\frac{1}{40000}$
26.	Seacoast of Virginia and entrance to Chesapeake bay, Virginia	$\frac{1}{200000}$
27.	James river, (upper sheet,) Virginia	$\frac{1}{40000}$
28.	Rappahannock river, No. 1, Virginia	$\frac{1}{20000}$
29.	Rappahannock river, No. 2, Virginia	$\frac{1}{20000}$
30.	Wachapreague, Machipongo, and Metomkin inlets, Virginia	$\frac{1}{40000}$
31.	Ship and Sand Shoal inlets, Virginia	$\frac{1}{40000}$

No. 32.	Entrance to Chesapeake bay, Virginia	$\frac{1}{100000}$
33.	Cape Charles and vicinity ... do	$\frac{1}{80000}$
34.	Cherrystone inlet ... do	$\frac{1}{40000}$
35.	Pungoteague creek ... do	$\frac{1}{40000}$
36.	Fishing or Donoho's battery, Maryland	$\frac{1}{80000}$
37.	Albemarle sound, North Carolina	$\frac{1}{200000}$
38.	Diagrams showing the effect of the wind in elevating or depressing the water in Albemarle sound	
39.	Hatteras shoals, North Carolina	$\frac{1}{20000}$
40.	Cape Hatteras ... do	$\frac{1}{20000}$
41.	Hatteras inlet ... do ... fourth edition	$\frac{1}{20000}$
42.	Ocracoke inlet ... do	$\frac{1}{40000}$
43.	Seacoast, North Carolina, from Hatteras to Ocracoke	$\frac{1}{200000}$
44.	Wimble shoals, North Carolina	$\frac{1}{80000}$
45.	Beaufort harbor ... do ... on steel	$\frac{1}{20000}$
46.	Do ... do	$\frac{1}{20000}$
47.	New river and bar .. do	$\frac{1}{15000}$
48.	Frying-pan shoals ... do	$\frac{1}{120000}$
49.	Cape Fear river and New inlet, North Carolina	$\frac{1}{40000}$
50.	Entrances to Cape Fear river ... do	$\frac{1}{30000}$
51.	Cape Fear river, from Federal Point to Wilmington	$\frac{1}{30000}$
52.	Gulf Stream explorations, 1853	$\frac{1}{5000000}$
53.	Diagrams, Gulf Stream explorations, 1853	
54.	Gulf Stream explorations, 1854	$\frac{1}{5000000}$
55.	Diagrams, Gulf Stream explorations, 1854	
56.	Gulf Stream explorations, 1855	$\frac{1}{5000000}$
57.	Co-tidal lines, Atlantic coast	$\frac{1}{10000000}$, $\frac{1}{15000000}$
58.	Diagrams of secular variation of magnetic dip, Atlantic coast.	
59.	Cape Roman shoals, South Carolina	$\frac{1}{100000}$
60.	Winyah bay and Cape Roman shoals, South Carolina	$\frac{1}{100000}$
61.	Winyah bay and Georgetown harbor ... do.	$\frac{1}{40000}$
62.	Bull's bay ... do.	$\frac{1}{40000}$
63.	Comparative chart, Maffitt's channel, South Carolina, new edition	$\frac{1}{5000}$
64.	Maffitt's channel, sections, South Carolina	
65.	North Edisto river, (new edition,) South Carolina.	$\frac{1}{50000}$
66.	Romerly marshes ... do	$\frac{1}{10000}$
67.	Savannah river entrance, Georgia	$\frac{1}{30000}$
68.	Savannah city, Front and Back rivers, Georgia	$\frac{1}{20000}$
69.	Savannah river, Georgia	$\frac{1}{40000}$
70.	Doboy bar and inlet, Georgia	$\frac{1}{40000}$
71.	St. Andrew's shoals ... do	$\frac{1}{60000}$
72.	St. Mary's bar and Fernandina harbor, Florida—comparative chart	$\frac{1}{20000}$
73.	St. John's river, from entrance to Brown's creek, Florida	$\frac{1}{25000}$
74.	Mosquito inlet, Florida	$\frac{1}{40000}$
75.	Cape Cañaveral .. do	$\frac{1}{60000}$

No. 76.	Florida reefs, Florida	$\frac{1}{200000}$
77.	Turtle harbor, Florida reefs, Florida	$\frac{1}{40000}$
78.	Beacons on Florida reefs ...... do	
79.	Coffin's Patches .... do	$\frac{1}{20000}$
80.	Key Biscayne, Cape Sable and bases	$\frac{1}{400}$ & $\frac{1}{600000}$
81.	Legaré anchorage, Florida	$\frac{1}{20000}$
82.	Key West harbor ... do .. second edition	$\frac{1}{100000}$
83–89.	Key West tidal diagrams, Florida	
90.	Rebecca shoal .... do	$\frac{1}{600000}$
91.	Reconnaissance vicinity of Cedar Keys, Florida	$\frac{1}{300000}$
92.	Channel No. 4, Cedar Keys .... do.	$\frac{1}{30000}$
93.	Cedar Keys and approaches .... do.	$\frac{1}{60000}$
94.	Ocilla river .... do.	$\frac{1}{20000}$
95.	St. Mark's bar and channel .... do.	$\frac{1}{40000}$
96.	Middle or main and western entrances St. George's sound, Florida	$\frac{1}{80000}$
97.	St. Andrew's bay, Florida	$\frac{1}{40000}$
98.	Seacoast of part of Alabama and Mississippi	$\frac{1}{200000}$
99.	Mobile bay, second edition, Alabama	$\frac{1}{200000}$
100.	Horn Island pass and Grand bay, Mississippi	$\frac{1}{300000}$
101.	Do .... do .... do .... new edition	$\frac{1}{40000}$
102.	Pascagoula river .... do	$\frac{1}{20000}$
103.	Biloxi bay .... do	$\frac{1}{40000}$
104–113.	Cat Island tidal diagrams .... do	
114.	Pass Christian .... do	$\frac{1}{40000}$
115.	Delta of Mississippi, Louisiana	$\frac{1}{60000}$
116.	Gulf of Mexico, with profiles of deep-sea soundings, new edition	$\frac{1}{2400000}$
117.	Barataria bay entrance, Louisiana	$\frac{1}{30000}$
118.	Pass Fourchon .... do	$\frac{1}{10000}$
119.	Timballier bay entrance ... do	$\frac{1}{20000}$
120.	Isle Dernière or Ship Island shoals	$\frac{1}{80000}$
121.	Entrances to Vermilion bay and Calcasieu river	$\frac{1}{30000}$ & $\frac{1}{40000}$
122.	Sabine Pass, Texas	$\frac{1}{40000}$
123.	Seacoast of Texas from Galveston, south	$\frac{1}{200000}$
124.	San Luis Pass, Texas	$\frac{1}{20000}$
125.	Aransas Pass—2d edition—Texas	$\frac{1}{30000}$
126.	Entrance to Rio Grande .... do	$\frac{1}{20000}$
127.	Diagrams of heights and luni-tidal intervals of diurnal and semi-diurnal tides in the Gulf of Mexico	
128–129.	Co-tidal lines, Gulf of Mexico—2 plates	
130.	Type curves, Gulf of Mexico	
131.	Wind curves, Cat island	
132.	Alden's reconnaissance Western Coast, lower sheet, San Francisco to San Diego—new edition—California	$\frac{1}{1200000}$
133.	Cortez Bank	$\frac{1}{10000}$, $\frac{1}{1200000}$
134.	San Diego entrance, (new edition,) California	$\frac{1}{15000}$, $\frac{1}{25000}$

135.	Geological map of San Diego, California	$\frac{1}{1608228}$
136.	Catalina harbor . . . . . . do	$\frac{1}{15000}$
137.	San Pedro anchorage and vicinity of Santa Barbara, California	$\frac{1}{20000}$, $\frac{1}{40000}$
138.	Anacapa island, (sketch,) . . . . . . do	
139.	Anacapa island and east end of Santa Cruz island	$\frac{1}{30000}$
140.	Prisoner's harbor, Cuyler's harbor, and northwest anchorage San Clemente island, California	$\frac{1}{20000}$
141.	Santa Barbara, California	$\frac{1}{20000}$
142.	San Simeon, Santa Cruz, San Luis Obispo, and Coxo harbors, California	$\frac{1}{20000}$, $\frac{1}{40000}$
143.	Point Conception . . . . . . do	$\frac{1}{40000}$
144.	Point Pinos . . . . . . do	$\frac{1}{20000}$
145.	Monterey harbor . . . . . . do	$\frac{1}{40000}$
146.	Geological map of Monterey . . . . . . do	$\frac{1}{150000}$
147.	Santa Cruz and Año Nuevo harbors . . . . . . do	$\frac{1}{400000}$, $\frac{1}{1200000}$
148.	San Pedro harbor . . . . . . do	$\frac{1}{20000}$
149.	San Francisco bay entrance . . . . . . do	$\frac{1}{400000}$
150.	San Francisco city—3d edition . . . . . . do	$\frac{1}{10000}$
151.	Geological map San Francisco . . . . . . do	$\frac{1}{150000}$
152.	South Farallone island . . . . . . do	
153.	Tidal diagrams, Rincon Point . . . . . . do	
154.	Pulgas base . . . . . . do	$\frac{1}{400000}$, $\frac{1}{4000000}$
155.	Mare Island straits . . . . . . do	$\frac{1}{30000}$
156.	Alden's reconnaissance Western Coast, middle sheet, San Francisco to Umpquah river, California and Oregon	$\frac{1}{1200000}$
157.	McArthur's reconnaissance Western Coast, from Monterey to mouth of Columbia river, sheet No. 1—3d edition	
158.	McArthur's reconnaissance Western Coast, from Monterey to mouth of Columbia river, sheet No. 2—3d edition	
159.	McArthur's reconnaissance Western Coast, from Monterey to mouth of Columbia river, sheet No. 3—3d edition	
160.	Alden's reconnaissance Western Coast, northern sheet	$\frac{1}{1200000}$
161.	Point Reyes and Drake's bay, California	$\frac{1}{40000}$
162.	Geological map Point Reyes . . . . . . do	$\frac{1}{150000}$
163.	Humboldt bay . . . . . . do	$\frac{1}{30000}$
164.	Trinidad bay . . . . . . do	$\frac{1}{20000}$
165.	Shelter cove, Mendocino city, and Crescent city harbors, and Port Orford, or Ewing harbor, California and Oregon	$\frac{1}{20000}$
166.	Umpquah river, Oregon	$\frac{1}{20000}$
167.	Mouth of Columbia river—2d edition—Oregon	$\frac{1}{40000}$
168.	Do . . . . . . do . . . . . . do	$\frac{1}{200000}$
169.	Entrance to Columbia river . . . . . . do	$\frac{1}{40000}$
170.	Tidal diagrams Rincon Point, San Diego, and Astoria, California and Oregon	
171.	Co-tidal lines of the Pacific coast	$\frac{1}{10000000}$
172.	Cape Disappointment, Washington Territory	$\frac{1}{20000}$

173.	Shoalwater bay—new edition—Washington Territory	$\frac{1}{80000}$
174.	Alden's reconnaissance, Western Coast, from Gray's harbor to Admiralty inlet, Washington Territory	$\frac{1}{600000}$
175.	Grenville harbor, Washington Territory	$\frac{1}{20000}$
176.	Cape Flattery and Neé-ah harbor, Washington Territory	$\frac{1}{40000}$
177.	False Dungeness harbor, do	$\frac{1}{30000}$
178.	New Dungeness harbor, do	$\frac{1}{40000}$
179.	Canal de Haro and strait of Rosario, and approaches, Washington Territory	$\frac{1}{200000}$, $\frac{1}{600000}$
180.	Port Townshend, Washington Territory	$\frac{1}{40000}$
181.	Duwamish bay and Seattle harbor, Washington Territory	$\frac{1}{40000}$
182.	Smith's or Blunt's island, do	$\frac{1}{20000}$
183.	Port Ludlow, do	$\frac{1}{20000}$
184.	Port Gamble, do	$\frac{1}{20000}$
185.	Olympia harbor, do	$\frac{1}{20000}$
186.	Steilacoom harbor, do	$\frac{1}{30000}$
187.	Bellingham bay, do	$\frac{1}{40000}$
188.	Blakely harbor, do	$\frac{1}{10000}$
189.	Base apparatus	
190.	Self-registering tide gauge	
191.	Craven's current indicator	
192.	Craven's specimen box for deep sea soundings	
193.	Mitchell's seacoast tide gauge	
194.	Figures to illustrate Appendix No. 33, 1854	
195.	Diagrams of secular variation in magnetic declination, 1855	
196.	Lines of equal magnetic declination	$\frac{1}{15000000}$
197.	Boutelle's scaffold for stations, and Farley's signal	
198.	Boutelle's apparatus for measuring preliminary bases	
199.	Diagrams illustrating earthquake waves at San Diego and San Francisco	
200.	Diagrams of secular variation in magnetic declination, 1856	
201.	Sands' gas pipe tripod	
202.	Sands' specimen box for deep sea soundings and revolving heliotrope.	
203.	Map of magnetic declination	
204.	Map of magnetic dip and intensity	
205.	Apparatus for measuring minor bases	
206.	Polyconic development of the sphere	
207.	Diagrams to illustrate telegraphic methods for difference of longitude	
208.	Diagrams showing injury to boilers of steamer Hetzel	
209–228.	Progress sketches	

Report of Mr. George Mathiot, in charge of the Electrotype Division.

ELECTROTYPE DIVISION, *October* 1, 1857.

I respectfully present the following report of the operations in this division since November 1, 1856.

By the electrotype process we have made eighty-four plates. Of this number forty-six were in alto, and thirty-three in basso, from the charts of the survey; five were for other departments of the government. I append tables of the plates from the Coast Survey charts.

The work of combining, extending, and altering the charts by the electrotype process has increased on former years. It now occupies a considerable part of the time; is performed with certainty, and gives full satisfaction.

The usual assistance to the party for taking longitudes by the electro-telegraph has been rendered.

The work of electro-gilding the deep sea thermometers has been executed as in former years.

The work of furnishing thin electrotypes, for printing, was delayed during the early part of the year by the want of suitable metallic beds for stretching the thin plates; but a suitable article has at length been found in the sheet steel used in the manufacture of large saws, and the use of thin printing plates is now entirely satisfactory.

The working of the thin electrotypes has suggested to me the idea of using these plates on a circular bed or roller, and gaining thereby the great advantages of cylinder printing for flat plates. This has often been sought before, but the impossibility of getting a rigid plate to conform accurately to a cylindrical figure has hitherto defeated it. As the thin electrotypes are easily strained over a curved surface, the great desideratum is now attainable. I am about having this matter put to a practical test, and have every hope that copper-plate printing can thus be executed by steam machinery, with almost the rapidity of letter-press work.

During the year some very important experiments have been made on the art of photography, with a view to its employment in the illustrations of the survey.

LIST OF PLATES ELECTROTYPED IN ALTO.

NAME.	NUMBER MADE.
Hudson river	1
Savannah river	1
Ship Island shoal	1
Shoalwater bay	1
False Dungeness	1
Galveston bay	1
Cape Fear river	2
Approximate co-tidal lines, Gulf of Mexico	1
Ipswich and Annis Squam harbors	1
Winyah bay and Georgetown harbor	1
Chesapeake and Delaware bays	1
Mobile bay	1
Seacoast of Texas	1
Lines of equal magnetic dip, &c.	1
Diagram of heights of tides, Gulf of Mexico	1
Lines of equal magnetic declination	1
Profiles of bottoms, &c., Gulf of Mexico	1
Boston harbor	4
General coast chart, Gay Head to Henlopen	1
New York bay and harbor ($\frac{1}{80000}$)	1
Views of Boston harbor	1
Anacapa island	1
Type curves of tides, Gulf of Mexico	1
Seacoast of North Carolina	1
Long Island sound, sheet No. 3	2
St. John's river, sheet No. 1	1
Florida reefs, (title and notes)	1
Seacoast of Massachusetts	1
San Francisco bay	1
St. John's river, sheet No. 2	1
Florida reefs	1
Rappahannock river, sheet No. 1	1
Rappahannock river, (title and notes)	1
Charleston harbor	1
Polyconic projection of the sphere	1
Rappahannock river, sheet No. 2	1
Rec. West Coast, from Gray's harbor to N. W. boundary	1
Rec. West Coast, sheet No. 1, (Alden's)	1
Monomoy shoals	1
Entrance to Galveston bay	1
Long Island sound, sheet No. 2	1

LIST OF PLATES ELECTROTYPED IN BASSO.

NAME.	NUMBER MADE.	NAME.	NUMBER MADE.
Hudson river	1	Gloucester harbor	1
False Dungeness	1	New London harbor	1
Galveston bay	1	Nantucket harbor	1
Albemarle sound	1	Seacoast of North Carolina	1
Mobile bay	1	Long Island sound, part of sheet No. 1	1
Seacoast of Texas	2	Seacoast of Massachusetts	1
Lines of equal magnetic dip, &c	1	San Francisco bay	1
Diagram of heights of tides, Gulf of Mexico	1	St John's river, sheet No. 2	1
Lines of equal magnetic declination	1	Patapsco river and approaches	1
Profile of bottoms and deep sea temperatures	1	Charleston harbor	1
Boston harbor	4	Rappahannock river, sheet No. 2	1
General coast chart, Gay Head to Henlopen	1	Reconnaissance West Coast, sheet No. 2 (Alden's)	1
New York bay and harbor ($\frac{1}{80000}$)	1	Oyster or Syosset bay	1
Views of Boston harbor	1	Florida reefs	1
Anacapa island	1		

LIST OF PLATES ALTERED OR EXTENDED BY THE ELECTROTYPE PROCESS.

Charleston harbor.
Florida reefs.
Rappahannock river.
Long Island sound, sheet No. 3.
Seacoast of Texas.
Hudson river.
Alden's West Coast reconnaissance.
Boston harbor.

Report of Lieutenant A. P. Hill, United States army, assistant on the progress made in printing.

COAST SURVEY OFFICE,
Washington, D. C., November 1, 1857.

I have the honor to submit a report of the results accomplished in printing during the year ending October 31, 1857. The discontinuance of the small press, for some time, caused by the want of a printer, together with the loss of time to both presses, from repairs to the boiler, has necessarily diminished the number of impressions struck off. A careful attention to the quality of the ink used, and the burning of the oil, has caused a decided improvement in the printing, both as to distinctness and adhesiveness, the ink now drying hard upon the paper, and the lines being clear and well defined. Since the 1st of July, the large press has been in charge of Mr. John Rutherdale, who has also had the general oversight of the printing room, and I am gratified to bear witness to his attention and industry.

Since the 1st of November, there have been printed from the following plates:

SECTION I.

	No. of impressions.
Sketch A	50
York river harbor	200
Eggemoggin reach	50
Portsmouth harbor	12
Seacoast of Massachusetts	50
Newburyport harbor	62

	No. of impressions.
Ipswich and Annis Squam harbor	40
Gloucester harbor	160
Salem harbor	311
Boston harbor	322
Stellwagen's bank	50
Minot's ledge	50
Currents in Boston harbor	50
Wellfleet harbor	100
Monomoy shoals	50
Muskeget channel	75
Sow and Pigs reef	50

SECTION II.

Sketch B	15
General Coast chart from Gay Head to Cape Henlopen	672
Long Island Sound, No. 1	214
Long Island Sound, No. 2	160
Long Island Sound, No. 3	165
Harbor of New London	100
Mouth of Connecticut harbor	100
Harbor of New Haven	100
Harbors of Black Rock and Bridgeport	100
Oyster bay or Syosset harbor	100
Hart and City island, and Sachem's Head harbor	100
Romer shoal and Flynn's knoll	50
Changes in Sandy Hook	50
Hell Gate	456
New York bay and harbor $\frac{1}{80000}$	320
New York bay and harbor $\frac{1}{30000}$	36
Little Egg harbor	100

SECTION III.

Sketch C	52
Delaware bay and river	510
Seacoast of Delaware, Maryland, and part of Virginia	40
Delaware and Chesapeake bays	150
Chincoteague inlet	50
Wachapreague inlet	50
Ship and Sand Shoal inlets	50
Seacoast of Virginia and entrance to Chesapeake bay	50
Cape Charles	50
Cherrystone inlet	50
Pungoteague inlet	50
Fishing or Donoho's battery	50

	No. of impressions.
Mouth of Chester river	100
Rappahannock river	185
James river	46

SECTION IV.

Sketch D	50
Seacoast of North Carolina	50
Albemarle Sound	409
Diagrams of winds, Albemarle Sound	50
Pasquotank river	100
Hatteras shoals	50
Hatteras inlet	50
Ocracoke inlet	55
Wimble Shoals	50
Frying-pan shoals	50
New river and bar	50
Cape Fear river and inlet	50
Cape Fear river	86

SECTION V.

Sketch E	50
Winyah bay	50
Winyah bay and Georgetown harbor	80
Bull's bay	50
Maffitt's channel	40
Charleston harbor	700
North Edisto	50
Savannah river	80
Romerly marshes	50
Doboy bar and inlet	50
St. Mary's bar and Fernandina harbor	30

SECTION VI.

Sketch F	100
Sketch F, No. 2	50
St. John's river $\triangle^{u}$	50
St. John's river	100
Musquito inlet	50
Cape Cañaveral	88
Florida reefs	16
Legaré anchorage	50
Turtle harbor	50
Coffin's patches	50
Key West harbor	108
Rebecca shoal	50

Section VII.

	No. of impressions.
Sketch G	50
Cedar Keys	232
Channel, No. 4, Cedar Keys	50
St. Mark's bar and channel	50
Entrance to St. George's Sound	50
Ocilla river	50
St. Andrew's bay	50

Section VIII.

Sketch H	75
Deep-sea soundings, Gulf of Mexico	50
Diagrams of tides, Gulf of Mexico	74
Co-tidal lines, Gulf of Mexico	100
Seacoast of Alabama and Mississippi	150
Mobile bay	850
Horn Island pass	50
Entrance to Pascagoula river	50
Ship Island shoal	50
Cat and Ship Island harbors	100
Diagrams of winds at Cat island	50
Biloxi bay	50
Mississippi delta	50
Barataria bay	50
Pass Fourchon	50
Entrance to Timballier bay	50

Section IX.

Sketch I	75
Seacoast of Texas	50
Vermilion bay and Calcasieu river	50
Sabine pass	50
Entrance to Galveston bay	270
San Luis pass	50
Aransas pass	50
Entrance to the Rio Grande	50

Sections X and XI.

Sketch J	100
Sketch K	50
Alden's reconnaissance, No. 2	1,084
Alden's reconnaissance, No. 3	1,206
Sub-sketches, Western Coast	50
Western Coast	50

	No. of impressions.
Anacapa island	458
San Pedro anchorage	200
Prisoner's harbor, Cuyler's harbor, &c.	50
Point Conception	50
San Simeon, Santa Cruz, &c.	50
Point Pinos	50
Monterey harbor	100
Geological map, vicinity of Monterey	100
Geological map, vicinity of Golden Gate	100
San Francisco city	50
San Francisco bay title	50
Point Reyes	50
Mare Island straits	50
Port Orford	50
Entrance to Umpquah river	50
Cape Disappointment	50
Shoalwater bay	52
Alden's reconnaissance from Gray's harbor to Admiralty inlet	50
Grenville harbor	50
Cape Flattery and Neé-ah harbor	50
False and New Dungeness harbors	50
Port Townshend	80
Port Ludlow	60
Port Gamble	60
Steilacoom harbor	50
Duwamish bay and Seattle harbor	50
Olympia harbor	50
Bellingham bay	60
Blakely harbor	60
Canal de Haro and Rosario strait	50

MISCELLANEOUS.

Current diagrams	450
Magnetic diagrams	200
Pleiades for occultations	130
Proofs from finished and unfinished plates	2,746
Circular protractors	120
Tidal diagrams	570
Diagrams of equal magnetic declination	350
Diagrams of equal magnetic dip	345
Tide curves	50
Injuries to steamer Hetzel	40
Apparatus for determination of longitudes	100
Contact slide apparatus	50

Scale of shades	50
Polyconic sphere	50
Clock dial	50
	22,242

Report of Mr. V. E. King on the distribution and sale of maps.

At the date of my last report, October 1, 1856, sixty-three sheets of Coast Survey maps had been published. Since then the following named maps have been added, viz:

Plymouth harbor.

South side of Long Island, middle sheet.

South side of Long Island, eastern sheet.

Monomoy harbor.

Making the number now published sixty-seven sheets.

Additions have been made to the following named maps during the year, and second editions of them have been published.

Bass river.

Galveston entrance.

Charleston harbor.

The fact of the finished maps mentioned above not appearing in the accompanying tabular statement is attributable to their very recent completion.

The following named preliminary charts have been added to the published matter during the year:

Muskeget channel.

Delaware and Chesapeake bays.

Seacoast of Virginia and entrance to Chesapeake bay.

Albemarle sound.

Winyah bay and Georgetown harbor.

Romerly marshes.

Legaré anchorage.

Cedar keys.

St. Andrew's bay.

Seacoast of Alabama and Mississippi.

Biloxi bay.

Anacapa island.

Port Ludlow.

Port Gamble.

Blakely harbor.

Bellingham bay.

Steilacoom harbor.

The list of gratuitous sketches has been increased by the following additions:

Stellwagen's bank.

Doboy bar and inlet.

Ocilla river.

Vermilion bay and Calcasieu river.

San Pedro anchorage and Santa Barbara.

Point Reyes and Drake's bay.

An annual distribution of presentation maps has been made during the year. The plates, ten in number, were as follows:

1. York river, Maine.
2. Newburyport harbor, Massachusetts.
3. Gloucester harbor, Massachusetts.
4. Salem harbor, Massachusetts.
5. Charleston harbor, South Carolina.
6. Mobile bay, Alabama.
7. Key West, Florida.
8. Galveston entrance, Texas.
9. Reconnaissance of the Western Coast, from San Francisco to Umpquah river, California and Oregon.
10. Reconnaissance of the Western Coast, from Umpquah river to the northwest boundary, Oregon and Washington Territories.

List of Coast Survey maps distributed during the year, for sale, use of office, and gratuitously.

Names of Charts.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Richmond Island harbor		4	161	165
York River harbor	12	1	811	824
Newburyport harbor		2	810	812
Gloucester harbor	15	2	819	836
Salem harbor	25	2	813	840
Wellfleet harbor		5	175	180
Nantucket harbor	10	2	158	170
Harbor of Edgartown	5		133	138
Hyannis harbor	10	1	157	168
Harbors of Holmes' Hole and Tarpaulin Cove	15	1	165	181
Harbor of New Bedford	60	4	157	221
General coast chart from Gay Head to Cape Henlopen	10	7	96	113
Long Island sound	80	6	64	150
Fisher's Island sound	30	2	166	198
Harbor of New London	20	1	165	186
Mouth of Connecticut river	20	1	161	182
Harbor of New Haven	15	1	166	182
Harbors of Black Rock and Bridgeport	10	1	136	147
Huntington bay	10	1	166	177
Harbors of Sheffield and Cawkin's Islands	5	2	167	174
Harbors of Captain's Island, east and west	10	1	164	175
Oyster bay, or Syosset harbor	5	1	165	171
Hart and City Island and Sachem's Head harbor	5	1	164	170
Hell Gate	25	3	45	73

List of Coast Survey maps distributed, &c.—Continued.

Names of Charts.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
New York bay and harbor, and the environs, $\frac{1}{30000}$	----------	2	3	5
New York bay and harbor, and the environs, $\frac{1}{80000}$	76	4	92	172
Western part of south coast of Long Island	----------	3	153	156
Little Egg harbor	5	2	163	170
Delaware bay and river	87	3	49	139
Mouth of Chester river	----------	2	156	158
Harbor of Annapolis and Severn river	----------	1	147	148
Pasquotank river	12	2	155	169
Beaufort harbor	----------	----------	----------	----------
Charleston harbor	----------	5	806	811
Cat and Ship Island harbors	----------	3	87	90
Mobile bay	5	----------	671	676
Mobile bay entrance	10	2	163	175
Galveston entrance	----------	1	821	822
Key West harbor and approaches	5	3	821	829
West Coast reconnaissance, from San Diego to San Francisco	----------	1	151	152
West Coast reconnaissance, from San Francisco to Umpquah river	----------	----------	701	701
West Coast reconnaissance, from Umpquah river to the NW. boundary	5	6	817	828
San Diego bay and approaches	----------	2	160	162
Trinidad bay	----------	3	161	164
Humboldt bay	----------	3	160	163
Monterey harbor	----------	2	161	163
Entrance to Columbia river	----------	2	163	165
Sketches of—Minot's ledge	----------	1	153	154
Muskeget channel	----------	----------	----------	----------
Nantucket shoals	12	1	153	166
Delaware and Chesapeake bays	----------	----------	18	18
Seacoast of Delaware, Maryland, and part of Virginia	----------	1	111	112
Chincoteague inlet	13	1	141	155
Seacoast of Virginia, and entrance to Chesapeake bay	----------	----------	----------	----------
Albemarle Sound	----------	----------	----------	----------
Ocracoke inlet	----------	2	58	60
Frying Pan shoals	----------	2	120	122
New river and bar	----------	1	144	145
Cape Fear river and New inlet	----------	----------	----------	----------
North Edisto entrance	----------	2	120	122
Winyah bay and Georgetown harbor	----------	----------	----------	----------
Entrance to Savannah river	----------	2	142	144
Savannah city, Front and Back rivers	----------	1	142	143
Romerly Marshes	----------	----------	----------	----------
St. Mark's bar and channel	----------	1	143	144
Entrance to St. John's river	----------	2	99	101
Legaré anchorage	----------	----------	----------	----------
Cedar keys	----------	----------	----------	----------
St. Andrew's bay	----------	----------	----------	----------
Seacoast of Alabama and Mississippi	----------	----------	----------	----------
Biloxi bay	----------	----------	2	2

List of Coast Survey maps distributed, &c.—Continued.

Names of charts.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Sketches of—Delta of Mississippi river		1	162	163
Ship Island shoal		1	13	14
Galveston bay		1	17	18
San Luis pass		1	54	55
Catalina harbor		2	126	128
Prisoner's, Cuyler's, and San Clemente harbors		3	145	148
Santa Barbara		3	161	164
Anacapa island			16	16
San Simeon, Santa Cruz, &c		3	139	142
Santa Cruz and Año Nuevo		3	149	152
San Pedro harbor		3	144	147
San Francisco city			144	144
Port Orford, Shelter Cove, &c		2		2
Entrance to Umpquah river		3	147	150
Shoalwater bay		4	160	164
Reconnaissance from Gray's harbor to Admiralty inlet		2	58	60
Cape Flattery and Neé-ah harbor		3	150	153
False Dungeness harbor		2	146	148
Port Townshend		2	159	161
Canal de Haro		4	150	154
Port Ludlow				
Port Gamble				
Blakely harbor				
Bellingham bay				
Steilacoom harbor				
Eggemoggin Reach		1	77	78
Current chart, Boston harbor		1	12	13
Stellwagen's bank			3	3
Sow and Pigs reef		1	29	30
Romer shoal and Flynn's knoll		1	91	92
Changes in Sandy Hook		1	50	51
Wachapreague and Machipongo inlets, &c	1	1	63	65
Ship and Sand Shoal inlets		1	15	16
Cherry Stone inlet		1	62	63
Pungoteague creek		1	85	86
Fishing or Donoho's battery		1	26	27
Hatteras shoals	5	2	39	46
Hatteras inlet	10	2	32	44
Wimble shoals	5	1	85	91
Winyah bay and Cape Roman shoals		1	74	75
Bull's bay		2	97	99
Doboy bar and inlet			1	1
St. Andrew's shoals		1	81	82
Mosquito inlet		2	55	57
Cape Cañaveral		1	143	144
Rebecca shoal		1	153	154
Turtle harbor		1	32	33

List of Coast Survey maps distributed, &c.—Continued.

Names of charts.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Sketches of—Coffin's patches	....	1	90	91
Ocilla river	....	....	1	1
Entrance to St. George's channel	....	1	62	63
Horn Island Pass, Grand bay	....	1	13	14
Entrance to Pascagoula river	....	1	62	63
Pass Christian	....	1	47	48
Entrance to Barataria bay	....	1	21	22
Pass Fourchon	....	....	10	10
Entrance to Timballier bay	....	....	16	16
Vermilion bay and Calcasieu river	....	....	....	....
Aransas Pass	....	....	20	20
Sabine Pass	....	....	25	25
Entrance to Rio Grande river	....	....	61	61
San Pedro anchorage and Santa Barbara	....	....	....	....
Mare Island Straits	....	1	73	74
Point Conception	....	....	105	105
Point Pinos	....	....	136	136
Point Reyes and Drake's bay	....	....	....	....
Cape Disappointment	....	....	74	74
Grenville harbor	....	....	84	84
Duwamish bay and Seattle harbor	....	....	16	16
Total	648	195	18,952	19,795

Annual statement of the distribution of the reports of the United States Coast Survey, for the years 1851, 1852, 1853, 1854, *and* 1855.

Names of States.	Report of 1851.			Report of 1852.			Report of 1853.			Report of 1854.			Report of 1855.		
	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.
Maine	1	1	2	1	....	1	19	1	20	21	....	21	76	8	84
New Hampshire	1	....	1	2	....	2	7	....	7	10	....	10	68	6	74
Vermont	....	....	....	....	....	....	1	....	1	2	....	2	43	2	45
Massachusetts	10	....	10	11	....	11	39	....	39	57	....	57	384	31	415
Rhode Island	....	....	....	1	....	1	6	....	6	5	....	5	34	3	37
Connecticut	1	....	1	1	....	1	6	....	6	6	....	6	92	13	105
New York	10	....	10	25	....	25	48	....	48	52	....	52	638	74	712
New Jersey	2	....	2	3	....	3	11	....	11	10	....	10	104	17	121
Pennsylvania	5	....	5	5	....	5	11	....	11	22	....	22	396	79	475
Delaware	....	....	....	....	....	....	......	....	......	......	....	......	3	2	5
Maryland	2	....	2	1	....	1	7	....	7	8	....	8	118	7	125

Statement of distribution of Coast Survey reports—Continued.

Names of States.	Report of 1851. Individuals.	Report of 1851. Institutions.	Total.	Report of 1852. Individuals.	Report of 1852. Institutions.	Total.	Report of 1853. Individuals.	Report of 1853. Institutions.	Total.	Report of 1854. Individuals.	Report of 1854. Institutions.	Total.	Report of 1855. Individuals.	Report of 1855. Institutions.	Total.
District of Columbia	8	----	8	6	----	6	20	----	20	24	----	24	129	----	129
Virginia	2	----	2	7	----	7	20	----	20	28	----	28	160	1	161
North Carolina	1	----	1	1	----	1	8	----	8	10	----	10	71	3	74
South Carolina	----	----	----	1	----	1	5	1	6	4	----	4	114	8	122
Georgia	----	----	----	----	----	----	5	----	5	6	----	6	54	1	55
Alabama	----	----	----	----	----	----	1	----	1	1	----	1	44	5	49
Mississippi	----	----	----	----	----	----	1	----	1	1	----	1	30	1	31
Louisiana	----	----	----	----	----	----	3	----	3	4	----	4	42	5	47
Ohio	----	----	----	----	----	----	2	----	2	7	----	7	215	34	249
Kentucky	----	----	----	----	----	----	4	----	4	4	----	4	75	12	87
Tennessee	1	----	1	1	----	1	2	----	2	2	----	2	71	14	85
Indiana	----	----	----	----	----	----	1	----	1	1	----	1	109	14	123
Illinois	----	----	----	----	----	----	7	----	7	9	----	9	83	29	112
Missouri	----	----	----	1	----	1	2	----	2	2	----	2	65	13	78
Arkansas	----	----	----	----	----	----	1	----	1	1	----	1	13	----	13
Michigan	2	1	3	2	1	3	6	1	7	7	1	8	38	12	50
Florida	1	----	1	1	----	1	10	----	10	10	----	10	21	2	23
Texas	----	----	----	----	----	----	8	----	8	9	----	9	26	----	26
Iowa	----	----	----	----	----	----	2	----	2	4	----	4	12	13	25
Wisconsin	----	----	----	----	----	----	1	----	1	2	----	2	37	5	42
California	----	----	----	----	----	----	9	----	9	9	----	9	35	3	38
Minnesota Territory	----	----	----	----	----	----	----	----	----	----	----	----	5	4	9
Washington Territory	----	----	----	2	----	2	5	----	5	7	----	7	4	----	4
Oregon Territory	----	----	----	----	----	----	2	----	2	2	----	2	10	1	11
Army officers and military posts	----	----	----	----	----	----	----	----	----	----	----	----	425	----	425
Navy officers	----	----	----	----	----	----	----	----	----	----	----	----	240	----	240
Members of Congress	1	----	1	2	----	2	79	----	79	145	----	145	10	----	10
Receivers, registers, &c., connected with General Land Office	----	----	----	----	----	----	----	----	----	----	----	----	152	----	152
Collectors of ports and naval officers	----	----	----	----	----	----	----	----	----	----	----	----	129	----	129
Surveyors general of public lands	----	----	----	----	----	----	----	----	----	----	----	----	12	----	12
Inspectors of steamboats	----	----	----	----	----	----	----	----	----	----	----	----	9	----	9
Governors, lieutenant governors, librarians, &c	----	----	----	----	----	----	----	----	----	----	----	----	161	----	161
Meteorological Observers, Smithsonian Institution	----	----	----	----	----	----	----	----	----	----	----	----	49	----	49
Newspapers	----	----	----	----	----	----	----	----	----	----	----	----	689	----	689
Foreign	2	----	2	3	----	3	26	----	26	26	----	26	366	----	366
Grand total 7,120	50	2	52	77	1	78	385	3	388	518	1	519	5,661	422	6,083

APPENDIX No. 23.

List of original topographical sheets registered in the archives of the United States Coast Survey, geographically arranged.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast and islands between Kennebec river and Point Judith.					
Kennebec river, from Bath to Jones' Eddy	Maine	1-10,000	1857	W. S. Gilbert	667
Kennebec river, from Indian Point to Cox's Head	do	1-10,000	1857	do	666
Mouth of New Meadows river	do	1-10,000	1857	C. T. Iardella	655
Kennebec river, approaches	do	1-10,000	1856	I. Hull Adams	588
Kennebec river, entrance, and Cape Small Point	do	1-10,000	1856	do	587
Baker's island	do	1-2,500	1854	W. E. Greenwell	463
Cape Small Point, and adjacent islands	do	1-10,000	1854-'57	S. A. Gilbert, C. T. Iardella	465
Ragged island, and adjacent islands near Cape Small Point	do	1-10,000	1854-'57	do do	466
Casco bay, upper part, Mare's Point to Yarmouth	do	1-10,000		A. W. Longfellow	
Casco bay, Middle bay to Jaquish island	do	1-10,000		do	
Casco bay, Great Jebeig, Cousin's, and Littlejohn's islands	do	1-10,000	1856-'57	do	
Casco bay, outer islands between Jaquish and Long Island	do	1-10,000		do	
Part of Cape Elizabeth	do	1-10,000	1852	do	414
Richmond's island	do	1-10,000	1850	do	312
Cape Neddick and Ogunquit	do	1 10,000	1854	A. S. Wadsworth	459
York and Cape Neddick harbors, with intermediate coast	do	1-10,000	1853	A. W. Longfellow	440
Vicinity of Great Boar's Head	Massachusetts	1-10,000	1855	H. L. Whiting	
Rowley river, and part of Plum island, to Newburyport	do	1-10,000	1854	H. L. Whiting, I. Hull Adams	559
Newburyport and the mouth of Merrimac river	do	1-10,000	1851	A. W. Longfellow	355
Ipswich, (unfinished)	do	1-10,000		H. L. Whiting	467
Cape Ann, northern shore, including Essex river	do	1-10,000	1855	do	556
Annis Squam harbor and vicinity, Cape Ann	do	1-10,000	1852	H. L. Whiting, R. M. Bache	396
Rockport, extremity of Cape Ann, from Milk island to Lane's Cove	do	1-10,000	1851	H. L. Whiting	341
Gloucester harbor and vicinity, Cape Ann	do	1-10,000	1851	H. L. Whiting, R. M. Bache	397
South shore of Cape Ann, from Danver's New Mills to Beverly Farms	do	1-10,000	1851	H. L. Whiting	304

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast and islands—Continued.					
Salem harbor, from Beverly Farms to Kettle Cove, (Manchester)	Massachusetts	1–10,000	1851	H. L. Whiting	340
Salem harbor, including the city and islands	do	1–10,000	1851	do	303
From Saugus river to Marblehead, northwest shore of Massachusetts bay	do	1–10,000	1849–'50	do	305
Nahant Neck and Tinker's island	do	1–10,000	1847	do	235
From Point Shirley to Point Pines and Winnissimet village	do	1–10,000	1847	do	234
Governor's island and Castle island, Boston harbor	do	1–5,000	1846	do	231
Thompson's island, Outer Brewster, and intermediate islands, Boston harbor	do	1–10,000	1847, '49	J. S. Williams, H. L. Whiting	238
Cities of Boston and Charlestown	do	1–5,000	1846–'47	H. L. Whiting	229
East and South Boston	do	1–5,000	1846–'47	do	230
From Neponset to Roxbury, (interior)	do	1–10,000	1847	do	232
From Roxbury to Malden, (interior)	do	1–10,000	1847	do	233
From Milton Mills to Hingham, southern shore of Boston bay	do	1–10,000	1847	J. B. Glück	227
From Nantasket Hill to Green Hill, Boston bay	do	1–10,000	1847	J. S. Williams	237
From World's End Hill to Cohasset harbor, Boston bay	do	1–10,000	1847	J. B. Glück	228
From Cohasset harbor to Scituate harbor, eastern shore	do	1–10,000	1847	H. L. Whiting, S. A. Gilbert	236
Plymouth harbor, northern part, (unfinished)	do	1–10,000	1853–'54	S. A. Gilbert, R. M. Bache	425
Plymouth harbor and vicinity, (unfinished)	do	1–10,000	1853	S. A. Gilbert	455
Back river and vicinity, near Plymouth	do	1–10,000	1856–'57	R. M. Bache, A. M. Harrison	612
Northern part of Cape Cod and Provincetown harbor	do	1–10,000	18—	H. L. Whiting	616
Cape Cod peninsula, from Billingsgate light to Pamet river	do	1–10,000	1848	do	259
Wellfleet harbor, Cape Cod peninsula	do	1–10,000	1851	J. B. Glück	368
From Highland to Nausett light	do	1–10,000	1848	H. L. Whiting	260
From Nausett light to Orleans, (unfinished)	do	1–10,000	1856	C. T. Iardella	579
Part of South Yarmouth, Barnstable county	do	1–10,000	1852	A. W. Longfellow	356
Southern extremity of Cape Cod	do	1–10,000	18—	J. B. Glück	441
Monomoy island	do	1–20,000	1853, '56	S. A. Gilbert, C. T. Iardella.	424
From Bass river eastward	do	1–10,000		J. B. Glück	402
From Bass river to Hyannis, including West Yarmouth and South Dennis	do	1–10,000	1855	H. L. Whiting, J. A. Sullivan	553
From West Yarmouth to Hyannis Point	do	1–10,000	1846	W. M. Boyce	290
From Hyannis Point to Succonessett	do	1–10,000	1846	do	318

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast and islands—Continued.					
From Succonessett Point to Falmouth spire	Massachusetts	1-10,000	1846	W. M. Boyce	289
Elizabeth islands	do	1-10,000	1845	do	192
Cuttyhunk island, with Sow and Pigs shoal	do	1-5,000	1853	H. L. Whiting	437
From Falmouth to Back river, eastern shore of Buzzards' bay	do	1-10,000	1845	W. M. Boyce	191
From Back river to Great Hill Neck, northern part of Buzzards' bay	do	1-10,000	1845	H. L. Whiting	195
From Great Hill Neck to Sconticut Neck, western shore of Buzzards' bay	do	1-10,000	1845	do	196
From Sconticut Neck to Clark's Neck, including New Bedford	do	1-10,000	1845	do	194
From Clark's Point to Mishaum, (missing)	do	1-10,000	1845	do	193
From Mishaum Point to Saughkonnet Point	Mass. and R. I.	1-10,000	1844	W. M. Boyce	183
Eastern part of Nantucket, Great Point to Siasconsett	Massachusetts	1-10,000	1846	H. L. Whiting, W. E. Greenwell	206
Western part of Nantucket, including Tuckernuck and Muskeget island	do	1-10,000	1846	H. L. Whiting	205
Martha's Vineyard, eastern part, from Cape Poge to East Chop	do	1-10,000	1846	do	204
Northern shore of Martha's Vineyard, from East Chop to Menamsha Bight	do	1-10,000	1846	do	203
Southern shore of Martha's Vineyard, from Sampson's Hill to East Edgartown harbor	do	1-10,000	1846, '56	do	202
Gay Head, part of Martha's Vineyard, and No Man's Land	do	1-10,000	1845, '53	W. M. Boyce, H. L. Whiting	362
Saughkonnet river, from Church's Point, northward	Rhode Island	1-10,000	1844	H. L. Whiting	180
Entrance to Narragansett bay, Eastern Rock to Beaver Tail	do	1-10,000	1844	W. M. Boyce	182
From McSparran Hill to Point Judith	do	1-10,000	1839	J. J. S. Hassler	92
From McSparran Hill to Tiff's Hill, (interior)	do	1-10,000	1839	do	93
Shores of Long Island sound; Long Island and others adjacent; New York bay and its dependencies; Atlantic coast, and shores of Delaware bay to Cape Henlopen.					
From Point Judith to Noyes' Point	do	1-10,000	1839	do	91
From Tiff's Hill, westward, (interior)	do	1-20,000	1839	do	94
Kingston, from Fairbank's Cut, northward	do	1-20,000	1840	do	128
Joshua Champlin, Fairbank's Cut to Sand Hill, southward	do	1-20,000	1840	do	129
Block island	do	1-10,000	1839	do	90
From Hopkinton city to Sand Hill, (interior)	do	1-10,000	1840	F. H. Gerdes	126
From Big Hill to North Stonington, (interior)	R. I. and Conn.	1-10,000	1840	do	125

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Shores of Long Island sound, &c.—Continued.					
From Mystic river, including Groton, to Noyes's Point, Fishers' island	Connecticut	1–10,000	1839	F. H. Gerdes	88
Milltown and interior, from North Stonington to Niantic village	do	1–10,000	1840	do	123
North Stonington and interior, from Eel's Hill to Quaquotogue	do	1–10,000	1840	do	124
From Fort Hill to Mystic river	do	1–10,000	1838	Charles Renard	65
From Lantern Hill to Thames river	do	1–10,000	1839	F. H. Gerdes	89
From Fort Hill to Black Point, including Niantic bay	do	1–10,000	1838	Charles Renard	64
New London harbor, eastern shore of Thames river	do	1–10,000	1846	J. B. Glück	85
Thames river, western shore	do	1–10,000	1846	do	84
Thames river, from New London to Mohican	do	1–10,000	1839	F. H. Gerdes	86
Thames river, continued	do	1–10,000	1841	do	87
Between Niantic river and Thames river, (interior)	do	1–10,000	1839	do	83
From Niantic river to Lynn city, (interior)	do	1–20,000	1838	Charles Preuss	78
From Black Point to Cornfield Point, mouth of Connecticut river	do	1–10,000	1838	B. F. Sands	81
Mouth of Connecticut river	do	1–10,000	1850	H. L. Whiting	297
From Lynn city to Westbrook, (interior)	do	1–20,000	1838	Charles Hassler	79
From Cornfield Point to Hammonasset, Saybrook, and Clinton	do	1–10,000	1838	J. J. S. Hassler, W. M. Boyce	80
From Essex to North Killingworth, including Clinton, (interior)	do	1–10,000	1840	T. W. Werner	130
From North Killingworth to North Hill, East Haven, and Hammonasset	do	1–10,000	1839	do	105
From Hammonasset Point to New Haven	do	1–10,000	1838	W. M. Boyce	82
From New Haven to Fairhaven, Catron's Rock, and Whitneyville	do	1–10,000	1838	John Farley	76
From West Haven to Black Rock, (Sound shore)	do	1–10,000	1837	C. M. Eakin	22
From Bridgeport to New Haven, East Rock, and Sherwood	do	1–10,000	1837–'38	T. W. Werner	35
From Cheshire and Mount Carmel to Tashua and Mervin	do	1–20,000	1839–'40	do	106
From Centre Redding to Wilton, east of Ridgefield	do	1–20,000	1840	H. L. Dickens	131
From Tashua westward, Chestnut Hill to New Canaan	do	1–10,000	1839	T. A. M. Craven	107
From Bridgeport to Saugatuck, Sherwood, and Gorham	do	1–10,000	1838	do	51
From Black Rock to Norroton	do	1–10,000	1835	C. M. Eakin	19

APPENDIX No. 23.—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Shores of Long Island sound, &c.—Continued.					
From Saugatuck and Westbrook to Darien, (interior)	Connecticut	1-10,000	1838	T. A. M. Craven	50
Scofield and vicinity, (interior)	do	1-10,000	1839	do	108
From Round Hill to Newcastle, (interior)	do	1-10,000	1839	do	109
From Darien to Glenville and Horse Neck	do	1-10,000	1838	do	49
From Norroton Point to Delaney's Point, including Rye	do	1-10,000	1836	C. M. Eakin	20
Fisher's island and others adjacent, Long Island sound	New York	1-10,000	1838	F. H. Gerdes	57
Plum island and Gull island, Long Island sound	do	1-10,000	1838	do	56
Gardiner's island, Long Island sound	do	1-10,000	1838	T. A. Jenkins	75
Long Island, from Montauk Point to Napeague bay	do	1-10,000	1838	C. Renard and B. F. Sands	62
Napeague bay, vicinity of Amagansett, Long Island	do	1-10,000	1845	Captain W. M. Boyce	61
From Napeague to East Hampton	do	1-10,000	1838	Charles Renard	60
Bridge Hampton to Acabomock and East Hampton	do	1-10,000	1838-'46	T. A. Jenkins, J. B. Glück	74
Sag harbor, Gardiner's bay, and Three-Mile harbor	do	1-10,000	1838-'46	do do	72
Shelter island, Peconic bay, Long Island sound	do	1-10,000	1838	T. A. Jenkins	69
Cooper's Hill and Oyster Pond Point	do	1-10,000	1838	F. H. Gerdes	55
North Peconic bay, from Cutchogue to Hallock's Point	do	1-10,000	1838	T. A. Jenkins	68
Peconic bay, from Noyack to Sag harbor	do	1-10,000	1838	do	71
From Good Ground to East Hampton, (southern shore)	do	1-10,000	1838	Charles Renard	59
Southampton, interior of Long Island	do	1-10,000	1838	T. A. Jenkins	73
Peconic bay, Good Ground to Noyac	do	1-10,000	1838	do	70
Peconic bay, River Head to Little Hog Neck	do	1-10,000	1838	do	67
Old Landing, Cooper's Hill, and Cypress Point	do	1-10,000	1838	F. H. Gerdes	54
Friar's Head, River Head, and Old Landing	do	1-10,000	1838	do	53
Smith's Point, to Good Ground and Inlet West	do	1-10,000	1838	Charles Renard	58
From Ruland's to River Head, (interior)	do	1-20,000	1838	H. L. Dickens	77
Drowned Meadow harbor, Mount Misery, and Friar's Head	do	1-10,000	1838	F. H. Gerdes	52
From Patchogue to Smith's Point	do	1-10,000	1835	Charles Renard	2
West end of Fire island and Watch Hill	do	1-10,000	1834		479
From Stony Brook to Drowned Meadow, (interior)	do	1-20,000	1837	Charles Preuss	43
Setauket city and Drowned Meadow, Old Field Point, and Mount Misery	do	1-10,000	1837	F. H. Gerdes	32

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Shores of Long Island sound, &c.—Continued					
From Old Field and Setauket to Stony Brook	New York	1–10,000	1837	F. H. Gerdes	31
From Smithtown to Stony Brook, (interior)	do	1–10,000	1837		42
From Babylon to Patchogue and George's Neck	do	1–10,000	1834	Charles Renard	1
From West Hills to Ruland's	do	1–20,000	1837	H. L. Dickens	45
West Hills and vicinity, (interior)	do	1–10,000	1836	do	44
Nissequague river, Smithtown, and Stony Brook	do	1–10,000	1837	F. H. Gerdes	30
Red Hook, Bread and Cheese Hollow, and Smithtown, (interior)	do	1–10,000	1837	Charles Preuss	41
Eaton's Neck to Smithtown, (interior)	do	1–10,000	1837	F. H. Gerdes	29
From North Port to Red Hook, (interior)	do	1–10,000	1837	Charles Preuss	40
Cow harbor, North Port, and Eaton's Neck	do	1–10,000	1837	F. H. Gerdes	28
Lloyd's Neck, to East Neck and Lloyd's harbor	do	1–10,000	1836	do	23
Huntington bay	do	1–10,000	1837	do	24
Oyster bay, Cold Spring, and Hog island	do	1–10,000	1837	do	25
From Babylon to Fire island and Rockaway	do	1–20,000	1835	Charles Renard	3
Hicksville and Jamaica, Brushville and Miltham	do	1–20,000	1837	T. A. Jenkins	37
From Newlett's to Jamaica and Hicksville	do	1–20,000	1837	do	38
From Glen Cove to Oyster bay, (interior)	do	1–10,000	1837	Charles Preuss	39
From Cold Spring to Glen Cove	do	1–20,000	1838	T. A. Jenkins	66
Hog Island, Matinicock Point, and Red Spring	do	1–10,000	1837	F. H. Gerdes	26
Matinicock and Hempstead harbor	do	1–10,000	1837	do	27
Cow Neck and Manhasset	do	1–10,000	1837	T. W. Werner	34
From Great Neck to Bowen Station	do	1–10,000	1837–'50	T. W. Werner, H. L. Whiting	33
Throg's Neck and vicinity, Long Island	do				605
Hewlett's Cove, Wilkins' Point, and Great Bay	do	1–10,000	1837	Charles Renard	14
Hell Gate and vicinity	do	1–5,000	1848	H. L. Whiting	258
From Hell Gate to Babylon	do	1–10,000	1855	F. H. Gerdes	483
From Throg's Neck to Ward's island	do	1–10,000	1855	do	488
Ward's, Randall's, N. and S. Brother, and Riker's island	do	1–5,000	1857	H. L. Whiting	675
Flushing bay and vicinity, Long Island	do				604
From Flushing to Brooklyn	do				606
From Hewlett's Cove to Brooklyn	do	1–10,000	1837	Charles Renard	13
Brooklyn and vicinity	do				607
Williamsburg and part of Brooklyn	do				608
From Brooklyn to Jamaica	do	1–20,000	1837	T. A. Jenkins	36
From Brooklyn to Fort Hamilton and Gowanus island	do	1–10,000	1837	Charles Renard	12
Gowanus bay and vicinity	do	1–10,000	1856	S. A. Gilbert	599
Gowanus bay and vicinity	do	1–10,000	1856	do	598

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State	Scale.	Date.	Topographers.	Register number.
Shores of Long Island sound, &c.—Continued.					
Gowanus bay and vicinity	New York	1–10,000	1856	S. A. Gilbert	597
From Gowanus bay to Bath	do	1–10,000	1855	do	487
From Fort Hamilton to Coney island	do	1–10,000	1835	Charles Renard	5
Coney island and Dead Horse inlet	do		1855–'56	S. A. Gilbert	586
From Coney island to Rockaway Pavilion	do	1–20,000	1835	Charles Renard	4
Gravesend bay and Dead Horse inlet	do	1–10,000		S. A. Gilbert	544
Barren island, Rockaway Beach	do	1–20,000		do	535
Staten Island	do	1–10,000	1835–'36	Charles Renard	9
Staten Island from Ward's Point to Great Kills	do	1–10,000	1856	H. L. Whiting	680
Tompkinsville, Staten Island	do	1–5,000	1835	Charles Renard	6
From New Brighton to Great Kills, Staten Island	do	1–10,000	1855	A. S. Wadsworth	490
Ward's Point, Rossville, and Arthur Kill, Staten Island	do		1856	H. L. Whiting	
Port Richmond, Frame Village, Old Places, and Chelsea, Staten Island	do		1856	do	
Stapleton, Vanderbilt's Landing, New Durp, and Richmond, Staten Island	do		1856	do	
Bedloe's and Ellis' islands, New York harbor	do	1–10,000	1855	F. H. Gerdes	543
Governor's, Ellis', and Bedloe's islands	do	1–5,000	1857	John Mechan	677
Manhattan island, eastern part, New York city to West Farms	do	1–10,000	1837	Charles Renard	16
New York city and Manhattan island	do	1–10,000	1854–'55	F. H. Gerdes	475
Manhattan island, from Macomb's Dam to Spuyten Duyvel creek	do	1–10,000	1857	John Mechan	658
Harlem river and Throg's Neck	do	1–10,000	1837	Chas. Renard	15
From Throg's Neck to Rodman's Point	do	1–10,000	1837	W. M. Boyce	46
From Kingsbridge to Rye Point	do	1–10,000	1837	T. A. M. Craven	47
Rye Point, Delaney's Point, and Rodman's Neck	do	1–10,000	1837	C. M. Eakin	21
From Horse Neck to Rye	do	1–10,000	1838	T. A. M. Craven	48
From Field West to Round Hill	do	1–10,000	1839	do	110
From North Castle to Hudson river, at Tarrytown	do	1–10,000	1839	do	111
From Communipaw to Palmipaw	do	1–10,000	1857	John Mechan	662
Hudson river, from Jersey city to Gutenberg	do	1–10,000	1855	F. H. Gerdes	484
Hudson river, from Gutenberg to Tubby Hook	do	1–10,000	1855	do	485
Hudson river, from Gutenberg	do				610
Hudson river, from Spuyten Duyvel creek to Sounding Point	do		1853	F. H. Gerdes	419
Hudson river, from Spuyten Duyvel creek to Fort Washington	do	1–10,000	1853	do	418

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Shores of Long Island sound, &c.—Continued.					
Hudson river, Kingsbridge, and vicinity	New York	1-10,000	1839	T. A. M. Craven	113
Hudson river, Greensburg, and vicinity	do	1-10,000	1839	do	112
Hudson river, Bull's Ferry to Fort Washington	do				609
Hudson river, from Hastings to Tarrytown	do	1-10,000	1853	F. H. Gerdes	420
Hudson river, vicinity of Godwinsville	do	1-20,000	1840	H. L. Dickens	132
Hudson river, from Tarrytown to Croton river	do	1-10,000	1853	F. H. Gerdes	421
Hudson river, from Sing Sing to Stony Point	do	1-10,000	1854	do	468
Hudson river, from Haverstraw bay to Anthony's Nose	do	1-10,000	1854	do	480
From Croton Point, Hudson river, to Baker's Hill, and Bald Hill	do	1-20,000	1839	H. L. Dickens	95
Hudson river, above New Baltimore	do		1856	A. S. Wadsworth	596
Hudson river	do		1856	do	595
Hudson river	do		1856	do	594
Hudson river	do		1856	do	593
From Fort Lee to Jersey City	New Jersey	1-10,000	1837	Chas. Renard	17
From Fort Lee to Boomper's Hook	do	1-10,000	1839	T. A. Jenkins	96
From North Scalenburg to Passaic river	do	1-10,000	1839	do	97
From Patterson to Weasel, (interior)	do	1-10,000	1839	do	99
From Weasel Mount to Springfield, (interior)	do	1-10,000	1839	do	102
From Hackensack to Newark and Elizabethtown	do	1-10,000	1839	do	100
Hackensack to Patterson, (interior)	do	1-10,000	1839	do	98
From Jersey City to Caven Point	do	1-10,000	1855	A. S. Wadsworth	482
From Jersey City to Constable's Point	do	1-10,000	1837	Chas. Renard	18
From Caven Point to Constable's Point	do	1-10,000	1855	A. S. Wadsworth	489
Kill van Kull and Newark bay	do	1-10,000	1855	do	533
New Market, (interior)	do	1-10,000	1840	T. A. M. Craven	134
Bound Brook, (interior)	do	1-10,000	1840	do	135
From Elizabethtown, eastward	do	1-10,000	1836	Chas. Renard, T. A. Jenkins	10
From Perth Amboy to Elizabethtown	do	1-10,000	1836	Charles Renard	8
Elizabethport to Rahway creek	do	1-10,000	1855	A. S. Wadsworth	530
Bellville, (interior)	do	1-10,000	1839	T. A. Jenkins	101
Rahway, (interior)	do	1-10,000	1839	do	104
Springfield, (interior)	do	1-10,000	1839	do	103
South Rahway, (interior)	do	1-10,000	1840	T. A. M. Craven	133
From Fresh Kills, southward	do	1-10,000	1855	A. S. Wadsworth	531
From Perth Amboy to Woodbridge	do	1-10,000	1855	I. Hull Adams	534
Raritan bay, from Great Kills to Ward's Point	do	1-10,000	1855	A. S. Wadsworth	532
Raritan bay, from East Point to South Amboy	do	1-10,000	1855	A. M. Harrison	542

APPENDIX No. 23.—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Shores of Long Island sound, &c.—Continued.					
Raritan bay, Cowhead to Point Comfort	New Jersey	1-10,000	1855	A. M. Harrison	541
Raritan valley, from Perth Amboy to New Brunswick	do	1-10,000	1836	Charles Renard	11
Sandy Hook	do	1-5,000	1836	do	239
Sandy Hook beach, Navesink to South Amboy	do	1-20,000	1836	do	7
Sandy Hook island	do	1-20,000	1848	S. A. Gilbert	252
Sandy Hook	do	1-20,000	1850	H. L. Whiting	278
Sandy Hook, northward of Ocean House	do	1-10,000	1851	R. M. Bache	342
Sandy Hook, shore line	do	1-10,000	1853	F. H. Gerdes	413
Sandy Hook and Highlands of Navesink	do	1-10,000	1855	A. M. Harrison	486
From Navesink to Poplar creek	do	1-10,000	1839	B. F. Sands	114
From Shrewsbury to New Brunswick, (interior)	do	1-20,000	1840	do	122
New Brunswick and vicinity	do	1-10,000	1840	T. A. M. Craven	136
Between Shrewsbury and Princeton, (interior)	do	1-20,000	1841	H. L. Dickens	145
From Poplar creek to Manasquam	do	1-10,000	1839	B. F. Sands	115
Interior, in vicinity of Squam	do	1-20,000	1842	H. L. Dickens	158
From Manasquam to Metiticonk	do	1-10,000	1839	B. F. Sands	116
From Metiticonk to Barnegat inlet	do	1-20,000	1839	Charles Renard	120
Metiticonk to Cedar creek	do	1-10,000	1839	B. F. Sands	117
Interior, Goose creek and Good Luck Point	do	1-20,000	1842	H. L. Dickens	159
Vicinity of Goose creek, (interior)	do	1-20,000	1842	do	160
From Cedar creek to Barnegat	do	1-10,000	1839	B. F. Sands	118
From Barnegat inlet to Great Swamp	do	1-20,000	1839	Charles Renard and B. F. Sands	121
From Barnegat bay to Little Egg Harbor	do	1-20,000	1839'41	B. F. Sands	119
From Little Egg Harbor to Dry inlet	do	1-20,000	1841	do	142
From Dry inlet to Great Egg Harbor	do	1-10,000	1841	do	143
From Great Egg Harbor to Corson's inlet	do	1-10,000	1842	do	146
From Corson's inlet to Cape May Court-house	do	1-10,000	1842	do	147
From Cape May Court-house to Cape May island	do	1-10,000	1842	George D. Wise	148
From Cape May light to Cape May Court-house	do	1-10,000	1842	do	149
From Cape May light-house to Dennis' creek	do	1-10,000	1842	F. H. Gerdes	153
From Goshen to Fishing creek, peninsula of Cape May	do	1-10,000	1842	do	154
From Greenwich creek to Dennisville, (interior)	do	1-20,000	1842	H. L. Whiting	157
From Ben Davis' Point to Dennis' creek, Delaware bay	do	1-20,000	1842	F. H. Gerdes	152
From Liston's Point to Ben Davis' Point, Delaware river	do	1-20,000	1841	do	63
From Greenwich creek and Cohansey to Salem creek	do	1-20,000	1842	H. L. Whiting	155

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Shores of Long Island sound, &c.—Continued.					
From Salem creek to opposite Penn's Grove	New Jersey	1-10,000	1843	H. L. Whiting	156
From Salem creek to Penn's Grove	do	1-20,000	1846	J. J. S. Hassler	163
From Lazaretto to mouth of Schuylkill river, Pennsylvania	N. J. and Pen.	1-10,000	1842	W. M. Boyce	164
From Cowperthwaite to Cooper's Point, Rancocus creek	do	1-10,000	1843-'44	J. J. S. Hassler	168
From Rancocus creek to Burlington and Bristol	do	1-10,000	1843-'44	do	167
From New Cold islands to White Hill	do	1-10,000	1843-'44	do	173
From White Hill to Trenton	do	1-10,000	1843-'44	George D. Wise	172
Interior between Princeton, Trenton, and Pennington	New Jersey	1-20,000	1841	T. A. M. Craven	144
Princeton and vicinity, (interior)	do	1-20,000	1840	F. H. Gerdes	127
Sandhills and vicinity, (interior)	do	1-20,000	1840-'41	T. A. M. Craven	137
From Bristol to New Cold island	N. J. and Pa	1-10,000	1843-'44	J. J. S. Hassler	171
Part of Philadelphia, Camden, N. J., and vicinity	do	1-10,000	1843	W. M. Boyce	165
Part of Philadelphia, and New Jersey side of Delaware river, (missing)	do	1-5,000		do	166
From Penn's Grove to Lazaretto	N. J. and Pa	1-10,000	1841-'42	do	161
Lazaretto to Dupont's wharf	do	1-20,000	1846	J. J. S. Hassler	162
From Wilmington to Pea Patch island	N. J. and Del.	1-10,000	1841	F. H. Gerdes	138
Wilmington to Newcastle	do	1-10,000	1839		139
From Wilmington to Iron Hill, (interior)	Del. and Md	1-20,000	1843	T. W. Werner	169
From Ash Signal to Riggs' Hill, (interior)	do	1-20,000	1843	do	170
From Pea Patch island to Liston's tree	N. J. and Del.	1-10,000	1841	F. H. Gerdes	140
From Liston's Point to Ben Davis' Point	do	1-10,000	1841	do	141
Bombay Hook island to Mispillion light	Delaware	1-20,000	1842	do	150
From Mispillion light to Cape Henlopen	do	1-20,000	1842	do	151
Atlantic coast, and shores of the Chesapeake bay and its tributaries, from Cape Henlopen to Cape Henry.					
From Cape Henlopen to Indian river	Delaware	1-20,000	1845	J. J. S. Hassler	226
From Salt Point beach to Dromedary signal	Del. and Md	1-20,000	1850	George D. Wise	299
Beach House to South Birch	Maryland	1-20,000	1849	do	263
Head of Assateague bay to Pope's island	do	1-20,000	1850	do	264
From Pope's island beach to Lonesome Hill	Virginia	1-20,000	1850	do	311
Coast southward to Little inlet	do	1-20,000		do	524
Lonesome Hill to Chincoteague inlet	do	1-20,000		do	522
Chincoteague inlet and vicinity	do			do	580
Wallop's island and Assawaman island	do	1-20,000	1851	W. M. Johnson	378
From Wallop's island to westward of Gargathy inlet	do	1-20,000	1855	George D. Wise	492
From Gargathy to Wachapreague inlet	do	1-20,000	1852-'54	do	464
Wachapreague inlet and vicinity	Md. and Va	1-20,000		do	510

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast and shores of Chesapeake Bay and its tributaries—Continued.					
Little Machipongo, Paramore's island, and Wachapreague	Virginia	1-20,000		George D. Wise	512
Great and Little Machipongo inlets	do	1-20,000		do	511
Great Machipongo inlet to Little inlet	do	1-20,000		do	523
New inlet, southward to Smith's island light	do	1-20,000		do	525
From New inlet to Cape Charles	do	1-20,000		do	509
Entrance to Chesapeake bay (practice sheet)	do	1-20,000	1853	S. A. Wainwright	394
From Cherrystone inlet southward to Costen's station	do	1-20,000		John Seib	495
Occohannock, Naswaddox, and Hunger's creeks	do	1-20,000	1851	do	350
From Sandy Point to Pungoteague creek	do	1-20,000	1850	J. Seib, S. A. Wainwright	307
Pungoteague creek to Chesconessex and Onancock creeks	do	1-20,000	1850	do	308
Pocomoke sound and bay	do	1-20,000	1851	do	349
Tangier Island and Watt's island	do	1-20,000	1850	do	309
Pocomoke sound from Guilford creek to Messanger	do	1-20,000		S. A. Wainwright	529
Pocomoke sound, Ape's Hole creek	do	1-20,000		do	528
From Fox's island to Little Annemessex river	Maryland	1-20,000	1849-'51	R. D. Cutts, J. Seib, S. A. Wainwright	272
Deil's island and Manokin river	do	1-20,000	1849	R. D. Cutts, J. Seib, S. A. Wainwright	270
Smith's island, Chesapeake bay	do	1-20,000	1849	John Seib	271
Bloodsworth island and South Marsh island	do	1-20,000	1849	do	269
Tangier sound and Wicomico river	do	1-20,000	1849	R. D. Cutts, J. Seib, S. A. Wainwright	268
Fishing bay and part of Nanticoke river	do	1-20,000	1849	R. D. Cutts, J. Seib, S. A. Wainwright	267
Part of Nanticoke river, vicinity of Vienna	do	1-20,000	1849	J. Seib, S. A. Wainwright	266
Mouth of Honga river and Hooper's strait	do	1-20,000	1848	R. D. Cutts, J. Seib	265
Honga river, upper part	do	1-20,000	1848	R. D. Cutts	255
Meekins' Neck (included in No. 255)	do	1-20,000	1854	H. L. Whiting	451
Little Choptank river from Meekins' Neck to Cook's Point	do	1-20,000	1847-'48	George D. Wise	250
Sharp's island, Chesapeake bay	do	1-20,000	1848	do	251
Mouth of Choptank river, Cook's Point to Cambridge	do	1-20,000	1847	R. D. Cutts	225
Choptank river, from Hanbrook's Point to Cabin creek	do	1-20,000	1848	do	253
Choptank river, from Cabin creek to Wing's Landing	do	1-20,000	1848	do	254
St. Michael's river and Third Haven creek	do	1-20,000	1847	do	224
Kent island, Eastern bay, Wye and St. Michael's rivers	do	1-20,000	1847	do	223

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast and shores of Chesapeake Bay and its tributaries—Continued.					
From Ward's Point to Locust Point, Sharp's island and Poplar island	Maryland	1-20,000	1846-'47	George D. Wise	215
Kent Island base and vicinity	do	1-10,000	1844	H. L Whiting	181
Part of Kent island	do	1-20,000	1847	R. D. Cutts	222
Mouth of Chester river	do	1-20,000	1846	J. C. Neilson	200
Shores of Chester river	do	1-20,000	1846	do	201
From Swan creek to Eastern Neck inlet	do	1-20,000	1846	R. D. Cutts	199
From Swan Point to Wharton Point and Pool's island	do	1-20,000	1845	do	187
Sassafras river entrance	do	1-20,000	1854	H. L. Whiting	469
Sassafras river	do	1-20,000	1846	J. J. S. Hassler	279
Elk and Bohemia rivers, and Back creek	do	1-20,000	1845-'55	J. J. S. Hassler, H. L. Whiting	186
Northeast river entrance	do	1-10,000	1844-'45	J. J. S. Hassler	185
Northeast river	do	1-10,000	1844-'45	do	184
Susquehanna river, Havre de Grace, and Port Deposit	do	1-10,000	1845	R. D. Cutts	189
Head of Chesapeake bay, from Havre de Grace to Spesutie creek	do	1-10,000	1845	do	188
Head of Chesapeake bay, from Susquehanna river to Bush river	do	1-20,000	1845	Geo. D. Wise	212
From Swan creek to Bush river	do	1-20,000	1845-'46	R. D. Cutts	190
Bush, Gunpowder, Beach, and Middle rivers	do	1-20,000	1846-'47	Geo. D. Wise	213
From Bush river to Baltimore city	do	1-20,000	1846	R. D. Cutts	197
Back river	do	1-20,000	1846-'47	Geo. D. Wise	214
North Chop of Back river, Miller's and Pool's islands	do	1-20,000	1854	H. L. Whiting	450
Patapsco Neck, Bear creek to North Point	do	1-20,000	1853	do	436
Patapsco river, eastern shore	do	1-20,000	1845-'46	Geo. D. Wise	219
Patapsco river, from Colegate creek to Bear creek	do	1-20,000	1852	H. L. Whiting	401
Baltimore city	do	1-10,000	1845	Geo. D. Wise	216
Baltimore city	do			J. B. Glück	217
Patapsco river	do	1-20,000	1847	Geo. D. Wise	221
Patapsco river, eastern shore	do	1-20,000	1845-'46	do	218
Patapsco river, western shore	do	1-20,000	1846	do	220
Patapsco river	do	1-10,000	1851-'55	J. B. Glück, H. L. Whiting	306
From Sandy Point and Merrick to Bodkin Point	do	1-10,000	1844	F. H. Gerdes	175
Magothy river, Chesapeake bay	do	1-10,000	1845	do	179
From Sandy Point to Thomas' Point and mouth of Severn river	do	1-10,000	1844	do	174
Severn river, Hackett's Point to Cedar Point	do	1-10,000	1844	do	176
Severn river (included in No. 176.)	do	1-10,000			177

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast and shores of Chesapeake bay and its tributaries—Continued.					
South river, Chesapeake bay	Maryland	1–20,000	1847	Geo. D. Wise	248
South river (included in No. 248.)	do	1–20,000	1847	do	249
South river (included in No. 176.)	do	1–10,000			178
From Sanders' Point to Chew's and West river	do	1–20,000	1846	R. D. Cutts	198
From Chew's to Parker's creek	do	1–20,000	1847	J. J. S. Hassler	280
From Parker's creek to Cove Point	do	1–20,000	1847	do	281
Cove Point and vicinity	do	1–20,000	1852	John Seib	388
Patuxent river entrance, Cove Point to Drum Point	do	1–20,000	1848	R. D. Cutts	256
Jenkins' creek, Cambridge, Oyster Point, and Jamaica Point	do	1–20,000	1848	R. D. Cutts, John Seib	257
Entrances to Great Wicomico and Potomac rivers	Md. and Va.	1–20,000	1850–'56	John Seib	500
Potomac river entrance	Virginia		1856	do	458
Ingram's bay, Dividing creek, and Fleet's bay	do	1–20,000	1850	J. Seib, S. A. Wainwright	310
Rappahannock river entrance	do	1–10,000	1851–'56	John Seib	521
Rappahannock river, Mechim's creek to Stiff	do	1–10,000	1857	I. Hull Adams	660
Rappahannock river, Bailey's Bluff to Mechim's creek	do	1–10,000	1857	do	659
Rappahannock river and Currotoman	do	1–10,000	1857	do	661
Rappahannock river	do	1–10,000	1856	do	603
Rappahannock river, La Grange to Punch Bowl	do	1–10,000	1856	do	602
Rappahannock river, Punch Bowl to Layton	do	1–10,000	1855	John Seib, A. Strausz	520
Rappahannock river, Layton to Accaceek Point	do	1–10,100	1855	do do	519
Rappahannock river, from Accaceek Point to Ferry marsh	do	1–10,000	1855	do do	518
Rappahannock river, from Ferry marsh to Cliff	do	1 10,000	1855	do do	517
Rappahannock river, from Cliff to Leeds	do	1–10,000	1855	do do	516
Rappahannock river, from Leeds to Brick Quarter	do	1–10,000	1855	do do	515
Rappahannock river, from Brick Quarter to Holland Point	do	1–10,000	1854	John Seib	514
Rappahannock river, Holland Point to Lamb's creek	do	1–10,000	1853–'54	do	513
Rappahannock river, above Corbin's Neck	do	1–10,000	1853	do	435
Rappahannock river, from Taylor to Falmouth	do	1–10,000	1853	do	434
Chesapeake bay, from Wolf Trap to Cherry Point	do	1–20,000		do	503

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast and shores of Chesapeake Bay and its tributaries—Continued.					
Mobjack bay, tributary of Chesapeake	Virginia	1-20,000		John Seib	504
Mouth of York river	do	1-20,000	1853-'54	do	496
Back river and Pocosin river entrances	do	1-20,000	1853-'54	do	499
Old Point Comfort and entrance to Hampton roads	do	1-20,000	1853-'54	do	502
Hampton roads and vicinity	do	1-20,000		do	501
James river entrance	do	1-20,000		do	497
James river, from Maycox Point to City Point	do	1-10,000	1853	do	431
Appomattox river, from City Point to Point Walthall	do	1-10,000	1853	do	390
Part of Appomattox river and Petersburg	do	1-10,000	1853	J. Seib, S. A. Wainwright	389
James river, from City Point to Curl's Neck	do	1-10,000	1853	John Seib	430
James river, from Curl's Neck to Dutch Gap	do	1-10,000	1853	do	429
James river, from Dutch Gap to Wilton	do	1-10,000	1853	do	428
James river, from Warwick bar to Richmond bar	do		1853	S. A. Wainwright	392
James river, from Drury's island to Mayo's bridge	do		1853	do	391
James river, Trent's reach	do		1853	do	393
Nansemond river, upper part	do			John Seib	505
Elizabeth river entrance	do	1-20,000		do	498
Norfolk harbor	do			do	506
Lynn Haven roads	do	1-20,000		do	507
Atlantic coast and sounds between Cape Henry and Cape Fear.					
Currituck sound	North Carolina	1-20,000	1857	J. J. S. Hassler	657
Currituck sound, from North banks to Jones' Hill	do	1-20,000	1851-'52	do	381
Currituck sound, from North banks to North river	do	1,20,000	1848-'49	do	292
Pasquotank river, from entrance to Floating bridge	do	1-20,000	1847	J. C. Neilson	207
Big Flatty river, Albemarle sound	do	1-20,000	1847	do	208
Little river and environs, Albemarle sound	do	1-20,000	1847	do	209
Perquimon's river, Albemarle sound	do	1-20,000	1847	do	210
Albemarle sound, from Smith's Point to Sandy Point	do	1-20,000	1848	J. J. S. Hassler	247
Albemarle sound, from Laurel Point to Smith's Point	do	1-20,000	1848	do	211
Albemarle sound, from Long Shoal to Laurel Point	do	1-20,000	1848	do	246
Alligator river, from Cypress creek to Long Shoal	do	1-20,000	1849	A. W. Longfellow	284

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast and sounds between Cape Henry and Cape Fear—Continued.					
Alligator river, from Cypress point to Bear point	North Carolina	1-20,000	1849	A. W. Longfellow	285
Albemarle Sound, Durant island haulover	do	1-20,000	1848-'49	J. J. S. Hassler	293
Roanoke Sound, Kill Devil Hills to Nag's Head	do			do	351
Bodie's island, Nag's Head to Wreck	do	1-20,000	1849	A. W. Longfellow	354
From Wreck Stafford to Bay signal	do	1,20,000	1852	I. Hull Adams	367
From Bay signal to Cape Hatteras	do	1-20,000	1852	do	377
Hatteras inlet	do	1-20,000	1852	do	372
Hatteras inlet	do	1-10,000	1857	John Mechan	623
Ocracoke inlet	do	1-20,000		I. Hull Adams	376
Ocracoke inlet	do	1-10,000	1857	John Mechan	622
Cape Lookout and part of Core sound	do	1-20,000	1853	A. S. Wadsworth	416
Beaufort harbor	do	1-10,000	1851	H. L. Whiting	315
Beaufort harbor	do	1-10,009	1851	Chas. P. Bolles	348
Beaufort harbor	do	1-20,000	1854	A. S. Wadsworth	438
New river and part of Stump sound	do	1-10,000	1856	A. S. Wadsworth, J. Mechan	558
Topsail sound and Stump sound	do	1-10,000	1856	do do	565
Rich inlet and Topsail sound	do	1-10,000	1857	John Mechan	617
Middle sound and Topsail sound	do	1-10,000	1857	do	618
Masonboro' inlet and Middle sound	do	1-10,000	1857	do	619
Myrtle sound	do	1-10,000	1857	do	620
Myrtle sound and Federal point	do	1-10,000	1857	do	621
Cape Fear river entrance and Smith's island	do	1-10,000	1851-'56	Chas. P. Bolles	346
Oak island, Cape Fear entrance, and Smithville	do	1-10,000	1851	do	345
Cape Fear river, Bay lights to Reeves' point	do	1-10,000	1851-52-56	do	344
Cape Fear river, Reeves' point to Hill	do	1-10,000	1853	Chas. P. Bolles, G. W. Gregory	446
Cape Fear river and Campbell's island	do	1-10,000	1853	Chas. P. Bolles	449
Cape Fear river and mouth of Brunswick creek	do	1-5,000	1853	do	447
Cape Fear river and mouth of Northwest river	do		1853	do	448
Cape Fear entrance and westward	do	1-10,000	1852	do	674
Lockwood's Folly inlet and vicinity	do	1-10,000	1856	do	673
From Lockwood's Folly to Bacon's inlet	do	1-10,000	1857	do	672
Atlantic coast and harbors between Cape Fear and St. Mary's river.					
Winyah bay and Georgetown harbor	South Carolina	1-10,000	1857	S. A. Wainwright L. H. Whiting	526
Winyah bay and Georgetown harbor	do	1-10,000	1857	do do	527

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast and harbors between Cape Fear and St. Mary's river—Continued.					
Part of Long island, Breach inlet to Rattlesnake inlet	South Carolina	1-20,000	1854	R. M. Bache	471
Charleston harbor, north side, and Sullivan's island	do	1-10,000	1849-'58	S. A. Gilbert W. S. Edwards	262
Charleston harbor, south side, to Lighthouse inlet	do	1-10,000	1849	do do	261
Part of Folly island	do	1-20,000	1849-'50	do do	296
Folly island, west end, to Kiawah island	do	1-20,000	1854	R. M. Bache	491
North Edisto river, northeastern part	do	1-20,000	1851	Geo. D. Wise	322
North Edisto river, southwestern part	do	1-20,000	1851	do	327
Part of Edisto island and Jehossee island	do	1-20,000	1856-'57	John Seib	679
South Edisto river	do	1-20,000		do	508
St. Helena sound	do	1-20,000	1856	do	611
Savannah river, entrance to Four-mile point	Georgia	1-10,000	1852	H. L. Whiting	379
Savannah river, Cross Tides to Isla island	do	1-10,000	1852	do	380
Savannah river, city, and Elba island	do	1-5,000	1852	do	383
Savannah city and environs	do	1-10,000	1852	do	343
Savannah city and vicinity northward	do	1,10,000	1852	do	385
Sapelo island, (reconnaissance)	do	1-10,000	1857	H. S. Du Val	678
Sapelo island and river to Sutherland's Bluff	do		1857	A. W. Longfellow	----
Atlantic coast of Florida, Keys, and Gulf coast, between St. Mary's river and St. Joseph's bay.					
Cumberland island base site, (reconnaissance)	Florida	1-10,000	1857	A. M. Harrison	624
Fernandina harbor and vicinity	do	1-10,000	1857	do	613
Amelia river and vicinity	do	1-10,000	1857	do	615
St. Mary's river and vicinity	Ga and Fla	1-10,000	1857	do	614
St. John's river and Fort George inlet	Florida	1-10,000	1853	R. M. Bache	411
St. John's river, from entrance to Brown's creek	do	1-10,000	1855	A. M. Harrison	550
St. John's river, Brown's creek to Point Saurrez	do	1-10,000	1855	do	551
St. John's river, Point Saurrez to Jacksonville	do	1,10,000	1855-'56	do	552
Cape Cañaveral	do	1-20,000	1850	I. Hull Adams	300
Coast of Florida, Miami river, and Key Biscayne bay	do	1-20,000	1851	do	336
Elliott's key, Soldier key, and Ragged keys	do	1-20,000	1852-'53	do	409
Elliott's key, Cæsar's creek, and Old Rhodes' key	do	1-20,000	1853	do	408
Key Largo, Old Rhodes to Basin Hill	do	1-20,000	1854-'55	S. A. Wainwright	573
Key Largo, Basin Hill to Excelsior	do	1-20,000	1855	do	574
From Egan creek to Indian key	do	1-20,000	1857	do	640
Lower Matecumbe and Lignumvitæ keys	do	1,20,000	1857	do	641
Vaccas keys	do	1-20,000	1857	F. W. Dorr	651

APPENDIX No. 23.—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Atlantic coast of Florida, Keys, and Gulf coast, between St. Mary's river, &c.—Continued.					
Little Pine key, Johnson's, Flat key, and others adjacent	Florida	1-20,000	1857	C. T. Iardella	627
Howe's key, Annette, Spanish keys, and others	do	1-20,000	1857	do	626
Big Pine key, Ramrod key, and others adjacent	do	1-20,000	1857	do	625
Sugar Loaf, Cudjoe, Summerland, and Loggerhead keys	do	1-20,000	1856	do	568
Content, Water, Raccoon, and Knock-'em-down keys	do	1-20,000	1857	F. W. Dorr	652
Bahia Honda harbor, Pine island signal	do	1-20,000	1851	I. Hull Adams	339
Bahia Honda or Spanish harbor	do		1854	S. A. Wainwright	461
Johnston and Sawyer keys	do	1-20,000	1856	do	560
Snipe and Saddle Bunch keys	do	1-20,000	1855	I. Hull Adams	494
Mud keys	do	1, 20,000	1855	do	493
Boca Chica and adjacent keys	do		1853	R. M. Bache	417
Keys north and east of Boca Chica	do	1-20,000	1853-'54	I. Hull Adams	457
Key West, Stock island, and adjacent keys	do	1-10,000	1850	do	291
Keys off the harbor of Key West	do	1-20,000	1850	do	302
Keys and ledges, vicinity of Key West	do	1-10,000	1850	do	301
Marquesas keys and Boca Grande	do	1-20,000	1851	do	319
Cape Sable, from Palm Point to Upper Crossing	do	1-20,000	1857	F. W. Dorr	649
Cape Sable, from Palm Point to Northwest Cape	do	1-20,000	1857	do	650
Gulf of Mexico, coast and harbors between St. Joseph's bay and Mobile bay					
We-thlocco-chee river, (reconnaissance)	do	1-10,000	1856	A. M. Harrison	570
Waccasassa reefs	do	1, 10,000	1856	do	571
Waccasassa river, (reconnaissance)	do	1-10,000	1856	do	569
Cedar keys, and vicinity eastward	do	1-10,000	1856	do	572
Cedar keys	do	1-10,000	1852-'54	F. H. Gerdes	423
Cedar keys	do	1-10,000	1852	do	422
Ocilla river	do	1-20,000	1854	Geo. D. Wise	454
St. Mark's river	do	1-20,000	1856	do	575
From Green Point, Apalachicola bay, to East Pass, St. George's sound	do	1-20,000	1856-'57	do	647
Delta of Apalachicola river	do	1-20,000	1857	do	648
Apalachicola river	do	1-20,000	1857	do	601
Apalachicola entrance	do	1-20,000	1857	do	646
St. Andrew's bay and sound	do	1-20,000	1855	do	477
Pensacola bay, entrance	do	1-10,000	1856	F. H. Gerdes	566
Pensacola bay, navy yard to Emanuel's Point	do	1-10,000	1856	do	567

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Gulf coast, bays, islands, &c., between Mobile Point and Vermilion bay.					
Bon Secour bay, from Mullet to Cypress Point	Alabama	1-20,000	1849	W. E. Greenwell	277
Bon Secour bay, Little Point Clear to Cypress Point	do	1-20,000	1849	do	276
Mobile bay, Mullet to Ragged Point	do	1-20,000	1849	do	286
Mobile bay, Ragged Point to Vessel Point	do	1-10,000	1849	do	294
Mobile bay, upper part	do	1-20,000	1850	do	288
Mobile city	do	1-10,000	1850	do	295
Mobile bay, Choctaw Point to Deer river	do	1-20,000	1850	do	287
Mobile bay, Deer River Point to Cedar Point	do	1-20,000	1849	do	275
Mobile bay entrance and Dauphine island	do	1-20,000	1847	do	240
Dauphine Island spit	do	1-10,000	1853	do	406
Dauphine island, base line and vicinity	do	1-10,000	1846-'51	F. H. Gerdes	326
Mississippi sound, Grand Batture to Grande Point.	Mississippi	1-20,000	1848	W. E. Greenwell, F. H. Gerdes	243
Petit Bois island, Mississippi sound	do	1-20,000	1848	W. E. Greenwell	245
Mississippi sound, Grand Batture to West Pascagoula river	do	1-20,000	1848	do	273
Horn island, entrance to Mississippi sound	do	1-10,000	1847	do	241
Horn island, Mississippi sound	do	1-20,000	1849	do	274
From West Pascagoula river to Biloxi bay	do	1-20,000	1851	do	323
Biloxi harbor, town, and Back bay	do	1-10,000	1851	do	324
Deer island, Mississippi sound	do	1-10,000	1852		384
Ship island, Mississippi sound	do	1-20,000	1848	W. E. Greenwell	244
Ship island	do	1-10,000	1853	do	407
Cat island and Isle au Pied	do	1-20,000	1848	do	242
From Mississippi City to Pitcher Point	do	1-20,000	1852	do	369
Harbor of Pass Christian	do	1-10,000	1851	do	325
Bay of St. Louis and town of Shieldsboro'	do	1-20,000	1852	do	370
Malheureux islands, Pearl river to Point Clear	do	1-20,000	1852	do	371
Pearl island and vicinity	Miss. and La	1-20,000	1856	R. M. Bache	633
The Rigolets	Louisiana	1-20,000	1855	do	656
Mississippi sound, Isle au Pied to Nine-Mile bayou	do	1-20,000	1853	W. E. Greenwell	404
Eastern and southern shores of Lake Borgne	do	1-20,000	1853	do	405
Lake Borgne, from Chef Menteur pass to Shell Point	do	1-20,000	1857	W. S. Gilbert	630
Lake Borgne, from Fort Wood to Proctorville	do	1,20,000	1857	do	629
Lake Borgne, from Proctorville to Point aux Marchette	do	1,20,000	1857	do	628
Chandeleur islands, northern part	do	1-10,000	1852	F. H. Gerdes	366
Chandeleur islands	do	1-20,000	1855	J. E. Hilgard, J. G. Oltmanns	548
Chandeleur islands	do	1-20,000	1855	J. E. Hilgard, J. G. Oltmanns	549

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Gulf coast, bays, islands, &c., between Mobile Point and Vermilion bay—Continued.					
Chandeleur islands, from Sunrise shell bank to Martin's island	Louisiana	1-20,000	1857	J. E Hilgard	654
Isle Derniere, western part	do	1, 10,000	1853	F. H. Gerdes	410
Atchafalaya bay, entrance	do			do	636
Atchafalaya bay, eastern side	do			do	637
Atchafalaya bay, eastern side	do			do	638
Atchafalaya bay, north side	do			do	639
Atchafalaya bay, northwest part	do	1-20,000	1857	do	632
Atchafalaya bay, Point au Fer to Plum island	do	1-10,000		do	546
Atchafalaya bay, Point au Fer to White Shell	do	1-10,000		do	547
Atchafalaya bay, Belle island to Plum island	do	1-10,000		do	545
Côte Blanche bay, eastern part	do	1-20,000	1857	do	631
Gulf coast between Vermilion bay and Rio Grande, southwestern boundary of the United States.					
Galveston East bay and Bolivar peninsula	Texas	1-20,000	1851	J. M. Wampler	329
Galveston bay, Lawrence cove to Stevenson's	do	1-20,000	1851	do	330
Galveston bay, Lawrence cove to San Jacinto bay, inclusive	do	1-20,000	1851	do	331
Galveston bay, Highland bayou to Harris' signal	do	1-20,000	1850	do	283
Red Fish bar, Galveston bay	do	1-20,000	1850	do	298
Galveston entrance, harbor and city	do	1-20,000	1850	do	282
Galveston West bay, and part of Galveston island	do	1-20,000	1851	do	328
Galveston West bay, Galveston island and Chocolate bay	do	1-20,000	1852	do	374
Coast of Gulf, from San Luis to Jupiter station	do	1-20,000	1852	do	375
From Brazos river to Matagorda peninsula	do	1-20,000	1853	J. S. Williams, J. M. Wampler	412
Coast and part of Matagorda bay	do	1-20,000	1855	J. A. Sullivan	557
Matagorda peninsula and main land opposite	do	1-20,000	1857	S. A. Gilbert	642
Matagorda bay	do	1-20,000		do	600
Matagorda peninsula and Decros point	do	1-20,000	1857	do	643
Matagorda and part of Espiritu Santo bay	do	1-20,000	1857	do	644
Matagorda bay	do	1-20,000	1857	do	645
Rio Bravo del Norte, entrance and vicinity	do	1-20,000	1854	W. E Greenwell	453
Western coast of the United States, between San Diego and the forty-second parallel of north latitude.					
From southern boundary to San Diego bay	California	1-10,000	1852	A. M. Harrison	365
San Diego bay, from La Carbonina to Sweetwater valley	do	1-10,000	1852	do	364
San Diego bay, from Point Loma to Newtown	do	1-10,000	1851	do	333

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets	State.	Scale.	Date.	Topographers.	Register number.
Western coast of the United States, &c.—Continued					
Los Coronados island	California		1851	R. D. Cutts	332
False bay, dependency of San Diego bay	do	1-10,000	1852	A. M. Harrison	363
Point Fermin and Point Pedro	do	1-10,000	1854	W. M. Johnson	476
From Hueneme Point to Santa Clara river	do	1-10,000	1855	do	576
Anacapa and part of Santa Cruz island	do	1-10,000	1855	do	555
Vicinity of Santa Barbara	do	1-10,000	1854	do	470
Santa Barbara and vicinity	do	1-10,000	1852	A. M. Harrison	373
Point Conception, (reconnaissance)	do		1850	do	313
Point Pinos, Monterey bay	do	1-10,000	1851	do	320
Monterey harbor	do	1-10,000	1851-'52	R. D. Cutts	357
Monterey harbor	do	1-10,000	1854	W. M. Johnson	554
Monterey bay, northward to Salinas river	do	1-10,000	1854	do	478
Monterey bay, northward to Pajaro river	do	1-10,000	1854	do	473
Pajaro river and vicinity, Monterey bay	do	1-10,000	1853	A. M. Harrison	442
Sauquel cove and vicinity, Monterey bay	do	1-10,000	1853	do	443
Santa Cruz harbor, Bay of Monterey	do	1-10,000	1853	do	444
Coast northward to Point Año Nuevo	do	1-10,000	1853	do	445
Point Año Nuevo and Punta del Bolsa	do	1-10,000	1854	W. M. Johnson	653
Coast, from Point Pedro northward to Point Lobos	do	1-10,000	1853	A. M. Harrison	395
Point Lobos and vicinity	do	1-10,000	1852	do	382
Vicinity of Point Lobos	do	1-10,000	1853	A. F. Rodgers	427
Fort Point and Alcatraz island	do	1-10,000	1851	R. D. Cutts	338
Golden Gate, entrance to San Francisco bay	do	1-10,000	1852	do	359
San Francisco entrance	do	1-10,000	1857	Aug. F. Rodgers	663
San Francisco bay, entrance	do	1-10,000	1850	R. D. Cutts	314
San Francisco city and vicinity	do	1-10,000	1852	A. F. Rodgers	352
San Francisco city and vicinity	do	1-10,000	1852	do	398
Yerba Buena island, San Francisco bay	do	1-10,000	1851	do	353
San Francisco bay, from Cañada de Visitacion to Point San Mateo	do		1854	do	460
Point San Mateo and Guano island, San Francisco bay	do	1-10,000	1853		433
Angelo creek and Redwood city, San Francisco bay	do	1-10,000	1857	Aug. F. Rodgers	665
Pulgas Base and vicinity, San Francisco county	do	1-10,000		R. D. Cutts	432
San Francisco bay, Angelo creek to Ravenswood	do	1-10,000	1857	Aug. F. Rodgers	664
San Francisco bay, Ravenswood to Alvise	do	1-10,000	1857	do	676
San Francisco bay, Beard's creek to Mowry's creek	do	1-10,000	1857	do	634
San Francisco bay, Contra Costa to Beard's creek	do	1-10,000	1857	do	635

APPENDIX NO. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Western coast of the United States, &c.—Continued.					
San Francisco bay, San Antonio creek and Oakland	California	1-10,000	1856	A. F. Rodgers	592
San Francisco bay, from San Antonio creek southward	do	1-10,000		do	481
San Francisco bay, Contra Costa	do	1-10,000	1852	R. D. Cutts	360
Contra Costa, San Francisco bay	do	1 10,000	1852	do	358
San Francisco bay, from Contra Costa to San Antonio creek	do	1-10,000	1856	A. F. Rodgers	591
Contra Costa, San Francisco bay	do	1-10,000	1853	A. M. Harrison	399
San Pablo bay, from Penole Point to Molate Reef	do	1-10,000		A. F. Rodgers	561
San Pablo bay, from Point Wilson to Lone Tree Point	do	1-10,000		do	562
Mare Island and Karquines strait, San Pablo bay	do		1850	R. D. Cutts	316
Karquines strait, Suisun bay and city of Benicia	do	1-10,000		A. F. Rodgers	577
Vicinity of Mare Island, San Pablo bay	do	1-10,000		do	563
San Pablo bay, from Long Pond to Petaluma creek	do	1-10,000		do	564
Petaluma creek to San Pedro Point	do	1-10,000	1854	do	472
San Francisco bay, north shore, vicinity of Bluff Point	do	1-10,000		do	415
Richardson's bay, dependency of San Francisco bay	do	1-10,000	1851	do	334
Angel island and Raccoon straits, San Francisco bay	do	1-10,000	1852	do	361
San Francisco bay, north side of entrance	do	1-10,000	1850	do	321
Coast, northward from San Francisco entrance	do	1-10,000	1853	do	400
Ballenas bay and vicinity	do	1-10,000	1854	do	452
Coast adjacent to Ballenas Bluff	do	1-10,000	1854	do	456
Point Reyes	do	1-10,000	1852-'53	J. S. Lawson	403
Tomales bay, entrance	do	1-10,000	1853-'54	do	439
Tomales bay station, (reconnaissance)	do	1-10,000	1856	C. B. Ellis	578
Humboldt bay, entrance	do	1-10,000	1854	J. S. Lawson	474
Pacific coast, Strait of Fuca, Admiralty Inlet, &c., between the forty-second parallel and northwestern boundary of the United States.					
Port Orford or Ewing harbor	Oregon	1-10,000	1851	A. M. Harrison	347
Point Adams and Sand island, Columbia river	do	1-10,000	1851	do	335
Columbia river, entrance	do	1-22,762	1850-'51	W. B. McMurtrie	317
Cape Disappointment	do	1-10,000	1851	A. M. Harrison	337
Strait of Juan de Fuca, from Cape Flattery to Neé-ah bay	Wash'gton Ter.	1-10,000	1852	James S. Lawson	386

APPENDIX No. 23—TOPOGRAPHICAL SHEETS—Continued.

