REPORT

OF

THE SUPERINTENDENT

OF THE

COAST SURVEY,

SHOWING

THE PROGRESS OF THE SURVEY

DURING

THE YEAR 1859.

WASHINGTON:
THOMAS H. FORD, PRINTER.
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National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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LETTER

FROM THE

SECRETARY OF THE TREASURY,

COMMUNICATING


In the House of Representatives, June 13, 1860.

Resolved, That there be printed five thousand extra copies of the Report of the Superintendent of the Coast Survey for the year 1859; three thousand of which shall be for distribution by the Superintendent, and two thousand shall be for the use of the members of the House.

JOHN W. FORNEY, Clerk.

TREASURY DEPARTMENT, February 6, 1860.

Sir: I have the honor to present, for the information of the House of Representatives, a report made to the Department by Professor A. D. Bache, Superintendent of the United States Coast Survey, stating the progress in that work during the year ending November 1, 1859, accompanied by an engraved