Localities and limits of sheets.	State.	Scale.	Date.	Topographers.	Register number.
Pacific coast, Strait of Fuca, Admiralty Inlet, &c.—Continued.					
Cape Flattery, eastward to Neé-ah bay	Wash'gton Ter.	1-10,000	1852	James S. Lawson	387
New Dungeness, Strait of Juan de Fuca	do	1-10,000	1855	do	539
Port Townshend, Admiralty Inlet	do	1-10,000	1856	do	581
Port Townshend	do	1-10,000	1856	do	582
Port Townshend, vicinity of Base	do	1-10,000	1856	do	589
Port Ludlow, entrance to Hood's Canal	do	1-10,000	1855	do	537
Mats-Mats, or Boat harbor	do	1-10,000	1855	do	540
Part of Admiralty Inlet	do	1-10,000	1857	do	668
Entrance to Hood's Canal	do	1-10,000	1857	do	669
Entrance to Port Gamble	do	1-10,000	1857	do	671
Port Gamble, entrance to Hood's Canal	do	1-10,000	1856	do	585
Apple Cove, Admiralty Inlet	do	1-20,000	1856	Geo. Davidson, J. S. Lawson	583
Murden's Cove, Admiralty Inlet	do	1-20,000	1856	J. S Lawson	584
Duwamish bay	do	1-10,000	1856	Geo. Davidson	590
Fauntleroy Cove, Admiralty Inlet	do	1-10,000	1857	do	670
Admiralty Inlet, reconnaissance of shores	do	1-100,000	1855	do	536
Smith's island, Rosario Strait	do	1-10,000	1855	J. S. Lawson	538
Canal de Haro, and Rosario Strait, reconnaissance	do	1-140,000	1853	Geo. Davidson	426
Strawberry bay, Cypress island, Rosario Strait	do	1-10,000	1854	J. S. Lawson	462
Total number of sheets registered 680					

APPENDIX No. 24.

List of original hydrographic sheets, registered in the archives of the United States Coast Survey, geographically arranged.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.					
Kennebec river entrance	Maine	1-20,000	1856	Lieut. Comg. S. D. Trenchard	552
Casco bay	do	1-10,000	1856	do	602
Casco bay	do	1-10,000	1856	do	614
Portland harbor, (outside of entrance)	do	1-20,000	1854	Lieut. Comg. M. Woodhull	403
Portland harbor	do	1-10,000	1854	do	404
Jordan's rock, near Portland harbor	do	1-5,000	1857	Lieut. F. A. Roe	601
Bank off Union wharf, Portland harbor	do	1-5,000	1857	Lieut. Comg. S. D. Trenchard	600
Richmond's Island harbor	do	1-10,000	1850	Lieut. Comg. M. Woodhull	243
York harbor	do	1-10,000	1853	do	376
Boon island and York harbor, (outside)	do	1-20,000	1853	do	366
Portsmouth harbor and approaches	N. Hampshire	1-20,000	1851	do	294
Portsmouth to Newburyport	N. H. and Mass.	1-20,000	1857	Lieut. Comg. C. R. P. Rodgers	627
Newburyport harbor	Massachusetts	1-10,000	1851	Lieut. Comg. M. Woodhull	292
Cape Ann and Newburyport	do	1-20,000	1857	Lieut. Comg. C. R. P. Rodgers	594
Ipswich and Annis Squam harbors	do	1-10,000	1852	Lieut. Comg. M. Woodhull	346
Annis Squam and Ipswich	do	1-20,000	1856	Lieut. Comg. S. D. Trenchard	574
Annis Squam to Thatcher's island, (Cape Ann)	do	1-10,000	1857	Lieut. Comg. C. R. P. Rodgers	597
Gloucester harbor and approaches	do	1-10,000	1853	Lieut. Comg. H. S. Stellwagen	396
Salem harbor and approaches	do	1-10,000	1850-'51	Lieut. Comg. C. H. McBlair	284
From Lynn to Marblehead	do	1-20,000	1853-'54	Lieut. Comg. H. S. Stellwagen	413
Massachusetts bay and Stellwagen's bank	do	1-80,000	1854-'55	do	516
Stellwagen's bank, Massachusetts bay	do	1-100,000	1854	do	457
Boston harbor and approaches	do	1-20,000	1846-'47-'48	Lieut. Comg. C. H. Davis	221
Boston harbor, (the inner harbor)	do	1-5,000	1846	do	178
Minot's ledge, off Boston harbor	do	1-500	1853	Lieut. Comg. H. S. Stellwagen	412
Stellwagen's and Cohasset rocks, (see 516)	do	1-10,000	1856	do	582
Off shore, between Newburyport and Monomoy	do	1-300,000	1857	Lieut. Comg. C. R. P. Rodgers	593
Philip's ledge, Green Harbor river	do	1-40,000	1846	Lieut. Comg. C. H. Davis	183
Plymouth harbor	do	1-10,000	1853	Lieut. Comg. M. Woodhull	422
Cape Cod, Race point to Nausett light	do	1-40,000	1855-'56	Comr. H. S. Stellwagen	519
Provincetown harbor, Cape Cod	do	1-40,000	1856	do	578
Cape Cod, Nausett light to Monomoy	do	1-40,000	1856	do	570

APPENDIX NO. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Maine, New Hampshire, Massachusetts, and Rhode Island—Continued.					
Wellfleet harbor	Massachusetts	1–20,000	1849–'50	Lieut. Comg. C. H. McBlair	249
Chatham harbor	do	1–10,000	1851	Lieut. Comg. M. Woodhull	293
Monomoy shoals	do	1–30,000	1853	do	387
Nantucket shoals, (Davis' south shoal)	do	1–40,000	1847–'48–'49–'50	Lieut. Comg. C. H. Davis	223
Off Nantucket and Martha's Vineyard, (deep-sea soundings)	do	1–400,000	1853	Lieut. Comg. H. S. Stellwagen	406
Nantucket shoals, (off-shore soundings)	do	1–300,000	1853–'54–'55	do	440
Nantucket shoals	do	1–40,000	1846	Lieut. Comg. C. H. Davis	179
Nantucket sound, (entrance)	do	1–40,000	1856	Comr. H. S. Stellwagen	569
Nantucket sound, Nobska light to Monomoy	do	1–40,000	1854	Lieut. Comg. M. Woodhull	455
Nantucket sound	do	1–30,000	1855–'56	Lieut. Comg. C. R. P. Rodgers	527
Bass river	do	1–20,000	1849	Lieut. Comg. C. H. McBlair	245
Hyannis harbor	do	1–20,000	1847	Lieut. Comg. J. N. Maffitt	184
Nantucket harbor	do	1–20,000	1846	Lieut. Comg. C. H. Davis	181
Nantucket island, (south side)	do	1–40,000	1854	Lieut. Comg. H. S. Stellwagen	445
Nantucket harbor, (see No. 181)	do	1–10,000	1846	Lieut. Comg. C. H. Davis	180
Edgartown harbor, Vineyard sound	do	1–20,000	1846	do	222
Naushon and vicinity	do	1–20,000	1857	Lieut. Comg. C. R. P. Rodgers	595
Muskeget channel and approaches	do		1851	Lieut. Comg. C. H. McBlair	239
Holmes' Hole and vicinity	do	1–10,000	1845	Lieut. Comg. G. S. Blake	161
Martha's Vineyard sound, Edgartown harbor	do	1–10,000	1846	Lieut. Comg. C. H. Davis	182
Martha's Vineyard, (south side)	do	1–40,000	1853	Lieut. Comg. H. S. Stellwagen	378
Lone Rock, &c., between Gay Head and No Man's Land	do	1–20,000	1852	Lieut. Comg. C. H. McBlair	344
Cuttyhunk to Gay Head	do	1–40,000	1857	Lieut. Comg. C. R. P. Rodgers	596
Buzzard's bay, (eastern side)	do	1–20,000	1845	Lieut Comg. G. S. Blake	160
New Bedford harbor	do	1–20,000		do	158
Buzzard's bay, (western side)	do	1–20,000	1845	do	159
Buzzard's bay and Martha's Vineyard sound	do	1–20,000	1845–'46	Lieuts. Comg. G. S. Blake and C. H. Davis	163
Sow and Pigs reef, (off Cuttyhunk)	do	1–5,000	1853	Lieut. Comg. M. Woodhull	357
Sow and Pigs reef	do	1–120	1853	do	358
Westport harbor, Mass., and coast westward	Mass. and R. I.	1–10,000	1844	Lieut. Comg. G. S. Blake	155
From Mishaum Point to East Rock	Rhode Island	1–20,000	1844	do	154
Block island, Cuttyhunk, and Gay Head, (off-shore)	Mass. and R. I.	1–20,000	1847–'48	Lieuts. Comg. Rich'd Bache and J. R. Goldsborough	204
No Man's Land, (off-shore soundings)	do	1–40,000	1851	Lieut. Comg. C. H. McBlair	238
Off Point Judith and No Man's Land	do	1–100,000	1851	Lieut. Comg. S. Swartwout	283

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Maine, New Hampshire, Massachusetts, and Rhode Island—Continued.					
Saughkonnet river and vicinity	Rhode Island	1-10,000	1848	Lieut. Comg. J. R. Goldsborough	205
From East Rock to Point Judith	do	1-20,000	1844	Lieut. Comg. G. S. Blake	153
Point Judith and eastward, (off-shore)	do	1-20,000	1847-'48	Lieuts. Comg. Rich'd Bache and J. R. Goldsborough	206
Point Judith and southward to Block island	do	1-40,000	1845	Lieut. Comg. G. S. Blake	162
Block Island sound, Point Judith to Quonacutog	do	1-20,000	1839	Lieut. Comg. T. R. Gedney	84
Block island and Fisher's island to Quonacutog	do	1-20,000	1839		86
Coast of Connecticut, New York, and New Jersey, and Delaware bay.					
Pawcatuck river, near Stonington	Connecticut	1-10,000			98
Fisher's Island sound, (see No. 97)	do	1-10,000	1839	Lieut. Comg. G. S. Blake	99
Long Island sound, vicinity of Fisher's island	do	1-10,000	1839	do	97
Little Narragansett bay	do	1-20,000	1856	Lieut. Comg. C. R. P. Rodgers	551
Watch Hill reef, Block Island sound	do		1847	Lieut. Comg. C. P. Patterson	85
Fisher's Island sound	do	1-20,000	1839	Lieut. Comg. G. S. Blake	96
From Gull island to Watch hill, Long Island sound	do	1-10,000	1839	Lieut. T. R. Gedney	91
Thames ferry, Long Island sound	do	1-10,000	1841	Lieut. Comg. G. S. Blake	115
Thames ferry, from Gates' ferry to New London	do	1-10,000	1839	do	114
From Black Point to New London harbor	do	1-10,000	1839	do	92
New London harbor, Long island sound	do	1-10,000			93
Frank's ledge, off New London harbor	do	1-10,000	1847	Lieut. Comg. Rich'd Bache	94
From Griswold's to Black Point, Long Island sound	do	1-10,000	1838	Lieut. Comg. G. S. Blake	42
Connecticut river, (resurvey)	do	1-10,000	1849	Lieut. Comg. J. R. Goldsborough	233
Connecticut river	do	1-10,000	1851	Lieut. Comg. M. Woodhull	276
Connecticut river bar	do	1-20,000	1851	do	275
From Fisherman's Crutch southward, Long Island sound	do	1-10,000	1838	Lieut. Comg. G. S. Blake	41
From Hammonasset to Cormorant Point	do	1-20,000	1838	do	39
Tuck's island and vicinity of Madison, Long Island sound	do	1-10,000	1838	do	38
From Bartlett to Tuck's island	do	1-10,000	1838	do	37
West Branton and vicinity of Hoadly and Hammonasset	do	1-20,000	1838	do	35
From Saltall to Hoadly, Long Island sound	do	1-10,000	1838	do	34
From Oyster River Point to Saltall, abreast of New Haven	do	1-10,000	1838	do	32

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Connecticut, New York and New Jersey, and Delaware bay—Continued.					
Quinnipiack river at Fairhaven	Connecticut	1–10,000			33
From Stratford light-house to Indian Neck	do	1–20,000	1838	Lieut. Comg. G. S. Blake	29
From Charles' island to Oyster River Point	do	1–10,000	1838	do	28
From Black Rock to Charles' island	do	1–20,000	1837	do	24
From Charles' island to Black Rock	do	1–10,000	1837	do	23
Vicinity of Bridgeport, Long Island sound	do	1–5,000			25
From Sheffield Island light to Black Rock	do	1–10,000	1835	Lieut. Comg. G. S. Blake	18
From Black Rock to Frost Point	do	1–10,000			20
From Frost Point to Sheffield Island light	do	1–10,000			19
From Sheffield light to Greenwich Point	do	1–10,000			9
From Greenwich Point to Sheffield light	do	1–10,000	1836	Lieut. Comg. G. S. Blake	8
From Minursen island to Greenwich Point, Long Island sound	New York	1–10,000	1836–'37	do	6
Montauk Point, Plum island, and vicinity	do	1–10,000	1845	Lieut. Comg. C. H. Davis	88
Plum island, Montauk point, and vicinity	do	1–10,000			89
Gardiner's bay, Long Island sound	do	1–20,000	1838	Lieut. Comg. T. R. Gedney	80
From Fisher's island to Plum Point, Long Island	do	1–20,000	1839		87
From Race Point, (Fisher's island,) to Oyster Point, Long Island sound	do	1–10,000	1839	Lieut. Comg. G. S. Blake	95
Bedford reef, (see Nos 87, 88, and 95)	do	1–10,000	1847		90
From Plum island to Brown's Hill, Long Island sound	do	1–10,000	1838	Lieut. Comg. G. S. Blake	43
From Brown's Hill to Manor light, Long Island sound	do	1–20,000	1838	do	40
Orient bay, Long Island sound	do	1, 10,000	1839	Lieut. Comg. T. R. Gedney	81
Southhold and Orient bays and Greenport harbor	do	1–10,000		do	78
Greenport harbor, Long Island sound	do	1–10,000	1838	do	79
Sag Harbor, eastern end of Long Island	do	1–10,000	1839	do	82
Sag Harbor and vicinity	do	1–10,000	1839	do	83
Great and Little Peconic bays, Long Island	do	1–20,000		do	77
From Single Bull station to Glover, Long Island sound	do	1–20,000	1838	Lieut. Comg. G. S. Blake	36
From Glover to Oldfield Point, Long Island sound	do	1–20,000	1838	do	30
From Oldfield Point to Miller's place, Long Island sound	do	1–10,000	1838	do	31
From Oldfield Point to Eaton Point, Long Island sound	do	1–20,000	1837	do	21
From Eaton Point to Oak Neck, Long Island sound	do	1–10,000			10
From Smithtown to Oldfield Point, Long Island sound	do	1–10,000	1837	Lieut. Comg. G. S. Blake	26

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Connecticut, New York and New Jersey, and Delaware bay—Continued.					
Stony Brook and vicinity, Long Island	New York	1–10,000			27
From Smithtown to Eaton Point, Long Island sound	do	1–10,000	1837	Lieut. Comg. G. S. Blake	22
Cow harbor, Long Island sound	do	1–10,000			15
Cow harbor, Long Island sound, (see No. 15)	do	1–3,333.3			16
Huntington harbor, Long Island	do	1–10,000			17
Oyster bay and Cold Spring harbor, Long Island	do	1–3,333.3			14
Cold Spring harbor and Oyster bay, Long Island	do	1–3,333.3			13
Oyster bay and Cold Spring harbor	do	1–10,000			11
Oyster bay and Cold Spring harbor (duplicate)	do	1–10,000			12
Whortleberry island to Greenwich Point, Long Island sound	do	1–10,000	1836–'37	Lieut. Comg. G. S. Blake	4
From Captain's island to Whortleberry island	do	1–10,000	1836–'37	do	5
From Sand's light to Matinicock, Long Island sound	do	1–10,000	1836–'37	do	7
Throg's Neck and Davenport Point, Long Island sound	do	1–10,000	1837	do	1
Hewlett's Point to Whortleberry island, Long Island sound	do	1–10,000			2
Matinicock Point and Throg's Neck, Long Island sound	do	1–10,000	1837	Lieut. Comg. G. S. Blake	3
East river, Flushing bay, and vicinity	do	1–10,000	1841	Lieut. Comg. G. M. Bache	67
Harlem river and Little Hell Gate	do	1–2,500	1849	Lieut. Comg. M. Woodhull	225
Hell Gate, resurvey	do	1–2,500	1848	Lieut. Comg. D. D. Porter	224
East river, from Hell gate to Throg's Neck	do	1–10,000	1856	Lieut. Comg. T. A. Craven	580
New York harbor (vicinity of city)	do	1–10,000	1854	Lieut. Comg. M. Woodhull	460
From Jersey City to Williamsburg, New York harbor	do	1–10,000	1855	Lieut. Comg. T. A. Craven	491
Communipaw Flats, Gowanus bay, and Buttermilk channel	do	1–10,000	1841	Lieut. Comg. G. M. Bache	130
Diamond reef and Prince's reef	do	1–2,500	1849	Lieut. Comg. M. Woodhull	226
From Governor's island to Blackwell's island, East river	do	1–10,000	1837	Lieut. Comg. T. R. Gedney	66
Buttermilk channel, New York bay	do	1–5,000	1848	Lieut. Comg. D. D. Porter	208
Coenties' reef and Diamond reef, New York harbor	do	1–2,000	1855	Lieut. Comg. T. A. Craven	497
Hudson river, from Jersey City to Fort Washington	do	1–5,000	1837	Lieut. Comg. T. R. Gedney	70
Hudson river, from Jersey City to Fort Washington	do	1–10,000	1837	do	71
Hudson river, from Fort Washington northward	do	1–10,000	1855	Lieut. Comg. Rich. Wainwright	475

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Connecticut, New York and New Jersey, and Delaware bay—Continued.					
Hudson river, from Castle Garden northward	New York	1-10,000	1855	Lieut. Comg. Rich. Wainwright	477
Hudson river, from 60th street, New York city, to Tubby Hook	do	1-10,000	1855	do	496
Hudson river, from Beecker's Landing to Pollock's Point	do	1-5,000	1837	Lieut. Comg. T. R. Gedney	68
Hudson river, from Beecker's Landing to Pollock's Point	do	1-5,000			69
Hudson river	do	1-10,000	1853	Lieut. Comg. Rich. Wainwright	408
Hudson river	do	1-10,000	1854	do	409
Hudson river	do	1-10,000	1854	do	410
Hudson river, from Toller's Point to Peekskill	do	1-10,000	1854	do	458
Hudson river	do	1-10,000	1854	do	459
Hudson river, Fort Montgomery to Buttermilk Hill	do	1-5,000	1857	Lieut. Comg. James H. Moore	630
Hudson river, Buttermilk Hill to Stony Point	do	1-5,000	1857	do	631
Hudson river, Stony Point to Whortleberry	do	1-10,000	1857	do	632
Hudson river, from New Baltimore to Albany	do	1-5,000	1856	Lieut. Comg. Rich. Wainwright	549
South side of Long Island	do	1-40,000	1851	Lieut. Comg. M. Woodhull.	253
South coast of Long Island	do	1-40,000	1850	do	232
From Montauk Point to Quogue	do	1-40,000	1838	Lieut. Comg. T. R. Gedney.	76
From Quogue to Montauk Point	do	1-20,000	1838	do	74
From Montauk Point to Quogue	do	1-20,000	1838	do	75
South side of Long Island, vicinity of Quogue	do	1-40,000	1838	do	73
Vicinity of Quogue, south side of Long Island	do	1-20,000	1838	do	72
From Gilgo inlet to Quogue, off-shore soundings	do	1-40,000	1848	Lieut. Comg. Rich. Bache.	203
From Smith's Point to Fire island, east base	do	1-20,000	1835	Lieut. Comg. T. R. Gedney.	46
Great South bay, eastern part	do	1-10,000	1834	do	44
Great South bay, western part	do	1-20,000	1834	do	45
From Fire Island inlet, westward, south shore of Long Island	do	1-10,000	1834-'35	do	48
South side of Long Island, from Fire island to Coney island	do	1-40,000	1835	do	47
Gilgo inlet, south side of Long Island	do	1-10,000	1835	do	49
New inlet and Great South bay	do	1-10,100	1835	do	50
From Rockaway to Sandy Hook, (off-shore soundings)	do	1-20,000	1835	do	51
Rockaway inlet and part of Jamaica bay	do	1-10,000	1841	Lieut. Comg. G. M. Bache.	129
From Fort Hamilton to Sandy Hook, New York harbor	do	1-20,000	1855	Lieut. Comg. T. A. Craven.	526

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Connecticut, New York and New Jersey, and Delaware bay—Continued.					
Rockaway, and vicinity of Coney island	New York	1-20,000			56
Gravesend bay, and vicinity of Coney island	do	1-20,000	1841	Lieut. Comg. G. M. Bache and Lieut. Jos. C. Walsh.	59
Vicinity of Coney island and Rockaway	do	1-10,000			57
Gedney's channel, verification chart	do				55
Gravesend bay	do	1-10,000	1841	Lieut. Comg. G. M. Bache.	128
From Fort Hamilton to Governor's island, New York harbor	do	1-10,000	1855	Lieut. Comg. T. A. Craven.	490
The Narrows, entrance to New York harbor	do	1-10,000		Lieut. Comg. T. R. Gedney.	63
Romer and Flynn's shoals and Swash channels	do	1-20,000	1853	Lieut. Comg. M. Woodhull.	356
Jersey flats, New York harbor	New Jersey	1-10,000	1853	do	423
Hackensack river	do	1-10,000	1841	Lieut. Comg. G. M. Bache.	131
Bar at mouth of Passaic river	do	1-5,000		Lieut. Comg. T. R. Gedney.	65
Newark bay	do	1-10,000	1855	Lieut. Comg. R. Wainwright	493
Newark bay	do	1-10,000	1855-'56	do	547
Kill van Kull	do	1-10,000	1855	do	492
Newark bay, Kill van Kull, and Raritan bay	do	1-10,000		Lieut. Comg. T. R. Gedney	61
Raritan bay and Newark bay	do	1-20,000	1836	do	62
Staten Island sound and part of Raritan bay	do	1-10,000	1841	Lieut. Comg. G. M. Bache.	127
Arthur Kill, vicinity of Elizabethport	do	1-10,000	1855	Lieut. Comg. R. Wainwright	494
Staten Island sound	do	1-10,000			64
Arthur Kill, vicinity of Perth Amboy	do	1-10,000	1855	Lieut. Comg. R. Wainwright	495
Raritan bay	do	1-20,000		Lieut. Comg. T. A. Craven.	572
Raritan bay, Amboy to Sandy Hook	do	1-10,000	1841	Lieut. Comg. G. M. Bache.	126
Middletown creek, Raritan bay	do	1-10,000	1841	do	58
Shrewsbury river	do	1-10,000	1840	do	60
Shrewsbury river	do	1-10,000	1840	do	107
Sandy Hook bar	do	1-10,000	1835	Lieut. Comg. T. R. Gedney.	52
Sandy Hook bar	do	1-10,000	1835	do	53
Sandy Hook to Rockaway, (old and new channels)	do	1-20,000	1840	do	54
Sandy Hook and vicinity, (resurvey)	do	1-10,000	1848	Lieut. Comg. Rich'd Bache.	207
From Sandy Hook to Barnegat, (outer coast)	do	1-40,000	1840	Lieut. Comg. T. R. Gedney.	106
From Highland light to Long Branch	do	1-20,000	1840	do	103
From Long Branch to Barnegat	do	1-20,000	1840	do	102
From Long Branch to Barnegat	do	1-20,000	1847	do	113
From Long Branch to Metiticonk	do	1-20,000		do	104
From Jones' to Barnegat	do	1 20,000		do	105
Barnegat bay and inlet and Thomas' river	do	1,10,000	1840	Lieut. Comg. G. M. Bache.	108
Coast of New Jersey	do	1-40,000	1847	Lieut. Comg. T. R. Gedney	112
From Barnegat to Little Egg harbor	do	1-20,000	1841	do	111

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Connecticut, New York and New Jersey, and Delaware bay—Continued.					
Little Egg harbor	New Jersey	1–10,000	1840	Lieut. Comg. G. M. Bache	109
Little Egg harbor	do	1–10,000	1840	do	110
From Long Branch to Cape May	do	1–40,000		Lieut. Comg. T. R. Gedney	116
Off Delaware bay	do	1–40,000		do	117
Off Cape May and Cape Henlopen	Del. and N. J.	1–40,000	1844	Lieut. Comg. G. M. Bache	151
From Cape May to Montauk Point	N. Y. and N. J.	1–400,000	1842	Lieut. Comg. T. R. Gedney	100
From Cape May to Montauk Point	do	1–400,000	1842–'44–'47	do	101
Delaware bay and river, up to Trenton		1–80,000	1841–'42–'43	Lieut. Comg. G. S. Blake	148
Delaware bay and river, from Capes to Fishing creek		1–20,000	1842, '43	do	118
Delaware bay		1–20,000	1842	do	119
Overfalls, Delaware bay, (resurvey)		1–20,000	1847	Lieut. Comg. Rich'd Bache	125
Crow shoal, Delaware bay		1–10,000		Lieut. Comg. G. S. Blake	120
Hen and Chickens shoals, (Delaware bay)		1–20,000	1847	Lieut. Comg. S. P. Lee	152
Cape May roads and Crow shoal		1–10,000	1847	Lieut. Comg. Rich'd Bache	157
Delaware bay, vicinity of Fishing creek		1–10,000	1842	Lieut. Comg. G. S. Blake	123
Delaware bay, vicinity of Clark's Point		1–20,000	1842	do	122
Cohansey, Maurice and Duck rivers		1–20,000	1843	do	121
From Egg Island light to Davis' Point, Delaware		1–20,000	1841	do	124
Dona and Mahon rivers	Delaware	1–10,000	1852	Lieut. Comg. M. Woodhull	352
Joe Flogger shoal and Dona river		1–20,000	1852	do	299
From Ben Davis' Point to Liston's tree, Delaware bay		1–10,000	1841	Lieut. Comg. G. S. Blake	132
From Liston's tree to New Castle, Delaware bay		1–10,000	1840–'41	do	133
Bulkhead shoals, (Delaware bay)		1–10,000	1846–'47	Lieuts. Comg. J. R. Goldsborough and W. P. McArthur	156
From New Castle to Liston's tree, (resurvey)		1–20,000	1843	Lieut. Comg. G. S. Blake	134
From New Castle to Dupont's wharf		1–10,000	1841	do	135
From Dupont's wharf to New Castle, (duplicate)		1–10,000		do	136
Christiana creek, Delaware bay		1–5,000	1841	do	137
From Dupont's wharf to Tompkins' island		1–10,000	1842	do	138
From Tompkins' island to Upper Tinicum, Delaware river		1–10,000	1842	do	139
From Upper Tinicum to Fort Mifflin, Delaware river		1–5,000	1842	do	140
From Fort Mifflin to Philadelphia, Delaware river		1–10,000	1843	do	141
From Philadelphia to Bridesburg, Delaware river		1–10,000	1843	do	142

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Connecticut, New York and New Jersey, and Delaware bay—Continued.					
Delaware river, opposite Philadelphia		1–5,000	1843	Lieut. Comg. G. S. Blake	143
From Bridesburg to Dunk's, Delaware river		1–10,000	1844	do	144
Delaware river, from Dunk's to Smith's		1–10,000	1844	do	145
From Smith's to Shives', Delaware river		1–10,000	1844	do	146
Delaware river, from Bordentown to Trenton		1–10,000	1844	do	147
Coast of Delaware, Maryland and Virginia, including Chesapeake bay.					
Off Cape Henlopen		1–200,000	1847	Lieut Comg. S. P. Lee	189
From Cape Henlopen to Indian River Inlet		1–20,000	1844	Lieut Comg. G. M. Bache	149
Off Cape Henlopen, and southward of Cape Henry		1–40,000	1849–'50	Lieut Comg. T. A. Jenkins	237
Indian river and Rehoboth bay		1–20,000	1847	Lieut. Comg. Rich'd Bache	150
From Indian River Inlet to Beach House	Del. and Md.	1–40,000	1848	Lieut. Comg. S. P. Lee	212
From Beach House station to North Birch	do	1–40,000	1844	do	213
Seacoast of Maryland	Maryland	1–40,000	1850	do	251
Chincoteague Shoals and Chincoteague Inlet	Virginia	1–40,000	1851	Lieut. Comg. J. J. Almy	298
Chincoteague Inlet and Chincoteague Shoals	do	1–20,000	1851	do	297
Wachapreague Inlet and Hog Island harbor	do	1–40,000	1852	do	348
Metomkin Inlet	do	1–10,000	1852	do	349
Hog Island harbor and Wachapreague Inlet	do	1–20,000	1852	do	354
Hog island and vicinity, to Cape Henry	do	1–40,000	1853	do	397
Sand Shoal Inlet and Ship Shoal Inlet	do	1–20,000	1853	do	388
Cape Charles and vicinity of Cherrystone Inlet	do	1–40,000	1852–'53	do	364
Entrance of Chesapeake bay	do	1–20,000	1851	Lieut. Comg. B. F. Sands	286
From Cape Henry to Mobjack bay	do	1–40,000	1854	Lieut. Comg. J. J. Almy	446
Lynn Haven Roads, Chesapeake bay	do	1–10,000	1854	do	449
Hampton Roads and part of Elizabeth river	do	1–20,000	1854	do	447
Norfolk harbor, Chesapeake bay	do	1–10,000	1854	do	448
Cape Charles and vicinity	do	1–20,000	1852	do	345
Cherrystone inlet, Chesapeake bay	do	1–20,000	1852	do	353
Chesapeake bay, from Rappahannock river to Wolf Trap	do	1–40,000	1851	do	285
Hunger's creek, Chesapeake bay	do	1–20,000	1853	do	368
Occohannock creek and Heath's Landing	do	1–20,000	1853	do	367
Chesapeake bay, from Potomac to Rappahannock river	do	1–40,000	1850	Lieuts. Comg. S. P. Lee and J. J. Almy	252
Pungoteague creek	do	1–20,000	1851	Lieuts. Comg. B. F. Sands and J. J. Almy	332
Pocomoke sound	do	1–40,000	1855	Lieut. Comg. J. J. Almy	515
Tangier sound	Md. and Va.	1–40,000	1856	do	557
From Point No Point to Smith's Point light, Chesapeake bay	do	1–20,000	1849	Lieut. Comg. S. P. Lee	211

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Delaware, Maryland, Virginia, &c.—Continued.					
From Cove Point to Point No Point, and entrance to Patuxent river	Maryland	1-20,000	1848	Lieut. Comg. S. P. Lee	209
Patuxent river, from entrance to St. Leonard's creek	do	1-20,000	1848	do	210
Meekins' Neck and vicinity of Cove Point	do	1-20,000	1847, 1848	Lt. Comg. W. P. McArthur	199
Little Choptank river, Chesapeake bay	do	1-20,000	1848	do	200
Choptank river	do	1-20,000	1848	do	202
Choptank river	do	1-20,000	1848	do	201
Chesapeake bay, from Thomas' Point to Tilghman's island	do	1-20,000	1846	Lieut. Comg. S. P Lee	188
Eastern bay, and Wye and Miles' rivers	do	1-20,000	1847	Lt. Comg. W. P. McArthur	177
Annapolis harbor, Chesapeake bay	do	1-20,000	1844	Lieut. Comg. G. M. Bache	167
Chester river, Chesapeake bay	do	1-20,000	1846	Lt. Comg. W. P. McArthur	174
Chesapeake bay, from Sandy Point to Spy's stand	do	1-20,000	1845	Lieut. Comg. G. M. Bache	166
Mouth of Chester river, Chesapeake bay	do	1-20,000	1847	Lt. Comg. W. P. McArthur	175
Magothy river, Chesapeake bay	do	1-10,000	1845	Lieut Comg G. M. Bache	164
Entrance of Patapsco river	do	1-20,000	1854	Lt. Comg. R'd Wainwright	415
Patapsco river, at Baltimore	do	1-10,000	1845	Lieut. Comg. G. M. Bache	165
Patapsco river, from Rock Point to Sollers' Point	do			Lieut. Comg. C. H. McBlair	339
Belvidere shoal, Patapsco river entrance	do	1-5,000 1-20,000	1852	A. Boschke	469
Gunpowder, Middle, and Back rivers	do	1-20,000	1846	Lt. Comg. W. P. McArthur	169
Chesapeake bay, from Howell's Point to Pool's island	do	1-10,000	1846	Lieut. Comg. S. P. Lee	187
Bush river, Chesapeake bay	do	1-20,000	1846	Lt. Comg. W. P. McArthur	171
Chesapeake bay, from Turkey Point to Howell's Point	do	1-10,000	1846	Lieut. Comg. S. P. Lee	186
Sassafras river, Chesapeake bay	do	1-20,000	1847	Lieut. Comg. W. P. McArthur	176
Chesapeake bay, northern part, down to Turkey Point	do	1-10,000	1846	Lieut. Comg. S. P. Lee	185
Elk river, Chesapeake bay	do	1-10,000	1846	Lieut. Comg. W. P. McArthur	172
Bohemia river and Back creek	do	1-10,000	1846	do	170
North East river, Chesapeake bay	do	1-10,000	1846	do	173
Susquehanna river	do	1-10,000	1846	do	168
Susquehanna river, (see No. 168, duplicate)	do	1-10,000	1852		326
Rappahannock river, entrance	Virginia	1-10,000	1857	Lieut. Comg. R. Wainwright	610
Rappahannock river	do	1-10,000	1857	do	609
Rappahannock river	do	1-10,000	1857	do	608
Rappahannock and Currotoman river	do	1-10,000	1857	do	611

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Delaware, Maryland, Virginia, &c.—Continued.					
Rappahannock river	Virginia	1–10,000	1856	Lieut. Comg. R. Wainwright	607
Rappahannock river	do	1–10,000	1856	do	606
Rappahannock river	do	1–10,000	1856	do	605
Rappahannock river	do	1–10,000	1855	do	523
Rappahannock river	do	1–10,000	1855	do	522
Rappahannock river	do	1–10,000	1855	do	521
Rappahannock river	do	1–10,000	1854	do	454
Rappahannock river at Tobago bay	do	1–10,000	1854	do	453
Rappahannock river at Port Royal	do	1–5,000	1854	do	452
Rappahannock river	do	1–5,000	1854	do	451
Rappahannock river	do	1–5,000	1854	do	450
Rappahannock river	do	1–5,000	1853–'54	do	400
Rappahannock river	do	1–5,000	1853–'54	do	399
Rappahannock river at Fredericksburg	do	1–5,000	1853–'54	do	398
York river, from entrance to Bigler's Mill	do	1–20,000	1857	Lieut. Comg. J. J. Almy	583
York river, from Bigler's Mill to West Point	do	1–20,000	1857	Lieut. R. D. Minor	584
James river, entrance	do	1–20,000	1854–'55	Lieut. Comg. J. N. Maffitt	529
James river, Shoal Point to Jamestown island	do	1–20,000	1855	do	530
James river	do	1–20,000	1856	do	615
James river	do	1–10,000	1857	do	616
James river	do				
James river, Harrison's bar	do	1–10,000	1852	Lieut. Comg. R. Wainwright	331
James river	do	1–5,000	1853	do	395
James river	do	1–5,000	1853	do	394
James river	do	1–5,000	1853	do	393
James river	do	1–5,000	1853	do	392
James river	do	1–5,000	1853	do	391
James river, Trent's reach bar	do	1–5,000	1853	do	343
James river	do	1–5,000	1853	do	340
James river	do	1–5,000	1853	do	390
James river at Warwick bar	do	1–5,000	1852–'53	do	341
James river at Richmond	do	1–5,000	1852–'53	do	342
Appomattox river	do	1–5,000	1852	do	316
Appomattox river	do	1–5,000	1852	do	315
Appomattox river at Petersburg	do	1–5,000	1852	do	314
Appomattox river	do	1–1,000	1851	do	279
Coast from Cape Henry southward to boundary	do	1–40,000	1855	Lieut. Comg. J. J. Almy	520

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of North Carolina, South Carolina, and Georgia.					
Currituck sound	North Carolina	1-20,000	1851	Lieut. Comg. R. Wainwright	258
North river	do	1-20,000	1850	do	230
Pasquotank river, Albemarle sound	do	1-20,000	1847	Lieut. Comg. W. P. McArthur	195
Little river	do	1-20,000	1848	do	197
Perquimons river	do	1-20,000	1848	do	196
Albemarle sound, Harvey's creek to Hornblow Point	do	1-20,000	1849	Lieut. Comg. James Alden	219
Albemarle sound, Mackey's creek to Roanoke river	do	1-20,000	1849	Lieut. Comg. T. A. Jenkins	216
Scuppernong river and Bull's bay, Albemarle sound	do	1-20,000	1849	do	217
Albemarle sound, Mills' Point to Pear Tree Point	do	1-20,000	1848	Lieut. Comg. W. P. McArthur	198
Haulover, Albemarle sound, and vicinity of Powell's Point	do	1-20,000	1849	Lieut. Comg. James Alden	220
Alligator river, Albemarle sound	do	1-20,000	1849	do	218
Albemarle, Roanoke, and Croatan sounds	do	1-20,000	1850-'51	Lieut. Comg. R. Wainwright	257
Hatteras shoals	do	1, 20,000	1850	Lieut. Comg. T. A Jenkins	244
Coast from Cape Hatteras to Ocracoke inlet	do	1-40,000	1856	Lieut. Comg. J. J. Almy	538
Hatteras inlet	do	1-10,000	1852	Lieut. Comg. R. Wainwright	322
Hatteras inlet, (reconnaissance)	do	1-5,000	1850	Lieut. Comg. T. A. Jenkins	235
Hatteras inlet, (resurvey)	do	1-10,000	1857	Comr. W. T. Muse	612
Ocracoke inlet	do	1-10,000	1852	Lieut. Comg. R. Wainwright	321
Ocracoke inlet, (resurvey)	do	1-20,000	1857	Comr. W. T. Muse	613
From Cape Lookout towards Bogue sound	do	1-40,000	1857	Lieut. Comg. C. R. P. Rodgers	577
Beaufort harbor and vicinity of Cape Lookout	do	1-10,000	1854	Lieut. Comg. J. N. Maffitt	419
Beaufort harbor	do	1-10,000	1850	do	259
Beaufort harbor and bar	do	1-10,000	1857	Lieut. Comg. C. R. P. Rodgers	576
Beaufort harbor	do		1850	Lieut. Comg. J. N. Maffitt	246
Bogue sound, from Carolina city to Beaufort	do	1-10,000	1854	do	418
New river and bar	do	1-10,000	1851	do	280
Cape Fear river	do	1-5,000	1853	do	375
Cape Fear river	do		1853	do	416
Cape Fear river	do	1-10,000	1853	do	374
New inlet, Cape Fear entrance, (resurvey)	do	1-10,000	1852	do	370
Cape Fear River bar	do		1852	do	372
Cape Fear bar and New inlet	do	1-10,000	1851	do	278
New Inlet bar, northern entrance of Cape Fear river	do	1-10,000	1856	do	618

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of North Carolina, South Carolina, and Georgia—Continued.					
New Inlet bar, (Cape Fear)	North Carolina	1–10,000	1857	Lieut. Comg. J. N. Maffitt	621
Frying-Pan shoals	do	1–20,000	1851	Lieut. Comg. T. A. Jenkins	306
Southern bars of Cape Fear river	do	1–10,000	1856	Lieut. Comg. J. N. Maffitt	619
Southern bars of Cape Fear river	do	1–10,000	1857	do	624
Frying-Pan shoals	do	1–20,000	1851	Lieut. Comg. T. A. Jenkins	277
Off-shore, between Charleston and Savannah entrance	South Carolina	1–200,000	1857	Lieut. Comg. J. N. Maffitt	622
Georgetown harbor and bar	do	1–10,000	1853	do	371
Winyah bay and Georgetown harbor	do	1–10,000		do	373
Cape Roman	do	1–20,000	1852	Lieut. Comg. T. A. Craven	350
Georgetown bar, (resurvey)	do	1–20,000	1856	Lieut. Comg. J. N. Maffitt	533
Cape Roman to Charleston	do	1–40,000	1857	do	626
Charleston harbor and bar	do	1–10,000	1851	do	254
Main Ship bar, Charleston harbor	do	1–10,000	1857	do	625
Maffitt's channel, Charleston harbor	do	1–10,000	1854	do	411
North channel and Maffitt's channel	do		1855	do	476
Maffitt's channel, (resurvey)	do	1–5,000	1856	do	532
Maffitt's channel and North channel	do	1–5,000	1857	do	623
Charleston harbor, entrance	do	1–5,000	1852	do	536
North Edisto harbor and bar	do	1–20,000	1851	do	272
North Edisto bar	do	1–20,000	1856	do	534
St. Helena sound and bar, and south Edisto river	do	1–15,000	1856–'57	do	620
Port Royal entrance and Beaufort harbor	do	1–20,000	1855–'56	do	535
Savannah river bar	South Carolina and Georgia	1–20,000	1854	do	439
Savannah river bar, (reconnaissance)	do	1–20,000	1851	do	269
Savannah river, entrance	do	1–10,000	1852	do	317
Savannah river	do	1–10,000	1850	do	267
Savannah river, Hutchinson's and Elba islands	do	1–5,000	1852	do	318
Savannah river, (Front and Back rivers)	do	1–10,000	1851	do	266
Savannah river, part of Hutchinson's and Argyle islands	do	1–5,000	1852	do	319
Savannah river, Argyle, Onslow, and Isla islands	do	1–5,000	1852	do	320
Romerly Marshes	Georgia	1–5,000	1856	do	617
Doboy bar and sound, (reconnaissance)	do	1–20,000	1854	Lieut. Comg. T. A. Craven	461
St. Simon's, entrance	do	1–10,000	1856–'57	Lieut. Comg. S. D. Trenchard	590
St. Simon's bar and Brunswick harbor	do	1–10,000	1856	do	537
St. Simon's bar and Brunswick harbor	do	1–10,000	1856	do	548
Brunswick harbor	do	1–10,000	1856	do	575
Brunswick harbor and Turtle river	do	1–10,000	1857	do	587
St. Andrew's shoal, (reconnaissance)	do	1–20,000	1850	Lieut. Comg. John Rodgers	231

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of North Carolina, South Carolina, and Georgia—Continued.					
St. Mary's bar and Fernandina harbor	Ga. & Fla.	1–10,000	1855–'56–'57	Lieut. Comg. R. Wainwright	591
St. Mary's bar, (resurvey)	do	1–10,000	1857	Lieut. Comg. S. D. Trenchard	571
St. Mary's bar	do	1–20,000	1855	do	479
St. Mary's entrance and Fernandina harbor	do	1–10,000	1855–'56–'57	do	579
St. Mary's river	do	1–10,000	1856	do	592
St. Mary's river, up to St. Mary's	do		1856	do	550
Coast of Florida and Alabama.					
St. John's river, entrance, and Fort George inlet	Florida	1–10,000	1853	Lieut. Comg. T. A. Craven	351
St. John's bar and vicinity, (current chart)	do		1855	Lieut. Comg. R. Wainwright, S. D. Trenchard	511
St. John's river bar, (resurvey)	do	1–10,000	1857	Lieut. Comg. S. D. Trenchard	586
St. John's river, Mayport Mills to Brown's creek	do	1–10,000	1855	Lieut. Comg. R. Wainwright	481
St. John's river, Brown's creek to Six Miles creek	do	1–10,000	1855	do	482
St. John's river, Jacksonville and vicinity	do	1–10,000	1855	do	484
Mosquito inlet, (reconnaissance)	do	1–20,000	1851	Lieut. Comg. John Rodgers	260
Cape Canaveral shoals, (reconnaissance)	do	1–20,000	1850	do	234
Key Biscayne bay and vicinity	do	1–20,000	1852	do	407
Key Biscayne bay and Card's sound	do	1–20,000	1854	Lieut. Comg. T. A. Craven	444
Florida reef, Triumph reef, and Old Rhodes' bank	do	1–20,000	1853	do	369
Pacific reef to Carysfort reef	do	1–20,000	1854	do	443
Carysfort reef to Grecian shoal	do	1–20,000	1855	do	568
Florida reef	do	1–20,000	1856	do	553
Collins' Patches, Florida reef	do	1–20,000	1854	do	417
Key West, approaches to harbor	do	1–20,000	1850	Lieut. Comg. John Rodgers	248
Key West harbor and vicinity	do	1–20,000	1851	do	281
Key West harbor	do	1–5,000	1850–'51	do	287
Key West harbor	do	1–5,000	1850–'51–'52	do	338
Marquesas keys and vicinity of Boca Grande	do	1–20,000	1851–'52	do	282
Boca Grande, Marquesas keys and vicinity	do	1–20,000	1852	do	359
Rebecca shoals, (reconnaissance)	do	1–10,000 1–30,000	1852	do	313
Gulf of Mexico, deep-sea temperatures		1–1,200,000	1854–'55	Lieut. Comg. B. F. Sands	483
Gulf of Mexico, deep-sea soundings and temperatures			1855	Lieut. Comg. O. H. Berryman	468

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Florida and Alabama—Continued.					
Tampa bay, (reconnaissance)	Florida	1–60,000	1855	Lieut. Comg. O. H. Berryman	478
Waccasassa bay	do	1–20,000	1857	Lieut. Comg. J. K. Duer	581
Waccasassa bay	do	1–20,000	1856	do	531
Cedar keys, (reconnaissance of channel No. 4)	do	1–10,000	1852	F. H. Gerdes	304
Cedar keys	do	1–20,000	1854	Lieut. Comg. O. H. Berryman	424
Cedar keys	do	1–20,000	1855	do	513
Cedar keys	do	1–20,000	1855	do	512
Ocilla river	do	1–10,000	1855	do	517
St. Mark's river	do	1–10,000	1856	do	541
St. Mark's river bar	do	1–20,000	1856	do	540
St. Mark's river, bar and channel, (reconn.)	do	1–20,000	1852	F. H. Gerdes	305
St. George's sound, St. Joseph's and St. Mark's, (reconnaissance)	do		1852	do	307
St. Andrew's bay	do	1–20,000	1856	Lieut. Comg. O. H. Berryman	518
St. Andrew's bay	do	1–20,000	1855	do	514
Pensacola bar and bay entrance	do	1–20,000	1856	Lieut. Comg. J. K. Duer	585
Gulf of Mexico, soundings and temperatures			1856	Comr. B. F. Sands	528
Gulf of Mexico, soundings and temperatures, Key West to delta		1–120,000	1857	do	599
Mobile bay, soundings to Mississippi delta	Alabama	1–600,000	1854	Lieut. Comg. B. F. Sands	420
Eastward from Fort Morgan	do	1–20,000	1851	do	262
Bonsecour bay	do	1–20,000	1851	Lieut. Comg. Jas. Alden	263
Mobile bay, lower part	do	1–20,000	1844	Lieut. Comg. C. P. Patterson	215
Mobile bay, middle and upper part	do	1–20,000	1850	Lieut. Comg. Jas. Alden	227
Mobile bay, upper part and Dog river bar	do	1–10,000	1844	Lieut. Comg. C. P. Patterson	214
Mobile bay delta and Mobile city	do	1–10,000	1850	Lieut. Comg. Jas. Alden	228
Mobile bay, upper delta	do	1–10,000	1850	do	229
Mobile bay, lower part	do	1–20,000	1848	Lieut. Comg. C. P. Patterson	193
Mobile bay, approaches and entrance	do	1–20,000	1847–'48	do	192
Pelican channel	do	1–20,000	1855	Lieut. Comg. B. F. Sands	467
Pelican channel, (resurvey)	do	1–20,000	1853	do	361
Coast of Mississippi and part of Louisiana.					
Mississippi sound, north of Dauphine island	Mississippi	1–20,000	1847	Lieut. Comg. C. P. Patterson	191
From Munder's Point to Grand bay, Mississippi sound	do	1–20,000	1852	Lieut. Comg. B. F. Sands	329
Westward from Fort Morgan, Mississippi sound	do	1–20,000	1851	do	261
Horn Island Pass	do	1–20,000	1852	do	327
Horn Island Pass, (resurvey)	do	1–20,000	1853	do	362
From Grand Batture to Pascagoula, Mississippi sound	do	1–20,000	1852–'53	do	328

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Mississippi and part of Louisiana—Con'd.					
Horn Island channel, Mississippi sound	Mississippi	1–20,000	1846	Lieut. Comg. C. P. Patterson	190
From Pascagoula river to east end of Horn island	do	1–20,000	1853	Lieut. Comg. B. F. Sands	365
Southward of Horn and Ship islands	do	1–20,000	1854	do	430
Between Horn island and Ship island, Mississippi sound	do	1–20,000	1855	Comr. B. F. Sands	489
Biloxi bay	do	1–20,000	1855	do	485
Mississippi sound, from Cat island to Mississippi City	do	1–20,000	1855	do	488
Mississippi sound, Cat and Ship islands	do	1–20,000	1848	Lieut. Comg. C. P. Patterson	194
St. Louis bay and part of Mississippi sound	do	1–20,000	1856	Comr. B. F. Sands	546
Pass Christian	do	1–10,000	1851	Lieut. Comg. B. F. Sands	256
Pass Christian and part of Mississippi sound, (resurvey)	do	1–20,000	1857	Comr. B. F. Sands	589
Chandeleur sound and Nassau roads	Miss. and La.		1857	do	598
Grand Island Pass and Pearl river entrance	do	1–20,000	1856	do	545
Ship Island shoal	Louisiana	1–20,000	1853	Lieut. Comg. B. F. Sands	360
Nassau roads, north of Chandeleur island	do	1–20,000	1852	do	363
Delta of Mississippi river, (reconnaissance)	do	1–20,000	1851	do	255
Southwest and South Passes, Mississippi delta	do	1–20,000	1852	do	330
Barataria harbor and bar, (reconnaissance)	do	1–10,000	1853	F. H. Gerdes	441
From Southwest Pass to Atchafalaya bay, (reconnaissance)	do	1–20,000	1853	do	442
Vermilion bay entrance, (reconnaissance)	do	1–200,000	1855	Comr. B. F. Sands	486
Coast of part of Louisiana and coast of Texas.					
Calcasieu river, (reconnaissance)	do	1–20,000	1855	do	487
Galveston bay, upper part, Turtle bay to Smith's Point	Texas	1–20,000	1855	Lieut. Comg. E. J. De Haven	470
Galveston bay, western part	do	1–20,000	1853–'54	Lieuts. Comg. H. S. Stellwagen, E. J. De Haven	414
East Galveston bay	do	1–20,000	1854	Lieut. Comg. E. J. De Haven	425
Off Galveston bar, and westward	do	1–20,000	1855	do	471
Galveston bar, outside and southward	do	1–20,000	1851	Lieut. Comg. T. A. Craven	265
Galveston harbor	do	1–20,000	1851	do	264
Galveston harbor	do	1–20,000	1850	Lieut. Comg. A. S. Baldwin	247
Galveston bay, from Bolivar Point to Hanna's island	do	1–20,000	1852	Lieut. Comg. T. A. Craven	323
Galveston bay, from Smith's Point to Edward's Point	do	1–20,000	1852	do	324

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of part of Louisiana and coast of Texas—Continued.					
Westward of Galveston bar and Galveston island	Texas	1-20,000	1855	Lieut. Comg. E. J. De Haven	472
From Galveston island, westward	do	1-20,000	1855	do	473
San Luis Pass	do	1-10,000	1853	Lieut. Comg. H. S. Stellwagen	389
From Velasco, westward, along the coast	do	1-20,000	1855	Lieut. Comg. E. J. De Haven	474
Gulf coast, from Quintana, westward	do	1-20,000	1856	do	539
Matagorda entrance and bar	do	1-20,000	1856	Lieut. Comg. J. C. Febiger	588
Aransas Pass, (reconnaissance)	do	1-10,000		Lieut. Comg. H. S. Stellwagen	386
Rio Grande river and bar, (reconnaissance)	do	1-10,000	1853	Lieut. Comg. John Wilkinson	377
Coast of California.					
Shoal southeast of San Nicolas island, (Cortez Bank)	do	1-5,000	1853	Lieut. Comg. T. H. Stevens	355
Cortez Bank	California	1-40,000	1856	Comr. James Alden	542
Coast from San Diego to Point Conception, (reconnaissance)	do		1851	Lieut. Comg. Jas. Alden	289
San Diego harbor, (reconnaissance)	do	1-10,000	1851	R. D. Cutts	268
San Diego bay and vicinity	do	1-10,000	1856	Comr. James Alden	564
San Diego bay	do	1-10,000	1856	do	565
San Diego bay	do	1-10,000	1856	do	566
San Diego bay	do	1-10,000	1856	do	567
San Clemente anchorage, southeast end of island	do	1-10,000	1856	do	543
San Clemente anchorage, northwest end of island	do	1-10,000	1852	Lieut. Comg. Jas. Alden	312
Catalina Island anchorage, northeast side	do	1-5,000	1852	Lieut. Comg. Jas. Alden	308
Catalina harbor and anchorage, northeast side	do	1-5,000	1851	do	291
San Pedro and vicinity of Los Angeles	do	1-10,000	1852	do	310
San Pedro anchorage	do	1-10,000	1854	Lieut. Comg. T. H. Stevens	437
Anacapa, and eastern end of Santa Cruz island	do	1-10,000	1855	Comr. James Alden	501
Prisoners' harbor, Santa Cruz island	do	1-10,000	1852	Lieut. Comg. Jas. Alden	303
San Buenaventura and vicinity	do	1-10,000	1855	Comr. James Alden	503
Point Hueneme and vicinity, Santa Barbara channel	do	1-10,000	1856	do	554
Santa Cruz, (reconnaissance)	do	1-10,000	1852	Lieut. Comg. James Alden	300
Point Conception, and vicinity of Coxo	do	1-30,000	1852	do	295
Coast from Point Conception to San Francisco entrance	do	1-375,000	1851	do	290

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of California—Continued.					
Santa Barbara and vicinity	California	1–10,000	1852	Lieut. Comg. James Alden	311
Santa Barbara	do	1–10,000	1854	Lieut. Comg. T. H. Stevens	436
Cuyler's harbor, island of San Miguel	do	1–10,000	1852	Lieut. Comg James Alden	309
San Luis Obispo and vicinity	do	1–10,000	1852	do	302
San Simeon bay and vicinity	do	1–10,000	1852	do	301
Coast from Point Pinos to Cape Mendocino, (reconnaissance)	do	1-1,000,000	1851	Lieut. Comg. W. P. McArthur	241
Sauquel cove, Monterey bay	do	1–10,000	1855	Lieut. Comg. James Alden	504
Santa Cruz harbor, Monterey bay	do	1–10,000	1853	do	379
Monterey bay	do	1–20,000	1851	do	296
Monterey bay	do	1–40,000	1856	Comr. James Alden	558
Monterey bay	do	1–10,000	1856	do	559
Monterey bay	do	1–10,000	1856	do	560
Monterey bay	do	1–10,000	1856	do	561
Williams' Landing and vicinity, Monterey bay	do	1–10,000	1855	do	505
Williams' Landing and westward, Monterey bay	do	1–10,000	1855	do	506
Point Año Nuevo and Southward	do	1–10,000	1853	Lieut. Comg. James Alden	380
Point Año Nuevo and Northward	do	1–10,000	1856	Comr. James Alden	555
Coast Northward of Pigeon Point	do	1–10,000	1856	do	556
San Francisco entrance and westward	do	1–80,000	1857	do	562
San Francisco entrance and bar	do	1–20,000	1855	do	456
San Francisco bay, from Point Boneta to Angel island	do	1–10,000	1855	do	462
San Francisco bay, Point Avisadera to Point Bruno	do	1–10,000	1854	Lieut. Comg. James Alden	421
San Francisco bay, Angel island to Point Avisadera	do	1–20,000	1855	Comr. James Alden	464
San Francisco bay, Point Avisadera to Coyote Hill creek	do	1–20,000	1857–'58	Comr. James Alden, Lieut. Comg. R. M. Cuyler	628
San Francisco bay	do	1–10,000	1857–'58	Lieut. Comg. R M. Cuyler	629
San Francisco harbor, vicinity of city	do	1–10,000	1853	Lieut. Comg. James Alden	347
San Francisco city front, (resurvey)	do	1–10,000	1857	Lieut. Comg. R. M. Cuyler	604
San Francisco bay, from Angel island to Richmond Point	do	1–10,000	1855	Comr. James Alden	465
San Francisco bay, from Point San Pablo to Point San Quentin	do	1–10,000	1855	do	466
San Pablo bay	do	1–20,000	1856	do	524
Mare Island strait, (reconnaissance)	do	1–5,000	1849	Lieut. Comg. W. P. McArthur	288
Mare Island strait, (reconnaissance)	do	1–5,000		do	236
Mare Island strait	do	1–10,000	1856	Comr. James Alden	544
Karquines strait	do	1–10,000	1857	do	563

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of California—Continued.					
Richmond bay and Raccoon strait	California	1–10,000	1855	Comr. James Alden	463
San Antonio creek, San Francisco bay	do	1–10,000	1857	do	573
Ballenas bay and Duxbury reef	do	1–10,000	1854	Lieut. Comg. James Alden	438
Point Reyes and Drake's bay	do	1–10,000	1854	do	435
Coast from San Francisco to Crescent City	do		1854	do	401
Mendocino City harbor, (reconnaissance)	do	1–10,000	1853	do	384
Shelter cove, (reconnaissance)	do	1–10,000	1853	do	385
Humboldt bay	do	1–10,000	1851	do	270
Humboldt bay	do	1–10,000	1851	do	271
Trinidad bay	do	1–5,000	1851	do	274
Crescent City harbor, (resurvey)	do	1–10,000	1855	Comr. James Alden	480
Crescent City harbor	do	1–10,000	1853	Lieut. Comg. James Alden	383
Coast from False Klamath to Columbia river			1854	do	402
Coast of Oregon and Washington Territories.					
Coast from Table Bluff to Coquille river	Oregon			Lieut. Comg. W. P. McArthur	242
Coast from Umpquah head to Columbia river	do		1851	do	240
Port Orford or Ewing harbor	do	1–10,000	1853	Lieut. Comg. James Alden	381
Umpquah river entrance	do	1–10,000	1853	do	382
Coast from Columbia river to Point Grenville	do		1852	do	334
Coast from Columbia river to Admiralty inlet			1852	do	333
Columbia river, (entrance)	Oregon	1–20,000	1851	Lieut. Comg. W. P. McArthur	273
Columbia river, (entrance)	do	1–20,000	1854	Lieut. Comg. James Alden	428
South channel bar, mouth of Columbia river	do	1–10,000	1854	do	429
Columbia river, (entrance)	do	1–20,000	1852	do	336
Columbia river, (entrance)	do	1–20,000	1850	Lieut. Comg. W. P. McArthur	250
Shoalwater bay	Wash. Ter	1–18,818	1855	Comr. James Alden	498
Shoalwater bay	do	1–20,000	1852	Lieut. Comg. James Alden	335
Grenville harbor	do	1–10,000	1854	do	426
Coast from Columbia river to Cape Flattery	do		1852	do	427
Neé-ah harbor, straits of Juan de Fuca	do	1–10,000	1852	do	337
False Dungeness, straits of Juan de Fuca	do	1–10,000	1852	do	325
New Dungeness, straits of Juan de Fuca	do	1–10,000	1855	Comr. James Alden	500
Port Townshend	do	1–10,000	1854	Lieut. Comg. James Alden	434
Port Ludlow, entrance of Hood's canal	do	1–10,000	1855	Comr. James Alden	508
Admiralty inlet	do	1–100,000	1855	do	510
Port Gamble, entrance of Hood's canal	do	1–10,000	1855	do	509
Blakely harbor	do	1–10,000	1856	do	525
Duwamish bay	do	1–10,000	1854	Lieut. Comg. James Alden	432
Steilacoom harbor, and vicinity of Puget's Sound	do	1–10,000	1855	Comr. James Alden	499
Olympia harbor, Puget's Sound	do	1–10,000	1855	do	507
Rosario and Haro straits	do	1–100,000	1854	Lieut. Comg. James Alden	433

APPENDIX No. 24—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Coast of Oregon and Wash'ton Territories—Cont'd.					
Haro and Rosario straits, near Vancouver's island	Wash. Ter		1853	Lieut. Comg. James Alden	405
Smith's or Blunt's island, Rosario strait	do	1-10,000	1854	do	431
Bellingham bay	do	1-20,000	1855	Comr. James Alden	502
Semi-ah-moo bay	do	1-20,000	1857	Lieut. Comg. R. M. Cuyler	603
Total number of sheets registered..632					

APPENDIX No. 25.

List of geographical positions determined by the United States Coast Survey, and continued from reports of 1851, 1853, *and* 1855.

The present list is a continuation of that published in the annual reports for 1851, 1853, and 1855, and contains the geographical positions of points determined astronomically and trigonometrically since the date of the former reports, with the repetition of some points previously published, for convenience of reference. The following explanations will give all the information required for the use of the tables.

For the purposes of the survey, the coast is divided into eleven sections, in all of which the work is carried on simultaneously. The survey being in different stages of progress in the several sections, and new results being added from year to year to those here given, the same divisions have been adopted in the publication.

The several sections are defined as follows:

SECTION I. From Passamaquoddy bay to Point Judith.

SECTION II. From Point Judith to Cape Henlopen.

SECTION III. From Cape Henlopen to Cape Henry.

SECTION IV. From Cape Henry to Cape Fear.

SECTION V. From Cape Fear to St. Mary's river.

SECTION VI. From St. Mary's river to St. Joseph's bay.

SECTION VII. From St. Joseph's bay to Mobile bay.

SECTION VIII. From Mobile bay to Vermilion bay.

SECTION IX. From Vermilion bay to the Rio Grande.

SECTION X. Coast of California, San Diego bay, to 42d parallel.

SECTION XI. Coast of Oregon and Washington Territories, 42d to 49th parallel.

The tables give the latitudes and longitudes of the trigonometrical points in each section, and their relative azimuths or bearings and distances. The manner in which these data have been obtained may be briefly explained here.

In each section a base line of from five to ten miles is measured with all possible accuracy. A series of triangles, deriving the length of their sides from this base, is then established along the coast by the measurement of the angles between the intervisible stations. In this primary series the triangles are made as large as the nature of the country will permit, because the liability to error increases with the number of triangles.

On the bases furnished by the sides of the primary triangles a secondary triangulation is next established, extending along the coast, and over the smaller bays and sounds, and determining a large number of points at distances a few miles apart.

The distances between the points thus determined, as given in the tables, are liable to an average error of about one foot in six miles, until a final adjustment between the base lines shall have been made.

In some parts of the survey the base lines for the primary triangulations have not yet been measured, or the connexion between the secondary and primary triangulation has not yet been made, in which cases the distances depend on preliminary base lines, measured with great care, and they are liable to an average error of one foot in three miles. This applies to the positions on Savannah river in Section V, to a part of those in Section VI, and to the positions in Sections VII, IX, X, and XI.

As on the completion of the primary triangulation in each section the several series form one connected chain, the different bases afford verifications of each other, and of the triangulation connecting them. The first four sections are thus connected, the last section, however, only in a preliminary way.

Observations for latitude and azimuth are made at a number of stations of the primary triangulation in each section. The differences of latitude, longitude, and azimuth between these and other stations are then computed, under the supposition that the earth is a spheroid of revolution of the following dimensions, which are those determined by Bessel, from the reliable measurements made at the time, viz :

Equatorial radius = 6377397.16 metres.

Polar radius = 6356078.96 metres.

Eccentricity = 0081696.83.

It has been found that the differences of latitude and longitude, as computed in this manner from the distance and azimuth between two stations, and which are called geodetic, differ from those obtained by astronomical observations at the several stations, by quantities which are greater than the errors of the observations. Such disagreements are due to local irregularities in the figure and density of the earth, and the error resulting from them in the determinations of latitude and of the meridian plane is designated as station error. It amounts, according to the results obtained at present, to between one and four seconds of arc in the eastern section of the survey, and to about one second and a half in the sections south of the Delaware.

In order to eliminate the influence of station errors on the general result, observations are made at a number of stations; the results are referred to a central station by means of the geodetic differences, and the mean of all is used for the computation of the positions given in the tables. The geographical positions must therefore be considered as liable to future changes from the accumulation of new observations, and from the final discussion of all the results obtained.

The *differences of longitude* are obtained, as has been stated, by computation, from the distances, latitudes, and azimuths of the triangulation. In adding up the differences from station to station, an accumulation of the unavoidable errors is probable. They are checked, however, by differences of longitude determined by means of the electro-magnetic telegraph in every section where the introduction of the latter makes it practicable.

Seaton station, in Washington city, has been selected as the centre for the telegraphic differences of longitude. The sections at present connected by telegraph are Sections I, II, III, IV, V, and VIII. The first three being also connected by primary triangulation, the check on the geodetic differences of longitude is here obtained and the agreement is very close.

The longitudes from Greenwich in the first five sections depend upon that of Cambridge observatory, as determined by chronometric differences between Liverpool and Cambridge, and by occultations, eclipses, and moon culminations, observed at various observatories in the United States, and referred to Cambridge by means of telegraphic differences. The following statement shows the result up to the present time.

Longitude of Cambridge, Mass., from Greenwich.

	h.	m.	s.
By moon culminations observed at Cambridge, Hudson, Ohio, Wilkes' observatory and National observatory	4	44	28.4
By eclipses and occultations at Cambridge, Brooklyn, Philadelphia and Wilkes' observatory	4	44	29.6
By chronometric differences from 1,065 exchanges in 1849, 1851 and 1855	4	44	30.8

The longitude adopted for the present is $4^h\ 44^m\ 29^s.5$ or $71^\circ\ 07'\ 22''.50$.

In Sections VI, VII, VIII and IX the longitudes are counted from some central station in each, for which we have at present the following data, subject to future corrections:

Section VI. Cape Florida, west of Greenwich	80°	09′	31″.2	
Section VI. Sand key has been assumed, west of Greenwich	81	52	43	and in
Section VII. St. Mark's, west of Greenwich	84	12	30	
Sections VIII and XI. Fort Morgan, Mobile Point, west of Greenwich	88	00	25	

The longitudes in Sections X and XI are reckoned from Greenwich. They depend on moon culminations observed at San Diego, Point Conception, Point Pinos, Presidio, Telegraph Hill, Port Orford, Cape Disappointment and Cape Flattery, compared with corresponding observations at Greenwich and American observatories, and on chronometric differences between the same and other stations.

The Section XI longitudes depend upon Lummi island. The longitude of the astronomical station has been found 122° 40′ 36″.9 W.

Explanation of the tables.

The first column on the left contains the name of the several stations or triangulation points. Their general locality is indicated by the heading at the top of the page, by means of which they may be readily found on the sketches accompanying the tables. Sub-headings in the first column indicate the locality more minutely where it is practicable.

The stations are generally either prominent objects of permanence, such as spires, light-houses, beacons, &c., or they are the points on prominent hills, capes, and points of land, where signals have been erected for the purposes of the survey, and which are marked on the ground. In a small number of cases in the first three sections, but much more frequently in the southern sections, where settlements on the coast are sparse and few permanent objects are to be found, the stations have no other distinguishing mark than the signal erected on the spot; and after its decay the mark left in the ground to designate the station point. The latter generally consists of posts or stones set around the point, while the centre of the station is designated by an earthen cone or glass bottle buried under the surface of the ground, and marked on the top by a stone or post. Where the station is on a rock, a copper bolt, or a hole filled with lead or sulphur will be found to designate the exact spot.

The sketches showing the configuration of the land, as well as the relative positions of the stations, no great difficulty will be experienced in finding the latter when desired for local surveys or reference. In any case where minute descriptions of particular points are required, they can be had by application addressed to the Coast Survey Office.

The second and third columns contain the latitudes and longitudes of the stations named.

The fourth column contains the azimuth of the line joining the station named in the first column with that named in the fifth; that is to say, the angle which that line makes with the meridian of the former station, reckoned from south around by west through the whole circle; the sixth column gives the back azimuth of the same line, or the angle which it makes with the meridian of the latter station, reckoned as before; the difference between the azimuths in the fourth and those in the sixth columns being 180° less the inclination of the meridians at the two stations.

The seventh, eighth, and ninth columns give the distances, in metres, yards, and miles, between the stations named in the first and fifth columns. The relation of the metre to the yard used in obtaining these results is:

1 metre = 1.0935696 yard, or 39.368505 United States standard inches.

For each station the azimuths and distances to two other stations are given. In every case the lines so given have actually been observed.

In each section the stations of the primary triangulation are distinguished by being printed in small capitals.

In Section IV some points previously published are repeated, with slight changes in their positions, arising from an adjustment of the triangulation between the Bodies Island base and the Kent Island base, and the carrying of the Section III latitudes and longitudes into Section IV. Corresponding changes should be made in the positions of the 1851, 1853, and that part of 1855 report depending on the former. In Section VIII a number of points already published in the report for 1851 have been repeated on account of a slight change in the base. In Section IX the longitudes given in the reports of 1851 and 1853 should be increased by 20″ to conform to the latest determination.

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Coast of Maine. Sketches Nos. 1 and 2.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Edgecombe	43 57 12.31	69 35 56.86	44 53 28	Cape Small	244 43 28	27431.5	29998.3	17.05
			24 22 14	Seguin Light	204 15 51	30039.7	32850.5	18.67
Coxe's Head	43 46 00.64	69 47 00.32	105 38 21	Cape Small	285 36 01	4699.4	5139.1	2.92
			42 38 38	Morse	222 37 06	4392.1	4803.1	2.73
Damiscove	43 45 15.64	69 36 26.24	98 09 21	Cape Small	277 59 43	18894.3	20662.2	11.74
			65 44 40	Seguin Light	245 48 38	12857.4	14060.5	7.99
Parker's Island	43 49 21.49	69 43 40.90	61 15 46	Cape Small	241 11 08	10246.4	11205.2	6.36
			8 53 00	Seguin Light	188 51 58	13000.3	14216.7	8.08
Back River	43 50 08.18	69 46 05.86	42 01 59	Cape Small	221 59 01	8577.5	9380.1	5.33
			293 58 15	Parker's Island	113 50 55	3544.7	3876.4	2.20
Rotundo Hill	43 48 03.62	69 46 27.82	187 16 28	Back River	7 16 43	3875.1	4237.7	2.41
			66 57 28	Burnt Ledge	266 55 12	4407.0	4819.4	2.74
Bowker	43 49 57.95	69 48 48.51	265 01 08	Back River	85 03 01	3647.1	3988.4	2.27
			318 17 06	Rotundo Hill	138 18 43	4725.5	5167.7	2.94
Great Hill	43 53 45.39	69 50 53.05	357 01 49	Cape Small	177 02 10	13094.4	14319.6	8.14
			52 24 22	Kellogg	232 19 31	11846.8	12955.3	7.36
Hodgkins	43 58 42.03	69 48 26.67	348 46 48	Back River	168 48 26	16166.5	17679.2	10.04
			19 38 29	Great Hill	199 36 47	9718.9	10628.3	6.04
Sprague	43 58 30.46	69 53 43.41	336 37 35	Great Hill	156 39 33	9582.5	10479.2	5.95
			267 04 28	Hodgkins	87 08 08	7067.9	7729.2	4.39
Gilmer's Hill	43 54 42.08	69 46 25.18	73 42 50	Great Hill	253 39 44	6227.8	6810.5	3.87
			125 50 38	Sprague	305 45 34	1204.8	1317.5	0.75
White Island	43 47 13.33	69 34 05.71	87 31 53	Cape Small	267 20 37	21865.7	23911.7	13.59
			40 52 57	Damiscove	220 51 20	4802.7	5252.1	2.98
Monseag	43 53 25.56	69 43 23.98	30 41 56	Back River	210 40 05	7082.7	7745.4	5.40
			39 56 08	Burnt Ledge	219 51 44	13256.8	14497.2	6.24
Bartoe	43 53 27.41	69 40 10.72	31 45 10	Parker's Island	211 42 44	8923.3	9758.3	5 54
			89 15 24	Monseag	269 13 10	4313.6	4717.2	2.68
Kenniston	43 53 02.31	69 36 54.27	357 30 26	Damiscove	177 30 45	14414.8	15763.6	8.96
			100 02 23	Bartoe	280 00 07	4452.8	4869.5	2.77
Blin	44 07 16.02	69 40 31.88	94 35 54	Sebattis	274 19 18	31892.1	34876.2	19.82
			341 46 53	Edgecombe	161 50 04	19611.7	21446.8	12.19
Wetmore, (W.,) chimney of house.	43 53 19.09	69 47 41.60	340 02 53	Back River	160 03 59	6267.5	6853.9	3.89
			356 05 47	Coxe's Head	176 06 16	13562.0	14831.0	8.43
Arronseag, black and red flag	43 53 48.52	69 47 18.41	346 35 38	Back River	166 36 28	6990.5	7644.6	4.34
			215 41 28	Gilmer's Hill	35 42 05	2035.6	2226.1	1.27
Bath, South Methodist spire	43 54 30.57	69 48 38.83	182 00 06	Hodgkins	2 00 14	7764.8	8491.4	4.82
			137 29 43	Sprague	317 26 12	10047.2	10987.3	6.24
Bath, North Methodist spire	43 55 31.37	69 48 29.83	180 41 11	Hodgkins	0 41 13	5884.3	6434.9	3.66
			128 21 30	Sprague	308 17 53	8912.3	9746.2	5.54
Bath, Baptist spire	43 54 50.57	69 48 39.04	182 12 40	Hodgkins	2 12 49	7148.3	7817.2	4.44
			135 01 38	Sprague	314 58 07	9597.8	10495.9	5.96
Bath, Winter Street church	43 54 55.21	69 48 39.90	182 24 47	Hodgkins	2 24 56	7005.7	7661.2	4.35
			134 29 52	Sprague	314 26 22	9483.7	10371.1	5.89
Bath, Central church	43 54 45.53	69 48 40.88	182 29 09	Hodgkins	2 29 19	7305.3	7988.9	4.54
			135 51 00	Sprague	315 47 30	9679.8	10585.5	6.02
Bath, Episcopal spire	43 54 59.98	69 48 45.12	183 26 03	Hodgkins	3 26 16	6864.9	7507.2	4.27
			280 01 18	Gilmer's Hill	100 02 55	3170.4	3467.1	1.97
Bath, Old North Methodist spire.	43 54 41.84	69 48 51.34	336 21 28	Back River	156 23 23	9218.9	10081.5	5.73
			137 19 06	Sprague	317 15 43	9602.5	10501.0	5.97
Bath, Universalist spire	43 54 43.71	69 48 81.43	339 04 11	Back River	159 05 52	9103.3	9955.1	5.66
			271 00 29	Gilmer's Hill	91 01 57	2817.1	3080.7	1.75
Bath, Calvinist church	43 55 07.03	69 48 38.94	339 39 18	Back River	159 41 04	9835.7	10756.0	6.11
			284 27 03	Gilmer's Hill	104 28 36	3080.6	3368.9	1.91
New Meadow church	43 53 03.73	69 54 37.99	334 09 47	Cape Small	154 12 44	13097.0	14322.5	8.14
			36 15 44	Kellogg	216 13 28	7374.5	8064.5	4.58
East Telegraph pole	43 57 04.35	69 48 31.69	182 07 45	Hodgkins	2 07 48	3016.7	3299.0	1.87
			110 57 40	Sprague	290 54 04	7439.6	8135.7	4.62
West Telegraph pole	43 56 57.90	69 48 45.07	187 16 27	Hodgkins	7 16 40	3239.7	3542.8	2.01
			113 16 27	Sprague	293 13 00	7238.2	7915.5	4.50

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Coast of Maine. Sketches Nos. 1 *and* 2.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Pond Island Light, (new)	43 44 22.96	69 45 53.53	87 14 25	Morse	267 12 07	4475.0	4893.7	2.78
			153 38 43	Coxe's Head	333 37 57	3364.2	3679.0	2.09
Pond Island Light, (old)	43 44 23.45	69 45 53.52	87 02 55	Morse	267 00 37	4475.7	4894.5	2.78
			153 31 46	Coxe's Head	333 31 00	3351.2	3664.8	2.08
Salter's Island Tree, S.W. end	43 44 38.53	69 45 05.88	1 27 53	Seguin Light	181 27 50	4113.9	4498.8	2.56
			134 43 16	Coxe's Head	314 41 57	3601.7	3938.7	2.24
Pond Island Bell-house	43 44 19.50	69 45 53.15	88 36 32	Morse	268 34 14	4479.4	4898.5	2.78
			154 18 10	Coxe's Head	334 17 24	3463.9	3788.0	2.15
Heron Island Tree	43 43 20.34	69 47 59.01	135 55 04	Morse	315 54 13	2388.9	2612.4	1.49
			194 51 40	Coxe's Head	14 52 21	5118.1	5597.0	3.18
Hunnewell's flag staff	43 45 13.75	69 46 43.53	61 58 43	Morse	241 56 59	3796.0	4151.2	2.36
			165 27 24	Coxe's Head	345 27 12	1495.1	1635.0	0.93
Hunnewell's Hill, black flag in tree.	43 44 41.25	69 47 13.10	73 48 41	Morse	253 47 18	2800.4	3062.4	1.74
			186 39 14	Coxe's Head	6 39 23	2466.7	2697.5	1.53
Spinney's (R.) House	43 45 25.50	69 46 25.82	343 09 11	Seguin Light	163 10 03	5811.2	6355.0	3.61
			47 31 31	Hunnewell's Flag staff.	227 31 19	537.0	587.3	0.33
Spinney's (E.) House	43 46 00.22	69 46 24.78	345 56 53	Seguin Light	165 57 24	6838.2	7478.1	4.25
			49 31 32	Morse	229 29 35	4956.2	5420.0	3.08
Oliver's House (W. P.) House on Parker's Island.	43 46 40.12	69 45 24.15	357 47 24	Seguin Light	177 47 33	7871.2	8607.7	4.89
			60 29 04	Coxe's Head	240 27 57	2471.3	2702.5	1.54
Parker's Island, chimney of new house.	43 45 59.69	69 46 00.54	350 24 20	Seguin Light	170 24 55	6710.9	7338.8	4.17
			91 15 42	Coxe's Head	271 15 01	1337.1	1462.2	0.83
Red Chimney	43 45 58.18	69 44 42.80	5 24 22	Seguin Light	185 24 03	6599.9	7217.5	4.10
			91 25 06	Coxe's Head	271 23 31	3076.3	3364.2	1.91
Parker's Island, flag in tree	43 45 59.36	69 45 47.82	91 24 21	Coxe's Head	271 23 31	1621.7	1773.4	1.01
			41 31 09	Hunnewell's Flag-staff.	221 30 30	1879.6	2055.5	1.17
Parker's Island, chimney of Berry's house.	43 47 09.54	69 45 29.47	43 04 37	Morse	223 02 02	7332.1	8018.2	4.56
			286 05 04	Damiscove	106 11 20	12645.6	13828.9	7.86
Parker's Head, white flag in tree.	43 47 24.92	69 47 16.86	197 28 25	Back River	17 29 14	5282.3	5776.6	3.28
			106 11 39	Burnt Ledge	286 09 57	3441.3	3763.3	2.14
Parker's Island, white flag in tree.	43 51 00.22	69 44 54.39	44 49 36	Back River	224 48 47	2264.7	2476.6	1.41
			163 31 18	Gilmer's Hill	343 30 15	7140.6	7808.8	4.44
Parker's Island, chimney centre of white house.	43 50 03.71	69 45 04.21	95 42 27	Back River	275 41 44	1384.0	1513.5	0.86
			168 07 36	Gilmer's Hill	348 06 40	8779.0	9600.5	5.46
Back River Station No. 2.	43 54 02.47	69 43 00.45	29 48 31	Back River	209 46 22	8331.3	9110.9	5.18
			38 38 19	Burnt Ledge	218 33 38	14471.0	15825.1	8.99
Burnt Ledge Station No. 12.	43 49 44.64	69 53 12.04	326 09 19	Cape Small	146 11 16	6798.3	7434.4	4.22
			305 52 18	Burnt Ledge	125 54 42	5719.5	6254.7	3.55
Booth Bay, centre brown spire	43 52 33.83	69 37 44.20	45 07 52	Morse	224 59 56	21754.3	23789.6	13.52
			352 39 12	Damiscove	172 40 06	13634.0	14909.7	8.47
Rotundo Hill, black flag	43 48 00.32	69 46 23.20	12 40 10	Coxe's Head	192 39 44	3785.1	4139.3	2.35
			88 19 24	Burnt Ledge	268 17 05	4505.9	4927.5	2.80
Beale's (S.) Chimney	43 49 35.26	69 47 56.12	325 05 07	Rotundo Hill	145 06 08	3448.2	3770.9	2.14
			120 54 09	Bowker	300 53 33	1363.9	1491.5	0.85
Phipsburg Spire	43 49 08.42	69 48 15.81	237 33 44	Back River	57 35 14	3439.5	3761.3	2.14
			309 38 00	Rotundo Hill	129 39 15	3134.0	3427.3	1.95
Cushing's House	43 49 44.21	69 48 01.56	254 01 06	Back River	74 02 26	2688.2	2939.7	1.67
			325 58 42	Rotundo Hill	145 59 47	3744.8	4095.2	2.33
Bowker's (E.) House	43 49 50.32	69 48 50.20	261 26 52	Back River	81 28 46	3712.3	4059.7	2.31
			315 58 19	Rotundo Hill	135 59 57	4578.8	5007.3	2.85
Cutting's Drummond Barn	43 50 18.85	69 48 36.41	275 34 32	Back River	95 36 16	3378.9	3695.1	2.10
			325 26 18	Rotundo Hill	145 27 47	5066.6	5540.7	3.15
Pemaquid Point Light	43 50 12.00	69 30 01.81	54 45 34	Seguin Light	234 35 05	24908.7	27239.4	15.48
			66 59 45	Morse	246 46 28	27990.0	30520.4	17.39
Monhegan Light	43 45 52.24	69 18 37.43	132 13 13	Edgecombe	312 01 13	31291.3	34219.1	19.44
			86 02 15	Morse	265 41 05	41175.0	45027.7	25.58
Primary and Secondary Points.								
Mount Harris	44 39 53.57	69 08 32.90	52 18 28.3	Sebattis	231 39 24.6	94065.1	102866.7	58.45
			94 38 44.0	Mount Blue	273 48 20.3	94898.2	103777.8	58.96
Humpback	44 51 49.46	68 08 15.60	49 10 49.5	Ragged Mount	228 27 00.7	109932.5	120218.9	68.31
			75 18 58.6	Mount Harris	254 35 06.8	85097.2	93059.7	52.87

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Coast of Maine. Sketches Nos. 1 *and* 2.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Mount Desert	44 21 03.86	68 13 15 48	78 30 46.4	Ragged Mount	257 52 02 8	75382.4	82435.9	46.84
			115 46 17.4	Mount Harris	295 07 31.9	81140.7	88733.0	50.42
Saunders' Mount	44 39 28.36	68 35 59.00	318 24 27.3	Mount Desert	138 40 23.1	45486.7	49742.9	28.26
			91 13 35.7	Mount Harris	270 50 42.3	43047.1	47075.0	26.75
Isle au Haut	44 04 01.92	68 36 42.54	110 51 38	Ragged Mount	290 29 20	45632.0	49901.8	28.35
			147 41 32	Mount Harris	327 19 16	78731.1	86097.9	48.92
Monhegan Island	43 46 15.39	69 17 56.93	91 15 13	Cape Small	270 52 47	43517.3	47589.2	27.04
			194 03 48	Ragged Mount	14 10 13	50551.3	55281.4	31.41
Pigeon Hill	44 27 17.55	67 53 01.92	66 52 23	Mount Desert	246 38 14	29222.6	31956.9	18.16
			111 53 07	Saunders' Mount	291 22 58	61179.5	66904.0	38.01
Tunk Mount	44 38 21.99	68 05 17.85	18 16 25	Mount Desert	198 10 50	33733.0	36889.4	20.96
			93 04 14	Saunders' Mount	272 42 40	40617.1	44417.6	25.24
Mount Waldo, (B.)	44 34 47.67	68 53 21.41	249 14 30	Saunders' Mount	69 26 42	24557.6	26855 4	15.26
			115 15 30	Mount Harris	295 04 50	22199.8	24277.0	13.79
Blue Hill	44 26 01.45	68 35 06.47	177 20 21	Saunders' Mount	357 19 45	24931.3	27264.1	15.49
			287 26 23	Mount Desert	107 41 40	30430.6	33278.0	18.91
Peaked Mount	44 49 43.27	68 27 29.59	30 36 27	Saunders' Mount	210 30 29	22040.3	24102.6	13.69
			71 40 21	Mount Harris	251 11 27	57156.9	62505.0	35.51
Thomas' Hill, Bangor	44 48 22.55	68 46 39.00	61 36 20	Mount Harris	241 20 55	32898.7	35977.0	20.44
			19 26 41	Mount Waldo, (B.)	199 21 58	26665 8	29161.0	16.57
Mount Desert Rock Light	43 58 06.79	68.07 21.82	169 33 34	Mount Desert	349 29 28	43219.4	47263.4	26.85
			168 38 50	Ragged Mount	287 56 08	86250.1	94320.5	53.59

Section II.—Vicinity of New York. Sketch No. 11.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Harrow	40 47 52.89	73 38 02.16	....	....	....	....	....	....
Weasel	40 52 34.18	74 10 52.42	280 28 02	Harrow	100 49 30	46962.6	51356.9	29.18
Howard	40 37 36.73	74 05 03.90	163 34 41	Weasel	343 30 54	28862.3	31562.9	17.93
			243 19 10	Harrow	63 36 48	42541.7	46522.3	26.43
Mount Prospect	40 40 15.73	73 57 41.40	64 47 02	Howard	244 42 14	11493.6	12569.1	7.14
			140 54 53	Weasel	320 46 16	29373.2	32121.6	18.25
New York City Hall	40 42 43.17	74 00 03.11	36 48 06	Howard	216 44 50	11799.5	12903.6	7.33
			323 47 59	Mount Prospect	143 49 31	5634.6	6161.8	3.50
Highwood, (1)	40 46 07.73	74 00 44.40	338 24 10	Mount Prospect	158 26 10	11675.5	12768.0	7.25
			21 09 17	Howard	201 06 28	16897.2	18478.3	10.50
Betts	40 44 13.51	73 54 08.91	34 14 15	Mount Prospect	214 11 57	8869.4	9699.3	5.51
			110 49 54	Highwood, (1)	290 45 36	9922.7	10851.2	6.16
Highwood, (2.)	40 46 10.02	74 00 42.15	338 46 14	Mount Prospect	158 48 12	11721.9	12818.7	7.28
			291 15 03	Betts	111 19 20	9898.6	10824.8	6.15
Receiving Reservoir	40 46 43.78	73 57 49.86	359 02 59	Mount Prospect	179 03 05	11970.6	13090.7	7.43
			75 33 39	Highwood, (2)	255 31 46	4171.9	4562.2	2.59
West Hoboken	40 44 48.76	74 02 07.00	239 30 26	Receiving Reservoir	59 33 14	6996.7	7651.4	4.35
			323 27 56	Mount Prospect	143 30 49	10477.3	11457.7	6.51
Clark	40 46 52.80	73 42 31.00	89 20 38	Receiving Reservoir	269 10 38	21544.9	23560.8	13.39
			60 15 24	Mount Prospect	240 05 30	24623.7	26927.7	15.30
New York Trinity church	40 42 25.72	74 00 24.24	151 21 00	West Hoboken	331 19 53	5027.7	5498.2	3.13
			204 27 04	Receiving Reservoir	24 28 45	8744.8	9563.1	5.43
Latting's Observatory	40 45 15.24	73 58 39.53	120 26 54	Highwood, (2)	300 25 34	3335.1	3647.2	2.07
			286 40 08	Betts	106 43 05	6627.5	7247.8	4.12
Cypress Hill	40 41 36.62	73 52 07.92	72 21 16	Mount Prospect	252 17 39	8217.8	8986.7	5.11
			139 46 27	Receiving Reservoir	319 42 44	12414.1	13575.7	7.71
Jersey City spire	40 42 50.49	74 01 56.85	195 53 13	Highwood, (2)	15 54 02	6398.9	6797.6	3.98
			176 15 57	West Hoboken	356 15 50	3655.4	3997.4	2.27
Forty-seventh Street Pier	40 45 52.97	73 59 40.09	60 07 44	West Hoboken	240 06 08	3974.1	4345.9	2.46
			109 52 07	Highwood, (2)	289 51 26	1547.3	1692.1	0.97

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of New York. Sketch No. 11.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Thirty-seventh Street Pier	40 45 30.48	73 59 57.19	284 27 33	Latting's Observatory	104 28 24	1880.5	2056.5	1.17
			139 09 18	Highwood, (2)	319 08 49	1612.0	1762.8	1.01
Pier 52	40 43 57.68	74 00 26.19	45 45 35	Jersey City spire	225 44 36	2970.0	3247.9	1.85
			123 40 28	West Hoboken	303 39 22	2841.6	3107.5	1.76
Twenty-fourth Street Pier	40 44 58.75	74 00 12.19	162 16 49	Highwood, (2)	342 16 29	2307.6	2523.5	1.43
			256 49 26	Latting's Observatory	76 50 27	2232.0	2440.9	1.38
Twenty-second Street Pier	40 44 55.00	74 00 17.50	254 47 42	Latting's Observatory	74 48 46	2381.2	2604.0	1.48
			227 07 34	Twenty-fourth St. Pier	47 07 37	169.9	185.8	0.10
Pier 41	40 43 29.48	74 00 29.38	136 52 51	West Hoboken	316 51 47	3350.2	3663.7	2.08
			59 38 37	Jersey City spire	239 37 40	2379.0	2591.6	1.48
Jersey City Pier	40 42 59.63	74 01 33.46	238 38 58	Pier 41	58 31 40	1763.2	1928.2	1.10
			166 50 33	West Hoboken	346 50 11	3456.5	3779.9	2.15
Pier 18	40 42 41.80	74 00 39.68	113 33 16	Jersey City Pier	293 32 41	1376.8	1505.6	0.85
			98 25 29	Jersey City spire	278 24 39	1830.8	2002.1	1.14
Pier 60	40 44 32.09	74 00 26.17	0 01 01	Pier 52	180 01 01	1061.3	1160.6	0.66
			34 11 00	Jersey City spire	214 10 01	3787.7	4142.1	2.35
Fifty-second Street Pier	40 46 04.05	73 59 30.81	96 17 40	Highwood, (2)	276 16 53	1682.8	1840.3	1.05
			29 51 51	Jersey City spire	209 50 16	6883.2	7527.3	4.28
Guttenberg Pier	40 47 07.52	73 59 44.21	350 52 28	52d Street Pier	170 52 37	1982.8	2068.3	1.23
			37 27 08	Highwood, (2)	217 26 30	2234.0	2443.0	1.39
Ffty-fifth Street Pier	40 46 10.43	73 59 24.42	165 14 10	Guttenberg Pier	345 13 57	1821.1	1991.5	1.13
			89 36 35	Highwood, (2)	269 35 44	1822.7	1993.3	1.14
Number 6 Station	40 47 26.03	73 58 31.17	71 34 18	Guttenberg Pier	251 33 30	1804.9	1973.8	1.12
			28 10 09	Fifty-fifth Street Pier	208 09 34	2644.9	2892.4	1.64
Bull's Ferry Pier	40 47 57.61	73 59 14.98	313 28 55	Number 6 station	133 29 24	1415.4	1547.9	0.88
			23 55 07	Guttenberg Pier	203 54 48	1690.0	1848.3	1.05
Russ & Reid's Pier	40 48 05.19	73 59 08.58	324 01 18	Number 6 station	144 01 42	1492.6	1632.3	0.93
			25 09 33	Guttenberg Pier	205 09 10	1965.1	2149.0	1.22
Vreeland, (2)	40 49 09.02	73 58 20.86	4 21 02	Number 6 station.	184 20 55	3185.7	3483.8	1.98
			29 36 09	Russ & Reid's Pier	209 35 38	2264.0	2475.8	1.41
Mott's Wharf	40 47 43.63	73 58 16.15	118 25 25	Russ & Reid's Pier	298 24 51	1397.4	1528.2	0.87
			177 35 52	Vreeland, (2)	357 35 49	2635.8	2882.4	1.64
Switch Number 3	40 48 54.37	73 57 29.70	110 39 00	Vreeland, (2)	290 38 27	1281.3	1401.2	0.80
			56 48 14	Russ & Reid's Pier	236 47 09	2769.6	3028.3	1.72
Manhattan Pier	40 49 07.49	73 57 21.33	91 56 08	Vreeland, (2)	271 55 29	1395.8	1526.4	0.87
			52 36 33	Russ & Reid's Pier	232 35 23	3163.6	3459.6	1.96
Tillietudlum Pier	40 49 44.18	73 57 57.62	336 55 42	Switch Number 3	156 56 00	1669.7	1825.9	1.04
			323 04 23	Manhattan Pier	143 04 47	1415.3	1547.7	0.88
Harris' Pier	40 50 09.88	73 56 38.49	66 50 57	Tillietudlum Pier	246 50 05	2016.3	2205.0	1.25
			27 33 11	Manhattan Pier	207 32 43	2170.4	2373.5	1.35
South Pier, Fort Lee	40 50 32.21	73 57 37.02	18 02 34	Tillietudlum Pier	198 02 21	1558.2	1704.0	0.97
			296 39 49	Harris' Pier	116 40 27	1534.3	1677.9	0.95
Manhattan Iron Works Wharf	40 49 34.73	73 56 56.52	201 17 03	Harris' Pier	21 17 15	1163.8	1272.7	0.72
			151 51 04	South Pier, Fort Lee	331 50 38	2011.0	2199.2	1.25
North Pier, Fort Lee	40 50 54.45	73 57,21.13	323 59 20	Harris' Pier	143 59 48	1699.1	1858.1	1.06
			28 29 18	South Pier, Fort Lee	208 29 08	780.2	853.2	0.49
Fort Washington Point	40 50 58.56	73 56 30.72	6 55 04	Harris' Pier	186 54 59	1512.6	1654.1	0.94
			19 05 49	Manhattan Pier	199 05 16	3625.1	3964.3	2.25
Fort Lee Point	40 51 10.62	73 57 14 59	289 53 20	Fort Washington Point.	109 53 49	1092.7	1195.0	0.68
			335 42 25	Harris' Pier	155 42 49	2055.3	2247.6	1.28
Moffat's Wharf, southwest post.	40 48 10.54	73 57 58.40	26 37 52	Mott's Wharf	206 37 40	928.3	1015.2	0.58
			206 27 32	Switch Number 3	26 27 51	1510.1	1651.4	0.94
Moffat's Wharf, north post	40 48 10.82	73 57 57.71	84 04 01	Russ & Reid's Pier	264 03 15	1669.6	1825.8	1.04
			27 16 04	Mott's Wharf	207 15 52	943 5	1031.8	0.59
Pettigrove	40 51 52.41	73 56 49.96	344 48 51	Fort Washington Point.	164 49 04	1721.0	1882.0	1.07
			24 06 00	Fort Lee Point	204 05 44	1412.2	1544.4	0.88
Lydecker, (2)	40 52 24.49	73 56 32.13	22 27 32	North Pier, Fort Lee	202 27 00	3005.0	3286.2	1.87
			359 16 57	Fort Washington Point.	179 16 58	2650.3	2898.3	1.65
Tubby Hook Signal	40 52 06.97	73 55 36.34	112 28 41	Lydecker, (2)	292 28 04	1413.6	1545.9	0.88
			31 06 41	Fort Washington Point.	211 06 05	2464.4	2695.0	1.53
Spuyten Duyvil	40 52 32.91	73 55 21.38	23 38 55	Tubby Hook Signal	203 38 45	873.4	955.1	0.54
			81 05 59	Lydecker, (2)	261 05 13	1676.7	1833.6	1.04

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Section II.—Vicinity of New York. Sketch No. **11.**

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Tubby Hook Wharf	40 52 09.26	73 55 35.49	109 30 53	Lydecker, 2	289 30 16	1406.8	1538.4	0.87
			204 21 25	Spuyten Duyvil	24 21 34	800.7	875.6	0.50
Cox	40 53 02.38	73 54 58.91	30 03 06	Spuyten Duyvil	210 02 51	1050.5	1148.8	0.65
			61 50 11	Lydecker, 2	241 49 10	2475.7	2707.4	1.54
Wagner	40 53 02.91	73 56 15.32	306 13 50	Spuyten Duyvil	126 14 25	1565.5	1712.0	0.97
			332 07 08	Tubby Hook Signal	152 07 34	1952.0	2134.6	1.21
Delafield Wharf	40 53 39.14	73 54 45.79	22 11 33	Spuyten Duyvil	202 11 10	2207.7	2414.3	1.37
			47 14 20	Lydecker, 2	227 13 10	3391.0	3708.3	2.10
Ellerson	40 53 43.61	73 55 51.34	275 06 56	Delafield Wharf	95 07 39	1540.4	1684.5	0.96
			342 10 43	Spuyten Duyvil	162 11 03	2290.8	2505.1	1.42
Normansville Wharf	40 52 14.55	73 56 37.55	279 15 17	Tubby Hook Signal	99 15 57	1452.0	1587.9	0.90
			252 22 39	Spuyten Duyvil	72 23 29	1871.3	2046.4	1.16
Riverdale Wharf	40 54 10.07	73 54 33.93	20 20 21	Spuyten Duyvil	200 19 50	3196.0	3495.0	1.99
			65 44 59	Ellerson	245 44 08	1986.6	2172.5	1.23
Nolton	40 54 52.32	73 55 22.88	318 41 44	Riverdale Wharf	138 42 16	1734.8	1897.1	1.08
			17 26 43	Ellerson	197 26 24	2221.7	2429.6	1.38
Flag on Delafield Wharf	40 53 38.59	73 54 45.95	196 08 46	Riverdale Wharf	16 08 54	1010.9	1105.5	0.63
			95 47 03	Ellerson	275 46 20	1538.0	1681.9	0.96
Forrest	40 54 45.60	73 54 23.24	12 51 58	Riverdale Wharf	192 51 51	1124.0	1229.2	0.70
			18 23 47	Spuyten Duyvil	198 23 09	4313.[illegible]	4716.7	2.68
Lower Closter	40 55 34.76	73 55 10.73	341 45 24	Riverdale Wharf	161 45 48	2750.6	3008.1	1.71
			323 45 58	Forest	143 46 29	1880.0	2055.9	1.17
Ludlow	40 55 08.97	73 54 12.71	120 22 36	Lower Closter	300 21 58	1573.2	1720.4	0.98
			18 51 55	Forrest	198 51 48	762.0	833.3	0.47
Lower Yonkers	40 56 01.93	73 53 55.77	64 27 50	Lower Closter	244 27 01	1943.3	2125.2	1.21
			15 16 09	Forrest	195 15 51	2440.5	2668.8	1.52
Upper Yonkers	40 56 08.55	73 53 53.84	59 55 10	Lower Closter	239 54 20	2078.5	2273.0	1.29
			15 03 01	Forrest	195 02 42	2649.6	2897.5	1.65
Upper Closter	40 56 47.34	73 54 46.94	313 55 19	Upper Yonkers	133 55 54	1724.5	1885.9	1.07
			351 36 03	Forrest	171 36 19	3795.6	4150.8	2.36
Glenwood	40 56 50.28	73 53 42.85	86 32 27	Upper Closter	266 31 45	1501.7	1642.2	0.93
			11 17 22	Upper Yonkers	191 17 15	1312.6	1435.4	0.81
Middle Yonkers	40 56 06.88	73 53 53.76	190 47 56	Gleenwood	10 48 03	1362.7	1490.2	0.85
			135 06 17	Upper Closter	315 05 42	1761.8	1926.6	1.09
Flag on wharf below bedstead factory.	40 55 40.25	73 53 59.64	151 52 29	Upper Closter	331 51 58	2346.3	2565.8	1.46
			84 12 08	Lower Closter	264 11 21	1671.4	1827.8	1.04
Tall white chimney, above Upper Closter.	40 57 59.30	73 54 43.99	341 02 47	Upper Yonkers	161 03 20	3611.8	3949.8	2.24
			326 06 41	Gleenwood	146 07 21	2564.3	2804.2	1.59
Yonkers, yellow spire	40 56 19.53	73 53 25.63	114 16 52	Upper Closter	294 15 59	2086.0	2281.2	1.30
			60 41 13	Lower Closter	240 40 04	2819.6	3083.4	1.75
Willey	40 53 14.66	73 56 07.11	320 16 25	Spuyten Duyvil	140 16 55	1674.8	1831.5	1.04
			202 27 55	Ellerson	22 28 05	966.2	1056.6	0.60
Forest's Castle	40 54 45.53	73 54 16.45	97 40 48	Nolton	277 40 05	1568.2	1714.9	0.97
			20 23 23	*Spuyten Duyvil*	200 22 40	4363.9	4772.2	2.71
Buckingham Cupola	40 54 51.57	73 55 24.38	317 18 32	Riverdale Wharf	137 19 05	1741.2	1904.1	1.08
			277 19 45	Forrest	97 20 25	1442.3	1577.3	0.90
Coil's House	40 51 37.53	73 57 10.14	322 28 10	Fort Washington Point	142 28 36	1515.6	1657.4	0.94
			7 09 18	Fort Lee Point	187 09 15	836.7	915.0	0.52
Fort Washington, south telegraph pole.	40 50 57.95	73 56 25.14	291 04 25	Clark	111 13 30	20958.9	22920.0	13.02
			64 46 52	South Pier, Fort Lee	244 46 05	1861.7	2035.9	1.16
Telegraph Insulator	40 50 59.87	73 56 29.00	82 12 08	North Pier, Fort Lee	262 11 34	1232.4	1347.7	0.76
			61 50 20	South Pier, Fort Lee	241 49 35	1807.3	1976.4	1.12
Telegraph Pole on west side of *river.*	40 51 12.91	73 57 14.38	336 36 47	Harris' Pier	156 37 11	2118.1	2316.3	1.32
			2 24 47	Manhattan Pier	182 24 42	3871.9	4234.2	1.40
Fort Washington Flag-staff	40 51 09.44	73 56 01.28	35 41 04	Highwood, (2)	215 38 00	11290.6	12347.1	7.01
			6 40 18	*Mount Prospect*	186 39 12	20238.0	22131.7	12.57
Tillietudlum Flag-staff	40 49 44.33	73 57 59.85	247 31 27	Harris' Pier	67 32 20	2062.7	2255.7	1.28
			199 54 05	South Pier, Fort Lee	19 54 20	1570.7	1717.7	0.97
Fort Lee Flag-staff	40 50 46.36	73 57 33.83	16 12 04	Tillietudlum Pier	196 11 48	1997.5	2184.4	1.24
			310 56 58	Harris' Pier	130 57 34	1716.6	1877.2	1.07
Fort Lee, south telegraph pole	40 51 12.77	73 57 19.25	333 47 37	Harris' Pier	153 48 04	2161.1	2363.3	1.34
			337 38 19	Cypress Hill	157 41 42	19212.0	21009.7	11.94

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Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Brown wooden building, cupola.	40 51 22.49	73 55 53.01	67 16 01 57 31 42	North Pier, Fort Lee... South Pier, Fort Lee...	247 15 03 237 30 34	2237.8 2887.8	2447.2 3158.0	1.39 1.79
Asylum....................	40 50 20.07	73 56 22.48	63 35 24 51 41 47	Tillietudlum Pier....... Vreeland, (2)..........	243 34 22 231 40 30	2489.2 3535.2	2722.1 3866.0	1.55 2.2[illegible]
Trinity Cemetery Spire........	40 49 48.68	73 56 16.90	125 35 03 86 38 29	South Pier, Fort Lee... Tillietudlum Pier......	305 34 11 266 37 23	2307.7 2363.9	2523.6 2585.1	1.43 1.47
Carmans' House..............	40 49 11.38	73 56 47.19	121 30 55 88 06 24	Tillietudlum Pier...... Vreeland, (2)..........	301 30 09 268 05 23	1935.4 2196.1	2116.5 2401.6	1.20 1.36
Manhattan, brown spire........	40 49 48.72	73 56 16.93	42 41 14 6 24 16	Highwood, (2)......... Mount Prospect........	222 38 21 186 23 21	9173.0 17784.0	10031.3 19448.1	5.70 11.05
Manhattan, spire...............	40 48 59.78	73 57 02.88	164 19 53 136 52 46	South Pier, Fort Lee... Tillietudlum Pier	344 19 31 316 52 10	2961.1 1876.3	3238.2 2051.9	1.84 1.17
Manhattan, large white chimney.	40 48 56.45	73 57 17.55	171 13 31 147 28 35	South Pier, Fort Lee... Tillietudlum Pier.......	351 13 18 327 28 09	2988.6 1745.9	3268.3 1909.3	1.86 1.08
Meeks' House.................	40 47 28.80	73 59 33.89	273 19 10 207 51 10	Number 6 Station...... Russ & Reid's Pier.....	93 19 51 27 51 27	1472.7 1269.7	1610.5 1388.5	0.92 0.79
Van Wort's House............	40 48 50.77	73 58 51.58	266 41 01 15 49 15	Switch Number 3...... Russ & Reid's Pier.....	86 41 55 195 49 04	1922.0 1461.2	2101.8 1597.9	1.19 0.91
Gomez' House.................	40 48 20.51	73 59 18.98	247 48 47 307 40 28	Switch Number 3...... Mott's Wharf..........	67 49 58 127 41 09	2765.8 1860.2	3024.6 2034.3	1.72 1.15
Arsenal Flag-staff..............	40 46 00.88	73 57 58.17	94 12 39 188 22 34	Highwood, (2)......... Receiving Reservoir....	274 10 52 8 22 39	3855.6 1337.8	4216.4 1463.0	2.40 0.83
Empire Slaughtering and Packing House.	40 45 29.42	73 59 42.60	37 38 54 131 53 28	Twenty-second st. Pier. Highwood, (2).........	217 38 31 311 52 49	1340.3 1875.6	1465.7 2051.1	0.83 1.16
Chimney, foot of Fifty-second street.	40 46 02.10	73 59 27.61	97 57 37 169 04 55	Highwood, (2)......... Guttenberg Pier........	277 56 48 349 04 44	1764.8 2055.0	1929.9 2247.3	1.10 1.28
Nash's House.................	40 46 15.22	73 58 51.20	79 15 21 142 23 38	Fifty-fifth street Pier... Guttenberg Pier........	259 14 59 322 23 03	792.6 2036.5	866.8 2227.1	0.49 1.27
Carpet Factory Chimney.......	40 45 42.59	73 59 39.74	120 02 13 31 06 38	Highwood, (2)......... Twenty-second st. Pier.	300 01 39 211 06 13	1690.3 1714.1	1848.5 1874.5	1.05 1.07
Wm. Menzies' Steam Saw-mill.	40 45 45.19	73 59 37.15	116 40 46 31 26 41	Highwood, (2)......... Twenty-second st. Pier.	296 40 04 211 26 15	1705.7 1814.3	1865.3 1984.1	1.06 1.13
Holy Apostles' Church........	40 44 55.02	73 59 37.72	98 07 19 146 51 19	Twenty-fourth st. Pier. Highwood, (2)........	278 06 56 326 50 37	816.9 2763.1	893.3 3021.6	0.51 1.72
Annunciation Church..........	40 48 59.81	73 57 02.87	3 12 14 44 29 04	Mount Prospect........ Highwood, (2).........	183 11 49 224 26 41	16189.9 7317.9	17704.8 8024.5	10.06 4.56
Dutch Reformed Church, marble steeple.	40 44 41.45	73 58 54.40	137 14 15 277 18 20	Highwood, (2)......... Betts..................	317 13 05 97 21 27	3721.5 6752.7	4069.7 7384.6	2.31 4.20
Sixty-ninth Street Belfry.......	40 46 03.94	73 57 31.44	160 39 02 92 25 13	Receiving Reservoir.... Highwood, (2).........	340 38 50 272 23 08	1302.6 4475.8	1424.5 4894.6	0.81 2.78
Zion Church, Thirty-eighth st...	40 44 57.78	73 58 33.20	282 23 42 352 02 27	Betts.................. Mount Prospect........	102 26 35 172 03 01	6348.3 8783.9	6942.3 9605.8	3.94 5.46
Mount Olivet..................	40 42 37.90	73 52 46.60	241 22 45 120 25 58	Clark.................. Highwood, (2).........	61 29 27 300 20 47	16441.8 12932.9	17980 3 14143.0	10.22 8.04
Yorkville, chimney...........	40 46 59.26	73 57 07.75	73 12 36 3 37 59	Highwood, (2)......... Mount Prospect........	253 10 16 183 37 37	5251.4 12471.3	5742.8 13638.2	3.26 7.75
Factory Chimney, above Fifty-fifth street.	40 46 45.80	73 58 53.10	119 12 47 66 39 51	Guttenberg Pier.... ... Highwood, (2)....	299 12 14 246 38 40	1373.0 2784.9	1501.5 3045.5	0.85 1.73
Melting Association Chimney...	40 44 57.30	73 57 43.46	37 18 38 359 40 55	Howard .... Mount Prospect........	217 13 51 179 40 56	17075.5 8684.7	18673.3 9497.3	10.61 5.40
Williamsburg Methodist Episcopal Church.	40 42 35.49	73 57 25.73	236 46 19 4 52 45	Betts..... .... Mount Prospect........	56 48 28 184 52 35	5520.2 4326.3	6036.7 4731.1	3.43 2.69
Williamsburg Boneblack Factory	40 42 21.91	73 57 49.44	357 13 31 236 20 57	Mount Prospect........ Betts..................	177 13 36 56 23 21	3896.5 6215.1	4261.1 6796.6	2.42 3.86
Williamsburg, St. Mary's church.	40 42 34.81	73 56 31.52	20 56 06 148 45 13	Mount Prospect........ Latting's Observatory...	200 55 21 328 43 50	4593.1 5788.5	5022.9 6330.1	2.85 3.60
Brooklyn Naval Hospital Flag-staff.	40 41 52.96	73 57 36.74	2 05 42 228 20 52	Mount Prospect........ Betts..................	182 05 39 48 23 08	3000.9 6525.5	3281.7 7136.1	1.86 4.05
Bergen Dutch Reformed Church.	40 43 34.47	74 03 44.49	246 29 20 305 41 25	Latting's Observatory.. Mount Prospect.......	66 32 39 125 45 22	7800.2 10498.5	8530.1 11480.8	4.85 6.52
Bergen Institute..............	40 44 02.60	74 02 41.10	314 49 18 248 24 23	Mount Prospect........ Latting's Observatory..	134 52 33 68 27 00	9922.4 6093.4	10850.8 6663.6	6.16 3.79

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	° ′ ″	° ′ ″	° ′ ″		° ′ ″	Metres.	Yards.	Miles.
Fiedler	40 38 03.10	74 04 34.86	193 32 03	Bergen Institute	13 33 17	11405.4	12472.6	7.09
			247 07 24	Mount Prospect	67 11 53	10538.6	11524.7	6.55
Caven Point, (2)	40 41 31.54	74 03 59.46	7 22 20	Fiedler	187 21 57	6482.3	7088.9	4.03
			284 43 21	Mount Prospect	104 47 28	9179.7	10038.6	5.70
Bedloe's Island Signal	40 41 16.78	74 02 19.39	28 03 24	Fiedler	208 10 56	6768.1	7401.4	4.20
			182 32 54	West Hoboken	2 33 02	6544.6	7157.0	4.07
Bedloe's Island Flag staff, 1855.	40 41 17.42	74 02 20.81	100 39 24	Caven Point, (2)	280 38 20	2357.0	2577.5	1.46
			286 08 54	Mount Prospect	106 11 56	6830.7	7469.9	4.24
New York and Erie Railroad Pier	40 43 02.14	74 00 34.66	146 37 49	West Hoboken	326 36 49	3937.7	4306.2	2.45
			86 47 39	Jersey City Pier	266 47 01	1381.9	1511.2	0.86
Governor's Island, (2)	40 41 31.50	74 00 33.17	300 04 43	Mount Prospect	120 06 35	4661.5	5097.7	2.90
			187 08 23	Trinity church, N. Y.	7 08 29	1685.8	1843.5	1.05
Ford's Pier	40 41 41.09	73 59 47.21	74 39 33	Governor's Island, (2).	254 39 03	1118.6	1223.3	0.69
			147 44 21	Trinity church, N. Y.	327 43 57	1628.1	1780.4	1.01
Pier 10	40 42 03.93	74 00 07.78	325 34 16	Ford's Pier	145 34 29	854.0	933.9	0.53
			30 46 52	Governor's Island, (2)	210 46 35	1164.5	1273.5	0.72
Fulton Ferry Pier	40 42 11.89	73 59 22.79	31 07 12	Ford's Pier	211 06 56	1109.5	1213.3	0.69
			76 55 57	Pier 10	256 55 28	1084.1	1185.5	0.67
Pier 15	40 42 08.81	74 00 00.10	263 48 22	Fulton Ferry Pier	83 48 46	881.1	963.5	0.55
			340 30 39	Ford's Pier	160 30 47	906.8	991.6	0.56
Tenth Street Pier	40 43 22.80	73 58 02.76	304 38 21	St. Mary's ch., Willmsb'g	124 39 20	2602.9	2846.4	1.62
			355 01 53	Mount Prospect	175 02 07	5791.7	6333.6	3.60
St. Peter and St. Paul church	40 42 47.19	73 57 35.93	1 34 45	Mount Prospect	181 34 41	4673.5	5110.8	2.90
			241 15 15	Betts	61 17 30	5539.4	6057.7	3.44
Pier 55	40 42 42.13	73 58 14.57	260 14 33	St. Peter and St. Paul ch.	80 14 58	920.2	1006.3	0.57
			350 12 51	Mount Prospect	170 13 13	4582.3	5011.1	2.86
Brooklyn City Hall	40 41 31.26	73 59 06.55	319 21 28	Mount Prospect	139 22 23	3069.8	3357.0	1.91
			209 09 45	Pier 55	29 10 19	2503.6	2737.9	1.56
Seventeenth Street Bulkhead	40 43 42.31	73 57 58.93	315 24 40	St. Mary's ch., Willmsb'g	135 25 37	2922.4	3195.8	1.81
			356 18 16	Mount Prospect	176 18 27	6384.8	6982.2	3.97
Brooklyn Gas Company	40 42 18.42	73 58 26.48	233 12 19	St. Peter and St. Paul ch.	53 12 52	1481.6	1620.2	0.92
			200 54 59	Pier 55	20 55 07	783.0	856.3	0.49
Peck Slip Ferry	40 42 35.15	73 57 54.23	55 42 42	Brooklyn Gas Company.	235 42 21	916.1	1001.8	0.57
			114 16 48	Pier 55	294 16 35	523.6	572.6	0.33
Holy Redeemer church	40 43 21.80	73 58 45.58	239 58 07	17th Street Bulkhead	59 58 37	1264.4	1382.7	0.78
			65 14 53	Caven Point, (2)	245 11 28	8114.3	8873.6	5.04
North Eighth Street Pier	40 43 17.99	73 57 30.60	93 49 31	Holy Redeemer church.	273 48 42	1763.4	1928.4	1.10
			138 27 35	17th Street Bulkhead	318 27 17	1002.3	1096.1	0.62
Conover, (2)	40 44 10.89	73 55 30.87	267 34 41	Betts	87 35 35	1924.7	2104.8	1.20
			22 54 48	Mount Prospect	202 53 23	7873.9	8610.7	4.89
Blackwell's Island, (2).	40 45 02.41	73 57 16.41	302 40 54	Conover, (2)	122 42 03	2941.9	3217.2	1.83
			3 47 54	Mount Prospect	183 47 38	8861.6	9690.8	5.51
Twenty-eighth Street Pier	40 44 17.67	73 58 07.39	220 54 36	Blackwell's Island, (2).	40 55 09	1826.0	1996.9	1.13
			273 14 40	Conover, (2)	93 16 22	3678.1	4022.3	2.28
Grace church	40 43 52.67	73 59 09.64	152 53 11	Highwood, (2)	332 52 11	4759.8	5205.2	2.96
			199 30 54	Receiving Reservoir	19 31 46	5599.7	6123.7	3.48
Hunter's Point Bulkhead	40 44 35.90	73 57 13.65	65 57 45	28th Street Pier	245 57 10	1380.5	1509.7	0.86
			175 28 17	Blackwell's Island, (2).	355 28 15	820.0	896.7	0.51
Wetmore's Wharf	40 42 16.88	73 59 01.19	190 21 48	Holy Redeemer church.	10 21 58	2035.7	2226.2	1.26
			250 16 29	Peck Slip Ferry	70 17 13	1669.6	1825.8	1.04
Pier 45	40 42 29.49	73 59 00.42	2 40 29	Wetmore's Wharf	182 40 29	389.4	425.8	0.24
			263 35 28	Peck Slip Ferry	83 36 11	1563.2	1709.5	0.97
Pier 29	40 42 22.68	73 59 35.86	255 49 50	Pier 45	75 50 13	858.3	938.6	0.53
			282 23 42	Wetmore's Wharf	102 24 05	833.2	911.2	0.52
Shot Tower	40 45 16.06	73 57 25.93	27 47 27	28th Street Pier	207 47 01	2035.7	2226.2	1.27
			329 37 28	Blackwell's Island, (2).	149 37 35	488.1	533.8	0.30
Marston and Powers' Pier	40 42 14.17	73 59 14.63	255 08 36	Wetmore's Wharf	75 08 45	326.3	356.8	0.20
			215 12 38	Pier 45	35 12 47	578.5	632.6	0.36
Brooklyn Pilgrim church	40 41 36.45	73 59 21.45	166 40 02	Pier 29	346 39 53	1465.9	1603.1	0.91
			217 45 54	Pier 55	37 46 38	2562.4	2802.2	1.59
South Battery on Governor's Island.	40 41 13.99	74 00 37.04	293 31 42	Mount Prospect	113 33 37	4498.8	4919.7	2.79
			43 30 50	Fiedler	223 28 15	8115.8	8875.2	5.04

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	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Atlantic Dock	40 49 44.88	74 00 49.81	115 04 48	Bedloe's Island	295 03 50	2322.2	2530.5	1.44
			198 27 54	South Battery	18 28 02	946.6	1035.2	0.59
Jersey City Gas chimney	40 43 28.13	74 62 03.33	178 01 08	West Hoboken	358 01 06	2488.3	2721.1	1.55
			313 57 36	Mount Prospect	134 00 27	8545.3	9344.9	5.31
Gowanes, cupola	40 39 36.59	73 59 15.90	241 26 31	Mount Prospect	61 27 33	2526.3	2762.7	1.58
			118 03 35	Caven Point, (2)	298 00 30	7543.9	8249.8	4.69
Green Point	40 43 50.75	73 57 07.07	6 55 59	Mount Prospect	186 55 27	6680.6	7305.7	4.15
			254 35 57	Conover, (2)	74 37 00	2341.0	2560.0	1.45
St. Paul's church	40 42 38.41	74 00 15.22	68 37 40	Caven Point, (2)	248 35 14	5653.6	6182.6	3.51
			127 11 43	Bergen Institute	307 10 08	4296.5	4698.5	2.67
House of Refuge	40 47 35.78	73 55 17.93	274 08 43	Clark	94 17 04	18028.2	19715.1	11.20
			47 29 45	Latting's Observatory	227 27 33	6414.2	7014.4	3.98
Constable Point, (2)	40 39 14.16	74 05 08.50	200 55 57	Caven Point, 2	20 56 42	4536.7	4961.2	2.82
			259 42 36	Mount Prospect	79 47 27	10671.3	11669.9	6.63
Cazet	40 37 35.41	74 05 04.05	189 34 03	Bergen Dutch Ref. ch.	9 34 55	11230.7	12281.6	6.98
			212 26 33	Latting's Observatory	32 30 44	16812.0	18385.1	10.45
Pavilion Rockaway	40 35 44.78	73 44 55.51	136 55 44	Cypress Hill	316 51 02	14864.9	16255.7	9.23
			114 58 41	Mount Prospect	294 50 22	19841.7	21698.3	12.33
Coney Island, East, (1855)	40 34 36.23	73 56 01.26	262 14 52	Pavilion Rockaway	82 22 05	15796.4	17274.5	9.81
			202 53 57	Cypress Hill	22 56 29	14077.9	15395.3	8.75
Jersey City Reservoir	40 44 25.77	74 03 19.38	10 59 53	Cazet	190 58 45	12893.2	14099.5	8.01
			314 09 38	Mount Prospect	131 13 18	11063.9	12099.2	6.87
Lentz	40 42 46.39	74 07 59.91	336 41 15	Cazet	156 43 10	10442.8	11420.0	6.49
			256 04 53	Bergen Dutch Ref. ch.	76 07 40	6174.5	6752.3	3.84
Elizabeth Port Hotel	40 38 49.99	74 10 46.78	285 54 38	Cazet	105 58 21	8374.8	9158.4	5.20
			225 21 43	Jersey City Reservoir	45 26 35	14750.3	16130.5	9.16
Blazing Star	40 34 57.78	74 12 25.51	244 51 23	Cazet	64 56 10	11460.2	12532.5	7.12
			197 56 33	Elizabeth Port Hotel	17 57 37	7529.1	8233.6	4.68
Miller	40 36 27.17	74 12 49.83	348 16 35	Blazing Star	168 16 51	2815.6	3079.1	1.75
			259 04 32	Cazet	79 09 35	11147.7	12190.6	6.92
Elizabeth Port Signal	40 39 01.29	74 10 22.12	36 09 04	Miller	216 07 27	5885.8	6436.6	3.66
			227 53 54	Bergen Dutch Ref. ch.	47 58 13	12575.3	13752.1	7.81
Frost	40 33 38.62	74 10 47.79	180 08 32	Elizabeth Port Hotel	0 08 33	9603.4	10501.9	5.97
			151 06 41	Miller	331 05 22	5938.0	6493.7	3.69
Meissner	40 35 38.18	74 07 39.98	101 44 44	Miller	281 41 22	7439.3	8135.4	4.62
			79 30 33	Blazing Star	259 27 27	6828.1	7467.0	4.24
Braisted	40 34 57.68	74 12 46.34	201 24 18	Elizabeth Port Hotel	21 25 36	7695.6	8415.7	4.78
			178 17 35	Miller	358 17 33	2761.3	3019.7	1.72
Elizabethtown Presbyterian ch.	40 39 42.83	74 12 37.07	290 13 30	Cazet	110 18 25	11345.5	12407.0	7.05
			302 09 40	Elizabeth Port Hotel	122 10 52	3060.5	3346.9	1.90
Brooker's house	40 35 48.07	74 06 50.76	54 24 36	Frost	234 22 02	6856.3	7497.9	4.26
			75 14 34	Meissner	255 14 02	1197.0	1309.0	0.74
Bird, (2.)	40 39 08.64	74 10 08.12	291 53 37	Cazet	111 56 55	7701.1	8421.7	4.79
			57 38 46	Elizabeth Port Hotel	237 38 31	1075.0	1175.6	0.67
Bergen Point	40 38 37.87	74 08 20.85	110 38 31	Bird, (2)	290 37 21	2693.0	2945.0	1.67
			108 26 00	Elizabethtown Pres. ch.	288 23 13	6343.4	6937.0	3.94
Fort Hill, (1)	40 34 21.46	74 08 58.99	62 42 00	Frost	242 40 49	2880.0	3149.5	1.79
			103 00 28	Blazing Star	282 58 14	4984.2	5450.7	3.10
Fort Hill, (2)	40 34 21.60	74 08 58.85	62 38 53	Frost	242 37 42	2885.3	3155.3	1.79
			101 46 42	Braisted	281 44 14	5464.3	5975.6	3.40
Hancock	40 35 01.60	74 11 41.96	85 27 40	Braisted	265 26.58	1519.1	1661.3	0.94
			83 24 22	Blazing Star	263 23.54	1030.4	1126.8	0.64
Cortelyou	40 33 13.83	74 69 21.26	110 35 35	Frost	290 34 39	2174.4	2377.9	1.35
			194 09 10	Fort Hill, (2)	14 09 25	2156.1	2357.9	1.34
Vanderbilt	40 35 29.35	74 13 05.53	191 41 04	Miller	11 41 14	1821.3	1991.7	1.13
			293 32 03	Hancock	113 32 57	2143.8	2344.4	1.33
Chelsea	40 36 09.53	74 11 25.40	62 14 43	Vanderbilt	242 13 38	2660.4	2909.4	1.65
			105 20 22	Miller	285 19 27	2058.2	2250.8	1.28
Old Places, red flag	40 37 55.01	74 11 04.21	42 30 32	Miller	222 29 23	3675.2	4019.1	2.28
			193 34 54	Elizabeth Port Hotel	13 35 05	1741.6	1907.9	1.08
Brickkiln Point	40 38 23.14	74 11 28.86	279 12 30	Cazet	99 16 41	9161.0	10018.1	5.69
			230 01 44	Elizabeth Port Hotel	50 02 11	1290.0	1410.7	0.80

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of New York. Sketch No. 11.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Brick Yard	40 38 09.39	74 11 50.07	276 14 12	Cazet	96 18 36	9597.3	10495.4	5.96
			292 20 00	Old Places, red flag	112 20 30	1165.7	1274.8	0.72
Toad Hill, (2)	40 38 05.23	74 06 39.84	218 58 32	Cazet	38 59 34	3578.5	3913.4	2.22
			136 08 00	Elizabeth Port Signal	316 05 35	7534.9	8240.0	4.68
Lutheran Cemetery	40 42 37.94	73 52 46.54	57 39 56	Mount Prospect	237 36 44	8195.2	8962.0	5.09
			334 23 32	Cypress Hill	154 23 57	2097.2	2293 5	1.30
Fort Independence	40 52 51.50	73 54 35.24	303 02 27	Clark	123 10 21	20255.7	22151.0	12.59
			350 33 29	Cypress Hill	170 35 35	21100.3	23074.6	13.11
Van Dyne, (2)	40 43 33.93	73 50 53.49	56 56 48	Lutheran Cemetery	236 55 34	3165.3	3461.5	1.97
			25 46 44	Cypress Hill	205 45 55	4018.8	4394.9	2.50
Howard, (2)	40 43 39.47	73 52 18.00	274 55.00	Van Dyne, (2)	94 55 55	1990.4	2176.7	1.24
			356 25.31	Cypress Hill	176 25 38	3796.3	4151.5	2.36
Mitchell	40 43 02.75	73 48 45.76	107 48 07	Van Dyne, (2)	287 46 44	3148.0	3442.5	1.96
			82 18 40	Lutheran Cemetery	262 16 03	5702.3	6235.9	3.54
Valentine, (3)	40 44 33.87	73 44 25.71	81 25 59	Howard, (2)	261 20 51	11207.0	12255 6	6.96
			73 07 19	Lutheran Cemetery	253 01 52	12283.5	13432.9	7.63
Lawrence, (2)	40 45 13.70	73 46 59.66	288 46 32	Valentine, (3)	108 48 12	3814.5	4171.4	2.37
			59 28 39	Lutheran Cemetery	239 24 53	9450.8	10335.2	5.87
Duryea	40 44 37.38	73 47 29.57	212 03 17	Lawrence, (2)	32 03 36	1322.0	1445.7	0.82
			271 25 12	Valentine, (3)	91 27 12	4314.6	4718.3	2.68
Smith	40 42 46.95	73 47 58.42	196 55 30	Lawrence, (2)	16 56 08	4731.3	5174.0	2.94
			104 55 01	Howard, (2)	284 52 12	6302.3	6892.0	3.92

Section III.—York River. Sketch No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
York River.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Thoroughfare	37 13 20.67	76 24 58.63	....	....	....	....	....	....
Hog Island	37 15 47.73	76 22 44.68	....	....	....	....	....	....
Quarter Point	37 14 55.55	76 27 29.04	308 15 34	Thoroughfare	128 17 05	4721.9	5163.7	2.93
			257 02 49	Hog Island	77 05 41	7188.7	7861.4	4.47
Selby's Point	37 12 54.68	76 28 04.26	193 06 53	Quarter Point	13 07 14	3825.7	4183.7	2.38
			260 03 15	Thoroughfare	80 05 07	4645.8	5080.5	2.89
York Town	37 14 05.56	76 30 09.89	248 44 30	Quarter Point	68 46 07	4253.2	4651.2	2.64
			305 11 35	Selby's Point	125 12 51	3789.8	4144.4	2.35
Dobbs	37 15 10.32	76 29 23.71	29 41 17	York Town	209 40 49	2298.0	2513.0	1.43
			334 53 54	Selby's Point	154 54 42	4617.0	5049.0	2.87
Billups	37 15 36.84	76 30 12.65	358 36 58	York Town	178 37 00	2814.7	3078.1	1.75
			304 07 50	Dobbs	124 08 20	1456.7	1593.0	0.91
Stony Point	37 14 57.48	76 31 45.54	242 03 46	Billups	62 04 42	2590.7	2833.1	1.61
			304 09 57	York Town	124 10 55	2849.2	3115.8	1.77
Carmines	37 16 53.13	76 31 49.58	358 24 14	Stony Point	178 24 16	3566.6	3900.3	2.22
			314 33 23	Billups	134 34 22	3351.5	3665.1	2.08
Sandy Point	37 16 02.47	76 32 51.04	224 06 32	Carmines	44 07 09	2175.3	2378.9	1.35
			321 08 28	Stony Point	141 09 08	2572.6	2813.3	1.60
Green Point	37 17 48.24	76 33 12.30	350 52 38	Sandy Point	170 52 51	3302.2	3611.2	2.05
			309 48 52	Carmines	129 49 42	2652.6	2900.8	1.65
King's Creek	37 16 57.34	76 34 51.65	237 19 21	Green Point	57 20 21	2906.9	3178.9	1.81
			299 38 32	Sandy Point	119 39 45	3418.8	3738.7	2.12
Rosewell	37 19 33.10	76 35 05.08	356 03 35	King's Creek	176 03 43	4812.8	5263.1	2.99
			319 19 29	Green Point	139 20 37	4261.4	4660.1	2.65
Waller	37 18 23.43	76 36 46.59	229 19 01	Rosewell	49 20 03	3295.0	3603.3	2.05
			313 08 47	King's Creek	133 09 57	3880.0	4243.1	2.41
Clay Bank	37 21 02.27	76 36 20.93	7 21 12	Waller	187 20 56	4936.9	5398.8	3.07
			325 48 44	Rosewell	145 49 30	3322.7	3633.6	2.06
Bigler's Mill	37 20 14.64	76 38 19.83	243 20 34	Clay Bank	63 21 46	3274.0	3580.3	2.03
			326 11 06	Waller	146 12 03	4125.5	4511.5	2.56

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section III.—York River. Sketch No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Ferry Point	37 21 55.27	76 39 21.31	290 11 27	Clay Bank	110 13 16	4729.6	5172.2	2.94
			333 59 39	Bigler's Mill	154 00 16	3451.3	3774.2	2.15
Russell	37 23 34.20	76 38 53.48	12 39 18	Ferry Point	192 39 01	3125.5	3418.0	1.94
			321 16 42	Clay Bank	141 18 15	6001.5	6563.1	3 73
Moody's Wharf	37 24 09.93	76 41 27.39	286 12 41	Russell	106 14 14	3942.0	4310.9	2.[illegible]
			323 13 33	Ferry Point	143 14 50	5181.5	5666.3	3.[illegible]
Purtan Island	37 24 58.24	76 40 39.73	38 12 10	Moody's Wharf	218 11 41	1895.2	2072.6	1.18
			314 45 00	Russell	134 46 04	3679.4	4023.7	2.29
Holt	37 25 52.83	76 41 34.87	356 40 46	Moody's Wharf	176 40 50	3177.5	3474.8	1.97
			321 08 19	Purtan Island	141 08 53	2161.0	2363.2	1.34
Richardson	37 25 12.16	76 42 46.33	234 28 36	Holt	54 29 19	2158.3	2360.3	1.34
			314 39 21	Moody's Wharf	134 40 09	2729.1	2984.5	1.70
Mount Folly	37 26 05.34	76 43 57.92	312 57 47	Richardson	132 58 31	2405.4	2630.5	1.50
			276 14 48	Holt	96 16 15	3537.5	3868.5	2.20
Roane, (1)	37 27 05.74	76 42 50.72	41 34 55	Mount Folly	221 34 14	2488.9	2721.8	1.55
			358 13 59	Richardson	178 14 02	3503.1	3830.9	2.18
Terrapin Point	37 27 58.89	76 45 27.00	327 58 13	Mount Folly	147 59 07	4128.5	4514.8	2.56
			293 05 32	Roane, (1)	113 07 07	4175.2	4565.9	2.59
Roane, (2)	37 27 22.65	76 43 02.85	107 31 03	Terrapin Point	287 29 35	3714.2	4061.7	2.31
			29 36 03	Mount Folly	209 35 30	2740.7	2997.2	1.70
Anderson	37 29 19.07	76 44 11.67	36 49 58	Terrapin Point	216 49 12	3087.4	3376.3	1.92
			334 45 51	Roane, (2)	154 46 33	3967.0	4338.2	2.46
Goff's Point	37 30 41.32	76 46 28.79	306 58 02	Anderson	126 59 25	4215.5	4610.0	2.62
			343 07 51	Terrapin Point	163 08 29	5232.0	5721.6	3.25
Fillbates	37 29 22.05	76 46 39.68	186 14 42	Goff's Point	6 14 49	2458.4	2688.4	1.53
			271 26 07	Anderson	91 27 37	3636.8	3977.1	2.26
Brick house	37 30 41.53	76 47 59.12	270 09 13	Goff's Point	90 10 08	2218.1	2425.7	1.38
			321 27 50	Fillbates	141 28 36	3131.9	3425.0	1.95
West Point	37 31 41.28	76 47 23.60	323 56 16	Goff's Point	143 56 49	2286.4	2500.3	1.42
			25 20 03	Brick house	205 19 41	2038.1	2228.8	1.27
Brooks	37 31 43.25	76 46 37.87	86 54 36	West Point	266 54 08	1124.4	1229.7	0.70
			353 20 21	Goff's Point	173 20 26	1922.1	2102.0	1.19
Glass Island	37 32 31.63	76 47 08.54	333 12 41	Brooks	153 13 00	1670.6	1826.9	1.04
			13 24 06	West Point	193 23 57	1595.5	1744.8	0.99
Taylor's Quarter	37 33 09.94	76 49 03.20	341 01 08	Brick house	161 01 47	4838.0	5290.7	3.01
			318 10 36	West Point	138 11 37	3656.8	4009.9	2.28

Section IV.—Seacoast of Virginia and North Carolina. Sketch No. 25.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
Seacoast south of Cape Henry to Bodies Island.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Cape Henry Light-house	36 55 28.58	76 00 11.56						
Cape Henry Light-house, eccentric.	36 55 28.53	76 00 11.63						
Pleasure House Point	36 55 23.35	76 08 05.43						
Brock	36 52 19.97	76 01 10.77	194 08 11	Cape Henry Light-house, eccentric.	14 08 46	5992.9	6553.6	3.73
			118 52 12	Pleasure House Point	298 48 03	11718.1	12814.6	7.28
Mink Hill	36 52 53.96	75 58 56.47	158 40 29	Cape Henry Light-house, eccentric.	338 39 44	5114.3	5592.8	3.18
			72 31 49	Brock	252 30 28	3486.6	3812.8	2.17
Rainey, (2)	36 51 10.28	75 58 14.36	116 11 59	Brock	296 10 13	4869.0	5324.6	3.02
			161 55 46	Mink Hill	341 55 21	3361.8	3676.4	2.09
James	36 48 50.59	76 00 05.21	165 52 44	Brock	345 52 05	6655.2	7277.9	4.13
			212 31 28	Rainey, (2)	32 32 34	5106.8	5584.6	3.17
Lovett	36 48 03.28	75 57 26.53	168 23 04	Rainey, (2)	348 22 35	5884.3	6434.9	3.66
			110 21 28	James	290 19 53	4194.5	4586.9	2.60

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section IV.—Seacoast of Virginia and North Carolina. Sketch No. 25.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ″ ′	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Malbon	36 46 31.88	75 59 18.28	164 47 01	James	344 46 33	4431.1	4845.7	2.75
			224 30 33	Lovett	44 31 40	3951.3	4321.1	2.45
Bonney	36 45 32.93	75 56 35.60	164 45 40	Lovett	344 45 10	4803.3	5252.7	2.98
			114 15 33	Malbon	294 13 56	4424.5	4838.5	2.75
Green Branch	36 43 46.66	75 58 01.79	159 34 25	Malbon	339 33 39	5434.2	5942.7	3.38
			213 07 43	Bonney	33 08 35	3911.4	4277.4	2.43
Deep Ditch	36 43 25.53	75 55 42.92	161 35 53	Bonney	341 35 22	4138.6	4525.8	2.57
			100 43 10	Green Branch	280 41 47	3506.7	3834.8	2.18
Ship's Marsh	36 41 16.51	75 57 15.14	165 57 31	Green Branch	345 57 03	4770.9	5217.3	2.96
			209 54 47	Deep Ditch	29 55 42	4588.3	5017.6	2.85
Little Island	36 40 42.85	75 54 28.63	159 49 04	Deep Ditch	339 48 20	5342.3	5842.2	3.32
			104 06 05	Ship's Marsh	284 04 26	4261.6	4660.4	2.64
Little Narrow	36 38 46.68	75 56 19.04	163 13 14	Ship's Marsh	343 12 41	4823.3	5274.6	3.00
			217 25 59	Little Island	37 27 05	4509.6	4931.6	2.80
Wash Flat	36 38 07.84	75 53 20.05	160 23 07	Little Island	340 22 26	5072.1	5546.7	3.16
			105 05 05	Little Narrow	285 03 18	4604.3	5035.1	2.86
Ragged Island	36 36 36.50	75 55 26.40	161 57 02	Little Narrow	341 56 31	4220.4	4615.3	2.62
			228 05 54	Wash Flat	48 07 10	4216.7	4611.3	2.61
Wash Hill	36 35 51.67	75 52 36.50	165 32 46	Wash Flat	345 32 20	4334.3	4739.8	2.69
			108 07 59	Ragged Island	288 06 18	4442.3	4857.9	2.76
North End, Knott Island	36 33 53.28	75 54 59.99	172 34 01	Ragged Island	352 33 54	5073.3	5548.1	3.16
			224 20 07	Wash Hill	44 21 33	5102.8	5580.3	3.17
Sheep-house	36 33 40.81	75 52 16.03	172 48 47	Wash Hill	352 48 35	4065.3	4445.7	2.52
			95 23 51	North End Knott Island	275 22 13	4094.6	4477.7	2.54
Cason's Point	36 31 27.37	75 54 20.40	167 39 09	North End Knott Island	347 38 45	4603.6	5034.4	2.86
			216 56 00	Sheep-house	36 57 14	5146.0	5627.5	3.20
Fresh Pond	36 30 01.32	75 51 22.44	168 51 26	Sheep-house	348 50 54	6895.4	7540.6	4.29
			120 56 22	Cason's Point	300 54 36	5161.2	5644.1	3.21
Smith's Place	36 29 12.13	75 54 41.29	187 06 20	Cason's Point	367 06 32	4200.8	4593.9	2.61
			252 57 00	Fresh Pond	72 58 58	5175.5	5659.8	3.21
Penny's Hill, (2)	36 28 02.76	75 50 51.62	168 08 49	Fresh Pond	348 08 31	3733.6	4083.0	2.32
			110 31 26	Smith's Place	290 29 10	6103.3	6674.4	3.79
Gray's Point	36 24 31.27	75 54 56.89	182 34 12	Smith's Place	2 34 21	8665.1	9475.9	5.39
			223 07 07	Penny's Hill, (2)	43 09 33	8933.1	9769.0	5.55
Jones' Hill	36 23 35.43	75 49 30.36	166 12 25	Penny's Hill, (2)	346 11 37	8484.4	9278.3	5.27
			101 58 17	Gray's Point	281 55 03	8315.7	9093.8	5.17
Wood-house	36 19 05.86	75 53 27.16	167 26 05	Gray's Point	347 25 12	10275.7	11237.2	6.38
			215 22 34	Jones' Hill	35 24 54	10192.0	11145.7	6.33
Poyner's Hill	36 18 17.19	75 48 05.22	167 47 42	Jones' Hill	347 46 52	10035.2	10974.1	6.23
			100 36 21	Wood-house	280 33 10	8169.3	8933.7	5.08
Poke Point	36 13 03.71	75 50 47.13	160 19 26	Wood-house	340 17 51	11854.4	12963.6	7.36
			202 41 08	Poyner's Hill	22 42 44	10472.6	11452.5	6.51
North Banks	36 11 48.33	75 45 21.50	161 11 00	Poyner's Hill	341 09 23	12662.3	13847.1	7.87
			105 58 05	Poke Point	285 54 53	8458.6	9250.1	5.26
Thoroughfare	36 09 34.60	75 48 32.87	152 31 01	Poke Point	332 29 42	7265.4	7945.2	4.51
			229 13 26	North Banks	49 15 19	6312.9	6903.6	3.92
Martin's Point	36 07 27.91	75 44 50.24	174 26 32	North Banks	354 26 14	8064.1	8818.6	5.01
			125 04 13	Thoroughfare	305 02 01	6798.4	7434.5	4.22
Sampson's Point	36 04 45.37	75 47 07.52	166 32 29	Thoroughfare	346 31 39	9165.9	10023.5	5.69
			214 26 55	Martin's Point	34 26 16	6073.1	6641.4	3.77
Shell Bank	36 03 17.23	75 44 08.47	172 18 10	Martin's Point	352 17 45	7796.1	8525.6	4.84
			121 14 41	Sampson's Point	301 12 56	5239.1	5729.3	3.26
Roberts' Fishery	35 56 02.36	75 46 40.39	177 35 20	Sampson's Point	357 35 04	16132.5	17642.0	10.02
			195 50 10	Shell Bank	15 51 39	13931.4	15235.0	8.65
Mann's Point	35 58 10.73	75 39 42.60	*144 50 48	Shell Bank	324 48 12	11556.0	12637.3	7.18
			69 19 59	Roberts' Fishery	249 15 54	11191.3	12238.5	6.95
Roanoke Marshes	35 48 40.87	75 41 46.60	151 35 02	Roberts' Fishery	331 32 10	15473.3	16921.2	9.61
			190 01 50	Mann's Point	10 03 03	17835.1	19503.9	11.08
Bodies Island base, north end	35 53 52.85	75 35 33.52	141 52 16	Mann's Point	321 49 50	10106.2	11051.8	6.28
			44 15 42	Roanoke Marshes	224 12 03	13418.0	14673.5	8.34
Bodies Island base, south end	35 48 30 32	75 32 40.98	91 24 18	Roanoke Marshes	271 18 59	13700.3	14982.3	8.51
			156 28 46	Bodies Isl'd base, N. end	336 27 07	10841.5	11855.9	6.74

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section IV.—Seacoast of Virginia and North Carolina. Sketch No. 25.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Bodies Island, astronomical station.	35 47 27.58	75 31 38.90	153 38 42	Bodies Island, N. end..	333 36 25	13252.3	14492.3	8.24
			98 28 13	Roanoke Marshes......	278 22 17	15422.7	16865.8	9.58
Lime Wreck	36 53 13.55	75 58 49.98	14 54 49	Mink Hill..............	194 54 45	624.5	682.9	0.39
			346 55 31	Rainey, (2)............	166 55 52	3900.4	4265.4	2.42
Digg's Hill.....................	36 53 47.46	75 59 16.36	327 59 53	Lime Wreck...........	148 00 09	1231.7	1346.9	0.76
			343 22 34	Mink Hill..............	163 22 46	1719.9	1880.8	1.07
Barrel.........................	36 54 45.32	75 59 19.66	357 22 23	Digg's Hill.............	177 22 25	1784.5	1951.5	1.10
			345 26 09	Lime Wreck..........	165 26 27	2921.0	3194.3	1.82
Cape Henry East................	36 55 11.99	76 00 01.10	308 42 29	Barrel.................	128 42 54	1314.3	1437.3	0.82
			336 57 44	Digg's Hill............	156 58 11	2830.3	3095.1	1.76
Tidal station........	36 55 43.13	76 00 16.55	344 35 16	Cape Henry Light.... .	164 35 19	464.7	508.2	0.29
			338 16 14	Cape Henry East.......	158 16 23	1032.4	1128.9	0.64
Cape Henry West, (1)..........	36 55 33.86	76 01 19.34	129 24 12	Back River Point	309 15 25	27951.9	30567.0	17.37
			186 37 08	Costin..................	6 38 27	27974.4	30591.5	17.38
Cape Henry West, (2)..........	36 55 32.82	76 01 18.65	258 18 13	Tidal Station..........	78 18 50	1569.1	1715.9	0.96
			288 28 08	Cape Henry East.	108 28 55	2023.1	2212.4	1.26
Moore's (A.) Windmill	36 46 55.28	75 57 20.23	336 26 07	Bonney	156 26 34	2769.1	3028.2	1.72
			175 44 27	Lovett.................	355 44 23	2101.8	2198.5	1.31
Malbon's Windmill	36 46 59.53	75 57 17.97	338 30 37	Bonney................	158 31 02	2868.6	3137.1	1.78
			173 50 09	Lovett............... .	353 50 04	1976.5	2161.4	1.23
Whitehurst Windmill..........	36 44 47.36	75 56 37.61	182 02 23	Bonney................	2 02 24	1405.4	1536.9	0.87
			331 43 01	Deep Ditch............	151 43 34	2864.4	3132.4	1.78
Sand Bridge Windmill..........	36 44 35.52	75 56 30.65	176 02 23	Bonney................	356 02 20	1774.0	1939.9	1.10
			331 13 38	Deep Ditch............	151 14 08	2461.1	2691.4	1.53
Piney Point Windmill..........	36 42 20.26	75 57 57.37	331 55 10	Ship's Marsh	151 55 35	2227.3	2435.7	1.38
			238 54 12	Deep Ditch	58 55 33	3896.9	4261.5	2.42
Hill's Landing................	36 39 18.97	75 58 27.29	287 20 29	Little Narrow..........	107 21 46	3336.9	3649.2	2.07
			206 18 28	Ship's Marsh	26 19 11	4041.3	4419.4	2.51
Morris Point..................	36 37 51.65	75 58 59.77	293 34 59	Ragged Island..........	113 37 07	5785.4	6226.7	3.59
			246 58 00	Little Narrow..........	66 59 36	4338.0	4743.9	2.69
Cedar Island.............. ..	36 36 04.44	75 55 15.36	275 42 51	Wash Hill.............	95 41 25	3943.1	4311.9	2.45
			354 56 46	North End, Knott Island	174 56 55	4058.4	4438.2	2.52
Miller's Fishery, house.........	36 31 38.30	75 51 42.79	350 22 42	Fresh Pond............	170 22 54	3031.8	3315.5	1.88
			85 06 14	Cason's Point.........	255 04 41	3934.6	4302.7	2.44
Dunton.......................	36 26 19.53	75 50 08.28	349 25 01	Jones' Hill............	169 25 24	5145.2	5626.6	3.20
			65 07 32	Gray's Point...........	245 04 41	7925.3	8666.8	4.92
Penny's Hill, (1)...............	36 28 03.97	75 50 51.58	346 15 39	Jones' Hill............	166 16 21	8521.0	9318.3	5.29
			110 11 41	Smith's Place..........	290 09 30	6091.1	6661.1	3.78
Duck Point.....................	36 25 40.93	75 55 29.69	190 29 06	Smith's Place..........	10 29 37	6620.0	7239.4	4.12
			237 29 42	Penny's Hill, (1)	57 32 24	8209.0	8977.1	5.11
Halfway.......................	36 28 56.85	75 58 17.90	278 18 32	Penny's Hill, (1).......	98 22 57	11228.2	12278.8	6.97
			325 14 33	Duck Point....	145 16 14	7348.6	8036.2	4.56
Parker, (P.)	36 26 28.94	76 00 04.11	282 11 35	Duck Point............	102 14 18	6992.7	7647.0	4.34
			210 06 20	Halfway	30 07 23	5270.2	5763.3	3.27
Baxter, (Th.)	36 29 20.65	76 01 43.16	278 09 13	Halfway	98 11 15	5160.9	5643.8	3.21
			335 00 37	Parker, (P.)...........	155 01 36	5838.5	6384.8	3.63
Mackey's Island...............	36 29 40.96	75 59 03.50	14 18 26	Parker, (P.)...........	194 17 50	6107.7	6679.2	3 79
			81 03 30	Baxter, (Th.)..........	261 01 55	4022.3	4408.7	2.49
Peter's Quarter................	36 20 25.00	75 48 51.28	343 44 02	Poyner's Hill	163 44 29	4103.4	4487.4	2.55
			70 29 57	Wood-house...........	250 27 13	7299.5	7982.4	4.53
Jonathan's Creek	36 22 04.14	75 55 08.95	335 11 54	Wood-house...........	155 12 54	6052.5	6618.8	3.76
			303 28 06	Poyner's Hill	123 32 17	12671.3	13856.9	7.87
Baum's (A.) Chimney.........	36 17 01.80	75 47 50.31	338 57 08	North Banks...........	158 58 36	10351.3	11319.8	6.43
			31 02 36	Poke Point............	211 00 51	8563.0	9364.3	5.32
Baum's Windmill..............	36 15 32.36	75 47 08.82	338 46 36	North Banks...........	158 47 40	7406.3	8099.3	4.61
			49 58 05	Poke Point	229 55 56	7120.0	7786.2	4.42
Lindsay	36 16 59.29	75 52 30.72	250 03 15	Poyner's Hill	70 05 52	7046.0	7705.3	4.38
			160 09 25	Wood-house...........	340 08 52	4147.2	4535.3	2.57
Rattlesnake Island...	36 15 26.43	75 51 03.50	308 10 40	North Banks..	128 14 03	10868.0	11884.9	6.75
			220 11 36	Poyner's Hill	40 13 20	6891.4	7535.3	4.28
Jew's Quarter..................	36 11 18.78	75 49 30.21	335 56 59	Thoroughfare..........	155 57 33	3516.2	3845.2	2.18
			261 38 30	North Banks...........	81 40 57	6279.6	6867.2	3.90

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section IV.—Seacoast of Virginia and North Carolina. Sketch No. 25.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Hog Quarter, windmill..........	36 07 15.62	75 48 16.08	265 46 32 174 24 18	Martin's Point.......... Thoroughfare..........	85 48 33 354 24 09	5160.9 4303.6	5643.8 4706.3	3.21 2.67
Pig Point.....	36 06 44.55	75 47 32.74	350 15 05 251 47 05	Sampson's Point....... Martin's Point..........	170 15 18 71 48 43	3727.9 4277.6	4075.7 4677.8	2.31 2.66
Kill Devil Hill	36 01 03.35	75 39 48.52	48 04 31 121 57 00	Roberts' Fishery .... Sampson's Point.......	228 00 29 301 52 42	13873.9 12943.0	15172.2 14154.1	8.62 8.04
Gamiel's (P.) Hill..............	36 09 12.58	75 44 26.51	96 18 30 26 03 56	Thoroughfare.......... Sampson's Point.......	276 16 05 206 02 20	6194.5 9166.8	6774.2 10024.5	3.85 5.69

Section V.—Coast of South Carolina. Sketch No. 31.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
Primary stations from Edisto island to Charleston.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Edisto base, East end...........	32 33 14.31	80 13 20.64	....	....	....	....	....	....
Edisto base, West end..........	32 30 27.31	80 19 21.15	241 18 06.4	Edisto base, East end...	61 21 20.3	10721.3	11724.5	6.66
Aiken	32 38 26.53	80 21 40.27	306 23 51.1 346 10 47.2	Edisto base, East end... Edisto base, West end..	126 28 20.3 166 12 02.1	16192.1 15199.9	17707.2 16622.1	10.06 9.44
New Cut....	32 41 50.63	80 11 23 32	10 53 35.9 68 41 02.1	Edisto base, East end... Aiken	190 52 32.6 248 35 29.1	16194.8 17259.0	17710.1 18873.9	10.06 10.72
Mathews, (I)...................	32 38 51.41	80 02 00.,4	59 41 29.3 110 40 52.6	Edisto base, East end... New Cut.............	239 35 23.0 290 35 48.9	20543.7 14661.1	22466.0 17126.5	12.76 9.73
Elliott's Cut	32 45 56.71	79 59 47.78	67 20 18.2 14 48 57.6	New Cut............. Mathews, (1).........	247 14 02.1 194 47 45.8	19630.5 13550.0	21467.3 14817.9	12.20 8.42
Charleston Light...............	32 41 54.67	79 52 29.05	69 17 09.7 123 10 00.7	Mathews, (1).......... Elliott's Cut..........	249 12 01.1 303 06 03.5	15927.2 13639.8	17417.5 14916.1	9.90 8.47
Breach Inlet...................	32 46 19.27	79 48 43.14	87 44 59.1 35 49 51.3	Elliott's Cut.......... Charleston Light.......	267 38 59.4 215 47 49.1	17310.1 10050.6	18925.7 10991.0	10.75 6.24
From Edisto island to Charleston harbor.								
Tube 76, Edisto base	32 33 07.22	80 13 35.98	241 21 12	Edisto base, East end...	61 21 20	456.0	498.7	0.28 ....
East base observatory, transit...	32 33 15.42	80 13 36.57	274 39 56 356 31 02	Edisto base, East end... Tube 76, Edisto base...	94 40 05 176 31 02	416 9 253.0	455.9 276.7	0.26 0.16
Magnetic station, East base.....	32 33 16.18	80 13 36.57	277 51 43 356 48 37	Edisto base, East end... Tube 76, Edisto base...	97 52 17 176 48 37	419.5 276.5	458.8 302.4	0.26 0.17
First milestone, Edisto base.....	32 32 49.29	80 14 14.73	241 20 51	Tube 76, Edisto base...	61 21 12	1151.9	1259.7	0.72 ....
Tube 411, Edisto base..........	32 32 35.93	80 14 43.59	241 20 35	Edisto base, East end...	61 21 20	2466.0	2696.7	1.53 ....
Second milestone, Edisto base..	32 32 24.25	80 15 08.81	241 20 22	Edisto base, East end...	61 21 20	3215.8	3516.7	2.05 ....
Elongation mark, cupola of house of J. F. Townsend.	32 33 06.92	80 13 48.83	252 47 30 268 26 55	Edisto base, East end... Tube 76, Edisto base...	72 47 45 88 27 02	769.6 335.1	841.6 366.5	0.48 0.21
La Roche, (1)..................	32 31 36.28	80 14 50.79	162 20 48 217 54 30	2d milestone, Edisto base Edisto base, East end...	342 20 38 37 55 18	1550.7 3827.5	1695.8 4185.6	0.96 2.38
Bailey's (Th.) centre of house...	32 33 44.61	80 14 05.60	308 26 53 33 41 33	Edisto base, East end... 2d milestone, Edisto base	128 27 17 213 40 59	1497.8 2972.6	1637.9 3250.8	0.93 1.85
Baptist parsonage, centre of.....	32 32 12.55	80 15 18.61	238 16 12 215 23 39	Edisto base, East end... 2d milestone, Edisto base	58 17 16 35 23 44	3618.0 441.5	3956.5 482.8	2.25 0.27
Jenkins' house at Edings bay, (chimney.)	32 31 50.93	80 14 42.12	145 50 17 219 36 11	2d milestone, Edisto base Edisto base, East end...	325 50 03 39 36 55	1239.9 3333.9	1355.9 3645.8	0.77 2.07
Third milestone, Edisto base....	32 31 59.21	80 16 02.89	241 19 53	Edisto base, East end...	61 21 20	4823.7	5275.1	3.00 ....
Fourth milestone, Edisto base...	32 31 34.16	80 16 56.95	241 19 24	Edisto base, East end...	61 21 20	6431.6	7033.4	4.00 ....

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Coast of South Carolina. Sketch No. 31.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Fifth milestone, Edisto base....	32 31 09.11	80 17 51.01	241 18 55	Edisto base, East end...	61 21 20	8039.5	8791.8	5.00
Middleton's (O. H.) house, center of.	32 31 00.62	80 15 58.23	206 35 19	2d milestone, Edisto base	26 35 46	2880.5	3150.0	1.79
			95 05 01	5th milestone, Edisto base	275 04 00	2954.7	3231.2	1.84
Edings, hydrographic signal.....	32 30 28.27	80 16 57.72	180 33 59	4th milestone, Edisto base	0 33 59	2029.8	2219.7	1.26
			132 08 09	5th milestone, Edisto base	312 07 40	1875.3	2050.8	1.16
Sixth milestone, Edisto base....	32 30 44.05	80 18 45.06	241 18 26	Edisto base, East end...	61 21 20	9647.4	10550.1	5.99
Rockville Church	32 35 57.69	80 11 30.24	29 47 03	Edisto base, East end...	209 46 04	5797.7	6340.2	3.60
			106 07 40	Aiken................	286 02 11	16549.2	18097.7	10.28
Wilson, (1)	32 37 08.76	80 13 28.71	358 19 50	Edisto base, East end...	178 19 55	7224.4	7900.4	4.49
			100 37 34	Aiken.	280 33 09	13034.0	14253.6	8.10
K, (1).......................	32 34 03.03	80 11 42.73	59 34 11	Edisto base, East end...	239 33 18	2962.1	3239.4	1.84
			185 16 07	Rockville Church.......	5 16 14	3546.5	3878.3	2.20
K, (2).......................	32 35 08.38	80 09 31.08	59 36 41	Edisto base, East end...	239 34 38	6941.5	7591.0	4.31
			116 03 28	Rockville Church.......	296 02 24	3158.3	3781.9	2.15
Legare, (1).................. .	32 35 01.21	80 13 25.94	357 35 43	Edisto base, East end...	177 35 46	3295.5	3603.9	2.05
			178 56 52	Wilson, (1)............	358 56 51	3929.4	4297.1	2.44
Horse Island..................	32 35 09.14	80 11 49.09	84 29 17	Legare, (1)....	264 28 25	2539.8	2777.4	1.58
			144 48 05	Wilson, (1)....	324 47 11	4509.3	4931.2	2.80
Wm. Seabrook, (1)............	32 35 37.87	80 14 51.64	217 40 22	Wilson, (1)............	37 41 07	3537.3	3868.3	2.20
			296 47 57	Legare, (1)............	116 48 43	2503.8	2738.1	1.56
Townsend.....................	32 32 59.82	80 11 38.72	143 12 51	Legare, (1)............	323 11 53	4669.1	5106.0	2.90
			62 50 05	La Roche, (1)..........	242 48 22	5633.2	6160.3	3.50
De Vaux Bank, hydrographic signal, 1851.	32 32 48.32	80 10 22.45	72 26 04	La Roche, (1)..........	252 23 40	7344.6	8031.8	4.56
			100 05 46	Townsend.............	280 05 45	2021.1	2210.2	1.26
Seabrook's Island.............	32 33 53.72	80 10 03.62	13 42 15	DeVaux B'k, h. sig., 1851	193 42 05	2073.4	2267.4	1.29
			56 12 49	Townsend.............	236 11 58	2985.1	3264.4	1.86
B, (1)........................	32 34 28.29	80 09 26.14	25 30 20	DeVaux B'k, h. sig., 1851	205 29 50	3411.4	3730.6	2.12
			51 46 24	Townsend.............	231 45 13	4402.8	4814.8	2.74
Seacloud House, Townsend, (J. F.)	32 33 28.15	80 15 03.79	341 52 05	Tube 411, Edisto base..	161 52 16	1692.5	1850.9	1.05
			278 59 40	Edisto base, East end ..	99 00 35	2724.1	2979.0	1.69
Rabbit Point..................	32 36 29.17	80 18 32.41	126 26 57	Aiken.................	306 25 16	6086.0	6655.5	3.78
			261 13 15	Wilson, (1)............	81 15 58	8010.5	8760.1	4.98
Slann's Bluff	32 38 48.12	80 19 34.80	339 11 35	Rabbit Point...........	159 12 08	4578.4	5006.8	2.84
			78 30 37	Aiken.................	258 29 29	3336.9	3649.1	2.07
Slann's Island	32 38 10.05	80 17 36.62	94 35 14	Aiken.................	274 33 03	6370.3	6966.4	3.96
			110 51 14	Slann's Bluff..........	290 50 11	3295.6	3604.0	2.05
Wadmelaw Point	32 37 53.02	80 15 51.83	58 20 10	Rabbit Point...........	238 18 43	4918.5	5378.7	3.06
			100 52 48	Slann's Island........	280 51 51	2780.8	3041.0	1.73
Whaley, (2)	32 35 37.64	80 20 51.21	166 11 20	Aiken............	346 10 54	5357.0	5858.3	3.33
			246 18 19	Rabbit Point...........	66 19 34	3951.6	4321.4	2.45
Watts' Cut....................	32 36 56.88	80 22 58.40	216 24 14	Aiken.................	36 24 56	3430.9	3751.0	2.13
			306 20 38	Whaley, (2)...........	126 21 46	4117.7	4503.0	2.56
Hanahan..............	32 37 13.72	80 21 19.11	78 40 30	Watts' Cut............	258 39 36	2639.7	2886.7	1.64
			346 11 04	Whaley, (2)	166 11 19	3047.6	3332.8	1.89
Mathews, (2)..................	32 36 45.14	80 25 32.84	242 43 35	Aiken............	62 45 40	6818.9	7457.0	4.24
			285 47 19	Whaley, (2)	105 49 51	7631.4	8345.5	4.74
Raccoon Island...............	32 32 56.15	80 23 23.53	154 27 46	Mathews, (2)..........	334 26 36	7818.1	8549.7	4.86
			305 55 22	Edisto base, West end .	125 57 32	7811.2	8542.1	4.85
Mikell	32 32 27.54	80 19 56.02	166 11 43	Whaley, (2)...........	346 11 13	6028.9	6593.0	3.75
			346 11 44	Edisto base, West end .	166 12 03	3813.8	4170.8	2.37
B (4,) hydrographic signal, 1851.	32 33 31.17	80 11 13.60	249 09 18	Seabrook's Island......	69 09 56	1953.1	2135.9	1.21
			314 40 41	DeVaux B'k, h. sig., 1851	134 41 09	1876.6	2052.2	1.17
B (5,) hydrographic signal, 1851.	32 33 01.38	80 11 32.47	235 10 24	Seabrook's Island......	55 11 12	2823.4	3087.6	1.75
			282 24 45	DeVaux B'k, h. sig., 1851	102 25 23	1870.6	2045.6	1.16
Mad. Seabrook	32 36 04.76	80 16 39.33	248 20 58	Wilson, (1)............	68 22 41	5346.2	5846.4	3.32
			286 25 43	Wm. Seabrook, (1).....	106 26 41	2927.5	3201.4	1.82
Whooping Island	32 37 43.55	80 19 35.42	324 21 22	Rabbit Point...........	144 21 56	2818.7	3082.5	1.75
			112 08 52	Aiken.................	292 07 44	3512.9	3841.6	2.18
Rivers, (1)	32 38 35.17	80 15 06.21	78 50 47	Slann's Island.........	258 49 26	3994.0	4367.7	2.48
			356 00 12	Wm. Seabrook, (1).....	176 01 20	5473.3	5985.4	3.40

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Coast of South Carolina. Sketch No. 31.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
King's	32 39 44.55	80 16 49.05	23 04 00	Slann's Island	203 03 34	3163.8	3459.8	1.97
			308 34 05	Rivers, (1)	128 35 01	3427.8	3748.5	2.13
Bailey, (1)	32 40 01.77	80 13 49.82	36 44 02	Rivers, (1)	216 43 20	3328.7	3640.2	2.07
			83 31 58	King's	263 30 21	4699.8	5139.6	2.92
Whaley, (C)	32 41 06.46	80 14 43.16	325 06 18	Bailey, (1)	145 06 47	2429.3	2656.6	1.51
			7 20 43	Rivers, (1)	187 20 30	4699.0	5138.7	2.92
Mott	32 41 04.50	80 12 23.75	42 37 50	Rivers, (1)	222 36 23	6251.3	6836.2	3.88
			49 14 56	Bailey, (1)	229 14 10	2959.8	3236.7	1.84
Rivers, (2)	32 42 54.42	80 12 49.36	348 51 21	Mott	168 51 35	3450.9	3773.8	2.14
			41 43 01	Whaley, (C)	221 41 59	4454.6	4871.4	2.77
Mikell, (E)	32 43 33.98	80 10 53.72	13 36 44	New Cut	193 36 28	3275.3	3581.8	2.03
			67 59 59	Rivers, (2)	247 58 57	3247.2	3551.0	2.02
Chisholm, (1)	32 43 01.07	80 09 17.45	56 30 33	New Cut	236 29 25	3930.7	4298.5	2.44
			112 01 42	Mikell, (E)	292 00 50	2703.9	2956.9	1.68
Bailey, (2)	32 44 17.23	80 10 21.42	19 38 50	New Cut	199 38 17	4794.5	5243.1	2.98
			32 15 43	Mikell, (E)	212 15 25	1575.4	1722.8	0.98
Chisholm, (2)	32 43 19.52	80 09 28.27	47 35 06	New Cut	227 34 04	4058.6	4438.4	2.52
			142 06 15	Bailey, (2)	322 05 46	2252.7	2463.5	1.40
Wilson, (2)	32 44 12.73	80 08 33.80	40 50 47	Chisholm, (2)	220 50 18	2166.4	2369.1	1 35
			92 50 35	Bailey, (2)	272 49 37	2803.8	3066.2	1.74
Wilkes	32 47 13.25	80 02 31.13	298 59 58	Elliott's Cut	119 01 26	4860 6	5315.4	3.02
			41 38 48	Prentice	221 38 07	2969.7	3247.6	1.85
Prentice	32 46 01.19	80 03 46.96	140 17 55	Barker	320 17 03	3886.8	4250.5	2.41
			221 38 07	Wilkes	41 38 48	2969.7	3247.6	1.85
Barker	32 47 38.27	80 05 22.30	279 48 04	Wilkes	99 49 36	4522.0	4945.1	2.81
			320 17 03	Prentice	140 17 55	3886.8	4250.5	2.41
Whaley, (1)	32 46 34.32	80 06 22.74	218 33 37	Barker	38 34 09	2518.6	2754.3	1.57
			284 07 19	Prentice	104 08 43	4180.3	4571.5	2.60
Fuller	32 47 18.56	80 07 05.30	257 13 33	Barker	77 14 29	2745.3	3002.2	1.71
			320 53 40	Whaley, (1)	140 54 03	1756.0	1920.3	1.09
La Roche, (2)	32 45 24.88	80 07 19.13	185 51 56	Fuller	5 52 04	3520.4	3849.8	2.19
			214 26 49	Whaley, (1)	34 27 19	2594.2	2836.9	1.61
Rose	32 46 04.99	80 08 06.80	215 13 00	Fuller	35 13 34	2773.9	3033.5	1.72
			251 32 24	Whaley (1)	71 33 20	2855.0	3122.2	1.77
Ingalls	32 45 10.36	80 08 34.48	203 10 37	Rose	23 10 52	1830.5	2001.8	1.14
			257 09 16	La Roche (2)	77 09 57	2011.2	2199.4	1.25
Dr. Townsend	32 45 01.47	80 02 05.09	244 31 46	Elliott's Cut	64 33 00	3958.3	4328.7	2.46
			170 31 30	*Wilkes*	350 31 16	4115.1	4500.2	2.56
Gervais	32 43 36.12	80 00 29.29	194 00 22	Elliott's Cut	14 00 45	4463.4	4881.0	2.77
			136 30 59	Dr. Townsend	316 30 07	3623.9	3963.0	2.25
Royall	32 44 22.70	79 56 57.20	123 07 40	Elliott's Cut	303 06 08	5300.8	5796.8	3.29
			303 07 34	Charleston Light	123 09 59	8339.0	9119.3	5.18
Wm. Seabrook, (2)	32 36 33.16	80 08 55.11	74 53 47	Rockville Church	254 52 23	4189.5	4581.5	2.60
			19 45 43	K (2)	199 45 24	2774.5	3034.1	1.72
Haulover	32 36 41.72	80 08 54.02	18 34 59	K (2)	198 34 39	3032.8	3316.6	1.89
			71 35 47	Rockville Church	251 34 23	4292.7	4694.4	2.67
Burrell	32 35 57.92	80 07 37.77	124 10 23	Haulover	304 09 42	2402.4	2627.2	1.49
			118 18 00	Wm. Seabrook, (2)	298 17 18	2290.0	2504.3	1.42
Legare, (2)	32 37 54.54	80 07 03.16	52 11 29	Haulover	232 10 29	3658.1	4000.4	2.27
			49 20 50	Wm. Seabrook (3)	229 19 50	3847.1	4207.1	2.39
Drayton	32 36 37.38	80 05 35.82	88 34 49	Wm. Seabrook (2)	268 33 02	5196.9	5683.2	3.23
			69 05 20	Burrell	249 04 15	3403.7	3722.2	2.11
Roper, (1)	32 38 07.98	80 05 13.28	11 52 25	Drayton	191 53 13	2851.9	3118.8	1.77
			81 46 50	Legare, (2)	261 45 51	2893.3	3164.0	1.80
Vanderhorst, (1)	32 37 14.53	80 03 44.52	68 28 53	Drayton	248 27 28	3119.1	3411.0	1.94
			125 26 28	Roper, (1)	305 25 40	2839.5	3105.2	1.76
Roper, (2)	32 38 50.54	80 03 42.50	60 59 43	Roper, (1)	240 58 54	2705.2	2958.3	1.68
			269 24 52	Mathews, (1)	89 25 47	2651.8	2899.9	1.65
Big Sandy Point	32 37 01.91	80 01 08.02	95 26 33	Vanderhorst, (1)	275 25 09	4098.1	4481.6	2.55
			157 49 59	Mathews, (1)	337 49 30	3642.2	3983.0	2.26
Cole's Island	32 38 28.75	80 00 38.69	15 56 53	Big Sandy Point	195 56 37	2781.8	3042.1	1.73
			108 05 20	Mathews, (1)	288 04 36	2249.5	2460.0	1.40

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

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Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Vanderhorst, (2)	32 37 51.32	80 01 57.30	240 37 55 123 38 57	Cole's Island Roper, (2)	60 38 38 303 38 00	2350.9 3293.1	2570.9 3601.2	1.46 2.05
Campbell	32 39 14.96	79 57 03.69	75 45 50 57 15 23	Cole's Island Big Sandy Point	255 43 54 237 13 12	5781.9 7572.9	6322.9 8281.5	3.59 4.71
Old Battery	32 40 00.11	79 59 36.21	23 33 41 30 03 48	Big Sandy Point Cole's Island	203 32 52 210 03 14	5987.7 3251.5	6548.0 3555.7	3.72 2.02
Burden	32 41 10.53	80 01 17.34	309 27 18 14 47 33	Old Battery Mathews, (1)	129 28 13 194 47 10	3412.6 4431.7	3731.9 4846.4	2.12 2.75
Rivers, (H.)	32 41 40.88	79 57 21.98	353 56 54 48 25 11	Campbell Old Battery	173 57 04 228 23 58	4519.8 4676.0	4942.7 5113.5	2.81 2.91
Fripp	32 42 23.77	79 59 27.98	51 37 42	Burden Rivers, (H.)	231 36 43	3633.7	3973.7	2.26 ....
Cole's Island, eccentric	32 38 28.82	80 00 38.66	....	....	....	....	....	....
Bird Key, (1,) erected in 1852	32 37 11.91	79 58 48.70	129 32 35 121 29 32	Cole's Island Mathews, (1)	309 31 36 301 27 48	3718.3 5869.7	4066.2 6418.9	2.31 3.65
Bird Key, (2,) erected in 1854	32 37 15.27	79 58 53.19	83 20 02 129 27 57	Big Sandy Point Cole's Island	263 18 49 309 27 00	3538.4 3561.4	3869.5 3894.6	2.20 2.21
Bird Key, (3,) erected in 1855	32 37 16.79	79 58 56.74	82 23 00 129 52 07	Big Sandy Point Cole's Island, eccentric	262 21 49 309 51 12	3453.1 3461.7	3776.2 3785.6	2.15 2.15
Maffitt	32 35 03.35	80 07 53.91	194 02 54 250 55 56	Burrell Big Sandy Point	14 03 03 70 59 35	1732.3 11195.4	1894.4 12243.0	1.08 6.96
Whaley's, (W.,) west chimney	32 37 14.37	80 09 53.60	303 36 57 309 46 37	Burrell Wm. Seabrook, (2)	123 38 10 129 47 08	4252.6 1984.0	4650.5 2169.6	2.64 1.13
Whaley's, (W.,) east chimney	32 34 19.05	80 13 34.07	21 46 01 37 45 16	La Roche, (1) Bailey, (H.)	201 45 20 217 44 59	5398.5 1343.8	5903.6 1469.5	3.35 0.83
Burrell's Stable	32 36 28.97	80 06 06.61	68 04 27 252 06 08	Burrell Drayton	248 03 38 72 06 25	2561.8 843.4	2801.5 922.3	1.59 0.52
Vanderhorst, east chimney	32 36 58.63	80 04 09.27	110 49 03 191 24 26	Legare, (2) Roper, (2)	290 47 29 11 24 40	4848.5 3519.6	5302.2 3848.9	3.01 2.19
Vanderhorst, center of house	32 36 58.40	80 04 09.47	223 55 49 232 43 40	Mathews, (1) Vanderhorst, (1)	43 56 58 52 43 53	4834.9 818.2	5287.3 894.8	3.00 0.51
Legare's (Sal.) Cotton-house	32 37 35.27	80 06 52 45	154 47 49 311 44 13	Legare, (2) Drayton	334 47 48 131 44 54	655.4 2677.6	716.7 2928.1	0.41 1.66
Roper's (J.) House	32 38 04.30	80 06 04.08	341 36 56 78 57 55	Drayton Legare, (2)	164 37 11 258 57 23	2777.7 1568.7	3037.6 1715.5	1.73 0.97
Flag on Roper's Blade-house	32 37 57.39	80 05 13.05	289 46 25 13 32 05	Vanderhorst, (1) Drayton	119 47 13 193 31 53	2658.5 2535.5	2907.3 2772.8	1.65 1.58
Roper's (B.) Cotton-house	32 38 25.76	80 04 57.34	319 08 04 16 43 14	Vanderhorst, (1) Drayton	139 08 43 196 42 53	2901.5 3486.3	3173.0 3812.5	1.80 2.17
Kiawah Island, flag in pine	32 36 28.78	80 03 28.33	175 09 43 259 39 13	Roper, (2) Bird Key, (1)	355 09 35 79 41 44	4380.2 7406.6	4790.1 8099.6	2.72 4.60
Flag on Legare's (J.) house, on Hundcomb's Point.	32 40 48.21	80 00 11.53	328 08 36 9 21 34	Old Battery Cole's Island	148 08 55 189 21 19	1744.2 4353.6	1907.4 4761.0	1.08 2.70
Grimball's (P.) House	32 41 22.15	79 59 53.84	349 41 15 12 19 41	Old Battery Cole's Island	169 41 25 192 20 17	2568.4 5467.5	2808.7 5979.1	1.60 3.40
Legare's (S.) Chimney, Legareville.	32 39 51.45	80 00 17.01	255 54 43 12 30 29	Old Battery Cole's Island	75 55 05 192 30 17	1096.5 2609.4	1199.1 2853.6	0.68 1.62
Grimball's (G.) Cotton-house	32 42 04.83	79 58 45.52	333 06 14 23 54 22	Campbell Cole's Island	153 07 09 203 53 21	5866.5 7279.8	6415.4 7961.0	3.65 4.52
James Island, small house	32 40 21.92	79 58 27.92	213 12 30 44 21 52	Campbell Cole's Island	133 13 24 224 20 41	3011.9 4875.2	3293.7 5331.4	1.87 3.03
Elisha Place, flag near S. Legare's	32 40 31.13	79 57 47.20	49 52 02 71 24 05	Cole's Island Old Battery	229 50 29 251 24 06	5846.8 2996.7	6393.9 3277.1	3.63 1.86
Cole's Island House, center of	32 38 31.65	79 59 05.53	87 53 48 97 36 41	Cole's Island Matthews, (1)	267 52 58 277 35 06	2429.4 4606.2	2656.7 5037.2	1.51 2.86
Gilbert, Folly Island Beach	32 38 40.07	79 57 03.67	45 14 31 48 57 52	Bird Key, (1) Bird Key, (3)	225 13 34 228 56 51	3857.0 3905.9	4217.9 4271.4	2.41 2.43
Vanderhorst, summer-house chimney.	32 37 32.99	79 59 42.02	295 02 08 123 45 32	Bird Key, (1) Mathews, (1)	115 02 37 303 44 17	1534.5 4348.3	1678.1 4755.2	0.95 2.70
Steamer Pilot, smoke pipe	32 35 55.38	79 58 50.72	119 48 05 181 17 43	Big Sandy Point Bird Key, (1)	299 46 51 1 17 44	4124.5 2357.8	4510.4 2578.4	2.56 1.46

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

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Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Mainmast of barque Lark	32 35 35.22	79 58 59.17	128 29 15	Big Sandy Point	308 28 06	4291.2	4692.7	2.67
			185 14 48	Bird Key, (1)	5 14 54	2990.5	3270.3	1.86
Rivers' (J.) House, west chimney.	32 42 25.34	79 59 11.63	330 22 06	Campbell	150 23 26	6745.6	7376.8	4.19
			8 08 22	Old Battery	188 08 09	4518.9	4941.7	2.81
Old House, on Grimball's (P.) place.	32 42 01.06	79 59 13.26	147 42 24	Fripp's	327 42 16	717.6	784.8	0.45
			283 49 40	Rivers, (H).	103 51 15	2985.5	3264.9	1.86
Grimball's (P.) cotton house	32 42 01.02	79 58 43.41	121 06 25	Fripp's	301 06 01	1355 8	1482.7	0.84
			286 18 11	Rivers, (H.)	106 18 55	2210.0	2416.8	1.37
East chimney on Bluff	32 41 54.26	80 11 40.89	283 42 47	New Cut	103 42 57	471 0	515.1	0.29
			72 47 58	Whaley, (C.)	252 46 20	4969.7	5434.7	3.09
West chimney on Bluff	32 41 54.28	80 11 41.36	283 28 47	New Cut	103 28 57	483.4	528.6	0.30
			72 45 03	Whaley, (C.)	252 43 25	4958.3	5422.3	3.08
Mott's (N.) house, center of	32 41 31.87	80 12 22.56	164 39 13	Rivers, (2)	344 38 59	2637.9	2884.9	1.64
			2 04 04	Mott	182 04 03	842.2	921.0	0.52
Chisholm's house, center of	32 41 33.65	80 12 26.20	166 20 57	Rivers, (2)	346 20 44	2559.3	2798.8	1.59
			355 51 45	Mott	175 51 46	900.4	984.7	0.56
Whaley's (B.) cotton house, center of.	32 49 01.65	80 12 36.21	176 19 11	Rivers, (2)	356 19 04	5332.4	5831.4	3.31
			189 31 37	Mott	9 31 44	1962.3	2145.9	1.22
Simon's Bluff, tall pine at	32 41 43.70	80 13 24.84	307 19 00	Mott	127 19 33	1997.3	2184.2	1.24
			266 08 41	New Cut	86 09 47	3172.1	3468.9	1.97
Clark's (E. M.) house	32 45 42 33	79 59 47.73	70 36 58	Townsend	250 35 44	3790.1	4144.7	2.36
			179 51 27	Elliott's Cut	359 51 27	443.1	484.6	0.28
Wilson's house, Simon's Bluff	32 41 19.09	80 13 19.38	251 05 16	New Cut	71 06 15	3002.4	3283.3	1.87
			289 24 57	Mott	109 25 23	1343.4	1469.9	0.83
Scharlock's store, center of	32 41 46.78	80 11 52.63	261 11 44	New Cut	81 12 00	773.3	845.7	0.48
			74 24 32	Whaley, (C.)	254 23 00	4612.2	5043.8	2.87
Mrs. Townsend's (J. H.) house, center of.	32 41 19.39	80 11 59.36	54 11 01	Mott	234 10 48	782.5	855.7	0.49
			224 19 41	New Cut	44 20 00	1344.0	1469.8	0.83
Bailey's (R.) house, center of	32 40 13.00	80 13 52.43	232 14 53	New Cut	52 16 13	4912.2	5371.8	3 05
			32 33 58	Rivers, (1)	212 33 18	3572.8	3907.1	2.22
Edisto Landing, chimney of house.	32 36 13.86	80 17 52.13	100 13 25	Rabbit Point	280 12 31	2638.8	2885.7	1.64
			212 22 54	Rivers, (1)	32 23 51	5154.5	5636.8	3.20
Baynard's (E.) house, center of.	32 35 57.52	80 18 05.95	144 28 48	Whooping Island	324 28 00	4015.5	4391.2	2.49
			144 41 32	Rabbit Point	324 41 18	1191.9	1303.4	0.74
Dawho ferry house chimney	32 37 58.33	80 20 19.78	291 30 04	Whooping Island	111 30 28	1242.5	1358.8	0.77
			112 29 37	Aiken	292 28 54	2270.4	2482.8	1.41
Hart's (Dr.) cotton house	32 42 25.32	80 10 46.02	230 29 00	Chisholm, (2)	50 29 42	2624.2	2869.7	1.63
			244 28 13	Chisholm, (1)	64 29 01	2555.8	2794.9	1.59
Jenkins' (Dr.) house, John's Island.	32 43 54.16	80 09 37.46	347 21 23	Chisholm, (2)	167 21 27	1093.3	1195.6	0.68
			121 50 46	Bailey, (2)	301 50 22	1347.2	1473.3	0.84
Rainer's house church flats, chimney of.	32 44 39.24	80 09 45.75	349 29 51	Chisholm, (2)	169 30 00	2497.4	2731.1	1.55
			53 52 06	Bailey, (2)	233 51 47	1149.7	1257.3	0.71
Parker's house church flats, center of.	32 44 57.44	80 09 31.83	46 11 14	Bailey, (2)	226 10 47	1788.4	1955.8	1.11
			312 20 06	Wilson, (2)	132 20 37	2042.7	2233.8	1.27
La Roche's (Dr.) house, west chimney.	32 42 16.51	80 10 19.32	179 09 23	Bailey, (2)	359 09 22	3718.8	4066.8	2.31
			214 24 19	Chisholm, (2)	34 24 47	2352.4	2572.5	1.46
Townsend's (Dr.) boat house	32 46 02.84	80 01 32.75	273 56 30	Elliott's Cut	93 57 27	2738.3	2994.5	1.70
			24 00 20	Dr. Townsend	204 59 13	2069.2	2262.8	1.29
Whaley's boat house, John's Island.	32 46 14.75	80 02 05.15	159 26 29	Wilkes	339 26 15	1924.5	2104.6	1.19
			278 49 15	Elliott's Cut	98 50 29	3618.0	3956.5	2.25
Barker's (S. G.) house, west chimney.	32 47 21.74	80 05 49.86	234 32 58	Barker	54 33 13	877.4	959.5	0.54
			30 21 18	Whaley, (1)	210 21 11	1692.5	1850.9	1.05
Gervais' (Rev.) house, centre of.	32 46 25.71	80 04 45.69	156 52 01	Barker	336 51 41	2430.6	2658.0	1.51
			247 17 36	Wilkes	67 18 49	3795.2	4150.3	2.36
La Roche's (J.) house, chimney.	32 46 17.05	80 07 08.22	76 18 12	Rose	256 17 40	1568.7	1715.5	0.97
			182 17 33	Fuller	2 17 35	1896.0	2073.4	1.18
Rose's house, east chimney	32 45 53.98	80 07 59.47	15 59 47	Wilson, (2)	195 59 28	3244.1	3547.6	2.02
			310 30 48	La Roche, (2)	130 31 10	1380.5	1509.7	0.86
Seabrook's mill, Sampson Island, chimney of.	32 35 39 62	80 25 19.01	227 56 57	Aiken	47 58 55	7678.2	8396.7	4.77
			237 00 43	Watts Cut	57 01 59	7371.2	4780.2	2.71
Overseer's house, Jehossee, chimney of.	32 37 13.09	80 23 39.24	233 52 38	Aiken	53 53 42	3837.5	4196.6	2.38
			303 51 04	Whaley, (2)	123 52 35	5276.0	5769.7	3.28

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	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Jehossee West steam mill, chimney of.	32 37 16.87	80 23 50.84	237 45 27	Aiken	57 46 37	4023.0	4399.4	2.50
			69 49 31	Mathews, (2)	249 48 36	2832.3	3097.3	1.76
Aiken's water mill, pole of	32 38 45.62	80 23 09.45	284 11 30	Aiken	104 12 18	2397.4	2621.7	1.49
			45 12 38	Mathews, (2)	225 11 21	5267.1	5759.9	3.27
Marshall's steam mill, chimney of.	32 39 36.43	80 21 33.14	318 34 09	Whooping Island	138 35 12	4636.3	5070.1	2.88
			4 56 10	Aiken	184 56 06	2160.7	2362.9	1.34
Rice mill at Mathews, (2) chimney of.	32 36 44.14	80 25 34.49	242 39 51	Aiken	62 41 57	6871.5	7514.5	4.27
			264 28 50	Watts Cut	84 30 14	4088.1	4470.6	2.54
Morris' rice mill, Wilton	32 39 45.36	80 23 28.62	310 41 17	Aiken	130 42 15	3723.9	4072.3	2.31
			30 15 32	Mathews, (2)	210 14 25	6426.0	7027.3	3.99
Hanahan's (J.) house, center of.	32 35 48.85	80 22 45.99	111 44 41	Mathews, (2)	291 43 11	4682.7	5120.9	2.90
			171 13 31	Watts Cut	351 13 24	2120.5	2318.9	1.32
Bailey, E	32 35 19.32	80 22 51.20	122 06 39	Mathews, (2)	302 05 03	4974.7	5440.2	3.09
			176 25 27	Watts Cut	356 25 23	3010.9	3292.6	1.87
Bull's Creek, flag at mouth	32 36 19.02	80 25 15.61	150 50 02	Mathews, (2)	330 49 53	921.3	1007.5	0.57
			251 55 55	Watts Cut	71 57 09	3762.5	4114.6	2.34
Jehossee East steam mill, chimney of.	32 38 21.23	80 23 06.43	355 23 35	Watts Cut	175 23 39	2606.3	2850.2	1.62
			52 12 55	Mathews, (2)	232 11 36	4829.4	5281.3	3.00
Baynard's (W.) house, center of	32 34 41.22	80 22 46.81	16 29 30	Raccoon Island	196 29 10	3375.4	3691.2	2.10
			131 25 04	Mathews, (2)	311 23 35	5771.3	6311.3	3.59
Murray's (Maj.) house	32 32 12.08	80 15 28.04	233 12 59	Second mile-stone, Edisto base.	53 13 09	626.3	684.9	0.39
			318 36 01	La Roche, (1)	138 36 21	1469.8	1607.3	0.91
Murray's (Maj.) house, Fenwick's Island.	32 32 34.66	80 25 02.45	201 49 10	Watts Cut	21 50 17	8700.2	9514.3	5.41
			255 37 11	Raccoon Island	75 38 04	2664.0	2913.3	1.66
Kiawah Beach, flag in pine	32 35 47.57	80 05 50.21	154 04 33	Legare, (2)	334 03 54	4348.5	4755.4	2.70
			192 32 46	Roper, (1)	12 33 06	4430.7	4845.3	2.75
Milne's cotton house	32 47 42.20	80 03 21.32	304 19 27	Wilkes	124 19 54	1581.4	1729.8	0.98
			12 06 14	Prentice	192 06 00	3181.8	3479.5	1.98
Charleston harbor and vicinity.								
Circular church, Charleston	32 46 42.54	79 55 39.05	77 43 02	Elliott's Cut	257 40 47	6624.7	7244.6	4.12
			273 45 30	Breach Inlet	93 49 15	10846.3	11861.2	6.74
Fort Sumpter	32 45 06.65	79 52 17.87	2 49 07	Charleston Light	182 49 01	5920.6	6474.6	3.68
			51 20 49	Rivers, (H.)	231 18 05	10143.7	11092.9	6.30
Fort Johnson	32 45 09.47	79 53 35.04	272 28 13	Fort Sumter	92 28 55	2010.5	2198.6	1.25
			344 00 57	Charleston Light	164 01 33	6241.5	6825.5	3.88
Vincent	32 43 42.45	79 51 48.86	225 00 27	Breach Inlet	45 02 08	6833.8	7473.2	4.25
			132 48 51	Circular church	312 46 47	8165.0	8929.0	5.07
Mount Pleasant	32 47 13.41	79 52 37.82	348 54 06	Vincent	168 54 32	6621.9	7241.5	4.11
			78 36 51	Circular church	258 35 13	4810.3	5260.4	2.99
Castle Pinckney	32 46 23.92	79 54 25.32	270 53 44	Breach Inlet	90 56 50	8905.6	9738.9	5.53
			241 24 12	Mount Pleasant	61 25 11	3185.5	3483.6	1.98
Styles	32 45 10.67	79 55 34.69	177 42 20	Circular church	357 42 18	2832.1	3097.1	1.76
			218 39 42	Castle Pinckney	38 40 20	2889.5	3159.9	1.80
Orphan's Asylum, Charleston	32 47 08.70	79 56 02.54	348 43 32	Styles	168 43 47	3706.9	4053.8	2.30
			268 25 36	Mount Pleasant	88 27 27	5328.4	5827.0	3.30
Gibbes' (Prof. L. R.) Observatory, Charleston.	32 47 05.29	79 56 00.00	147 40 00	Orphan's Asylum	327 40 00	123.5	135.1	0.08
			......	......	......	......	......	......
Hobcaw	32 48 47.29	79 54 11.79	30 34 44	Circular church	210 33 56	4462.9	4880.5	2.77
			4 33 33	Castle Pinckney	184 33 26	4430.0	4844.5	2.75
North base, Charleston	32 48 48.88	79 56 51.63	334 06 36	Circular church	154 07 16	4325.6	4730.4	2.69
			270 40 01	Hobcaw	90 41 25	4157.8	4546.8	2.58
South base, Charleston	32 47 46.41	79 56 15.15	334 28 34	Circular church	154 28 54	2179.9	2383.9	1.36
			153 44 58	North base, Charleston.	333 44 38	2145.8	2346.6	1.33
Crafte	32 47 10.31	79 58 07.49	213 00 52	North base, Charleston.	33 01 33	3621.2	3960.0	2.25
			312 48 39	Styles	132 50 01	5421.5	5928.8	3.37
United States Arsenal, Charleston.	32 47 07.62	79 56 41.93	295 16 23	Circular church	115 16 57	1809.3	1978.6	1.12
			210 14 57	South base, Charleston.	30 15 12	1383.0	1512.4	0.86
Oyster Point	32 49 40.14	79 55 13.59	24 33 59	South base, Charleston.	204 33 26	3851.9	4212.3	2.39
			6 54 18	Circular church	186 54 04	5510.5	6026.1	3.42
Riley	32 50 04.82	79 53 14.16	32 06 48	Hobcaw	212 06 17	2819.6	3083.4	1.75
			76 15 12	Oyster Point	256 14 07	3197.2	3496.4	1.99

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Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Furman	32 50 46.34	79 53 54.44	320 41 15	Riley	140 41 37	1653.0	1807.7	1.03
			45 16 10	Oyster Point	225 15 27	2897.2	3168.3	1.80
Fort Moultrie, flag-staff	32 45 31.11	79 51 15.08	249 25 33	Breach Inlet	69 26 55	4223.3	4618.5	2.62
			14 43 14	Vincent	194 42 56	3460.6	3784.4	2.15
Haddrell's Point Beacon, back of Sullivan's Island, (1849.)	32 46 50.56	79 51 16.05	8 23 16	Vincent	188 22 58	5856.9	6404.9	3.64
			80 33 27	Castle Pinckney	260 31 45	4992.6	5459.8	3.10
Beacon south of Fort Moultrie	32 45 29.39	79 51 11.14	80 41 59	Fort Johnson	260 40 41	3794.5	4149.6	2.36
			16 36 41	Vincent	196 36 21	3437.0	3758.6	2.14
Pinckney house, on Sullivan's Island.	32 45 47.49	79 49 59.34	36 30 46	Vincent	216 29 47	4792.0	5240.4	2.98
			243 43 04	Breach Inlet	63 43 45	2211.1	2418.0	1.37
Fort Sumter, frame of Artesian well, (1849.)	32 45 07.92	79 52 14.73	171 09 41	*Mount Pleasant*	351 09 28	3912.1	4278.2	2.43
			91 17 35	Fort Johnson	271 16 52	2090.2	2285.8	1.30
St. Michael's church, Charleston	32 46 33.12	79 55 37.90	308 51 17	Fort Johnson	128 52 23	4107.0	4491.3	2.55
			278 31 04	Castle Pinckney	98 31 43	1909.2	2087.8	1.19
White house on Cooper river	32 49 39.36	79 56 08.36	297 52 27	Hobcaw	117 53 30	3429.7	3750.5	2.13
			269 01 34	Oyster Point	89 02 04	1424.5	1557.8	0.88
Belvidere mill, Cupola	32 49 07.75	79 56 10.36	2 50 06	South base, Charleston.	182 50 03	2508.8	2743.5	1.56
			349 40 52	Circular church	169 41 09	4546.2	4971.6	2.83
Wappoo	32 46 10.09	79 57 24.97	250 03 40	*Circular church*	70 04 37	2932.2	3206.6	1.82
			212 17 12	United States Arsenal	32 17 35	2096.1	2292.2	1.30
Cotton Factory, chimney of	32 47 45.05	79 55 52.73	317 42 02	Castle Pinckney	137 42 49	3379.1	3695.3	2.10
			196 01 40	Oyster Point	16 02 01	3688.7	4033.9	2.29
Flynn's church	32 47 18.09	79 55 49.62	222 47 55	Hobcaw	42 48 48	3745.0	4095.4	2.33
			354 20 44	Styles	174 20 52	3943.9	4312.9	2.45
Hog Island Beacon, (1849)	32 46 55.55	79 54 42.11	22 57 31	Styles	202 57 03	3508.3	3836.6	2.18
			335 51 04	Castle Pinckney	155 51 13	1067.5	1167.4	0.66
Grace church, Charleston	32 46 52.02	79 55 58.85	348 36 37	Styles	168 36 50	3184.3	3482.3	1.99
			218 06 03	Hobcaw	38 07 01	4512.5	4934.7	2.80
Hugher	32 47 36.66	79 49 36.15	329 56 33	Breach Inlet	149 57 02	2754.3	3012.0	1.71
			33 39 26	Fort Moultrie	213 38 33	4645.8	5080.5	2.89
Swinton	32 47 06.32	79 47 13.00	58 17 45	Breach Inlet	238 16 56	2757.1	3015.1	1.71
			104 05 57	*Hugher*	284 04 39	3840.0	4199.3	2.39
Bancroft	32 49 18.77	79 46 24.93	33 02 50	Breach Inlet	213 01 35	6595.4	7212.5	4.10
			17 02 49	Swinton	197 02 23	4267.5	4666.8	2.65
Palmetto, Goat Island	32 48 40.91	79 45 05.63	74 18 54	Hugher	254 16 27	7310.4	7994.4	4.54
			119 29 37	Bancroft	299 28 54	2369.4	2591.1	1.47
Webber	32 49 09.85	79 44 22.47	51 32 55	Palmetto, Goat Island	231 32 32	1433.5	1567.6	0.89
			94 56 27	Bancroft	274 55 20	3196.8	3495.9	1.99
Boutelle	32 47 48.01	79 45 30.68	61 23 04	Breach Inlet	241 21 20	5704.6	6238.4	3.55
			64 15 08	*Swinton*	244 14 13	2956.6	3233.3	1.84
Evans	32 48 53.09	79 43 44.65	79 54 14	*Palmetto, Goat Island*	259 53 30	2139.3	2339.5	1.33
			117 41 59	Webber	297 41 38	1110.7	1214.6	0.69
Roberts	32 49 36.68	79 43 08.54	34 58 30	Evans	214 58 10	1638.5	1791.8	1.02
			66 44 41	Webber	246 44 01	2092.6	2288.4	1.30
Long Island Point, (1854)	32 48 10.49	79 43 46.15	69 50 45	Swinton	249 48 53	5733.5	6270.0	3.56
			49 39 23	Charleston Light	229 34 40	17867.1	19538.9	11.10
Allen	32 48 43.28	79 42 51.76	54 28 51	Long Island Point	234 28 22	1737.5	1900.1	1.08
			165 08 27	Roberts	345 08 18	1701.1	1860.3	1.06
Club house, west apex	32 46 49.39	79 48 31.51	255 40 35	Swinton	75 41 17	2108.2	2305.5	1.31
			18 04 35	Breach Inlet	198 04 34	975.9	1067.2	0.61
Fort Sumter, flag-staff, (1855)	32 45 07.65	79 52 16.41	50 48 53	Fort Sumter	230 48 52	46.2	50.5	0.03
			119 01 00	Circular church	298 59 10	6028.8	6592.9	3.75
Morris Island, hydrographic tripod at north end.	32 43 43.90	79 51 49.92	132 42 59	Circular church	312 40 55	8113.9	8873.1	5.04
			164 04 51	Fort Sumter	344 04 36	2650.6	2898.6	1.65
West or back Overall Beacon, new, (1855.)	32 42 59.17	79 52 12.29	141 59 04	Circular church	321 57 12	8734.7	9552.0	5.43
			177 53 15	Fort Sumter	357 53 12	3929.3	4297.0	2.44
Folly Island beach, flag in pine	32 40 11.92	79 53 59.63	53 39 59	Bird Key, (1)	233 37 23	9353.7	10228.9	5.81
			196 15 51	Fort Sumter	16 16 46	9457.1	10342.0	5.88
East Overall Beacon, (1849)	32 43 01.12	79 51 57.91	139 51 08	Circular church	319 49 08	8924.7	9759.8	5.54
			219 42 01	Breach Inlet	39 43 46	7934.8	8677.3	4.93
West Overall Beacon, (1849)	32 43 00.44	79 52 02.57	140 32 16	Circular church	320 30 19	8863.0	9692.3	5.50
			220 16 15	Breach Inlet	40 18 03	8028.5	8779.7	4.99

UNITED STATES COAST SURVEY—GEOGRAPHICAL POSITIONS.

Section V.—Coast of South Carolina. Sketch No. 31.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
St. Helena Sound.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Edisto base, west end	32 30 27.31	80 19 21.15	....	....	....	....	....	....
Baynard	32 30 58.45	80 18 14.00	61 18 43	Edisto base, west end	241 18 06	1997.9	2184.8	1.24
Mikell	32 32 27.54	80 19 56.02	346 11 44 315 52 16	Edisto base, west end Baynard	166 12 03 135 53 11	3813.8 3824.2	4170.8 4182.1	2.37 2.38
Pine Island	32 30 14.97	80 21 35.23	263 48 08 212 21 44	Edisto base, west end Mikell	83 49 20 32 22 37	3520.0 4835.3	3849.4 5287.8	2.19 3.00
Raccoon Island	32 32 56.15	80 23 23.53	279 13 06 330 20 23	Mikell Pine Island	99 14 57 150 21 21	5484.5 5712.0	5997.7 6246.5	3.41 3.55
Bay Point	32 29 16.96	80 20 14.63	184 43 36 130 21 00	Mikell Pine Island	4 43 46 310 20 16	5891.1 2760.3	6442.3 3018.6	3.66 1.72
Otter Island	32 28 27.44	80 24 35.44	192 46 20 257 21 13	Raccoon Island Bay Point	12 46 58 77 23 33	8486.7 6977.8	9280.8 7630.7	5.27 4.34
March	32 31 51.83	80 27 52.16	254 11 44 320 47 08	Raccoon Island Otter Island	74 14 08 140 48 54	7283.2 8123.6	7964.7 8883.7	4.53 5.05
Morgan's Island	32 27 48.60	80 28 27.97	187 06 35 258 50 07	March Otter Island	7 06 54 78 52 11	7549.8 6188.4	8256.2 6767.5	4.69 3.85
Hunting Island	32 24 34.65	80 24 39.16	135 00 14 180 46 35	Morgan's Island Otter Island	314 58 11 0 46 37	8449.8 7170.5	9240.4 7841.5	5.25 4.45
Egg Bank	32 26 17.74	80 26 17.62	129 26 04 213 44 00	Morgan's Island Otter Island	309 24 54 33 44 54	4406.7 4804.1	4819.0 5253.6	2.74 2.98
Hutchinson	32 29 45.69	80 28 16.86	4 35 56 292 37 07	Morgan's Island Otter Island	184 35 50 112 39 06	3618.2 6262.5	3956.8 6848.5	2.25 3.89
Seabrook, (J.)	32 30 55.58	80 19 54.45	9 50 26 64 34 36	Bay Point Pine Island	189 50 15 244 33 42	3082.9 2912.5	3374.4 3185.0	1.92 1.81
Mikell's Magnolia	32 32 12.89	80 20 19.75	28 28 30 358 34 57	Pine Island Bay Point	208 27 49 178 35 00	4131.0 5420.0	4517.5 5927.2	2.57 3.37
Fenwick Island, house	32 31 45.28	80 23 46.95	195 38 03 91 49 31	Raccoon Island March	15 38 16 271 47 19	2266.9 6401.4	2479.0 7000.4	1.41 3.98
Fenwick Island, oak	32 31 30.52	80 24 17.80	43 42 37 17 59 52	Morgan's Island Egg Bank	223 40 23 197 58 48	9453.2 10130.0	10337.7 11077.9	5.87 6.29
Shell Bank	32 30 13.56	80 25 08.07	1 58 06 39 17 28	Egg Bank Morgan's Island	181 58 01 219 16 13	7267.5 5768.8	7947.5 6308.6	4.51 3.58
Hutchinson's Magnolia	32 32 19.57	80 27 18.76	229 11 11 12 13 00	Otter Island Morgan's Island	149 12 39 192 12 23	8324.1 8539.5	9103.0 9338.5	5.17 5.31
Beef Island, tuft in pine	32 31 51.20	80 30 03.89	306 11 01 269 39 52	Otter Island March	126 13 58 89 41 03	10624.1 3437.1	11618.2 3758.7	6.60 2.14
Beef Island, flag in tree	32 31 51.20	80 30 03.81	269 40 21 324 09 41	March Hutchinson	89 41 42 144 10 38	3435.3 4768.3	3756.8 5214.5	2.14 2.96
Fripp's Pine	32 28 17.50	80 31 03.48	304 20 08 268 14 31	Hunting Island Otter Island	124 23 34 88 17 59	12160.7 10136.5	13298.6 11085.0	7.56 6.30
Coffin's House, east corner	32 26 05.91	80 28 08.57	231 39 13 177 43 36	Otter Island Hutchinson	51 41 06 357 43 30	7028.1 6774.3	7685.7 7408.2	4.37 4.21
Coffin's Pine	32 24 49.26	80 27 38.41	215 24 17 275 28 24	Otter Island Hunting Island	35 25 55 95 30 00	8245.7 4704.2	9017.5 5144.4	5.12 2.92
Otter Island No. 2	32 28 16.03	80 23 34.66	250 13 12 13 53 02	Bay Point Hunting Island	70 14 59 193 52 27	5549.2 7024.1	6068.4 7681.3	3.45 4.36
Light-ship, (position at ebb tide, May, 1851.)	32 24 43.73	80 21 30.89	111 09 18 145 02 17	Egg Bank Otter Island	291 06 44 325 00 38	8030.6 8408.9	8782.0 9195.7	4.99 5.23
Hangman's Point	32 30 46.46	80 30 58.47	293 55 12 324 20 31	Hutchinson Morgan's Island	113 56 39 144 21 52	4614.4 6742.0	5046.2 7372.9	2.87 4.19

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—Florida Reef. Sketch No. 40.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
Pine Islands to Matecumbe Key.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Palmetto	24 39 36.72	81 27 41.92						
American Shoal	24 31 21.16	81 31 15.71						
Sawyer	24 45 04.85	81 32 55.06	45 11 25	Johnston's Key	225 10 17	6477.8	7083.9	4.03
			7 33 27	Point Dora	187 33 14	6651.7	7274.1	4.13
Budd	24 42 33.97	81 30 01.49	133 35 42	Sawyer	313 34 30	6733.1	7363.1	4.18
			71 16 14	Point Dora	251 14 49	6075.2	6643.7	3.77
Content	24 47 32.34	81 29 46.74	49 23 17	Sawyer	229 21 58	6969.2	7621.3	4.32
			2 35 04	Budd	182 34 58	9188.9	10048.7	5.70
Plover	24 44 21.63	81 25 15.58	67 34 27	Budd	247 32 28	8692.5	9505.9	5.40
			127 35 33	Content	307 33 39	9611.4	10510.7	5.97
Torch	24 41 18.82	81 23 54.23	157 54 26	Plover	337 53 52	6077.0	6645.6	3.77
			63 52 54	Palmetto	243 51 19	7130.0	7797.2	4.43
Newfound Harbor	24 37 20.96	81 24 10.58	125 06 55	Palmetto	305 05 27	7264.5	7944.2	4.51
			183 35 36	Torch	3 35 43	7332.1	8018.2	4.55
Harbor	24 48 41.72	81 26 35.61	68 19 17	Content	248 17 57	5776.2	6315.8	3.58
			344 17 22	Plover	164 17 56	8306.1	9083.3	5.16
Soldier Crab	24 46 36.19	81 22 28.08	48 42 23	Plover	228 41 13	6263.0	6849.0	3.89
			119 04 10	Harbor	299 02 26	7952.5	8696.6	4.94
Driftwood	24 44 23.82	81 22 00.50	169 13 48	Soldier Crab	349 13 36	4145.5	4533.4	2.57
			89 22 08	Plover	269 20 46	5480.9	5993.7	3.40
Johnson	24 45 55.29	81 19 32.23	55 58 03	Driftwood	235 57 01	5026.9	5497.3	3.12
			104 18 10	Soldier Crab	284 16 56	5097.3	5574.2	3 16
Little Pine, 1856	24 42 52.60	81 18 05.41	156 32 32	Johnson	336 31 56	6126.9	6700.2	3.80
			113 01 48	Driftwood	293 00 10	7177.4	7849.0	4.45
No Name, (Rockwell's)	24 41 50.18	81 20 32.74	192 42 06	Johnsón	12 42 31	7730.3	8453.6	4.80
			159 47 16	Soldier Crab	339 46 28	9377.2	10254.6	5.82
Middle Summerland	24 39 09.03	81 18 14.95	142 00 28	No Name, (Rockwell's)	321 59 31	6291.7	6880.4	3.90
			182 13 56	Little Pine, 1856	2 14 00	6883.5	7527.6	4.27
Big Pine	24 38 06.08	81 20 53.64	246 31 34	Middle Summerland	66 32 40	4864.4	5319.6	3.02
			184 52 09	No Name, (Rockwell's)	4 52 18	6919.9	7567.4	4.29
Big Pine East	24 39 50.58	81 20 27.47	288 55 39	Middle Summerland	108 56 34	3939.2	4307.8	2.44
			177 41 45	No Name, (Rockwell's)	357 41 43	3682.7	4027.3	2.28
Burnt Key	24 42 28.34	81 27 21.06	92 12 30	Budd	272 11 23	4511.7	4933.9	2.80
			225 16 43	Plover	45 17 35	4962.7	5427.0	3.08
Ramrod	24 38 46 36	81 25 33.24	113 12 11	Palmetto	293 11 17	3936.0	4304.3	2.44
			57 46 42	Loggerhead	237 45 21	6472.9	7078.6	4.02
Looe Key, (Rockwell's)	24 32 47.14	81 24 16.08	181 03 25	Newfound Harbor	1 03 27	8426.2	9214.6	5.23
			134 49 58	Loggerhead	314 48 05	10781.5	11790.3	6.69
Bahia Honda	24 39 55.24	81 15 07.94	137 34 39	Little Pine, 1856	317 33 25	7393.3	8085.1	4.59
			74 52 55	Middle Summerland	254 51 37	5446.6	5956.2	3.38
Cocoanut Key	24 44 34.04	81 14 08.69	64 52 42	Little Pine, 1856	244 51 03	7347.5	8035.0	4.56
			10 59 23	Bahia Honda	190 58 58	8737.8	9555.4	5.42
Molasses Key	24 40 53.69	81 11 32.40	147 04 12	Cocoanut Key	327 03 07	8077.7	8833.5	5.01
			73 28 51	Bahia Honda	253 27 21	6320.5	6911.9	3.92
Horseshoe Key	24 46 00.58	81 17 08.07	15 34 06	*Little Pine, 1856*	195 33 42	6003.7	6565.5	3.73
			297 50 20	Cocoanut Key	117 51 35	5699.7	6233.0	3.54
Pigeon Key, 1856	24 42 08.10	81 09 22.71	119 12 32	Cocoanut Key	299 10 33	9205.6	10067.0	5.72
			67 10 40	Bahia Honda	247 08 16	10530.1	11515.4	6.54
Lemon Key	24 46 27.29	81 13 43.86	11 19 33	Cocoanut Key	191 19 23	3553.3	3885.8	2.20
			340 11 55	Molasses Key	160 12 50	10907.9	11928.5	6.77
Sombrero Key, 1856	24 37 34.95	81 06 44.39	127 04 18	Molasses Key	307 02 18	10147.1	11096.6	6.30
			106 58 54	Bahia Honda	286 55 24	14802.2	16187.2	9.19
Boot Key, 1856	24 41 15.73	81 06 28.94	85 28 22	Molasses Key	265 26 16	8557.0	9357.7	5.31
			3 39 33	Sombrero Key, 1856	183 39 27	6806.4	7443.3	4.22
Knight's Key, 1856	24 42 12.89	81 07 27.60	351 54 43	Sombrero Key, 1856	171 55 01	8636.8	9444.9	5.36
			316 50 37	Boot Key, 1856	136 51 01	2410.4	2635.9	1.49
Eagle Cove	24 41 57.92	81 04 49.55	95 55 37	Knight's Key, 1856	275 54 31	4465.9	4883.8	2.77
			21 45 43	Sombrero Key, 1856	201 44 55	8711.0	9526.1	5.41
No Name, (Hilgard's)	24 40 23.36	81 18 46.17	194 00 33	Little Pine, 1856	14 00 50	4732.4	5175.2	2.94
			278 00 51	Bahia Honda	98 02 22	6195.8	6775.5	3.84

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—Florida Reef. Sketch No. 40.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Shoe	24 41 20.43	81 05 58.95	239 24 08	Eagle Cove	59 24 37	2266.2	2478.2	1.40
			122 56 16	Knight's Key, 1856	302 55 39	2968.5	3246.3	1.84
Ida	24 42 14.54	81 06 05.54	283 27 32	Eagle Co	103 28 04	2195.2	2401.7	1.36
			353 39 04	Shoe	173 39 07	1675.0	1831.7	1.04
Shellfish Key	24 43 10.36	81 17 20.94	183 56 42	Horseshoe Key	3 56 47	5249.6	5740.8	3.26
			244 30 19	Cocoanut Key	64 31 39	5984.1	6544.0	3.71
House, S.W. Gable of	24 42 13.64	81 07 19.60	70 55 14	Molasses Key	250 53 28	7519.4	8223.0	4.67
			353 24 43	Sombrero Key, 1856	173 24 57	8631.2	9438.8	5.36
Washerwoman	24 39 54.00	81 04 24 38	169 29 34	Eagle Cove	349 29 23	3877 6	4240.4	2.40
			125 41 07	Boot Key, 1856	305 40 13	4311.3	4714.7	2 67
East Sister	24 41 09.85	81 04 33 03	87 36 37	Molasses Key	267 33 42	11798.9	12902.9	7.33
			29 11 44	Sombrero Key, 1856	209 10 49	7573.2	8281.8	4.70
West Sister	24 41 05.26	81 05 32.95	265 12 03	East Sister	85 12 28	1690.4	1848.6	1.05
			17 14 58	Sombrero Key, 1856	197 14 28	6775.0	7408.9	4.21
Jacob's Point	24 43 02.12	81 01 40.80	69 35 19	Eagle Cove	249 34 00	5660.1	6189.7	3.51
			38 28 31	Washerwoman	218 27 23	7391.6	8083.2	4.59
Coffin's Patches	24 41 27.66	80 55 38.90	105 58 00	Jacob's Point	285 55 29	10578.3	11568.1	6.57
			93 28 29	Eagle Cove	273 24 39	15504.9	16955.7	9.63
Bethel Bank.	24 43 52.52	81 08 23 09	333 02 19	Knight's Key, 1856	153 02 41	3438.7	3760.5	2.13
			27 33 36	Pigeon Key, 1856	207 33 11	3623.2	3962.2	2.25
Bush	24 42 59.78	81 03 37.32	46 50 59	Eagle Cove	226 50 29	2782.4	3042.8	1.72
			268 44 01	Jacob's Point	88 44 50	3275.2	3581.7	2.03
Saunders' Cupola	24 43 32.94	81 02 15.37	56 00 08	Eagle Cove	235 59 04	5226.8	5715.9	3.24
			314 18 46	Jacob's Point	134 19 00	1357.4	1484.4	0.84
Hog Key	24 42 32.94	81 06 50.60	133 17 56	Bethel Bank	313 17 17	3570.0	3904.0	2.21
			79 52 30	Pigeon Key, 1856	259 51 26	4342.8	4749.2	2.69
Rachel Key	24 43 32.57	81 04 37.84	63 49 17	Hog Key	243 48 22	4157.6	4546.6	2.58
			95 32 54	Bethel Bank	275 31 20	6358.5	6953.5	3.95
Palmetto Bank	24 44 38.88	81 04 39.29	43 36 24	Hog Key	223 35 29	5350.6	5851.3	3.32
			358 51 08	Rachel Key	178 51 09	2040.5	2231.4	1.26
Stirrup Key	24 44 31.32	81 02 33.99	93 47 20	Palmetto Bank	273 46 28	3528.3	3858.4	2.19
			62 33 44	Rachel Key	242 32 52	3921.4	4288.3	2.43
Pigeon Key, 1849	24 42 08.57	81 09 21.87	57 53 15	Molasses Key	237 52 20	4332.1	4737.5	2.69
			119 03 36	Cocoanut Key	299 01 36	9219.1	10081.7	5.72
Boot Key, 1849	24 41 15.75	81 06 28.97	108 29 53	Pigeon Key, 1849	288 28 41	5124.9	5603.7	3.18
			85 28 11	Molasses Key	265 26 04	8556.3	9356.9	5.31
Sombrero Key, 1849	24 37 33.44	81 06 44.83	183 43 48	Boot Key, 1849	3 43 55	6853.8	7495.1	4.25
			127 19 21	Molasses Key	307 17 21	10165.2	11116.4	6.31
Knight's Key, 1849	24 42 12.95	81 07 28.53	316 25 35	Boot Key, 1849	136 26 00	2429.0	2656.3	1.50
			70 25 58	Molasses Key	250 24 16	7275.4	7956.2	4.52
Sister Key	24 41 05.26	81 05 32.93	101 34 34	Boot Key, 1849	281 34 11	1607.9	1758.3	0.99
			88 00 13	Molasses Key	267 57 43	10111.0	11057.1	6.28
West Bahia Honda	24 38 56.62	81 16 56.99	248 26 25	Molasses Key	68 28 40	9810.5	10728.5	6.09
			204 29 14	Cocoanut Key	24 30 24	11408.0	12475.5	7.08
Duck Key	24 40 52.10	81 13 48.99	269 15 30	Molasses Key	89 16 27	3839.8	4199.3	2.38
			175 21 59	Cocoanut Key	355 21 51	6850.5	7491.5	4.25
East Bahia Honda	24 39 55.03	81 15 08.27	59 32 56	West Bahia Honda	239 32 11	3545.7	3877.5	2.20
			253 25 27	Molasses Key	73 26 57	6331.2	6923.6	3.93
Little Pine Key, 1849	24 42 46.59	81 18 12.38	12 09 43	No Name, (Hilgard's)	192 09 29	4507.5	4929.3	2.80
			244 13 00	Cocoanut Key	64 14 42	7603.8	8315.3	4.72
Summerland Key	24 39 05.44	81 18 12.67	158 33 53	No Name, (Hilgard's)	338 33 39	2575.9	2816.9	1.60
			277 15 45	West Bahia Honda	97 16 17	2145.4	2346.2	1.33
East Summerland	24 39 17.98	81 18 03.66	149 17 46	No Name, (Hilgard's)	329 17 28	2339.7	2558.6	1.45
			289 19 09	West Bahia Honda	109 19 37	1986.7	2172.6	1.23
C.	24 39 31.29	81 16 40.05	80 07 42	East Summerland	260 07 07	2386.2	2609.5	1.48
			24 03 12	West Bahia Honda	204 03 05	1168.2	1277.5	0.72
Pine Key, (1)	24 38 19.56	81 20 00.64	208 47 43	No Name, (Hilgard's)	28 48 14	4346.8	4753.5	2.70
			257 32 24	West Bahia Honda	77 33 41	5288.5	5783.4	3.28
Pine Key, (2)	24 39 53.75	81 20 20.26	287 05 08	West Bahia Honda	107 06 33	5979.3	6538.8	3.71
			285 58 55	East Summerland	105 59 52	3994.8	4368.6	2.48
South Point	24 37 48.76	81 21 50.66	213 27 38	Pine Key, (2)	33 28 16	4609.6	5040.9	2.86
			255 47 47	West Bahia Honda	75 49 50	8517.7	9314.7	5.29

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—Florida Reef. Sketch No. 40.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Looe Key, (Hilgard's)	24 32 53.56	81 24 21.81	205 04 47	South Point	25 05 50	10028.0	10966.3	6.22
			228 13 12	West Bahia Honda	48 16 17	16772.5	18341.9	10.42
Crescent Shoal	24 45 26.80	81 06 30.66	336 08 39	Eagle Cove	156 09 21	7026.5	7684.0	4.36
			284 25 47	Stirrup, 1857	104 27 26	6868.7	7511.4	4.26
Stirrup, 1857	24 44 31.12	81 02 33.90	38 58 20	Eagle Cove	218 57 23	6061.8	6629.0	3.76
			251 35 08	Grassy Key	71 37 46	11194.8	12242.3	6.95
Horseneck West	24 48 46.72	81 00 51.38	228 48 01	Middle Shoal	48 49 36	8483.5	9277.3	5.27
			299 12 53	Grassy Key	119 14 49	8870.8	9700.2	5.51
Grassy Key	24 46 25.93	80 56 15.77	172 13 52	Middle Shoal	352 13 32	10010.0	10946.6	6.21
			249 31 00	Long Key	69 33 13	9505.3	10394.7	5.90
Middle Shoal	24 51 48.30	80 57 03.97	252 59 01	Horseneck East	73 01 15	9386.2	10264.5	5.83
			302 43 16	Long Key	122 45 49	12192.9	13333.8	7.57
Long Key	24 48 13.95	80 50 58.69	172 13 12	Horseneck East	352 12 53	9425.4	10307.3	5.85
			232 54 20	Jewfish	52 55 43	7002.4	7657.6	4.35
Horseneck East	24 53 17.48	80 51 44.16	306 42 00	Jewfish	126 43 43	8558.3	9359 1	5.31
			352 12 53	Long Key	172 13 12	9425.4	10307.3	5.85
Jewfish	24 50 31.18	80 47 39.74	52 55 43	Long Key	232 54 20	7002.4	7657.6	4.35
			126 43 43	Horseneck East	306 42 00	8558.3	9359.1	5.31
Sombrero Light-House	24 37 36.13	81 06 42.92	151 46 43	Pigeon, 1856	331 45 36	9497.1	10385.7	5.90
			201 35 02	Eagle Cove	21 35 49	8662.1	9472.6	5.38
Dewitt	24 43 25.58	81 00 42.27	122 44 20	Stirrup, 1857	302 43 34	3729 1	4078.0	2.21
			68 48 18	Eagle Cove	248 46 35	7454.4	8151.9	4.63
Bamboo	24 45 16.86	81 00 17.05	69 54 26	Stirrup, 1857	249 53 29	4094.3	4477.4	2.54
			171 30 26	Horseneck West	351 30 12	6528.3	7139.2	4.05
Fat Deer	24 44 13.82	81 00 52.81	207 23 17	Bamboo	27 23 32	2184.3	2388.7	1.35
			100 37 17	Stirrup, 1857	280 35 35	2889.7	3160.1	1.79
Crawl Cut	24 44 28.48	80 58 44.76	155 53 30	Horseneck West	335 52 37	8704.8	9519.3	5.40
			90 44 14	Stirrup, 1857	270 42 38	6438.5	7041.0	4.00
Willie	24 45 32.39	80 59 22.90	157 26 04	Horseneck West	337 25 27	6474.5	7080.3	4.02
			252 35 34	Grassy Key	72 36 52	5508.9	6024.4	3.42
Channel Key	24 47 32.86	80 55 03.89	103 07 43	Horseneck West	283 05 17	10019.6	10957.1	6.22
			44 26 12	Grassy Key	224 25 42	2883.7	3153.5	1.79
Duck Key	24 45 53.19	80 54 51.77	173 39 48	Channel Key	353 39 43	3085.3	3374.0	1.91
			113 07 18	Grassy Key	293 06 43	2565.6	2805.7	1.59
Conch Key	24 47 16.83	80 53 23.33	43 59 41	Duck Key	223 59 04	3576.6	3911.3	2.22
			99 54 41	Channel Key	279 53 59	2867.0	3135.3	1.78
Coffin's Patches, E. Screw Pile	24 41 30.37	80 56 23.88	181 26 08	Grassy Key	1 26 11	9096.0	9947.1	5.65
			216 19 38	Long Key	36 21 54	15415.5	16857.9	9.57
Tom's Harbor	24 45 41.03	80 55 58.76	258 44 56	Duck Key	78 45 24	1918.8	2098.4	1.19
			160 55 37	Grassy Key	340 55 30	1461.8	1598.6	0.91
Breckinridge	24 48 40.17	80 49 10.96	75 04 31	Long Key	255 03 46	3131.0	3424.0	1.95
			216 51 38	Jewfish	36 52 16	4269.2	4668.7	2.65
Viper	24 48 41.50	80 47 38.98	179 38 20	Jewfish	359 38 20	3374.7	3690.5	2.09
			81 25 03	Long Key	261 23 39	5671.9	6202.6	3.52
Estella Beach	24 45 56.58	80 56 26.62	272 14 09	Duck Key	92 14 49	2666.7	2916.2	1.66
			301 26 21	Tom's Harbor	121 26 33	917.4	1003.2	0.57
Cocoanut Tree	24 45 55.08	80 55 20.12	68 17 09	Tom's Harbor	248 16 53	1168.4	1277.7	0.73
			274 10 09	Duck Key	94 10 21	798.6	873.3	0.50
North Base	24 45 20.67	80.57 29.38	256 10 32	Tom's Harbor	76 11 10	6221.5	6803.6	3.86
			237 55 22	Estella Beach	57 55 48	2080.4	2275.1	1.29
Crawl Cut, (S. B.)	24 44 54.34	80.58 05.36	231 17 43	North Base	51 17 58	1295.5	1416.7	0.80
			248 00 13	Tom's Harbor	68 01 06	3835 7	4194.6	2.38
Bank Signal	24 44 14.49	80 58 23.23	216 36 58	North Base	36 37 20	2536.8	2774.2	1.58
			236 43 53	Tom's Harbor	56 44 53	4854.2	5308.4	3.02
Spar Buoy	24 41 49.24	80 58 25.17	218 36 03	Duck Key	38 37 30	9609.5	10508.7	5.97
			185 34 52	Crawl Cut, (S. B.)	5 35 00	5723.1	6258.6	3.56

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VII.—St. Mark's harbor. Sketch No. 44.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
Harbor of St. Mark's, Fla.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Base, north end	30 09 09.12	84 12 04.42	....	....	....	....	....	....
Base, south end	30 08 32.42	84 11 49.29	160 17 10	Base, north end	340 17 02	1200.2	1312.5	0.74
Astronomical Station	30 09 01.28	84 12 30.00	309 12 08	Base, south end	129 12 28	1405.9	1537.4	0.87
			250 34 59	Base, north end	70 35 12	725.7	793.6	0.45
Fort St. Mark's	30 09 01.13	84 12 30.33	308 49 36	Base, south end	128 49 57	1409.6	1541.5	0.88
			250 27 19	Base, north end	70 27 32	735.6	804.4	0.46
Walker	30 08 28.94	84 12 51.99	210 19 18	Fort St. Marks	30 19 29	1148.0	1255.4	0.71
			266 20 31	Base, south end	86 21 02	1681.2	1838.5	1.04
Port Leon	30 07 30.55	84 11 26.97	128 19 20	Walker	308 18 37	2900.0	3171.3	1.80
			162 35 31	Base, south end	342 35 20	1996.6	2183.4	1.24
West Bayou Point	30 06 37.40	84 12 58.10	236 08 21	Port Leon	56 09 07	2937.5	3212.4	1.82
			182 43 46	Walker	2 43 49	3438.4	3760.1	2.14
East River	30 06 43.32	84 11 03.47	156 36 30	Port Leon	336 36 18	1584.1	1732.3	0.98
			86 36 16	West Bayou Point	266 35 19	3074.0	3361.6	1.91
St. Marks Light-house	30 04 25.71	84 10 37.99	167 02 02	Port Leon	347 01 37	5839.5	6385.9	3.63
			137 14 08	West Bayou Point	317 12 58	5523.0	6039.8	3.43

Section VIII.—Coast of Mississippi and Louisiana. Sketch No. 47.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
Primary stations.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Dauphin Island, East base	30 15 02.38	W. 0 06 51.09	....	....	....	....	....	....
Dauphin Island, West base	30 14 27.48	0 13 27.90	264 11 19.4	Dauphin Isl'd, East base.	84 14 39.3	10661.5	11659.0	6.62
Cat Island	30 19 02.21	0 11 15.17	316 16 55.5	Dauphin Isl'd, East base.	136 19 08.7	10214.1	11169.6	6.34
			22 45 23.8	Dauphin Isl'd, West base	202 44 16.9	9172.3	10030.6	5.70
Cedar Point	30 20 50.43	0 05 53.84	8 07 37.8	Dauphin Isl'd, East base.	188 07 08.9	10825.4	11838.4	6.73
			45 50 51.0	Dauphin Isl'd, West base	225 47 01.9	16917.8	18500.8	10.51
Fort Morgan	30 13 46.23	0 00 00.00	93 15 32.4	Dauphin Isl'd, West base	273 08 45.6	21632.6	23656.6	13.44
			143 59 46.6	Cedar Point	323 56 48.1	16074.3	17578.4	9.99
Point aux Pins	30 22 09.77	0 17 28.36	335 41 28.0	Dauphin Isl'd, West base	155 43 29.3	15616.8	17078.0	9.70
			300 03 52.8	Cat Island	120 07 01.4	11518.8	12596.6	7.16
			277 27 20.2	Cedar Point	97 33 10.0	18705.2	20455.4	11.62
Petit Bois	30 12 15.29	0 22 23.24	254 05 26.0	Dauphin Isl'd, West base	74 09 55.5	14881.9	16274.3	9.25
			203 16 12.3	Point aux Pins	23 18 41.0	19928.1	21792.8	12.38
Grande Batture	30 19 31.77	0 23 50.73	299 19 55.7	Dauphin Isl'd, West base	119 25 09.8	19099.7	20886.9	11.87
			244 29 54.2	Point aux Pins	64 33 07.4	11311.0	12369.4	7.03
			350 07 21.8	Petit Bois	170 08 05.9	13641.1	14917.5	8.48
Horn Island, East, 1855	30 13 19.80	0 30 32.80	278 35 33.5	Petit Bois	98 38 56.2	13241.3	14480.3	8.23
			223 08 43.7	Grande Batture	43 12 06.4	15704.4	17173.9	9.76
Bayou Casotte	30 19 50.49	0 29 24.34	273 40 42.3	Grande Batture	93 43 31.7	8929.3	9764.8	5.55
			321 12 21.2	Petit Bois	141 15 53.5	17975.1	19657.0	11.17
			8 39 08.5	Horn Island, East, 1855.	188 38 34.0	12167.8	13306.3	7.56
East Pascagoula	30 20 41.51	0 31 22.19	354 27 10.1	Horn Island, East, 1855.	174 27 35.0	13664.2	14942.7	8.49
			296 30 49.2	Bayou Casotte	116 31 48.8	3517.9	3847.1	2.19
Belle Fontaine	30 20 38.18	0 41 11.33	308 18 05.6	Horn Island, East, 1855.	128 23 27.6	21756.4	23792.1	13.52
			269 35 08.8	East Pascagoula	89 40 06.4	15733.5	17205.6	9.77
Horn Island, West	30 15 18.82	0 41 45.88	281 27 51.3	Horn Island, East, 1855.	101 33 30.2	18363.6	20081.9	11.41
			185 21 36.4	Belle Fontaine	5 21 53.8	9876.5	10800.6	6.14
Deer Island, 1855	30 21 48.94	0 48 02.71	281 11 21.7	Belle Fontaine	101 14 49.6	11199.1	12247.0	6.96
			320 00 26.9	Horn Island, West	140 03 37.1	15672.8	17139.3	9.74
Ship Island, 1855	30 14 34.39	0 51 56.29	265 09 52.7	Horn Island, West	85 15 00.2	16374.3	17906 4	10.17
			204 59 14.5	Deer Island, 1855	25 01 12.3	14763.8	16145.2	9.17
Mississippi City	30 22 54.12	1 00 33.75	275 39 47.2	Deer Island, 1855	95 46 06.9	20151.2	22036.7	12.52
			318 01 38.6	Ship Island, 1855	138 05 59.8	20684.6	22620.0	12.85
Cat Island, 1855	30 14 21.74	W 1 02 41.36	192 11 04.7	Mississippi City	12 12 09.1	16140.8	17651.1	10.03
			268 39 38.1	Ship Island, 1855	88 45 03.0	17249.6	18863.6	10.72

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VIII.—Coast of Mississippi and Louisiana. Sketch No. 47.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Pitcher Point, (2)	30 20 02.54	W. 1 09 31.13	249 44 56.5	Mississippi City	69 49 28.1	15291.0	16721.8	9.50
			313 45 09.2	Cat Island, 1855	133 48 35.9	15166.0	16585.1	9.36
Cat Island Light	30 13 56.55	1 08 17.71	216 47 43.4	Mississippi City	36 51 37.5	20678.9	22613.8	12.85
			265 02 51.6	Cat Island, 1855	85 05 41.0	9025.7	9870.2	5.61
Ship Island Light	30 12 54.41	0 56 33.27	160 49 51.9	Mississippi City	340 47 50.6	19551.4	21380.8	12.15
			247 24 29.5	Ship Island, 1855	67 26 49.0	8019.9	8770.3	4.99
Chandeleur Light, 1855	30 03 07.67	0 51 12.85	176 51 24.8	Ship Island, 1855.	356 51 03.0	21176.1	23157.5	13.16
			154 37 49.8	Ship Island Light	334 35 08.9	19997.5	21868.7	12.42
Intermediate and secondary positions.								
Biloxi Light	30 23 45.41	0 52 40.97	355 58 22	*Ship Island, 1855*	175 58 45	17008.0	18599.4	10.57
			295 44 57	Deer Island, (1855)	115 47 18	8248.5	9020.3	5.13
Round Island Light	30 17 30.49	0 33 44.56	326 24 04	Horn Island East, 1855.	146 25 40	9265.6	10132.6	5.76
			212 52 31	East Pascagoula	32 53 42	7003.8	7659.1	4.35
Pascagoula River Light.	30 21 02.97	0 32 42.90	346 17 28	Horn Island East, 1855.	166 18 34	14678.7	16052.1	9.12
			53 53 30	Horn Island West	233 48 56	17964.7	19645.6	11.16
Monk's Point, hydrographic, 1855	30 21 02.05	0 43 37.58	344 13 23	Horn Island West	164 14 19	10981.3	12008.8	6.82
			101 32 48	Deer Island, (1855)	281 30 34	7225.4	7901.5	4.49
Chandeleur Islands.								
North Key	29 54 35.82	0 51 59.69	184 33 04	Chandeleur Light, 1855.	4 33 27	15809.3	17288.6	9.82
Rescue Hill	29 57 18.92	0 47 49.96	153 09 35	*Chandeleur Light, 1855.*	333 07 54	12035.9	13162.1	7.48
			53 09 11	North Key	233 07 06	8370.2	9153.4	5.20
North base	29 52 42.11	0 47 30.00	176 24 23	Rescue Hill	356 24 13	8539.5	9338.5	5.31
			115 50 33	North Key	295 48 19	8037.5	8789.6	4.99
New Harbor.	29 51 31.36	0 51 03.06	165 01 37	North Key	345 01 09	5879.2	6429.3	3.65
			249 07 42	North base	69 09 28	6118.0	6690.5	3.80
South base	29 51 10.19	0 47 47.50	97 05 32	New Harbor	277 03 54	5288.5	5783.3	3.29
			189 25 17	North base	9 25 25	2868.6	3137.0	1.78
Chandeleur North	30 03 07.91	0 51 15.14	332 53 14	Rescue Hill	152 54 56	12070.3	13199.7	7.50
			4 20 00	*North Key*	184 19 38	15811.9	17291.4	9.82
North base, (2)	29 52 40.59	0 47 42.99	68 21 30	New Harbor	248 19 50	5776.2	6316.7	3.59
			117 16 32	North Key	297 14 25	7746.5	8471.3	4.81
South base, (2)	29 51 12.15	0 47 49.03	96 29 34	New Harbor	276 27 57	5240.5	5730.9	3.26
			183 24 25	North base, (2)	3 24 28	2727.7	2982.9	1.69
Pelican Island	29 52 35.51	0 56 09.44	241 02 45	North Key	61 04 50	7656.0	8372.4	4.76
			283 29 15	New Harbor	103 31 48	8455.4	9246.6	5.25
Point Hope	29 50 47.81	0 55 38.31	259 41 37	New Harbor	79 43 55	7508.0	8210.4	4.66
			165 51 44	Pelican Island	345 51 28	3419.6	3739.6	2.12
Neptune Point	29 51 19.32	0 57 34.71	224 16 52	Pelican Island	44 17 35	3277.0	3583.7	2.04
			287 14 34	Point Hope	107 15 32	3271.2	3577.3	2.03
Point Nameless	29 49 47.10	0 57 02.36	162 59 57	Neptune Point	342 59 41	2969.1	3246.9	1.84
			230 21 07	*Point Hope*	50 21 49	2929.9	3204.0	1.82
Freemason Key	29 48 03.19	0 57 43 98	196 49 00	Pelican Island	16 49 47	8759.1	9578.7	5.44
			239 11 32	New Harbor	59 14 51	12524.0	13695.8	7.78
Isle of Palos	29 43 43.51	0 50 43.19	125 18 30	*Freemason Key*	305 15 01	13842.9	15138.2	8.60
			177 52 47	New Harbor	357 52 37	14414.1	15762.8	8.96
Peter Wilson	29 48 21.16	0 48 34.36	145 43 52	New Harbor	325 42 38	7086.9	7750.0	4.40
			193 00 37	South base, (2)	13 01 00	5403.4	5909.0	3.36
Dead Tree	29 51 33.95	0 55 07.51	221 58 17	North Key	41 59 51	7533.1	8238.0	4.68
			270 40 50	New Harbor	90 42 52	6560.6	7174.5	4.08
South Point of North Key, (post).	29 52 29.38	0 51 29.03	338 41 16	New Harbor	158 41 29	1917.5	2096.9	1.19
			266 29 13	North base	86 31 12	6425.4	7026.6	3.99
Lakes Borgne and Pontchartrain.								
Cat Island, 1852	30 14 21.90	1 02 41.10	133 46 42	Pitcher Point, (2)	313 43 15	15167.8	16587.1	9.42
			192 09 54	Mississippi City	12 10 48	16134.1	17643.8	10.02
Bayou Pierre, 1852	30 07 50.22	1 12 34.60	192 15 37	*Pitcher Point, (2)*	12 17 09	23075.8	25235.0	14.34
			232 44 12	Cat Island, 1852	52 49 11	19936.7	21802.1	12.39
Point Clear	30 15 55.01	W. 1 22 07.85	249 17 30	Pitcher Point, (2)	69 23 51	21606.5	23628.2	13.43
			314 11 37	Bayou Pierre, 1852	134 16 25	21397.7	23399.8	13.30

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VIII.—Coast of Mississippi and Louisiana. Sketch No. 47.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Grand Island, 1852	30 08 57.63	W.1 23 47.84	276 31 29	Bayou Pierre, 1852	96 37 07	18135.5	19832.4	11.27
			191 44 51	Point Clear	11 45 42	13126.5	14354.8	8.16
Nine Mile Bayou	30 01 43.21	1 23 14.80	236 33 49•	Bayou Pierre, 1852	56 39 10	20531.8	22453.0	12.76
			183 54 11	Point Clear	3 54 45	26287.8	28747.5	16.33
Grand Island, 1855	30 09 06.41	1 24 03.71	277 12 06	Bayou Pierre, 1852	97 17 52	18589.4	20328.9	11.55
			354 30 53	Nine Mile Bayou	174 31 17	13708.4	14991.1	8.52
Malheureux Point	30 04 32.14	1 28 14.89	218 30 30	Grand Island, 1855	38 32 36	10794.4	11804.4	6.71
			302 53 05	Nine Mile Bayou	122 55 35	9573.7	10469.5	5.95
Rigolet Light	30 09 21.31	1 37 41.45	300 22 39	Malheureux Point	120 27 23	17585.9	19231.4	10.93
			271 08 38	Grand Island, 1855	91 15 29	21885.2	23933.0	13.60
East Pearl River	30 11 04.09	1 30 04.20	290 33 56	Grand Island, 1855	110 36 57	10302.6	11266.6	6.40
			75 31 38	Rigolet Light	255 27 49	12635.3	13817.6	7.85
Oyster Bayou, 1855	30 03 50.51	1 19 07.11	59 26 42	Nine Mile Bayou	239 24 38	7705.9	8427.0	4.79
			140 47 41	Grand Island, 1855	320 45 13	12555.7	13730.5	7.80
Point aux Marchettes	29 59 39.37	1 33 48.30	257 17 47	Nine Mile Bayou	77 22 04	17398.2	19026.2	10.81
			160 48 20	Rigolet Light	340 46 23	18974.1	20749.5	11.79
Shell Point	30 04 27.38	1 39 44.70	312 51 38	Point aux Marchettes	132 54 36	13030.3	14249.5	8.10
			200 01 12	Rigolet Light	20 02 14	9632.5	10533.8	5.98
Fort Wood	30 04 00.36	1 46 52.63	265 49 07	Shell Point	85 52 41	11489.9	12565.0	7.14
			290 52 25	Point aux Marchettes	110 58 58	22496.4	24601.4	13.98
Proctor Point, 1853	29 57 34.77	1 42 06.49	253 56 11	Point aux Marchettes	74 00 20	13894.1	15194.2	8.63
			196 38 25	Shell Point	16 39 36	13260.0	14500.7	8.24
Proctorville Light	29 52 25.71	1 39 04.41	212 23 22	Point aux Marchettes	32 26 00	15815.9	17295.8	9.83
			152 50 39	Proctor Point, 1853	332 49 09	10695.2	11695.9	6.65
Martello Castle	29 56 47.64	1 48 44.09	262 13 16	Proctor Point, 1853	82 16 34	10758.3	11765.0	6.68
			192 31 41	Fort Wood	12 38 37	13653.9	14931.4	8.48
Battery Bienvenue	29 59 10.75	1 51 28.55	314 58 14	Martello Castle	134 59 34	6233.1	6816.3	3.87
			219 38 24	Fort Wood	39 40 42	11582.9	12666.7	7.20
Fort Pike	30 10 02.94	1 42 49.13	278 49 42	Rigolet Light	98 52 17	8331.1	9110.6	5.18
			334 26 55	Shell Point	154 28 28	11450.4	12521.8	7.11
Bonfouca Light	30 15 05.92	1 50 35.69	343 44 48	Fort Wood	163 46 40	21343.8	23340.9	13.26
			306 45 10	Fort Pike	126 49 04	15578.8	17036.5	9.68
Turkey Bayou	30 05 56.18	1 16 33.21	241 10 59	Bayou Pierre, 1852	61 12 58	7288.5	7970.5	4.53
			115 41 00	Grand Island, 1852	295 37 22	12905.0	14112.5	8.02
Oyster Bayou, 1852	30 03 50.67	1 19 07.25	234 55 04	Bayou Pierre, 1852	54 58 21	12841.3	14042.9	7.98
			141 32 34	Grand Island, 1852	321 30 13	12072.5	13202.1	7.50
Shell Bank	30 05 17.74	1 15 51.62	136 44 41	Turkey Bayou	316 44 20	1624.9	1776.9	1.01
			228 18 42	Bayou Pierre, 1852	48 20 21	7060.7	7721.4	4.39
East Branch	30 04 41.84	1 15 21.83	140 08 30	Turkey Bayou	320 07 55	2981.8	3260.8	1.85
			217 39 02	Bayou Pierre, 1852	37 40 26	7326.8	8012.4	4.55
Grand Pass	30 05 39.74	1 11 50.10	93 50 24	Turkey Bayou	273 48 02	7596.4	8307.2	4.72
			72 33 33	East Branch	252 31 47	5942.7	6498.8	3.69
Gull Island	30 02 27.86	1 14 21.57	151 12 58	Turkey Bayou	331 11 52	7319.1	8004.0	4.55
			214 27 46	Grand Pass	34 29 01	7166.6	7837.3	4.45
Crooked Island	30 00 29.70	1 18 04.59	105 15 21	Nine Mile Bayou	285 12 46	8614.2	9420.2	5.35
			162 49 46	Oyster Bayou, 1852	344 49 15	6411.6	7011.6	3.98
Wild Goose Island	29 59 12.84	1 20 39.85	240 21 32	Crooked Island	60 22 50	4786.6	5234.5	2.97
			138 07 32	Nine Mile Bayou	318 06 15	6219.1	6801.0	3.86
Shell Island	29 58 47.13	1 24 21.51	198 14 40	Nine Mile Bayou	18 15 13	5708.6	6242.7	3.55
			262 23 48	Wild Goose Island	82 25 39	5993.6	6554.4	3.72
Grassy Island	30 07 18.96	1 26 45.98	331 18 15	Nine Mile Bayou	151 20 01	11783.3	12885.9	7.32
			237 28 52	Grand Island, 1852	57 30 21	5653.1	6182.1	3.51
Lower Point Clear	30 10 26.64	1 26 23.79	303 17 12	Grand Island, 1852	123 18 30	4991.9	5459.0	3.10
			5 52 11	Grassy Island	185 52 00	5808.9	6352.4	3.61
Mouth of Pearl River, tree	30 11 09.05	1 30 05.56	291 47 48	Grand Island, 1852	111 50 58	10885.3	21903.9	6.76
			322 58 42	Grassy Island	143 00 22	8871.7	9701.8	5.51
St. Joseph's Island	30 11 16.19	1 24 05.36	353 43 47	Grand Island, 1852	173 43 56	4292.0	4693.6	2.67
			67 36 55	Lower Point Clear	247 35 45	4005.0	4379.8	2.49
Pearl River Island	30 10 07.31	1 32 56.55	79 29 30	Rigolet Light	259 27 07	7752.5	8477.9	4.82
			314 51 42	Nine Mile Bayou	134 56 33	21987.4	24044.8	13.66
Proctor Point, 1852	29 57 35.13	W.1 42 06.28	253 58 25	Point aux Marchettes	74 02 34	13885.5	15184.8	8.63
			147 07 20	Fort Wood	327 04 57	14126.4	15448.2	8.78

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VIII.—Coast of Mississippi and Louisiana. Sketch No. 47.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Alligator Point	30 01 32.33	W. 1 41 38.26	5 52 22	Proctor Point, 1852	185 52 08	7341.8	8028.8	4.56
			285 24 22	Point aux Marchettes	105 28 17	13064.4	14286.8	8.12
Bayou No. 1	29 58 04.43	1 51 56.40	294 37 15	Martello Castle	114 38 51	5672.1	6202.8	3.52
			200 04 46	Battery Bienvenue	20 05 00	2173.9	2377.3	1.35
Little Bayou	30 01 33.01	1 29 55.01	60 46 53	Point aux Marchettes	240 44 56	7163.6	7833.9	4.45
			139 08 10	Rigolet Light	319 04 16	19075.2	20860.0	11.85
Oak Hammock	29 52 46.93	1 34 26.11	125 42 00	Proctor Point, 1853	305 38 10	15196.7	16620.8	9.44
			184 33 44	Point aux Marchettes	4 34 03	12739.1	13931.1	7.92
West Shore	30 06 40.40	1 38 43.85	328 34 09	Point aux Marchettes	148 36 37	15189.0	16610.2	9.44
			198 37 20	Rigolet Light	18 37 51	5228.2	5717.4	3.25
East Shore	29 55 25.39	1 34 03.52	107 10 59	Proctor Point, 1852	287 06 58	13547.2	14814.8	8.42
			182 59 08	Point aux Marchettes	2 59 16	7830.7	8563.5	4.87
Bonfouca	30 14 20.22	1 50 10.54	294 37 13	Rigolet Light	114 43 31	22047.5	24110.4	13.70
			334 28 42	Fort Wood	164 30 21	19806.4	21659.7	12.31
Little Woods	30 06 14.96	1 53 39.95	200 32 21	Bonfouca	20 34 06	15956.8	17449.9	9.92
			257 19 34	Rigolet Light	77 27 35	26286.8	28746.4	16.33
Point aux Herbes	30 09 27.15	1 49 51.67	334 30 58	Fort Wood	154 32 26	11144.9	12187.7	6.92
			176 47 58	Bonfouca	356 47 49	9037.9	9883.5	5.62
Bayou Grande	29 57 03.80	1 30 45.33	60 19 25	East Shore	240 17 46	6117.9	6690.4	3.80
			134 20 00	Point aux Marchettes	314 18 28	6855.7	7497.2	4.26
Lone Tree	29 56 26.63	1 30 42.14	70 46 02	East Shore	250 44 21	5720.1	6255.3	3.55
			139 57 06	Point aux Marchettes	319 55 33	7754.0	8479.6	4.82
Saint Malo Swamp	29 53 23.99	1 30 41.58	124 37 09	East Shore	304 35 28	6581.1	7196.9	4.09
			156 35 26	Point aux Marchettes	336 33 53	12595.5	13774.0	7.83
East Cove	29 54 16.21	1 42 39.61	300 29 35	Proctorville Light	120 31 22	6700.9	7327.9	4.16
			188 15 43	Proctor Point, 1853	8 16 00	6177.6	6755.7	3.84
House on Proctor Point, south-east gable.	29 56 17.61	1 43 03.38	350 19 00	East Cove	170 19 12	3791.9	4146.7	2.36
			212 42 04	Proctor Point, 1853	32 42 32	2823.1	3087.3	1.75
Fort Wood Flagstaff	30 03 58.38	1 46 53.55	202 10 31	Fort Wood	22 10 31	65.9	72.1	0.04
			236 01 49	Rigolet Light	56 06 26	17812.4	19479.2	11.07
Saw Mill, (1)	30 11 13.83	1 37 14.49	11 45 40	Rigolet Light	191 45 26	3538.8	3869.9	2.20
			286 30 51	Pearl River Island	106 33 00	7197.1	7870.6	4.47
Saw Mill, (2)	30 13 11.23	1 35 27.88	26 46 40	Rigolet Light	206 45 33	7932.5	8674.7	4.93
			324 27 07	Pearl River Island	144 28 23	6962.8	7614.3	4.33
North West Signal	30 10 18.42	1 38 31.77	322 33 31	Rigolet Light	142 33 56	2214.5	2421.7	1.38
			86 03 28	Fort Pike	266 01 19	6901.6	7547.4	4.29
East Rigolet	30 09 03.34	1 36 02.49	101 48 35	Rigolet Light	281 47 45	2704.8	2957.8	1.68
			154 23 16	Saw Mill, (1)	334 22 40	4455.8	4872.7	2.77
North East Signal	30 10 20.02	1 35 23.52	63 54 36	Rigolet Light	243 53 27	4109.4	4493.9	2.55
			23 49 53	East Rigolet	203 49 33	2581.2	2822.7	1.60
Saint Catharine	30 06 52.21	1 44 20.05	246 41 14	Rigolet Light	66 44 34	11613.4	12700.0	7.22
			202 29 58	Fort Pike	22 30 44	6356.7	6951.5	3.95
Claiborne	30 14 02.16	1 33 07.66	40 16 40	Rigolet Light	220 14 22	11331.5	12391.8	7.04
			357 39 01	Pearl River Island	177 39 07	7237.0	7914.2	4.50
Rigolet, north telegraph pole	30 10 50.71	1 43 09.07	287 24 35	Rigolet Light	107 27 19	9187.1	10046.8	5.71
			25 21 15	Fort Wood	205 19 23	13979.6	15287.6	8.69
Rigolet, south telegraph pole	30 10 35.28	1 43 14.36	284 19 14	Rigolet Light	104 22 01	9194.0	10054.3	5.71
			25 40 33	Fort Wood	205 38 43	13489.8	14752.0	8.38
Chef Menteur, northeast telegraph pole.	30 04 18.53	1 46 56.69	211 58 58	Fort Pike	32 01 02	12503.9	13673.9	7.77
			348 54 13	Fort Wood	168 54 15	17545.3	19187.0	10.90
Chef Menteur, southwest telegraph pole.	30 04 15.37	1 47 05.41	212 38 21	Fort Pike	32 40 30	12709.8	13899.0	7.90
			323 17 20	Fort Wood	143 17 26	575.2	629.0	0.36
Nifflheim.	30 05 37.76	1 39 22.50	147 50 05	Rigolet, N. tel. pole	327 48 11	11384.8	12450.0	7.07
			78 41 24	Chef Menteur, N.E. tel. pole.	258 37 36	12404.0	13564.7	7.71
Raggedy Point	30 15 27.52	1 57 26.69	340 21 47	Little Woods	160 23 41	18062.0	19752.1	11.22
			280 02 50	Bonfouca	100 06 30	11841.6	12949.6	7.36
Pontchartrain	30 01 46.31	2 02 18 38	197 08 07	Raggedy Point	17 10 34	26462.3	28938.4	16.44
			239 10 41	Little Woods	59 15 01	16161.1	17673.3	10.04
Schooner Sinus	30 15 46.70	2 04 26.21	352 27 38	Pontchartrain	172 28 42	26100.7	28543.0	16.23
			272 59 09	Raggedy Point	93 02 40	11228.6	12279.3	6.98
Jefferson	30 01 06.52	W. 2 05 52.90	184 53 11	Schooner Sinus	4 53 55	27199.8	29744.9	16.90
			257 57 08	Pontchartrain	77 58 55	5876.5	6426.4	3.65

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VIII.—Coast of Mississippi and Louisiana. Sketch No. 47.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Railroad Wharf, Jefferson and Pontchartrain.	30 01 43.83	W. 2 05 50.89	269 13 01	Pontchartrain	89 14 47	5693.8	6226.6	3.54
			2 40 52	Jefferson	182 40 51	1150.0	1257.6	0.71
Breakwater	30 02 36.99	2 02 18.29	0 05 29	Pontchartrain	180 05 29	1560.5	1706.5	0.97
			73 58 50	Railr'd Wht., Jeff. and Pontchartrain.	253 57 04	5925.9	6480.4	3.68
Point of Woods	30 03 05.33	1 57 29.35	83 35 19	Breakwater	263 32 54	7788.3	8517.1	4.84
			72 34 33	Pontchartrain	252 32 08	8115.6	8875.0	5.04
Bayou St. John	30 01 52.09	2 03 34.94	236 02 40	Breakwater	56 03 18	2475.5	2707.2	1.54
			274 57 14	Pontchartrain	94 57 52	2058.8	2251.4	1.28
New Canal Light-house	30 01 42.56	2 05 25.09	251 28 22	Breakwater	71 29 55	5277.5	5771.4	3.28
			268 39 57	Pontchartrain	88 41 30	5003.5	5471.4	3.11
Marine Hospital	29 56 19.94	2 01 50.26	143 37 23	Jefferson	323 35 22	10961.5	11987.2	6.81
			175 42 44	Pontchartrain	355 42 30	10076.9	11019.8	6.26
Greenville	29 55 41.05	W. 2 06 24.63	260 44 17	Marine Hospital	80 46 34	7454.4	8151.9	4.63
			184 50 58	Jefferson	4 51 14	10056.9	10997.9	6.25

Section IX.—Coast of Texas. Sketch No. 53.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
Matagorda Bay.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Live Oak	28 44 42.31	W. 7 44 59.47	....	....	....	....	....	....
Sargent	28 43 43.83	7 40 04.37	....	....	....	....	....	....
Bath, 1855	28 41 04.68	7 45 22.90	185 25 12	Live Oak	5 25 23	6729.2	7358.9	4.18
			240 26 13	Sargent	60 28 46	9936.2	10865.9	6.17
Seven Mile Station	28 43 32.96	7 51 03.20	257 46 14	Live Oak	77 49 09	10097.1	11041.9	6.27
			296 16 36	Bath, 1855	116 19 19	10302.2	11266.2	6.40
Duncan	28 39 31.92	7 51 04.31	180 13 52	Seven Mile Station	0 13 53	7420.0	8114.3	4.61
			252 51 16	Bath, 1855	72 54 00	9698.6	10606.1	6.03
Matagorda	28 41 28.95	7 57 03.76	248 39 48	Seven Mile Station	68 42 41	10503.2	11486.0	6.53
			290 14 21	Duncan	110 17 13	10401.9	11375.2	6.46
Gulf Shore	28 36 29.26	7 56 15 36	171 53 48	Matagorda	351 53 25	9318.5	10190.4	5.79
			236 19 52	Duncan	56 22 21	10147.9	11097.4	6.31
Mad Island	28 38 19.21	8 03 32.69	241 01 32	Matagorda	61 04 39	12067.4	13196.5	7.50
			285 52 29	Gulf Shore	105 55 59	12351.0	13506.7	7.67
Shell Island	28 37 19.90	8 02 26.13	228 45 52	Matagorda	48 48 27	11635.7	12724.5	7.23
			278 46 27	Gulf Shore	98 49 25	10191.0	11144.6	6.33
Three Mounds	28 34 35.02	8 02 56.98	172 00 00	Mad Island	351 59 43	6969.0	7621.1	4.33
			252 06 35	Gulf Shore	72 09 47	11464.1	12536.8	7.12
Barn	28 34 33.24	8 01 23.41	161 37 53	Shell Island	341 37 23	5405.6	5911.4	3.36
			208 50 25	Matagorda	28 52 29	14610.9	15978.0	9.08
Chimney of House	28 35 16.08	7 59 35.57	129 27 17	Shell Island	309 25 55	5999.6	6561.0	3.73
			199 45 51	Matagorda	19 46 04	12196.1	13337.3	7.58
Dog Island	28 39 08.95	8 00 17.50	230 39 26	Matagorda	50 40 59	6799.9	7436.2	4.23
			306 45 44	Gulf Shore	126 47 40	8210.3	8978.5	5.10
Ruin Rancho	28 37 28.72	7 53 35.56	142 37 06	Matagorda	322 35 26	9308.0	10179.0	5.78
			227 16 23	Duncan	47 17 35	5590.4	6113.5	3.47
Idleburg's House	28 40 20.83	7 46 54.72	77 29 07	Duncan	257 27 07	6941.1	7590.6	4.31
			131 15 57	Seven Mile Station	311 13 58	8970.3	9809.7	5.57
Hawkins' (Col.) new house	28 49 41.77	7 46 44.19	31 45 50	Seven Mile Station	211 43 45	13350.9	14600.1	8.29
			352 06 25	Bath, 1855	172 07 04	16069.6	17573.2	9.98
Three Mile Signal	28 42 29.65	7 54 27.14	314 48 17	Duncan	134 49 54	7761.9	8488.2	4.82
			66 16 49	Matagorda	246 15 34	4643.3	5077.8	2.88
Eleven Mile Signal	28 44 24.17	7 47 57.60	325 37 47	Bath, 1855	145 39 01	7438.9	8135.0	4.62
			72 37 48	Seven Mile Signal	252 36 19	5276.7	5770.4	3.28
Lake	28 36 13.45	W. 8 08 56.84	246 14 39	Mad Island	66 17 14	9617.7	10517.6	5.98
			287 11 41	Three Mounds	107 14 33	10235.9	11193.7	6.36

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section IX.—Coast of Texas. Sketch No. 53.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
High Mound	28 31 17.58	W.8 08 42.11	177 29 02	Lake	357 28 55	9116.3	9969.3	5.66
			237 02 19	Three Mounds	57 05 04	11177.2	12223.1	6.94
Osgood	28 27 42.87	8 17 00.45	219 52 46	Lake	39 56 37	20490.4	22407.7	12.73
			243 58 09	High Mound	64 02 07	15078.0	16488.9	9.37
Well Point	28 38 33.78	8 18 31.87	285 25 20	Lake	105 29 55	16204 7	17721.0	10.07
			352 55 30	Osgood	172 56 14	20190.1	22079.3	12.55
Mad Island West	28 37 33.28	8 05 25.58	323 38 59	Three Mounds	143 40 10	6812.5	7450.0	4.23
			66 49 51	Lake	246 48 10	6242.5	6826.6	3.88
Green's Line	28 32 56.34	8 05 06.36	134 06 29	Lake	314 04 39	8719.9	9535.8	5.42
			229 10 08	Three Mounds	49 11 10	4646.5	5081.3	2.89
Philipp's House	28 29 54.60	8 11 37.45	200 30 38	Lake	20 31 55	12452.1	13617.3	7.74
			241 48 21	High Mound	61 49 45	5408.6	5914.7	3.36
Palacios	28 34 36.87	8 12 55.03	311 43 38	High Mound	131 45 39	9213.4	10075.5	5.72
			245 18 45	Lake	65 20 39	7121.7	7788.1	4.42
Grimes' House	28 36 05.69	8 12 54.60	267 52 02	Lake	87 53 56	6463.3	7068.1	4.02
			322 15 14	High Mound	142 17 15	11213.4	12262.6	6.97
Shell Reef Point	28 38 32.95	8 13 26.32	300 22 58	Lake	120 25 07	8486.0	9280.0	5.27
			90 11 45	Well Point	270 09 19	8297.7	9074.1	5.16
Turtle Bay	28 40 33.42	8 15 23.91	319 16 01	Shell Reef Point	139 16 57	4893.8	5351.7	3.04
			54 11 37	Well Point	234 10 07	6293.6	6882.5	3.91
Tarantula	28 41 42.79	8 13 27.21	359 45 47	Shell Reef Point	179 45 47	5844.1	6390.9	3.63
			56 01 34	Turtle Bay	236 00 38	3820.3	4177.8	2.37
Mott	28 40 53.94	8 11 07.03	41 04 39	Shell Reef Point	221 03 32	5756.6	6295.3	3.58
			111 34 34	Tarantula	291 33 27	4091.5	4474.3	2.54
Fiber's House	28 38 02.20	8 20 16.35	251 04 54	Well Point	71 05 44	2999.1	3279.7	1.86
			344 22 58	Osgood	164 24 32	19791.1	21646.2	12.30
Half Moon Reef	28 32 54.81	8 14 32.80	148 06 52	Well Point	328 04 58	12290.9	13441.0	7.64
			236 09 45	Lake	56 12 26	10987.5	12015.6	6.83
Brant House	28 35 38.30	8 25 09.05	243 22 32	Well Point	63 25 42	12064.9	13193.8	7.50
			317 44 27	Osgood	137 48 20	19763.7	21613.0	12.28
Casimir House	28 30 54.76	8 28 30.78	228 59 36	Well Point	49 04 23	21551.7	23568.3	13.39
			287 25 12	Osgood	107 30 41	19680.9	21522.4	12.23
La Salle	28 30 01.99	W.8 27 01.99	221 18 37	Well Point	41 22 41	20984.6	22948.1	13.04
			284 37 42	Osgood	104 42 29	16911.4	18493.8	10.51

Section X.—Vicinity of San Francisco. Sketch No. 57.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
Eastern shore of San Francisco bay.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Red Hill	37 33 01.62	122 04 42.24	....	....	....	....	....	....
			....	....	....	....	....	....
Union Island	37 34 18.59	122 05 13.78	....	....	....	....	....	....
			....	....	....	....	....	....
Uncle Edward	37 34 00.31	122 06 34.98	303 10 25	Red Hill	123 11 34	3305.8	3615.1	2.05
			254 12 17	Union Island	74 13 07	2070.6	2264.4	1.29
Peak	37 33 12.04	122 04 39.37	157 37 57	Union Island	337 37 36	2218.3	2425.9	1.38
			117 41 04	Uncle Edward	297 39 53	3203.4	3503.1	1.99
Union Creek	37 36 22.16	122 07 41.70	339 28 23	Uncle Edward	159 29 04	4669.1	5506.0	2.90
			316 22 49	Union Island	136 24 19	5261.1	5753.4	3.27
Contra Costa, (2)	37 37 19.66	122 08 05.80	340 04 12	Uncle Edward	160 05 07	6535.7	7147.3	4.06
			322 54 03	Union Island	142 55 48	6996.2	7650.8	4.35
Red Chimney	37 37 29.40	122 06 30.55	0 58 00	Uncle Edward	180 57 57	6446.5	7049.7	4.01
			342 14 35	Union Island.	162 15 22	6177.2	6755.2	3.84
Union City Mills, (Rodgers')	37 35 40.49	122 04 24.70	45 59 23	Uncle Edward	225 58 03	4444.6	4860.5	2.76
			119 26 08	Contra Costa, (2)	299 24 53	6223.5	6805.8	3.87

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section X.—Vicinity of San Francisco. Sketch No. 57.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Eden Staff	37 37 01.36	122 06 07.23	6 57 21	Uncle Edward	186 57 04	5622.4	6148.5	3.49
			100 58 28	Contra Costa, (2)	280 57 16	2960.6	3237.6	1 84
Ditch, (Rodgers')	37 39 36.30	122 08 24.91	353 38 41	Contra Costa, (2)	173 38 53	4238.5	4635.1	2.63
			324 21 28	Red Chimney	144 21 19	4810.9	5261.1	2.99
Thompson's Point	37 40 33.07	122 08 58.76	334 38 03	Ditch, (Rodgers')	154 38 24	1936.7	2117.9	1.20
			347 42 27	Contra Costa, (2)	167 42 59	6102.8	6673.8	3.79
Contra Costa, (1)	37 41 41.42	122 10 16.54	324 40 10	Ditch, (Rodgers')	144 41 18	4730.5	5173.1	2.94
			338 20 13	Contra Contra, (2)	158 21 33	8685.5	9498.2	5.40
San Lorenzo	37 39 43.26	122 07 32.95	10 18 06	Contra Costa, (2)	190 17 46	4499.8	4920.8	2.80
			126 08 30	Thompson's Point	306 07 37	2603.8	2847.4	1.62
North Chimney	37 39 10.89	122 06 16.12	117 55 10	San Lorenzo	297 54 23	2131.1	2330.5	1.32
			103 56 54	Ditch, (Rodgers')	283 55 35	3259.4	3564.4	2.03
Kerr	37 40 27.19	122 07 18.60	94 13 26	Thompson's Point	274 12 25	2461.2	2691.5	1.53
			14 33 22	San Lorenzo	194 33 13	1399.1	1530.0	0.87
Polite Man	37 41 20.70	122 07 50.90	334 21 36	Kerr	154 21 56	1829.6	2000.8	1.14
			48 33 17	Thompson's Point	228 32 35	2218.4	2426.0	1.38
Thompson's Staff	37 40 39.78	122 08 49.94	279 49 53	Kerr	99 50 49	2217.5	2425.0	1.38
			312 43 16	San Lorenzo	132 44 03	2568.2	2808.5	1.60
Warehouse	37 41 00.07	122 09 23.22	324 15 24	Thompson's Point	144 15 39	1025.7	1121.7	0.64
			254 17 11	Polite Man	74 18 07	2349.4	2569.2	1.46
Ballenas Bay.								
Cayote Ridge	37 51 57.77	122 32 07.58	...	...	...	...	...	...
			...	...	...	...	...	...
Duxbury	37 52 40.10	122 34 39.24	...	...	...	...	...	...
			...	...	...	...	...	...
Bald Hill	37 53 49.74	122 35 19.84	306 17 32	Cayote Ridge	126 19 30	5829.5	6375.0	3.62
			335 11 56	Duxbury	155 12 21	2365.0	2586.3	1.47
Rocky Point	37 52 42.23	122 36 05.24	208 02 59	Bald Hill	28 03 27	2358.5	2579.2	1.46
			271 46 44	Duxbury	91 47 37	2102.4	2299.1	1.31
Frank's Lagoon	37 51 42.69	122 34 06.01	122 13 01	Rocky Point	302 11 48	3443.7	3765.9	2.14
			155 21 10	Duxbury	335 20 50	1947.3	2129.5	1.21
Ballenas Reef Point	37 53 37 26	122 41 04.85	267 21 23	Bald Hill	87 24 55	8437.4	9226.9	5.24
			283 01 22	Rocky Point	103 04 26	7514.5	8217.6	4.67
Ballenas Bluff	37 54 08.55	122 40 23.38	46 24 38	Ballenas Reef Point	226 24 12	1398.9	1529.8	0.87
			292 51 19	Rocky Point	112 53 58	6845.2	7485.7	4.25
Ballenas Beach	37 54 25.65	122 39 32.85	56 26 00	Ballenas Reef Point	236 25 03	2697.4	2949.8	1.68
			66 52 33	Ballenas Bluff	246 52 02	1342.1	1467.7	0.83
Briones	37 55 17.76	122 41 35.29	346 30 10	Ballenas Reef Point	166 20 29	3186.2	3484.3	1.98
			298 14 12	Ballenas Beach	118 15 28	3394.4	3712.0	2.11
Embarcadero	37 56 04 59	122 40 21.39	338 45 35	Ballenas Beach	158 46 05	3272.4	3578.6	2.03
			51 20 28	Briones	231 19 40	2310.9	2527.1	1.44
Morgan	37 54 48.65	122 38 02.49	124 37 27	Embarcadero	304 36 01	4121.5	4507.2	2.56
			72 11 53	Ballenas Beach	252 10 57	2318.3	2535.2	1.44
Rodea Stake	37 54 08.27	122 40 54.62	192 44 59	Embarcadero	12 45 19	3676.8	4020.8	2.28
			155 07 54	Briones	335 07 29	2361.2	2582.1	1.47
Baulenes North	37 54 08.16	122 42 20.04	206 59 32	Briones	26 59 59	2408.1	2633.4	1.50
			297 24 10	Ballenas Reef Point	117 24 57	2069.1	2262.7	1.29
Briones House, south gable end	37 55 06.05	122 40 37.43	192 14 42	Embarcadero	12 14 52	1846.5	2019.3	1.15
			308 17 50	Ballenas Beach	128 18 29	2009.8	2197.8	1.25
Embarcadero House, south gable end	37 55 56.04	122 40 54.42	251 54 30	Embarcadero	71 54 51	848.5	927.9	0.53
			324 26 04	Ballenas Beach	144 26 54	3425.5	3746.0	2.13
Entrance to San Francisco bay.								
Point Bonata Light-house	37 49 10.05	122 30 50.26	296 13 50	Presidio Hill	116 16 17	6562.0	7176.1	4.08
			285 30 15	Fort Point	105 32 15	4951.1	5414.4	3.08
Point Bonata Light, keeper's house.	37 49 14.74	122 30 46.35	297 44 18	Presidio Hill	117 46 43	6542.8	7155.0	4.06
			287 25 48	Fort Point	107 27 45	4900.2	5358.7	3.04
Fort Point Light-house	37 48 37.37	122 27 37.85	168 55 31	Lime Point Bluff	348 55 22	1888.9	2065.7	1.17
			39 20 00	Point Lobos, (1)	219 19 06	3389.4	3706.5	2.11
Inside Telegraph Station	37 47 42.25	122 27 35.35	173 11 48	Lime Point Bluff	353 11 37	3578.2	3913.0	2.22
			180 09 39	Fort Point	0 09 39	1381.7	1511.0	0.86

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section X.—Vicinity of San Francisco. Sketch No. 57.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Outside Telegraph Station......	37 46 56.55	122 29 23.32	221 37 19	Point Lobos (1)........	41 37 30	651.1	712.0	0.40
			223 27 37	Fort Point............	43 28 43	3844.6	4204.4	2.39
Point Lobos, site of light-house.	37 46 56.87	122 29 39.50	227 33 07	Fort Point............	47 34 23	4120.4	4506.0	2.56
			207 48 27	Lime Point Bluff......	27 49 33	5598.8	6122.8	3.48
Alcatraz Island Light-house....	37 49 33.01	122 24 18.77	45 38 23	Presidio Hill..........	225 36 51	5162.0	5645.1	3.21
			67 04 44	Fort Point............	247 02 43	5216.3	5704.4	3.24

Section XI.—Canal de Haro and Rosario Strait. Sketch No. 63.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Lummi Island, astronomical station.	48 44 01.74	0 00 00.00	....	....	....	....	....	....
Lummi Island, South base......	48 47 10.45	W.0 01 14.42	345 22 46	Lummi Island, astro-*nomical station.*	165 23 42	6023.7	6587.3	3.74
Bend............	48 46 41.09	E. 0 02 28.84	31 42 55	Lummi Isl'd, ast. station.	211 41 03	5784.7	6326.0	3.59
			101 16 50	Lummi Island, S. base..	281 14 02	4646.5	5081.4	2.89
River Point....................	48 48 00.35	W.0 00 15.89	37 47 03	Lummi Island, S. base..	217 46 44	1949.7	2132.1	1.21
			306 02 35	Bend..................	126 04 39	4158.9	4548.0	2.58
Lummi Island, North base......	48 47 48.62	0 01 17.15	357 17 44	Lummi Island, S. base..	177 17 46	1180.0	1290.4	0.73
			253 49 42	River Point...........	73 50 28	1301.4	1423.2	0.81
Lummi Island................	48 44 53.18	0 01 34.96	185 38 51	Lummi Island, S. base .	5 39 07	4260.8	4659.5	2.65
			236 10 19	Bend..................	56 13 22	5091.1	6551.7	3.72
Matia Island East..............	48 44 36.80	0 07 51.73	239 37 51	*Lummi Island*, S. base..	59 42 50	9398.7	10278.1	5.84
			266 12 04	Lummi Island..........	86 16 47	7712.5	8434.1	4.79
Barne's Island.................	48 42 12.20	0 05 09.13	143 22 12	Matia Island East......	323 20 10	5566.7	6087.6	3.46
			221 19 58	Lummi Island..........	41 22 39	6623.8	7243.6	4.11
Clark's Point	48 42 25.55	0 04 37.58	135 38 22	Matia Island East......	315 35 56	5672.4	6203.2	3.52
			219 16 35	Lummi Island	39 18 52	5892.0	6443.3	3.66
Raccoon Bluff.................	48 41 49.55	0 08 34.53	189 36 19	Matia Island East	9 36 51	5239.5	5729.8	3.26
			260 31 11	Barne's Island.........	80 33 45	4257.1	4655.4	2.64
Thompson's Point..............	48 42 43.22	0 11 15.54	251 14 43	Lummi Island.........	71 21 59	12523 4	13695 2	7.78
			273 47 50	Clark's Point	93 52 49	8153.0	8915.9	5.07
Matia Island West.............	48 44 33.62	0 08 33.45	265 54 55	Lummi Island	86 00 09	8569.5	9371.4	5.32
			316 16 18	Barne's Island.........	136 18 52	6042.6	6608.0	3.75
Orcas	48 42 50.71	0 12 16.60	238 46 50	Matia Island East.....	58 50 09	6326.8	6918.8	3.93
			235 05 46	Matia Island West	55 08 33	5558.5	6078.6	3.45
Sucia East....................	48 44 44.63	0 12 30.41	355 24 50	Orcas	175 25 01	3529.9	3860.2	2.19
			273 59 33	Matia Island West.....	94 02 31	4852.4	5306.4	3.02
Pt. Hammond	48 43 18.37	0 19 15.30	275 39 27	Orcas	95 44 42	8599.5	9404.1	5.34
			252 06 17	Sucia East.............	72 11 21	8690.7	9503.9	5.40
Bare Island...................	48 43 44.21	0 19 29.93	257 40 20	Sucia East............	77 45 35	8771.2	9591.9	5.45
			280 31 30	Orcas	100 36 56	9008.1	9851.0	5.60
Sucia West....................	48 45 17.05	0 14 01.04	66 55 17	Bare Island............	246 51 09	7304.7	7988.2	4.54
			60 18 29	Point Hammond......	240 14 33	7392.8	8084.5	4.59
Patos Island..................	48 47 03.04	0 16 54.33	22 32 51	Point Hammond.......	202 31 05	7512.9	8215.9	4.67
			27 22 26	Bare Island............	207 20 29	6914.6	7561.6	4.30
East Point....................	48 46 50.32	0 21 34.95	266 02 49	Patos Island..........	86 06 20	5741.2	6278.4	3.57
			336 02 12	Bare Island............	156 03 46	6290.1	6878.6	3.91
Doughty.......................	48 42 41.14	0 15 38.95	104 36 02	Point Hammond.......	284 33 19	4568.7	4996.2	2.84
			202 32 57	Sucia West............	22 34 11	5214.5	5702.4	3.24
Java Head....................	48 45 49.94	0 24 15.04	255 51 58	Patos Island...........	75 57 29	9275.9	10143.8	5.76
			303 40 00	Bare Island........ ...	123 43 35	6999.6	7654.5	4.35
Waldron, (2)..................	48 43 00.15	0 21 04.21	143 23 45	Java Head.............	323 21 21	6534.5	7145.9	4.06
			234 45 10	Bare Island............	54 46 21	2359.0	2579.7	1.47
Wooded Island	48 43 52.35	0 20 55.03	278 12 51	Bare Island...........	98 13 55	1757.0	1921.4	1.09
			6 38 03	Waldron, (2)...........	186 37 56	1623.2	1775.1	1.01
Douglas	48 44 00.56	W.0 29 54.18	243 57 53	Java Head....	64 02 08	7707.0	8428.1	4.79
			272 12 06	Bare Island....	92 19 55	12764.6	13959.2	7.93

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Canal de Haro and Rosario Strait. Sketch No 63.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Waldron West	48 41 56.31	W. 0 22 54.22	167 07 10	Java Head	347 06 09	7402.6	8095.2	4.60
			114 08 01	Douglas	294 02 45	9402.0	10281.7	5.84
John's Island	48 39 32.95	0 26 43 39	154 45 16	Douglas	334 42 52	9139.8	9995.0	5.68
			226 36 21	Waldron West	46 39 13	6447.9	7051.2	4.01
Hydrographic Rock, (1)	48 39 02.89	0 24 01.58	105 40 44	John's Island	285 38 42	3438.6	3760.3	2.14
			194 25 12	Waldron West	14 26 03	5530.5	6048.0	3.44
Hydrographic Rock, (2)	48 40 02.52	0 22 56.03	78 54 59	John's Island	258 52 09	4740.4	5184.0	2.95
			180 36 13	Waldron West	0 36 14	3514.8	3843.7	2.18
Point Disney	48 40 32.30	0 21 15.67	74 44 30	John's Island	254 40 24	6950.4	7600.7	4.32
			142 10 28	Waldron West	322 09 14	3285.3	3592.7	2.04
Stuart East	48 41 21.64	0 31 34.44	264 11 52	Waldron West	84 18 23	10690.8	11691.1	6.64
			202 39 06	Douglas	22 40 22	5319.0	5816.7	3.30
A	48 41 55.21	0 36 33.00	244 33 11	Douglas	64 38 10	9023.9	9868.2	5.61
			279 36 29	Stuart East	99 40 13	6192.2	6771.6	3.85
Stuart Middle	48 41 17.50	0 32 52.67	104 31 10	A	284 28 25	4653.4	5088.8	2.89
			215 54 06	Douglas	35 56 20	6218.9	6800.8	3.86
B	48 44 09.07	0 32 47.27	1 11 33	Stuart Middle	181 11 29	5300.4	5796.4	3.29
			48 09 28	A	228 06 38	6194.9	6774.5	3.85
C	48 39 44.91	0 35 10.86	157 21 00	A	337 19 58	4361.2	4769.3	2.71
			224 39 05	Stuart Middle	44 40 49	4021.0	4397.2	2 50
Stuart West	48 40 59.20	0 32 52.21	51 01 02	C	230 59 18	3649.2	3990.7	2.27
			110 58 08	A	290 55 22	4834.3	5286.6	3.00
Spieden	48 38 46.76	0 28 22.73	102 10 47	C	282 05 41	854[illegible].6	9341.9	5.31
			120 10 53	A	300 04 45	11595.8	12680.8	7.20
Henry Island	48 35 18.39	0 30 44.52	146 30 18	C	326 26 58	9874.2	10798.1	6.14
			166 04 12	Stuart West	346 02 36	10847.8	11862.9	6.74
Sidney	48 35 49.38	0 35 50.12	280 44 35	Henry Island	100 47 39	5122.2	5601.4	3.18
			194 08 27	Stuart West	14 09 55	9870.7	10794.3	6.13
Darcy	48 34 05.16	0 34 36.92	175 11 44	Sidney	355 11 34	3230.8	3533.1	2 01
			244 34 21	Henry Island	64 37 15	5272.5	5765.9	3.28
Red Signal	48 47 09.93	0 00 58.89	92 55 28	Lummi Isl'd, South base	272 55 16	317.3	347.0	0.20
			162 41 08	Lummi Isl'd, North base	342 40 54	1251.6	1368.8	0.78
White Signal	48 47 23.86	0 00 46.51	53 59 07	Lummi Isl'd, South base	233 58 46	704.3	770.2	0.44
			140 43 37	Lummi Isl'd, North base	320 43 14	987.7	1080.1	0.61
Clark's Island, flag on tree	48 42 25.76	0 04 37.55	135 35 20	Matia Island East	315 32 54	5668.1	6198.5	3.52
			219 18 45	Lummi Island	39 21 02	5886.6	6437.4	3.66
Lummi Island, (2)	48 44 16.68	0 01 51.68	188 03 49	Lummi Isl'd, South base	8 04 17	5420.9	5928.2	3.37
			94 52 02	Matia Island East	274 47 31	7381.5	8072.2	4.59
Lummi Island, (3)	48 43 49.87	0 01 59.00	101 24 41	Matia Island East	281 20 16	7350.7	8038.5	4.57
			188 21 14	Lummi Isl'd, South base	8 21 47	6262.4	6848.2	3.89
Parker's Reef	48 43 30.99	0 12 18.66	249 31 49	Matia Island East	69 35 09	5820.3	6364.9	3.62
			87 25 18	Point Hammond	267 20 05	8522.9	9320.4	5.30
Village Point	48 43 00.84	0 01 45.40	111 38 27	Matia Island East	291 33 52	8050.6	8803.9	5 00
			109 00 41	Matia Island West	288 55 34	8816.4	9641.3	5.48
Lawrence Point, (1)	48 39 41.10	W. 0 03 13.72	121 11 33	Raccoon Bluff	301 07 32	7667.7	8385.1	4.76
			196 18 30	Village Point	16 19 37	6428.4	7030.0	3.99
Reef Point	48 41 38.82	E. 0 03 36.71	66 37 23	Lawrence Point, (1)	246 32 15	9148.6	10004.6	5.68
			111 04 35	Village Point	291 00 33	7055.2	7715.4	4.38
Sisters	48 41 21.73	W. 0 04 15.33	99 14 03	Raccoon Bluff	279 10 48	5369.2	5871.6	3.34
			337 55 36	Lawrence Point, (1)	157 56 22	3354.0	3667.9	2.08
Lummi Rock	48 40 14.32	E. 0 01 19.38	79 37 14	Lawrence Point, (1)	259 33 49	5680.8	6212.4	3.53
			143 43 04	Village Point	323 40 45	6381.8	6978.6	3.96
Lawrence Point, (2)	48 39 36.45	W. 0 03 11.03	195 29 43	Village Point	15 30 47	6551.1	7164.1	4 07
			258 02 06	Lummi Rock	78 05 29	5554.6	6183.7	3.51
Sinclair North	48 37 45.59	E. 0 00 56.21	124 06 33	Lawrence Point, (2)	304 03 27	6110.0	6681.7	3.80
			185 53 24	Lummi Rock	5 53 42	4618.0	5050.1	2.87
Viti Rock	48 37 57.89	E. 0 03 58.60	84 12 40	Sinclair North	264 10 23	3753.1	4104.3	2.33
			142 18 16	Lummi Rock	322 16 16	5326.6	5825.0	3.31
Marsh Point, Cypress island	48 35 04.39	W. 0 03 05.09	179 10 16	Lawrence Point, (2)	359 10 12	8403.9	9190.3	5.22
			209 28 04	Lummi Rock	29 31 22	10997.9	12027.0	6.83
Vendovi	48 36 50.76	E. 0 04 31.44	111 02 41	Sinclair North	290 59 59	4721.2	5163.0	2.93
			148 00 18	Lummi Rock	327 57 54	7415.0	8108.8	4.61

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Canal de Haro and Rosario Strait. Sketch No. 63.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Lummi Southwest	48 39 03.46	E. 0 03 16.97	339 35 25 50 09 48	Vendovi Sinclair North	159 36 21 230 08 02	4372.9 3753.0	4782.0 4104.2	2.72 2.33
Lummi South	48 38 24.05	0 04 48.78	7 01 44 76 00 55	Vendovi Sinclair North	187 01 30 255 58 00	2903.3 4906.9	3174.9 5366.0	1.80 3.05
Sinclair East	48 36 36.80	E. 0 01 55.40	173 44 27 262 18 02	Lummi Rock Vendovi	353 44 00 82 19 59	6758.7 3224.6	7391.1 3526.3	4.20 2.00
Obstruction Pass	48 36 08.02	W. 0 06 35.22	212 58 36 294 30 55	Lawrence Point, (2) Marsh Pt., Cypress Isl'd	33 01 09 114 33 33	6775.8 4732.6	7409.8 5175.5	4.21 2.94
Sinclair West	48 37 20.49	0 00 33.88	73 12 37 142 33 51	Obstruction Pass Lawrence Point, (2)	253 08 06 322 31 53	7731.5 5289.9	8455.0 5784.9	4.80 3.29
Peapod, (1)	48 38 30.22	*0 03 16.66*	357 51 50 42 48 44	*Marsh Pt., Cypress Isl'd* Obstruction Pass	177 51 59 222 46 15	6361.7 5985.0	6957.0 6545.1	3.95 3.72
Peapod, (2)	48 37 59.76	0 04 11.36	345 55 30 40 30 07	Marsh Pt., Cypress Isl'd Obstruction Pass	165 56 20 220 28 19	5583.8 4537.5	6106.2 4962.0	3.47 2.82
Blakely, (1)	48 33 42.75	0 04 55.48	155 31 06 221 53 14	Obstruction Pass *Marsh Pt., Cypress Isl'd*	335 29 51 41 54 37	4930.7 3387.8	5392.1 3704.8	3.06 2.10
Struwberry Point	48 34 12.84	0 02 54.14	69 31 30 128 09 57	Blakely, (1) Obstruction Pass	249 29 59 308 07 11	2655.3 5760.2	2903.8 6299.1	1.65 3.58
Southwest Cypress	48 32 26.00	0 02 00.21	123 25 33 161 28 46	Blakely, (1) Strawberry Point	303 23 21 341 28 05	4305.2 3480.1	4708.0 3805.7	2.68 2.16
James North	48 30 56.67	0 05 05.41	203 56 37 233 59 42	Strawberry Point Southwest Cypress	23 58 15 54 02 00	6629.8 4695.2	7250.2 5134.5	4.12 2.92
Blakely, (2)	48 33 08.35	0 04 58.90	232 04 48 1 52 47	Strawberry Point James North	52 06 22 181 52 42	3241.7 4069.2	3545.0 4450.0	2 01 2.53
Fidalgo, (1)	48 29 30.39	0 00 49.36	116 54 58 163 39 38	James North Strawberry Point	296 51 46 343 38 04	5892.2 9091.2	6443.5 9941.8	3.66 5.65
Fidalgo, (2)	48 29 53.94	W. 0 00 43.62	109 51 31 161 30 30	James North Southwest Cypress	289 48 15 341 29 33	5711.2 4952.3	6245.5 5415.7	3.55 3.08
Fidalgo, (3)	48 30 28.03	E. 0 00 10.63	97 48 03 143 38 00	James North Southwest Cypress	277 44 06 323 36 22	6545.4 4525.5	7157.9 4948 9	4.07 2.81
Southeast Cypress	48 32 34.76	E. 0 00 08.83	12 13 54 64 51 41	Fidalgo, (2) James North	192 13 15 244 47 45	5082.3 7122.6	5557.8 7789.1	3.16 4.43
Southwest Cypress, (2)	48 32 21.13	W. 0 01 39.80	348 53 26 245 46 07	Fidalgo, (1) Fidalgo, (2)	168 54 04 165 46 50	5373.9 4689.8	5876.7 5128.6	3.34 2.91
Southwest Guemes	48 31 48.17	E. 0 02 15.33	46 09 49 80 04 09	Fidalgo, (2) James, North	226 07 35 259 58 39	5092.3 9181.1	5568.7 10040.2	3.16 5.71
Black Rock	48 32 43.46	W. 0 04 36.12	148 42 49 322 00 47	Blakely, (2) Fidalgo, (1)	328 42 32 142 03 37	899.5 7563.4	983.7 8271.1	0.56 4.70
James, South	48 30 29.82	0 04 51.89	224 26 56 290 12 45	Southwest Cypress Fidalgo, (1)	44 29 04 110 15 47	5026.2 5305.8	5498.6 5802.2	3.12 3.30
Burrows	48 28 41.46	0 01 28.16	174 35 08 207 47 48	Southwest Cypress Fidalgo, (1)	354 34 44 27 48 17	6966.3 1708.5	7618.1 1868.4	4.33 1.06
Bird Rock	48 29 03.91	0 04 24.30	167 57 09 205 19 56	James, South Southwest Cypress	347 56 48 25 41 44	2713.0 6906.5	2966.8 7552.7	1.69 4.29
Boulder	48 25 55.04	0 06 46.63	195 30 21 227 56 37	James, South *Fidalgo, (1)*	15 31 47 47 51 04	8807.5 9904.2	9631.6 10830.9	5.47 6.15
Allan	48 27 42.18	0 01 17.05	63 59 30 139 35 30	Boulder James, South	243 55 23 319 32 49	7537.0 6801.7	8242.3 7438.2	4.68 4.23
Williamson's Rock	48 26 59.35	W. 0 01 01.08	74 24 39 143 55 38	Boulder James, South	254 20 20 323 52 45	7373.4 8044.9	8063.4 8797.7	4.57 5.00
Deception	48 24 24.76	E. 0 01 03.30	106 08 56 154 41 51	Boulder Allan	286 03 05 334 40 06	10055.2 6745.4	10996.1 7376.4	6.25 4.19
Southeast Island	48 24 53.30	W. 0 07 56.99	237 33 26 274 28 49	Allan Deception	57 38 25 94 35 33	9734.4 11144.1	10645.2 12186.8	6.05 6.92
Smith's Island	48 19 16.66	W. 0 09 13.31	188 34 57 233 04 20	Southeast Island Deception	8 35 54 53 12 01	10514.8 15861.3	11498.7 17345.4	6.53 9.86
Northwest Island	48 25 08.56	E. 0 01 07.56	98 25 40 147 57 19	Boulder Allan	278 19 45 327 55 31	9852.4 5598.5	10774.4 6122.4	6.12 3.48
North Whidbey Beach	48 24 05.37	0 01 29.12	56 04 20 97 18 19	Smith's Island Southeast Island	235 58 20 277 11 16	15947.9 11734.5	17440.2 12832.5	9.91 7.29
Sares Head, North	48 26 18.32	E. 0 00 37.81	85 32 38 76 07 07	Boulder Southeast Island	265 27 05 256 00 42	9162.0 10903.2	10019.3 11923.4	5.69 6.77

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Canal de Haro and Rosario Strait. Sketch No. 63.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Stone	48 25 36.18	W.0 06 49.36	185 29 38	Boulder	5 29 40	585.2	640.0	0.36
			240 17 06	Allan	60 21 15	7859.4	8594.9	4.88
White Bluff	48 29 38.72	0 06 39.90	234 32 28	James, South	54 33 49	2721.3	2975.9	1.69
			298 27 48	Allan	118 31 50	7543.5	8249.4	4.69
Dead tree	48 29 11.98	0 07 33.32	234 01 23	James, South	54 03 24	4093.7	4476.8	2.54
			289 42 18	Allan	109 47 00	82[illegible]9.7	8977.9	5.10
Northeast head	48 28 51.81	0 07 45.28	229 36 04	James, South	49 38 14	4672.4	5109.6	2.90
			285 03 09	Allan	105 08 00	8258.0	9030.7	5.13
Southeast head	48 28 19.71	0 07 27.90	218 32 22	James, South	38 34 19	5138.6	5619.4	3.19
			278 36 47	Allan	98 41 25	7704.5	8425.4	4.79
Swamp signal	48 27 34.16	0 07 51.90	214 14 49	James, South	34 17 04	6564.4	7178.6	4.08
			268 12 34	Allan	88 17 30	8114.6	8873.9	5.04
Shoal bight	48 27 09.47	0 07 00.44	203 05 18	James, South	23 06 54	6727.2	7356.6	4.18
			261 48 48	Allan	81 53 05	7126.2	7793.1	4.43
Johnson	48 26 49.28	0 06 41.54	198 16 47	James, South	18 18 09	7173.6	7844.9	4.46
			3 24 24	Boulder	183 34 20	1678.5	1835.5	1.04
Minor signal	48 19 24.08	0 07 59.19	208 13 24	Allan	28 18 25	17468.3	19102.8	10.85
			81 27 04	Smith's Island	261 26 09	1543.6	1688.0	0.96
Hydrographic signal, Smith's island.	48 19 09.14	0 08 56.82	186 36 07	Southeast Island	6 36 52	10700.2	11701.4	6.65
			210 47 01	Allan	30 52 45	18453.0	20179.7	11.47
Iceberg	48 25 10.26	0 11 44.12	276 22 41	Southeast Island.	96 25 31	4698.9	5138.6	2.92
			344 07 15	Smith's Island	164 09 08	11353.1	12415.4	7.05
Middle signal	48 25 10.83	0 10 00.20	282 03 19	Southeast Island	102 04 51	2590.3	2832.7	1.61
			354 57 15	Smith's Island	174 57 50	10980.9	12008.4	6.82
C, on Lopez Island	48 25 29.06	0 09 07.43	307 19 28	Southeast Island	127 20 21	1821.3	1991.7	1.13
			0 36 10	Smith's Island	180 36 06	11502.0	12578.2	7.15
Tree on Sisters	48 41 38.39	0 04 04.77	228 11 40	Village Point	48 13 25	3821.2	4178.8	2.37
			343 55 10	Lawrence Point, (1)	163 55 48	3761.7	4113.7	2.34
Strawberry Island, south	48 33 34.30	W.0 02 49.85	95 47 38	Blakely, (1)	275 46 04	2588.5	2830.7	1.61
			175 46 31	Strawberry Point	355 46 28	1193.8	1305.5	0.74

APPENDIX No. 26.

Notes on the measurement of a base for the primary triangulation of the eastern section of the coast of the United States, on Epping Plains, Maine, by A. D. Bache, Superintendent United States Coast Survey.

[Communicated by authority of the Treasury Department to the American Association for the Advancement of Science.]

The reconnaissance for a base of verification at the eastern extremity of the primary triangulation in Section I of the coast was commenced by Charles O. Boutelle, esq., and Major Henry Prince, U. S. A., Assistants in the Coast Survey, in 1853, and continued through 1854 and 1855. The absence of long and straight sea beaches on this coast rendered it absolutely necessary to look for an interior site.

The reconnaissance resulted in the selection of Epping Plains, Washington county, Maine, as the most suitable site for the purpose, considering the character of the ground itself and the facility of connecting the ends of the base with the primary triangulation. In this selection and the examination of the plains these officers were much assisted by the local knowledge and the kind offices of J. A. Milliken, esq., now of Cherryfield, to whom I beg leave here to return the thanks of the Coast Survey.

Major Prince being relieved from the survey, the final minute examination of the site and the determination of the best line which could be obtained on the plain devolved upon Assistant Boutelle, who was assisted at different times by Sub-Assistant J. A. Sullivan, Lieut. J. C. Clark, U. S. A., and Mr. F. P. Webber.

Epping Plains, or "Barrens," as they are called, lie between the Narraguagus and Pleasant rivers. They present a moderately rolling surface of sand, generally destitute of trees, except in the lower and swampy parts, and are traversed by sand ridges of different elevations, resembling very much the surface which the sounding line develops in such regions as the Nantucket shoals, at present below the surface of the water.

The plain is quite elevated, and falls suddenly from an irregularly curved margin, by a steep slope, to a lower plain or a wide valley.

Portions of the plain are strewed with boulders of various sizes, some of them containing not less than 4,000 cubic feet, and of various granitic materials. Schoodiac Hill was found to limit the position of the base, so that the problem became to draw the longest line through a point at the base of that hill, the ends of which would be easily visible from the secondary and primary stations.

Before the final selection of the line a topographical survey was made, under the direction of Assistant C. O. Boutelle, by Sub-Assistant J. A. Sullivan and Mr. Webber, and the profile was studied upon a sketch of the plain made by Lieut. Clark.

In 1856 I examined the site and took steps to obtain the necessary estimates of the cost of preparing it for measurement. The profile of the line as graded gives a good general idea of the ground, as it varied but little from the natural profile, (Sketch No. 3.)

The whole length of the line is about 8,716 metres, or 5.4 miles. Its general direction is E. 16° S., *(true bearing.)* From the eastern end, for about four miles, the plain is quite level, rising in the first mile pretty regularly about fifteen feet, descending nearly as much in the next, to rise by the same quantity in the third mile. It then runs along an elevated level for a fourth of a mile, and descends gradually to the rougher part of the base, which is included between the $3\frac{3}{4}$ the miles from the east end and the western end of the base.

This line was skilfully graded by Mr. Boutelle, so as to follow the natural surface when the grade did not run above three degrees, and to give as long slopes as possible of the same grade, for the convenience of measuring, (Sketch No. 3.)

As it was found more economical to make the temporary embankments than to excavate, a profile giving a considerable excess of embankment was selected.

This was executed in the cheapest way which would give stability for the time during which it was required to stand. The least width was twelve feet, of which nine feet was on the south, and three feet on the north side of the line to be measured. The base was very carefully aligned. High signals were placed over the termini which are intervisible. On the Schoodiac a signal of moderate elevation is visible from both, and the distances between this point and the termini were gradually subdivided until the smallest limit, the distance easily reached by a small transit, was obtained.

The verification of the aligment at different points of the measurement, when the seeing was good, was complete.

In all these preliminary operations Mr. Boutelle was assisted by Sub-Assistant J. A. Sullivan and Mr. Webber.

His grading party consisted of the farmers and lumbermen of the district, who served with great cheerfulness and skill in the use of the heavy implements for rough grading.

One of the greatest difficulties was the removal of such boulders as were in the line, many of them being of such size as to require blasting to break them up, and some being actually removed to the required distance from the line by heavy blasts.

The signals erected at the two ends are very substantial, each forty-three feet in height to the top of the tripod, and fifty-three to the cone which surmounts them.

The base apparatus already described before the association, and described and figured in my report for 1854, by Lieut. E. B. Hunt of the Corps of Engineers, was used in this measurement, preliminary trials being made in the office to test its steadiness under the greatest inclinations to which it would be subjected, and the accuracy of the surface upon which the measuring stem traverses, and which determines the length of the apparatus. I was assisted in the measurements by Assistant G. W. Dean, Prof. Fairman Rogers, who volunteered for the purpose, Sub-Assistants Goodfellow, Stephen Harris, and Sullivan, and Mr. Thomas McDonnell, among whom the different operations were divided.

The usual comparisons of the apparatus with the standard six metre bar were made before and after the measurement, to ascertain that no change had taken place in the length from damage by transportation, and to add to the results of former comparisons.

The measurement was begun at the west end of the line on Saturday, the 18th of July, but the next week proved so rainy that it was only resumed in earnest on Monday, the 27th.

The work of the first Saturday, (24 tubes,) was remeasured on the following Monday, with precisely the same result as to length, the end of the second measurement falling exactly on the marks which had been placed as terminating the first, and which were fine dots upon the head of a copper nail placed in a stake, some eighteen inches in length, driven into the ground until its head just projected above the surface. The position of the mark was determined and verified, as all others of the sort in our measurements, by using a transit placed at right angles to the line and at a moderate distance from it.

This was on a descending slope of the strongest grade adopted, and there was a difference of temperature of some five degrees in the two measurements. On Tuesday a length of 18 tubes which had been measured on Monday was remeasured with an identical result. This was on ascending slope.

On Monday the work was, in part, interrupted by the arrangements for photographing the apparatus, on Tuesday by a fog, and on Wednesday by showers in the beginning of the day; we made, however, half a mile on both days. On Wednesday began a series of four unbroken days, during the first of which we measured about seven-eighths of a mile, and on the three others a mile or more than a mile each day, reaching the east end of the base on Monday evening. Thus, counting in the broken days, 5.4 miles were measured in eight days.

This time included the marking of five permanent points near to the ends of the successive miles where stone posts have since been placed. The ends of the base will be marked by regular monuments. The base of the monument at the west end is cut from the ledge of rocks upon which the signal stands.

By the kindness of Professor Fairman Rogers I have been enabled to collect approximately some of the statistics of the measurement in a tabular form, (No. I.) A second table contains the comparison with the other five Coast Survey bases which I have measured.

EPPING BASE.—(TABLE I.)

Whole length of base in tubes, 1,453.

Whole length of base in metres, 8,714.52*m.*

1*m.*425 added at east base, making 8,715*m.*97, or 28,594 feet, or about 5.4 miles.

Difference of level between highest and lowest points, 104 feet nearly.

Mean level of base above mean tide, 251 feet, or 76*m.*45.

Approx. corr. for reduction to the level of the sea, 0*m.*10438, or 4 inches nearly.

Number of tubes inclined, 643.

Number of tubes level, 810.

Ratio of tubes inclined to the whole number, 0.442 nearly.

Ratio of tubes level to the whole number, 0.550.

Correction for versed sine for whole base, 2*m.*8038437, or 9.2 feet to be subtracted.

Maximum inclination, 3° 14′.

			Ratio to whole number inclined.
Number of tubes inclined	3° and over	31	0.048
Do. do. do.	2° 30′ and over	234	0.364
Do. do. do.	2° and over	79	0.123
Do. do. do.	1° 30′ and over	120	0.186
Do. do. do.	1° and over	110	0.171
Do. do. do.	0° 30′ and over	21	0.032
Do. do. do.		48	0. 74
		643	

Greatest day's work, 281 tubes, 1.05 miles in 11*h.* 10*m.* working time, averaging 1 tube in 2*m.* 27*s.*

Greatest number in 1 hour 37, or 1*m.* 37*s.* for each tube.

TABLE II.

Comparative table of the measurements of six United States Coast Survey bases.

	Dauphine island.	Bodies island.	Edisto island.	Key Biscayne.	Cape Sable.	Epping Plains
Whole number of tubes measured	1,777	1,807	1,787	965	1,072	1,453
Do......days employed	17	10	13	9	8	8
Do......hours employed	143*h.* 17*m.*	81*h.* 08*m.*	97*h.* 28*m.*	66*h.* 31*m.*	46*h.* 26*m.*	69*h.* 43*m.*
Do......tubes level	961	1,496	862	473	994	810
Do......tubes inclined	816	311	925	492	78	643
Average length of working day	8*h.* 25*m.* 7*s.*	8*h.* 07*m.*	7*h.* 30*m.*	7*h.* 23*m.*	5*h.* 48*m.* 18*s.*	10*h.* 07*m.*
Do...time of one tube	5*m.* 32*s.*	2*m.* 54*s.*	3*m.* 22*s.*	4*m.* 20*s.*	2*m.* 51*s.*	2*m.* 58*s.*
Do...No. of tubes per day	104.5	180.7	137.5	107.2	134	181.6
Do........do.......day of 9 hours	108.0	197.9	165.9	130.0	200.0	187.2
Do........do.......hour	11.85	21.98	18.40	14.40	22.47	20.8
Average plus inclination	17′.6	16′.2	24′.5	31′.0	12′.0	1° 53′
Do...minus inclination	16′.6	19′.6	23′.0	26′.0	10′.0	1° 54′
Do...of greatest plus inclination	40′.8	23′.7	55′.4	58′.0	14′.0	2° 52′
Do.....do..... minus....do	42′.6	29′.5	48′.4	54′.0	11′.0	2° 46′
Do...temperature Fahrenheit	84° 50	52° 01	59° 50	82° 90	87° 90	70° 0

The photographs of the apparatus and operations, which I submit to the Association, were taken by Mr. Black, of the firm of Whipple & Black, of Boston, who exerted himself especially in the matter, and succeeded, under many disadvantages from variable weather and the roughness of field arrangement for photography, in making satisfactory representations.

The views of the apparatus and operations include the placing the apparatus over a mark, the aligning, the setting of the trestles in advance of the measurement, the transfer of the measuring tube, and the making of contact. The comparing apparatus and tent are also shown.

Sketch No. 3 shows the topographical features of the ground, and gives the profile of the base as graded for measurement.

APPENDIX No. 27.

Report of Dr. B. A. Gould, jr., assistant, on the progress made in telegraph campaigns for differences of longitude, and the preparation of results for publication.

CAMBRIDGE, MASS., *October* 1, 1857.

DEAR SIR: During the past year the work of reduction and computation of the telegraphic campaigns for the longitude has progressed rapidly, and copious materials have been collected for the volume upon the results of the telegraphic longitude measurements of the Coast Survey. The large quantity of data already collected, and consequent pressure of the work of reduction, combined with other motives to render me anxious to be relieved from field duty, and to devote my whole attention to the computations and the deduction of results from the abundant store already accumulated. With your approval, therefore, the entire charge of the observations at the south was left to Messrs. Dean and Goodfellow, whose experience of many years and unwearying zeal succeeded in ultimately accomplishing the connection of Montgomery with Mobile by means of an intermediate station at Lower Peach Tree, (Ala,)—as described in full by Mr. Dean in his report.

The methods used have been essentially the same as arranged for previous years, and are described in full detail by Mr. Dean in the very faithful account appended to your last annual report. The chief advance consists in the preparation and adoption of a standard catalogue of right ascensions of stars for determination of time and azimuth, analogous to the list of right ascensions of circumpolar stars, appended to my report of last year. The details of the preparation of this "Time-star list" will shortly be presented to you in a separate report. Meanwhile, I have the honor to offer herewith, in a special report, the discussion of the places of the 48 stars of the circumpolar catalogue, declinations included.

The necessity of an intermediate station between Montgomery and Mobile, imposed by the extremely unfavorable condition of the telegraph line, entailed a large amount of labor; but even after this intermediate station was established, it was only with great difficulty that signals could be simultaneously communicated in both directions. On one occasion, indeed, as is now evident, both clocks were breaking circuit, one at each extremity of the line, and both observers tapping, but without the signals from either station reaching the other. Various expedients were resorted to for remedy, but neither an increased number of cups, nor increased surface of the elements proved of sufficient avail, and it is evident that incomplete insulation and inadequate connexions must have combined to render the communication so difficult. A necessary result was great difficulty in the armature adjustment, leading to indistinctness of the records, and great embarrassment in the reading off.

The experience of the earlier campaigns led to my conviction of the importance of some guard, not only against accidental errors in the process of reading off the observations, but also against personal equation in the application of the glass reading-scales. Such personal equation would enter into a longitude determination to its whole amount, unless the corresponding records at both stations were read off by the same individual. The plan which I have in all cases adopted for the last two or three years has been: first, to have every register read by two different persons and the reading compared in cases of discrepancy by a third; and, second, that the corresponding records at the two stations be read by the same assistant. The amount of labor is necessarily great, but the trustworthiness of the results is more than commensurate. I find that the average discordance between practiced readers does not often exceed $0^s.02$ for the fillets, and $0^s.03$ for the chronograph sheets. There is, in some cases, indication of a personal equation in reading off, amounting to two or three hundredths of a second, but all such effects are entirely eliminated by the mode of combination.

From present appearances, I am inclined to believe that, with the assistance with which I am at present provided, the whole series of longitude campaigns undertaken since I first took charge of the telegraph longitudes in 1852 will be fully reduced and ready for the press before the time for my next annual report. The material for the desired volume is already assuming shape and consistency; and the coming winter will, I trust, enable Messrs. Dean and Goodfellow to connect the stations already erected at Mobile and New Orleans. We shall then have the following longitude determinations by the electric telegraph carried out since 1852:

Washington—Raleigh.	Raleigh—Charleston.	Washington—Petersburg.
Raleigh—Columbia.		Petersburg—Wilmington.
		Wilmington—Columbia.

Columbia—Macon.
Macon—Montgomery.
Montgomery—Peach Tree.
Peach Tree—Mobile.
Mobile—New Orleans,

in addition to the Bangor-Calais connection in the north, now going on under your own supervision, and such other northern campaigns as may be carried out during the next season.

The connection of Macon with Savannah at some future time would furnish a duplicate series between Raleigh and Macon similar to that already obtained between Washington and Columbia; and if the New Orleans station be then astronomically connected with Cincinnati by means of the western line of wire, a magnificent check will be provided, Cincinnati having long ago been connected with the Seaton station by Mr. Walker. Three intermediate stations, one of which might, if desired, be directly connected with Macon, will doubtless suffice for this desirable end; and if the reasonably anticipated accordance be once attained, we shall be in possession of a series of standard points of reference for the continent which the Coast Survey may regard with great and warrantable pride; a system of standard zeros such as was never before known, and until the invention and introduction by the Coast Survey of our American method, never possible.

Should it appear desirable, several cross-connections can readily be made to this beautiful net-work of longitude determinations, and the labors of Mr. Walker have already extended its tributary connections to the north and east. Longitude measurements, which already have been very desirable, and which will be attended with much less embarrassment and difficulty than those further south, will extend the system of mutually dependent points, and amplify the reticulations; and we may reasonably hope, in the near future, to see the Atlantic and Gulf coasts of the United States studded with stations whose relative position is certain within one-tenth of a second of time, as they now are with stations whose astronomical latitude is trustworthy to within a second of arc.

Among the most interesting general results, it may not be inappropriate here to mention one or two.

The mean error of a transit over a single thread does not, from the experience of several campaigns, appear to be of an essentially different order, whether recorded upon the chronographic register by means of taps, or noted through the employment of eye or ear by an astronomer of skill and experience. The mean deviation of a single tap from the mean of 15 or 25 varies usually from about $0^s.11$ under favorable circumstances to $0^s.15$ in unfavorable ones. This statement has reference, of course, to the portable 30-inch transit instruments of the Coast Survey. The most experienced and accurate observers may claim for their results an equal degree of precision, but if this be conceded, it must also be remembered how close and devoted attention is requisite, and how great is the fatigue accompanying the concentration of effort. And there is no risk in asserting that the mean error of ordinary observers by eye and ear far exceeds this limit, even when we disregard the influence of any constant inaccuracy in the scale of subdivision of seconds. This most fruitful source of incorrect results is of necessity entirely eliminated in the chronographic method. But little doubt exists in my mind that the use of higher magnifying powers will diminish the amount of mean discordance; and I trust that the new and powerful instruments of the Dudley Observatory may soon afford the means of submitting this question to a practical test.

The experience of a decade enables us at present to form our judgment with great confidence concerning the advantages and disadvantages of the chronographic method. Prominent among the latter is the labor entailed by the necessity of reading off the records, especially when, as in the case of our longitude determinations, the degree of accuracy required will not authorize reliance upon the unchecked figures of a single reader. To this disadvantage is to be added the care (not great) required by the chronograph, and the possibility of its derangement. On the other hand the record of every tap is automatic, ineffaceable, easily legible, and capable of preservation without difficulty, qualities which quite compensate the former objections and leave the remaining and chief advantages without drawback; the great gain consists then chiefly in the following points:

1. The needlessness of long experience to insure accuracy in observation, inasmuch as we find the observations of young untrained assistants to be often quite as good as any, and not unfrequently superior to those long accustomed to astronomical work.

2. The greatly diminished effort on the part of the observer, so that forty stars, on fifteen or twenty-five threads, may be observed with less fatigue than twenty over seven threads in the old method by eye and ear.

3. The larger number of threads over which the transit may be observed and the consequent gain in accuracy.

4. The freedom from errors arising from a uniformly distorted estimation of the subdivisions of the second—a source of error from which no astronomer seems to be wholly free, and which the observations of many show to be so serious as to demand, in delicate researches, a systematic translation of their estimated tenths of a second into those fractional parts which investigation shows to correspond.

5. The smaller personal equation, and the facility and minuteness with which it may be determined.

6. The reference of different observations to the indications of one and the same clock—an absolutely indispensable requisite for longitude measurements, and of paramount importance even in an observatory.

During the past few years numerous experiments have been made, and their results published in different European countries, for the telegraphic determination of longitudes. In most cases the methods have been extremely crude, and the results highly discordant from those previously obtained by moon culminations, occultations, and even from terrestrial signals. Still they appear to have been adopted without hesitation. My apprehension is that subsequent experiments will shake the confidence now apparently bestowed upon these results, but should this be the case, the telegraphic method cannot be held responsible, for to the best of my belief it has not been fairly applied. The processes of the Coast Survey, even in the infancy of the method ten years ago, were environed with safeguards which seem to have been wholly neglected in the European operations to which I refer. The accordances between the results obtained on different nights are, in some instances, so wondrously close as almost to compel the conviction of some overpowering constant error, and in other cases so discordant as to excite grave misgivings as to the mode of operation. Without the use of recording apparatus at each end, without the entire absence of any intermediate signal apparatus analogous to repeaters, and without full elimination of the time consumed in the transmission of the signals, trustworthy determinations of the longitude cannot reasonably be anticipated.

The results of former years relative to the velocity of the signals are confirmed by each successive campaign, and experiments, made by varying the battery power on different nights, seem to lead irresistibly to the conviction that this velocity varies, according to some simple law, with the intensity of the current. Among the most singular phenomena is one for which I am, as yet, unprepared to offer any explanation, although its existence appears beyond dispute, namely: that the deduced velocity is different for signals sent in the two directions. Since the only available means for its measurement is by comparison of the two records of the interval between a clock signal, which travels in one direction, and a tap signal, which travels in the opposite one, we cannot assume that the discordance is due to a difference of velocity in the two directions, since, even if such a difference existed, it would not be made manifest. The batteries being at the extremities of the line and in immediate communication with the ground, the idea of any unequal resistance to conduction, arising from their unsymmetrical position, is altogether precluded. A concise summary of the velocity results deduced from the Wilmington—Columbia campaign will illustrate the character and the amount of the phenomenon of which I speak.

A small table will readily exhibit the mean excess of the interval between the clock signals and the observation signals, as recorded at the clock station, over the same interval as recorded at the other station. Any apparent results deduced from comparison of the records of observation would, of course, be simply illusory were they other than zero, although the influence of errors in reading off or of uncompensated irregularities of any one of the chronographs may thus be made manifest. I have consequently incorporated in the table the amount of excess for observations made at the clock station, in order, by comparison, to show the reality of the velocity measurement and the order of discordance which may reasonably be attributed to the above named errors.

In every case the ground connection was with the platinode at Wilmington and the zincode at Columbia. The distance of the two stations is, at the best estimate, two hundred miles, including a submerged cable, 687 feet long, across the Cape Fear river. The line was entirely new, having been put up within a few months. The number of cups was always the same at each end of the line.

Time of transmission for signals between Wilmington and Columbia.

Date.	No. of cups at each end.	Clock at—	Taps at—	No. of taps.	Mean excess at clock station.	Taps at—	No. of taps.	Mean excess at clock station.
					s.			s.
Jan. 9	10	Wilmington ..	Wilmington ..	150	+ 0.003	Columbia.....	147	+ 0.056
		Columbia.....	Columbia.....	63	+ 0.004	Wilmington ..	72	+ 0.035
10	15	Wilmington ..	Wilmington ..	134	0.000	Columbia.....	135	+ 0.051
		Columbia.....	Columbia.....	237	— 0.002	Wilmington ..	165	+ 0.031
15	20	Wilmington ..	Wilmington ..	180	— 0.001	Columbia.....	180	+ 0.059
		Columbia.....	Columbia.....	10	0.000	Wilmington ..	15	+ 0.045
16	25	Wilmington ..	Wilmington ..	170	+ 0.002	Columbia.....	180	+ 0.035
		Columbia.....	Columbia.....	180	— 0.003	Wilmington ..	175	+ 0.029
Feb. 10	30	Wilmington ..	Wilmington ..	219	— 0.003	Columbia.....	125	+ 0.033
		Columbia.....	Columbia.....	177	+ 0.005	Wilmington ..	180	+ 0.038
17	35	Wilmington ..	Wilmington ..	285	— 0.001	Columbia.....	283	+ 0.046
Mean ...	24.0	Wilmington ..	Wilmington ..	1,138	— 0.0003	Columbia.....	1,050	+ 0.0469
	21.9	Columbia.....	Columbia.....	667	— 0.0003	Wilmington ..	607	+ 0.0333

The decrease of the amount of discordance as the strength of the current increased cannot escape remark. At some not distant period I propose to present in full detail the results of these velocity measures as afforded by the different campaigns.

The supervision of the preparation for observations at the Dudley observatory has demanded a large amount of care and attention. The trustees have now nearly completed this observatory and taken measures to equip it with instruments of the highest order, capable of rendering essential service to science and greatly facilitating the coast survey operations, both by furnishing accurate places of latitude stars and by the triangulation of the Pleiades. This latter operation will contribute largely to the facility and precision of the astronomical determinations of longitude, according to the methods of Professor Peirce, in cases where the use of the electro-telegraphic method is not practicable.

Dr. C. H. F. Peters has been stationed at the observatory during the entire year, charged with the immediate supervision, and with a careful determination of the latitude by means of the zenith telescope. I hope soon to transmit his report upon latitudes. He has, at the same time, been employed in the computation of the Pleiades occultations for Professor Peirce, preparatory to the fuller development of the longitude methods of this astronomer, who will speak for himself on this subject. We anxiously await the completion of the heliometer, by Mr. Spencer, in order to proceed to the work of triangulating the Pleiades, for which, as well as the determination of latitude stars, the trustees of the observatory have so handsomely placed the observatory and its instruments at the disposal of the Coast Survey. All seems now to promise that, before the time for my next annual report, the magnificent instruments of the observatory may have been received, mounted, and made to render important service to all the astronomical parties of the survey, as well as to the office for the reduction and computation of former observations.

Throughout the year I have been aided in the work of reductions by Messrs. J. H. Toomer, A. E. Winslow, and A. T. Mosman, who have labored with interest, assiduity, and zeal, and for whose constant and ready assistance I desire to return my best acknowledgment. To Mr. Toomer I am also indebted for constant assistance in the preparation of the two star lists, to which he has devoted much care and with great success.

With sincere respect, I remain, dear sir, most faithfully and truly yours,

B. A. GOULD, JR.

Prof. A. D. BACHE, LL. D.,
Superintendent United States Coast Survey.

APPENDIX No. 28.

Report of Professor W. C. Bond, director of Harvard College observatory, Cambridge, Massachusetts, on the moon culminations and other phenomena observed for the Coast Survey.

CAMBRIDGE, *Massachusetts, October* 6, 1857.

DEAR SIR: I have to report the observation of thirty moon culminations and seventeen occultations of stars by the moon, together with a considerable number of meridian passages of the bright points A and A′ Messier, according to Beer and Mädler's designation on their large maps of the moon. These latter observations were more particularly intended to connect this observatory with stations on the Pacific side of the continent, as proposed to Dr. De

Moesta, superintendent of the Chilian observatory at St. Jago, and other observers on the western coast. The occultations of stars have had, usually, two or more observers at this station.

You will be gratified to learn that, assisted by Messrs. Whipple & Black, of Boston, we have succeeded, at this observatory, in obtaining photographic impressions of stars down to the sixth magnitude, and of the surface of the moon so distinct as to show the positions of A and A′ Messier, and other similar bright points, very nearly as well as they are seen with an object glass of $2\frac{3}{4}$ inches aperture—that is, with about the quantity of light of one of the forty-eight inch transits. On the night of the occultation of Spica, June 2d, we obtained many photographic impressions of the moon and star when near conjunction.

The star, when approaching the moon's enlightened limb, appears to lose in intensity of light, so much so that stars of the fifth and sixth magnitude are usually lost sight of before contact with the bright limb of the moon, and are not seen on emersion until they are some distance from it; but in regard to the photographs of Spica, taken on the night of the 2d of June, the impression of the star upon the plate seemed to be as strong when the star was in apparent conjunction with the moon's limb as it was when at a considerable distance from it.

At the request of Prof. De Moesta, I have prosecuted a series of declination observations on the north and south limbs of the planet Venus when near its inferior conjunction, in the months of April, May, and June last. No difficulty was experienced in obtaining observations on the day of conjunction. Prof. De Moesta was to have made simultaneous observations at the government observatory in Chili.

At the suggestion of Sir William E. Logan, I have been in electro-telegraphic communication with Lieut. Ashe, R. N. After much delay and many disappointments, we have at length succeeded in interchanging a full and satisfactory series of electric signals, which will afford the data for an accurate determination of the difference of longitude between Cambridge and Quebec by the route of Portland and Montreal.

Respectfully and truly yours,

W. C. BOND.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 29.

Report of Prof. Benjamin Peirce, LL.D., on the determination of longitudes by occultations of the Pleiades and solar eclipses.

CAMBRIDGE, *October* 31, 1857.

SIR: I inclose you my report upon longitudes for the past year.

Yours, very respectfully,

BENJAMIN PEIRCE.

A. D. BACHE, LL.D.,
Superintendent of the Coast Survey.

The labors of the Coast Survey for the determination of the longitude of some central positions upon this continent have been conducted with singular consistency, according to the method commenced by *S. C. Walker.* The conclusions which seem to have been hitherto established are, that neither by moon culminations nor by the transportation of chronometers is there any reasonable hope of obtaining a longitude which can be relied upon nearer than to about a second of time, and that the further multiplication of observations by either of these processes is not likely to lead to results of any higher order of approximation. Until, therefore, the Atlantic telegraph shall be successfully accomplished, the method of solar eclipses and occultations must remain unrivalled in accuracy, and the labor of bringing this method to its full measure of perfection is no longer to be postponed.

Upon the use of the solar eclipses.

The solar eclipses have the great advantage of facility of observation, as then the same eclipse is observed in a sufficient variety of places to correct all of the elements of the tables, except those dependent upon parallax. In *Walker's* reports upon longitudes in the years 1848 and 1851 this matter was specially considered, and the importance of Henderson's correction of the constant of lunar parallax and Longstreth's correction of the theory were amply discussed, the mean error of the previous computations determined, and the correctness of these researches has been fully established by the profound investigations of Hansen. In reference to this subject permit me to remark, that after carefully reading these reports, I am constrained to declare that Mr. Walker, in his generosity, was far too liberal in the amount of credit which he awarded to me ; so far as I can remember, all the details of the suggestions were his own, and they were so judicious that my part was only to approve them. This portion of the work cannot, however, be regarded as properly concluded until all the eclipses have been recomputed by means of the latest tables of the sun and moon ; and it is also important that the subsequent eclipses which have been observed should be thoroughly reduced, and especially that of July 28, 1851. This latter eclipse was so well observed in Europe and America, that I am disposed to think that the longitude obtained from this eclipse alone will be nearly or quite as valuable as that which has been hitherto derived from all other sources. The reductions of this eclipse are quite far advanced among my manuscripts, and will at any time be placed at the disposal of the Coast Survey. The chief difficulty in the solar eclipses may now be regarded as dependent upon the personal equations of the observers, which cannot easily be eliminated, because the phases of the eclipse, which are nearly simultaneous in Europe and America, are the reverse of each other ; that is, the emersion in America corresponds to the immersion in Europe. It is probable, nevertheless, that the longitude determined from the solar eclipses may be depended upon to about a half or a third of a second of time.

Upon the occultations of the Pleiades.

Even with the advantage of Hansen's new tables of the moon, it is not probable that isolated occulations can at present be rendered available for the nice determination of distant longitudes, because they are so much affected by the small errors which still remain in the places of the moon and of the stars, and by the undetermined irregularities of the lunar disc. It has, therefore, been found necessary to resort to the mutually dependent occultations of the *Pleiades*. The ultimate necessity of this method of solving the problem of the longitude was clearly foreseen by *Walker*, and in his report of 1848 he suggests that it is proper "*to institute a full discussion of all the observations of occultations of stars in the group of the Pleiades extant in any country. This discussion is earnestly recommended by Bessel as certain to afford more perfect* *data than those from any other source for the determination of longitudes and for the correction of the moon's parallax and semi-diameter.*" The equations required for conducting this investigation have been given in my previous reports. Dr. Peters has been employed in collecting the data for the application of the formulæ and in making the preliminary computations required for their discussion, as well as the predictions by which the additional data may be secured, which are still wanting upon this continent. The data consist, of course, of the extant records referred to by *Walker*, of which Dr. Peters has collected many thousand, so that they are probably sufficient for all the purposes of the theory. The difficulties of the investigation are undoubtedly great, and it will require judgment and skill to conduct it to a successful conclusion. At the recorded instant of each observed immersion and emersion the distance of the star from the lunar disc is to be computed from the ephemeris of the moon. Were there no errors in the tables, in the records of the observer, or in his geographical position, and no irregularities in the disc of the moon, the computed distance would vanish in correspondence with the observation. But besides the errors of observation, there are those of the latitudes and longitudes of the moon and stars, and of the lunar parallax and semi-diameter, and of the longitude of the observer. The tabular and constant errors must first be determined before it can be known what remains to be divided between the observer and the irregularities of the moon's disc. There is much reason to hope that the lunar parallax and latitude given by Hansen will prove to be so accurate as to require no further correction; and this will be assumed until it shall be found to be incompatible with the observations. It is also probable that the moon's motion in longitude is given with sufficient precision. Bessel's relative places of the Pleiades for 1840 cannot need to be corrected, but their mutual changes of position will cause much perplexity of computation until the new survey shall have been instituted by Dr. Gould with the heliometer of the Dudley observatory; and it is greatly to be desired that this important national institution shall be placed as soon as possible in complete working condition. After setting aside these various sources of error as unimportant, there will remain the constant error of the moon's longitude for each night, the error of the constant of the moon's semi-diameter, the error in the geographical longitude of the observer, the irregularities of the lunar disc, and the errors of observation. In the first approximation the irregularities of the disc will be neglected, as well as those of the longitudes of the observers, except for places in America, and the investigation will be restricted to the determination of the correct longitude of the moon and its mean semi-diameter. In the second approximation the irregularities of the lunar disc will be the special object of inquiry, subject, however, to the errors of observation; and the longitudes of the European observatories will, in the course of this computation, be carefully scrutinized, and will probably need to be corrected in some of the less accurately determined positions. To investigate its irregularities, the surface of the moon will be divided into zones of three minutes of arc in geocentric latitude, commencing with the lunar equator and extending so as to comprise four zones on each side of this equator. The character of the irregularities as to form, position, and approximate height, must, as far as possible, be determined from direct observation, and here again it is greatly to be desired that the assistance of the Dudley observatory may be secured, and its immediate co-operation obtained in this difficult and delicate research. To conduct these observations properly will require skilful and wise direction; but it is worthy of notice that the libration of the moon, which seriously embarrasses the measurement of the heights by means of the Pleiades, will, on the contrary, facilitate their determination by direct observation. But when the heights shall have been measured and the final solution of the problem of the longitude obtained from the Pleiades, it can be asserted with confidence that the resulting longitude will not be liable to a greater error than *one-tenth of a second of time.*

APPENDIX No. 30.

Notice of the determination of the longitude of Fernandina, Amelia island, Florida, by means of chronometer exchanges from Savannah, Georgia, by A. D. Bache, Superintendent, and Charles A. Schott, Assistant, United States Coast Survey. (Sketch No. 67.)

[Communicated by authority of the Treasury Department to the American Association for the Advancement of Science.]

It is proposed to connect the triangulations of the Atlantic coast and the Gulf of Mexico by a series of triangles across the peninsula, from near Fernandina to near Cedar Keys, the termini of the air line railroad. The importance of this connection will be obvious when the distance around the peninsula and the nature of the triangulation which will envelope it are considered. A reconnaissance had shown such a triangulation to be practicable, and it was desirable to keep the general direction of the line already referred to. The latitude of the two termini had been observed and the longitude of a point on one of the Cedar Keys.

The determination of the longitude of Fernandina would furnish the remaining element needed, and also an important datum for the geodetic work of the coast of Georgia and Florida, already in progress. The longitude of Savannah had been obtained by telegraph, and the connection of Fernandina with it was easily made by the transportation of chronometers in the steamers running twice a week between Savannah and the St. John's and stopping at Fernandina.

It is proposed to give an account of the operations of this expedition, with the results for personal equation, for the performance of the chronometers under different circumstances, and others, and of the final determinations of the difference of longitude.

The incidental results will probably have more interest for the American Association than the mere longitude question, though as the two best maps differ some nine miles in the longitude of Fernandina, the final result must, in a practical point of view, be esteemed of great importance.

Early in the spring of the present year arrangements were made for executing this work by a party under the immediate direction of the Superintendent of the Coast Survey. The old astronomical station near the Exchange in the city of Savannah was re-arranged and furnished with suitable instruments. This station is on the bank of the Savannah river and forty-four feet above mean low water, commanding a good view of the heavens both to the south and the north. It has one drawback, namely, that the stone supporting the transit instrument rests upon an arch, and that the vibration from heavy vehicles passing in the street is communicated to the instrument, affecting, in a degree, the accordance of individual results, but not sensibly the final determination of time.

The outfit of the station consisted of transit instrument No. 3, by Troughton and Simms, with a focal length of forty inches and a magnifying power of seventy; of an observing chronometer, (sidereal,) No. 1707, by John Fletcher; and of the usual meteorological instruments. The observations generally were made at this station by the Superintendent, replaced for a few days in the early part of the work by Assistants Charles A. Schott and Charles O. Boutelle. Mr. J. H. Toomer was the aid in the party.

The transit was mounted on the 25th of March, and the observations were closed on the 30th of April.

At the other end of the line a smaller transit, by Würdemann, C. S., No. 10, was mounted at the station near the railroad wharf, occupied the year previous by Sub-Assistant Edward Goodfellow for the determination of the latitude of Fernandina. The observations were made by Assistant Charles A. Schott and by Mr. J. E. Blankenship. The transit instrument used has a focal length of twenty-six inches and a magnifying power of nearly thirty-five. The observing chronometer was by J. Hutton, No. 311, (sidereal.) The same meteorological instruments were used as at Savannah daily at 6 a. m. and at 2 and 10 p. m. The barometers and thermometers used were afterwards compared for index error. This station is but a few feet above the level of the tide of Amelia river, and the wooden blocks upon which the transit was placed actually reached that level, which caused an instability in azimuth, requiring a determination of that element by suitable stars every observing night. The observations here were begun on the first of April and continued until the 27th of the same month.

Observations for personal equation in observing transits were made at Savannah at the beginning of the work and near its close, and at Fernandina at the close. No difference appeared in the values found by the two series at Savannah nor by the use of the two different transit instruments.

Ten chronometers were employed, divided into two sets, and packed in two of the boxes used in the chronometer expedition of 1855, the sides, top, and bottom of which were thickly padded to prevent abrupt changes of temperature and the effects of jarring.

Eight of these chronometers were regulated to solar time, the other two as comparing chronometers, so as to lose about four minutes in mean time in twenty-four hours. With set No. 1 was the thermometric chronometer of Mr. Bond, without compensation, and indicating the mean temperature of its exposure by its gain or loss. Each boat of the line between Savannah and Fernandina made usually one trip to and fro within a week, the days of departure and arrival being so arranged as to require that the same set of chronometers should go and return in the same boat, the first boat from Savannah in the week not returning in time to permit the rating of the chronometers for the trip of the second. Mr. D. Hinkle, aid, was charged with the exchange of the boxes and accompanied one of the sets going and returning. The other set was placed in charge of the captain of the boat and both were always kept in the captain's office. Twice the observers when changing places accompanied the instruments. They were transported by hand between the wharf and the stations. This precaution secured general uniformity of rate. Some of the chronometers were supplied with a thermometer which was read at each comparison. The average duration of the trip was twenty-nine hours from comparison to comparison, these being made as near as possible to the time of arrival and departure.

Diagram No. 1 shows at a glance the number of trips made and the dates of departure and arrival of each set of chronometers at the two stations.

One of the chronometers of set No. 2 being required for other use was withdrawn, and another instrument, kindly loaned by Mr. Richmond, (of Wilmot & Co.,) of Savannah, substituted for it about the middle of the operations, causing no inconvenience from the change. The weather was generally favorable, the clear sky permitting regular observations, and only one very abrupt change of temperature occurring during the series.

As far as practicable the same stars were used at both stations. The routine of observations was as follows: 1st, the level was read; 2d, a low star was observed for azimuth; 3d, two zenith stars for time; 4th, the level was again read. Occasionally special observations for collimation were made by reversals on Polaris on the middle wire. The Savannah transit had seven wires and the Fernandina nine. The probable error of time for the transit over all the wires of each transit was about the same namely $\pm$ 0^s.11. This includes any error of right ascension. The places of the stars were taken from the Greenwich Nautical Almanac. The equatorial intervals of the wires of the two transits were known to within a probable error of $\pm$ 0^s.05 and $\pm$ 0^s.04 respectively. The value of one division of the level of transit No. 3 was found to be 1$''$.05 $\pm$ 0$''$.02 and of No. 10, 0$''$.73 $\pm$ 0$''$.02. Observations made for the purpose show that the pivots of the first named instrument are sensibly equal, and gave for the second a correction which at the greatest is 0^s.02, the clamp pivot being the larger.

Fifteen hundred and twelve transits were observed at Savannah and twelve hundred and sixty-nine at Fernandina. They were all reduced by the method of least squares. In observing, time was marked for the Superintendent by Mr. Toomer. Mr. Schott marked time for himself. The records were kept by Mr. Toomer and Mr. Blankenship.

Personal equation.—Observations on alternate wires for personal equation, between the Superintendent and Assistant Boutelle, showed no sensible difference, time being marked for both by Mr. Toomer. Ten stars observed on April 4th gave for personal equation — 0^s.01 $\pm$ 0^s.02 and seven stars on the 6th + 0^s.05 $\pm$ 0^s.02. The following are the results for personal equation between the Superintendent and Assistant Schott.

Locality.	Date.	Trans. No.	Magnifying power.	No. of stars.	B—S.	Probable error.
	1857.				s.	s.
Savannah	March 30	3	70	23	— 0.62	$\pm$ 0.03
do	April 22	3	70	10	— 0.64	0.04
do	April 23	3	70	12	— 0.50	0.03
Fernandina	April 26	10	35	12	— 0.73	0.10

The result is: B — S = — 0^s. 58 $\pm$ 0^s. 04, which has been applied when necessary. The results are remarkably accordant when the variety of circumstances is considered. The first were made when the first observer had the day before arrived from a fatiguing journey, and the second had had several days of practice. In the second and third, both observers were in full practice, the second having had but a brief interval from work for the short trip from Fernandina by water. The practice had been, it is true, with the smaller instrument at Fernandina.

In the last series both were fresh from the short trip to Fernandina; the first had been in full practice with the large instrument, but had not used the smaller one.

The probable error of one determination varies under the different circumstances, within the limits of $\pm$ 0^s. 10 & $\pm$ 0^s. 14, under the circumstances already stated, while the average is still preserved. In a few cases the first observer took the star's passage over the first four, and the last, the second three wires of the transit. The results for personal equation were grouped for stars observed for illumination east, and then west, for the two observers leading, respectively, for stars north and south of the zenith, and for low and high stars, without sensible deviations from the mean value. To determine how much of this large personal equation was due to the difference between the marking of time by Mr. Schott and Mr. Toomer, and how much to the difference of observation of the star's passage over the wires, Mr. Toomer was directed on the 26th of April to mark time for both observers. Eleven stars were thus observed with a personal equation of $B - S = 0^s.30 \pm 0^s.03$; thus 0^s28, or nearly one-half of the personal equation, was due to the difference in marking time, or ear perception, and the other half to the difference in the observation of the transit, or the eye perception. This supposes the tapping to be simultaneous with the perception of the transit, and on the average this is probably really so.

Diagram No. 2 shows the separate values found for personal equation, and presents some results worthy, when time and opportunity serve, to be further pursued. The steadiness to the mean, with large accidental fluctuations on the first night, and the running up on the nights of the 23d and 24th, towards the close, and down on the 26th, are very curious.

Temperature compensation.—The compensation of chronometers is never perfect for any considerable range of temperature.

Professor W. C. Bond pointed out, in the Coast Survey chronometer expedition between Cambridge and Liverpool, the consequences of this, and elaborately examined the rates at the different temperatures to which the chronometers were likely to be subjected in the different voyages. Diagrams Nos. 3 and 4 show conclusively the over compensation of the observing chronometers used at the two stations, the curves of rate and of temperature corresponding remarkably.

Twenty-four conditional equations between the observed rate and temperature were found for Savannah and seventeen for Fernandina, and the solution of the normal equations gave the correction to be applied to the rate of each chronometer for temperature as follows:

$$\text{Chron. } 1707\ r_t = +\,0^s.12 - 0.095\ (t - 56^\circ.9.)$$
$$311\ r_t = +\,0^s.36 - 0.155\ (t - 61^\circ.0.)$$

where r_t is the daily rate in seconds at the mean temperature t.

The results were thus reduced to a mean temperature, and the remaining irregularities were equalized graphically.

These corrections were applied during the interval between the time of observations of transits and of the comparison of the chronometers in determining the error of the chronometer on siderial time for the epoch of the comparison.

Chronometer comparisons.—Each set of chronometer comparisons consists of a double operation, the repetition being considered necessary to insure correctness. The chronometers beating half seconds, there is a coincidence of beat between the comparing chronometer and a mean time chronometer every minute, and between the comparing and siderial chronometer every minute and a half. The comparing chronometer was observed, in turn, in a regular order with each of the others, passing from one end of the box containing them to the other, and then back again to the first. To the mean of the observed times of coincidence of beats a small correction is applied for the gain of the comparing chronometer on mean or on siderial time, giving the chronometer time at the common epoch of comparison.

To these times the corrections already referred to were applied.

The peculiar arrangement of the chronometers forming one set and the order of comparison, and the reduction of the chronometer time of all the chronometers to a common epoch, viz: the chronometer time of the observing sidereal chronometer, is exhibited in the following specimen of record. The small correction is owing to the gain of the comparator or mean time of its $\frac{1}{120}$ part, and on sidereal time of its $\frac{1}{180}$ part of the interval. No. 1507 is the comparator, 1707 the sidereal observing chronometer, and the rest are mean time chronometers.

Chronometer comparison at Savannah; set No. 1, D. Hinkle, observer, April 25th, a. m.

Chron's.	Direct.		Return.		Mean.	Difference from common epoch and corrected difference.	Chro. time at common epoch.
	1st comparison.	2d comparison.	1st comparison.	2d comparison.			
	h. m. s.	*m. s.*	*h. m. s.*	*m. s.*	*h. m. s.*	*s.*	*h. m. s.*
1507	18 54 35.5	55 34.0	19 09 43.0	10 44.5	19 02 39.25	+01.50	-------------
175	7 50 37.0	51 35.0	8 05 37.0	06 38.0	7 58 36.75	+01.49	7 58 38.24
1507	18 55 59.5	56 59.5	19 08 02.5	09 03.0	19 02 31.12	+09.63	-------------
177	7 59 05.0	60 04.5	8 11 02.0	12 02.0	8 05 33.38	+09.56	8 05 42.94
1507	18 58 05.5	58 16.5	19 07 05.5	07 15.5	19 02 40.75	-------------	19 02 40.75
1707	21 00 52.0	01 03.0	21 09 49.0	09 59.0	21 05 25.75	-------------	21 05 25.75
1507	18 59 20.5	60 20.0	19 04 29.5	05 22.5	19 02 23.13	+17.62	-------------
191	6 53 56.0	54 56.0	6 59 02.5	59 55.0	6 56 57.13	+17.57	6 57 14.70
1507	19 01 13.5	02 16.0	19 03 15.5	04 16.0	19 02 45.25	—04.50	-------------
301	7 53 06.0	54 08.0	7 55 07.0	56 07.0	7 54 37.00	—04.46	7 54 32.54

Temperature of comparator, 57°.2, (chronometers wound up.) The following is a specimen of the next table formed, viz: the corrections to chronometer time at epoch of comparison:

Fernandina, April 14th, a. m., set No. 2, before departure; sid. time 13d. 19h. 49m. 41s.41.

Chron's.	Chron. time at com. Ep.	Correction to chronometer.
	h. m. s.	*h. m. s.*
311	19 36 06.00	+ 0 13 35.41
1508	17 00 30.62	+ 2 49 10.79
184	7 16 49.65	+12 32 51.76
193	6 29 08.23	+13 20 33.18
195	6 26 19.97	+13 23 21.44
1285	6 38 34.90	+13 11 06.51

311 is the sidereal observing chronometer, 1508 a comparator, the rest are mean time chronometers, the last is an eight day chronometer.

Throughout the reduction the sign + to the chronometer correction indicates "chronometer slow," and when applied to the rate it indicates "chronometer losing;" the reversed sign applies to chronometer fast and to gaining rate.

Stationary and travelling rates.—The next step is the determination of the stationary and travelling rates of the chronometers.

The stationary rates resulted directly from the observed change (corrected) and the interval between the time of arrival and departure at each station.

The following is a copy of the form of reduction :

Set No. 1. Savannah interval, April 11th, a. m., April 14th, a. m.

Sid. interval, 2*d.* 21*h.* 06*m.* 37*s*.47. = 2*d.* 8796.

Chron's.	Change in int'l 13*d*—11*d*.	Lg. change.	Lg. rate.	Daily sta'ry rate.
	h. m. s. *s.*			*s.*
1507....	—0 23 14.53 = —1394.53	3.14444—	2.68511—	—484.30
175....	+0 11 07.44 = + 667.44	2.82441+	2.36508+	+231.78
177....	+0 11 20.98 = + 680.98	2.83313+	2.37380+	+236.48
191....	+0 11 21.34 = + 681.34	2.83336+	2.37403+	+236.61
301....	+0 11 06.75 = + 666.75	2.82396+	2.36463+	+231.54

In making these reductions it was found most convenient to regard the chronometers as sidereal ones with a large rate; stationary rates were deduced for eight intervals, four at each station for each chronometer.

The travelling rates were obtained by deducting from the whole interval between the departure from and return to the same station the shorter stationary interval at the other station, to obtain the sidereal travelling interval ; and from the whole change of chronometer time, the change during the stationary interval, to obtain the travelling change.

The following specimen of reduction illustrates this process:

Voyage No. 2, set No. 2, Initial station, Savannah.

	d. h. m. s.
April 11th, epoch of comparison	10 19 52 30.16
April 15th, epoch of comparison	15 00 41 54.07
Sidereal interval	4 04 49 23.91 = 4*d.* 2010
Sidereal interval at Fernandina, April 13*d.*—11*d.*	1 23 35 .39.27
Sidereal travelling interval	2 05 13 44.64 = 2*d.* 2179

Chron's.	Change for int. April 15*d*—10*d*.	Change for sta'ry interval, Ap. 13*d*—11*d*.	Change for travelling interval.	Lg. change.	Lg. rate.	Daily travelling rate.
	h. m. s *s.*	*s.*	*s.*			*s*
1508	—0 23 59.71 = —2039.71	—963.98	—1075.73	3.03170—	2.68576—	—485.02
184	+0 16 07.00 = + 967.00	+456.44	+ 510.56	2.70805+	2.36211+	+230.20
193	+0 16 29.96 = + 989.96	+468.08	+ 521.88	2.71757+	2.37163+	+235.30
195	+0 16 30.84 = + 990.84	+466.63	+ 524.21	2.71951+	2.37357+	+236.36
1285	+0 16 27.71 = + 987.71	+466.47	+ 521.24	2.71704+	2.37110+	+235.02

These travelling rates were ascertained for the trips from Savannah and back again, as well as from Fernandina and back ; and by using these, approximate values for the difference of longitude were obtained.

The error arising from the assumption of equal travelling rates for the outward and home trip of each journey, implied in this process for deducting the travelling rates, is partially corrected by taking the mean of the longitudes from and to Savannah, and from and to Fernandina.

Taking the mean of seven values for travelling rates of each chronometer, the stationary and travelling rates compare as follows:

Set No. 1.			Set No. 2.		
Chronometers.	Mean stationary rate.	Mean travelling rate.	Chronometers.	Mean stationary rate.	Mean travelling rate.
	s.	s		s.	s.
1507	— 484. 75	— 484. 12	1508	— 485. 42	— 485. 60
175	+ 232. 07	+ 232. 75	184	+ 230. 82	+ 229. 92
177	+ 236. 48	+ 237. 09	193	+ 236. 40	+ 235. 53
191	+ 236. 55	+ 236. 60	195	+ 235. 86	+ 236. 84
301	+ 231. 07	+ 231. 19	442	+ 240. 44	+ 239. 67
			1285	+ 235. 06	+ 234. 78

This table shows that travelling affected the two sets differently, all the five chronometers of the first set and only two of the second set lost by travelling. The separate comparisons of the travelling rates in the different trips agreed well among themselves. To show how the travelling rates themselves compare, one of the four tables of results is here given.

Travelling rates from voyages from and to Savannah, set No. 2.

Chronometers.	April 8th—4th.	April 15th—11th.	April 22d—18th.	April 29th—25th.
	s.	s.	s	s.
1508	— 485. 05	— 485. 02	— 486. 43	— 486. 06
184	+ 230. 87	+ 230. 20	+ 229. 84	+ 229. 00
193	+ 235. 39	+ 235. 30	+ 235. 53	+ 235. 85
195	+ 236. 74	+ 236. 36		
442			+ 239. 50	+ 239. 96
1285	+ 235. 31	+ 235. 02	+ 234. 60	+ 234. 24

Having the travelling rates deduced from the voyages or trips from and back, the travelling rate for each trip was deduced by the application of the method of least squares, as follows:

Let $r_1\ r_3\ r_5\ r_7$ be the successive stationary rates at Savannah; $r_2\ r_4\ r_6$ be the successive stationary rates at Fernandina; $R_1\ R_3\ R_5\ R_7$ be the travelling rates from successive voyages from and to Savannah; $R_2\ R_4\ R_6$ the same in reference to Fernandina; $x_1\ x_3\ x_5\ x_7$ be the travelling rates of the successive trips from Savannah to Fernandina; $x_2\ x_4\ x_6$ the same in reference to return trips; $a_1\ a_3\ a_5\ a_7$ the duration of the several trips from Savannah to Fernandina, and expressed in siderial days, and fractions of days; $a_2\ a_4\ a_6$ the same for the return trips.

We then have the conditions:

$$\left.\begin{array}{l} a_1 x_1 + a_2 x_2 = (a_1 + a_2)\,R_1 \\ a_2 x_2 + a_3 x_3 = (a_2 + a_3)\,R_2 \\ a_3 x_3 + a_4 x_4 = (a_3 + a_4)\,R_3 \\ + \textit{etc.} \end{array}\right\}\ \text{I.}$$

from which we obtain

$$\left.\begin{aligned}
x_1 &= \frac{a_1}{a_1} x_1 \\
x_2 &= \frac{1}{a_2}\left(a_1 + a_2\right) \mathrm{R}_1 - \frac{a_1}{a_2} x_1 \\
x_3 &= \frac{1}{a_3}\left(a_2 + a_3\right) \mathrm{R}_2 - \frac{1}{a_3}\left(a_1 + a_3\right) \mathrm{R}_1 + \frac{a_1}{a_3} x_1 \\
x_4 &= \frac{1}{a_4}\left(a_3 + a_4\right) \mathrm{R}_3 - \frac{1}{a_4}\left(a_2 + a_3\right) \mathrm{R}_2 + \frac{1}{a_4}\left(a_1 + a_2\right) \mathrm{R}_1 - \frac{a_1}{a_4} x_1
\end{aligned}\right\} \text{II.}$$

$+$ *etc.*

We next form the differences of rates for the successive trips, the squares of which are to be a minimum :

$$x_1 - x_2 = \left(\frac{a_1}{a_1} + \frac{a_1}{a_2}\right) x_1 - \frac{1}{a_2}\left(a_1 + a_2\right) \mathrm{R}_1$$

$$x_3 - x_2 = \left(\frac{a_1}{a_2} + \frac{a_1}{a_3}\right) x_1 - \left(\frac{1}{a_2} + \frac{1}{a_3}\right)\left(a_1 + a_2\right) \mathrm{R}_1 + \frac{1}{a_3}\left(a_2 + a_3\right) \mathrm{R}_2$$

$$x_3 - x_4 = \left(\frac{a_1}{a_3} + \frac{a_1}{a_4}\right) x_1 - \left(\frac{1}{a_3} + \frac{1}{a_4}\right)\left(a_1 + a_2\right) \mathrm{R}_1 + \left(\frac{1}{a_3} + \frac{1}{a_4}\right)\left(a_2 + a_3\right) \mathrm{R}_2 - {}_{a_4}\left(a_3 + a_4\right) \mathrm{R}_3$$

$$x_5 - x_4 = \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$+$ *etc.*,

squaring, differentiating and putting the first differential coefficient zero, the equations, when added up, give us the normal equation :

$$\begin{aligned}
0 = \alpha_1 x_1 &\left[\alpha_1 \alpha_2 + \alpha_2 \alpha_3 + \alpha_3 \alpha_4 + \cdots + \alpha_{n-1} \alpha_n + \tfrac{1}{2} \alpha_1^2 + \alpha_2^2 + \alpha_3^2 + \alpha_4^2 + \cdots + \alpha^2_{n-1} + \tfrac{1}{2} \alpha^2_n\right] \\
- \left(a_1 + a_2\right) \mathrm{R}_1 &\left[\tfrac{1}{2} \alpha_1 \alpha_2 + \alpha_2 \alpha_3 + \cdots\cdots + \alpha_{n-1} \alpha_n + \alpha_2^2 + \alpha_3^2 + \cdots\cdots + \alpha^2_{n-1} + \tfrac{1}{2} \alpha^2_n\right] \\
+ \left(a_2 + a_3\right) \mathrm{R}_2 &\left[\tfrac{1}{2} \alpha_2 \alpha_3 + \alpha_3 \alpha_4 + \cdots\cdots + \alpha_{n-1} \alpha_n + \alpha_3^2 + \alpha_4^2 + \cdots\cdots + \alpha^2_{n-1} + \tfrac{1}{2} \alpha^2_n\right] \\
- \textit{etc.} \qquad &\qquad \mp \tfrac{1}{2} \alpha_n \left(\alpha_{n-1} + \alpha_n\right)\left(a_{n-1} + a_n\right) \mathrm{R}_{n-1}
\end{aligned}$$

in which expression $\alpha_1 = \frac{1}{a_1}$ $\alpha_2 = \frac{1}{a_2}$ *etc.* $\alpha_n = \frac{1}{a_n}$

This equation may be written in the form :

$$0 = \mathrm{A}\, x_1 + \mathrm{B\, R}_1 + \mathrm{C\, R}_2 + \mathrm{D\, R}_3 + \cdots\cdots\cdots + \mathrm{H\, R}_7$$

for the case under consideration, where the coefficients A, B, C, D $\cdots\cdots$ are constant for the chronometers forming one set.

By this equation x_1 becomes known, and if it should be desirable $x_2\, x_3\, x_4 \cdots\cdots x_8$ can be determined from equations (II); they should produce the same longitude. In order to eliminate the effect of accumulated small errors in the last place of decimals, the rates $x_2\, x_3\, x_4 \cdots x_8$ have been calculated and the mean result for longitude has been used; this small additional labor furnishes an acceptable check for these calculations.

The following table gives a specimen of the result for one of the chronometers of the second set, (No. 1285 :)

TRAVELLING RATE OF CHRONOMETER.				DURATION OF TRIP.	
From voyage to and fro.		From single trip.			
From Savannah and back.	From Fernandina and back.	From Savannah to Fernandina.	From Fernandina to Savannah.	Savannah to Fernandina.	Fernandina to Savannah.
s.	*s.*	*s.*	*s.*	*d.*	*d.*
235.31		235 25	235.38	1.092	1.073
	235.50	235.64		1.076	
235.02			234.50		1.202
	234.61	234.72		1.322	
234.60			234 49		1.361
	234.17	233 81		1.265	
234.24			234.76		0.995

Comparing the travelling rates of the separate trips with the average travelling rate before found for the voyage, or trip to and fro, the differences will be seen to be quite small, showing the satisfactory character of the first hypothesis, from which the approximate longitude was deduced.

Having thus the individual travelling rates for the several chronometers of each set, a difference of longitude was deduced by using it in combination with the stationary rate, as follows :

Trip No. 1. Set No. 1.

	d.	*h.*	*m.*	*s.*	
Savannah epoch, March	30	19	02	34.73	
Fernandina " "	31	22	38	31.22	
Uncorrected interval	1	03	35	56.49	
Approximate difference of longitude	+		1	29.53	
Sidereal	1	03	37	26.02	= 1*d.*1510.

Chronometer.	Lg. daily rate x_1.	Lg. rate interval.	Change for interval.
177	2.37496 +	2.43607 +	+ 272.92 *s.* = + 4 *m.* 32.92 *s.*

	h.	*m.*	*s.*
Correction at Savannah epoch	+ 12	17	06.37
Same referred to Fernandina epoch	+ 12	21	39.29
Correction at Fernandina epoch	+ 12	20	09.71
Fernandina west of Savannah	+	1	29.58

The remaining rates $x_2\ x_3 \cdots x_8$ gave the following results :

Trip No.	1.	2.	3.	4.	5.	6.	7.	8.
m. *s*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*
1 29 +	.58	.58	.58	.60	.59	.60	.60	.59

The mean of 1*m*. 29*s*.59 has been adopted for this chronometer.

The following table gives the separate longitudes deduced from each chronometer :

Set No. 1.			Set No. 2.		
Chron.	Diff. long.	Probable error of each chron.	Chron.	Diff. long.	Probable error of each chron.
	m. s.	*s.*		*m. s.*	*s.*
1507	+ 1 29.47	± 0.11	1508	+ 1 29.78	± 0.09
175	29.19	0.30	184	30.40	0.15
177	29.59	0.10	193	29.45	0.20
191	29.57	0.07	195	30.29	0.29
301	29.79	0.05	442	29.93	0.10
			1285	29.94	0.09

Mean, + 1*m*. 29*s*. 73. ; ± 0*s*. 07.

This table shows such a decided difference between the longitudes given by the two sets of chronometers, or what may be called a personal equation between the two sets, even after the application of corrections for the temperature deduced for each instrument, that it was deemed advisable to try whether if the two sets were exposed to identically the same circumstances this difference would remain. They were therefore carried, side by side, from Savannah to Fernandina and back, and carefully rated at both places. The resulting longitude for set No. 1 was 1*m*. 28*s*.6., and for set No. 2 was 1*m*. 29*s*.3., agreeing with the former results.

In accordance with the method of reduction pursued, the relative weight to the result by each chronometer will depend on the changes of rate of the successive trips. Let $n =$ the number of rates $x_1\, x_2 \cdots$ or $n - 1 =$ the number of changes of rates, and $\Sigma\, \Delta\, x^2 =$ the minimum sum of squares of differences of rates, then the probable error of a change of rate,

$$= \pm \frac{0.6745}{n - 1} \sqrt{\Sigma\, \Delta\, x^2}$$

and since the trips are not of equal duration, the probable error of the first rate or x_1 becomes

$$\pm \frac{0.6745}{n - 1} \cdot \frac{a_1\, a_2}{a_1\, a_1 + a_1\, a_2} \sqrt{\Sigma\, \Delta\, x^2}$$

This rate applies through a_1 days, hence the probable error of the result for difference of longitude by any one chronometer

$$\pm \frac{0.6745}{n - 1} \cdot \frac{a_1\, a_1\, a_2}{a_1\, a_1 + a_1\, a_2} \sqrt{\Sigma\, \Delta\, x^2} = \mathrm{E}.$$

and the weight $= \frac{1}{\mathrm{E}^2}$.

Set No. 1.			Set No. 2.		
Chronometer.	Prob. error.	Weights.	Chronometer.	Prob. error.	Weights.
	s.			*s.*	
1507	± 0. 11	76	1508	± 0. 09	114
175	0. 30	11	184	0. 15	45
177	0. 10	106	193	0. 20	25
191	0. 07	190	195	0. 29	12
301	0. 05	359	442	0. 10	94
			1285	0. 09	129
				Z. =	1161

Let M_1 M_2 M_3 $\cdots$ be the resulting difference of longitude by each chronometer;
w_1 w_2 w_3 $\cdots$ the corresponding weight,
then the final value for Fernandina, west of Savannah,

$$M = \frac{M_1 w_1 + M_2 w_2}{w_1 + w_2 +} + \cdots\cdots\cdots\cdots = 1m.\ 29s.76.$$

with a probable error of $\pm$ 0*s*.06.

The difference between this result and the contradictory ones of two of the best charts of Fernandina has already been stated in our prefatory remarks.

APPENDIX No. 31.

Account of the method and formulæ for the determination of the astronomical latitude by means of the zenith telescope, as used in the survey of the coast of the United States.

Principle of the method.—Let L = the latitude of the station; D_s and D_n, the declinations of a south and north star, the difference of whose meridional zenith distances is less than the arc embraced in the field of view of the telescope; ζ_s and ζ_n, the true meridional zenith distances of the south and north stars.

From the south star $L = D_s + \zeta_s$ and
From the north star $L = D_n - \zeta_n$
Adding and dividing by 2,
$$L = \tfrac{1}{2}(D_s + D_n) + \tfrac{1}{2}(\zeta_s - \zeta_n)$$

Now, if z denote the observed zenith distance, N and S the north and south readings of the level, b the value of a division of the level scale in arc, r the refraction, and m the reduction to meridian, we have —

$$\zeta_s = z_s + \tfrac{1}{2}(N_s - S_s)\, b + r_s - m_s$$
$$\zeta_n = z_n - \tfrac{1}{2}(N_n - S_n)\, b + r_n - m_n$$

Hence:

$$L = \tfrac{1}{2}(D_s + D_n) + \tfrac{1}{2}(z_s - z_n) + \tfrac{1}{4}\{(N_s - S_s) + (N_n - S_n)\}\, b + \tfrac{1}{2}(r_s - r_n) + \tfrac{1}{2}(m_n - m_s)$$

If M_s, M_n be the micrometer readings of the south and north stars, the micrometer being supposed to read from the zenith, and v the value of a division of the screw

$$\tfrac{1}{2}(z_s - z_n) = \tfrac{1}{2}(M_s - M_n)\, v.$$

Determination of value of micrometer.—Several methods have been used for this purpose, the one which has been commonly adopted is, by turning the micrometer at right angles to the position in which it is used for making latitude observations, and noting the times of the passage of Polaris, on any close circumpolar star near culmination, over the micrometer wire, placed at the successive turns or half turns of the screw. The method now in use is, by observing the star near elongation, when rapidly rising or falling with but a slight motion in azimuth; this method avoids the displacement of the micrometer, and as the level is read at every alternate noting, any disturbance of the instrument in the direction of the vertical can be corrected for. It is necessary in this method to apply a correction for difference of refraction.

Let H be the hour angle of the star reckoned from elongation, and x'' the number of seconds of arc in the direction of the vertical from elongation, and Δ the north polar distance of the star, then

$$x'' = \frac{\text{Sin. } \Delta \text{ sin. H}}{\text{Sin. } 1''} = \frac{\text{Sin. } \Delta\ (\text{H} - \frac{1}{6}\text{H}^3)}{\text{Sin. } 1''}$$

or, if H be expressed in seconds of time,

$$x'' = 15 \text{ sin. } \Delta \left\{ \text{H} - \tfrac{1}{6}\,(15 \text{ sin. } 1'')^2\, \text{H}^3 \right\}$$

It is convenient to apply the term $\frac{1}{6}$ (15 sin. $1''$)^2 H^3 to the observed time of noting. It is added to the observed time before, and subtracted after either elongation.

The following table gives the value of $\frac{1}{6}$ (15 sin. $1''$)^2 H^3 for every minute of time from elongation up to 44*m*.

H.	Term.	H.	Term.	H.	Term.	H.	Term.
m.	*s.*	*m.*	*s.*	*m.*	*s.*	*m.*	*s.*
5	0. 0	15	0. 6	25	3. 0	35	8. 2
6	0. 0	16	0. 8	26	3. 3	36	8. 9
7	0. 0	17	0. 9	27	3. 7	37	9. 6
8	0. 1	18	1. 1	28	4. 2	38	10. 4
9	0. 1	19	1. 3	29	4. 6	39	11. 3
10	0. 2	20	1. 5	30	5. 1	40	12. 2
11	0. 2	21	1. 8	31	5. 7	41	13. 1
12	0. 3	22	2. 0	32	6. 2	42	14. 1
13	0. 4	23	2. 3	33	6. 8	43	15. 1
14	0. 5	24	2. 6	34	7. 5	44	16. 2

The correction to be applied to the observed times of noting for change of level is given by the formula—

$$\pm \left\{ \tfrac{1}{2}\,(\text{N} - \text{S}) - \tfrac{1}{2}\,(\text{N}_{\circ} - \text{S}_{\circ}) \right\} \frac{b}{15 \text{ sin. } \Delta}$$

where $\text{N}_{\circ}$, $\text{S}_{\circ}$, are the north and south readings for a selected state of level, N, S the north and south readings for any other state, and b the value of one division of level in seconds of arc, the upper sign is to be used for western, and the lower for eastern elongation.

After these two corrections have been applied to the observed times of noting, we have in one column the readings of the micrometer, and in another the corresponding times, such as would actually have been observed if the star had moved uniformly in the direction of the vertical through the point of elongation, and the instrument had been steady, leaving out, for the present, the change in refraction. Various methods of combination may be adopted for the determination of the value of one turn of the screw. That used in the following example is probably as good as any other, and recommends itself by its simplicity.

The correction for refraction to the value of one turn is negative for either eastern or western elongation, and equals the change of refraction for the space equal to one turn. It is obtained from the proportion—

$$3600'' : \text{diff. of refr'n for } 1^\circ \text{ at star's alt.} = \text{value of 1 turn} : \text{corr'n.}$$

Station Harris Mountain, August 24, 1855.—Observations on Polaris, near E. elongation, for value of micrometer of zenith telescope No. 2.—Elong. by Chron. 19h. 15m.0., 1. div. of level scale = 1″.16.

No.	Reading of micrometer.	Time by chron.	Level readings.		Time from elong.	Red. to mean state of level.	Corr. for H.	Corr. for level.	Reduced time.
			N.	S.					
	T.	*h. m. s.*			*m.*		*s.*	*s.*	*h. m. s.*
1	5.0	18 36 11.5			38.8		+11.0	+3.0	18 36 25.5
2	5.5	37 09.7	24.9	12.2	37.8	+1.00	10.2	+3.0	37 22.9
3	6.0	38 10.0			36.8		9.4	+2.3	38 21.7
4	6.5	39 09.5	25.2	11.6	35.8	+0.55	8.7	+1.7	39 19.9
5	7.0	40 10.0			34.8		8.0	+2.0	40 20.0
6	7.5	41 10.0	25.1	11.7	33.8	+0.65	7.3	+2.3	41 19.6
7	8.0	42 11.0			32.8		6.7	+2.0	42 19.7
8	8.5	43 10.0	25.2	11.6	31.8	+0.55	6.1	+1.7	43 17.8
9	9.0	44 08.4			30.9		5.5	+1.5	44 15.4
10	9.5	45 07.2	25.3	11.5	29.9	+0.45	5.0	+1.2	45 13.4
11	10.0	46 08.0			28.9		4.5	+1.4	46 13.9
12	10.5	47 03.0	25.2	11.5	27.9	+0.50	4.1	+1.5	47 08.6
13	11.0	48 04.7			26.9		3.7	+1.1	48 09.5
14	11.5	49 03.0	25.4	11.2	25.9	+0.25	3.3	+0.8	49 07.1
15	12.0	50 02.4			25.0		2.9	+0.5	50 05.8
16	12.5	51 00.0	25.6	11.1	24.0	+0.10	2.6	+0.3	51 02.9
17	13.0	51 56.0			23.1		2.3	+0.1	51 58.4
18	13.5	52 57.2	25.7	11.0	22.1	0.00	2.0	0.0	52 59.2
19	14.0	53 52.4			21.1		1.8	0.0	53 54.2
20	14.5	54 53.0	25.7	11.0	20.1	0.00	1.6	0.0	54 54.6
21	15.0	55 54.1			19.1		1.3	0.0	55 55.4
22	15.5	56 50.9	25.7	11.0	18.2	0.00	1.1	0.0	56 52.0
23	16.0	57 48.0			17.2		1.0	0.0	57 49.0
24	16.5	58 48.4	25.7	11.0	16.2	0.00	0.8	0.0	58 49.2
25	17.0	59 47.0			15.2		0.7	0.0	59 47.7
26	17.5	19 00 44.4	25.7	11.0	14.3	0.00	0.6	0.0	19 00 45.0
27	18.0	01 44.4			13.3		0.5	—0.1	01 44.8
28	18.5	02 42.0	25.8	10.9	12.3	—0.10	0.4	—0.3	02 42.1
29	19.0	03 43.4			11.3		0.3	—0.2	03 43.5
30	19.5	04 39.9	25.8	11.0	10.4	—0.05	0.2	—0.1	04 40.0
31	20.0	05 39.8			9.4		0.2	—0.3	05 39.7
32	20.5	06 36.9	25.8	10.8	8.4	—0.15	0.1	—0.4	06 36.6
33	21.0	07 39.0			7.4		0.1	—0.4	07 38.7
34	21.5	08 34.5	25.9	10.9	6.4	—0.15	0.1	—0.4	08 34.2
35	22.0	09 33.0			5.4		0.0	—0.5	09 32.5
36	22.5	10 31.0	25.9	10.8	4.5	—0.20	0.0	—0.6	10 30.4
37	23.0	11 30.7			3.5		0.0	—0.6	11 30.1
38	23.5	12 25.2	25.9	10.8	2.6	—0.20	0.0	—0.6	12 24.6
39	24.0	13 27.0			1.6		0.0	—0.7	13 26.3
40	24.5	14 23.9	25.9	10.7	0.6	—0.25	0.0	—0.8	14 23.1

	Time for 10 turns.	Δ	$Δ^2$		Time for 10 turns.	Δ	$Δ^2$
	m. s.				m. s.		
No. 1 to 21	19 29.9	2.2	4.8	No. 11 to 31	19 25.8	1.9	3.6
2 to 22	29.1	1.4	2.0	12 to 32	28.0	0.3	0.1
3 to 23	27.3	0.4	0.2	13 to 33	29.2	1.5	2.2
4 to 24	29.3	1.6	2.6	14 to 34	27.1	0.6	0.4
5 to 25	27.7	0.0	0.0	15 to 35	26.7	1.0	1.0
6 to 26	25.4	2.3	5.3	16 to 36	27.5	0.2	0.0
7 to 27	25.1	2.6	6.8	17 to 37	31.7	4.0	16.0
8 to 28	24.3	3.4	11.6	18 to 38	25.4	2.3	5.3
9 to 29	28.1	0.4	0.2	19 to 39	32.1	4.4	19.4
10 to 30	26.6	1.1	1.2	20 to 40	28.5	0.8	0.6
				Mean	19 27.74		83.3

Time for 1 turn = 116s.774. log 2.06735
sin. N. P. D., log 8.40750
15 log 1.17609

1 turn = 44″.765 1.65094
Corr. for refraction = − 0″.025.

Probable error of 10 turns, (time):

$$= \sqrt{\frac{0.455 \times 83.3}{20 \times 19}} = \pm 0s.31$$

Probable error of 1 turn, = ± 0s.031
= ± 0″.012

Value of one turn, = 44″.740 ± 0″.012

Determination of value of level.—The value of a division of the level is next found in terms of the micrometer value.

The telescope is directed upon a collimator placed at a convenient distance; the displacement of the line of collimation as the bubble of the level is made to travel from one end of the tube to the other being measured by the micrometer. The following example is annexed to show the method:

Station Harris Mountain, August 23, 1855.—*Observations for value of level B of zenith telescope No.* 2.

No.	Micrometer reading.	Level reading. N.	Level reading. S.	Difference of reading. Micrometer.	Difference of reading. Level.	Value of 1 division of level in micrometer divisions.	Δ	Δ²
	r.			*d.*				
1	18. 94	34. 2	1. 8					
	18. 30	9. 0	27. 0	64	25. 20	2. 54	0. 01	0. 000
2	18. 26	34. 7	1. 4					
	17. 65	10. 0	25. 8	61	24. 55	2. 48	0. 07	0. 005
3	17. 64	36. 0	0. 0					
	16. 98	8. 8	27. 0	66	27. 10	2. 44	0. 11	0. 012
4	16. 95	35. 5	0. 0					
	16. 22	5. 5	30. 0	73	30. 00	2. 43	0. 12	0. 014
5	16. 22	34. 0	1. 5					
	15. 48	5. 6	30. 0	74	28. 45	2. 60	0. 05	0. 002
6	15. 43	34. 3	1. 2					
	14. 67	3. 5	32. 1	76	30. 85	2. 46	0. 09	0. 008
7	14. 62	31. 0	1. 8					
	13. 81	— 1. 5	37. 0	81	32. 35	2. 50	0. 05	0. 003
8	13. 77	33. 4	2. 2					
	13. 10	8. 2	27. 0	67	25. 00	2. 68	0. 13	0. 017
9	13. 07	35. 0	0. 2					
	12. 36	7. 5	27. 8	71	27. 55	2. 58	0. 03	0. 001
10	12. 33	35. 0	0. 6					
	11. 66	9. 5	25. 7	67	25. 30	2. 65	0. 10	0. 010
11	11. 65	30. 5	4. 8					
	11. 05	8. 0	27. 0	60	22. 35	2. 68	0. 13	0. 017
12	11. 00	33. 0	1. 9					
	10. 32	6. 8	28. 2	68	26. 25	2. 59	0. 04	0. 002
					Mean	2. 55		0. 091

Probable error of one division of level, $= \sqrt{\frac{0.455 \times 0.091}{12 \times 11}} = \pm 0.018 = 0''.01$.

One division of micrometer, $= 0''.447$.

One division of level, $= 2.55 \times 0''.447 = 1''.14$.

Correction for refraction.—One of the great advantages of the determination of latitude by zenith telescope observations is, that the correction for refraction is very small, being for the difference merely of the two refractions on each side of the zenith. The correction for temperature and pressure of the atmosphere is insignificant. The refraction being nearly proportional to the tangent of the zenith distance, the difference of refraction for the two stars of the pair will be given by the formula

$$r_s - r_n = 58'' \sin. (z_s - z_n) \sec^2. z_s.$$

The following table gives the value of $\frac{1}{2} (r_s - r_n)$ for every minute of difference of zenith distance up to 24′ and for different zenith distances.

Correction for refraction to be used in correcting observations with zenith telescope.

The correction is applied to the latitude; the sign is the same as that of the micrometer difference.

Half Diff. Z D.	Zenith distance. 0°	10°	20°	25°	30°	35°
′ ″	″	″	″	″	″	″
0 00	.00	.00	.00	.00	.00	.00
0 30	.01	.01	.01	.01	.01	.01
1 00	.02	.02	.02	.02	.02	.02
1 30	.02	.03	.03	.03	.03	.03
2 00	.03	.03	.04	.04	.04	.05
2 30	.04	.04	.05	.05	.05	.06
3 00	.05	.05	.06	.06	.07	.08
3 30	.06	.06	.07	.07	.08	.09
4 00	.07	.07	.08	.08	.09	.10
4 30	.08	.08	.09	.09	.10	.11
5 00	.08	.09	.10	.10	.11	.13
5 30	.09	.10	.10	.11	.12	.14
6 00	.10	.10	.11	.12	.13	.15
6 30	.11	.11	.12	.13	.14	.16
7 00	.12	.12	.13	.14	.15	.18
7 30	.13	.13	.14	.15	.16	.19
8 00	.13	.14	.15	.16	.18	.21
8 30	.14	.15	.16	.17	.19	.22
9 00	.15	.16	.17	.18	.20	.23
9 30	.16	.17	.18	.20	.21	.24
10 00	.17	.18	.19	.21	.23	.26
10 30	.18	.19	.20	.22	.24	.27
11 00	.18	.19	.21	.23	.25	.28
11 30	.19	.20	.22	.24	.26	.30
12 00	.20	.21	.23	.25	.27	.31

Reduction to meridian.—The formula for reduction to meridian, when the line of collimation of the instrument is off the meridian, is

$$m = \frac{\cos. L \cos. D}{\sin. (L - D)} \cdot \frac{2 \sin.^2 \frac{1}{2} \tau}{\sin. 1''}$$

Correction to latitude $= \frac{1}{2} (m_n - m_s)$

The value of $\frac{2 \sin.^2 \frac{1}{2} \tau}{\sin. 1''}$ for every second of time up to two minutes (a star being rarely observed at a greater distance than this from the meridian in zenith telescope observations) is given in the following table :

0^m	$\frac{2 \sin.^2 \frac{1}{2} \tau}{\sin. 1''}$	0^m	$\frac{2 \sin.^2 \frac{1}{2} \tau}{\sin. 1''}$	0^m	$\frac{2 \sin.^2 \frac{1}{2} \tau}{\sin. 1''}$	1^m	$\frac{2 \sin.^2 \frac{1}{2} \tau}{\sin. 1''}$	1^m	$\frac{2 \sin.^2 \frac{1}{2} \tau}{\sin. 1''}$	1^m	$\frac{2 \sin.^2 \frac{1}{2} \tau}{\sin. 1''}$
s.	"	*s.*	"	*s.*	"	*s.*	"	*s.*	"	*s.*	"
0	0.00	20	0.22	40	0.87	0	1.96	20	3.49	40	5.45
1	.00	21	.24	41	.91	1	2.03	21	3.58	41	5.56
2	.00	22	.26	42	.96	2	2.10	22	3.67	42	5.67
3	.00	23	.28	43	1.01	3	2.16	23	3.76	43	5.78
4	.01	24	.31	44	1.06	4	2.23	24	3.85	44	5.90
5	.01	25	.34	45	1.10	5	2.31	25	3.94	45	6.01
6	.02	26	.37	46	1.15	6	2.38	26	4.03	46	6.13
7	.02	27	.40	47	1.20	7	2.45	27	4.12	47	6.24
8	.03	28	.43	48	1.26	8	2.52	28	4.22	48	6.36
9	.04	29	.46	49	1.31	9	2.60	29	4.32	49	6.48
10	.05	30	.49	50	1.36	10	2.67	30	4.42	50	6.60
11	.06	31	.52	51	1.42	11	2.75	31	4.52	51	6.72
12	.08	32	.56	52	1.48	12	2.83	32	4.62	52	6.84
13	.09	33	.59	53	1.53	13	2.91	33	4.72	53	6.96
14	.11	34	.63	54	1.59	14	2.99	34	4.82	54	7.09
15	.12	35	.67	55	1.65	15	3.07	35	4.92	55	7.21
16	.14	36	.71	56	1.71	16	3.15	36	5.03	56	7.34
17	.16	37	.75	57	1.77	17	3.23	37	5.13	57	7.46
18	.18	38	.80	58	1.83	18	3.32	38	5.24	58	7.60
19	.20	39	.83	59	1.89	19	3.40	39	5.34	59	7.72

When the star is observed on either side of the vertical wire, the instrument being in the meridian, the formula for reduction to meridian is

$$\mu = \sin. D \cos. D . \frac{2 \sin.^2 \frac{1}{2} \tau}{\sin. 1''} \text{ and the correction to latitude} = \tfrac{1}{2} (\mu_s + \mu_n)$$

The following table gives the value of μ for every 5° of declination, and for every 5 seconds of time, from ten seconds to one minute:

D.	*s.* 10	*s.* 15	*s.* 20	*s.* 25	*s.* 30	*s.* 35	*s.* 40	*s.* 45	*s.* 50	*s.* 55	*s.* 60	D.
	"	"	"	"	"	"	"	"	"	"	"	
5°	.00	.01	.02	.03	.04	.06	.08	.10	.12	.14	.17	85°
10	.01	.02	.04	.06	.08	.11	.15	.19	.23	.28	.34	80
15	.01	.03	.05	.09	.12	.17	.22	.28	.34	.41	.49	75
20	.02	.04	.07	.11	.16	.22	.28	.36	.44	.53	.63	70
25	.02	.05	.08	.13	.19	.26	.34	.42	.52	.63	.75	65
30	.02	.05	.09	.15	.21	.29	.38	.48	.59	.71	.85	60
35	.03	.06	.10	.16	.23	.31	.41	.52	.64	.77	.92	55
40	.03	.06	.11	.17	.24	.33	.43	.54	.67	.81	.97	50
45	.03	.06	.11	.17	.25	.33	.44	.55	.68	.82	.98	45

Selection of stars.—In selecting pairs of stars for use with this instrument, the following rules have been found convenient or necessary. The British Association, the Greenwich Twelve and

Six Year Catalogues, and Rumker's Catalogue, afford ready means for their selection and the computation of their places:

1. The latitude of the place should be known within one or two minutes.

2. The difference of zenith distance of the south and north stars should not exceed a convenient range of the micrometer—say, fifteen minutes, corresponding (in the instruments in use) to about twenty turns of the micrometer

3. The interval of time between the culmination of the stars, of a pair, should not be less than one minute, so as to give time deliberately to read the micrometer and to turn the instrument in azimuth, to be prepared for observation, and should not exceed about twenty minutes, to avoid changes in the instrument.

4. The interval between the pairs should afford time for reading the micrometer and level and for setting the instrument for the next pair. This will vary with different observers, but three minutes is about the time adopted by most of our observers. When the intervals between the pairs are unavoidably long, they may be filled up by observing transits for time.

5. The $6\frac{1}{2}$ magnitude is the least that admits of easy observation with the telescopes which we use ; we commonly observe with a magnifying power of fifty or sixty.

6. All stars marked "doubtful" are rejected; in general, those having but one authority are not taken.

7. In order to be certain to embrace all desirable combinations, the catalogues are to be consulted from the earliest RA which the daylight, at the time of beginning the series of observations, permits, to the latest hour at which it is desirable to observe.

8. Since $z_s - z_n = 2\text{ L} - (\text{D}_s + \text{D}_n)$ or $= \Delta_s + \Delta_n - 2$ colat., the stars are selected whose declinations are such that $z_s - z_n$ is within the prescribed limits. It is desirable that the algebraical sum of the $z_s - z_n$ for all the pairs shall be nearly zero, so that the error arising from any uncertainty in the value of the micrometer be eliminated in the final result for latitude.

Sources of error in the determination of the value of micrometer.—The value of the micrometer, as obtained from observations made for that purpose, may be in error from either of the following causes:

1st. The observations may not be sufficiently numerous.

2d. When the observations are made on a close circumpolar star near culmination, a slight disturbance of the instrument in azimuth will vitiate the result. A considerable disturbance will be readily detected from the observations themselves, but slight disturbances, continually occurring in the same direction, may remain undetected and, by their accumulation, very much vitiate the result.

3. There is yet another source of error which, there is reason to believe, is of more common occurrence than the preceding ; this arises from a change of focal adjustment in turning the micrometer at right angles, in order to bring it into the position used in making the latitude observations, after having made observations on a close circumpolar star, near culmination, for value of micrometer.

The two latter sources of error are avoided by observing the star near elongation.

Method of correcting the value of micrometer from the latitude observations themselves.—When the computation of a latitude has been made with an insufficiently determined value of micrometer, a correction to the value of one division, and also a correction to the resulting latitude, may be made in the following manner:

Let v be the value of one division of micrometer used in the computation and dv its correction. L, the latitude from all the pairs, obtained by using the value v of one division of micrometer and $d\ L$ its correction. $M_1\ M_2\ M_3 \cdots$ half the mean difference of micrometer readings of the south and north stars of the several pairs. $l_1\ l_2\ l_3 \cdots$ the results for latitude of theseveral pairs, obtained by using the value v of one division of micrometer.

We have the conditional equations—

$$\begin{aligned} M_1\ dv - d\ L &= L - l_1 \\ M_2\ dv - d\ L &= L - l_2 \\ M_3\ dv - d\ L &= L - l_3 \\ \cdots\cdots &= \cdots\cdots \end{aligned}$$

Hence the normal equations for finding dv and d L,

$$\begin{aligned} \Sigma\ M\ dv - \Sigma\ d\ L &= \Sigma\ (L - l) \\ \Sigma\ M^2\ dv - \Sigma\ M\ d\ L &= \Sigma\ M\ (L - l). \end{aligned}$$

If the weights $w_1\ w_2\ w_3 \cdots$ are given to the several pairs, depending upon the probable error of declination of stars, number of observations on a pair, &c., the normal equations are—

$$\begin{aligned} \Sigma\ w\ M\ dv - \Sigma\ w\ d\ L &= \Sigma\ w\ (L - l) \\ \Sigma\ w\ M^2\ dv - \Sigma\ w\ M\ d\ L &= \Sigma\ w\ M\ (L - l). \end{aligned}$$

Discussion of the results of observation.—The following notation has been adopted:

λ, a single result for latitude.

l, the mean result from a pair.

L, a latitude resulting from combination of the mean results of pairs.

L, the final latitude.

n_p, the number of pairs.

n_o, the number of observations or single results for latitude.

e_o, the probable error of observation of a single result.

$e_{\frac{o}{n}}$, the probable error of observation of a pair, n being the number of observations upon it.

$e_{\frac{**}{2}}$, the probable error of half the sum of the declinations of the stars forming a pair.

$e_{\frac{o}{n} + \frac{**}{2}}$, the probable error of the mean result for latitude from a pair, involving error of observation and declination of stars.

e_{L}, the probable error of latitude from any combination of the results of pairs.

e_{L}, the probable error of final latitude.

w and p denote weights.

In discussing the results of observation, the first step is to determine the probable error of observation, this is obtained from the formula.

$$e_o^2 = \frac{0.455\ \Sigma\ (l - \lambda)^2}{n_o - n_p}$$

$$\text{and } e^2_{\frac{o}{n}} = n^1\ e^2_o$$

The discrepancies which exist among the results for latitude, (on the supposition that the value of micrometer and level have been accurately determined, and that the computations have been correctly made,) are composed of errors of observation and errors of catalogue mean declinations of the stars, we, therefore, proceed next to determine the probable error of a mean result for latitude from a pair by the formula.

$$e^2_{\frac{\circ}{n}+\frac{**}{2}} = \frac{0.455\ \Sigma\ (L-l)^2}{n_p - 1}$$

and this for each of the catalogues used. We have now

$$e^2_{\frac{**}{2}} = e^2_{\frac{\circ}{n}+\frac{**}{2}} - e^2_{\frac{\circ}{n}}$$

for each of the catalogues.

The catalogues generally used are he British Association, the Greenwich Twelve and Six Year, and Rumker's ; the probable errors of the declination of a star from these catalogues may be denoted by e_{B_*}, e_{G_*}, e_{R_*}.

Since $e^2_* = 2\,e^2_{\frac{**}{2}}$, the probable errors of declinations of the different catalogue stars may be found from the latitude observations. The probable errors of the different catalogue stars must also be modified, so as to make them also depend on the number of authorities or number of observations used in the determination of their declinations ; for further information on this subject, see a manuscript paper on computation of star places.

If the probable errors of the declination of different catalogue stars are determined from many previously discussed zenith sector or zenith telescope latitudes, we may find $e_{\frac{B_*\,G_*}{2}}$ from the formula

$$e^2_{\frac{B_*\,G_*}{2}} = \tfrac{1}{4}\left(e^2_{B_*} + e^2_{G_*}\right)$$

It has, however, been found preferable to adopt the declination of each star from the best sources extant, without further distinction of catalogues.

The weights to be given to the mean results for the respective pairs are found from the formula

$$w = \frac{1}{e^2_{\frac{\circ}{n}} + e^2_{\frac{**}{2}}} \text{ or } w = \frac{n}{e^2_{\circ} + n e^2_{\frac{**}{2}}}$$

It sometimes happens that instead of a single south and north star being combined for latitude, one or more south are combined with one or more north stars. In this case, the mean of the declinations of the south stars may be combined with the mean of the declinations of the north stars, the corresponding means of the micrometer and level readings, &c., being also used. If N_s be the number of south and N_n the number of north stars so combined, then for $e^2_{\frac{**}{2}}$ in the formula for weights we must use

$$\tfrac{1}{4}\left(\frac{\Sigma\ e^2_{s*}}{N^2_s} + \frac{\Sigma\ e^2_{n*}}{N^2_n}\right)$$

If all the stars entering into this combination have the same probable error of declination, viz: e_*, this expression becomes

$$\frac{e^2{}_*}{4}\left(\frac{1}{N_s} + \frac{1}{N_n}\right), \text{ or } \frac{e^2{}_*}{4} \cdot \frac{N_s + N_n}{N_s\,N_n}$$

If, instead of combining the north and south stars in the manner described above, they are combined separately; that is, each south with each of the north stars, giving $N_s N_n$ individual results for latitude, the mean of all these results, which is the same as the result for the entire combination, must be used for $e^2_{\frac{s}{2}}$.

Weights being thus found for the results of the several pairs, we obtain for the final latitude

$$L = \frac{\Sigma\, w\, l}{\Sigma\, w}$$

and

$$e_L = \pm \sqrt{\frac{0.455\ \Sigma\, w\ (L - l)^2}{(n_p - 1)\ \Sigma\, w}}$$

UNITED STATES COAST SURVEY.

Section II.—Latitude.—Station Mount Desert, Maine.—Observations with Zenith Telescope.—Reduction.

Date.	Star.		Micrometer.		Level.			Meridian distance.	Declination.	Sum and half sum.	Corrections.				Latitude.
	No. B. A. C.	N. S.	Reading.	Diff. Z. D	N.	S.	Diff. N. − S				Microm.	Level.	Refr.	Merid.	
1856.			*T. D.*	*T. D.*				*s.*	° ′ ″	° ′ ″	′ ″	″	″	″	° ′ ″
Sept. 25	6255	N.	24 28.0		30.2	41.0			49 03 13.48	88 29 14.88					
	6268	S.	5 50.5	+18 77.5	41.0	31.0			39 26 01.40	44 14 37.44	+6 28.83	−0.14	+0.11		44 21 06.24
					71.2	72.0	− 0.8								
Sept. 25	7800	N.	16 52.0		40.5	32.7			45 49 05.74	88 50 40.89					
	7803	S.	28 79.5	−12 27.5	38.2	34.8			43 01 35.15	44 25 20.44	−4 14.22	+2.00	−0.08	+0.15	08.29*
					78.7	67.5	+11.2	24							
Oct. 4	7800	N.	16 55.5		42.0	38.3			45 49 07.87	88 50 45.06					
	7803	S.	28 77.5	−12 22.0	33 5	46 5			43 01 37.19	44 25 22.53	−4 13.08	−1.66	−0.08		07.71†
					75.5	84.8	− 9.3								
Oct. 4	7855	N.	16 65.5		35.7	44.0			49 32 57.83	88 35 44.88					
	7858	S.	7 28.5	+ 9 37.0	44.0	35.5			39 02 47.05	44 17 52.44	+3 14.06	+0.04	+0.06		06.60
					79.7	79.5	+ 0.2								

* Very faint off meridian. † Very faint.

APPENDIX No. 32.

Report of Assistant Chas. A. Schott upon the gradual loss of magnetism of the several magnets in use in the survey of the coast.

COMPUTING DIVISION, COAST SURVEY OFFICE,
January 28, 1857.

DEAR SIR: In conformity with the Superintendent's direction, a discussion of the gradual loss of magnetism of the several magnets used in the survey has been made, and the results are herewith respectfully submitted.

This paper may be considered as a continuation of the series of magnetic results published in the Coast Survey reports of 1855 and 1856. The computations were made by Mr. J. Main, of the computing division.

Before the deduced magnetic moments of the magnets observed at different periods could be compared, it was necessary to reduce the magnetic moments to a uniform standard temperature, for which 62° Fahrenheit was adopted. Let m equal the magnetic moment at the standard temperature, m_t the same at any temperature, t and q the change of magnetic moment for a change of 1° temperature, then

$$m = m_t \; [1 + (t - 62^\circ) \; q].$$

By means of this formula the observed m_t have all been reduced to the standard temperature. The resulting m and the discussion is best preceded by a short historical note of the magnets which have been used for the determination of horizontal intensity.

Magnet S 8, belonging to declinometer C. S. No. 1, (Jones 22,) length 3.25 inches, was used as a deflector by Capt. Lee, during the years 1845, '46, and '47, at thirty stations in Sections I and III. Within this period it was also used by Mr. Boutelle at three stations in Section IV.

In 1848 it was used by Mr. Ruth at four stations in Sections I and III.

In 1849 it was used by Mr. Boutelle at Breach inlet; at Marriott and Kent island by Mr. Hewston; at Patuccawa by Mr. Boutelle; and at Mt. Independence by Mr. Davidson.

In 1850 it was used by Mr. Davidson at Edisto island; then by Mr. Dean, who used it till the end of 1851 at Soper, Hill, Webb, Causten, Mt. Pleasant, and Cape Small.

In the early part of 1852 this declinometer passed into the hands of Mr. Hilgard, who, however, did not use S 8 as a deflector, but the longer magnet C 32, (at Depot Key.)

About the middle of 1852 this declinometer again passed into the hands of Mr. Dean, who (with the exception of one station (Allston) occupied by Mr. Boutelle) has continued to use it till the present time. At the stations Roslyn, East Base, Galveston Island, and Jupiter, both S 8 and C 32 were used as deflectors. Since the occupation of Allston by Mr. Boutelle, S 8 has ceased to be used as the deflector.

Magnet C 32, belonging to declinometer C. S. No. 1, (Jones 22,) length 3.92 inches, was, as already noticed, first used as a deflector by Mr. Hilgard at Depot Key in 1852, and has been used ever since (with the exception noticed) by Mr. Dean as such. [Since the date of this report, it has been used at Lower Peach Tree, Alabama, in 1857.]

Magnet C 9, belonging to declinometer C. S. No. 2, (Jones 20,) length 4.00 inches, was first used by Mr. Ruth at Fort Morgan and E. Pascagoula in 1847; then by Mr. Fauntleroy at Point Judith, Fort Wooster, and Legget, in the same year.

In 1848 it was also used by Mr. Fauntleroy at Dollar Point.

From 1849.7 till 1853.6 it was used exclusively by Mr. Hilgard. It sunk with the schooner Phoenix, in 1854, but was recovered.

Magnet D, belonging to declinometer C. S. No. 4, (Jones,) has been used by Lieut. Trowbridge on our Pacific coast in the years 1853, 1854, and 1855.

Magnet C 6, belonging to declinometer C. S. No. 2, (Jones 20,) has taken the place of the above magnet C 9 since the accident. It has only as yet been used at two stations, and by Mr. Hilgard in 1854 and 1855. [Since the date of this report, Mr. Harris used it at Barrel Key in 1857.]

Magnet H, belonging to magnetometer C. S. No. 6, (Jones,) length 4 inches, was first used by Messrs. Hilgard and Harris, in April, 1856, at the magnetic observatory in the Smithsonian grounds, in this city, for the purpose of determining its moment of inertia, magnetism, and changes of magnetism for 1° of temperature. It was used by Mr. Schott in August and September, 1856, at seventeen stations in Section III. [Since the date of this report, this magnet has been used by Mr. Schott, of the Superintendent's party, at Fernandina, Florida, and at Hutchinson's island, Georgia, in the spring of 1857.]

Note.—The magnet used by Mr. Schott, in 1855, at sixteen stations in Sections I, II, and III, (Appendix No. 49, C. S. report of 1855,) belonged to the Smithsonian Institution, and has been used since in Mexico.—(See page 214 of Coast Survey report of 1856.)

Recapitulation of values for the magnetic moment of magnet S 8, as resulting from corresponding observations of vibrations and deflections. The value of q for this magnet has been found $=0.00026$.

Stations.	Date.	Temperature of deflections. t.	m_t.	m.
		°		
Washington, Coast Survey Office	1845 .40	76.0	0.7465	0.7490
Taylor	.41	65.0	.7477	.7483
South Base, Kent Island	.42	80.0	.7331	.7365
Rosanne	.44	86.3	.7295	.7341
Finlay	.45	80.3	.7275	.7310
Osborne's Ruin	.49	81.0	.7344	.7380
Indian Hill	.59	76.5	.7239	.7266
Shootflying Hill	.65	78.5	.7200	.7231
Manomet Hill	.70	64.0	.7158	.7162
Blue Hill	.75	69.0	.7108	.7121
Fairhaven	.79	50.0	.7133	.7111
Washington, Coast Survey Office	.85	55.0	.7113	.7100
Finlay	1846 .28	49.5	.7057	.7035
Marriott	.42	83.5	.6903	.6942
North Point	.51	86.0	.6836	.6879
Sampson's Hill	.57	72.1	.6795	.6813
Nantucket	.58	79.1	.6786	.6816
Tarpaulin Cove	.60	85.0	.6757	.6797
Indian Hill	.62	78.0	.6735	.6763
Hyannis	.65	68.0	.6712	.6723
Shootflying Hill	.66	77.0	.6660	.6686
Dorchester Heights	.68	89.4	.6657	.6704
Tuckerton	.86	63.2	.6639	.6641
Bodies Island Base	.99	53.4	.6656	.6641
Stevenson's Point	1847 .10	47.5	.6649	.6624
Shellbank	.25	55.8	.6603	.6592
Bodkin Light	.31	59.5	.6601	.6597
Taylor	.41	85.2	.6542	.6581
Pool's Island	.49	89.4	.6508	.6554
Susquehanna Light	.51	83.7	.6498	.6534
Isle of Shoals	.63	71.2	.6460	.6475
Nantasket	.67	68.2	.6445	.6455
Agamenticus	.75	64.3	.6406	.6410
New Haven Pavilion	1848 .62	83.3	.6069	.6103
Fort Wooster	.65	75.9	.6077	.6100
Oyster Point	.67	81.7	.6074	.6104
Unkonoonuc	.77	53.0	.6131	.6117
Breach Inlet	1849 .27	77.2	.5983	.6007
Marriott	.45	78.7	.5873	.5898
Kent Island, I	.50	74.5	.5798	.5817
Do	.52	69.1	.5635	.5645
Patuccawa	.62	81.8	.5584	.5612

RECAPITULATION—Continued.

Station.	Date.	Temperature of deflections. t.	m_t.	m.
		°		
Mount Independence	.78	55.2	.5626	.5616
East Base, Edisto Island	1850 .27	69.4	.5551	.5562
Soper's Hill	.56	72.1	.5614	.5628
Hill's Hill	.73	81.4	.5535	.5562
Webb's Hill	.90	60.0	.5536	.5533
Causten's Hill	1851 .47	80.0	.5509	.5535
Mount Pleasant	.65	62.0	.5503	.5503
Cape Small	.81	56.0	.5486	.5477
Roslyn	1852 .60	72.3	.5345	.5360
East Base, Galveston Island	1853 .23	74.9	.5311	.5330
Jupiter	.37	82.0	.5271	.5299
Allston	.99	50.0	.5148	.5133

Recapitulation of values for the magnetic moment of magnet C 32 . $q = 0.00020$.

Station.	Date.	Temperature of deflections. t.	m_t.	m.
Depot key	1852 .20	76.6	0.8298	0.8322
Savannah	.32	----------	.8280	----------
Tybee	.33	----------	.8270	----------
Roslyn	.60	67.8	.8195	.8204
East Base, Galveston island	1853 .23	75.1	.8081	.8102
Jupiter	.37	82.2	.8035	.8068
Raleigh, Capitol square	1854 .03	49.4	.7757	.7737
Columbia, Capitol square	.15	60.6	.7682	.7680
Wilmington, De Rosset	.42	68.2	.7589	.7598
Mount Ragged	.73	61.7	.7551	.7551
Camden village	.84	48.4	.7554	.7534
Macon	1855 .04	43.4	.7568	.7540
Harris mountain	.69	71.9	.7477	.7492
Montgomery, Capitol square	1856 .27	69.0	.7440	.7450
Mount Saunders	.53	72.3	.7430	.7446
Southwest Harbor, (Mount Desert)	.74	56.5	.7416	.7408
Mount Desert, (summit)	.78	68.1	.7403	.7412

[In 1857.35 *m* was found = 0.7364 at Lower Peach Tree, Alabama.]

Recapitulation of values for the magnetic moment of magnet C 9 . $q = 0.00019$.

Station.	Date.	Temperature of deflections. t.	m_t.	m.
		°		
Fort Morgan	1847.39	83.5	0.8608	0.8644
East Pascagoula	.47	86.9	.8500	.8541
Point Judith	.68	72.3	.8347	.8363
Fort Wooster	.74	66.7	.8307	.8314
Legget	.80	62.7	.8299	.8300
Dollar Point	1848.35	88.9	.8216	.8260
Sand Key	1849.64	88.5	.7718	.7758
Cape Florida	1850.15	80.6	.7529	.7556
Kittery Point	.68	78.5	.7082	.7104
Fletcher's Neck	.70	61.9	.7095	.7095
Richmond island	.71	56.4	.7094	.7087
Plum island	.72	64.7	.7085	.7088
Bowdoin Hill	1851.64	75.6	.7008	.7026
Kennebunkport	.65	49.3	.7015	.6998
Cape Neddick	.66	65.1	.7043	.7047
Mount Rose	1852.62	82.5	.7118	.7146
Mount Sebattis	1853.57	68.5	.7061	.7070

Recapitulation of values for the magnetic moment of magnet D. *Assumed* $q = 0.00022$.

Station.	Date.	Temperature of deflections. t.	m_t.	m.
		°		
San Diego	1853.77	68.0	0.8446	0.8457
San Pedro	.92	82.0	.8235	.8271
San Luis Obispo	1854.10	67.0	.7991	.8000
Neè-ah bay, (Waddah island)	1855.62	69.5	.7706	.7719
Do........do	.62	65.0	.7490	.7495

Recapitulation of values for the magnetic moment of magnet C 6 . $q = 0.00040$.

Station.	Date.	Temperature of deflections. t.	m_t.	m.
		°		
Yard	1854.83	64.9	0.9292	0.9303
East Pascagoula	1855.06	49.4	.9382	.9335

[Since the date of this report *m* was determined at Barrel Key, Louisiana, and found = 0.8874 in 1857.30.]

Recapitulation of values for the magnetic moment of magnet H. $q = 0.00020$.

Station.	Date.	Temp. of deflections t.	m_t.	m.
		°		
Washington, Smithsonian grounds	1856.30	56.9	1.1068	1.1057
Washington, Coast Survey office	.60	91.5	1.0321	1.0381
Do.....do	.74	65.0	1.0113	1.0119

[Since the date of this report m was found at Fernandina, Amelia island, Florida, $= 0.9974$ in 1857.27, and at Hutchinson's island, Georgia, $= 0.0036$ in 1857.34.]

In order to trace the loss of magnetism in the course of time, the following consideration led to the adoption of the equation of an equilateral hyperbola referred to its asymptotes.

In conformity with experience, the loss of magnetism for several months after magnetisation is much greater than afterwards, and generally after the lapse of a few years the magnet appears to have approached a stationary condition, which relations can be represented by a hyperbolic curve, the abscissae being the time elapsed and the ordinates the corresponding amount of magnetism.

From the asymptotic equation $x = \frac{c}{y}$ we form, since we have only differences of time the equations,

$$x_{1} - x = c\left(\frac{1}{y_1} - \frac{1}{y}\right)$$
$$x_{11} - x = c\left(\frac{1}{y_{11}} - \frac{1}{y}\right)$$
$$x_{111} - x = c\left(\frac{1}{y_{111}} - \frac{1}{y}\right)$$

Assuming now a convenient value for y we find from the above equations by means of the method of least squares the corresponding value of x and the constant c; the normal equations become—

$$\Sigma\,\mathrm{X} - n\,x = c\,\Sigma\left(\frac{1}{\mathrm{Y}} - \frac{1}{y}\right)$$
$$\Sigma\,\mathrm{X}\left(\frac{1}{Y} - \frac{1}{y}\right) - x\,\Sigma\left(\frac{1}{Y} - \frac{1}{y}\right) = c\,\Sigma\left(\frac{1}{Y} - \frac{1}{y}\right)^2$$

By means of these formulæ the observed values of m have been discussed. In consequence of m being affected by errors of observers, as well as subject to sudden changes from causes which need no further enumeration here, several trials had to be made to represent the successive values of m, and in some cases it was found necessary to discuss the same magnet in two separate branches, as no continuous curve can possibly represent sudden changes. Referring to the diagram plate No. 68, the curves represent the computed values, and the dots the observed values of m.

That such sudden changes do occur in the magnets in use is known from the fact that magnet S 8 passes from $m = 0.5817$ to $m = 0.5645$ between the 5th and 9th of July, 1849, at Kent island, I. An equally striking example occurred at Neê-ah bay in regard to magnet D, the magnetic moment of this magnet having changed from 0.7719 to 0.7495 between the 15th and 16th of August, 1855. Whatever may be the cause of these sudden changes, there can be no doubt of the fact, as the vibrations and deflections equally showed a decided loss of magnetism.

The above formula is empirical, and was used on account of its fitness and convenience; the following formulæ, by Dr. Lamont, is based upon a physical principle, viz: that the velocity of loss is proportional to the excess of magnetism over that finally retained. Let x be the magnetism of a magnetic bar at the time, t and c the magnetism permanently retained, then the velocity with which x diminishes is $-\frac{d\,x}{d\,t}$ proportional to the excess x — C, hence $-\frac{d\,x}{d\,t} = q\,(x - \mathrm{C})$ where q is constant. Integrating we find log. $(x - \mathrm{C}) = -q\,t +$ constant.

To find the constant let $\mathrm{B} =$ the magnetism at the time $t = c$, then $x = \mathrm{C} + (\mathrm{B} - \mathrm{C})\,e^{-q\,t}$.

This formula would produce no better agreement between the observed and computed m, and since its numerical application is more laborious, the hyperbolic formula has been used here in preference.

Magnet S 8.—In consequence of the sudden loss of magnetism of this magnet at Kent island I., between July 5 and 9, 1849, it becomes impossible to represent the magnetic moment by the ordinates of the same rectangular hyperbola. It will be seen from what follows that a hyperbola has been found which represents tolerably well the values of the magnetic moment from the time of commencing observations with this magnet until the break above alluded to. Another hyperbola has been found which represents still better the remaining portion of the period during which this magnet was used as a deflector.

Magnet S 8 from 1845.40 to 1849.50, comprising the period from the commencement of observations in which this magnet was used as a deflector, until the sudden loss of magnetism in July, 1849:

For $y = 0.75$ we find $x = 1845.045$, $c = 11.949$, (and the epoch at origin 1829.113.)

Comparison of observed and computed values.

Mean date of groups.	Computed Y.	Observed Y.	Observed Y — computed Y.
1845.43	0.7323	0.7395	+ 0.0072
5.72	.7195	.7165	— 30
6.49	.6876	.6880	+ 4
6.74	.6779	.6693	— 86
7.46	.6513	.6536	+ 23
8.68	.6107	.6106	— 1
9.41	.5887	.5907	+ 20

Magnet S 8 from 1849.52 to 1853.99, comprising the period from sudden loss of magnetism in July, 1849, to the time when the magnet ceased to be used as a deflector:

For $y = 0.75$ we find $x = 1839.21$, $c = 24.822$, (and the epoch at origin 1806.114.)

Comparison of observed and computed values.

Mean date of groups.	Computed Y.	Observed Y.	Observed Y — computed Y.
1849.65	0.5701	0.5630	— 0.0071
50.62	.5577	.5571	— 6
51.64	.5452	.5505	+ 53
52.60	.5340	.5360	+ 20
53.30	.5260	.5314	+ 54
53.99	.5185	.5133	— 52

Magnet C 32 from 1852.40 to 1856.68. The decrease of magnetism of this magnet from time of observation at Jupiter, 1853.37, to that at Raleigh, 1854.03, is too great, compared with its general rate of decrease, to warrant representation by the same hyperbola.

Magnet C 32 from 1852.20 to 1853.37.

For $y = 1.00$ we find $x = 1845.77$, $c = 31.667$, (and the epoch at origin 1814.103.)

Comparison of observed and computed values.

Mean date of groups.	Computed Y.	Observed Y.	Observed Y — computed Y.
1852. 20	0. 8312	0. 8322	+ 0. 0010
. 60	. 8226	. 8204	— 22
1853. 23	. 8093	. 8102	+ 9
. 37	. 8065	. 8068	+ 3

Magnet C 32 from 1854.03 to 1856.78.

For $y = 1.00$ we find $x = 1836.83$, $c = 56.575$, (and the epoch at origin 1780.255.)

Mean date of groups.	Computed Y.	Observed Y.	Observed Y—computed Y.
1854. 03	0. 7669	0. 7737	+ 0. 0068
. 15	. 7656	. 7680	+ 24
. 42	. 7628	. 7598	— 30
. 73	. 7597	. 7551	— 46
. 84	. 7585	. 7534	— 51
1855. 04	. 7565	. 7540	— 25
. 69	. 7500	. 7492	— 8
1856. 27	. 7443	. 7450	+ 7
. 53	. 7417	. 7446	+ 29
. 74	. 7397	. 7408	+ 11
. 78	. 7393	. 7412	+ 19

Magnet C 9.—The magnetic moment of C 9 has changed very capriciously. It decreased with considerable rapidity from the time it was first brought into use at Fort Morgan, in 1847, but not with uniformity, until 1850.15, at Cape Florida. From this latter date until 1850.68 at Kittery Point, it decreased at a more rapid rate than at any previous period, and then remained stationary, or nearly so, until it ceased to be used in 1853. The only period, therefore, which can be subjected to hyperbolic law, is from 1847.39 to 1850.15.

For $y = 1.00$ we find $x = 1844.34$, $c = 17.949$, (and the epoch at origin 1826.393.)

Mean date of groups.	Computed Y.	Observed Y.	Observed Y—computed Y.
1847.39	0.8548	0.8644	+ 0.0096
.47	.8516	.8541	+ 25
.68	.8432	.8363	— 69
.74	.8408	.8314	— 94
.80	.8385	.8300	— 85
1848.35	.8175	.8260	+ 85
1849.64	.7721	.7758	+ 37
1850.15	.7555	.7556	+ 1

The values after 1850.15 are represented by a straight line.

Magnets D, C 6 and H will require further determinations of their magnetic moments before the present values can be discussed.

The question as to the propriety of changing the observed m into the deduced m in the final reductions of the magnetic intensity is answered in the negative, for the following reasons: There appear to be minor regular fluctations, such as the first curve of S 8 plainly shows; in other cases observations at consecutive stations show a remarkable coincidence, as the three values for 1849.5, 1849.6 and 1849.8, also 1851.4, 1851.6, and 1851.8, and many others; in all these cases it would be wrong to substitute the computed m. The difference in the determination of the moment of inertia by means of weights and ring may effect the values of m; for magnet S 8 there appears to be no difference in this respect, the break occurring at another time and at the same station (Kent island); for C 9 the break occurs at the time of change of method, but here the use of balancing rings would affect any conclusion that otherwise could be drawn from it; the break of C 32 is, however, not owing to this circumstance, since the inertia ring has been used throughout.

The magnet H showed, besides a very rapid loss of magnetism at first, a corresponding shifting of the direction of its magnetic axis. My observations give the reading of the magnetic axis in August, 1856, 16.52, in September, 1856, 19.01, and in April, 1857, 20.49, which latter reading is near the geometrical axis.

Yours, very respectfully,

CHAS. A. SCHOTT.

Capt. M. L. SMITH,
U. S. Top. Eng'rs, Assistant in charge, Coast Survey Office.

APPENDIX No. 33.

On the heights of the tides of the Atlantic coast of the United States, from observations in the Coast Survey, by A. D. Bache, Superintendent.

[Communicated, by authority of the Treasury Department, to the American Association for the Advancement of Science.]

It is well known that where a bay or indentation of the coast presents its opening favorably to the tide wave, and decreases in width from the entrance towards its head, that the tides rise higher and higher from the mouth upwards. The Rev. Mr. Whewell has stated that in a general way the same fact is deduced from the observations on the coast of Great Britain and Ireland, discussed by him.

The Coast Survey observations of the tides of the Atlantic coast, the results of which, from time to time, I have brought before the Association, furnish the means of a complete discussion of heights as well as of times, and very simple generalizations result from their examination. Through the kindness of Captain Shortland, R. N., and of Admiral Bayfield, R. N., I have been enabled to extend these results to the coasts of New Brunswick, Nova Scotia, and to part of Newfoundland.

I beg leave to make my best acknowledgments to these distinguished hydrographers for the prompt and liberal communication of the results of their observations.

The Coast Survey observations have been worked up in the tidal division under the direction of Assistant L. F. Pourtales, and I am indebted to him for giving the results the shape desired, and for the diagrams representing them.

The following table of stations on or near the exterior coast line of the United States is taken from the more extended tables of the Coast Survey, omitting stations which are up rivers or bays, except in special cases, the object of inserting which will be obvious.

Table A contains a number for reference, the locality of the tidal station, the State to which it belongs, the latitude, longitude, the mean height of the tide in feet and tenths, and a column of remarks.

TABLE A.

Heights of tides on the Atlantic coast of the United States.

No.	Locality.	State.	Latitude.	Longitude.	Heights in feet.	Remarks.
			° ′	° ′		
1	Portland	Maine	43 39	70 14	8.8	
2	Portsmouth	N. Hampshire	43 04	70 42	8.6	
3	Newburyport	Massachusetts	42 48	70 52	7.8	
4	Gloucester	do	42 37	70 40	8.9	
5	Salem	do	42 31	70 54	9.2	
6	Boston	do	42 22	71 03	10.0	
7	Plymouth	do	41 57	70 40	10.2	
8	Provincetown	do	42 03	70 11	9.2	Major Graham, U. S. A.
9	George's Shoals		41 40	67 45	7.0	Captain Wilkes, U. S. N.
10	Monomoy	Massachusetts	41 33	69 59	3.8	
11	Siasconsett	do	41 15	70 00	2.2	
12	Weweeder	do	41 15	70 05	1.2	
13	Smith's Point	do	41 17	70 16	2.1	
14	Wasque	do	41 21	70 30	1.7	
15	Menemsha	do	41 20	70 45	2.7	
16	Point Judith	Rhode Island	41 22	71 29	3.1	
17	Newport	do	41 29	71 20	3.9	
18	Block Island	do	41 10	71 34	2.8	
19	Montauk Point	New York	41 04	71 51	1.9	
20	Stonington	Connecticut	41 20	71 54	2.7	
21	New Haven	do	41 18	72 54	5.8	
22	Fire Island	New York	40 38	73 13	2.1	
23	Sands' Point	do	40 52	73 43	7.7	
24	Sandy Hook	do	40 28	74 00	4.8	
25	Cold Spring Inlet	New Jersey	38 57	74 45	4.4	
26	Cape May	do	38 56	74 57	4.8	
27	Old Point Comfort	Virginia	37 00	76 18	2.5	
28	Hatteras Inlet	N. Carolina	35 12	75 43	2.0	
29	Beaufort	do	34 42	76 40	2.8	
30	Cape Fear	do	33 52	78 00	4.4	
31	Winyah bay	S. Carolina	33 14	79 08	3.8	
32	Charleston	do	32 46	79 54	5.3	
33	North Edisto river	do	32 33	80 13	5.8	
34	Port Royal	do	32 17	80 40	7.0	
35	Savannah entrance	Georgia	32 02	80 53	7.0	
36	Sapelo	do	31 21	81 24	6.6	
37	St. Simon's	do	31 08	81 36	6.8	
38	St. Mary's river	do	30 42	81 36	5.9	
39	St. John's river	Florida	30 20	81 33	4.6	
40	St. Augustine	do	29 52	81 25	4.2	
41	Indian River Inlet	do	27 28	80 19	2.5	
42	Cape Florida	do	25 40	80 09	1.5	

The following table of tides of localities on the coast of Cape Breton, Nova Scotia, and New Brunswick, is from the observations of Admiral Bayfield and Captain Shortland. The authorities are given in the column of remarks, which also contains the remarks of Admiral Bayfield on the tidal results communicated by him. I have taken from his table the heights which were derived from the greatest number of observations. The column of means is the average of the heights of spring and neap tides in feet and tenths. The localities are arranged from the north, southward on the outer coast, and in the Bay of Fundy from the entrance up the bay.

From the table of Captain Shortland I have selected only a few localities as specimens, having no wish to anticipate through his generosity the use which he will doubtless make of his own results.

TABLE B.

Heights of tides on the Coast of Cape Breton, Nova Scotia, and New Brunswick.

No.	Localities.	Remarks on localities.	Latitude.		Longitude.		Rise of tide.					Remarks.
							Ordinary spring.		Ordinary neap.		Mean.	
	*Isl'd of Cape Breton.**		°	′	°	′	*ft.*	*in.*	*ft.*	*in.*	*ft.*	
1	St. Ann's Harbor...	Entrance	46	17	60	33	5	0	3	3	4.1	A complete semi-lunation observed.
2	Sydney Harbor.....	S. E. bar	46	12	60	13	2	9	2	4	3.1	At full moon, and a day or two before and after.
3	Menadon Harbor...	Near Scataria Island.....	46	00	59	50	5	6	3	4	4.4	Good. A complete semi-lunation observed.
4	St. Peter's Island ..	....	45	36	60	49	6	0	4	0	5.0	At new moon, and a day or two before and after.
5	St. Peter's Bay.....	Haulover, at head of bay.	45	39	60	52	5	9	4	1	4.9	Good observations, four times observed, twice at the full, and twice at the new moon, with several days before and after each.
6	Grandigue.........	In Lennox Passage.......	45	36	61	01	6	4	4	6	5.4	Good. A complete semi-lunation observed.
7	Arichat Harbor....	Jerseyman Island, North Point.	45	30	61	03	5	0	4	0	4.5	Good. A complete semi-lunation observed. Extraordinary tides, rise six feet.
	*Nova Scotia.**											
8	Canso Harbor......	E. end of Cutler's Island.	45	21	60	59	6	6	4	6	5.5	A complete semi-lunation observed, but tides very irregular.
9	White Haven......	Marshall Cove...........	45	15	61	11	6	1	4	1	5.1	A complete semi-lunation observed. Good observations.
10	Harbor Island......	N. E. Point..............	45	08	61	36	6	6	4	6	5.5	A complete semi-lunation observed, extraordinary tides, rise seven feet.
11	Liscomb Harbor....	Pye's Wharf.............	45	00	62	01	6	0	4	0	5.0	Three times observed; at full and new moon, and several days before and after.
12	Sheet Harbor......	Watering Cove...........	44	54	62	30	6	8	4	6	5.6	Good. Two complete semi-lunations observed.
13	Pope Harbor.......	Harbor Island, N.E. Point.	44	48	62	39	6	6	4	2	5.3	Three times observed; at full and new moon.
14	Ship Harbor.......	Salmon Point............	44	47	62	49	6	5	4	10	5.6	Good. A complete semi-lunation, extraordinary spring tides, rise seven feet, and extraordinary neaps, only four feet.
15	Jeddore Harbor ...	Marsh Point............	44	43	63	00	6	6	4	8	5.6	Two good and complete semi-lunations observed.
16	Halifax Harbor.....	Naval Yard..............	44	40	63	35	6	0	4	6	5.2	Mean of a complete year's observations with a tide-gauge.
	Bay of Fundy.†											
17	Cape Sable........	Cape Sable Isl'ds, Clark's Harbor.	43	25	65	29	11	6	4	11	8.2	
18	Ellenwood's Island.	Bird Rock..............	43	39	66	04	12	7	7	0	9.7	
19	Yarmouth Harbor..	Fourchue Island Light-house.	43	47	66	10	10	9	16	0	13.3	
20	Bryer's Island.....	Peter's Island Light-house	44	15	66	21	20	6	9	3	14.8	
21	Campbell's Island..	Owen's House...........	44	54	66	58	25	0	11	0	18.0	
22	St. John's, N. B....	Battery Point Rock.......	45	16	66	04	26	8	12	0	19.3	
23	Shadwood Point...	Cumberland Basin.......	45	54	64	22	50	0	22	0	36.0	

* Admiral Bayfield, R. N.

† Capt. Shortland, R. N.

These numbers may be extended beyond the turn of Cape Race, where the coast trends to the west of north, by further results of Admiral Bayfield, though the remarks which he makes show them to be only approximate. Thus two stations on the coast of Labrador, St. Lewis bay, in latitude 52° 19′ and longitude 55° 37′, and Henley island in latitude 52° 00′ and longitude 55° 53′, give each for the mean of the height of spring and neap tides 2.3 feet. St. John's, Newfoundland, gives 5.0 feet. Trepassey harbor, south of it, 5.8 feet.

Beginning with the southern end of Table A, and following the results northward and eastward, we find, from Cape Florida to Savannah and Port Royal, a gradual increase of the tides, and then a gradual decrease to Cape Hatteras, with a single contradiction, easily explained. Next following the stations on the coast, and omitting those in the bays and sounds, we have a less regular increase to Sandy Hook, and a decrease to Weweeder on Nantucket Island. Next is a less regular regimen, requiring a more detailed examination.

By developing the curved line of the coast into a straight line and marking upon it the tide stations, which will thus be at nearly their proper distances from each other, and by erecting ordinates at each of the station points, and setting off on a suitable vertical scale the heights of the tides at those points, and connecting the extremities of the several ordinates, we have the broken line shown in Diagram A. In drawing this line the stations of the coast only are joined, and the irregularities are cut off by the curve.

This curve shows distinctly the *physical* division of the coast between Cape Florida and Cape Sable into three great bays. The great Southern from Cape Florida to Cape Hatteras. The great Middle from Cape Hatteras to Siasconsett; the great Eastern from Siasconsett to Cape Sable. Perhaps this latter may be considered as only a portion of a great bay from Siasconsett to Cape Race, but this generalization is at present hardly safe, and I confine myself, therefore, to the more limited view. The tide wave setting into the southern bay rises as the bay contracts, and the heights of the tides along the shores increase as the places are more distant from the chord spanning the entrance.

If we suppose the lines of equal height to be straight lines, and draw them upon the diagram transferring them to a map of the coast, we shall find that they are more crowded on the more curved side, and more open on the less curved. The curve indicates Cape Hatteras and not the inlet, which was the tidal station, as the point of least height. The physical cause of this phenomenon is well understood if it has not yet been reduced to measure.

The next curve shows us plainly the Middle bay, having Hatteras for its southwestern cape, and Smith's Point or Weweeder for its northeastern entrance. The form of the shore is less favorable to regularity, but the result is nevertheless well marked. The interference of tidal waves which takes place off Nantucket tends also in a degree to confuse the results.

The chart shows how simple the system of co-tidal lines is in the three bays, running nearly parallel to the shores.

The eastern bay lies between the eastern part of Nantucket (Siasconsett) and Cape Sable, Massachusetts bay being subsidiary to this. The tide wave entering the eastern bay follows the deep water, and thus the co-tidal lines take generally the direction of the shores, until the tide wave enters the Bay of Fundy. The most probable form of the co-tidal lines, from XI to XV hours, inclusive, is shown upon the chart, which is merely an extension of the chart of co-tidal lines of the United States coast formerly presented to the Association. The heights increase rapidly from Nantucket to Cape Cod, being 2 feet at Siasconsett, and 9.2 feet at Provincetown. At Cape Ann they are nearly of this same height, and increase in passing up and into the bay to 10.0 feet at Boston, and 10.1 feet at Plymouth.

The height at Newburyport is probably local, depending upon the position of the tide-gauge. There is but little change from Portsmouth to Portland, and from Cape Sable to Ellenwood's island.

Shall we look to the greater bay between the Nantucket and Newfoundland shoals for the cause of the 8-feet rise at Cape Sable, and of the heights from Admiral Bayfield's table? We find the heights along the coast of Nova Scotia to vary from 7 to 6 feet; not with regularity, however. At Cape Breton island they vary from 6.4 to 4.6 feet, decreasing thus in going northward and eastward. Are these heights due to the crowding of the waters into this greater bay? If so, why are not the heights of Cape Breton greater than those of Nova Scotia? We require results on the south shores of Newfoundland, and on the Great Bank, to give us clear ideas on these points, and I hesitate to extend the generalizations to this tempting field.

The shoals from Nantucket and broken ground near George's Bank, and the comparatively shoal water in their vicinity, on the one side, and the Great Bank of Newfoundland on the other, look as if full of meaning of this sort. Further results may, however, show that this is not the interpretation of the phenomena. The tides of Labrador are but 2.3 feet, bringing us back to the standard of Hatteras and of Montauk Point, and what probably would be that of Nantucket but for interference. Soon after passing Mount Desert on the west side, and Ellenwood's island on the east side, the tide wave has turned into the Bay of Fundy, and the rise increases with extraordinary rapidity.

The complicated character of the co-tidal lines in this immediate vicinity is indicated by the chart, the lines from XII to XV hours being crowded into the very small space of a few miles, on the south side of Nantucket.

To return to the more limited scale, within which our inductions are safe, Delaware bay, New York bay, Long Island sound, Narragansett and Buzzard's bays, Nantucket and the Vineyard sounds, present, on a smaller scale, the same phenomena of increase in the height of the tide in ascending. On the contrary, in Chesapeake bay, which widens and changes direction at a right angle immediately from the entrance, the tides diminish in height, as a general rule, in going up the bay.

The results of the heights of tides along the coast are very satisfactorily shown upon a model which is now before the Association, for superintending the execution of which I am indebted to Mr. Pourtales. The basis is a map of the Atlantic coast, from Cape Florida to Cape Race, upon which the co-tidal lines of the United States are traced. The tidal stations are marked upon this, and rods, cut to length, and proportionate to the rise and fall of the tides at the several stations, are inserted in holes drilled at the station points. The steel rods refer to the heights at exterior stations, and the brass rods to interior ones. Paper cut to the form of the general curve of heights which has already been explained, and placed behind these rods, serves to show the generalizations with great distinctness.

I propose to call the bay between Cape Florida and Cape Hatteras the southern bay; that between Cape Hatteras and Nantucket the middle bay; and that between Nantucket and Cape Sable the eastern bay, of the coast of the United States. The general figure of the coast line has, of course, heretofore attracted the attention of geographers. The connection with the heights of the tides could only satisfactorily be made out by such a series of tidal observations as those embraced in the Coast Survey.

APPENDIX No. 34.

Report to the Superintendent by Assistant L. F. Pourtales, in charge of the office-work relating to tidal observations.

COAST SURVEY OFFICE, *October* 1, 1857.

SIR: In accordance with your directions I have the honor to submit herewith my report on the field and office work performed by the tidal party under my charge during the past year.

Field-Work.—The permanent stations at Boston, New York, Old Point Comfort, Charleston, on the Atlantic coast, and San Diego, San Francisco, and Astoria, have continued to furnish satisfactory results.

You have expressed the intention to add to the number the station at Fort Clinch, at the entrance to St. Mary's river, Fla.

Mr. Isaac Williams, for ten years the faithful observer at Boston, died on the 14th of August, and has been replaced by Mr. T. E. Ready, whose work, it is to be hoped, will prove as trustworthy as that of his predecessor.

Mr. Brooks, the observer at New York, resigned on the 1st of May, and has been replaced by Mr. R. T. Bassett.

The gauge has worked satisfactorily during the summer. The plan of discontinuing the self-registering observations during the winter, and relying on observations taken on a common gauge, was adopted last winter, and will probably be adhered to in future, as the self-registering gauge has been found to be too much interrupted and injured by floating ice. All the other permanent gauges are self-registering, have performed satisfactorily, and have been attended to with great care.

In the appended list of observations received from the field are some which were received after I had made out my report for last year, but which have been mentioned fully in other parts of your report.

The observations at Tappahannock, having extended over one year, were discontinued by your direction.

A station was occupied, under Lieutenant Trenchard's direction, on St. Simon's island, Ga., to clear up a discrepancy between two neighboring stations; that object was successfully reached.

During the discussion of your paper on the co-tidal lines of the Gulf of Mexico, some interesting questions presented themselves on the march of the tide wave in the Straits of Florida, which the existing observations were not sufficient fully to elucidate. In consequence, you directed Mr. G. Würdemann to establish four stations on the Florida keys, viz: at Cape Florida, Indian Key, Key West and the Tortugas, to be kept up during one year. They are now in operation, and so far very successfully.

From the Western Coast we have only a few temporary observations in San Francisco bay, which prove interesting from their confirmation of the fact first pointed out by Sub-Assistant A. F. Rodgers, that the tides are higher inside the bay than at the entrance.

Numerous observations have been made in the neighborhood of Hell Gate, and in Vineyard sound, by Sub-Assistant H. Mitchell, but they have not yet been turned into the office, and he will report on them himself.

By the kinndess of Baron Müller a set of tidal observations was taken at Vera Cruz, Mexico, with a gauge loaned for the purpose. They are a step towards the more complete knowledge of the anomalous tides of the Gulf of Mexico.

A tide-gauge was also set up by Commander John Rodgers, U. S. N., at the island of Tahiti, and a valuable record of observations obtained under the supervision of the French authorities of the island. These observations are of great value, partly on account of the well known, but unsatisfactorily explained peculiarities of tides in that locality, and partly on account of accidental disturbances of the surface, probably caused by earthquakes, which have also been recorded on our gauges in California and Oregon.

The list of observations received during the year is appended in a tabular form.

List of tidal observations received during the year ending September 30, 1857.

Stations.	Name of station.	Name of observer.	Kind of gauge.	Station, permanent or temporary.	Time of occupation.		Total days.	Remarks
					From—	To—		
I	Hunniwell's Point, Me	H. S. Young	Box	Temporary	Oct. 2, 1856	Nov. 11, 1856	40	
	Boston Dry Dock, Mass	J. Williams	Staff	Permanent	Oct. 1, 1856	Sept. 30, 1857	365	
II	Governor's Island, N. Y	J. B. Brooks	S. R.	....do	....do	Jan. 9, 1857	101	
	Do	R. T. Bassett	..do	....do	May 1, 1857	Sept. 30, 1857	153	
	Brooklyn, N. Y	J. B. Brooks and R. T. Bassett	Box	...do	Oct. 1, 1856	....do	365	
	Dobb's Ferry, N. Y	C. Keyser	Staff	Temporary	Aug. 23, 1856	Oct. 21, 1856	60	
	Verplanck's Point, N. Y	G. Hanlon	..do	....do	....do	Oct. 20, 1856	59	
	West Point, N. Y	Sergeant Gerber	..do	....do	Aug. 9, 1856	Oct. 22, 1856	75	
	Poughkeepsie, N. Y	G Würdemann	..do	....do	Aug. 13, 1856	Oct. 20, 1856	69	
	Tivoli, N. Y	E. Payne	..do	....do	Aug. 12, 1856	....do	70	
	Stuyvesant, N. Y	C. McAllister	..do	....do	Aug 13, 1856	....do	69	
	Castleton, N. Y	G. Würdemann	..do	....do	Aug. 30, 1856	....do	52	
	Greenbush, N. Y	C. Richardson	..do	....do	Aug. 27, 1856	Dec. 4, 1856	100	
	Sandy Hook, N. Y	A. P. Springer	Box		June 1, 1856	Sept. 30,	487	
III	Old Point Comfort, Va	M. C. King	S. R.	Permanent	Oct. 1, 1856	Sept. 30, 1857	365	
	Fort Carroll, Md		..do	Temporary	....do	Dec. 15, 1856	76	
	Tappahannock, Va	W. A. Muse	do	....do	....do	July 18, 1857	291	
V	Charleston, S. C	W R. Herron	..do	Permanent	....do	Sept. 30, 1857	365	
	North Edisto river, S. C	G. E. Hartwell	Box	Temporary	Dec. 8, 1855	April 12, 1856	126	
	St. Helena Sound, S. C	J. Williams	..do	....do	Feb. 23, 1856	May 16, 1856	83	
	Port Royal, S. C	F. Mulligan	..do	... do	May 2, 1855	June 4, 1855	34	
	Do	J. B. Duff	..do	....do	Dec. 28, 1855	Mar. 26, 1856	89	
	St. Simon's Island, Ga	Lieut. S. D. Trenchard	..do	....do	Mar. 25, 1857	June 24, 1857	92	
VI	Fort Clinch	F. A. Reharer	S. R.	Permanent	Oct. 1, 1856	Sept. 30, 1857	365	
	Cape Florida, Fla	C. Keyser	..do	Temporary	Feb. 13, 1857	Aug. 5, 1857	174	
	Indian Key, Fla	W. A. Bethel	..do	....do	Jan. 31, 1857	Aug. 24, 1857	203	
	Key West, Fla	J. C. Clapp	..do	....do	Feb. 24, 1857	Aug. 31, 1857	189	
	Tortugas, Fla	H. Benners	..do	....do	Feb. 27, 1857	...do	186	
X	San Diego, Cal	A. Cassidy	..do	Permanent	Aug. 1, 1856	July 31, 1857	365	
	Fort Point, Cal	H. E. Uhrlandt	..do	....do	... do	....do	365	
	Guano Island, Cal	Lieut. Comg. J. Alden	Box	Temporary	Mar. 26, 1857	April 18, 1857	24	San Francisco bay
	Peralta Wharf, Cal	......do	..do	...do	....do	April 27, 1857	34	
	Ravenswood, Cal	......do	..do	....do	Mar. 12, 1857	May 11, 1857	61	
XI	Astoria, Oregon	J. Wayne	S. R.	Permanent	Aug. 1, 1856	July 31, 1857	365	

Office-Work.—The reductions of the observations have been made to keep pace with their receipt as much as possible, though with some fluctuations, occasioned at times by deficiencies in the number of computers available, or by more pressing calls for their services. This work has been chiefly performed by Messrs. Blanchard, Evans, Bassett, and Maynadier. The reading off of the self-registering observations was done by Messrs. Blanchard and Evans, and for the Western Coast by Sergeant Uhrlandt, at San Francisco.

Constants for predictions, derived from the Boston observations, mentioned in last year's report, were found, on fuller trial, to be still in want of some improvement. They were, therefore, recomputed by Messrs. Meech and Avery. The results are still in the hands of the former. Mr. Avery also spent some time in studying out modes of discussion in connection with the same subject, and in forming auxiliary tables, &c., on which he has reported from time to time.

The tidal curve of San Diego for the whole year of 1855 was decomposed into the component diurnal and semi-diurnal curves by the graphical method by Messrs. S. Walker and C. M. Yulee, for comparison with the similar decompositions made last year for San Francisco.

Mr. Walker also treats in the same way the tidal observations received from Mr. Würdemann's party along the Florida reef.

The call for tide tables for the engraving division has been considerable during the spring, and has called for a careful revision of the reductions, examination of discrepant results, &c., to which I have always given personal attention.

Good progress has been made in the reduction of the meteorological observations made at the permanent tidal stations of the Western Coast by M. Thomas. The winds were tabulated according to the hours of the day and according to the months, and the results exhibited in diagrams, for the illustration of a paper on the subject prepared by you for the meeting of the "American Association for the Advancement of Science."

The barometer observations at San Francisco were corrected for temperature, and the daily variation obtained from the hourly observations, by means of which the reduction of the ordinary observations to the mean of the day can be made. This latter correction has also been obtained for the observations of the winds, the thermometer, and the psychrometer. They have thus far been obtained from one year's observation only, but the corrections are now being deduced from the second year, during which hourly observations were made once a week. They will then be applied, and the monthly variations obtained, after which the influence of the wind on the changes of temperature, moisture and pressure of the atmosphere can be deduced.

Very respectfully, your obedient servant,

L. F. POURTALES,

Assist. U. S. Coast Survey, in charge of Tidal Division.

Professor A. D. Bache, LL. D.,

Superintendent United States Coast Survey.

APPENDIX No. 35.

Report of Sub-Assistant H. Mitchell on observations of tides and currents in Nantucket and Martha's Vineyard sounds and in the East river at Hell Gate, with remarks on the revision of levellings on Hudson river.

Coast Survey Office, *November* 1, 1857.

Dear Sir: During the past season your instructions have directed my efforts to physical examinations in New York harbor and in Nantucket and Martha's Vineyard sounds. Impressed with the eminently practical nature of your inquiries, I have spared no pains in the collection of data, which I trust will afford the required aid.

The study of tides and currents must be regarded in a two-fold relation: first, as affording the means of constructing prediction tables for immediate use in navigation; second, as an inquiry into a class of agencies whose ceaseless activities are gradually altering the configuration of our harbors and seacoasts—here cutting away headlands, there stretching out hooks, destroying at one point and building at another. We are called upon not only to exhibit the daily and hourly conditions of these great elements, but to ascertain their offices, their modes of operation, and their effects. I offer the following as a brief report of the field-work done by the party under my direction in the localities to which I have above referred :

HELL GATE AND VICINITY.

Tides.—Permanent tidal stations were established at Ravenswood, Hell Gate ferry, Hallet's Point, and Pot Cove. At the first two stations Saxton's self-registering gauges were successfully used, while at the last two ordinary box gauges were employed. With the exception of Hallet's Point, these stations were simultaneously occupied during a period of five weeks. At Hallet's Point the series covered about two weeks. The box gauges were observed every fifteen minutes, night and day. Many other tidal stations were temporarily occupied at points intermediate and more distant, in order that no local change in the wave might escape our inspection. These observations exhibit the character of the interference between the two branches of the tide wave which have been propagated, respectively, by way of Long Island sound and the Sandy Hook entrance. The permanent stations were connected by lines of levels, so that we are able to refer all the observed heights to a common zero and ascertain the disturbance of sea level at each stage of interference. The transition of establishments is so rapid between the interfering tidal systems that it is necessary to construct tables for many places at short distances apart, and the ranges of the tides differ so materially from station to station that they cannot be too carefully determined in a locality where vessels are stranded daily.

The changes in the mean water level, caused by long continued gales of wind, are among the most striking characteristics of this region, and are susceptible of accurate classification by proper groupings of the observed heights.

Currents.—In situations subject to tidal interferences we find a peculiar class of currents, easily distinguished from the ordinary ebb and flood drifts accompanying a single tidal system. It is obvious that this class of currents bears a complicated relation to the observed rise and fall, and that we can only hope to obtain a comprehensive knowledge of this by subjecting both tides and currents to simultaneous observation. Your instructions pointed out the course to be pursued, and, as you will perceive, we have followed them closely. While those at the stations on shore noted the heights of the tide, another set of observers noted the velocity and direction of the current in the channel. The surveying schooner "Madison" was used for occupying stations where long series were required, and her boats were employed in positions where a single day's work would suffice. Great care was taken that each current station should be in the axis of the stream, and that as many points as possible should be occupied at once. At these stations the ordinary log was used, the velocities and directions being recorded each half hour. The exact time of slack water was also noted. At most of the stations occupied by the "Madison" the observations were kept up in unbroken series of from seven to nine days each, and it was designed from these records to form correction tables by which to reduce the single day series observed from the boats.

In addition to this method of observing, we made trials of free floats, following them through the channels, and by angles and ranges determined their positions at stated periods. The velocities given by these floats were corrected for mean values by referring to the log observations made at the same time from the schooner. I would remark here that this means of measuring currents, except for very limited distances, is subject to great objections. From a simple consideration of the distinctive definitions of fluids and solids, it will be seen that we cannot correctly represent the motion of one by that of the other. In irregular and crooked channels the solid body drifting with the current will not submit to changes of direction so readily as the water in which it is immersed. With the slightest bend in the course of the stream the float will leave the axis. This familiar fact is strikingly illustrated in the plottings of our current trips in Hell Gate, which I shall send to you when complete. It has occurred to me that the difficulties arising from this method of observing might be obviated by substituting a fluid in place of the solid float. There are some species of oil which float for a great distance before becoming dissipated.

In the course of our work the whirls and counter currents in the vicinity of Hell Gate were examined. Many of the more remarkable of these are confined to fixed limits, and regularly recur with each ebb or flood current. It was deemed important to determine their positions, in order to point out the course which a vessel must pursue in order to pass beyond their influences. The great whirls of Hallet's Cove and Pot Cove, with several others, have been plotted on diagrams with more or less accuracy. The relations which these currents and whirls bear to shoal formations and mud deposits have been traced to some extent. The shoal in Hallet's Cove, the mud deposits to the eastward of Hallet's Point, the "Middle Ground" shoal, below the Gate, as well as other similar formations, can be traced to the action of these drifts. But, while noting the accumulations which take place in certain situations, our attention was drawn to the work of destruction which is going on elsewhere. Even the rocks are wearing away by the rush of water over them. The materials of which these rocks are composed, and which are not uniformly distributed throughout the mass, do not equally yield to the wear of the water, and thus occur those sharp and ragged forms among the reefs and ledges. Nor is it difficult to distinguish these effects from those, equally conspicuous, which follow the action of ice. We have but to compare the portion of the rocks near the water's surface with that some distance below and quite beyond the reach of frost.

The results from the observations which I have described have been sent to you for discussion.

HUDSON RIVER.

Levellings.—Before referring to the operations in Section I, I beg leave to report the completion of the levellings which connect the tidal stations on the Hudson river. In order to place our results beyond all possible doubt, I directed Mr. Vose, to whom the levelling was assigned, to proceed slowly and with great care from station to station between New York and Albany. As you directed, a double series of levellings was made throughout the whole route and every doubtful step was retraced. With regard to the closeness of the results obtained, Mr. Vose says: "From a hasty computation which I have made, it appears that the probable error for the entire distance from New York to Greenbush does not exceed two-tenths of a foot. In some parts of the route—as, for instance, across the long bridge near Tivoli—it was necessary to run over the work five times." For the most part, our work confirms the accuracy of Mr. Würdemann's results obtained last year.

Nantucket and Martha's Vineyard sounds.—After closing our work at Hell Gate, we proceeded to Section I, to complete the investigation of tidal currents, &c., in Martha's Vineyard and Nantucket sounds. In this region we are presented with tidal phenomena similar to that existing in Hell Gate, though on a very much larger scale. The consideration of the tidal interferences has formed the subject of former field-work and reports, and the operations I am about to describe were undertaken with a special view to the determination of the laws of the currents, engendered by these interferences; it has, however, been necessary to repeat some of the tidal observations, in order to trace the connection between wave and current motions. Our field of work extended from No Man's Land to a point a few miles to the northeast of Monomoy.

Tides.—Tidal stations were established at No Man's Land, Menemsha Bight, Falmouth, and Monomoy. At these places the observations were kept up from six to eight weeks. In order to preserve a uniformity in the records, the observers were all furnished with the mean time of Nantucket. The extreme stations, No Man's Land and Monomoy, were chosen to exhibit the forms of the eastern and western waves before suffering interference; while Falmouth, being a meeting point, was a proper place to observe the compound interference tide. The observations at Menemsha Bight were intended for comparison with those of No Man's Land, in order to explain some peculiar changes in the form of the tide wave, noticed in the results of a former season.

Currents.—The current stations were so arranged as to give the characteristic epochs and velocities throughout all the channels, and at points but short distances apart. The Coast Survey schooner "Bowditch," the chartered sloop "Key West," and a whale-boat suitably constructed for this purpose, occupied stations in concert. The observations were made at frequent intervals during periods of thirteen to forty-eight hours. In order to correct the observations thus obtained for semi-menstrual and diurnal inequalities, as well as to detect anomalous results, a permanent current station was established at the Nantucket light-boat, situated in the main "South Channel," between the Horse Shoe and Cross Rip shoals. Here the observations were kept up during a large part of a lunation. In addition to these the Bishop and Clerks, Shovel Full, and Pollock Rip light-ships were occasionally occupied by observers. The several divisions of the party, shifting their stations over districts previously apportioned to each, soon collected the data for a chart of co-current lines. The information thus gained pointed so significantly to a possible explanation of the causes and offices of the beaches and shoals which have rendered this neighborhood notorious, that we received directions from you to extend our work to these inquiries. The shoals of these sounds are mostly composed of loose, quartzose sand, and the approach to them, in many cases, is so abrupt that vessels run upon them before the leadsman has detected the shoaling of the water. The very fact that such precipitous banks of loose material can exist in the midst of violent tidal drifts, is itself suggestive of the conclusion that upon the arrangement of these same tidal forces must depend their construction and preservation. Our course, at the outset, was to surround certain shoals by a cordon of current stations at points more or less remote, and the observations were in the highest degree satisfactory. We soon discovered that our results fell naturally into certain classes and represented certain type forms of deposit; they resolved apparent confusion into harmonious relations. Not only the shoals but the beaches and hooks are found to be the result of causes quite within the reach of the investigation you have instituted; even Cape Cod itself may fall within one of the determined classes. The whole number of current stations occupied amounts to above fifty, and some of these were repeated at different times. Upon the data collected I shall draw up a preliminary report and send the papers to you for discussion. In closing I would remark that, from my limited experience in field studies of this kind, I am convinced that the constant operations of these tidal agencies are (commercially speaking) in the highest degree beneficial in their ultimate purposes, and that where improvements of harbors or channels are contemplated, the design should be to aid, not thwart, these efforts of nature.

Very respectfully, yours,

H. MITCHELL.

Professor A. D. BACHE,
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APPENDIX No. 36.

On the winds of the western coast of the United States, from observations in connection with the United States Coast Survey, by A. D. Bache, Superintendent.

[Communicated by authority of the Treasury Department to the American Association for the Advancement of Science.]

The observations of which I propose at present to communicate the results were made in the year 1855, in connection with the tidal observations on the Pacific coast, at three permanent stations—Astoria, San Francisco, and San Diego.

The approximate latitude and longitude of each of the stations is as follows:

Astoria, Oregon, latitude 46° 11′ N., longitude 123° 49′ W.

San Francisco, California, latitude 37° 48′ N., longitude 122° 28′ W.

San Diego, California, latitude 32° 40′ N., longitude 117° 12′ W.

The mode of observing was that described in my paper on the winds at Cat Island, read before the Association in 1850. The observers were posted and practiced together by Lieutenant W. P. Trowbridge, of the United States corps of engineers, under whose supervision the observations were made.

The directions of the wind were noted in points, and the force in the conventional scale before referred to. These numbers were reduced to velocity in miles per hour by the tables given in my former paper, and the quantity of wind blowing from any quarter during a given period was thence readily found. The tables and diagrams are thus of the same kind as those which I have before presented to the Association. They were made under the direction of Assistant L. F. Pourtales, of the United States Coast Survey, to whose care, assiduity, and knowledge, I am indebted for the opportunity of presenting them. The computations and the diagrams were made by M. Thomas.

The observations were taken three times each day, at 6 a. m. and p. m., and at noon, except on Monday of each week, when hourly observations took the place of the regular daily ones. From these latter results the reference of the three daily observations to the mean of the day has been made. The quantities of wind for each hour and for each direction were computed and grouped by months, and then plotted. The eye readily takes in the characteristics of the winds at different periods of the day and year, and for the various directions. To apply these to the reduction of the daily observations, tables were formed of the average time during which each wind blowing would give from observations at the three hours already named the result for the day. For example, the west wind at San Francisco gave for the quantity in twenty-four hours by the daily observations 505, the mean hourly quantity at 6 a. m. being 6, at 12 m.

27, and at 6 p. m. 31. These quantities respectively being supposed continued for 9 hours, 5 hours, and 10 hours, which agrees with the diagram, would give 499, a number differing but little from the total found for the day.

In this way the following table was formed, which was applied to the reductions of the daily observations.

Table for deducing from the three daily observations the mean of the day.

Astoria.				San Francisco.				San Diego.			
Wind.	6 a. m.	12 m.	6 p. m.	Wind.	6 a. m.	12 m.	6 p. m.	Wind.	6 a. m.	12 m.	6 p. m.
	h.	h	h.		h.	h.	h.		h.	h	h.
NE	6	6	6	N. and NE	9	6	9	N. and NE	6	6	6
E. { Oct., Nov., Dec., Jan., Feb., Mar., }	9	6	9	E	3	3	3	E	3	3	3
E. { April, May, June, July, Aug., Sept. }	3	3	3	SE., S., and SW.	9	6	9	SE. and S	9	6	9
SE	6	6	6	W	9	5	10	SW. and W	18	6	6
S	9	6	9								
SW. and W	9	6	9	NW	9	6	9	NW	18	7	6
NW	8	5	7								
N	3	3	3								

From the tables of velocities in miles per hour deduced from the observations by the method just explained, the following table of quantities of wind from different directions for each month is found. The rhumbs are written at the top of the table, the months at the side, and at the meeting point of a vertical and horizontal line from the head and side titles are found the quantities. The last column at the side of the table gives the total quantities for the several months, and below is found the totals for each direction for the year.

Quantities of wind.

ASTORIA.

Month.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	
January	6	795	987	150	324	2719	1539		6520
February	138	282	1623	295	3079	225	850		6492
March			1253	509	933	585	428		3708
April	24	180	305	282	1218	969	1651	1801	6430
May		102	105	186	536	1437	876	1393	4635
June		60	33		9	258	2104	2760	5224
July		150	18			633	700	4221	5722
August		6	12	60	30	279	180	2543	3110
September		54		102	872		246	431	1705
October		754	294		1245	291	123	361	3068
November		583	182	399	2252	2927	348	447	7138
December		1535	456	693	2849	138	105	91	5867
	168	4501	5268	2676	13347	10461	9150	14048	

SAN FRANCISCO.

Month.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	
January	2302	375	147	177	21	1471	264	1161	5918
February	618	180	45	558	147	992	860	306	3706
March	218	60	28	639	470	1934	2447	426	6222
April	30	72	--------	168	312	2992	4845	209	8628
May	--------	--------	--------	348	24	1578	4928	2530	9408
June	--------	--------	--------	--------	18	8338	3428	--------	11784
July	--------	--------	--------	--------	9	8725	2020	362	11116
August	--------	--------	--------	--------	--------	2608	3908	2168	8684
September	--------	--------	--------	--------	54	2588	4219	500	7361
October	--------	6	--------	--------	63	136	4396	96	4697
November	630	252	--------	231	232	508	2056	222	4131
December	414	850	18	652	489	1290	1576	234	5523
	4212	1795	238	2773	1839	33160	34947	8214	

SAN DIEGO.

Month.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	
January	91	147	45	431	813	384	643	987	3541
February	204	48	207	1291	777	688	278	2461	5954
March	284	114	114	1095	726	912	1124	3219	7588
April	186	180	36	900	1019	798	810	2505	6434
May	156	24	57	396	834	1296	930	2296	5989
June	72	48	66	1100	827	882	892	2145	6032
July	39	192	16	285	1320	607	120	4066	6645
August	48	79	24	104	93	595	690	3823	5456
September	48	186	39	54	265	338	426	2418	3774
October	72	156	21	36	132	186	254	2411	3268
November	--------	108	93	240	231	542	198	1226	2638
December	114	--------	24	162	345	686	528	754	2613
	1314	1282	742	6094	7382	7914	6893	28311	

From this table the diagrams representing the quantities for each month from each direction (Plate 66, Nos. 1 to 12) are taken, and also those showing the total annual quantities of wind from each direction, and the total quantity of wind from all directions for each month.—(Plate 66, Nos. 16 and 17.)

It seems to me altogether probable, from the study of the figures of these tables, that the scale adopted by the observer at San Francisco is greater than that at the two other points. The total quantities at Astoria, San Francisco, and San Diego, are as 59, 87, and 60, and it is hardly probable that there is so large an excess of quantity at San Francisco. I have also the same remark to make as on the observations at Cat Island, on the absence of observations upon the intermediate points between the cardinal ones, showing the tendency to designate the winds only by the cardinal points.

From these diagrams we see at once the simple general regimen of the winds on this coast.

1. The great prevalence of westerly winds, representing a flow of the air at the surface from the ocean in upon the land.

2. The general absence of easterly winds, showing the absence of a return current at the surface. The proportion of westerly to easterly winds is as 8 to 1.

3. The increase of westerly winds in the summer and their decrease in the winter.

4. That when easterly winds blow at all, it is, as a rule, during the winter.

5. The N., NE. and E. winds blow more frequently in the morning than in the afternoon hours.

6. The SE., S. and SW. winds are, in general, pretty equally distributed over the morning and evening hours.

7. The NW. is the prevailing direction of the ordinary sea breeze at Astoria and San Diego, and the W. at San Francisco.

Sometimes the W. wind has that character at the first named stations, and sometimes the SW. wind at the last named.

A closer inspection of the same diagrams will lead to other interesting results.

Considering the quantities of wind at the three places for the whole year, (Diagram 3, No. 13,) San Diego and Astoria present remarkable similarities. There is more NE., E. and S. wind at Astoria, and more NW. wind at San Diego. The axis dividing the area symmetrically is in the same direction. On the contrary, at San Francisco the W. and SW. winds give the character to the rose, and the axis makes an angle of some sixty-seven degrees with that of the other spaces. All show the same deficiency of easterly winds, and San Francisco is deficient also in southerly ones.

The monthly curves grouped in two periods, from November to March, both included, and from April to October, (Plate 66, Nos. 14 and 15,) show that the annual curve has the summer type impressed upon it. The summer is, in fact, the windy part of the year. The NW. wind prevails in August at Astoria and San Diego, and the W. and SW. at San Francisco.

The scale of Diagram No. 14, is less than that of 15 in the proportion of 10 to 14. There is scarcely any wind from points between north, round by east and south.

The form of the rose is exceedingly simple and the generalization very obvious.

The winter system is less simple. The axes of the spaces for Astoria and San Diego make angles of more than 110° with each other. The NE., E., S. and SW. winds are considerable at Astoria, and the NW. wind is deficient. At San Francisco the W. winds give the prominent feature to the rose curve.

As the winter is not the windy season, so the months of March and September are not the windy months. On the contrary, July is one of the windiest months of the year.

San Francisco.—At San Francisco the great current of air flowing from the sea to the land comes generally from the W. or SW., rarely from the NW.

In the period from November to March, inclusive, (Diagram No. 14,) the W. is the prevailing wind, exceeding in quantity both the others, the SW. wind exceeding in quantity the NW. In the period from April to October, (Diagram No. 15,) the W. and SW. winds are nearly equal, and each exceeds the NW.

The W. wind has, in general, the features attributed to the sea breeze, beginning after the rising of the sun, increasing until after the hottest part of the day, and dying out or much diminishing at night-fall.

The W. and SW. winds give the prominent features to the wind rose at San Francisco.

The SW. is the prevailing wind in June and July, SW. and W. winds blowing nearly the whole of those months, not succeeded by an easterly land breeze, but rising and falling. The rose curves for May and August resemble each other, the NW. and SW. winds being nearly equal in quantity, and each less than the W. wind. So the curves for April and September, when the NW. wind has nearly died out. The W. wind diminishes in quantity through March and February, and through October, November and December, to January. The NW. d increases again from April towards December, and is very small in October and November The SW. wind disappears in October, changing the form of the rose curve, but reappearing in November and December, and increasing towards January. The W. wind has a maximum in April and May, and another in September and October, the minimum being July and January.

The N. wind in December, January, and February, reaching a maximum in January, is the only other point to be noticed for San Francisco, partaking with the other places in the general absence of easterly winds. The tables show a little in the winter. There is also but little S. wind there.

Astoria and San Diego.—In general the winds at these two places resemble each other more than those at San Francisco do either. The rose curves for April, May, June, July, and August, (Nos. 4 to 8,) have the same general character. The mean curve for the year, (No. 13,) and for the summer period, (No. 15,) have also the same general character.

The NW. wind is the summer wind, and has the characteristics of the sea breeze, but there is no return land breeze. The NW. wind reaches a maximum in July and a minimum in December. It is the great prevailing wind of the year (Diagram No. 13) at San Diego. As it decreases it is generally replaced by W. and SW. winds of less quantity. In December the quantities of the three winds are nearly equal.

The resemblance of these winds at San Diego and Astoria is remarkable, the remarks just made applying generally to both places. There is, however, much less NW. wind at Astoria than at San Diego. Except in June, July, and August, there is some S. wind each month at Astoria, and especially from September through October, November, December, and February, it presents a marked feature of the rose. At San Diego this is less marked, the two agreeing most nearly in quantity in March, April, and May.

The SE. wind is a distinct feature in both places in February and March, and at San Diego in April and June.

The E. wind is prominent at Astoria in January, February, and March, and the NE. from October to January, inclusive.

Astoria has the most easterly wind, the NE. beginning in October and blowing until February, and being replaced by the E. wind in March.

APPENDIX No. 37.

Report to the Commissioners on the preservation of New York harbor from encroachment, by the advisory council on the comparative map of New York bay and harbor and the approaches; prepared by the Coast Survey March, 1857, *including extracts from the report of A. Boschke, esq., United States Coast Survey, to Professor A. D. Bache, Superintendent, February,* 1857.

The advisory council has received from the Superintendent of the Coast Survey a map, prepared, under his direction, by A. Boschke, esq., comparing the shore lines and hydrography of

New York bay and harbor, and the approaches, as shown in the surveys of 1835–'36 and of 1855–'56 by officers of the Coast Survey.

This comparative map has been prepared with great care and ability by Mr. Boschke, and shows in a conspicuous manner the changes which have taken place within the last twenty years in the harbor and its dependencies. It is presented with this report to the commissioners.

The hydrography of Lieutenant Commanding (now Commander) T. R. Gedney, United States navy, is represented in blue upon the chart; and that from the recent surveys of Lieutenant Commanding T. A. Craven, United States navy, in red. The recent hydrography of the Hudson river is by Lieutenant Commanding Richard Wainwright, United States navy. The spaces over which encroachments have been made do not represent their danger as well as does the study of the effects in particular localities. It is, however, satisfactory, and, for some purposes, answers to know their general amount. Mr. Boschke calculated that, between the Hudson and East rivers alone, 1,220 acres of land have been made, upon which, formerly, the tide rose more than four and a half feet, removing thus a tidal space of nearly nine millions of cubic yards from this part of the harbor.

To this encroachment is to be added the space occupied by piers and slips, amounting to 519 acres, since the tidal currents are so checked between the piers as to lose nearly their whole scouring action. The piers alone displace about 312,000 cubic yards. It is, of course, to be considered that these encroachments are made upon a port of great capacity, and that they represent but a small fraction of the total area of even this portion of the harbor. If made according to a systematic plan which would have considered all the circumstances of the problem, they would by no means have produced injurious consequences, but the contrary.

The importance of these changes to the welfare of New York, as a great emporium of commerce, needs no enforcement from us. They should be watched carefully, be faithfully chronicled, and be attentively studied.

It is not sufficient to know the changes and their extent. The causes which have produced them must be ascertained. In this way alone can they be regulated and controlled. Thus only can injurious changes be prevented, and favorable ones be assisted. It by no means follows that, because a partial change in a particular direction is favorable, that if this be continued indefinitely it will still be advantageous. For example: a diminution in the water-span of a harbor, by increasing the velocity of the current, may deepen the harbor, and thus a first encroachment may appear to be advantageous. Continue this, and the velocity of the current becomes excessive; navigation is impeded by it; the bed of the harbor is torn up in one place to be deposited in another; the capacity of the harbor is contracted injuriously. Again: the contraction of the entrance to the harbor may act, at first, favorably by increasing the rate of flow of water over the bar and thus increasing its channels; but this contraction, if continued, may so alter the direction of the currents as to destroy the first favorable effect, and may even be carried so far as to obliterate, by its encroachments, some of the principal channels.

It will be seen, in the course of our remarks, that an increase in the velocity of currents and changes in their direction have, in many cases, produced favorable results, and that even the advance of Sandy Hook into the main ship channel may, up to this time, have been advantageous, while, if encroachments in the same direction were continued beyond certain limits, the destruction of the harbor might ensue.

It will be further seen that the *physical survey* of the harbor and approaches, which we have heretofore recommended in strong terms to the commissioners, is absolutely essential to furnish materials for the study of the diverse and complicated phenomena which the harbor presents. We have the basis of this in the present topographical and hydrographic surveys of the Coast Survey; but we need very elaborate observations on the tides and currents, and on the movement of the sand and other materials constituting the bottom of the harbor, before we can satisfactorily trace the causes of all the effects which the comparative map brings to light. We have an example of what is desired in the satisfactory results obtained from the observations on the growth of Sandy Hook, and a case in which the minuteness of the facts enables us to draw very safe conclusions.

We cannot too strongly or too often urge upon the commissioners the necessity for knowing whence the materials of the bar are derived, and how they are brought to their present places; why they are deposited as we find them, and why they change their places according to laws, which are obvious on a casual inspection of the comparative map, and are confirmed by a close study of its details.

In following out the important changes which have taken place in the harbor, we have been greatly assisted by the able report of Mr. Boschke, before referred to, and refer to it as our test for most of the numerical results, for many of the facts, and for some of the deductions which we present. Extracts from it, giving able and valuable statistics of the changes, will be found hereto appended.

We begin with the changes at the entrance of New York bay, and, first, with those of the land on the south side, namely, at Sandy Hook; second, with those on the north side, at Coney island and the shore of Long Island to the eastward as far as Rockaway beach; and next proceed to the changes of the bar itself, outer and inner, and the channels and shoals into which it is divided.

Upon the depths of the channels of this bar depends the commercial prosperity of New York.

1. *Changes at Sandy Hook.*

The light-house, which is now more than a mile from the point of Sandy Hook, was built near to that point. Maps of nearly a century ago show it as about one-third of a mile from the end of the Hook. The point both advances and recedes, but, upon the whole, grows to the northward, jutting out more and more into the main ship channel. Its rate of growth, on the average, for the last century, has been about one-sixteenth of a mile in twelve years. In the main ship channel, where, at the time of Captain Gedney's survey, there was 120 feet of water, there is now but 21 feet. Large areas, over which twenty years ago there was from 20 to 40 feet of water, are now dry ground. Within twenty years the point has grown to the northward 220 yards, narrowing the main ship channel, and changing in a degree the directions of both ebb and flood currents at this part of the entrance.

Various causes were assigned for this growth; and minute observations of the tides and currents were made by the Coast Survey, under the immediate direction of the Superintendent, by Sub-Assistant Henry Mitchell, under authority of the commissioners, to test the different suppositions, and to collect such a body of facts as would lead undoubtedly to the full solution of the problem.

The observations have shown that on both sides of Sandy Hook, the outer or ocean side, and the inner side of Sandy Hook bay, there prevails during the ebb and flood tides northwardly currents, varying in strength at different times and at different distances from the shore, but tending to carry the sand on both the outer and inner shores to the northward. On the outside, in False Hook channel, this current prevails for seven hours out of the twelve, being strongest in mid-channel, and the weakest on the shore of the Hook and on the False Hook shoal. On the inside the northwardly current prevails for eleven hours out of the twelve. At the meeting of these currents their motion is lost, and the sand which they transported is deposited. The comparative chart by the form of the curves of 6 and 12 feet depth off the point of the Hook shows this in a very perspicuous manner.

It is easy to see from the principles of the motion of fluids how these currents exist while the tidal currents are flowing in and out of the entrance to the bay. On the ebb the outside current is an eddy current, having nearly the opposite direction to the general tidal current issuing from the bay. Inside both ebb and flood draw the water from Sandy Hook bay by the western shore of the Hook, which is thus worn away.

The northwardly current outside has not only carried the materials of the New Jersey coast northward, but it has diminished very much the area of the shoals known as the False Hook and Outer Middle Ground; has deepened the bar at the southern end of False Hook channel from 21 to 22 feet; has, according to Mr. Boschke, deepened the channel by about one foot and a half; and has removed the bulkhead, which, in 1836, closed the northern end of False Hook channel, giving 30 feet water where there was twenty years ago but 13 feet. Eighteen feet can now be safely carried through this channel at mean low water. The projecting shoals formed just north of what was in 1836 an inlet, about a mile north of the old Shrewsbury inlet, have also considerably diminished. Shrewsbury inlet, which, in 1835, was about 1,100 yards north of the Ocean House, and through which six feet could be carried at low water, and the wider but shoaler entrance just referred to above, are now entirely obliterated.

Seeing in these northwardly currents the power which transports the sand to the point of the Hook, we have the obvious remedy afforded by jettees, at suitable intervals and of proper lengths and directions, for stopping the progress of the material. These constructions have of late years been so much studied by engineers that most of the circumstances attending them have been ascertained, and it will be easy, whenever the growth of Sandy Hook ought to be arrested, to do so by simple and comparatively inexpensive means.

By referring to the comparative map these changes will be distinctly seen, and also the northward movement of the False Hook shoal. Mr. Boschke estimates that in twenty years a million and a half cubic yards of sand have been removed from this channel;* that about a million cubic yards of sand have been transported from the Outer Middle and False Hook shoals, of which half a million have been re-deposited at the northern end, increasing it, as is shown upon the comparative map. Thus two millions of cubic yards of sand have been transported towards the point of Sandy Hook, the main ship channel, and the southern part of the bar from this locality alone; bounded on one side by Sandy Hook shore, and on the other by the outside of the Outer Middle and False Hook shoals.

Does not this show the absolute necessity of the most minute observations of currents, extending not only over these localities but further out from the land? Do not these facts argue that continued watchfulness is necessary in regard to these changes, and that no labor and no reasonable expense should be spared to keep them constantly under observation? The average depth of the main ship channel has changed but little. The western part has shoaled, but a deep hole has been excavated due north from the east beacon. On the whole, Mr. Boschke

* See report hereto appended.

reports that but ninety-five thousand cubic yards of sand have been deposited in this channel. The growth of the hook has added about two millions and a half cubic yards to this encroachment, representing, with the quantity just stated, more than the excavation from False Hook channel. The wear from the inside of the hook is estimated at about one hundred thousand cubic yards within the last twenty years. The wearing of the bluffs must not be confounded with the wearing of the shore, for the sand which is thus removed is deposited on the shore and on spits, causing an actual increase of the Hook. From these facts it is probable that the sand from False Hook channel does not at once reach the bar. The importance of knowing positively where the bar derives its supply of sand is obvious; since in that knowledge is involved the question whether this supply can be so cut off or diminished as to cause a deepening on the bar by natural means; and whether, if dredging were applied and the source of supply of the sand cut off, the improvement of the bar would be possible. This question of the deepening of the bar has in the progress of commerce, in the change of burden of ocean steamers and sailing vessels, derived new importance, and it is altogether probable that future progress will render it a vital question.

2. *Northern side of entrance, Coney Island and south shore of Long Island.*

The western part of Coney Island has made to the westward since 1855. The eighteen, twelve, and six feet curves of depth are now more than eighty yards further to the westward than they were twenty years ago. Rockaway inlet, which drains Jamaica bay, has passed, according to Mr. Boschke, 620 yards to the westward since 1836; and Duck Bar Island, which then was mainly on the eastern side of the entrance, is now on the western side. The shore of Barren Island to the west of Rockaway inlet has lost, according to Mr. Boschke's calculations, nearly a square mile of area, and the destruction would have been greater had not the woods upon the beach checked it. Hog inlet has shifted nearly a mile in the same time. We thus see a great westwardly movement of the sand along the south shore of Long Island perfectly established. It remains for such an examination as was made at Sandy Hook to explain the causes of these changes and their probable future progress, and thus to put us in possession of the means of controling them.

Near the western end of Coney Island there is a tendency to form a channel close to the land, which is the correlative of False Hook channel at Sandy Hook. This channel has not altered much in its general features since 1836, having moved, however, somewhat to the northward.

Great changes have taken place in the bar of Rockaway inlet, its depth having decreased from fourteen to twelve feet, and the direction of the entrance over it having changed to the southward and eastward, which is unfavorable. The point of the western six feet shoal has advanced southward and eastward nearly three quarters of a mile; and that of the eastern side has receded nearly as much. The general curves of six, twelve, and eighteen feet along this shore to the west of Rockaway inlet seem to show that its influence does not extend more than two miles and three-quarters, there being little or no change in those curves at that distance; but this point is too important to rely upon indirect observations to establish it. It would seem that the accumulation of sand at Rockaway inlet, and the projection of its shoals and bar further into the sea, may have stopped a portion of the supply of sand from the coast of Long Island to the New York bar. We want at every step direct observations of the tides and currents along this shore to enlighten us as to the causes of the changes which are determined.

If the supply of sand to any part of the great bar is derived from this shore of Long Island, how desirable must it not be to know it positively, and to be in possession of all the particulars of the movement?

3. *New York bar.*

In the old maps the bar was represented by a large bank called East Bank, the main ship channel skirting its western edge, and then turning along the southern side to the ocean.

In fact, across New York entrance below Sandy Hook and Coney Island lies an extensive bank* "intersected by five channels, giving thus alternately a shoal, a channel, a shoal, a channel, and so on." The main ship channel is next north of Sandy Hook, its direction is due east, and its width 1,050 yards, the passages from it through the outer bar are by Gedney's channel with 23½ feet, and by the south channel with 23 feet, at mean low water. North of this and separating it from the Swash channel is Flynn's Knoll, (the southwestern part of which is known as the SW. spit,) covering an area, within the eighteen feet curve of depth, of 852 acres. Northeast of Flynn's Knoll lies the Swash channel, the general direction of which is SE. by S., gently curving from its upper entrance so as to pass more eastwardly; its average width is 900 yards, and through it 21 feet can be carried at mean low water.

Though the main ship channel has the best water, the Swash, from its superior directness, is the favorite channel into New York. Northwest of the Swash channel is the Romer shoal, the area of which is 2,080 acres. Northeast of the Romer shoal is the eastern channel, 750 yards in width, running SE. for half its length, then E. and passing over the outer bar with 19 feet water, a remarkable slue running nearly due south, connecting this with Gedney's channel. Next, to the northeast, is the Middle Ground shoal, covering 1,548 acres. Next, the Fourteen-feet channel, running to the SE., and closed by a wide bar with 14½ feet upon it. Then the extensive East Bank, covering 3,063 acres. Finally, the slue close to the Long Island shore, having a bulkhead at its western end, near the point of Coney Island, and a bar at its eastern end. This entire bank through which the channels are cut is of sand, similar to that of the beaches of New Jersey and Long Island, the river deposits taking place higher up in the bay.

The directions of these channels and shoals show, in a general way, the directions of the forces of the water acting at this entrance. The tidal currents of ebb, reinforced by the affluents of New York and Raritan bays, displace the sand which the flood deposits, and the channels thus measure, in a general way, the forces of these affluents. A thorough investigation of the forces requires nothing less than the complete physical survey which we have recommended. Time would be wasted for purposes of navigation upon such a survey, but when it comes to those of improvement nothing less than a physical survey will answer. A few thousand dollars thus expended, by determining the minute actions of the tides and currents and their causes, may save hundreds of thousands in expensive tentative works of improvement. These observations could hardly fail to show where natural actions were to be aided or restrained, and when art might profitably come to their aid or must be used to control, modify, or change them.

While we consider that we are not yet justified in speculating upon the causes which have

* See Mr. Boschke's computations appended.

produced the peculiarities of these shoals and channels, and have led to their changes within the last twenty years, these changes are so clearly marked upon the map that we can be at no loss to discover their direction and magnitude. *It is observed that, in general, there has been a movement to the northward and eastward of all the channels and shoals.* Flynn's Knoll has been carried to the northward and westward.

From the elaborate computations of Mr. Boschke (hereto appended) it appears that in twenty years Flynn's Knoll has been carried 240 feet to NW. by W.; Romer shoals 920 feet to the NE.; the Middle Ground 270 feet to the NE.; and East Bank 2,840 feet to the NE. What portion of the movement is due to the extension of Sandy Hook, and what portion to other causes, acting in the lower and upper bay, we do not undertake to say, not having sufficient data for this purpose.

While this movement has gone on, *the channels have generally increased in depth*, and the *shoals have diminished in extent*. The main ship channel is the great exception to this rule among the channels, and the Middle Ground to that among the shoals. The enormous quantities of sand that have there been shifted in position, and small portions of which have been again deposited inside of the outer bar, while the main bodies have been carried away into deep water, are shown in the interesting tables of Mr. Boschke, which we extract from his report, hereto appended.

These alterations, by the removal of sand, prove that changes have occurred in the force and direction of the tidal currents, in regard to the nature and extent of which only a complete physical survey can inform us, and that for the future.

That twenty years have sufficed to produce such changes is a fact surely sufficient to make us alive to the necessity of procuring at once the materials by comparison with which, five, ten, fifteen, or twenty years hence, our successors may draw their conclusions.

From the channels the enormous amount of three millions of cubic yards is known to have been actually removed, or shifted in position, and in the shifting of the shoals fifty-four millions of cubic yards have been carried onward. While this has been going on, the main ship channel has had a deposit of sand in it of nearly one hundred thousand cubic yards, and the Middle Ground a deposit upon it of nearly a million of cubic yards. The shoals within the eighteen feet curves have diminished in extent nearly fifteen per cent., or from nearly nine thousand to between seven and eight thousand acres. For these positions we refer to the tables of Mr. Boschke.

An inspection of the comparative map will show changes on the West Bank in harmony with those which we have noticed at length. Gravesend bay has also changed very materially, the deposit in it being much increased.

It would lead us into too much detail to discuss thus elaborately the changes in other parts of the lower bay; the following, to which our attention has been directed by Mr. Boschke, will suffice, as bearing specially upon the navigation of the bay:

1. The outer bar has become more uniform in its depth, as is shown by the section across it on the comparative map. Gedney's channel has slightly improved. The north and south channels have coalesced, forming a better entrance than when they were separate.* A few isolated spots or lumps, of seventeen and a half and eighteen feet, occur, which possibly have for their nucleus portions of wrecks, or of the obstructions which were placed at the entrance by the British during the revolutionary war to prevent the entrance of the fleet of our allies, the French. We adopt the suggestion of Mr. Boschke that these should be removed by blasting or dredging, and that, in fact, a steam dredge should be kept at work on the bar during

the time of ebb current, and in suitable weather, to promote the tendency to deepen which now seems to exist. Two lumps, the one north of Gedney's channel, and 710 yards from the sailing line, with eighteen feet on it, and the other south 220 yards, with seventeen and a half feet on it, should also be removed.

2. West of Flynn's Knoll a small lump of eighteen feet has formed, which should be removed. It does not interfere, however, with the main ship channel, on the range for which twenty-three feet can be carried.

3. The Swash channel has widened and deepened ; the bar at its southern entrance, which had *only twenty* feet upon it, has deepened to *twenty-three* feet. The eighteen feet lump which lies inside of the channel should be removed.

In consequence of the changes in position of the Swash channel, the ranges reqpire to be used by keeping the upper light-house open about twice its length to the northward of the lower, according to Captain Craven's sailing directions. This carries not less than twenty-one feet through the Swash at mean low water.

Lieutenant Commanding Craven draws special attention, in his sailing directions, to the danger, when passing through the Swash, of being set on the Romer shoal, especially at half ebb, when the tidal current sets strong towards the shoal.

4. The East channel has improved, and the bar at its eastern entrance has diminished in width. Lieutenant Commanding Craven calls attention to the danger, in passing through this channel on the flood, of being set upon the Romer, and on the ebb upon the East Bank.

5. The fourteen feet channel has much improved ; it is still, however, of relatively little value.

6. At the entrance to the Narrows, Lieutenant Commanding Craven discovered, in his survey of 1855, a small shoal, marked as Craven's shoal on the comparative map. Lines of soundings on the former map do not run over this shoal, so that it is impossible now to say whether it existed in 1836, or has been formed since. It should be removed.

In closing this portion of our report which relates to changes in the lower bay, we would call attention to the importance of the Narrows, as giving the velocity and direction to the waters of the ebb, upon the scouring action of which the depths on the bar depend. The sooner the commissioners' lines are established there the better. The shores being rocky, natural changes will not be likely to occur, but artificial ones might seriously injure the harbor. In connection with this, we would call attention to the great importance of the shore lines, recommended by us in a former report to the commissioners, from the Quarantine to Fort Tompkins, and from Owl's Head to Fort Lafayette. The present condition of the shore, as Mr. Boschke justly remarks, between the Quarantine and Fort Tompkins, is unfavorable from its many irregular projections.

4. *New York upper bay.*

A general glance over the surface of the comparative map from north to south shows, by the portions left uncolored, the great body of the Hudson river flowing onward through the upper and lower bays, and passing by the underwater delta of the bar into the Atlantic.

The colored shoals on each side show that the expansion of the water, by checking its rate of motion, causes deposits of the silt, which it carries with it, forming extensive flats like those between Jersey City and Kill van Kull on the western side, or the Middle Ground and the flats of Gowanus bay on the eastern.

The East river is, in fact, a mere arm of the sea, and which, as the tidal currents divide on this side of Throg's Neck, the ebb running to the east through Long Island sound and to the west through Hell Gate, may be regarded as a tidal stream heading at that point of division.

Its influence is readily seen, as its ebb passes out on either side of Governor's island, sweeping through Buttermilk channel, forming Yellow Hook and Owl's Head channels, and causing the deposit of a triangular shoal at the south side of Governor's island and of the Middle Ground, as it comes in conflict with the main current from the northward. Buttermilk channel, to which attention was first directed by the survey of Lieut. D. D. Porter, U. S. N., one of the assistants of the Coast Survey, is of increasing importance, and nothing which can by possibility lead to its obstruction should be permitted. The shoal towards its southeastern entrance, by the Atlantic dock, seems to have at its point a rocky nucleus. The current of flood passes directly along the edge towards the entrance of the dock. It has undergone but little change since the date of the first survey. The shoal off the southern side of Governor's island, on the contrary, has worn away considerably. Mr. Boschke estimates that the inner bay contains 14,629 acres, or nearly 23 square miles. Of this, the Narrows to New Brighton occupy one-fourth; the Jersey flats and the main ship channel, from New Brighton to the Battery, nearly one-third each; and the Middle Ground and Gowanus bay nearly one-eighth. The Jersey flats contain 4,427 acres, the Middle Ground and Gowanus bay, 2,020 acres, and the shoal south of Governor's island, 83 acres.

The Jersey flats have increased in extent and diminished in depth within the last twenty years. The well defined edge has grown out particularly near to Jersey City, pointing to the encroachments there as the cause of this change, and showing so clearly the connection of this line or border of the flats with the encroachments as to indicate for the future what must occur if they are extended. The material of these flats is of soft mud, supplied by the river from the upland and from the sewerage of the cities. There are rocky or stony patches scattered over the area, but these are exceptions. The mud extends to a considerable depth before firm bottom is reached. Between Ellis' island and the canal basin, in Jersey City, the eighteen feet curve has advanced in twenty years some 230 yards. The computations of Mr. Boschke (hereto appended) show that an average daily deposit of 1,550 cubic yards takes place on these flats. Gowanus bay has in like manner shoaled from the same causes, increasing the area over which there is six feet and less of water by 177 acres. These spaces are, in fact, the expansions of the river bed, into which the waters, passing with diminished velocity, find places of deposit for the solid matter which the more rapid current above has carried off.

While these comparatively quiet spots have increased, the Middle Ground and the shoal south of Governor's island have worn away. This is, in part, no doubt, due to the general increase of velocity in the currents by local encroachments, but, as the map shows, is also produced by the changes in the shore line below Castle Point, (Hoboken and Jersey City,) which have thrown the current more over on the eastern side of the bay.

This same increase of velocity in the tidal current has deepened the main ship channel generally, and especially at the mouth of Kill van Kull.

The small changes of velocity necessary to effect these and other similar changes could only be established by the most elaborate and refined observations on the tidal currents. Such results as are ample for purposes of navigation would fail to detect such small changes. The variations in the rate of the currents at different parts of the lunar month follow those of the tides from which they are derived, and must be connected with them by observation, or else marked out independently by such a long continued series of observations as would deter the most indefatigable observer.

This entire matter would form part of the complete physical survey of the harbor, to which we have so often called your attention. The Coast Survey observations have shown, experimentally, the variation of the tidal currents with the well known tidal inequalities, called the half-monthly and the daily inequalities. This whole field should be explored in a way to put upon permanent record the most minute information for future guidance in reference to encroachments and to improvements.

An examination of the tidal registers, in the archives of the Coast Survey, does not show any change in the tidal establishment at Sandy Hook or at Governor's island of sufficient amount to be adopted as a certain conclusion. Had the observations of twenty years ago been continued over periods as long as those more recently made, we might have been able to decide this question definitely. In fact, in important harbors like New York, tidal observations should be constantly kept up, the time of high and low water, as well as the height, being carefully ascertained. The Coast Survey self-registering gauges give these elements, and, besides, the law of the rise and fall of the tide.

5. *Newark bay.*

This tidal reservoir, containing an area, according to Mr. Boschke, of about 6,000 acres, is supplied and drained through Kill van Kull into New York bay, and through Arthur's Kill and Staten Island sound into Raritan bay. It receives at its head the waters of the Hackensack and Passaic rivers. The bay is an extensive flat, with two channels, of which the principal one leads into Kill van Kull. The average depth of the bay is about six feet at mean low water, and the bottom generally of soft mud. The shortness, depth, and breadth of Kill van Kull render it the principal outlet and inlet for Newark bay, notwithstanding the sharp turn which the water is obliged to make as it passes from the bay into the Kill. Arthur's Kill is longer, narrower, shoaler, and more crooked than Kill van Kull, and the bottom is quite irregular, the profile of the channel presenting shoals and pools alternately. The minute tidal and current observations in the Kills have shown that the tides meet somewhere between Fallen Beacon and Elizabethport, and that the tidal currents meet over an area south and west of Shooter's island. The drainage channel from one Kill to the other across the mud flat, which is most clearly shown on the map, has really not less than seven feet in it at mean low water, but is so narrow that no vessel of any size can keep in it and carry this depth.

Newark bay has not altered generally in depth since the first survey. Kill van Kull has deepened, and Arthur's Kill has undergone changes of different kinds in different localities. In our former report we strongly urged uniform shore lines for these passages. When they have been adopted, there will be a tendency to greater uniformity of depth in Arthur's Kill, and dredging will be very effective. This would even now be quite useful, and would produce favorable changes in the flow of the tides and in the amount of rise and fall at the upper end of Arthur's Kill. Dredging is the best resource for making a deeper passage between the two Kills, and would necessarily be resorted to at intervals. It is an easy operation in such a locality and with such a bottom as here.

6. *Hudson river.*

We quote from Mr. Boschke's report: "The average width of the lower section of the Hudson river is 1,300 yards. Its average depth is from 30 to 50 feet, the channel being on the New York side, and the New Jersey shore being bordered by a flat of an average width of 400 yards, upon which there is at most eighteen feet of water.

"The construction of the Hudson River railroad has closed up the various little bays, and has given a more uniform shore line to the river, which has caused a general deepening and more uniformity of depth. The considerable encroachments between Thirtieth street and Hammond street have narrowed the river, and deepened it, on the average, six to ten feet in that locality, throwing, besides, the current over to the New Jersey shore. Below and above the projecting piers, and within the slips from about Thirtieth street south, the ground shoals considerably, and, from the nature of things, dredging must necessarily be resorted to to give an increased depth. The extension of the piers on the New York side, and particularly near the Battery, has increased the eddy in front of the Battery, and therefore caused the extension of the shoal there."

These changes, which the map fully shows, enforce all that we have heretofore said in regard to the danger of encroachments in this part of New York city front. We cannot too often repeat, that whatever changes the direction and velocity of the current, must change the regimen of the harbor for good or for evil.

7. *East river to Throg's Neck.*

The value of Buttermilk channel has been already referred to. Its eastern entrances are divided by a middle ground, one channel running close to Governor's island, the other to the Brooklyn wharves. These channels should be most jealously guarded from obstruction. The middle ground has, according to the statement of Mr. Boschke, drawn from the map, increased in area within the 18 feet curve by five and a half acres since 1836, and a spot of $11\frac{1}{2}$ feet at mean low water has formed since the first survey. A considerable deposit has occurred on the north shore of Governor's island. While the eastern branch of Buttermilk channel has somewhat deepened, there has been an accumulation on and south of the shoal in front of the Atlantic dock. We agree with Mr. Boschke in the judgment, that while the encroachments on the East river, between Corlaer's Hook and Fulton ferry, have increased the rapidity of the current so as to tear up the bottom in many places, they have also thrown the current of ebb more on the New York side, so that the Brooklyn side depends chiefly upon the flood current for keeping up the depth between the Atlantic dock and Fulton ferry. There is a general deepening of the river from the navy yard to the western side of Kip's bay, caused by the contraction of the stream until the point is reached, where the influence of Lowber's bulkhead, between Seventeenth and Fourteenth streets, is felt. The shoal between Fourth and Eighth streets has increased, and the channel has less water than before the construction of the bulkhead. This is caused by the deflection of the water from Kip's bay more directly to the opposite, or Williamsburg shore, by Lowber's bulkhead—an inference which the deepening in the new direction of the current towards the opposite shore fully sustains.

The rocky character of the shore and bottom between the points just noticed and Hell Gate precludes much natural change. In the cove between 100th and 116th streets Mr. Boschke notices a slight deposit.

From Astoria to Throg's Neck great changes have been produced. In the general there has been a deepening of the deeper water, but sometimes a mere transfer of shoal spots and deep ones to other localities, and sometimes a decrease of depth. Mr. Boschke computes that the area of this part of the river is 6,200 acres, and that 15,000,000 of cubic yards have been removed from its channels and shoals, giving an average deepening of between one and two feet.

The influence of the tide of Long Island sound disappears almost entirely at Pot Cove, between which and Throg's Neck the tide wave is compounded of that of Long Island sound and of the East river. The area over which the currents meet lies near to Throg's Neck and west of it.

Direct observations are wanting to establish definitely what changes have taken place in the rise and fall of the tides and in the currents over this space; but we can hardly suppose that, with the great changes in the East river, some alteration has not occurred in the general phenomena of the tides and tidal currents. The changes shown by the map, like those in the upper and lower bays of New York, correspond on the average to an increased velocity of current, which is thus, as before, fully established by the indirect observations, and is in accordance with what the encroachments of the kind and degree already made upon the water-space would necessarily produce.

Some of the changes in this part of the river require especial notice; such, for example, as the decrease of the shoal on the eastern side of Riker's island, where the six-feet shoal has, according to Mr. Boschke, lost 130 acres in area; the decrease of the eighteen-feet shoal of Flushing bay by 35 acres; the deepening of the passages between Port Morris and North Brother island, and between North and South Brother islands.

The shoals having six feet and less than six feet upon them, in the bays and coves, have generally increased in extent since 1836.

The main channel through this part of the river, from Throg's Point to Hell Gate, has nowhere less than thirty-seven feet of water at mean low water, affording the greatest encouragement to the removal of the dangers of Hell Gate from this eastern entrance to New York harbor.

The general changes in New York harbor, within the last twenty years, are thus shown to have been beneficial, while in special cases encroachments are found, conclusively, to have acted most injuriously upon particular localities, turning the channel away from the New York city side of the river, where natural causes had made it flow, increasing the velocity so as to wear the river-bed into hollows and contribute materials to shoals, and even, in some cases, to be injurious to navigation. While thus the general result is a favorable one, so many of the particular local results have been bad as to make it plain that a very different system should have been pursued in furnishing the facilities required by commerce on the water and on the land. The same good result, and a much better one, could have been obtained without such instances of evil had the shore-line been regulated years ago according to a systematic plan. The advisory council has not been opposed to such additions to the land as were required for present or future accommodation by wharves and docks; on the contrary, they have everywhere endeavored to provide such, where encroachments had not already been carried to the verge of imprudence, or beyond it, or had not been guided by erroneous principles, tending to produce injury to many while seeking individual benefit.

We have endeavored to trace such lines as would produce regular shores without abrupt changes of direction and width, to alter the proper directions of currents, or to increase or check their regular movement. The large traced map furnished to the commissioners, when spread upon a level surface, shows admirably the general harmony of the harbor lines which we have proposed. That we have not been unmindful of the wants of future commerce is proved by the fact that we have provided 1,840 acres of area for dock accommodation, according to the calculations of Mr. Boschke, made in reference to this matter. That we have not feared to recommend proper facilities for the riparian owners, within just limits, is proved by the fact that our lines contemplate the filling in of 2,480 acres of land now under water, amounting to some thirty-four millions of cubic yards. But this is done according to a systematic plan, which will avoid the dangers we have observed or have been able to foresee, and which will, as far as they have effect, favor those changes for the better which are now going on and avoid injurious ones.

In conclusion, we repeat that this is the time for a complete physical survey of the harbor, to be based upon the Coast Survey work and supplementary to it. We have already seen the value of a partial work of this kind and run no risk in guaranteeing similar important results for an entire work of the same description.

Respectfully submitted by

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Bvt. Brig. Gen. and Chief Engineer.
A. D. BACHE,
Supt. United States Coast Survey.
Advisory Council.

Hon. G. W. PATTERSON,
Chairman Commissioners on the preservation of New York harbor from encroachments.

Extracts from the report of A. Boschke, esq., United States Coast Survey, to Professor A. D. Bache, Superintendent, February, 1857.

New York harbor, like all other tidal harbors, must principally depend on the ebb and flood to keep its approaches and channels in navigable condition. For this reason it is necessary to preserve jealously, the water area of the harbor, so as to permit the greatest possible quantity of tide-water to enter it and by its efflux to scour the channel and bar.

But the great value of the land in New York city and on both shores of the Hudson and East rivers, as well as the dock accommodation desirable, have induced owners, in the course of time, to fill up the land under water to a very considerable extent. If we recur to the original condition of the harbor, we find, on comparison, that the shore has been artificially extended into the Hudson and East rivers so as to make, in filling up, 1,220 acres additional land where formerly the tide rose four and a half feet, thus taking away a tidal reservoir of 8,860,000 cubic yards. To this should be added the water area now occupied by the piers and slips, amounting to 519 acres, because in the body of water between the slips the current is completely checked by the hulls of vessels. The piers also obstruct the free flow of the water; eddies are formed between and behind them, and so the tide is retarded. The structures of the piers displace now the considerable space of 312,000 cubic yards, once occupied by water.

These encroachments will appear, however, comparatively small when we consider that the area of the harbor within the limits stated embraces 98,370 acres, and consequently represents a tidal reservoir of 714,166,000 cubic yards, and that the body of water at mean low tide of the whole mass in the harbor represents the enormous sum of 3,170,122,000 cubic yards.

These quantities compared with the amounts representing the encroachments are, of course, small, but it should be recollected that it is not the diminished water space alone, but principally alterations so brought about in the direction and velocity of the currents which have occasioned the changes.

The importance of arresting the increase of Sandy Hook becomes a vital question, for in the main ship channel, where twenty years ago a depth of 120 feet existed, we have now only twenty-one feet water, and close by, eighteen and twelve feet, and the entire channel has been thus affected in that immediate vicinity. Excluding the increase of the Hook, my calculation shows that a deposit of 93,800 cubic yards has been made in the main ship channel from Southwest Spit to Gedney's channel.

At False Hook, and Outer Middle can be plainly traced the same effect as at Sandy Hook, a *motion from south to north*, and we may justly attribute it to the same causes. My calculations show that the southern part of the flat called the Outer Middle has diminished by 1,030,000 cubic yards, but an increased deposit appears at the northern end to the amount of 500,000 cubic yards. This evident tendency of a current moving from south to north has had also considerable effect on the channel between False Hook shoal and the Hook. I find that a bulkhead or bar at the northern extremity has been removed and replaced by deeper water; and the removal from the channel of 1,560,000 cubic yards of solid matter has deepened it by an average of 1.45 feet.

The flats lying between Sandy Hook and Coney Island are intersected by five channels, giving thus alternately a channel, a shoal, a channel, &c.

Starting at Sandy Hook, and sounding northwardly, they lie in the following order.

1. Main ship channel, direction due east, width 1,050 yards.
2. Flynn's Knoll and Southwest Spit, with an area of 852 acres.
3. Swash channel, direction SE. by S., width 900 yards.
4. Dry Romer shoal, an area of 2,080 acres.
5. East channel, SE. for half its length, then S., width 750 yards.
6. Middle Ground shoal, an area of 1,548 acres.
7. Fourteen feet channel SE., terminating suddenly in a wide bar.
8. East Bank shoal, 3,063 acres.
9. The Slue, a small channel parallel and close to the shore of Long Island.

The forces of currents, or other agencies not yet fully developed, have, in the space of twenty years, occasioned the following changes at the entrance to New York bay, by the transposition of solid matter.

1. *Main ship channel* has, in the direction from south to north, filled, as already stated, 93,800 cubic yards.
2. *Flynn's Knoll*, 6,250,000 cubic yards removed.
3. *Swash channel* deepened, and 987,000 cubic yards removed.
4. *Dry Romer*, 5,280,000 cubic yards removed,
5. *East channel* deepened, and 1,160,000 cubic yards removed.
6. *Middle Ground*, 940,000 cubic yards deposited.
7. *Fourteen feet channel*, 1,280,000 cubic yards removed.

8. *East Bank*, 6,090,000 cubic yards removed.

The following table shows the comparative areas of the several shoals.

SHOALS.	1835 AND 1836, AREA IN ACRES.			1855 AND 1856, AREA IN ACRES.			
	Between 18 feet curve.	Between 12 feet curve.	Between 6 feet curve.	Between 18 feet curve.	Between 12 feet curve.	Between 6 feet curve.	Reduction in area of shoals having less than 18 feet water in acres.
Flynn's Knoll	1,363	68	....	852	13½	....	510½
Dry Romer	2,394	731	136	2,080	451	21	324
Middle Ground	1,773	252	....	1,548	373	....	225
East Bank shoal	3,281	1,756	254	3,063	1,433	171	217

Taking into account the diminished quantities of sand, these reductions of area do not convey a proper idea of the magnitude of changes which have taken place in this locality.

The following table, showing what enormous quantities of matter have been shifted in position since 1835, and re-deposited, leaves no further doubt as to the uniform action in one direction. I have placed opposite to the quantities the direction and distance to which the centre of gravity of each shoal has been removed.

Shoals.	Quantity in cubic yards shifted.	Directions.	Distances in feet.
Flynn's Knoll	5,065,600	NW. by W.	240
Dry Romer	16,112,000	NE.	920
Middle Ground	8,067,600	NE.	270
East Bank	23,675,000	N. by E.	2,840
Middle Ground and False Hook	1,301,600	N.NW.	3,120

The shoal which is called the bar proper, or the most easterly bar crossed by Gedney's channel and the north and south channels, has attained a more uniform depth, and I find that about 3,380,000 cubic yards have been removed from it. Few isolated spots of 18 and 17½ feet at mean low water yet exist where they were 20 years ago.

The proportional area of the parts forming the upper bay of New York are as follows:

The *Narrows to New Brighton* 3,662 acres, with a water capacity at mean low tide of 223,860,000 cubic yards.

Jersey flats 4,427 acres, with 63,756,000 cubic yards at mean low water.

Main ship channel from New Brighton to the Battery, 4,500 acres, with a body of water equivalent to 238,026,000 cubic yards.

Middle Ground and Gowanus bay 2,020 acres, with 32,485,000 cubic yards of water.

Shoal south of Governor's island 83 acres, with 1,340,000 cubic yards of water at mean low tide.

The changes which have taken place in this locality have been two-fold. The main ship channel has generally deepened, and particularly at the mouth of the Kill van Kull, in some places from one to two fathoms.

The Middle Ground and the shoal south of Governor's island have been washed away by the current of the Hudson river, deflected to this side since the extension of the shore on the Jersey side, below Castle Point. The area of the Middle Ground has been thus diminished 90 acres, and the shoal south of Governor's island 27 acres.

The solid matter removed from the Middle Ground is 1,410,000 cubic yards, and from Governor's island shoal 156,000 cubic yards. The same cause has probably effected the filling up of 7,230,000 cubic yards in Gowanus bay within the last 20 years, and thus increased the area of 6 feet and less than 6 feet water by 177 acres. A similar extension deposit has been made on the Jersey flats, which amounts, as shown by the comparison, to 11,291,850 cubic yards, giving an average daily deposit of 1,550 cubic yards.

APPENDIX No. 38.

Report of Mr. A. Boschke on the drawing of maps of New York harbor, made for the Commissioners on Harbor Encroachments.

COAST SURVEY OFFICE, *September* 18, 1857.

SIR: At the expiration of the term of the New York harbor commission, on the 15th day of January, 1857, the survey of the shores of the island of Manhattan, and of King's, Queen's, and Richmond counties, on Long Island, surrounding the harbor of New York, had been completed. The maps on which the preliminary bulkhead and pier lines were laid down, as recommended by the commissioners, were also drawn in outline, but were then incomplete in details. These maps form a series of forty-two sheets, each measuring thirty by fifty-two inches in size, and the whole are bound in two volumes or atlases.

The comparative map of the entire harbor, on the scale $\frac{1}{20000}$, ordered in your instructions, has been completed. It represents, in blue, the survey of 1835, by Lieut. T. R. Gedney, U. S. N., then an assistant in the Coast Survey, in comparison with the survey of 1855–'56, by Lieut. T. A. Craven, U. S. N., assistant, which, for distinction, is shaded in red.

The changes which the harbor of New York had undergone during twenty years are thus graphically shown, and in the report which I had the honor to submit to you on the subject they were stated in detail. In addition, there has been compiled from the surveys a series of maps on a scale of two hundred feet to the inch, on which it is intended to have plotted the grants of land under water at different periods, made by the colonial government, corporation, land office, commissioners, or by the State of New York. The collection of these grants was entrusted by the Commissioners on Harbor Encroachments to Assistant Edmund Blunt, with your concurrence. Those coming into my hands have been, for the present, deposited in the archives of the Coast Survey office, to await the receipt of others yet to come in.

A general map, which will embody the survey of the shores, the topographical survey of the lands adjacent to the shores, and the minute hydrography of New York harbor, from Yonkers southward to Shrewsbury river, N. J., and from South Amboy to Throg's Neck, was also commenced, in obedience to your instructions, on a scale of $\frac{1}{20000}$. The size of this map is ten feet by nine. At the beginning of the present year a considerable portion of the topography on the map was reduced in pencil; but the progress made, as compared with the whole work, has been limited, only two draughtsmen being available for duty in connection with it.

On the 15th of January the Commissioners on Harbor Encroachments reported to the legislature at Albany, and laid before the Committee on Commerce and Navigation the several maps in the condition just described. A further term of three months was then granted, to enable them to complete their labors and for finishing the drawings. During that period the maps contained in the two atlases were completed. I also marked plainly on them, in black ink, the bulkhead and pier lines, as recommended by the commissioners, and continued the work on the general map with one topographical and a hydrographic draughtsman. By the 15th of April considerable progress had been made, and in this advanced condition it was presented by the commissioners, with the other maps, to the legislature.

After the passage of the law adopting the lines as recommended by the commissioners, thirty days were allowed to make out descriptions of the lines, referring them, by offsets and bearings, to permanent objects and to the sides of streets in New York city. In accordance with your instructions, this voluminous and elaborate document was completed under the direction of the commissioners, and has been filed, together with the two atlases, in the office of the secretary of State, at Albany, as required by the law of the 17th of April, 1857.

A joint resolution of the legislature having been passed requesting the Superintendent of the Coast Survey to complete the general map of New York harbor, it was returned, by your direction, to the office in Washington, and is now in my hands for completion. Since the 20th of June two topographical draughtsmen have been employed on it under my direction. The progress of the work will bear a large proportion to the means assigned for its execution. The bulk of the details will probably be done before the next meeting of the legislature, and the style of execution will speak well for the skill of the draughtsmen engaged.

At the close of this final report, allow me to thank you for the confidence and liberality which you have shown towards me since the work was placed in my hands. I trust that my exertions and good will to execute it to your own and to the satisfaction of the commissioners and the credit of this office may have been successful.

I have the honor to remain, most respectfully, yours,

A. BOSCHKE.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 39.

Report made by Lieutenant A. W. Evans, U. S. A., Assistant Coast Survey, on a topographical reconnaissance of a part of Sapelo island, Georgia, for the selection of a site for a primary base line.

ELKTON, MD., *September* 8, 1857.

SIR: Your instruction respecting the reconnaissance of Sapelo island, Georgia, with a view to the selection of a site for a primary base line, embraced several heads, and particularly specified three distinct and separate portions of the island, each of which it was conjectured might afford a good line. The selection could be best made from the inspection of a topographical sketch of the localities.

Mr. H. S. Du Val was despatched to Sapelo on the 25th of May, with a copy of your directions for his guidance, and instructed to make a plane table map, on a scale of $\frac{1}{10000}$, of the southern and western portions of the island. This duty was completed on the 24th of June, when, in company with him, I personally inspected such parts of the work as I had not previously visited, and compared them with the map. It is due to the topographer to state that he appears to have labored very faithfully and accurately under all the disadvantages of inconvenient transportation, very sultry weather, and without trigonometrical points. His sketch gives a close representation of the ground, and, as you will observe, confirms the general accuracy of the old French map.

Facilities were afforded, in the progress of the reconnaissance, by Mr. Spalding, one of the proprietors, whose kindness in forwarding the work, though in accordance with his well known hospitality, I feel cannot be too highly commended.

Sapelo island is generally much more level than the one adjoining, (Black Beard,) and geologically older. The latter is a series of parallel sand ridges, the valleys being frequently filled by brackish ponds, and every spot bearing distinct traces of the recent action of the sea. Sapelo appears to be a congeries of hammock islands, originally separated, but now connected by marshes, which have assumed the character of hard savannahs, being now for the most part dry. These hammocks abound in live oak and palmetto, afford the best arable land, and are generally the highest ground. When they become, by successive vegetable deposits, a little higher than the neighboring marsh, the first growth is of scrubby pine. It is thus that the savannahs or prairies seem to possess no distinct line of separation from the adjacent pine land, but gradually to run into it, while oak is found growing upon higher and drier spots, having a well marked edge or shore.

Through the savannahs at the south end of the island, the ground examined by J. S. Williams, esq., (formerly assistant in the Coast Survey,) two lines seem practicable. I have indicated them on the map, and shall refer to them separately. The other lines drawn show the lines respectively suggested by Mr. Spalding and myself.

To commence at the north end, the line drawn from my north base past Chocolate plantation, and running to Little Sapelo river, is about three miles and eleven hundred metres in length, passing over hard and level ground, with but two ditches, a natural hollow and rivulet emptying into Mud river, at the old fort, and a piece of marsh near the southern end. Nearly a mile of the north end passes through a grove of young oak; thence it is clear, excepting a high hedge at Chocolate plantation, and a few valuable trees, which it would be difficult to avoid. Both ends of this line look directly upon the main, without involving the necessity of cutting. The north end is also very favorably situated with respect to Sapelo sound. This site is number two in your notes of instruction.

Site No. 1 commences in an open field at the southwest end of the island, with a clear view of the main, and offers no serious obstacles until it reaches Mr. Kenan's plantation, two miles and a quarter distant. It can be made four and a half miles long by a mile of heavy cutting through oak and pine, ending in an open savannah. A ditch occurs on the line at Mr. Spalding's plantation, and another at Mr. Kenan's. The ground is hard and nearly level throughout, being original hammock land. The north end affords a view in one direction clear to the main. The connections of the two sites described, with the main land, are good, and may possibly outweigh the objections to them which have occurred to my mind.

The other sites lie almost entirely in open prairie, but the ground is by no means so soft or wet as the ordinary marsh. In dry weather it is quite hard. The site indicated by Mr.

Williams, which was, in the course of the present season, examined personally by yourself, commences in the first open space at the south end of the island, just west of the oaks at Mr. Spalding's residence, and passes over arable ground and prairie to the point where the great savannah ends in the pine woods. The woods are here very thin, and by cutting a very few trees the line can be made five miles long. Two small oak groves, which must also be cut through, are not great obstacles. Several ditches must be crossed, but none on the island are more than three metres in width, and they can be easily bridged. The ground is generally dry and level throughout. This site I shall call No. 3.

Site No. 4 might commence near the point of beginning of the site first described, in the open field at the southwest point of the island, and run up the great savannah, intersecting No. 3 near its northern end. It can be made five miles long. The first obstacle on this site is a grove of oak and pine, with underbrush, about five hundred metres through, and a ditch. Thence it would pass among some negro houses, cross the road and a small corner of wood, and run up the great savannah without other obstacle, excepting from ditches. The ground is good and level throughout, though not quite so dry as site No. 3.

Either of the lines, No. 3 or No. 4, I would recommend as possessing advantages for a base. With regard to their connections with the main, the fact of their northern extremities both lying in the same large pine forest will, of course, suggest the necessity of considerable cutting. Here I would recommend the erection of a tripod, forty-five feet high, to overlook much of the pine, (which is of the character called "*loblolly*,") and such tall trees as might intervene could be cut. Time did not suffice to finish in detail the map of the northeastern part of Sapelo island, and it can only be stated, generally, that it is a large pine forest, in which lie, however, *several open prairies*. In that part looking towards Black Beard island is the site of an old plantation with some open fields; but the larger portion, from the head of the open savannah to the north end of the island, is a pine forest with but little undergrowth, the trees seldom attaining any great size. The line to St. Catharine's island would, in a very short distance, strike the marsh which separates Sapelo from Black Beard island, and then pass clear of everything.

At the south end of site No. 4 there need be nothing more than an ordinary signal on the ground.

If by any means site No. 3 could be prolonged to the neighborhood of the light-house across the marsh and creek, its south end would see clear in every direction, but this would be a difficult operation. Ending it on the hard, high hammock ground, an obstacle in the direction of the main is presented by a thick oak grove, requiring either heavy cutting or a high tripod and scaffold. In view of the great necessity, in this low, flat country, of elevating the theodolite, I would recommend the latter resource for each end of both sites, (No. 3 and No. 4.) Spars of any size may be obtained cheaply either at Doboy or Darien. For the tripod and scaffold at the north end, perhaps it would be better to cut the stuff upon the spot. From this point lines to signals upon the main must cross the whole breadth of the island, here two miles wide, and wooded nearly all the way. To the extreme northern point of the island is a distance of four miles, mainly through pine woods. It is not to be supposed that an elevation of even forty-five feet would overlook everything upon such lines. The oak wood in this country is all either of present or prospective value; such pine, however, as is found upon Sapelo island is comparatively worthless, and is used chiefly for fencing and fire-wood.

I do not think that upon any of the sites proposed the grading and bridging need be considered as matters involving any difficulty or delay. The ground on the prairies is beautifully level, and the opening of lines to the main presents the only difficulties that need be taken into serious consideration.

I would also suggest that the secondary triangulation be first completed from Sapelo entrance to Doboy, before making the selection of primary points upon the main. Without the previous choice of them, it is, of course, impossible to state precisely the amount of cutting requisite to come off the base.

The south end of Creighton island is a high shell bank covered by tall cedars, and might be a good primary point.

Directly west of Sapelo island lie Little Sapelo and several large wooded hammocks, separated from the larger island by Little Sapelo river.

The best season for measuring a base is the winter, both on account of climate, and as interfering least with cultivation along the line. November and December, I think, are drier months than either January or February, when most of the wet weather occurs. I believe the cotton crop is generally secured before November.

Very truly, your obedient servant,

A. W. EVANS,
Lieut. U. S. A., Assistant Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 40.

Extracts from a report by Assistant A. M. Harrison relative to the topographical features of Cumberland and Amelia islands, St. Mary's river, Georgia, and Amelia river, Florida.

UNITED STATES SCHOONER PEIRCE,
Plymouth, Mass., June 23, 1857.

SIR: * * * * * * * * * * *

My first sheet of the season, in the order of execution in the field, includes a part of Cumberland sound and Amelia river; the entrance to them from the ocean; the mouths of the St. Mary's, Jolly, and Bell's rivers, and Lanceford creek, together with portions of Cumberland and Amelia islands.

The topography of the country embraced by this sheet is varied. Cumberland island, Georgia, is generally level, the southern extremity being formed of marsh, divided irregularly by Beach creek and its many branches. The outer or ocean shore consists of low sand hills and a sandy beach, constantly washed by the breakers of the Atlantic. The rest of the island included upon this sheet is composed of the cultivated lands surrounding Dungeness, the residence of the proprietor, Mr. Nightingale, and thick woods of Spanish bayonet, oak, and some pine. A road extends nearly in a straight line northwardly through this forest, upon or near which, and its continuation still further north, is located the proposed site for the base. This island forms the northern shore of the entrance to Cumberland sound and Fernandina harbor. The boundary line separating Georgia and Florida runs between this and Amelia island, (which forms the southern shore,) and extends through part of Cumberland sound, and thence follows westwardly the channel of the St. Mary's river.

The aboriginal name of Cumberland island is said to have been "*Missoe,*" subsequently changed to its present title by General Oglethorpe at the solicitation of an Indian chief who had been the recipient of some kindly favors from the Duke of Cumberland.

Amelia island, Florida, presents a various topographical character. The trend of its outer shore forms, somewhat singularly, as far as surveyed, an obtuse angle with that of Cumberland. A work named Fort Clinch is in progress of erection upon the northern extremity of Amelia for the defence of the entrance.

The northern and eastern sides of Amelia island are bordered by rows of sand hills, thrown confusedly together, and backed by a thick forest of pine, palmetto, oak, and undergrowth. Immediately behind this is a narrow strip of marsh, running inland some miles, south and west of which the country rises into rolling hills, in some places cleared for cultivation, and in others covered with woods. Upon one of the most prominent of these hills Amelia light is situated. Very little cultivation is now carried on upon these cleared spots.

On the western or river side of Amelia island, upon the shore of Amelia river, are located the towns of Old and New Fernandina—the former a dilapidated relic of Spanish rule in Florida; the last named is a flourishing place, and has been selected as the Atlantic terminus of the Florida railroad. The land is rapidly clearing in the neighborhood, houses are going up, and it bids fair to become a thriving town.

The rest of the topography of sheet No. 1, including the mouths of the streams before mentioned, consists of marsh, cut up by many bayous and creeks, with occasionally a hammock or "island" of fast land rising slightly from the level of the surrounding swamp, and covered with a growth of pine and palmetto. In heavy gales this marsh is frequently submerged. On the Georgia shore of the St. Mary's, a short distance above its mouth, Point Peter (a wooded point of fast land, cleared at its extremity) comes down nearly to the water. An earthwork once stood here, and was the scene of a conflict during the last war with Great Britain.

Sheet No. 2 embraces the survey of the St. Mary's river from its termination on sheet No. 1 to a distance of three miles above the town; the upper parts of Jolly and Bell's rivers, and Lanceford creek; portions of North river and Burrell's creek, from their mouths inland; the town of St. Mary's and vicinity; Martin's island, and a large area of wooded country south of Bell's river.

The town of St. Mary's is situated about seven and a half miles from the entrance, immediately upon the shore of the St. Mary's river, on a point of fast land. Back of the town is a level, sandy, pine-covered country, divided by numerous roads and paths. The St. Mary's river is a narrow, crooked stream; and just below the town it receives the waters of North river, which is bordered by pine land and marsh. Upon it are three saw mills; one only, however, being now in operation. Above the town Burrell's creek runs through a patch of marsh, and empties into the St. Mary river.

Between the St. Mary's and Bell's river, extending southwardly and southeasterly, is a large area of marsh land, intersected by Jolly river and innumerable creeks and runs, turning in every conceivable direction, in some places presenting a confused network of muddy streams and sloughs. This is particularly the case eastward of Martin's island, a large wooded hammock, once under cultivation, but now abandoned. The intricacy is so great in this region, and the foothold so bad, that the topography could not be executed with the ordinary minuteness, and recourse to sketching was rendered unavoidable. Oysters and fish of excellent quality abound in these streams.

South of Bell's river the land is high, sandy, and mostly pine-clad. A few settlements are found here, but the quality of the soil for cultivation is poor.

Sheet No. 3.—This sheet includes a continuation of Amelia river, to the southward, as far as Kingsley's cut, and also of the Florida railroad from its termination upon sheet No. 1. The road crosses the marsh in that vicinity upon trestle work. Amelia river, on this sheet, runs through a marshy tract, bordered by wooded land on either side.

Sheet No. 4 contains the results of a reconnaissance for the base site, as proposed by you, upon Cumberland island. The survey represents the road, before referred to, running northwardly from Dungeness through woods and cleared fields. The topography is given for about an eighth of a mile on either side of the road, and four profiles of elevation and depression are also furnished. A sketch, upon a scale of $\frac{1}{60000}$, is drawn upon the sheet, showing the relative position of the base line.

Respectfully submitted by your obedient servant,

A. M. HARRISON,
Assistant U. S. Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey, Washington, D. C.

APPENDIX No. 41.

Report of Capt. J. H. Simpson, U. S. Topographical Engineers, Assistant in the Coast Survey, on the reconnaissance and progress made in triangulation for an air line between Fernandina and Cedar Keys, Florida.

CAMP NO. 32, NEAR FERNANDINA, FLORIDA, *May* 21, 1857.

SIR: I have the honor to make the following report of operations upon the air line triangulation between Fernandina, on the Atlantic, and Cedar Keys, on the Gulf coast of the peninsula of Florida, for the season which has just closed.

On the 22d November I embarked from New York, *via* Savannah, to Fernandina, the starting point of my labors. I reached Fernandina November 26, but finding I could not purchase there or in the vicinity the necessary mules for a reconnoitering expedition across to Cedar Keys, which I judged necessary in order to an enlightened development of plan of work, I embarked on the 28th November for Charleston. Here I obtained an outfit, consisting of three fine mules and two riding horses, with wagon and harness, and returned by steamer to Fernandina, reaching there the next day.

By the 5th December my party, consisting of Mr. Thomas Baltzell, jr., and Mr. Gustavus B. Maynadier, aids, and five men, were organized for the field, and on that day we started on a reconnaissance of the country between Fernandina and Cedar Keys.

We were engaged in this work twenty-one days, the party returning to Fernandina December 26; and the distance travelled without a guide was, in all, going and returning, 429 miles. Of this distance, the wagon travelled, as shown by the odometer, on the outward trip 176 miles; on the inward, 175 miles; and the balance of 78 miles was traversed by parties detached for the purpose.

Immediately on my return a map of the reconnaissance was traced and presented to you at Washington, together with my report. As that report gives an account of my operations up to the beginning of the year, I here introduce a large portion and forward in duplicate a map illustrative of it.

The route taken to Cedar Keys was along the line of the railroad, at present graded only from Fernandina for a distance of about 45 miles, and with its track laid for a distance of 14 miles. This road is at this date, May 21, finished, and the locomotive is running over it for a distance of thirty-odd miles, and it is embanked about halfway to Cedar Keys, or for a distance of, say, 75 miles. Of course, as the object was to see as much of the adjacent country as possible, we crossed the railroad line several times, and thus by a tortuous course made our route some 26 miles greater than the probable distance by the railroad. This railroad line, it will be perceived from the accompanying sketch, No. 39, makes a considerable detour to the north in order to head Nassau river and its tributaries.

The route taken on our return to Fernandina from Cedar Keys was generally in the vicinity of the air line connecting those points, and, like the former, was made long by many windings.

The country along the railroad site, as also that along the air line, we found essentially the same in character throughout, except that in the vicinity of Newnansville the latter presents a more rolling, hilly country than the first named route. Its general and, I may say, its invariable characteristic is a silicious alluvium superposed, in some localities, upon argillaceous clay, in others upon beds of marl; in some places, as in the vicinity of Hogtown creek, upon sand rock, and in others, to the south of Newnansville, upon a calcareous rock, which, on account of its solubility in many spots, gives rise to what are called sink holes, caverns, or water holes, into which several streams, such, for instance, as Hogtown creek, are known to lose themselves, not to appear again. Others, as the Santee Fé river, disappear for a distance, and then discover themselves. The limestone I found in some instances so soft and pliable as to appear as if already calcined; in others, so hard that only by the severest percussion could it be broken. This geological product, I have no doubt, will be found of value in the settlement of the country as a cement and fertilizer. These rocks form, as it were, the backbone of the peninsula in a north and south direction, and its breadth has been formed by the alluvium which has been washed against it from the Atlantic and Gulf waters. The singular symmetry of the formation in cross section, and its gradual emergence to an elevation above the sea of one hundred and eighty feet, will be well seen by reference to a profile made by Captain M. L. Smith and Lieut. F. S. Bryan, U. S. Topographical Engineers, in 1853–'54, for a ship canal on the line traversed by us, which profile will be found introduced in the accompanying map.

The *sylva* we passed through is what is familiarly known as the yellow pitch pine. It prevails almost entirely without intermission from one coast to the other; the only exceptions being the forest trees which border the streams we crossed, the cypress to be found in the swamps, generally of small extent, and the cabbage palmetto, which is seen mostly on approaching the Gulf in clustered groups, and sometimes as single trees sparsely intermixing with the pine. Thus disposed on the level surface the landscapes presented suggest an analogy to Oriental scenery.

The pine is generally below the medium size of large timber, and is so scattered as not to interrupt the view for a quarter of a mile; in other localities it is small and rather thickly scattered.

A system of well-conditioned triangles is practicable throughout, and I consider it as the best possible mode of accomplishing the problem proposed.

At either extremity of the line upon the coast no difficulty will be found in connecting the triangulation which has been already executed with that proposed; and neither route presents any obstacle to the opening, by cutting, of visual avenues, which will enable the observer to see any signals necessary in the measurement of angles.

The comparatively level country which lies towards either coast can assuredly, with the aid of suitably high signals, offer no obstacles, and the swelling eminences on the Back Bone ridge, if properly seized as station points, will much facilitate the work.

On either line triangle sides of five or more miles can, I believe, be readily obtained, and approximately with the condition best suited to insure the greatest attainable accuracy, that is, for the construction of equilateral triangles.

And now the question arises, upon which line, the railroad or air line, would it be most expedient to construct the triangles? The probable length of the railroad from Fernandina to the keys will not be far from 150 miles.

Measurements could not well be made on the railroad track on account of the continued passing and repassing of the cars, and the width of the embankments will not admit of placing the stations outside; but in the case of the air line, as it is to be straight between the extreme points, sites for bases and high points for stations can be selected at pleasure.

The number of the triangles may be made the least possible. Bases may be measured as often as may be required. And, what may be of some moment commercially, an air line avenue will thus be opened between the ports of Fernandina and Cedar Keys, now looming into merited importance by the approaching completion of the Florida railroad connecting them. For these reasons I am decidedly of the opinion that the air line basis of triangulation will best suit all the conditions of the problem to be solved, and should be the one ordered.

This report, sir, you were pleased to approve, and verbal instructions were given to go on with the construction of the triangles to the extent of about forty miles of cutting and the erection of the proper signals and stations.

Upon receiving these instructions I immediately returned to the theatre of my labors, and now report the following as the result.

The triangles were constructed to the extent required by the middle of March, and, agreeably to your directions of March 14, the cutting was continued still further; so that, on terminating for the season, four triangles were constructed, commencing at Fernandina and based on a line tending towards Cedar Keys, (see Sketch No. 39.) The sides of these triangles will be in no case less than $6\frac{1}{4}$ miles, and their aggregate length is about 59 miles. The greatest deviation of any one angle from the equilateral form will scarcely exceed 3°. Signals similar to that presented in the accompanying sketch were erected at each vertex, and observations within the degree of accuracy required for final measurement were made from every station.

Thus far the work has required the erection of but two stands to observe from—one 7 feet high, at O'Neill station; the other 25 feet high, at Drum creek, all the other observations having been made from the ground.

The signals erected have in every instance been about 50 feet high, and essentially consist of a tripod 25 feet high and a mast about 40 feet long, 25 feet of it surmounting the tripod, and the top made conspicuous by a barrel covered with white cloth, and a tin cone, having three cleets nailed on the side at the top so as to form in plan an equilateral triangle. On this the tripod of the instrument stood, and a scaffolding was made for the observer to stand on by nailing pieces around the legs of the signal tripod and laying on them a flooring of puncheons.

I cannot close this report without acknowledging, as I here do, the courtesy I have received at the hands of Messrs. Finegan & Co., of the Florida railroad, and of Mr. Daniel Callahan, contractor, in the prosecution of my duties. These gentlemen have frequently aided my party, in transporting it, with its camp equipage and livery, free of charge, and it is due to them that I should thus publicly acknowledge it.

I would fail in my duty if I did not bear testimony to the efficient manner in which my aids, Mr. Thomas Baltzell, jr., and Mr. Gustavus B. Maynadier, have seconded me in the prosecution of my duties. Prompt and effective in the execution of the duties assigned them, they have harmoniously coöperated with each other and with myself; and thus, while carrying on the work satisfactorily, have also recommended themselves as gentlemen of courtesy and worth.

All which is respectfully submitted.

J. H. SIMPSON,
Capt. Corps Topog. Engineers, Asst. U. S. C. S.

A. D. Bache, L.L. D.,
Superintendent U. S. Coast Survey, Washington City.

APPENDIX No. 42.

Report to the Commissioner of the General Land Office, showing the progress made in the survey and marking of the Florida Keys, in quarter sections, during the present season.

Coast Survey Office, *July* 20, 1857.

Sir: I have the honor to report, in continuation of the work on the Florida Keys undertaken for the General Land Office, that the triangulation of the outer keys, from Point Charles, on Key Largo, to Pigeon Key, on the southward and westward, has been executed within the present surveying season. The distance between the points named is about fifty-four miles. The triangulation on the outside of the keys is now complete from Key West upwards along the entire line of the reef. Three topographical parties have been engaged in extending the plane table survey, the operations of which commenced about twenty-five miles northward and eastward from Key West. In that vicinity Burnt Key, Knock-'em-Down Key, Budd Key, Raccoon Key, Water Keys, Eastern and Western Content Keys, and Harbor Key, were surveyed by the party of Mr. F. W. Dorr, extracts from whose report are herewith appended, marked, (A.) accompanied by a tracing from his survey.

The topographical sheet containing the keys just enumerated is joined on the southeast by three others executed by Sub-Assistant C. T. Iardella; copies of these are herewith transmitted with his remarks (B) upon the general character of the soil and the growth of timber on the keys. These exhibit the surface features of Ramrod Keys, Big Torch Key, Little Torch Key, Big Pine Key, No Name Key, New Found Harbor, Little Pine Key, Pye's Harbor Key, Annette Key, Big Spanish Key, Little Spanish Key, Crawl-Key, Howe's Key, Mayo's Key, Johnson's Keys, Flat Key, West Bahia Honda, and East Bahia Honda. Maps of the keys lying immediately to the eastward of that last mentioned, and extending as far as Key Vacas, have been already furnished to the General Land Office from surveys made in previous years. Continuing the work in the same direction, the accompanying copy of a sheet completed during the present year by Mr. Dorr will be found to contain the shore-line and the characteristics of Key Vacas, part of Boot Key, the Stirrup Keys, Fat Deer Key, and Bamboo Key. Particulars in reference to the size and quality of these are given in the report of Mr. Dorr, before referred to (A.)

The plane table work has been continued also on the outside of Key Largo, the shore-line having been traced from Point Charles southward and westward to its termination. Below, and adjacent to Key Largo, the outer shores of the Upper and Lower Matecumbe were likewise run during the season by Sub-Assistant S. A. Wainwright. His report, stating the comparative quality of soil, timber growth, and peculiarities of these and other keys in the vicinity, is appended, marked (C.) The triangulation of the keys last alluded to was executed by Lieut. A. H. Seward, U. S. A., Assistant.

This work is joined on the southward by a series of triangles begun at Pigeon Key by Lieut. J. C. Clark, U. S. A., Assistant, and extended northward and eastward to a station on Lower Matecumbe. In reference to the character of the keys falling within the limits of his triangulation, Lieut. Clark reports as follows: "From Pigeon Key to Lower Matecumbe, the line of keys is quite narrow, not affording well conditioned triangles, nor sides of sufficient length without using exterior points for stations, and the practicable points on the reef are too far apart for the purpose. Stations were erected on several shoals between the keys and the main land, but considerable difficulty was experienced in occupying them on account of the rush of the tide when accompanied by wind."

"Between these shoals and the keys is a channel for vessels of light draught, which is much used during the prevalence of high southerly winds."

"There are several harbors within the limits of the triangulation, as Knight's Harbor, Jacob's Harbor, Tom's Harbor, and a fourth at the eastern extremity of Long Key."

For statements of particulars in regard to the number and marking of the quarter sections in the several keys, I would respectfully refer to the tracings and accompanying reports.

The reported incursions of hostile Indians in the immediate vicinity of Cape Sable, at the extremity of the Florida peninsula, made it impracticable to commence the work there as early in the season as had been intended. Before its close, however, the party of Mr. Dorr succeeded in completing the plane table survey, and marking in quarter sections of the strip of land adjacent to Cape Sable and extending from N. W. Cape, on the northward and westward of it, to "Upper Crossing," opposite to the Oyster Keys. The sheet of this locality, a copy of which accompanies this report, includes the site of the base measured near Cape Sable in 1855, and also Sandy Key, lying outside, to the southward and eastward.

Descriptive references to the local features of the tract included in the survey here mentioned will be found in the appended report (A) of Mr. Dorr.

Very respectfully yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

A.

BOSTON, *June* 27, 1857.

SIR: In compliance with your instructions of November 19, 1856, I proceeded to Key West, but I was unable to engage a pilot to accompany me to Cape Sable, such was the general terror of Indians. I therefore lost no time in commencing a sheet among the keys about twenty-five miles to the northward and eastward of Key West. I reached the scene of active operations about the 20th of January, 1857.

Burnt Key, which was the first in order of survey, is upwards of a mile and a half in length, but quite narrow. The land is slightly elevated, and sustains a growth of large trees, principally button-wood, with scarcely any mangroves. South of this are two small keys, not wooded, and nearly covered at high water.

Directly west of Burnt Key, and scarcely half a mile distant, is Knock-'em-down Key, which is three miles in length, and averages nearly a mile in breadth. Comparatively a small portion of it is beyond the reach of ordinary high water, and it is very much cut up by lagoons and creeks. But a small portion of the key is wooded.

Budd Key, the next to the NW., is about a mile in length, but narrow. It is separated into three distinct parts by narrow channels, one of which is quite deep even at low water.

Beyond this, to the NW., are some half a dozen small mangrove keys and shoals, only one of which, Michael's Key, is judged worthy of a name, and that is but little more than a quarter of a mile in length.

A mile to the northward, however, brings us to Raccoon Key, which is one and a half miles long, and from a quarter to half a mile in width. The woods occupy but a small portion of the surface. They are principally of button-wood and mangrove.

NW. of this are three small mangrove keys, the largest of which, Eagle Key, covers an area of nearly a quarter of a square mile.

Parts of the *Torch* and *Howe's Keys* also came on my sheet. The former group, with its numerous shoals and small grassy keys, intersected by numerous channels, most of them dry, or nearly so, at low water, covers an area of about four square miles.

Torch Key proper is, in some places, a mile wide, and is to a great extent overgrown with button-wood, sea grape, torch, a few palmetto, and numerous other species of trees.

East of this are three small keys, from three to five hundred metres in length, each densely covered with mangrove.

Due north of *Torch*, and separated from it by a channel only one-fourth of a mile wide, are a group called the Water Keys. These stretch in a northerly direction about three miles, and are all connected by flats at low water, at which time they form one continuous chain. But long before the tide reaches its full height they are separated into nearly a dozen, most of them very small. The most southerly, and the only one of any size, is long and narrow, being more than half the length of the whole chain, and supports a ridge of large high trees.

The western half of *Howe's Key* lies to the SE. of Water Key, distant three-fourths of a mile, and the portion on my sheet covers an area of nearly two square miles. The NW. part is low and intersected by lagoons, and the woods are thin.

To the north and west of Water Key are the Eastern and Western *Contents*. These groups stretch in a NE. direction for about three miles, and vary in breadth from a half to three-quarters of a mile. They are intersected by numerous deep passages, mostly narrow, except the one between the two groups, which is over half a mile wide, and at the mouth of which there is a break in the reef which stretches along outside of these keys for a considerable distance.

Lastly comes *Harbor Key*, situated about one and a quarter mile E.NE. of the Contents. This is a small, nearly round key, scarcely two hundred metres in diameter; but the land is high, and the woods dense. It can be seen and readily distinguished at a considerable distance, and derives some importance from being a prominent landmark for vessels cruising in the bay.

There is a narrow strip of coral reef, north of the Eastern Content group, a little more than one-fourth of a mile distant, which is bare at low water. Between it and the shore the water is shallow, but the outer edge falls precipitately to a depth of one and a half fathoms. The space included between the Contents, Water, Torch, and Raccoon Keys, an area of six square miles, is one extensive flat, not quite dry at low water, except in a few scattered places, yet impassable for boats even of the smallest draught.

The accompanying map of this locality contains eighty-nine quarter section stakes, labelled, respectively, M, P, or MP.

After completing the sheet just mentioned, I succeeded in obtaining a pilot for Cape Sable, where I commenced about the middle of March, and worked as far from the base line as was practicable previous to triangulation.

Cape Sable, from what I could learn, is probably an island formed by Shark river, leading up to White Water bay, a large inland lake, and this, also, has an outlet towards the east, which empties somewhere into Barnes' sound.

From Cape Sable proper, or, as it is sometimes called, the Eastern Cape, to Palm Point there is a fine sand beach, with a ridge about three feet in height running along just back of high water mark.

This gradually falls away towards the woods, which are in most places upwards of a hundred yards from the shore, but in some places run in close to the beach.

At Palm Point there is a large open space of firm ground, a fine rolling prairie, some six feet above the level of the sea. It has recently been selected as the site for a small military station, Fort Cross.

The most prominent objects in this vicinity are two tall palm trees, the largest being upwards of one hundred feet in height. They are quite useful as landmarks.

Just beyond the prairie at Palm Point, proceeding in a NW. direction, the woods again approach to the water's edge and continue to skirt the shore for some two miles, where they begin gradually to recede, and there is a fine high sand beach, reaching to the Northwest Cape. Here, again, there is a high undulating prairie. Beyond that the woods grow close to the water's edge, and to the westward of this point there is no clear land for several miles. None, in fact, except here and there a very small prairie on some of the innumerable scattered islands, formed by the mouths of the various rivers between here and Cape Roman.

For the shore-line from Palm Point to the Northwest Cape, I was obliged to use a separate sheet.

From Fort Poinsett, eastward, there is a high sand beach, as far as a point which makes out abreast the east end of the base line. The walking would be good were it not for the dead mangroves which have decayed and fallen into the water. At the foot of the sand ridge the soft gray mud commences, and stretches out with scarcely a perceptible variation in the depth of the water for some distance, say two hundred yards, and from there shoals very gradually out to the channel, about three-quarters of a mile, where there is from seven to ten feet of water. This channel extends, perhaps, a mile beyond the Oyster Keys. To the eastward of that the whole country is one extensive flat, dry at low water for miles.

After a strong northerly wind has prevailed for a day or two, this becomes perfectly bare to a distance of two or three miles from the main, and remains so until a change of wind. The surface is covered entirely by gray mud, into which a pedestrian must sink more than two feet at every step.

Beyond the point above mentioned the mangroves grow to the water's edge, and, in fact, from the shore-line. This growth continues to the "Upper Crossing," opposite the Oyster

Keys, the eastern boundary of my sheet. Here there is a narrow opening, perhaps twenty yards wide, where the prairie comes down to the water's edge. Beyond that the mangrove appears again and is absolutely impenetrable.

There is a narrow strip of fast land between the beach and the base line. There the "Glades" commence—a marsh dotted with hammocks. These latter are mostly quite narrow, although some stretch to a considerable length.

To the NW. of the second mile-stone of the base line, there is a solid growth of black mangrove, reaching to Fort Poinsett. In it are several ponds, mostly small, although one, the largest, is three-fourths of a mile in length. These are all connected together by trails worn by the alligators in their migrations from one pond to the other, and to White Water lake, which commences about a mile and a half NW. of the west base, and stretches in a NW. direction between four and five miles to just beyond Palm Point. It averages three-quarters of a mile in width. The water is salt, and the ebb and flow of the tide, though slight, is plainly perceptible. The bottom is composed of very soft and unusually sticky black mud. The lake is completely enclosed by the woods, except portions of the eastern shore, which border on the prairie. While I was there the water was very shallow, as was the case with all the ponds, a number of them even being entirely dry. The greatest depth of water did not exceed six inches. But when the Glades are full—during the rainy season—the water rises to a height of over six feet. My sheet of this vicinity also embraces Sandy Key. This is a narrow strip of land, in shape resembling the two legs of a right-angled triangle, and is only remarkable for the countless flocks of sea birds which frequent it. The sheet last referred to is marked by fifty-two quarter section stakes, labelled, respectively, M, P, or MP, mostly the latter.

After completing all I judged it prudent to attempt previous to triangulation, towards the latter part of April I proceeded to the Vacas Keys. Having obtained points of Lieut. Clark, furnished from his work of this season, I commenced upon Key Vacas, joining Assistant Adams' work of a previous season, and worked in an easterly direction.

Key Vacas is about five and a half miles in length, and varies in width from a quarter to half a mile. It is mostly wooded, although parts of it are cleared, and towards the eastern extremity there is a small settlement of about a dozen houses.

An extensive shoal makes out from the southern shore for a mile or upwards, scattered portions of which are dry at low water.

A number of very small keys and rocks lie at short distances from the northern shore of Key Vacas, only one of which—*Rachel's Key*—has been named.

That part of *Boot Key* which my sheet embraces is nearly two miles long, but very narrow. The eastern portion is high, firm ground, but the middle of the key is entirely cut up by lagoons and deep channels.

The *Stirrup Keys* are three in number, and lie to the northward of Key Vacas; the largest, on which the station is situated, is three-fourths of a mile long, and in the widest place measures about a quarter of a mile.

Fat Deer Key lies to the eastward of Key Vacas, from which it is separated by a narrow but quite deep channel, called *Jacob's Harbor Passage.* This key is much cut up by numerous channels, most of them deep, and is, moreover, divided throughout its entire length by a large lagoon.

The whole length of that portion of the group which is contained on my sheet is about two miles, and it averages about a quarter of a mile in width.

Bamboo Key lies to the northward of the preceding. It is scarcely a quarter of a mile long by about one hundred metres in width.

This sheet is marked by sixty-seven quarter section stakes, labelled, respectively, M, P, or MP. It was completed on the 16th of May, at which date I discontinued operations in Section VI.

The total amount of work done by my party was: shore line, 210½ miles; wood and marsh line, 69 miles, within a total area of seventy-three square miles.

Yours, very respectfully,

F. W. DORR, *U. S. C. S.*

A. D. BACHE, L.L. D.,
Sup't U. S. Coast Survey.

B.

WASHINGTON CITY, D. C., *June* 10, 1857.

SIR: In pursuance of your instructions I repaired to Key West in November. Owing to repairs of my vessel, the U. S. schooner Agassiz, and the death of my assistant, Mr. S. J. Hough, the commencement of my work was delayed until the 3d of January.

The operations of my party this year embraced the topography and marking of the following named Florida keys, viz: Big Torch, Little Torch, Big Pine, No Name, Howe's, Newfound Harbor, Pye's, Annette, Little Spanish, Big Spanish, Flat, Grassy, Johnson's, East and West Bahia Honda, and several smaller keys in their vicinity.

Ramrod Key is one and a half miles in length by one and a quarter miles in breadth; the outer shore is of coral rock. The key is covered with heavy mangrove, palmetto, sea grape, and button-wood. On the southeastern end is a lagoon three and a quarter miles long by a quarter of a mile wide. The depth of water in this lagoon is from five to fifteen inches.

This key was marked by fourteen painted posts in parallel-meridian, and also in quarter sections. The rocky portion of the key was marked by iron stakes, two and a half feet long, driven into the rock four inches. These were marked with a cold chisel on one side, the letter M, MP, or P, being painted on another side. On other parts of the key yellow pine posts, four feet long, were driven into the ground one and a half feet, and protected by coral rocks piled around them. The posts were marked on one side with the letters U.S.C.S., and on the other side M, MP, or P, with black paint.

Big Torch Key, which lies next to Ramrod, is irregular in shape, and is divided into three separate keys by a channel one mile in length by one hundred and sixty-four yards wide, with a depth varying from six inches to three feet. The shore of *Torch* is rocky on the eastern and western sides; the northern and southern being extensive mud flats covered by the sea at high tide. This key is a formation of coral rock, covered with a thin crust of marl about one inch in depth, and is thickly wooded with black mangrove, palmetto, sea grape, and button-wood. The key was marked by thirty posts of iron and yellow pine, designated as those on Ramrod Key.

Little Torch Key is separated from Big Torch by a channel two and a quarter miles in length by a quarter of a mile in breadth, with a depth of three feet. This key is three miles in length and a half a mile in breadth; the soil and wood are like those of Big Torch Key. Little Torch was marked by fifteen posts of iron and yellow pine, similar to the section marks of Big Torch Key.

Big Pine Key, due east of Big and Little Torch, is of irregular shape. It is nine miles in length by three miles in breadth, comprises an area of thirteen square miles, and is covered with a heavy growth of yellow pine trees, varying in height from twenty-five to sixty feet. The eastern shore, extending from Big Pine station to nearly opposite *No Name* station, is a white sandy beach, the remainder being of coral rock, with mud flats here and there. This key, as others, is covered with small rocks, and with soil in some places from one to two inches in depth. The only feature claiming attention is the pine timber, the northern end being thickly wooded with mangrove and button-wood. There is on the northwestern side a small lagoon, which is nearly dry at low water. This key was marked by fifty-five posts of yellow pine, with the letters U.S.C.S. on one side, and M, MP, or P, on the other, with black paint.

No Name Key, which lies due east of Big Pine, is three miles in length and one and a half miles in breadth. This key is covered with a heavy growth of mangrove and palmetto. A grove of yellow pine trees about a quarter of a mile square extends into the middle of the key. The soil on *No Name* is similar in character to that of Big Pine Key. *No Name Key* was marked by seventeen posts of yellow pine, distinguished as those placed on Big Pine Key.

Newfound Harbor is a group of three small keys. The largest is of irregular shape, and is one and a quarter miles in length by a quarter mile in breadth in the middle, tapering at each end to two hundred and eighteen yards in breadth. Another is about two hundred and seventy-three yards in length by one hundred and sixty yards in breadth. The third, which nearly joins to Big Pine Key, is about a half mile in length by one hundred and sixty-four yards in breadth.

These keys are covered with mangrove and button-wood, and were marked by five posts. There is a fine harbor on the inside of the keys for vessels drawing from four to ten feet.

Little Pine Key lies due north of Big Pine and No Name Keys; is three miles in length by seven-eighths of a mile in breadth in the centre, the eastern and western ends being about two hundred and eighteen yards wide. This, like Big Pine Key, is mostly covered with yellow pine trees, varying in height from twenty-five to fifty feet. The eastern and western ends are thickly covered with black mangrove and button-wood. The soil is similar to that of Big Pine Key. On this key fourteen posts of yellow pine were planted, and marked as those on the key last mentioned.

Pye's Harbor Key is a small mangrove key, and lies between Loggerhead and Newfound Harbor. It is surrounded by extensive mud flats, covered with water at the lowest tides.

Annette Key, due north of Big Pine, is one and a quarter miles in length by a half mile in breadth. The surface is covered with thick mangrove and button-wood, and is marked by posts of yellow pine. There is a low flat key adjoining which is entirely covered by the sea at high tide, and is surrounded by extensive mud flats, bare at low water.

Big Spanish Key is the most northerly, covered with thick mangroves and entirely overflowed at the lowest tides.

Little Spanish Key, east of Big Spanish, is about three-quarters of a mile in length by one quarter of a mile in breadth. This key also is overgrown with mangrove, with extensive mud flats inside. The northern part of the key is nearly covered with water at high tide. This key was marked by two yellow pine posts.

Crawl Key, northeast of Annette Key, is very small, and covered with mangrove.

Howe's Key, which lies northwest of Big Pine, is thickly covered with black mangrove and button-wood. The southeastern end is much cut up with lagoons, varying in depth from six to twenty inches, but nearly dry at low tide.

This key was marked by fifteen posts of iron and yellow pine, designated as others already described.

Mayo's Key, east of Annette Key, is one mile in length by two hundred and seventy-three yards at the widest part. This key, like the others, is thickly overgrown with black mangrove, sea grape, and button-wood, and was marked by four yellow pine posts.

Johnson's Keys, three in number, lie due north of Little Pine Key. Key No. 1 is seven-eighths of a mile in length by a quarter of a mile in breadth. Key No. 2 is about one mile in length by a half mile in breadth. Key No. 3 is six hundred and fifty-six yards in length and one hundred yards in breadth. These keys are likewise covered with black mangrove, sea grape, and a small quantity of button-wood. The area was divided by eleven posts of yellow pine, and marked as those on other keys.

Flat Key, northeast of the Johnson Keys, is one mile in length by a half mile in breadth, and is covered by the sea at high tide. It is thickly overspread with mangrove and button-wood. This key was marked by three yellow pine posts.

West Bahia Honda, one mile from Flat Key, is a half mile in length by one-eighth of a mile in breadth. It is covered by the sea at high tide.

East Bahia Honda, two and a half miles east of West Bahia Honda, is about one-half mile in length by one-third of a mile in breadth. This key is also thickly covered with heavy mangrove.

My season's work, of four months, covers an area of thirty-one square miles, and includes one hundred and ninety miles of shore-line. Mr. G. U. Mayo assisted me in the work part of the season.

The topography is comprised in three sheets, which will be deposited in the archives when inked. Operations were discontinued on the 3rd of May. The schooner Agassiz was laid up in Baltimore, on June 3, 1857.

I have the honor to be, very respectfully, your obedient servant,

C. T. IARDELLA,
Sub-Assistant U. S. Coast Survey.

A. D. BACHE, L.L.D.,
Svperintendent of the United States Coast Survey.

C.

INDIAN KEY, FLORIDA,
May 4, 1857.

DEAR SIR: I have to report that, in obedience to your instructions of November, I proceeded to Key Largo, Florida, on the 16th of January.

After putting down eighty section posts there for the land office, the Indian hostilities having increased, it was deemed imprudent to expose the party, which was without any means of defence. I proceeded to Point Charles and continued the plane table work on the outside of Key Largo, and have completed all the key and the creeks, as far as it was possible to go from the sea-side; also the outside shore-line of Upper and Lower Matecumbe, which extends about four miles below Indian Key. I have surveyed about one hundred and twenty miles of coast and banks and about five or six of interior, and put down eighty section posts. Most of the outward shore of Key Largo and all the keys is of coral rock, soft enough in places to force the posts down; where this was impossible, I used iron stakes flattened at the top, and marked with a chisel U. S. C. S. on one side, M, or P, or MP, as the case required, on the other. The wooden posts were marked with the same characters in paint.

The soil on Largo Key, from Point Charles, where my season's work commenced, is superior to that of most of the other keys.

This key, Upper and Lower Matecumbe, and Lignumvitæ, being the most fertile of any of the large keys, the growth on them is large and very prolific. They are covered for some distance back from the water with a low growth of small trees and bushes, where the land is comparatively high, caused by the water making its deposit there. Going towards the interior the trees are large, but the ground swampy, from the creeks which pass through the higher land in small streams, and spread themselves over the key in numerous branches and ponds. The two Matecumbe Keys are much more free of these than Key Largo. The upper one has one spring; the lower, five.

Key Rodriguez is overflowed at high tide, and Tavernier has some fast land on it, only on the northern end, which would probably be overflowed at very high tide.

The two small keys *Dove* and *Tea Table* have a very good soil on them, deep enough for almost any growth. If properly drained they would be very profitable, having the best soil I have seen in Florida.

Very respectfully,

S. A. WAINWRIGHT.

Professor A. D. BACHE,
Supt. U. S. Coast Survey.

APPENDIX No. 43.

Extracts from the report of Sub-Assistant W. M. Johnson, on the topographical features of the coast adjacent to Santa Barbara channel, California.

COAST SURVEY CAMP, NEAR POINT DUMA, CAL.,
September 10, 1857.

SIR: In compliance with your instructions of June 16th, I have the honor to submit the following report of the operations of my party during the past year.

Our work has been extended from Point Conversion, near the southern limit of the Santa Clara valley, eastward to and including Point Duma.

The first plane table sheet extends from Point Conversion eastward to the Cañada de Isique, and embraces as rough and difficult a portion of topography as can well be imagined. A spur of the coast range of mountains here meets the ocean, and its steep and rocky sides, overgrown with brush and cactus, are made even more desolate and forbidding by innumerable *barráncas*, *gulches*, and *cañadas*. These terms have been adopted by Americans living in California, and are now in general use, as being much more expressive than any English words that could be employed to convey the same ideas. The first signifies a deep break cut into the hill-side by winter rains. The term "gulch" conveys the idea of a small and narrow valley, very tortuous in its course, the bottom cut into irregular falls, and strewed with large boulders, over which the waters sweep with violence. Its steep sides are generally covered with thick brush, and form the haunts of bear, deer, and great numbers of rattlesnakes. The "cañadas" differ from gulches, in being comparatively wide, level, and pleasant valleys, in which are to be found fine large oak and sycamore trees, and usually water, which, however, seldom reaches the coast, losing itself in the loose gravelly soil of its own bed some miles in the interior. * * * * * * * The part of the coast range embraced by the first sheet has an average altitude of about twelve hundred feet above high water. As the mountains spring abruptly from the water line, we were restricted to a small sand beach in laying out a base for the work.

Cañada de los Alisos, though small, is the principal valley represented on the first sheet. It extends from the coast in a northeasterly direction for about eight or nine miles, heading in the table-land or basin included by the ranchos of Conéjo and Truénso. This basin is from a thousand to twelve hundred feet above the ocean.

The names of the other principal gulches and cañadas are : *Cold Spring Gulch*, so called from a spring of delicious cool water that bursts out but a few yards from the beach ; *Cañada de Santa Jueta*, in which water is to be found in pools, and *Cañada de Isique.* In this last water may be had a mile and a half from the coast, near a point where it suddenly disappears. Judging from the number of rattlesnakes which we have killed in the field and among our tents, it seems a wonder that no serious misfortune has been met by the party. At the last station they were so numerous that it has been named by the men "rattlesnake camp." Two horses, temporarily in my employ, were bitten at different times. In both cases the swelling rapidly extended to the chest and neck, occasioning great difficulty in swallowing, but by repeated drenchings with a mixture of whiskey, salæratus and water, and proper attention to the wounds, both ultimately recovered. * * * * * *

Our second sheet extends from Cañada de Isique to Point Duma, (also called Suma.) On this the character of the topography undergoes a slight change. At the cañada just named commences a strip of table-land between the coast and the foot of the hills. This is only a hundred and fifty yards wide, but gradually increases in the direction to Point Duma, where it is several miles in extent. The average height of this table-land is about two hundred feet. About five miles east of Point Duma the hills again approach boldly to the shore-line.

Between Cañada de Isique and Point Duma the country is very much cut up by fifteen large gulches extending into the interior from six to eight miles. In several of these are fine streams of water, also a considerable quantity of oak timber; but this, from its situation, will never be of value. No names have yet been applied to the intervening gulches. The cañadas represented on the sheet are two in number : Cañada las Francas and Cañada del Suma. In the first of these, at a depth of twelve feet below the surface, and half a mile from the shore, we found water, but it was too brackish for use. Suma is the larger cañada of the two, and contains a spring of very good water and some very fine oak and sycamore trees. * *

After favorable winters, this part of the country might support from twenty-five hundred to three thousand head of cattle. Its use will probably be confined to pasturage. * * *

The winter has stolen upon us unusually early, and we have had several slight showers already. One of the surest indications of the approach of winter is found in the little springs that fail during the dry season, again making themselves visible at the approach of the rainy season. * * * * * * * * * *

I have the honor to be, very respectfully, your obedient servant,

W. M. JOHNSON, *Sub-Assistant U. S. Coast Survey.*

Professor A. D. BACHE, *Superintendent U. S. Coast Survey.*

APPENDIX No. 44.

Report of Assistant W. E. Greenwell, on the survey, character, and resources of the islands and main adjacent to Santa Barbara channel, California.

U. S. SCHOONER HUMBOLDT,
Prisoner's Harbor, August 16, 1857.

DEAR SIR: In conformity with your instructions of June 16th, I forward you a summary report of work executed the past year, and with it I propose to make some remarks, which may not be out of place, in reference to the coast, the Santa Barbara islands, and some suggestions as to the most practicable time of pushing the main and secondary triangulation in this section.

From San Pedro, excepting the high land immediately adjacent to the coast, is smooth and even prairie land for a distance well up in the bight of Bahia-Ona, and from thence to Point Conversion the mountains run down abruptly to the shore, barren, rugged, and useless for any habitable purpose. From Point Conversion to the old mission of San Buenaventura, some twenty miles, the coast is beautifully smooth and level—a wide open prairie of fertile land, part of which is watered by the Santa Clara river. From San Buenaventura to Santa Barbara the mountains again touch the shore, leaving occasional valleys and spots of cultivated ground. Between Santa Barbara and Point Conception, a distance of about forty-five miles, the line of coast is unbroken by any elevation, the range of mountains running parallel with it, but lying back in the rear from four to six miles, and gradually sloping to the very shores of the ocean. Such, in a word, are the general features of the line of coast stretching from San Pedro to Point Conception—a part of it offering advantages for the rapid secondary work, and a part presenting many obstacles to its progress.

You will see by the sketch enclosed (No. 56) that the secondary triangulation has been carried from San Pedro well up to Point Duma. I propose, when a suitable occasion presents itself, to complete this up to the last named point, so that this line of coast will be then ready for a topographical party. This secondary work was executed during my first winter in California, when the state of the atmosphere was such that no observations could be made on the main lines.

Santa Cruz island will likewise be triangulated before the season terminates, and a part of Santa Rosa or San Nicholas, whichever may be found most practicable, as the season advances.

By the sketch it will be seen that the main work has been carried along the coast up to its present limit without touching the islands. The work has been extended up to Anacapa, by avoiding the long lines centering on Santa Barbara island, which proved, during a part of my first winter, to be impracticable.

There is something remarkable about this little island of Santa Barbara. It is constantly enveloped in fog, and even when the rest are bright and clear the fog seems to hang over this isolated rock without ever lifting. I have observed the same phenomenon at a high bluffy point, exposed to the NW., on the island of Santa Cruz. From Laguna station the lines run to Anacapa, Santa Cruz island, San Buenaventura, and so on, from island to main up to Point Conception. The sketch gives a full idea of the scheme, as already completed, and as laid out for the future, but no description could give an adequate knowledge of the labor it has cost to carry it through. I feel proud that I have been able to accomplish it. With your approval and appreciation of my exertions, it in some measure compensates me for the hardships gone through, both in the prosecution of this main work and in the successful triangulation of the island of Santa Cruz. Of the primary work, the proper and only months to carry it on are, commencing in November and ending in March. Early in March the fogs set in, and if not fog, a sort of blue haze, through which no instrument will penetrate. It would be useless to attempt observations on the long lines at any other period of the year than these.

The spring, summer, and fall months are well suited for secondary and tertiary triangulation, when the lines are short, for island work particularly, or for such of them as can be triangulated upon short bases measured upon the island itself, or some one adjacent. Santa Rosa, San Miguel, and San Nicholas can be surveyed in this way; but I will speak of these hereafter, and give my views in reference to them.

San Pedro is the port of the little town of Los Angeles. As a harbor, it is perfectly safe in summer, spring, and fall, but open to the SE. gales of winter. It is the port of egress of all the produce of the section of country that surrounds it, and the point from whence the military post Fort Tejon, about one hundred miles off, secures its supplies, equipments, &c. I subjoin a statistical table of the exports shipped from this port for the first three quarters of the past fiscal year. It may be interesting, as showing its importance to the lower part of the Western coast.

Schedule showing the amount and value of domestic produce shipped coastwise from the port of San Pedro from July 1, 1856, to March 31, 1857.

	Beans.		Barley.		Corn.		Corn meal.		Grapes.		Oranges and other fruits.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
July, August, September, 1856...	21,910	$876	....	....	228,800	$4,576	2,800	$84	722,500	$65,025	26,593	$5,318
October, November, Dec., 1856...	94,320	3,773	....	....	133,900	2,678	23,800	714	704,490	63,396	18,020	3,604
January, February, March, 1857..	20,115	804	36,700	$917	280,600	5,612	7,400	222	810	73	11,760	2,352
Total....................	136,345	5,453	36,700	917	643,300	12,866	34,000	1,020	1,427,800	128,494	56,373	11,274

SCHEDULE—Continued.

	Hides.		Salt.		Wool.		Miscellaneous produce.	Wine.		Aggregate.	
	No. of.	Value.	Bushels.	Value.	Pounds.	Value.	Value.	Gallons.	Value.	Tons.	Value.
July, August, September, 1856..............	2,012	$4,024	4,774	$6,885	29,216	$2,921	$2,394	5,485	$4,113	894	$96,216
October, November, December, 1856.........	2,888	5,776	6,242	8,750	43,147	4,314	2,816	3,220	2,415	919	98,236
January, February, March, 1857	7,617	15,234	....	....	1,496	149	1,508	16,950	12,712	413	39,583
Total..................	12,517	25,034	11,016	15,635	73,859	7,384	6,718	25,655	19,240	2,226	234,035

Abstract of tonnage entered and cleared from July 1, 1856, to March 31, 1857.

	Tonnage entered.			Tonnage cleared.		
	No. of vessels.	Tons.	Men employed.	No. of vessels.	Tons.	Men employed.
Quarter ending September 30, 1856...............	30	9,067	403	29	8,623	385
Do......December 31, 1856.	24	10,147	415	25	10,608	405
Do......March 31, 1857..................	28	7,757	400	25	7,714	341
	82	26,971	1,218	79	26,945	1,131

Of the islands forming what is known as the Santa Barbara channel, *Santa Rosa* is, perhaps, the most valuable. It is level, compared with the other islands, but mountainous on the south side, the hills there sloping gradually to the north and west, and so smooth that a horseman can ride all over them. There is no wood on the island, but a bountiful supply of water, which runs the whole year round. At the present time there are some 7,000 head of cattle upon it—3,000 sheep, and probably as many wild hogs.

Santa Rosa has been confirmed to Captain Thompson by the United States district court, and is now considered as a private estate. Upon the island is a suitable site for a short base, from which both it and San Miguel could be triangulated.

San Miguel, adjacent to Santa Rosa, is a small, smooth island, the highest elevation being not more than four or five hundred feet above the ocean. It is without wood, and has a very limited supply of water. At present there are some four or five hundred head of sheep upon it. It is, I believe, public domain.

Santa Cruz is altogether different from the two islands last mentioned. It is very mountainous, the surface being thrown up in sharp ridges, and presenting gulches and peaks of every conceivable form, the latter averaging in height from 1,500 to 2,000 feet above the ocean. It is considered valuable, but is so rugged that it is impossible to ride over it, and it is only with the greatest difficulty that footmen can pass up or down the slopes of the mountains. There is a fine stream of water on this island, and very convenient to the anchorage in Prisoner's harbor. This fact is well worth being generally known. There is also wood (live oak) on the island, but not convenient to the anchorage.

The claim to this island has also been confirmed, and it is considered private property. At present there are some 7,000 or 8,000 head of sheep upon it, and probably the finest in California. The excellence of Santa Cruz mutton is proverbial in the San Francisco market, and it commands occasionally almost fabulous prices. This island, like all in its vicinity, is unfit for cultivation, but is valuable alone as a grazing rancho.

Here, as on the other islands, stock of every description is free from the depredation so common on the main land ; and the expense of transporting it to the main shore, and thence to market, is considered more than counterbalanced by the increase saved when thus free from the risk of being stolen, and the destruction of the young by bears, coyotes, &c.

San Nicholas is different from Santa Rosa or Santa Cruz. It is considered valueless on account of the sandy nature of its soil and its distance from the main land. The island is low table-land, not more than three or four hundred feet above the ocean, without valleys, and with very little vegetation. There is no wood on it, but good water can be found near the northwest point. It is, I believe, public property.

Santa Catalina I have described in a previous report. It is mountainous and rugged, and in this respect very much like Santa Cruz, but without the valleys or supply of water which that island affords. I believe it is public property.

San Clemente I have not visited, but, from all I can learn, it resembles the islands above described, with the exception of being less rugged, more level, and with less elevation. There is wood and water upon it, and a good shelter from the northwest winds at the southeast end of the island. This is also public property. It seems probable that a short base might be found on it sufficient for its triangulation. I propose to visit this island when a suitable occasion presents itself.

Of these islands, Santa Cruz, Santa Rosa, San Miguel, and San Nicholas, can be triangulated upon short bases, measured upon each separate island, if required. In the case of San Miguel, however, this would hardly be necessary, it being so small and so near Santa Rosa that one base would be sufficient for the triangulation of both. The three last named islands will not be difficult to triangulate or survey.

Santa Catalina has no spot upon it suitable for a base, and will thus have to be connected with the main work before a secondary triangulation of it can be made. I am under the impression that, with a side, as base, once upon the island, it can be cut up in triangles somewhat after the manner of Santa Cruz. Of this, however, I am not certain.

Very respectfully, &c.,

W. E. GREENWELL.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey, Washington, D. C.

APPENDIX No. 45.

Description of an apparatus for measuring subsidiary base lines.

Some improvements having been made in the mechanical parts of the apparatus described in Appendix No. 60 of the Coast Survey Report for 1856, which materially facilitate its use, it is thought desirable to describe it again in its improved form.

Any apparatus for the measurement of base lines which does not, in a great degree, combine the principles and details of the principal base apparatus of the coast survey, must necessarily fall far short of it, not only in accuracy, but also in facility of use and despatch.

The compensation of the effects of temperature, with all the means of securing uniformity of action, the delicacy of the level of contact, the facility of adjustment in line and elevation afforded by the elaborate construction of the trestles, cannot be approached by appliances much short of that apparatus itself, and to it we must always look for the accurate ascertainment of distances.

There are many cases, however, of local surveys in advance of primary triangulation, and of check measurements desired in extensive secondary series, in which an accuracy of lineal measurement less than that attainable with the compensating base apparatus is sufficient, and where the greater length of time required in using an inferior apparatus is compensated by the fact that it requires but little more than the usual force of a triangulation party to operate with it.

For the purposes indicated different means have, at various times, been devised and used by assistants having charge of such work, and an apparatus designed by Assistant C. O. Boutelle, is described in Appendix No. 41, Coast Survey Report for 1855.

The form of construction now presented is the result of a careful study of the subject by Assistant J. E. Hilgard and Mr. Joseph Saxton, in consultation with the Superintendent, with special reference to the experience with other apparatus. It has been used in the measurement of three lines during the past two years by different persons, and has given great satisfaction to the operators.

The principal points arrived at were the following:

1. To protect the iron rod from rapid changes of temperature, and to have a thermometer so placed that its indications will correspond to the temperature of the rod.

2. To effect the contact of the rods or coincidence of lines by a continuous screw motion.

3. In the construction of the supports, to combine a large range in elevation with the means of making a nice final adjustment.

The manner in which these ends have been attained may be seen on sketch No. 69, where the apparatus is figured. A round iron rod, five-sixteenths of an inch in diameter and four metres long, is encased in a solid wooden bar, three inches wide and six inches deep, composed of two pieces firmly screwed together, as seen on figures 1 and 2. Figure 3 shows the manner in which the thermometer is inlaid in the middle of the bar, so as to bring the bulb near the iron rod, the top of its case closely filling up the aperture. In practice, the thermometer is withdrawn and read every twenty minutes or half hour. The temperature of the rod changes slowly, and, while it never differs greatly from that of the surrounding air, it is unaffected by alternations of sunshine and clouds, which greatly affect the indications of an exposed thermometer.

In figure 1 the upper part of the wooden bar is taken off, in order to show the details of the arrangement for making the contact; *a* is the forward end of a rod already in position, armed at the end with a plane of hardened steel; a^1 is a portion of the forward bar about to be brought into position in contact with *a;* each rod is movable lengthwise in its groove by the action of a screw *d*, counteracted by the spring *e; f* is a short tube, armed with a steel knife-edge which slides over the end of the rod and is pushed outward by a spiral spring rather more than sufficient to overcome its friction, (see figure 7,) and has a delicate line drawn on it, the coincidence of which with a similar line on the index plate *i* fastened to the rod determines that position of the slide in which the knife-edge is at the known distance from the plane at the other end of the rod; the silver index plate *i* is visible through a slit in the sliding piece called the *abutting slide;* the plate *j* passes through a notch in the collar *k* and prevents the rod from twisting by the action of the screw.

When the whole bar is nicely adjusted on trestles or stands in elevation and alignment, and within one-eighth of an inch in distance either way, the exact adjustment is effected by sliding the rod within the bar by means of the screw *d*, counteracted by the spring *e*, until the lines on the index plate and abutting slide coincide, the knife-edge on the latter abutting meanwhile against the steel plane of the preceding bar, which suffers no pressure except that due to the small spiral spring within the abutting slide. In judging of the coincidence of lines, a magnifier is made use of, which can be conveniently attached to the bar or carried by the operator. A level sector, figure 2, by means of which the bar can be set level or to any desired inclination, or on which the accidental inclination of each bar may be read off, is attached near the back end of the bar close to the person directing the adjustment of the bar and making the contact. Before the measurement of a line the sectors should be adjusted by placing the knife-edge at one end and the middle of the plane at the other end of each bar on a level (by means of a levelling instrument or a theodolite set up equidistant from both ends) and adjusting the level to the zero of the arc.

Figures 4, 5 and 6, show the improved stand. On a tripod stand, with double legs of the usual construction, is screwed a cross-piece *l*, carrying the upright guides *m, m,* to which can be clamped at any elevation the cross-piece *n*, which has a small spirit-level attached to indicate its horizontal position; a similar cross-piece *o* can be moved parallel to *n*, up or down three-quarters of an inch from its average position by means of the wedge *p*, as the drawing shows abundantly. The spring *s* shown in the horizontal projection of the top of the stand, figure 5, and which is in a like manner attached to the lower cross-piece n, is introduced to react against the clamping screws, and to throw apart the pieces o and o^1 when the screws are loosened, so as to admit of easy movement along the upright guides m, n, to which end friction rollers x, x^1, are also inserted into the ends of the cross-pieces moving between the guides, a little play being of course allowed. The design is to make all the movements free and easy, so as to require no close fitting, and to operate well under all changes of heat and moisture, the *clamping* securing perfect stability after the bar is brought into position. An equable motion, without jarring and with certain bearing, is secured for the wedge by causing it to move between friction rollers, as indicated in figure 4. The rollers are of the simplest kinds, being merely perforated cylinders of brass running on steel pins driven into the wood. The wedge being found to run with great ease on the rollers, and liable to fly out when under the weight of the bars, a flat spring is introduced between the side of the wedge and cross-piece n, which, pressing the wedge against the guides m, n, causes a uniform friction independent of the weight of the bar. IN MAKING THE MEASUREMENT, the bars being four metres in length, the stands are set up at distances of two metres, each bar being supported at one-fourth its length from the ends. The tripod legs are so placed that one of each stand is in the direction of the line towards the middle of the bar. The height of the stands is approximately adjusted by the spreading of the legs, which, however, remain clamped at an average slope when the ground is even. The proper distance for the stands is ascertained by a light rod of two metres in length laid on the ground. The wedge p being now placed in its midway position, the cross-piece n is clamped at a suitable height, which is ascertained by sighting across the top of the pieces o to a bar already in position, n, being kept level by means of the small spirit-level attached to it, which should be placed on the forward side of n, so as to be under the eye of the person adjusting the height, one of the assistants tightening the clamps when so directed. The bar is next placed on the stands in approximate alignment, for which the space between the upright makes ample allowance, if the stands are set with moderate care ; it is then adjusted in elevation by means of the wedges, and either placed level or at any slight inclination, and the sector read off. The alignment is now perfected by means of the sights, figures 2 and 4, on the top of the bar, which is merely shifted by hand, and not in any way clamped to the stands, as its weight is quite sufficient to secure stability ; at the same time the position in distance is approximately so adjusted as to bring the perfecting of it within reach of the screw motion.

In launching the bars backward or forward by hand, the operator should lift the contact end slightly off the trestle, while the assistant at the forward end, with his hand placed under the bar, merely takes the weight of the bar off the trestle, leaving the operator free to move it either way, in which he may be assisted by a slight swinging movement of the hand.

Black bands are painted on the bars in the places where they ought to rest on the stands, figure 6, in order to call attention to any progressive error in placing the stands.

The bars can be readily adjusted to a level by means of the sector, the wedges working with perfect smoothness, and it is always preferable to use them level, where the nature of the ground permits. Considerable irregularities may be overcome by means of the stands described, and for general changes of level a vertical offset with a theodolite will be preferable to using the bars at considerable slopes.

The apparatus is provided with three pairs of stands, and six persons operate it with facility ; three persons to carry forward the stands, set them, and approximately adjust the cross-piece ; two to carry forward the bars, and, stationed at the stands, manipulate for its nice adjustment, under the direction of the operator between the bars, who makes the contact. One or two additional hands are required to transport tools, theodolite, water, posts for temporary marks, &c. The apparatus was first used in May, 1855, in remeasuring a portion of Dauphine Island base, between marks that had been left in the original measurement with the compensating base apparatus. One hundred and eighty-nine bars, or nearly half a mile, were measured at the rate of a little over three minutes to the bar, and the distance agreed with that previously measured within two-tenths of an inch. At that time the mechanical arrangements of the trestle were imperfect. Since then several lines have been measured with the apparatus as described in the report for 1856, and in November, 1857, a line of nearly four miles on the bank of the Mississippi river, near the Balize, was measured with the apparatus as now described, at the average rate of 1.7 minutes to a bar, the best time made being 230 bars in five successive hours.

APPENDIX No. 46.

Description of deep-sea sounding apparatus invented by Commander B. F. Sands, U. S. N., Assistant in the Coast Survey.

The rod *a a* (sketch No. 70) is of half-inch round iron, about eighteen inches long, with a swivel at the upper end for the lead line, and a socket at the lower end to receive the tenon of the specimen tube *b*, fastened by key *c*. Two wire rods *f*, about a foot in length, on each side of the rod, connect the flange *g* of the specimen tube with a small band *h* around the rod, having two spurs pointing downwards. Surrounding the sounding rod are two semi-cylindrical weights of cast iron *e e*, grooved on the flat sides to receive the rod, and to allow the valve connecting rods to play freely between the weights. Holes of three-fourths of an inch diameter are drilled in their lower ends to receive the plugs *d d* that are hinged upon the ends of the key *c*, and which keep the weights in their seat; and in their upper ends of one-fourth inch in diameter, to receive the small spurs of the band *h* which confine the upper ends of the weights to the sounding rod. In the act of the specimen tube piercing the bottom, the sliding valve of the tube is raised to admit the specimen, lifting also the band *h* connected with it by the wire rods *f* releasing the upper ends of the weights and causing them to fall free from the rod, leaving nothing but the rod and specimen tube to be brought on board. The upper portion of the sounding rod is flattened and pierced with two holes to allow the self-registering indicator to be clamped to it.

APPENDIX No. 47.

Notes by Lieutenant E. B. Hunt on a new Sounding Apparatus proposed by him for Coast Survey use.

The device proposed has for its chief object to run sounding lines in harbors and water of moderate depth. The principle is that of measuring, barometrically, the pressure due to the depth, this pressure being transmitted to the barometric basin by a column of atmospheric air.

The method is as follows:

Arrange a weighted India rubber air vessel for dragging on the bottom; connect this with a boat or surveying vessel by an air-tight tube of small bore; let this tube open in a cistern of mercury made air-tight, and from this cistern arrange a vertical glass column, open at the top, through which the mercury can rise to any height required by the pressure due to the depth.

The mode of use would be thus : throw the weighted air vessel overboard and let it sink to the bottom, being connected with the vessel by the air-tight tube, duly connected, in turn, with the barometric cistern. Let the boat or vessel be propelled on a course ; the air vessel will be dragged along the bottom, and, as the water must have free access to the bag inclosing the air, its pressure will compress the air to a density due to the depth. This pressure will be communicated along the tube to the vessel or boat, and, being received on the mercurial surface, will raise a column of such height that its weight will equal the weight of an equal column of the water. This column equals in height the depth to which the air-vessel is sunk, or, rather, that of the lowest part, on which the pressure acts. As this depth varies the height of the column will also vary. The relation of these heights is expressed by the specific gravity of mercury, divided by the specific gravity of the particular sea or other water in which the soundings are made. It would be necessary to make occasional observations with the hydrometer, and, in the case of tidal streams, these should be quite frequent.

The following will give a general idea of the construction of the parts :

The air vessel should be an easily flexible India rubber bag of the pear shape, with a tight neck screw on which to fasten the pipe. Around this bag a pear-shaped metal case must be adjusted, of weight sufficient to sink the air vessel and connected tube rapidly. I suppose lead will be the best. The form is important, as it should be such as to offer but slight resistance in being drawn through the water. It would be best to throw a large preponderance of weight on one side of the swelled part, so as to make that side keep towards the bottom. The superior forward surface can then be so arranged as to bring into action a component acting downwards and due to the forward dragging. The India rubber bag should then be fastened to the lower part so as to compel it always to indicate the pressure corresponding to the same distance from the ground.

The tube should, I suppose, be made of the common gas-pipe, (India rubber canvas patent,) the smallest bore being preferable. This tube must then be laid either with wire or fishing line of sufficient strength to bear the strain safely. By first laying lengthwise all around the tube a series of wires or twines, and then wrapping them all firmly, the strain of dragging would come almost wholly on the wires or twines, and yet the whole will be quite flexible. If a smaller size of flexible tube which will sufficiently resist inside pressures can be got it will be better ; for, as the pressure within will always exceed that from without, the arching stiffness is not required. As the wrapping will greatly strengthen the tube its sides may be of moderate thickness. I suppose the tube should be arranged at a number of points for fastening to the boat's or vessel's stern, so that the length out shall be always easily seen, and I presume it might very well be dragged at a slope of about one-fourth. All the tube not payed out is to be coiled between the stern and the gauge. By loading the air vessel the slope at which the tube can be dragged may be increased, or as before indicated, by a head armature or blade giving a downward component. As the effect of the change of tube slope will be but slight on the horizontal distance between the boat and the air vessel, the sounding, at any instant, may be taken to belong to a constant distance astern for each of the knots or loops of the tube. Thus a boat or vessel will give a continuous indication of depth along the line over which it passes. It will at once be seen how great an advantage this will give in dragging for bars or shoals along channel ways, to say nothing of other cases.

The air tube is to open into a cistern, or basin, or syphon branch, connecting with the open glass indicator, or scale tube; the whole to be gimbal mounted, and the tube to be led along the gimbal axes. The graduation can be made differential, so as to always show true inches of pressure. It would probably be, on the whole, quite as advantageous to have merely a glass tube of say one foot long fastened on an India rubber tube and arranged to slide up and down on a scale, the flexible tube connecting with the fixed cistern. If great depths are attempted with this combination, this will be necessary.

There would be some advantage in using an incompressible fluid in place of air, the small specific gravity of which might give a differential pressure. Thus, sulphuric ether has specific gravity = .715; absolute alcohol, = .792; olive oil, = .915; whale oil, = .923; either of which, introduced into the tube and bag and resting on the mercury, would give a tolerable indication, or, if used as the reading fluid without mercury, would be perhaps too sensitive. Sea water being of specific gravity = 1.026, we see that sulphuric ether will give over three feet on the scale for ten in depth, and whale oil just about one to ten. Linseed oil, specific gravity = .940, would be more manageable; and turpentine, specific gravity = .991, would, if its fluidity sufficed, be very good. Wine is .992, and if it could be kept pure might do, though too little sensitive in fresh water.

If we assume that one hundred feet is our limit of depth to be sounded, we can readily proceed from this to fix the size of air vessel required, if air is used, or the length of scale, in case any of the fluids named are used alone or with a mercurial reading column. There is the objection to these fluids, that the height of the zero level above the sea must be considered; but if air is used, this may be neglected. A careful study of the possible combinations will probably indicate substantial reasons for a preference. If air be used, the air vessel must be so large that it will be supplied with air at the maximum depth anticipated; for which purpose the entire air space of the tube and cistern must bear a less ratio to that of the air vessel than one atmosphere of pressure does to the pressure due to the maximum depth in the densest water. The air space being fixed, the weight must suffice to sink this readily; but as it goes down, the sinking power will increase, thus partly counteracting the lifting effect of propulsion on the sloping tube. If we assume a hundred feet as the maximum, and one-fourth as the slope, this tube must somewhat exceed four hundred feet, and the part out will be varied as the depth, though the whole will be in use as a connection at all times. These indications may suffice for the simple barometric form.

There is, however, a far finer possibility which may be ultimately attained; that is, the making this arrangement self-registering. Suppose a sheet of paper made to traverse over a roller either by spring clock work or by a mechanism moved by a screw propeller fixed to the side of the surveying vessel or boat. Then suppose a pencil point connected with a float on the top of the mercurial column, and made to traverse the recording roller as it rises or falls. This would trace a strictly proportional record curve of the bottom dragged. But this arrangement would be difficult and intricate. Suppose, however, that a light fluid is used in the chamber of the drag, the tube and the cistern, and let this cistern be made of shirred or corrugated material of a long cylindrical form; one head of the cylinder being fixed, and the other acting against a spring. If now this moving cylinder head bear a pencil point traversing the recording roller, it will indicate depths by ordinates which can be read by a fixed scale.

I suppose spring clock work moving a record sheet might be combined with this corrugated cylinder, so as to give a record proportional to time without *very* great difficulty. But the moving of a sheet by a side propeller, so that the abscissas would be proportional to the spaces traversed is very much the most desirable form, and may possibly not present difficulties too formidable to be overcome. It would, doubtless, be best to experiment first with the barometric form, and if no unforeseen obstacles occur, the greater object can then be maturely considered, and, if practicable, fully realized to the vast advantage of hydrography.

APPENDIX No. 43.

Report of Lieutenant Commanding W. G. Temple, United States navy, Assistant Coast Survey, on the result of trials made with the new Sounding Apparatus devised by Lieutenant E. B. Hunt, United States Engineers.

UNITED STATES SURVEYING STEAMER CORWIN,
New York, November 12, 1857.

SIR: In accordance with your verbal instructions, I went yesterday, in company with Mr. J. M. Batchelder, to test the practical application of Hunt's sounding apparatus. The operation was performed in the channel between the navy yard and the cob-dock in one of the sounding boats of this vessel, in depths varying from one to four fathoms.

The main features of the apparatus, as constructed by Mr. Batchelder for these experiments, are the elastic bag, the connecting tube, and the manometer or pressure indicator.

The bag was made of India rubber cloth, about eighteen by fourteen inches, and, when blown up, three inches in thickness. A screw thimble is inserted at one end to receive the screw attached to the India rubber tube. The bag is placed in a tin box, with suitable rings for attaching the drag rope, and at the forward end an aperture through which the tube passes. The tube is half an inch in diameter, with a bore of one-eighth of an inch, and made in lengths of twelve feet each, which are joined by tubular couplings having a collar on each end, half the length of the coupling being inserted into each tube, the ends of which are firmly moulded upon the coupling with waxed thread.

The tube and pressure gauge are connected by means of a joint coupling with stop-cock, which is fitted to the end of the tube and screwed firmly to the pressure gauge, which is one of those known as Ashcroft's steam-gauge. It may be attached to the gunwale of the boat or held in the hands of the observer. The tin box was kept down by a weight of twenty-five pounds attached. The tube and drag rope were lashed together at intervals of eight or ten feet.

By reference to the accompanying table, giving the soundings by lead and line, the pressure by the gauge, and the depths corresponding to the pressure, as taken from Mr. Batchelder's computations, it will be readily seen that thus far, at least, the invention is eminently successful. In no instance does the difference in the two readings amount to more than one foot, and this occurs but once in twelve times. This difference, however, is probably due to the somewhat precipitous character of the bottom. The indicator was found to be exceedingly sensitive, and at the same time to move without the slightest vibration.

I am of opinion that several alterations may be yet necessary to render the apparatus of practical value. The air chamber now in use is liable to rise when any headway is given to the boat, although a weight of twenty-five pounds was attached to it. Perhaps a thirty-two pound shot and spherical India rubber air chamber, reduced as much as possible in size, would present fewer obstacles to a successful issue of the experiment than any other size or form. I would also suggest that the gauge now used as an indicator be graduated to express fathoms and feet, instead of pounds of pressure, and, if practicable, that it be so constructed as to admit of being laid in a boat with the face upward. The tube, also, should be so constructed as to be as little liable to injury as possible, and to serve as a drag rope. If then a force pump be fitted for filling the air chamber, all the objections that have suggested themselves to me in the present apparatus would be obviated, and I am of opinion that in running lines of soundings for considerable distances, and in depths not exceeding three fathoms, with a soft or sandy bottom, it will be found very serviceable. I doubt, however, whether it can be used in its present form for greater depths to advantage, or that it will be found to answer the purpose intended, if towed by a steamer at a greater rate of speed than is usually attained by one of our ordinary sounding boats.

Respectfully,

WM. G. TEMPLE,

Lieut. Com'g U. S. N., Assistant Coast Survey.

Prof. A. D. BACHE,

Superintendent U. S. Coast Survey.

Soundings taken for testing Hunt's new Sounding Apparatus, November 11, 1857.

Soundings by lead.		Pressure.	Soundings by gauge.	
Fathoms.	Feet.	Pounds.	Fathoms.	Feet.
4	----------	10.5	3	5¼
2	5½	8.0	2	5
3	----------	8.3	3	----------
2	2½	6.6	2	2
1	2	4.0	1	2
3	----------	8.4	3	----------
2	3½	7.4	2	3½
2	3½	7.4	2	3½
3	2½	9.3	3	2
4	1	11.0	4	½
4	½	11.3	4	1
3	4½	10.5	3	5½

APPENDIX No. 49.

Description of the tide-gauge devised by Lieutenant Commanding S. D. Trenchard, U. S. N., Assistant in the Coast Survey.

This gauge (sketch No. 72) dispenses with the rod usually attached to the float, and substitutes in its place a varnished cotton belt about an inch and a half wide, which passes over a roller near the top of the gauge, and is kept tense by an attached weight working in a groove in the back of the box. The back of the gauge is made of two pieces: one, an inch and a quarter thick, with a groove in the front a half inch deep, and wide enough to admit of the free motion of the belt; over this is placed a board a half inch thick, which separates the groove from the float box, and keeps the former water-tight. One foot below the roller a slide works in grooves in the sides of the box, in which is cut a hole a quarter of an inch wide and an inch and three-quarters long. This serves as an index for reading the rise and fall, as well as for keeping the belt in the middle of the box.

A door opens from the top of the gauge to the slide, giving room for joining and disconnecting the belt and float, and securing, when closed, the whole from the influence of the wind and spray.

When it is desirable to place the gauge under a wharf, the top can be removed and the register taken from the belt as it passes over the roller.

The gauge may be used advantageously in observing the tides at a distance from the shore. For this purpose a chain is attached to the float, passed over the roller, and joins a wire which is led ashore over uprights, and to which is attached an index working along a stationary scale. The wire is passed over a pulley on shore, and a weight attached to the end of it; for this purpose the float should be large and heavy.

APPENDIX No. 50.

Letter from the Superintendent, communicating the description of a tide-gauge devised by Sub-Assistant H. Mitchell for taking observations in deep water.

NANTUCKET, *August* 28, 1857.

DEAR SIR: During the past season I have, among other duties, made a trial of an apparatus for observing the rise and fall of the tide in deep water, and in situations exposed to heavy sea. As my experiments proved entirely successful, I would respectfully offer for your inspection the accompanying drawing and description of the gauge.

You have frequently called my attention to the necessity of obtaining tidal observation on the open coast, in order that we may ascertain the form and character of the tide wave before it has submitted to the disturbances consequent upon its passage through irregular channels and into harbors. The necessity of this information in the computation of general prediction tables has been great. With the hope of meeting this want this gauge has been arranged.

General description.

A long pine spar, bolted at the foot, with a universal joint, to a block of stone, is lowered down to the bottom of the sea. The portion above the surface of the water is slender, so as to be less affected by the wind; while the part near the bottom is large, in order to be as buoyant as possible. To the top of this spar, which projects some ten or fifteen feet above the water, is attached the rod of a heavy pendulum, which slides over an arc five to eight feet below, and determines the inclination of the spar. To this buoy, thus arranged, is fastened the gauge, which is a glass tube set into a graduated staff, and having a red glass bubble rising and falling within. By a small hole in this tube, some eight to ten feet below the surface of the sea, the water enters, upon which the bubble floats.

The observer records at once the height of the bubble and the angle of inclination of the gauge. The computer, with the aid of a table of natural cosines, readily reduces these observations to perpendicular heights.

It was ascertained that the ordinary swells or wind waves extend to an inconsiderable depth, and that a gauge of this description, in ten fathoms water, is not subject to oscillation from those swells. The angle of inclination for the depth I have mentioned will vary between three and seven degrees where the range of the tide is from four to seven feet.

Explanation of figures.—(Sketch No. 72.)

Fig. 1. Front elevation.—A B is a spar sixty feet in length, (represented as broken in the sketch,) secured at B by a swivel joint to a stone resting on the bottom of the sea. A C is an additional shaft fastened to the main spar at A and projecting above the surface of the water.

This shaft is cut square; on one face is fastened the gauge D E, while from an adjacent face extends the arc F G, which passes through the rod of the pendulum C H. The band at C, to which the upper end of the pendulum is secured, is connected with the band at F, which secures the arc by an inflexible strip of iron, in order that there shall be no alteration in their relative positions and that of the arc.

The gauge D E is a graduated staff, into which is set a glass tube. The water enters the tube by a very small hole at E. Within this tube, and upon the surface of the water, floats a glass bubble. This bubble is colored, so as to be conspicuous at a short distance.—(See fig. 2, which shows this portion on an enlarged scale.)

As in setting this apparatus it is convenient to have the gauge D E movable, the bands are so arranged as to admit of its being shifted vertically.—(See fig. 3, which exhibits a side elevation of this portion on a larger scale.)

The weight of the arc and pendulum will be sufficient to turn the whole apparatus on the swivel at B, which is kept free by constant motion. The character of the joint at B will be seen from fig. 4, which represents a vertical section on an enlarged scale.

Respectfully submitted.

H. MITCHELL.

Prof. A. D. BACHE,
Superintendent Coast Survey, &c.

APPENDIX No. 51.

Report of Lieutenant E. B. Hunt, U. S. Engineers, Assistant in the Coast Survey, on the preparation of an index of scientific references.

BRISTOL, R. I., *October* 10, 1857.

DEAR SIR: The index of papers on subjects relating directly or indirectly to the various operations of the Coast Survey has made considerable progress since my last report, though much less than I had hoped or desired. The total of volumes examined now amounts to about seven thousand, and the total number of titles to about thirty-five thousand. It will probably be desirable to add about a thousand volumes more to the list examined before proceding to the classification of titles and the final publication.

It is due to myself to say that the almost continual demands on my time by my engineer duties at Fort Adams, Newport, R. I., and the charge of the light-house constructions in Rhode Island, have left me but little time or mental energy to give to the protracted labors of this index, except such as I could find during the winter while out-door work was suspended. I regret that I have reason to anticipate being deprived of this winter resource during the coming season, and that thus the completion of my index labors must again be put off by the exactions of other imperative duties. I shall not remit my efforts to reach an end at the earliest possible date.

It cannot fail to be a source of gratification to you that the train of circumstances in which originated my humble efforts towards forming the index in question, may prove to have been the fountain source whence a *general* index of physical science is ere long to emanate. If so, it will not be among the least of the many benefits which the Coast Survey has bestowed on the general cause of science, that a deliberate effort to supply its own necessities for full investigations has led to a like universal result.

As you are already aware, I began my index gleanings in 1854, and was gradually led to clearer views, not only of the Coast Survey needs, but of the general requirements of physical science. This resulted in various conferences with Professor Henry and Professor Baird, in which a free interchange of ideas took place, much to my advantage. I suppose it to have been a direct result of these interviews that Professor Henry addressed to the British Association a proposal to prepare a general physical index, and offering, in behalf of the Smithsonian Institution, to prepare a complete index of American papers, coming under this head. The original Smithsonian programme contemplated this general result, but then, for the first time, was a positive step proposed. The British Association responded to this proposal by appointing a committee, which has coöperated with a like committee of the Royal Philosophical Society. Two reports have been made, proposing a plan agreeing in many features with that explained in my communication at the Providence meeting of the American Association, in August, 1855, (hereto appended) though the importance of systematizing abbreviations, as explained in my communication read at the Albany meeting of the same body, (hereto appended,) appears not to be sufficiently realized by the British Association committee. I will not here enlarge on the prospects opened by the action of the Smithsonian Institution, British Association, and Royal Society, further than to express my earnest wish that the general result so much needed may be so fully attained that my own labors will be superseded before their completion, except for the direct uses of the Coast Survey. How long a labor must precede this consummation I so fully realize, that I do not look for a very speedy termination, and shall not permit the anticipation to abate my interest in finishing what I specifically undertook. From the prominence given to this index in the council report of the Liverpool meeting of the British Association, I am led to hope that a strong determination to meet this great requirement of scientific investigators is felt by those who are best situated for giving effect to their plans.

I cannot close without expressing my obligations to Mr. Charles A. Schott, assistant in the Coast Survey, for his collaboration in the German series. As all the remaining labor has actually been done by my own hands, I trust that those who are looking for the published index will esteem all the delays encountered as not unreasonable.

Very respectfully, yours, &c.,

E. B. HUNT,
Lieutenant Corps of Engineers.

Prof. A. D. Bache,
Superintendent U. S. Coast Survey.

*On an index of papers on subjects of mathematical and physical science. By Lieutenant E. B. Hunt, United States Corps of Engineers.**

The history of science exhibits a continual tendency towards specialization. The sphere of each laborer becomes more and more limited as the area of research is expanded and distributed into well defined specialities. The same thing is observable in scientific research, which, in the mechanical and chemical arts, is familiarized under the name of subdivision of labor. The same advantages and disadvantages of the specializing tendency are equally observable in the domains of science and of manufactures. The restriction of investigation and of industry to limited fields of exercise has the effect to produce the highest skill within those fields, at the price of narrowness of conception and privation of power concerning all other spheres of action and research. The man whose life is spent in heading pins becomes almost preternaturally skilful in the manipulations of that manufacture; but this man, in any other sphere of industry, is a blunderer and a bigot. So, too, the man of science who assiduously cultivates a chosen speciality becomes therein pre-eminent; but, in so doing, he is in great danger of losing his grasp on those generalities which transcend his particular field, and of becoming not only impotent, but bigoted, relative to those branches of research which he has not pursued. As the microscopist restricts his field but intensifies his vision within that field, so the cultivation of a speciality withdraws into a single study the diffused powers of the original mind. The microscopist and the specialist find the same difficulty in seeing the parts in their relations to the whole.

No problem is more important to the scientific investigator than that of rightly co-ordinating his general and special culture. If generalization too largely prevail, his life will probably be exuberant, but fruitless. If a speciality absorbs all his powers, there will be abundance of ignoble and innutritious fruit. If he knows how properly to combine the general and the special, he is likely to bear such rich and lasting fruit as has made the names of Newton and Leibnitz, Euler and Lagrange, Cuvier and Agassiz, and all of this illustrious kindred, such unfailing sources of strength. The power to generalize and the power to specialize must co-exist in the true magnate of science. Great things may be done by men strong in either, but not the greatest. Whoever neglects general culture, in his eager pursuit of the special, harms his own nature. It may be said that power in specialities can only thus be attained; that specialist devotees are essential to the progress of science; that science, like another Juggernaut, demands the sacrifice of the man himself to his chosen pursuit. Whoever thus reasons has already sacrificed his humanity to his speciality, and is but shouting the praises of Brahma. Nor is it easy to adopt a theory of scientific castes which would make the specialists a lower and necessary grade, whose business it is to gather materials for the generalizing noble to arrange in their true order around some latent principle which he alone is privileged to see. That some minds are thus noble by nature and by training is certain enough; but it is hard to believe that many who could be of any assistance as specialists cannot also do some part, however small, as the generalizers of their own field and of its relations to others.

The present age of science may, with great propriety, be called *the monographic age.* We have reached that period when every subdivision of research needs to be presented in the form of a monograph. While it is still possible for the student of any single subdivision to pursue

* Read at the Providence meeting of the American Association for the Advancement of Science, August, 1855.

it in all the original papers treating thereon, it is quite impossible for the investigator of a more extended area to study the contained and related subjects in their whole range of original papers. To him it is quite essential that the various subdivisions of research should each be digested, by thorough masters of their component contributions, and brought out in their orderly, well balanced proportions. The true, the proven, the mature, has need to be separated by adept monographers from the false, the speculative, and the crude. The contributions of many successive investigators, each tending to place their common speciality on higher ground and to bring it out in more perfect definition, have all to be digested by one who is qualified to take the judicial point of view and to use aright the privilege of moderns, who, as Bacon says, are the ancients of knowledge.

The model monograph is one which presents the known, substantive facts of the subject, treated in their natural order and relations with all attainable clearness, completeness, and brevity, and which gives such an insight into the nature of all original memoirs thereon as will enable investigators to recur to such originals as may be important for their special purposes. Already the mathematical and physical sciences have hundreds of subjects needing to be monographed, while comparatively few are yet so adequately presented under this form as not to need either a new monograph or a revision of the old. The great number of investigators now at work; the late remarkable increase of periodical publications and memoirs devoted to scientific subjects; the subdividing or fissiparous tendency of modern science, and its signal proclivity to annex fields of empirical practice, and make them rational or strictly scientific—these and other causes have thrown nearly all the provinces included within the present domains of science into the precise condition to need the services of well furnished monographers.

An invaluable result of such a presentation of these subjects would be found in the aid which investigators would thus receive towards keeping up their general scientific culture, without turning too much away from their specialities. There seems no possible way by which investigators can maintain the general and the special in correct and harmonious relations, except by means of an ever increasing expansion of their monographic aids. As the realm of knowledge goes on yearly expanding, and steadily growing more and more to exceed the possible grasp of any one mind, this need of a direct and disembarrassed presentation of all positive results, stated, as far as possible, in the common language of science, will become continually more pressing. It will be only by the aid of monographs of various degrees of generality that the entire domain of science can henceforth be at all surveyed by any single investigator. The narrowest fields, being first duly digested into monographs, will furnish the materials for monographs of higher generality; and from these, step by step, the ascent will be to that universal monograph which shall draw within its compass all the high generalities of the great epic cosmos in which science will attain its far off final consummation. When physical science becomes thus organized and digested, we shall no longer be constrained to behold the ardent mind borne away by generalizing speculations beyond all basis of fact, or the far more revolting arid mind cramped within a petty speciality and disdainfully ignoring all the vast domain of vital generalities, simply because it transcends its own dwarfed and grovelling comprehension. The only worthy type of scientific mind is that which at the same time pursues general and special truth; which can see grand generalities underlying the minutest phenomena, and which can trace in the loftiest generalities the simple convergence of an infinite series of kindred special phenomena. The entire character of the active investigating mind of the coming generation will be much influenced by this monographic tendency and need. The extent to which we shall digest into consistent wholes the now dispersed and fragmentary materials on a long array of subjects in mathematical and physical science will almost measure the prospective prevalence of that just union of the generalizing and the specializing powers whence alone can spring a true progress in scientific philosophy.

The views now presented are essential preliminaries to a full understanding of the bearings and workings of an index of papers on mathematical and physical science. This subject is one which the naturalists have better appreciated than the mathematicians and physicists. The proof of this will be seen in that laborious work which the genius of Agassiz inaugurated, and which presents, in four octavo volumes, the titles of all known papers on natural history and geology up to its date. These titles are arranged alphabetically, under the names of their authors, as is probably most convenient in the departments included. Natural history and geology, being essentially descriptive sciences, are less fitted for the classification of the subjects included than the more abstract or logical mathematical and physical sciences. A logical arrangement of subjects, at least for natural history, will scarcely now be proposed by those interested; though it is possible that Englemann's Bibliography of Natural History, which distributes authors alphabetically under a limited number of general heads, may yet serve as a model for indexing papers or memoirs in the same field.

In proceeding to examine somewhat the subject of an index of all original papers in mathematics and physics, it may be well briefly to state the circumstances which have led me to consider it. As an assistant in the Coast Survey, I had, on several occasions, to make special investigations, in which it was desirable to examine all good relevant authorities and original memoirs. How to do this was the question. To range over series after series, index after index, from beginning to end, would surely bring to light all such papers. But this is a labor of truly appalling magnitude, and not to be thought of for each minor research. It only remained to start with such papers as I chanced to know of, or could find by the few indexes of series at my command. Then, following up all the references which could be gleaned from these sources, I could go on till they were exhausted. By that time any man of moderate patience would himself be exhausted and indisposed to beat up for further game. Yet what guaranty is there in this process that the very best papers may not entirely escape one's knowledge? I found, from experience, just this result; nor do I suppose that any person can be sure of having examined all those printed papers, on a given subject of physical science, which are essential to a full comprehension of its history and development. He may find a vast deal more than he likes to read, and yet leave the best of all unknown. This is peculiarly true of those just entering on a career of research. Veterans bear in their memories some traces of the leading papers published during their lifetimes on all subjects ever likely to enlist their activity. But the neophyte has no such aid, and does not even know how to get at the most accessible memoirs. A great loss of time, in turning over leaves for the want of specific references, is common alike to young and old. Thus, for instance, when I wished to find all the published descriptions of automatic tide gauges, I spent a great deal of time to find what could be read in five minutes, and am by no means confident that I have seen the best description of the best foreign gauge. Every person's experience must abound in such illustrations.

I did not many times repeat this experience of time sacrifice before seeing the advantage of making this search for materials a general one, and so, once for all, mustering the forces which were likely to be needed, I was thus led to form the plan of a systematic examination of all the principal series of scientific memoirs and periodicals, for the purpose of extracting such titles of papers as I judged proper for a special index on subjects directly related to the various Coast Survey operations. This project met the hearty approval of the Superintendent, who has doubtless experienced its need more than any other person. He authorized my proceeding with its execution, and has furnished every encouragement. I have already examined considerably over one thousand volumes of memoirs, transactions, scientific periodicals, &c., and it is my expectation to advance this index so far as to permit its being included in the Coast Survey Report of this year as an appendix. It will be impossible for me to exhaust the field, but, fortunately, a supplement can, at any time, be added, with the contributions of succeeding years, in which omissions from the first index may be supplied. This index will be arranged by means of a detailed classification under subjects, and will embrace various heads of interest to cultivators of physical science at large. Though the principle of selection is that of probable use in the Coast Survey operations, the ground covered will be of considerable extent.

Such a fragment alone, though rather laborious, I should not think worthy to bring before this Association, were it not that it has served to indicate a far more catholic plan, and one which, if executed, will prove a signal benefaction to all cultivators of mathematical and physical science. This plan is simply an extension of the one already defined, so as to arrange in one general repository all titles of papers on mathematical and physical science. The ground unoccupied by the index of Agassiz and his collaborators should all be included, so as to aggregate in the two works references to all scientific researches. Engineering, machines, chemical, mechanical, and artistic technology, would be invaluable additions, and should, if possible, all be embraced. All these titles, being duly extracted, and, when necessary, annotated, would admit of classification into several volumes, each containing a connected group of subjects, so that every investigator would find most of the references he would need in a single volume. It was to somewhat such a shape that this plan reduced itself when I came to confer with Professor Henry and Professor Baird, of the Smithsonian Institution. In the programme of objects proposed to be accomplished by that institution is included a project of this very character. Professor Henry, having, as he declares, found particular advantages from using the Mathematical and Physical Index arranged by that clear-minded philosopher Dr. Thomas Young, on a somewhat similar idea, was not likely to forget this among plans for the increase and diffusion of knowledge. It is, indeed, a plan for rendering accessible the knowledge already recorded, and, as such, eminently deserves the aid of that institution. Were the work done, and well done, the institution would undoubtedly undertake its publication. But done it is not, and the question is how to accomplish its proper execution. Could I have commanded my own time, the performance of this task would have been a congenial labor. In spite of that precariousness of station which is my professional prerogative, I was much inclined to this undertaking, and probably should have begun it had not the assignment of triple public duties made it simple folly to venture it. Thus, with the best intentions, I am obliged to forego this expectation, and have brought the subject here in the hope that some one, more favored by circumstances, may be induced to undertake so needful an enterprise. I will gladly lend any aid in my power to any one who is both fit and willing thus to work for the good of science. How far assistance and compensation might be allowed by the Smithsonian Institution in the execution of this plan is, of course, not for me to say. From the real value of the proposed work, and the interest felt by the Smithsonian officers in its accomplishment, it is fair to infer that no reasonable aid would be denied which the means of the institution would authorize. Its valuable collection of memoirs and transactions would be of peculiar value in this connexion.

There is one excellent suggestion for which I am indebted to Professor Baird, this is, that an index of American scientific papers would be a useful and proper beginning for such an undertaking. The exceedingly scattered and anomalous vehicles through which American investigations have reached the present time will make this portion of the search rather peculiar, and it is on this account much more needful. In truth, we do not know the real wealth of our own science, especially those of us who are young in such pursuits. Europe, too, is in a state of deplorable ignorance relative to our investigations, an ignorance which has considerable excuse, too; for how can we expect foreigners to ferret our science from Patent Office or Coast Survey reports, or other public documents, Regents' reports, State legislative documents, or, indeed, from any except the standard journals and the volumes of memoirs. Thus, there are very good reasons for an American index as preliminary to a general one, with which it could be regularly incorporated.

The work now proposed is certainly one of great labor. It will require several years' time and an examination of various libraries for its completion. Our own libraries will not offer all the materials needed for its completeness. English, French, German, Dutch, Spanish, Italian, Hungarian, Russian, Swedish, and Latin series will need to be ransacked before the work is finished. A delicate exercise of judgment in accepting or rejecting titles will be required. There will be sundry questions such as these: Shall any anonymous papers be included? Shall papers in the literary magazines be selected? Shall titles be given in full and literally, or cut down, modernized, translated, or annotated? Shall translations be included? Shall reprints into more accessible series be referred to? &c. It has been my practice to include the date in each title, and to give the limiting pages of each memoir as an indication of the fullness with which its subject is treated.

The labor of classification will be one demanding a truly cosmopolite mind. Rightly to distribute the hundreds of subjects, and always to maintain the truly logical catena of succession, will require a broad power of appreciation such as few possess. Many plans of classification might be devised, and each having some advantages; but whatever system is adopted, an alphabetical index of subjects would make it easy of practical use. This study of classification would of itself be a most valuable research; for I am confident that any abstract or *a priori* plan would find the materials somewhat refractory, and thus would undergo modification and amplification. The general alphabetical arrangement of titles by authors' names would, I think, be quite unfit for this case. The greatest benefit of the whole plan would be in its bringing together references to all which has been written on each subject, and thus at once giving a clue to all the materials for perfect monographs. It is of far less importance in mathematics and physics to know the *who* than the *what;* but both can be sufficiently known by alphabetical arrangement of authors under subjects, and by an index of authors' names with references to all the subjects under which each has titles. Thus all the papers of any author and all the papers on any subject may be directly found.

I need not further enlarge on this plan. Should there be any one who has capacity and courage to undertake the great enterprise indicated, further hints would be superfluous for him. Should there be several who are willing to associate their labors, each taking certain series, and so together exploring the whole, it will not be difficult to concert a general plan. The greatest difficulty of such an association would be in securing thorough coöperation and uniform execution. The means of classification would, of course, be by movable slips, and thus most incongruities of plan would be avoided by making the classification the work of one.

When we look at an individual labor so valuable as Poole's Index of Periodical Literature, we cannot doubt that the labor now proposed is destined ere long to enlist far greater industry and talent, and that, if seriously undertaken, it must succeed. Dr. Young's Index, contained in the volumes of his works, would afford valuable aid towards conceiving the plan, though it is very far from perfect and of too old a date to permit the continuance of its classification without much change. The proposed index seems to be one of those undertakings which the current of events will render too indispensable not to be ere long begun. If so extended as to embrace engineering, machines, and the technology of arts and manufactures, (chemistry, in all its applications, would, of course, be included,) it will become sufficiently valuable to many practical interests to enlist their active support. Our Patent Office might well afford to defray all the cost of such a work in those departments over which examinations for patents are required to be made.

If for a moment we conceive the result attained, and the entire compass of reference to mathematical and physical papers brought into a systematic body under specific subject-headings, we shall better realize its value. The course of investigation on any particular subject would be made simple and direct. By yearly supplements we might be kept informed of new papers beyond our ordinary range. The investigator would proceed to exhaust all the papers of value on any subject in hand, and would know when he was done; thus he would start thoroughly furnished for making additions to existing knowledge, instead of wasting his strength on work already done. The preparation of a monograph would no longer involve a chartless roaming over a boundless sea, but our materials could be used in certainty of their completeness, and in such succession as our convenience might dictate. Monographs thus made easy could not fail to cover field after field with unprecedented completeness and facility. We should, in each branch, be soon furnished with that clear synoptic presentation of all its important elements and results which would enable us to give each speciality its true value and relations on the general chart of scientific coördination. Our general views would keep pace with our special investigations, and our minds would attain that harmony of culture characteristic of the well developed man. Alike versed in those grand generalities which form the groundwork of creation, and practiced in the study of our chosen fields of research, we should steer clear of fruitless speculation and of the bigotry of petty knowledge. Such would be the tendencies of the work proposed. What now remains is simply to do it, and for this nothing is wanting but the man or men. The benefit is for science among all nations. The benefactor's reward will be a truly honorable distinction, and a consciousness of usefulness such as few living men can rightly claim. When we remember how the mighty dead and the honored living have given record to their best thoughts, in hope that the world would not willingly let them die, it becomes in us a deed of pious duty to retrace and render legible the inscriptions on these too neglected record tablets.

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*Letter of Lieutenant E. B. Hunt, United States Corps of Engineers, to Professor A. D. Bache, Superintendent United States Coast Survey.**

In preparing, under your direction, an index of the titles of papers on subjects involved in the operations of the Coast Survey, gathered from all the scientific periodicals, transactions, memoirs, &c., to which I can obtain access, one unanticipated difficulty has again and again perplexed me. Every title which I take out must contain an abbreviation of the title of the work from which it is taken; hence I have been obliged to write many thousands of these abbreviations while gathering the materials for this Coast Survey Index. It is, therefore, a matter of considerable moment that these abbreviations should be as brief as possible, while serving their primary purpose. The special difficulty to which I refer is, that there is no authentic code of abbreviations in general use, and that many of those particular forms which I have encountered are long, unwieldy, indeterminate, and conflicting. In many instances I have to coin abbreviations, and in many others there are insuperable objections to such as are now more or less in vogue.

This subject is more important than it might at first appear; for these abbreviations are not only written and printed thousands of times each year, but every cultivator of science must, as a part of his special training, become familiar with the abbreviations which concern his own departments of research, as a kind of special alphabet. Hence the abbreviated forms ought to be as short as possible, without losing distinctness, to save needless writing and memorizing. This will be better appreciated when we bear in mind that the list of Agassiz and Strickland contains one thousand two hundred and eighty-four titles of acts, journals, and collections of papers on zoology and geology alone, without being complete, even on those subjects; while each of these titles must probably have one or more abbreviations in use. We ought not to forget that we are even now but at the beginning of scientific expansion, and that each succeeding year is bringing into being accessions to the long array of scientific records. It is therefore of the greatest prospective importance that principles for abbreviating titles should now be settled, and that practice should as rapidly as possible be brought to a uniformity based on these principles. In 1856 we should bear in mind that the year 2000 is to come, and that then the records of science will be found under at least a myriad of separate periodical titles, and each series will contain matters for future reference, just as we now refer to the various early series of transactions for the investigations of our predecessors. The results, on being aggregated, would doubtless make a proper subject for publication by the Smithsonian Institution. It seems to me that some plan of this general character would be feasible. Should the American Association share this impression, it is in its power to initiate the measure, and test its practicability with no fear of bad results. The demand of coming generations will be for freedom of memory, and our duty is to make their mnemonic burdens a minimum.

* Read at the Albany meeting of the American Association for the Advancement of Science, August, 1856.

I will cite here a few instances, and these not the worst, to show how unsettled and chaotic our existing practice of abbreviation is.

The American Journal of Science is abbreviated to—

Am. J. Sci. . . . . . . by Professor Dana, one of the editors.

Am. J.,
Amer. J., } by Agassiz and Strickland, in index.
Amer. Jour.,

Jour. of Sci. . . . . . by Poole, in his index.

Sill. Am. J. . . . . . . by Liebig and Kopp, in annual report, &c.

Sillim. J. . . . . by Dr. Schubarth, in his new Repertorium.

The Philosophical Transactions of the Royal Society, London, are abbreviated—

Phil. Tr.,
Phil. Trans., } by Agassiz and Strickland.

Philos. Transact., by Reuss, in his Repertorium.

Ph. Tr. . . . . by Dr. Young, in his index.

The Comptes Rendus, as follows:

Compt. Rend. . . . . by Liebig and Kopp.

Compt. r. . . . . by Schubarth.

C. r.,
C. R.,
Comptes Rendus, } by Agassiz and Strickland.
Compt. Rend.,

The French Academy and Institute Memoirs are thus abbreviated:

Mém. de Paris, by Reuss.

A. P.,
S. E., } by Young.

Mém. Acad. Sc. Par.,
Mém. Acad. des. Sc.,
Mém. Sav., étr., } by Agassiz and Strickland.
Mém. s. Prés. à l'Acad.,

Mém. Inst. is common for the later memoirs.

This chaotic diversity is common to nearly all abbreviations in the above cited works, where they must have received rather special deliberation; and by referring to individual modifications, by separate investigators, a perfect Babel of usage will be found. That this is a real evil, I assume none will question. Can it be corrected, is a question on which different opinions will probably be found to exist. Certainly, correction cannot come without some effort, and without the aid of time. There is time enough; there ought to be effort enough. Things cannot be worse, for there is now nothing fixed. Conservatism has nothing to fear in this instance.

It has occurred to me as a plan which would stand a respectable chance of success, for the American Association to initiate a reform by consigning the subject to a special committee with instructions to invite, in behalf of the Association, the coöperation of other countries concerning their own periodicals, &c. Thus, for instance, the American Association might fix such abbreviations for all American scientific issues. It might, by correspondence, invite the coöperation of the British Association, or Philosophical Society for British periodicals, &c.

Some principles of abbreviation might here be elaborated, but I shall only say, in brief, 1st. That abbreviations should be as brief as possible, without becoming obscure. The motto should be "abbreviations that are abbreviations." 2d. Only the leading characteristic words of a title should find place in an abbreviation. Connecting particles should be thrown out. The possessive or genitive form, which is by far the most frequent, can be easily disposed of by using the apostrophe or possessive sign for *of* or *of the*, thus: Am. J.' Sci.—J.' Soc.' Arts. 3d. Certain words of very frequent occurrence should be reduced to their initial as an abbreviation, as J. for Journal, M. for Memoirs, N. for New, Nouvelle, Nuovo, Neue, Nova; others to two initials, as Ph. for Philosophical, Tr. for Transactions, An. for Annals, Ac. for Academy, &c. In general, the abbreviation for the same word, when frequently occurring, should be constant, and a practical minimum in all combinations, and, when possible, the same in different languages. 4th. Location should, as a general rule, enter each abbreviation in some form, as M.' Ac.' Par., for the Paris Academy Memoirs; Am. Ph. Tr., American Philosophical Transactions. These hints will suffice to show that there are principles in this matter which should be carefully elaborated and weighed.

It may be that the coinage of abbreviations under compulsion, which has fallen to my lot, leads me to attach an undue importance to the subject; but I am confident that a like experience would make most persons quite as desirous of seeing an *established code of abbreviations for all the world* as I have become.

Very truly, yours, &c.,

E. B. HUNT,

Lieut. Corps of Engineers.

APPENDIX No. 52.

Report of J. G. Kohl, Esq., on the method, scope, and completion of a history of maritime discovery and exploration on the Western Coast of the United States, prepared for publication with the records of the United States Coast Survey.

CAMBRIDGE, MASS., *November* 10, 1857.

DEAR SIR: In the letter dated Washington, March 1, 1855, which I had the honor of addressing to you, and in which I announced that I had tried my best in composing the work relating to the orthography of names, the history of discovery, and the chartography of the Western Coast of the United States, the execution of which you had the kindness to confide to me, I took the liberty of stating that in the progress of that work, I felt the want of a comprehensive hydrographic description of this coast, and how desirable and useful it would be to combine such a description with the results of my historical researches.

You declared that my proposition on this subject fell in exactly with your own views, and you had the kindness to request me to undertake also the difficult task of embodying in my work "a full and complete account of the hydrography of the Western Coast and its configuration with details respecting the size, figure, and nature of its various sections and subdivisions, bays, gulfs, inlets, harbors, rivers, entrances, capes, rocks, banks, shoals and currents, prevalent winds, and other phenomena of general interest for maritime history and navigation." And in doing so, at the same time to make in the work itself the changes which might become necessary in consequence of the development and enlargement of its plan. We agreed, further, upon certain other changes to be adopted in the plan of the work. The researches upon the origin and orthography of the names, to which in my former work a separate chapter or division had been devoted, were now to be connected with the hydrographic description. The literary authorities and sources of information from which in my former work I had tried to make special catalogues of books and maps, were now to be connected with the body of the work itself, so that every division of the work, every point discussed, every expedition reported on, &c., should have its literary references near to it.

In fact, the whole plan of our work in diminishing the division was more simplified and made more practical, and it became at the same time possible to condense more matter in a smaller comparative compass.

In entering with my researches deeper into the peculiarities of the hydrography of the coast, I amended, in many cases, my historical results; they became clearer and more precise. I gained much new light, and I soon found it necessary to go over the ground again and reconstruct the whole.

From this has grown an entirely new work, which, after having completed, I have now the satisfaction of laying before you, and in so doing, I express a modest hope that it will gratify you and the classes of your great nation which take a particular interest in this subject.

Being invited to undertake this work by you, the chief of that most important branch of civil administration, the hydrographic survey of the coasts, I had in view, first of all, the interests of your office and its members, the many distinguished officers who are connected with it, and to whom I wished to become, in some respect, useful by my investigations.

Your operations spread now over a vast extent of many thousand miles of coast, and all that in former times has happened upon those coasts has a special interest in such a connection. The Cortes, the Cabots, the Malaspinas, the Vancouvers, and all the other old navigators, who, with sometimes very insufficient means, tried to find out the secrets of these coasts, may in a certain manner be called the predecessors of yourself and the United States officers who operate now on the same field of action with the most perfect instruments and the most ample means which the arts and sciences of the nineteenth century and a rich and powerful nation can afford for the work.

But the history of your department, or what might be called the earlier records of your office, comprise a great part of the whole maritime history of this country, and this maritime history of the United States includes a large portion of the entire political history of the nation, as referred to its true Atlantic origin. The history of discovery and maritime enterprise forms, as it were, its very basis and foundation.

The noble work of discovery, exploration, and surveying, very naturally has become, we venture to say, one of the favorite occupations of the nation. Not only the mariner, the naval officer, the whole mercantile community, and all those who live in the seaports and other numerous settlements along the line of the ocean, take a direct interest in this matter, but also the inland population, who look back to the shore where their forefathers landed, and from which they trace their descent.

To know, therefore, what brought these remarkable shores at first into notice; by what extraordinary and repeated undertakings the physiognomy of this shore-line of the country was first traced out; to observe how the progress of arts and sciences made the results of these exertions from age to age more satisfactory; and to inquire how this work, which was commenced four centuries ago, stands at the present day by exertions which have tended to make the shore-line and all its extensive approaches and dependencies continually more accurate and more applicable to the uses of commerce, navigation, and other great interests;—all these matters, and others connected with them, may well occupy thinking minds in this country; and a work which essays to treat of them may expect to find some favor and perhaps, even if it comes not quite up to its desired mark, a benevolent reception.

Having, therefore, in view, during the composition of my work, as the public to which it might be serviceable, if not exclusively professional men, at least the great classes of serious thinking and intelligent readers, I excluded from it all that might be called merely entertaining. I admitted nothing but what appeared to me to be to the purpose. Little attention has been given to embellishment, but I have tried to make it speak for itself in the development of the events and matters themselves. These I tried to bring forward in a simple and clear way, and arranged them in a manner and after a plan which offered itself to me as the most useful and practical.

To this latter point, the plan and arrangement of the work in question, I beg leave to refer more particularly. I have brought the whole matter under the following four principal heads or divisions:

I. Introductory remarks.

II. General sketch of the history of the Western Coast.

III. Special hydrographic and historical description.

IV. Appendages and illustrations.

Each of these divisions will be briefly described.

I. *General remarks on the physical features of the Western Coast of the United States.*

Before I could enter into any detail of the history or hydrography of the coast, it was necessary to give a distinct idea of the extent and limits of the section of the world on which I was to treat, and, further, to give a general view of the nature, aspects, trending, configuration, and tendency, of the principal physical phenomena characteristic of it.

By the prevalent winds and currents of our coast, by its trending and configuration, by the distribution of headlands, bays, and rivers on it, all the navigators who have come to it have been influenced, directed, helped along, or retarded in their operations nearly in the same way.

To point out such physical features in advance would serve very much to set us right at once with respect to the principal points to be taken into consideration. It would save us, in the sequel of our historical developments, much repetition, and would spare us the necessity of interrupting the thread of our historical narrative by explanations and discussions on physical subjects. It would be desirable, before attempting a history at all, to have before the eye quite a full and complete geographical picture of the coast; but as, for other decisive reasons, to which I will allude hereafter, it is not advisable to set out with a minute description, the work is prefaced by some general remarks on the physical features of the coast; these I have put in a short introductory chapter. This introduction is confined exclusively to the purpose of illustrating maritime history; I therefore took into consideration only those objects and features which had special interest for the navigator, the topographer, and hydrographer, and which were to be kept principally in view by the historian of nautical affairs.

The mariner looks upon all the numerous objects which a coast offers from his own point of view, and those which he at all thinks worth consideration are comparatively few. Of all the rich and manifold productions of vegetation he seldom takes notice, except when they appear in the shape of large trees standing on a high position, and which he can use in taking his bearings. The rough seaweeds which float in the salt water, and which enable him to mark his approach to the coast, have a greater charm for him than all the flowers of the meadows. Whether the mountains contain gold or silver, or are of "primary," "secondary," or any other formation, he does not inquire; he knows them only by their shape, as landmarks, and asks only after their height and at what distance they may be seen from the masthead.

The animals of a country, in regard to which the natural philosopher feels a deep interest, may be numerous, but the historian of maritime discovery notices only those which have for some period of time become articles of trade, and in this way furthered commerce, navigation, and the exploration of distant regions.

The winds and fogs, the rainy and dry seasons, and other meteorological phenomena attract the peculiar attention of the mariner, the hydrographer, and maritime historian, only so far as they move on the waters along the coast line. What seasons may govern beyond that line; what hails or drought may destroy the harvests of the farmer; what rains may fertilize his fields, and many other questions of this sort, have for them no special consequence.

As I have adopted the stand-point of the navigator, and written the introductory chapter in question only with respect to the wants of those who move along the coast, it may easily be conceived how little the naturalist will find in it.

The short paragraph on the physical changes during the historical period which I have appended to the introduction will, I hope, be found not misplaced. That there have been during the progress of discovery many physical changes, should be well remembered before tracing this progress itself, and the places in which changes have occurred should be pointed out at once; some parts of the historical accounts might not otherwise be intelligible. There are localities on our coasts where, in former times, ships could anchor or sail, and where to do so now is impossible; and, on the contrary, there are some harbors which we now enter more freely and with greater draught than formerly. We must keep this constantly in mind, or we should run the risk sometimes of refusing to old accounts that credit which they deserve.

II. *Memoir on the History of the Western Coast of the United States, from the time of the discovery of the American continent by Columbus to the surveying operations of the United States Coast Survey.*

At what early time and under what circumstances our coast was first discovered and settled by members of the human species is, and will probably forever be, a question hidden in utter darkness.

Some authors have traced the progressive march of at least some branches of the North American aborigines, (Aztecs, Toltecs, and other conquerors of Mexico,) from the far northwest, through our coast regions to the southward; have attempted to settle the chronology of their progress, to point out the stations or pauses of their wanderings, and to give us some hints about the names and geography which they introduced into the country north of Mexico.

Others have believed that also the Chinese, at one period, discovered and reached our coast, and that they even settled there, and had names for the countries.

Taking it for granted that we should investigate only the history of the present system of geography and navigation, commenced by the nations, mariners, and explorers of European descent, I commenced the historical memoir with the time of the discovery of America by the Spaniards, and excluded all the speculations on the ages previous to that event.

There are, also however, cases in which these European explorers have travelled, so to say, on old Indian trails; have been directed in their operations by Indian report and guidance, and have adopted into their geography a part of that knowledge acquired of the aborigines. Nay, sometimes even those speculations on Chinese discoveries have had some influence upon their movements and proceedings.

In such case I have occasionally alluded to the fact, pointed out the manner in which European navigators were helped along by foreign tribes, or were checked, and misdirected, and tried to determine the degree to which they admitted into their own geography that of the Indians.

For the most part, I have strictly and exclusively kept in view the boundaries of the United States coast as the limits of my field of research. What passed beyond those limits I have therefore disregarded.

When a great circumnavigator of the globe has appeared on the waters, I have traced his course only from the moment when he turned his keel to our coast, or got it in sight, and I have left him at the place where he left us. This could be done, however, only to a certain degree. Our section of the coast is like a stone embodied in the entire structure of the whole Western coast of North America. It has shared with it in many respects the same vicissitudes, and has profited with it by the same exertions.

Many astronomical observations, for instance, made in the north and south, have influenced ideas in regard to the position of our coast. When Abbé Chappe, for the first time, accurately determined the longitude of Cape Lucas, he fastened, so to speak, the wavering and movable coast line of the old maps, which thus acquired certainty throughout its whole extent. It would be a gross omission not to consider Abbé Chappe's expedition and operations as forming a part of the hydrographic history of our coast, which was so much affected by it.

The cosmographical ideas connected with the search after a northwest passage have not only modified in a great measure the views which geographers, at different times, formed of our coast, but they have also, in a high degree, assisted and furthered its discovery and development. It would be impossible, in a history of the Western Coast of the United States, not to allude to these "northwest passage" expeditions, and to keep their influence in view.

Numerous similar instances might be pointed out of cases in which we ought to look *beyond* the strict limits of our narrow field of research. It is, however, impossible to give general rules in reference to this point. How far we ought to enter in each case into the history of distant events depends partly upon the degree of importance of the case itself, and partly upon the size of the work which we devote to our object. In a book like ours, restricted to narrow limits, only brief allusions generally could be made to them. In a large work we might have extended our scope of view, and might have drawn more matter into our circle, for it is evident that such a circle is of a very expansive nature. One might say that nothing has taken place throughout the whole extent of the vast Pacific which had not some influence upon the geography of our coast; and again, that nothing has happened beyond the Rocky mountains which could not be shown as having been, to a certain degree, in connection with it.

The Pacific coast of Mexico, and that of the isthmus, which forms a comparatively narrow bridge between North and South America, were at several points first reached and explored by land expeditions from the European colonies on the Eastern Coast. But our Western Coast, being separated from the Eastern regions where Europeans first landed by a vast breadth of continent, was first reached by water. For more than two and a half centuries we read exclusively of maritime expeditions skirting along these shores. In the latter part of the eighteenth century the coast was connected with other European settlements in America, also by land expeditions; and during the present century the whole broad continent of North America has been traversed, and the shore has been reached repeatedly by exploring expeditions from the interior, though until very recently the most important operations in this way were conducted from the water side.

We have, therefore, throughout the whole course of our investigation, principally to deal with maritime expeditions, not only from the nature of our subject, which is maritime history, but also from the peculiar nature and position of the coast, which could not easily be reached from the opposite side of the continent. To a certain degree we must also pay attention to those land expeditions, and include them so far as they bear upon the object of our history.

The mariner and hydrographer derive valuable assistance and information from the land traveller; the latitudes and longitudes to which the latter, by carrying his series of observations through the interior of the country from a distant, well-established point, has arrived, may be used by the former to compare with and correct his own observations.

The traveller names and measures for the mariner the heights of the mountains and other objects which the latter uses as beacons and landmarks; he explores for him the distant heads of the rivers, their nature, length, climate, freshets, &c., and shows to him their value and importance, and the causes of the phenomena by which the sailor is struck and influenced at their mouth.

Many voyages have been made in connection with simultaneous land expeditions, and their proceedings and results have been combined. The sailor himself sometimes leaves his pitching vessel and becomes a wanderer, making travelling excursions to the interior.

It is hence obvious that, though maritime exploration is our principal object, we were obliged to keep always in view what was transpiring on the adjacent land; this, however, could only be done to a certain extent. Of the *naval* expeditions I have tried to give a complete account, including them all, but have reported only on those among the land explorations which reached the coast, and which had some marked influence on the progress of hydrographic knowledge.

In brief, I pointed out their commencement and direction; somewhat more minutely traced the circumstances under which they discovered the sources of the coast rivers, or the tops of mountains in view from the coast; more attention was paid to them from the time they reached tide water ; and when they got the ocean itself in sight, and wandered along its shores, I tried to accompany them with nearly the same solicitude as the navigators themselves, and have given them a full investigation.

Even by water our coast was not easily accessible to the European navigators ; it may be said to have been for them the very *ultima thule* of America ; from Europe directly it could only be reached by a circumnavigation of the whole American continent around Cape Horn. On this route nearly every other coast section of this continent would be seen previously, our coast being almost the very extremity of the track.

The Spanish enterprises commenced in the central parts of America and diverged from thence towards the south and north—at first along the eastern coasts, somewhat later along the western, and latest of all to the northwestern regions. The extremities of the southwestern radius towards Peru and Chili, after the discovery of Magellan's Strait, were soon reached and received light from two sides. In consequence of that discovery, they soon became principal stations on the great oceanic route round the globe. Every circumnavigator touched the southwestern, while the northwestern radius ended in darkness and uncertainty.

For a long time our coast thus lay far off from the great route of navigation, and was only now and then seen by a stray wanderer on the waters.

The Portuguese, on their advancement around Africa and southern Asia to the East, would be, of course, the very last to arrive there, and the Russians, in their march through Siberia to our region of the northwest coast, failed in their efforts to make extended settlements. At an early date they became acquainted with the more northern peninsulas and headlands of America, while our coast, intervening between their northern fur-hunting grounds and Spanish Central America, remained to them for a long time a *terra incognita.*

We dare say that on the whole globe there is no spot watered by the ocean which has been so completely passed by in the travelling and colonizing movements of the European nations as our Western Coast sections.

The history of its exploration derives some prominent features from the peculiar situation of the coast. It does not run on, like the history of some other parts of America, smoothly from a point of commencement. Its progress cannot be compared to the growth of a river, which commences with a little stream, and the course of which we can follow along an uninterrupted line to its swelling mouth ; we shall, on the contrary, have to travel over very bad roads, and we shall find long periods of time in which the march of history comes to a stand still, and nothing appears to have been done.

The exploration was repeatedly tried and repeatedly left off; sometimes it seems to be in good progress, but new impediments arise, and it is stopped again. In their first enthusiasm of enterprise, and full of hopes of finding something strikingly rich, the Spaniards, of the time of Cortez, reached pretty high latitudes on the northwestern track; Cabrillo, as early as 1543, doubled Cape Mendocino ; but not finding their expectations realized, they did not return, and Cabrillo's Cape Mendocino stood on the Spanish maps where he put it, for more than sixty years, as a fabulous *ne plus ultra*, never to be reached again.

The Englishman, Drake, an extraordinary man, upon a most adventurous voyage, ranged for a great distance along our coast, and fixed upon it the English name of New Albion. But this English country, which he laid down on the English maps of these regions, stood there only like the superstructure of an unfinished building, soon to be overgrown with the moss of oblivion.

For nearly two hundred years people in England spoke of New Albion as the Romans once spoke of Taprobane or Thule, but no other English navigator, before the time of Cook, came in sight.

In the beginning of the seventeenth century the Spaniards appeared to be willing to commence another series of northwestern explorations ; one of their best navigators, Sebastian Vizcaino, set out on the track of Cabrillo, made an extensive survey of the coast, passed even a little distance beyond the *ne plus ultra* of his old predecessor and was inclined to organize a second expedition, but he was not supported. His charts were hidden and forgotten in the Spanish archives, and he had no successor.

The Spaniards who found the pearls of the Californian gulf in their way, were, throughout the whole seventeenth century, occupied in pearl fishing expeditions ; for maritime enterprise they showed so little interest and energy that they lost even the knowledge of the northern part of that gulf, some supposing that it might be an endless strait. On this point the companions of Cortez had entertained no doubt.

Of the configuration of our more northern coasts, the most fabulous reports were at that time credited, and the De Fucas, Fontes, and other impostors, were believed to have sailed where water perhaps might have been found in antediluvian ages.

The Jesuits were the first to found the Californian conquest on the firm basis of settlement and colonization. During the first half of the eighteenth century they christianized and, though roughly, explored all the countries which surround the Gulf of California on both sides. They were in a fair way of progressing to the north, when suddenly they were interrupted by those divisions of the European powers, which gave the death blow to all their activity.

The Franciscan missionaries, in the latter half of the eighteenth century, took in hand the work commenced by the Jesuits, and assisted in their land excursions by a series of maritime expeditions of the government, and explored a great section of our coast in a more satisfactory manner than had yet been done.

At the same time the Russians came along the coast from the higher north to lower latitudes; and soon after also the English, conducted by their Pacific hero, James Cook, again made their appearance.

By a singular combination of circumstances, of which I have tried in my memoir to develop the particular causes, this hitherto forlorn region became then the general meeting place of navigators of nearly all the nations of Europe. The Portuguese, the French, the American citizens, all took some part in this new sphere of activity ; but in the midst of all, the English Vancouver bore away the palm by making at the end of the century that excellent survey, by which our coast became at once nearly as well known as other parts of the world.

This extraordinary activity was again interrupted during the European wars, after the French revolution, and in a certain sense our present century had to commence the work anew. Several Russian, French, and English navigators partly completed the surveys of Vancouver after the conclusion of peace. The Spaniards by and by disappeared from this scene of action, and the wheel of fortune, excluding all others, brought at last to the head of western affairs the nation whose pioneers and explorers now flocked in from all sides, by land as well as by sea, and which at last organized, as it had already done on the eastern and Mexican gulf coast, systematic plans to consummate the work of survey and exploration.

The circumstance that our Pacific coast lay so remote, and the difficulties which interposed in reaching it, have had another peculiar consequence, which is rather favorable to the historian.

To the eastern coast of America, which was so much nearer to Europe, many private expeditions went out from Spain, as well as from France and other countries, soon after the discovery by Columbus. The journals and reports of these adventurers, if they ever wrote any, have not been preserved. They could sometimes do their work only very secretly. No account of them is found in the archives. We therefore see many islands or coast sections mentioned as known, (some even laid down on the maps,) without being able to name the man who first made the discovery. Afterwards, when the eastern coast, especially that of North America, became thickly settled, so many obscure hands were at work in continuing the detail of the exploration, that it is sometimes impossible to find authentic evidence for the date and manner of each new appearance or name of river, cape, and harbor.

On our Western Coast private exertion, at least for a long period of time, did little or nothing. The attractions were so small, the difficulties so great, that combined forces, as governments or other powerful political bodies can only afford them, were necessary to overcome these obstacles.

We have, therefore, here, more than in any other part of America, to deal with *official* expeditions, fitted out as well as the time permitted, and sent to the coast on special command, either by the Viceroys of Mexico, the Kings of Spain, England, or France, or the President and Congress of the United States.

Not only the naval, but also the first land expeditions to the coast, were undertaken by well known religious, political, or commercial bodies ; by the orders of the Jesuits and Franciscans ; by the great Russian, English, and American fur companies, and some of them also by the American government. From the first movement on our coast, under Cortez and Mendoza, to the last exploring expeditions under Lewis and Clarke, Beechey, Wilkes, Frémont, Emory, and others, we have a chain of great official expeditions at long intervals, growing out partly, as I said, one from the other.

These circumstances give to the history of our Western Coast quite peculiar features. It is nearly all official and well authenticated history. In many cases the instructions given to the navigators at the outset are preserved to us. Of some of the northwestern expeditions, which happened to excite great interest in a more enlightened time, quite voluminous and complete accounts have been written. And though, as I have said, sometimes long series of years passed without action at all, we need not fear, as we might of other regions, that in the intervals much has escaped our notice. On what *was done* we are comparatively well instructed.

The progress of exploration and maritime enterprise depends, of course, like every national exertion, very much upon great political events. It progresses rapidly when the affairs of the exploring nation are in a flourishing state. It stops with the downfall of the State. Peace, war, the appearance of great and enterprising kings or other powerful characters, exercise a great influence on the development of the work.

I might, therefore, have arranged my reports after the periods and heads of the political history of Europe without losing the great and leading events of the time. This would, however, have had many inconveniences, because we had to deal with navigators belonging to very different nations and States.

We dare say that every special branch of history, though developing itself from the great general course of events, still brings along with it its own chronology; and the more special it is, the more this will be the case.

I have, therefore, for the history of our Western Coast, invented a special chronology, or, more properly speaking, I have adopted those periods or epochs which the development of this particular work seemed to offer.

Events on the Western Coast are divided into historical groups corresponding with the periods of Cortez, Drake, and Vancouver, who distinguished themselves in discovery. Allusion is sometimes made to general events which bore upon the subject, in order to show the connection of maritime enterprise with those great events.

From this has grown out a plan for the work, the special titles of which will be readily seen in the headings of its different chapters.

Accounts of all the western exploring expeditions are arranged in strict chronological order, to show the gradual growth of the improvement and completion of knowledge in discovery. To keep up this chronological arrangement through the whole body of the work was, from two circumstances, not very difficult. The field of discovery was not very extensive. An expedition which would touch on one part would usually sweep along the whole of it. Secondly, the operations were conducted for the sake of discovery. Through more than two and a half centuries there were never, at the same time, more than one expedition upon the coast. We could, therefore, treat as a whole the particulars of each, accompanying one explorer from the beginning of his excursion to the end, and then take up the next. A few general remarks and some retrospective observations suffice to interlink them all so as to form a connected narrative.

This method, however, required modification for more recent times, when the explorers began to crowd each other, as it were; several of them appearing at the same time, and pushing their researches parallel to each other, sometimes independent, and sometimes with united forces, through a series of years. Different nations, too, or commercial companies, then took an active part in the work, each executing a series of operations, some being more active in the north; others in the south; some exploring the interior, and others confining themselves to the margin of the waters.

A strict observance of chronological order for such a period would have had great inconveniences. During the short space of a year we would have to carry the reader from place to place. We would have had to leave one explorer in the very midst of his career, in order to take up the beginning of the route of one of his cotemporaries. It would be necessary to accompany the Russians one step further south, and then to show the French in Canada advancing a short distance further to the west, and at the same time turn our eyes to the Spaniards, in their missionary stations, to find that they, during that particular period, did nothing at all.

In fact, the strictest chronological order, under such circumstances, would be the greatest historical disorder; and hence, for such periods, it has not been attempted. Some well defined chains of operations have been followed out from beginning to end—special chapters being devoted to them. Such advance a little in time, and then run back to trace in the same manner a similar series of interlinked movements made in another section of the coast, or by another nation or company.

"Many have supposed," remarks the excellent Captain Burney, "that to abridge is a work of no great skill and labor."* It is sometimes called "compiling," an expression which may, indeed, be characteristic of the unskilful, careless, and rude manner in which some abridgements of voyages and reports on exploring expeditions have been made.

I have not tried to "compile," but to *digest* the rich material before me; to extract from it what appertained to my subject; to condense and compress it; and to lay the whole in a clear and connected historical narrative before the reader. This process of digesting, extracting, condensing, and relating requires a high degree of skill and critical judgment, and a great deal of knowledge of the principal subject, as well as of all of the manifold secondary subjects connected with it. Hence, the fear that I may have totally failed should, perhaps, keep me silent; but the conviction that I have done my best gives me the courage to explain further how and in what manner I have tried to accomplish the work in question. In doing so, I may, however, be stating rather what was wished than what I have done.

First of all, on taking up for notice an exploring expedition, I pointed out the circumstance which induced a new enterprise, and alluded in a few retrospective sentences to the state of local knowledge as left by the former expeditions.

The expedition was put down under the name of the chief commander of the vessel or vessels when a naval enterprise was in question; for the spirit of the commander pervades the whole undertaking, and what was done *under* him ought to be considered as done *by* him; the merits as well as the faults of the enterprise should be ascribed to him. In most cases I included the names of the second in command, and other principal officers. These sometimes take the lead in case of the death of the commander, and their names are frequently perpetuated in geography in the designation of capes, harbors, rivers, or other objects. The names of the vessels are likewise mentioned as contributing, according to their qualities, not a little to the success of an expedition, often not less than the officers and crew themselves. Their names, too, are often perpetuated in geography; and a knowledge of their size and burden often serves to decide doubtful but very interesting questions in the history of the expedition.

Unhappily, we are seldom made acquainted with the names of the crew and companions of an explorer, and their former and subsequent fate. If this had been done in all cases, we would frequently have been able to show much clearer how a school of explorers was formed, how one of these schools grew out from the other, and how a certain acquired knowledge was spread through the world.

The directions and instructions which a commander receives from his authorities for the expedition are of a decisive import in estimating its value. As he is directed in his movements by them, so we can only follow his movements and operations with a clear knowledge of them. Unhappily, these instructions are so often not to be found among the documents brought to our notice. When practicable, I have not omitted to mention the leading points of their contents.

The same may be said of the scientific outfit of the expedition, of the number and construction of the instruments used on board the vessels, and the qualifications of the learned men who, as assistants, accompanied the expedition. The old navigators and their historians rarely give

* *In his Chronological History of Discoveries in the South Sea, volume X; Introduction, page 5.*

us more than a hint on these most interesting subjects, and not always in modern reports do we find complete lists of the instruments used on board the vessels. On the good or bad qualities of a single set of instruments the geography of a coast may be truly or erroneously determined and put down for centuries. Take, for example, the astronomical positions determined by Vizcaino in the year 1603. He had no successor until 1770, and was the nautical authority for our Western Coast for more than one hundred and fifty years.

I have tried to find information on this most important but most obscure branch of maritime history, and have noticed the occasion at which a point on our coast, for the first time, was observed with tolerably good astronomical instruments. I have also pointed out the date at which, for the first time, a chronometer was carried along the coast, and have further alluded to the period of the first introduction of other scientific improvements. I could, however, but seldom attempt such explanations—partly from want of information, and as much from want of space.

It is evident that, in a general history like this, many important matters which are capable of being developed in special historical essays can only be touched upon in passing.

The same may be said with respect to the astronomical results which the discoverers and observers reached with their instruments. I have sometimes, in treating of a very eminent man, alluded to them, and have compared, for instance, the latitudes and longitudes of Vancouver with those of Malaspina, and again with those of our United States Coast Survey; but this could be done only in rare cases. To carry out such interesting and useful comparisons to any degree of completeness would have taken me beyond the limits of my sketch.

After having taken into consideration, in the manner stated above, the scientific outfit and import of the expedition; stating its principal character; whether from the beginning a true and genuine exploring expedition destined for discovery, or in its main objects a commercial, political, or military enterprise; and if for exploration and discovery only, whether as an accidental and secondary object, I proceed to relate the principal events of the voyage itself.

Selection from the many events which the journals written by navigators and travellers contain, was sometimes difficult. They usually report daily on everything occurring on board their ships, but often without any critical method whatever. They recite at greatest length what touches them nearest; and remarks which, for the subsequent historian, are of the highest interest, are sometimes only casually made and communicated in remote relation to the thread of the narrative.

The first thing which attracts the attention is the point where the strange coast was first seen—the Landfall. I have tried to fix this point accurately in all cases; it is sometimes involved in doubt, but, if properly determined, often serves to throw light upon all the future proceedings of the navigator, and upon the position of his ships, which may likewise be doubtful at subsequent events.

During the progress of the exploration I have endeavored to include every incident or remark which can be serviceable to the history of science, or which might illustrate the operations, the track, and the success of the navigator in question.

The events in a voyage, as in every other human undertaking, will generally be found so interlinked as to form, as it were, one continuous chain in which the accurate observer thinks he can spare no link whatever. A slight change of the wind to-day or to-morrow, some slight occurrence on board the vessel, the want of an article of provision, a turn in the mental disposition, or even the reveries of the commander, may sometimes give a perfectly new impulse or turn to the expedition, or may be the cause of its overthrow. To understand everything, and to see it in all its bearings, causes and effects, the reader would, therefore, wish to have at command the complete and full report. As this, however, cannot be expected from a general description like that of the Western Coast, the main object of which is to condense matter, it is evident that, in saying I had omitted no important incident, could only be meant no principal one of decisive and palpable influence and interest.

In accordance with this, I pointed out the objects on the coast which were for the first time seen and observed on the expedition in question, and the names which were for the first time introduced by it in geography—if the object, harbor, cape, bay, mountain, &c., had been already discovered. I indicated, in few words, what change or improvement was observable in the remarks of the later navigator, and whether he was aware of, or had noticed at all, the discoveries of his predecessors. Writing for hydrographic purposes, I took, of course, particular notice of the hydrographic discoveries made in the voyage of the observations for latitude and longitude; on the configuration and position of the coast; on soundings, good harbors and anchorage; on the size and course of the discovered rivers, &c. Botanical and other discoveries, in regard to the productions and nature of the soil, I have treated more slightly, and shortened very much, or left out entirely, the reports on the political state of the country, on the "mission," and especially on the transactions with the Indians, on which ancient as well as modern navigators have been fond of expatiating so much. I have referred to the Indians only in a few instances, when the navigators received from them good hints about the direction of the route to be taken, about the trending of the coast, the course of a river, &c., or when the Europeans adopted a geographical name invented by them, or when, perhaps, these transactions with the Indians were either particularly disastrous or otherwise important, and when the locality of the event, therefore, remained famous in the history of the coast.

I have tried particularly to find out and mark the places where the expedition anchored for some time, and the exact dates and period of such a stay. The journals of our mariners are often very far from being accurate and complete in their chronology, and not seldom even the date of such an important event as the "landfall" can only be arrived at by discussion from a combination of circumstances; yet these dates are, of course, all important for deciding in doubtful cases the priority of discovery.

Having accompanied, in this manner, the navigator on his entire route, and traced the principal directions and turnings of his track, I attempted at last to determine, in connection with the date, the locality of the limit reached by him. The coast limits of the explorers are as much shrouded in doubt as their landfalls, and are just as eagerly discussed. They became famous in maritime history, and we sometimes find the "*ne plus ultra*" of a celebrated navigator put down on the maps, and making a great figure there for more than a century, if during this time the place was not reached by a subsequent explorer.

Finally, I have pointed out the cause of the end of the expedition and its departure from the coast; whether it was occasioned by the want of provisions, sickness of the crew, shipwreck, the hostility of the Indians, or other disastrous events, or from the circumstance of the commander's having fulfilled his mission; and last of all, I have summed up, briefly, the geographical results of the expedition, showed what was made by it on the former voyages, and what was yet left to be done by subsequent explorers. In this manner I have tried to define the rank which the expedition in question should occupy in history, connecting it, at the same time, with the whole chain of enterprises in which it forms a link.

To do this the more effectually, I have now and then introduced general remarks on the progress of discovery, either in the shape of a short introductory note to a new voyage, or in that of a concluding note to the one preceding.

I have so far spoken only of the manner in which I tried to treat, extract, and compress the accounts of sea voyages and expeditions. I need not speak particularly of the mode of treatment when a land journey was in question, or where, instead of a single expedition, an account of a series of voyages of the same nation was to be given. I have applied, more or less, the same method also to them, and have arranged and reported on them in the same manner.

One principal point remains still to be touched upon, namely, the nature of the sources of information, the authorities, literary productions and documents, which I have used for composition, and the manner in which I arranged the materials. I sought, of course, only for the most authentic and original documents for every case, but in this pursuit met many difficulties.

It has been already shown that, for certain reasons, our literature, in respect to voyages on the northwest coast of America, is comparatively complete. Having nearly throughout to do, principally, with official government expeditions, which, for the time being, attracted a good deal of attention, we are correspondingly well furnished in official information, and with authentic reports and documents. This remark must, however, be received with a considerable degree of allowance.

That we are in possession of a part of the instructions given by Cortez to his captains, first sent out to the northwest, and have yet the original official reports of Ulloa, Alarcon, Coronado, and other commanders, to Cortez and the Viceroy (Mendoza) of Mexico, on returning from their earliest northwestern excursions, is a rare fortune, though it is characteristic of the whole documentary history of our Western Coast. For historical purposes, in reference to other regions of America, we are far less favored; the historian has, nevertheless, in the former case, to lament the loss of many valuable sources of information known to have once existed. He perceives, in reviewing and arranging his "authorities," many blanks, so that, although he may be regarded as comparatively rich in materials, he is often inclined to think himself very poor.

Nearly all the great exploring expeditions, before being determined upon, were preceded by manifold transactions, correspondence, and discussions between the authorities which decided and the persons interested in them—as between the royal governments and their viceroys, or other provincial chiefs, and between those and the persons destined for the command of the expedition, or otherwise to be engaged in it. There are instances in which such correspondence was carried on for years, volumes having been written on the expedition before it weighed anchor at all. We have sometimes long preliminary discussions on the subject of exploration in Congress or Parliament, and the learned academies and other scientific bodies discuss the matter in their way.

Most of these important sources of information are now quite lost or inaccessible to us. The preliminary official correspondence is very seldom fully preserved even in the archives of the States, or the hydrographic offices, and we are rarely favored with such glimpses or scattered specimens as the excellent Spanish archivest, Navarette, has communicated in his well known and most valuable collection of official letters and documents relating to voyages of discovery. Even with that important and nearly indispensable article—the instructions given to the commanders—we are seldom favored. These instructions were sometimes intentionally kept secret, and sometimes even the commanders of the expeditions have omitted them in their publications from negligence or oversight.

Throughout the expeditions themselves usually a great deal has been committed to paper. The commander-in-chief has kept journals, the second in command his log, and perhaps also the mates and the volunteers, preachers, missionaries, commercial agents, and scientific gentlemen have all taken their notes, and have, where occasion offered, written letters to their friends at home. Possibly a chart was drawn on board the vessel—perhaps one in each of several, or more than one on each vessel. Such charts were laid down on a large scale, each on the very spot itself, on numerous great sheets of paper, and step by step the track of the vessel was marked upon it. On these charts and in the journals are contained notes and letters written on the spot, under the impression of the moment, in the midst and in sight of the very objects they describe; thus forming the most anthentic and original sources of information on the events of the voyage. They constitute the most interesting library of the voyage which we could wish for. The historian would like to have them *all*. He would desire that nothing of all that should escape him. But in most cases—nay, nearly in all—he must greatly restrain his expectations. Of these original archives, accumulated during the voyage on board the vessel, very little comes to his notice. Instead of them, he obtains perhaps nothing but a contracted official report, made up from "notes" after the return; and, instead of the large sheets of charts made on the spot, on which he might note the position of the vessel at any particular moment, he is favored with nothing but a little reduced chart added at the end of the book. He is fortunate in having even that; for, in pursuing his researches, he will soon learn that, with at least half of the narratives, even "reduced" maps have never been published. The official reports made by the commanders to the government, in their original form, have been to the same extent kept in the secret archives, lost there in course of time, and then brought to light again in another shape, thought fit for the public at large.

Time, too, has carried on the work of destruction, so that for entire periods all official documents are wanting, and we lose all mention of the commander-in-chief, the soul of the expedition, in regard to his operations and intentions. Short accounts given by subordinate individuals must then be treated as precious documents, and laconic journals made by an ignorant sailor or soldier are to be commented upon in place of the brilliant reports of a Herodotus or Xenophon. Sometimes we have only second or third hand information, or perhaps nothing but hearsay reports; still we must listen attentively to this echo, which comes to us by a repeatedly broken reverberation, and construct from it our calculations and hypotheses.

It will, from this, easily be perceived under what restrictions the mention of authentic sources should be understood. The question has nearly always been to make a critical choice between the more or less unauthentic, and to take the least deceptive.

The critical and bibliographical discussion of the comparative value of the accounts of voyages are of the highest importance for our object.

An accurate knowledge of their chronology, and of the dates of different editions of maps and books, decides sometimes in regard to the question of a date or priority of discovery. It was evidently necessary to enter into these discussions to a certain degree. In a general work, like the history of the Western Coast, this could be done, of course, only to a very small extent. In very important cases I have expressed my opinions on the points involved. As this, however, could be done only in a very short and concise manner, I have stated these literary questions is additional notes under the text, so as not to interrupt the thread of my narrative.

In a general note, added to the inscription of the voyage, I have given a list of the titles of the works or documents which I regarded as containing the principal and most original accounts, excluding therefrom second-hand or more remote information. To this latter class, in which I include discussion of voyages and matters appertaining to them in critical reviews, in the memoirs of scientific bodies, in geographical works, maps, or atlases of the world, which show how the matter, brought before the world by the discoverer, was digested by the geographers of the time, how they understood his reports and used them for the advancement of knowledge, how they embodied his charts of a little section of the world in their general pictures of the globe ; to all these matters, when occasion offered, I have referred in subsequent notes under the text, so that I venture to say the reader will find at hand, and brought together in practical connection, all that he wants for convincing himself of the degree of correctness of my statements, and also for further information on the subjects.

I may be allowed to state on this point, further, that I have not considered myself as a distributer of praise or blame. My work was not to be a repository for critical remarks, though critical research must have preceded its composition. I have, therefore, all the authorities I thought to be the best, as a rule, simply quoted ; and I hope I have seldom, if ever, deviated from this rule.

III. *Special hydrography of the Western Coast.*

I have before said that a special description of the coast previous to entering the field of history would be desirable in some respects, but that, for certain decisive considerations, I thought it better to let a general sketch of the history of the exploration and geography of the coast be followed by such special description.

There are many nice historical points and questions which can be satisfactorily decided, so to say, only on the very field of action, and some which can only be made quite clear by means of the details of the description, and which, therefore, it is most convenient to bring forward with the description itself.

These historical niceties may easily be separated from the general historical sketch, but to make them intelligible such a general sketch must have already preceded.

The local history, also, of places can be much better understood in connection with minute hydrographic descriptions; they throw light upon each other, and should not be separated. But the local history can only be understood after a full development of the general history, which consequently carries with it the special description. This will be made still clearer in explaining the arrangement of matter in this third principal division of my work.

I have divided the coast into sections, putting down as dividing limits certain headlands, great turning points of the coast, or deep and broad indentations, river mouths, or other very marked and prominent natural features.

These divisions should be neither too large nor too small: too large, as not being throughout of the same character, would require other subdivisions; too small, as offering no striking differences and shades of character, would lead us to repetition and would destroy the contrasts. The proper limits could not, of course, be fixed by any general rule, but must depend chiefly on the extent and speciality of the work to be written. It would not do at all to adopt for our purposes the political divisions, the boundaries of States or provinces, because by this method objects which form a natural part of a physical division would sometimes be separated. Still it may be very convenient, and, under some circumstances, even necessary, to adopt as the end of a section a political boundary line.

The great headlands, remarkable bends, and turning points, on the coast, usually mark, also, its natural divisions. In the neighborhood of those headlands the climate of the coast often changes. They serve to break the prevalent winds, and have a great influence on the direction of the tides and currents. Frequently they are prominent landmarks, the terminations of great mountain ranges, and play as great a part in history as in nature; near them the navigators were accustomed to make their landfalls also, and they form the *ne plus ultra* of many expeditions.

Nevertheless, our coast divisions could not be made exclusively by the headlands; on great tracks of the coast we find no prominent headland at all, and must then, if a division be necessary, have recourse to a broad inlet, or river mouth, or some other well defined object.

As no method could be devised which would obviate every inconvenience, I have followed no strict method whatever, but have made my choice among the objects on the coast according to circumstances.

The small islands I have considered as dependencies of the coast section near which they lie, and have treated them in connection with it. Some extensive archipelagos I have treated of separately.

Very important rivers and bays have not been treated as appurtenances of the coast, but are described in special chapters, as San Francisco bay, Admiralty sound, Columbia river entrance, &c.

Generally I have not adopted many divisions and subdivisions, but rather preferred to put all the objects which belong to a greater section under running numbers, one *after* the other, though strictly taken they perhaps should have been put one *under* the other.

Of each larger coast section I have tried to give the general characteristics, the leading features, the trending of the whole coast line and range of the mountains and elevations which define the trending.

The history of the principal names under which the coast section has been known in the course of time is also given. After this I have taken into consideration each principal object on the coast section in succession, at first giving a hydrographic description of it, and then its history.

These objects, as well as the coast sections themselves, I have arranged as much as possible in geographical order, from south to north, following in this manner the whole of our Pacific coast from its initial point at San Diego to its northern end at the British American boundary in 49° north latitude.

This arrangement is the most natural and convenient, because it is pretty much in agreement with the march of the maritime history of the coast, which was first discovered and settled in its more southern parts from Mexico. The northern sections became known at a later time. In adopting this arrangement, we therefore proceed in parallelism with history, from the oldest known objects to matters of a later date.

In the hydrographic description of each cape, bay, harbor, island, river, &c., I have tried to give a general as well as special view of it. If a mountain or headland was under consideration, I described the aspect which it offers from the sea, its shape, size and connection with the interior of the country, its approaches and the rocks and islets scattered around it; I have pointed out the influence which it is likely to exert on winds and currents, and the protection which it affords to anchorage in its neighborhood.

If a harbor, lagoon, or bay was in question, I defined its outlines and extent generally in nautical miles, its characteristic soundings in fathoms and feet, the channels leading into it, and through its interior waters; the depth of water on its bar if one existed, the sand banks in its vicinity, and in all these particulars as far as I believed it necessary for such a general work as that under review; not so far, however, as would be requisite for the purposes of navigation; it was not the intention to write a coast pilot, but only to compose a work for the illustration of history.

Some peculiar difficulties arose with respect to the description of the rivers. The question how far they ought to be considered as belonging to the coast department and to form objects of marine hydrography was not always easily to be answered.

Their mouths, which are sometimes the most frequented harbors and anchorages, and the manner of their connection with the ocean, were decidedly parts of our field of research, and I have given to their bars, channels, currents, tides and freshets particular attention.

The limit of tide water might perhaps be considered as the boundary of research for the historical coast surveyor, but I thought that at least in a general way the river should be traced up throughout its interior course, and that its size and principal bends ought to be pointed out to show its importance and relation to the coast and to marine affairs. Beyond tide water no detailed description was deemed necessary.

It is an observation by which every geographer must often have been struck, that the objects on the same great division of a coast will have a remarkable resemblance to each other. Certain forms of headlands will sometimes be found to predominate on a coast section for a certain distance, and then give place to a class of differently shaped headlands. The configuration of harbors, bays and lagoons, the manner and circumstances under which rivers reach the coast, will in certain divisions be found strikingly similar. Such similarities along the coast line are of course, in most cases, only consequences of the predominant geological structure of the country; they may be partly due to the effect of prevalent currents, winds, and other agencies, peculiar to the regions.

Such similarities I have pointed out by repeated comparisons of one bay, cape or island with another. In the hydrographic descriptions, I closely followed the reports and descriptions of the navigators, and eye-witnesses themselves, and often used their very words when I believed them to be very appropriate and striking.

After the description of the object in question, I entered into its local history, the account of its discovery, name and survey, mentioning the time, and the navigator by whom the capes were first descried or doubled, the harbors entered, the rivers traced, the islands circumnavigated. I have showed who first surveyed, sounded and described them, and who made the first astronomical observations on the spot.

I have related, further, who made the second and improved explorations and survey, and who gave corrected longitudes and latitudes.

According to the importance of the object in question, I have entered more or less deeply into these researches, and pointed out at last where the latest and best views, plans, charts, and surveys of the locality may be found. In this manner I have brought the whole local history of the Western Coast of the United States to the period of the operations of the United State Coast Survey.

With the history of exploration and surveying, I also combined the history of the name first given to each object, the subsequent changes of the name, and by whom introduced, and have tried to settle questions in regard to the propriety of their application and orthography.

When the locality in question was somewhat extensive, I have given, after the general description of it, a general history of its exploration, and then afterwards a special description of its particular parts, combined with their particular local history.

It is obvious that in this way repetitions could not in all cases be avoided. Many events which had been already related in my general historical memoir were to be referred to again. I therefore preferred rather to admit some repetition than any incompleteness. Besides, the same events would thus be related in the two cases with different connections ; in the general historical sketch they stand in chronological order, but in the special hydrographic description are distributed geographically. Opportunities, of which I took advantage, were thus given to add certain minor discoveries, and to trace the history of some specialities of observation, for which I could find no convenient place in the general historical view.

In this way I believe the entire work will be found to progress from the more general to the more particular, everything growing from its root in an easy and logical manner.

We have begun with a general description in order to lay a sort of foundation for the work ; we have been able after this to give a general view of the history of the entire coast ; and then we have brought our history and description again together, developing the peculiar features of greater sections of the coast, and at last the geographical as well as historical specialities of every point and place.

IV. Appendices.

In two appendices to the work I have given—

I. A collection of reduced copies of maps and charts of the coast, made at several periods of time, ancient and modern, and II, a historical map of the coast, on which I have tried to represent in colors the tracks, the landfalls, and *ne plus ultras* of the navigators, and also the routes of the land travellers, so far as they fall within the range of our Western Coast.

The collection of ancient and modern maps and charts is arranged chronologically. It begins with a chart of the time of Cortez and ends with the first general chart made under the direction of the Superintendent of the United States Coast Survey.

The small copies, of course, only represent the most important features of the originals, and those among the names that were most renowned for the time being.

In the explanatory "notes" which accompany them, I have endeavored to give a short sketch of the history of each map, and have occasionally made some remarks on the chartography of the Western Coast in general.

The charts will serve to illustrate the history of the discovery of the Western Coast, and will themselves derive more light from this history. In the historical memoir I had frequent occasion to refer and make allusion to them.

On the large colored map of the Western Coast I have tried, by a new method, to represent in colors the field of each discoverer. In a note I have described the plan of its construction, and the use which may be made of it, for the further illustration of our subject.

I have further added to the work a full and complete table of contents, which shows its whole plan and purpose in a compendious manner, and enables the reader to find out readily every object connected with the history of the Western Coast to which he may be desirous to refer. To make the work still more useful as a book of reference, I would have added to it also an alphabetical index ; but as it is the intention to bring out similar comprehensive works on the Atlantic and Mexican Gulf coasts of the United States, it may perhaps be better to defer the preparation of such an index until after the entire work has been completed, and to comprise in it all matters connected with the history and hydrography of the coast of this great country.

In concluding this letter, where I have been assisted in my difficult task by so much kindness, I cannot help giving expression to warm feelings of thankfulness for the generous and liberal courtesies extended to me in the libraries of Cambridge and Boston. Still engaged, and yet enjoying this delightful literary hospitality, I can do full justice to the spirit which prompts it, and to my feelings and sense of duty, after I have brought to an end my whole task. I may then take the liberty to specify somewhat more at length the assistance which I have received in researches through the kindness of officers and owners of American libraries. Such specification may perhaps be useful to the American reader in learning at what places he may find stored up ample means of information on subjects kindred to that on which even so short a work as mine may, it is hoped, not prove uninteresting.

I have the honor to be, very respectfully, your obedient servant,

J. G. KOHL.

A. D. BACHE, LL. D.,
Superintendent United States Coast Survey.

APPENDIX No. 53.

Reports of Commander W. T. Muse and Lieutenant R. D. Minor, U. S. N., Assistants in the Coast Survey, on the rescue of the American ship Manlius from sinking near Cape Henry by the officers and crew of the Coast Survey steamer Hetzel.

UNITED STATES COAST SURVEY STEAMER HETZEL,
Portsmouth, N. C., July 13, 1857.

SIR: On the 6th instant, ascertaining that my orders to this vessel had been sent to Norfolk, I proceeded to Old Point Comfort and assumed command of her on the 9th. I immediately got under way, and when about ten miles from Cape Henry was boarded by Captain Pitman, of the ship "Manlius," of Boston, who represented his vessel to be in a very disabled condition, and applied to me for aid. Anxious to afford assistance, if required, I directed Lieutenant Minor to take some men on board the Manlius, ascertain her condition, and learn all the particulars, so that, if necessary, she might, at least, be taken within reach of other assistance. It was judged necessary, so I took her up to Old Point, afforded Captain Pitman aid in procuring other men, and kept our men on board until they were relieved by his recruits. Accompanying this you will find a report in relation to it from Lieutenant Minor, made by my order.

I arrived here this morning at about 9 a. m., having been delayed by easterly winds until the morning of the 12th.

Very respectfully, your obedient servant,

W. T. MUSE.
Commander U. S. N., Assistant Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

UNITED STATES COAST SURVEY STEAMER HETZEL,
Lynnhaven bay, July 11, 1857.

SIR: In compliance with your order of the 9th instant, I respectfully submit the following report of the assistance rendered to the American ship "Manlius," of Boston, by the officers and crew of this vessel.

On the morning of the 9th, while on our way from Old Point to Ocracoke inlet, North Carolina, we were boarded, off "Magnois," by Francis O. Pitman, esq., captain of the ship Manlius, of Boston, then on his way to Norfolk for assistance, who reported that his ship was at anchor off Cape Henry, and in a very disabled condition, leaking at the rate of 4,000 strokes per hour, and his officers and crew nearly exhausted from their continued efforts to keep her from sinking. He requested us to give him immediate assistance, and the steamer was at once headed for his vessel, then distant some ten miles. About 2 p. m. we arrived near her, and I, with Lieutenant Bayard E. Hand and twenty-four men from this vessel, boarded her, took charge of the ship, hove her anchor up, made sail, and stood up the channel way for Hampton Roads, the "Hetzel" keeping close to to render more assistance if necessary. On boarding the "Manlius" I found her to be a Boston built ship of over 700 tons, owned by Messrs. Howes & Crowell, large ship owners in Boston, and last from the coast of Chili, bound to Baltimore, with a cargo of 1,000 tons of copper ore on board consigned to the Baltimore Copper Smelting Company. The ship had been leaking a little for some time past, but on Sunday the 5th instant, when about 375 miles from the capes of Virginia, the leak was found to have suddenly increased to 3,500 strokes the hour. All hands were then sent to the pumps, but the leak increasing to 4,000 strokes, preparations were made on Tuesday the 7th instant to abandon her, the captain and officers considering it very doubtful if the ship could be kept afloat much longer; but with a favorable breeze and continued exertions they succeeded, with the assistance of a Baltimore pilot, Mr. Thomas Bean, (who boarded them on Monday,) in anchoring the ship off Cape Henry in ten fathoms of water. The crew were then too much exhausted to furl her heaviest sails, and moreover, too, they could not well leave the pumps, as their efforts could barely keep her afloat. Finding the ship in this state, I deemed it my duty to take immediate charge; and on an examination of her by Lieutenant Hand and myself, we found the leak to be in her starboard quarter very low down, and the water rushing into the ship with great rapidity, so that with a large force at the pumps we could barely keep her free. I estimate the value of the ship at $40,000, and cargo at $250,000, and, in my opinion, she would have sunk in from 15 to 20 hours had not assistance been so opportunely rendered.

At 5 p. m., the wind being light from the SE., the "Hetzel" took us in tow, and cast us off when well up in the roads.

I then anchored the ship, furled her sails, and with our men left her for the night, giving her in charge of Captain Pitman, who in the meantime had procured some laborers from Old Point to relieve his crew at the pumps. Before leaving, however, I made arrangements with Captain Pitman to send him more assistance during the night should he require it, and subsequently some supplies for the sick, and for the vessel also, were sent on board from the steamer.

On the 10th I again boarded her and found that Captain Pitman no longer needed our assistance, as he had obtained men enough in Norfolk to keep his ship afloat and take her in tow of a steam tug to Baltimore.

I remain, sir, yours, respectfully,

R. D. MINOR,
Lieutenant U. S. Navy.

Commander WM. T. MUSE, U. S. N.,
Commanding U. S. Coast Survey Steamer Hetzel.

BOSTON, *August* 28, 1857.

SIR: Lieuts. R. D. Minor and Bayard E. Hand, with twenty-four men from the United States steamer Hetzel, have recently rendered very important assistance to our ship "Manlius," while in a very leaky condition, near the entrance of the Chesapeake bay.

As a testimony of the appreciation of their services, the insurers on the ship and cargo, together with other parties interested, have requested us to present two chronometer watches—one to Lieut. Minor, the other to Lieut. Hand—which we have this day taken the liberty to send you by Adams' Express Company, and would thank you to forward the same to the parties for whom they are intended.

We also enclose a check, drawn by Messrs. Gilbert & Sons, on Messrs. Josiah Lee & Co., of

Baltimore, for four hundred and eighty dollars, to be divided among the twenty-four men, for the timely aid rendered on the occasion alluded to.

Your obedient servants,

HOWES & CROWELL,
Owners of ship "Manlius."

Prof. A. D. BACHE,
U. S. Coast Survey Office, Washington, D. C.

APPENDIX No. 54.

Letter of Lieut. Comg. J. K. Duer, U. S. N., Assistant Coast Survey, and correspondence showing the action taken by him, at the request of the United States vice consul at Nassau, N. P., and United States consul at Havana, relative to the crew and passengers of the American ship Julia Howard, wrecked on the Bahama bank.

U. S. SURVEYING SCHOONER "VARINA,"
Harbor of Pensacola, December 1, 1856.

SIR: I have the honor to inform you that I arrived here yesterday, having left the navy yard, Brooklyn, on the 8th ultimo, and Staten Island the following morning.

On my way across the Bahama banks I touched at New Providence, and afterwards put into Havana. At the former place I took on board, at the request of the United States vice consul at Nassau, thirteen distressed seamen, who had composed the crew of the American ship Julia Howard, recently sunk on the Bahama bank, and also six steerage passengers from the same vessel, for the purpose of conveying them to Pensacola.

At Havana, however, upon their own application, and by the advice of the United States consul at that port, I permitted the seamen to leave the vessel, and eight of them, claiming to be Portuguese subjects, were taken in charge by the consul for Portugal. The passengers, who are entirely destitute, I was obliged to bring to this place, as I could find no means of sending them to New Orleans, their place of destination.

I enclose a letter to the Hon. Secretary of the Navy, with copies of two communications in relation to this subject from the respective United States consuls.

Very respectfully, your obedient servant,

JOHN K. DUER,
Lieut. Comg., Assistant Coast Survey.

Hon. A. D. BACHE, LL. D.,
Superintendent U. S. Coast Survey, Washington, D. C.

UNITED STATES CONSULATE,
Nassau, N. P., Bahamas, November 19, 1856.

SIR: I have the honor to inform you that I have now in charge thirteen distressed seamen who belonged to the American ship Julia Howard, Patterson master, recently sunk on the Bahama banks while performing a voyage from Boston to New Orleans; and if you could conveniently and consistently do so, I should be very glad if you would give them a passage to Pensacola, for I see no very immediate opportunity of sending them away.

There were also six steerage passengers on board the "Julia Howard" at the time of her disaster, who represent themselves to me to be American citizens, and who are quite destitute, having lost everything when they were obliged to take to their boats.

I am unauthorized by government to take these men in charge, and since they have been here they have been maintained by private charity. If you would also take these poor fellows to Pensacola, they would be exceedingly obliged to you, and I should be relieved of a tax upon my purse.

Very respectfully, your obedient servant,

JOHN R. BACON,
U. S. Vice Consul.

Lieut. J. K. Duer,
Commanding U. S. Schooner Varina, &c., &c.

Consulate of the United States,
Havana, November 25, 1856.

Sir: Eight of the seamen belonging to the crew of the wrecked American ship "Julia Howard," Capt. Patterson, that were placed on board your ship by the United States consul at Nassau, having presented themselves to the consul for Portugal in this place, stating that they are Portuguese subjects; that they are named, respectively, José Viera, Pedro José Machado, Juan de Sousa Cardoso, Manuel Tejera Marcial, Antonio do Mato de Silveria, José de Oliverra Manuel Pereira Seal, and Manuel Miner da Cruz, and expressing a wish to be landed in this port, where they can obtain employment; and the said consul having requested me to permit the said seamen to be landed here, offering to take charge of them, thereby relieving the United States of all responsibility and expense, I have concluded that it is expedient and proper to accede to his request, and therefore I beg of you to allow the said men to come on shore with such baggage as they may have.

I remain, sir, respectfully, your obedient servant,

J. K. BLYTHE,
U. S. Consul.

Lieut. Duer, U. S. N.
Commanding U. S. Survey Schooner Varina, Harbor of Havana.

APPENDIX No. 55.

Results of examinations for sites of light-houses, &c., made by the Coast Survey, at the request of the Light-house Board, under directions from the Secretary of the Treasury, and in accordance with laws of March 3, 1851, *August* 31, 1852, *and August* 3, 1854.

Sec.	Locality.	Object.	By whom examined.	Report of Superintendent.
I.	Point of Rocks, Westport, Mass.	Re-examination for light-house site.	Lieut. Comg. C. R. P. Rodgers, U. S. N.	Recommended Septemb'r 8, 1857. (Appendix No. 56.)
X.	Shore of Santa Barbara channel, Cal.	Re-examination for light-house site.	Comd. Jas. Alden, U. S. N.	Recommended February 14, 1857. (Appendix No. 57.)
XI.	Point Wilson, Admiralty inlet, W. T.	Examination for light-house site and fog-bells.	Lieut. Comg. R. M. Cuyler, U. S. N.	
XI.	New Dungeness spit	Examination for position of fog-bell.	do	
XI.	Smith's island, entrance of Rosario strait.	Examination for position of fog-bell.	do	

APPENDIX No. 56.

Letter of the Superintendent, transmitting the report of Lieut. Comg. C. R. P. Rodgers, U. S. N., Assistant in the Coast Survey, upon a re-examination of the "Point of Rocks," at Westport, Mass., for a light-house site.

BANGOR, ME., *September* 8, 1857.

SIR: I have the honor to report that the re-examination of the Point of Rocks, at Westport, Mass., has been made in accordance with a direction contained in a letter from the department, under date November 29, 1856.

The following is a copy of the report addressed to me by Lieut. Comg. C. R. P. Rodgers, U. S. N., Assistant in the Coast Survey, on completing the service required:

"In pursuance of your instructions, I went in the steamer Bibb, on the 8th of August, to make an examination of the Point of Rocks, at Westport, Mass., in order to determine, in connection with the commerce of that locality, the expediency of erecting a light-house there.

"The inspector of the customs informs me that there are now belonging to Westport nineteen whaling vessels of from 120 to 350 tons, five coasting vessels of from 10 to 90 tons, and twelve fishing vessels of from 10 to 50 tons. Ten of the whaling vessels belonging to Westport are now refitted at New Bedford.

"I am led to believe that during the stormy months, if the harbor was marked by a light, many small coasting vessels would find shelter at Westport when baffled by wind and weather between New Bedford and Newport, instead of turning back to one of those places for a port of refuge.

"After a careful examination of the harbor and its approaches, and a long conference with the pilots and sea captains of Westport, I think there can be no doubt that the southeastern extremity of the 'Point of Rocks' is the best position for the proposed light-house. The channel, which is very narrow, runs within ten yards of the rocks, so that a vessel might steer directly for the light, and, grazing its tower, find herself at once in smooth water and a good anchorage.

"In conclusion, I respectfully state my opinion that the light-house ought to be built; that it should show a colored light to prevent mistakes, and it might be of the smallest size, as its light need not be visible more than six or seven miles."

I concur in the conclusions presented in the report of Lieut. Comg. Rodgers, and would respectfully request that a copy of this communication may be transmitted to the Light-house Board.

Very respectfully, yours,

A. D. BACHE,
Supt. U. S. Coast Survey.

Hon. HOWELL COBB, *Secretary of the Treasury.*

APPENDIX NO. 57.

Letter to the Secretary of the Treasury, transmitting a report from Commander James Alden, U. S. N., Assistant Coast Survey, on the result of his examination for a light-house site on the shore of Santa Barbara channel, California.

COAST SURVEY OFFICE, *February* 14, 1857.

SIR: I have the honor to enclose herewith a copy of a letter from Commander James Alden, U. S. N., Assistant Coast Survey, in relation to the proposed light-house on Point Hueneme, California; also a tracing from his hydrographic sheet containing the site selected, and a copy of the reconnaissance sheet of the United States Coast Survey, showing the position of the point, which I respectfully request may be communicated to the Light-house Board for their information.

Very respectfully,

A. D. BACHE,
Superintendent.

Hon. JAMES GUTHRIE,
Secretary of the Treasury.

U. S. COAST SURVEY STEAMER "ACTIVE,"
San Francisco, January 3, 1857.

DEAR SIR: I send, per Wells, Fargo & Co.'s express, a tin box containing the following charts, viz: Two sheets north of and joining on to Point Año Nuevo, and another containing Hueneme Point and vicinity, together with a sub-sketch showing the relative connection of the latter with Anacapa.

The distance between the island and the main land was gotten rather roughly by tangents, taken from the steamer, there being no opportunity to do it in the usual way.

The best position for a light in that vicinity has been selected, agreeably to instructions, and marked on the chart. But, after having given the subject my most attentive consideration, and while everything seems to make it the most desirable spot for such an aid to navigation, owing to the fact that it is a low sand beach, not easily distinguishable, and directly on the track of vessels sailing between Santa Barbara and San Pedro, and as there are not more than three or four vessels, including a steamer, engaged in the trade, that could be benefitted by it, I should hesitate to recommend the immediate erection of a light in that quarter. Should it, however, be decided to place one there, I would suggest that it be only of the third or fourth order, to serve merely as a guide to coastwise vessels; for since the discovery of the dangerous rock on Cortez Bank it would be imprudent for large vessels from sea to attempt that passage, and a coast light, therefore, on Hueneme Point is, in my opinion, entirely unnecessary.

The ground at the point selected is composed of irregular sand hills some ten or fifteen feet high.

The lantern should be elevated at least fifty feet above the sea, so that the mist which frequently rises from the surf may not obscure it. The arc of the horizon which it will illuminate is 210 degrees. The distance to which it will be seen must, of course, depend upon the size of the light.

I am, respectfully, your obedient servant,

JAMES ALDEN,
Commander U. S. N., Assistant U. S. C. S.

Prof. A. D. BACHE,
Superintendent U. S. C. S., Washington, D. C.

APPENDIX No. 85.

Letter from the Secretary of the Light-house Board, addressed to the Treasury Department, and referred to the Superintendent, with a communication from Commander S. Swartwout, U. S. N., relative to the establishment of a light-house and fog-bells at Point Wilson, Admiralty inlet, W. T., and fog-bells at Smith's island and New Dungeness spit.

TREASURY DEPARTMENT,
Office Light-house Board, December 20, 1856.

SIR: I have the honor to transmit a copy of a letter from Commander S. Swartwout, U. S. navy, commanding U. S. steamer "Massachusetts," dated "Harbor of Seattle, W. T., October 18, 1856," recommending the establishment of a light-house at Point Wilson and certain fog-bells on New Dungeness spit, Point Wilson, and Smith's island, on the Pacific coast, and respectfully to request that the same be communicated to the Superintendent Coast Survey, to whom the subject of the selection of site for light-house on Whidbey's island, at Red Bluff, has been referred.

Very respectfully,

THORNTON A. JENKINS,
Secretary.

Hon. JAMES GUTHRIE,
Secretary of the Treasury.

UNITED STATES STEAMER MASSACHUSETTS,
Harbor of "Seattle," W. T., October 18, 1856.

SIR: Believing that any suggestions from officers of the navy, founded upon actual observation, with regard to the most eligible locations for light-houses, or any information pertinent to this subject, will be always favorably entertained and duly appreciated by the Light-house Board, of which you are chairman, I have concluded to submit for your consideration the expediency and, in fact, necessity of establishing another light-house on "Fuca Straits," in addition to those already appropriated for by Congress, in order to insure safe navigation. The light-house alluded to, and which, in my judgment, is eminently required, should be erected on "Point Wilson," at the entrance of "Admiralty inlet," on "Puget's Sound." Fuca Straits will then have, on the American side, light-houses on Cape Flattery, "New Dungeness spit," Point Wilson, and Smith's island; these, together with a light-house on Race island, (where there is a very dangerous reef,) which it is the intention of the English government to establish, as I have been informed recently by Governor Douglass, of Vancouver's island, will render navigation in Fuca Straits perfectly safe in the darkest nights.

There being a great deal of densely foggy weather in the Straits, and the currents not only rapid but very irregular, I would recommend, as additional safeguards, that fog-bells be placed on New Dungeness spit, Point Wilson, and Smith's island. I have been compelled to anchor frequently with this vessel in Fuca Straits, owing to the very dense fog, and sometimes in fifty fathoms water; whereas, if there had been fog-bells on the different points suggested I could have stood on with safety.

I understand that some of the inhabitants of this Territory are urging upon the government the necessity of erecting a light-house on "Partridge Point" or "Admiralty Head," instead of Point Wilson. * * * * * * * * *

A glance at Captain Kellett's chart of Fuca Straits will, I am confident, satisfy you that Point Wilson is the most eligible site for a light-house, being the foulest shore, and very dangerous of approach, particularly at night and during a fog, in consequence of a low sandy spit extending some distance out from this point; but on Whidbey Island Point the shore is bold and free from reefs or rocks, and the bottom soft mud. This ship has been ashore there, owing to a very dense fog, in only five feet water, for some seventeen hours, without sustaining the slightest damage.

All the pilots of any experience in these waters, and masters of vessels trading between San Francisco and Puget's Sound, concur in opinion with regard to the necessity of a light-house at the entrance of Admiralty inlet, and of Point Wilson being the most eligible site. After doubling Point Wilson there is a safe anchorage for vessels of any draught, where they can find good holding ground and shelter from gales of wind from any quarter.

A light of the third magnitude would be sufficient, provided those on Dungeness spit and Smith's island are of greater magnitude.

Having been on this station for the last eight months, and almost constantly cruising in Puget's Sound and Fuca Straits, by day and night, I flatter myself these suggestions with reference to making navigation safe and easy in Fuca Straits, based upon my own experience, will meet with due consideration from the board.

I am, sir, very respectfully, your obedient servant,

S. SWARTWOUT, *Commander.*

Com. W. B. SHUBRICK,
Chairman Light-house Board, Washington city.

APPENDIX No. 59.

Aids to navigation, recommended in reports made to the Superintendent by Assistants in the Coast Survey.

Sec.	Object.	By whom recommended.	Date of report, &c.
I.	Large buoy to replace buoy on Jordan's Rock, entrance to Portland harbor.	Lieut. Comg. F. A. Roe, U. S. N.	October 30, 1857.
I.	Buoy to mark the flat ground northwest of the Salvages, (Cape Ann.)	Lieut. Comg. C. R. P. Rodgers, U. S. N.	Referred to Light-house Board Oct. 27, 1857. (Appendix No. 60.)
I.	Buoy on southern edge of Middle Ground, northeast of Cape Henry light.	Lieut. Comg. J. J. Almy, U. S. N.	Referred to Light-house Board Feb. 5, 1857. (Appendix No. 61.)
IV.	Buoys to mark a new channel into Beaufort harbor, N. C.	Lieut. Comg. C. R. P. Rodgers, U. S. N.	Referred to Light-house Board May 29, 1857. (Appendix No. 62.)
V.	Buoys for best line of water into St. Simon's sound, Ga.	Lieut. Comg. S. D. Trenchard, U.S.N.	Referred to Light-house Board July 3, 1857. (Appendix No. 63.)
V, VI.	First class buoy to replace that at entrance of St. Mary's river, and buoy for Middle Ground.	do	Referred to Light-house Board April 4 and July 3, 1857. (Appendix Nos. 63 and 64.)
VI.	Buoys for Cumberland island or Swash channel, entrance to Fernandina harbor.	do	Referred to Light-house Board July 3, 1857. (Appendix No. 63.)
VI.	Beacon on Looe key, Florida reefs	Lieut. Comg. T. A. Craven, U. S. N.	Referred to Light-house Board April 4, 1857. (Appendix No. 65.)

APPENDIX No. 60.

Letter to the Secretary of the Treasury, transmitting the recommendation of Lieutenant Commanding C. R. P. Rodgers, U. S. N., Assistant in the Coast Survey, for a buoy to mark the flat ground near the Salvages, (Cape Ann,) Massachusetts.

COAST SURVEY STATION,
Bangor, Maine, October 27, 1857.

SIR: I have the honor to communicate the following extracts from a report made by Lieutenant Commanding C. R. P. Rodgers, United States navy, assistant in the Coast Survey, on closing for the season the operations of his hydrographic party on the coast of Massachusetts:

"The flat ground northward and westward of the Salvages (near Cape Ann) is a dangerous ledge surrounded by deep water, and has as little as two feet upon it in one or two places. I would respectfully recommend that a buoy be placed to mark its position.

"We determined the position of a sunken ledge near Straitmouth island, lying in ten fathoms water, with only twelve feet upon it. This rock is known to very few persons, and its existence was not credited by the mariners who live in the immediate neighborhood."

I would respectfully request that a copy of this letter may be furnished to the Light-house Board.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB, *Secretary of the Treasury.*

APPENDIX No. 61.

Letter to the Secretary of the Treasury, communicating the position recommended by Lieutenant Commanding J. J. Almy, U. S. N., Assistant in the Coast Survey, for a buoy on the southern edge of the Middle Ground, near Cape Henry light-house.

COAST SURVEY OFFICE, *February* 5, 1857.

SIR: I have the honor to transmit herewith, for the information of the Light-house Board, a chart showing, on different scales, the entrance into Chesapeake bay, and having marked thereon the position recommended by Lieutenant J. J. Almy, United States navy, assistant in the Coast Survey, for a buoy to the northward and eastward of Cape Henry light-house, upon the southern edge of the Middle Ground.

Lieutenant Almy remarks, in reference to it: "A buoy in the position indicated would serve more particularly as a warning to large clipper ships, drawing from twenty-one to twenty-three feet water, when working in or out of the Chesapeake, so that they may not stretch over to the northward too far, and it will also distinctly mark the northern boundary of Cape Henry channel.

"From long experience and much observation in that locality, I would recommend the placing of a large substantial buoy there, with strong heavy moorings, as the situation is much exposed to a heavy sea."

Fully concurring in the suggestion made by Lieutenant Commanding Almy, I would respectfully request that a copy of this letter may be sent with the enclosed chart to the Light-house Board.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE,
Secretary of the Treasury.

APPENDIX No. 62.

Letter to the Secretary of the Treasury, communicating the recommendation of Lieut. Comg. C. R. P. Rodgers, U. S. N., Assistant Coast Survey, for buoys to mark a new channel westward of the main ship channel into Beaufort harbor, N. C.

COAST SURVEY OFFICE, *May* 29, 1857.

SIR: I have the honor to communicate, for reference to the Light-house Board, extracts from a report addressed to me by Lieut. Comg. C. R. P. Rogers, U. S. N., Assistant Coast Survey, upon concluding the resurvey of Beaufort harbor, N. C.:

"A new channel across the breakers of 1854 seems to be forming to the westward of the main ship channel, from which it turns at the southwest end of Shackleford, and runs into the open sea in a direction a little to the westward of south. Through it ten and a half feet may now be carried at low water. In 1854 there was a slue to the northward and westward of it, through which eight feet could be carried. This is now entirely closed by breakers, on which are from three to seven feet water where was a depth of more than twenty feet three years ago.

"It seems probable that this new channel will become deeper, and it is not unlikely that it may, at some future day, become the chief entrance to the harbor. If properly buoyed, it would prove of much value during the westerly winds of winter, by enabling vessels from the westward to get into Beaufort harbor with great ease at times when it would be impossible for them to enter by the main channel. Many vessels which are now driven to sea by the fierce northwesters, so prevalent in the winter, might thus find a safe port of refuge. Two or three buoys would be sufficient to mark the entrance, and I would most respectfully urge the expediency of placing them without delay.

"Buoys might also be placed with much advantage to mark the inner slue along Bogue beach, which is much used by small coasters."

I concur in the recommendations of Lieut. Comg. Rogers, and for the better understanding of his suggestions, I inclose herewith a tracing from the chart of resurvey of Beaufort harbor.

Very respectfully, yours,

A. D. BACHE,
Superintendent.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 63.

Letter to the Secretary of the Treasury, communicating the recommendations of Lieut. Comg. S. D. Trenchard, U. S. N., Assistant Coast Survey, for buoys at St. Simon's bar and St. Mary's river entrance, Georgia.

COAST SURVEY OFFICE, *July* 3, 1857.

SIR: I have the honor to append, for the information of the Light-house Board, extracts from the report of Lieut. Comg. S. D. Trenchard, U. S. N., Assistant in the Coast Survey, with recommendations in regard to buoys at St. Simon's bar, and for replacing the buoy at the entrance of the St. Mary's river, Georgia, and marking out the Cumberland island, or Swash channel. The report referred to was made under date of June 25, after completing the hydrographic survey in that vicinity. Lieut. Comg. Trenchard says:

"I would recommend that the present entrance buoy at St. Mary's bar be replaced by one of the first class, and that the Cumberland island or Swash channel be buoyed out. Nine feet can be carried through it at ordinary low water, and the channel would prove very useful to steamers and coastwise vessels.

"Two additional buoys will be necessary to mark out the best line of water into St. Simon's sound, the positions for which can be decided upon after the additional soundings just completed have been plotted."

I concur in the recommendations of Lieut. Comg. Trenchard, and would respectfully request that a copy of this communication may be transmitted to the Light-house Board.

The plotting of the chart of St. Simon's sound, referred to, will be executed without delay.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 64.

Letter to the Secretary of the Treasury, transmitting the recommendation of Lieut. Comg. S. D. Trenchard, U. S. N., Assistant Coast Survey, for an additional buoy on St. Mary's bar, Ga.

SAVANNAH, GEORGIA, *April* 4, 1857.

SIR: I have the honor to communicate the following extract from the report of Lieut. Comg. S. D. Trenchard, U. S. N., Assistant Coast Survey, accompanied by a tracing, recommending an additional buoy to be placed on St. Mary's bar, Georgia, and would respectfully request that it be referred to the Light-house Board.

"I have the honor to report, in conformity with your instructions, having made a very careful and thorough re-examination of St. Mary's bar, and established the positions of the buoys, which will be found upon the chart herewith transmitted. I find the bar somewhat changed since last year; the '13½ feet ridge' extending across the channel now appears broken, forming a middle ground, with a channel of over fourteen feet on either side. I would therefore recommend that a buoy be placed upon the middle ground. The other buoys are in good position."

Very respectfully, yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 65.

Letter to the Secretary of the Treasury, communicating the recommendation of Lieut. Comg. T. A. Craven, U. S. N., Assistant Coast Survey, for a beacon on Looe key, Florida reefs.

SAVANNAH, GEORGIA, *April* 4, 1857.

SIR: I have the honor to communicate, for the information of the Light-house Board, the following recommendation contained in a letter from Lieut. Comg. T. A. Craven, U. S. N., Assistant Coast Survey, dated Key West, March 23, 1857, which has my approval.

"I have to recommend that a permanent and substantial beacon be erected on '*Looe key*'; it is bare at low water only, (is a bank rather than a key,) and a beacon can be erected there at a very trifling expense. A well braced screw pile, similar to those put up two years ago near the entrance of Newark bay, would last here for ages."

Very respectfully, yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

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INDEX TO SKETCHES AND DIAGRAMS.

Omitted

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

Please Note:

This project currently includes the imaging of the full text of each volume up to the "List of Sketches" (maps) at the end. Future online links, by the National Ocean Service, located on the Historical Map and Chart Project webpage (http://historicals.ncd.noaa.gov/historicals/histmap.asp) will includes these images.

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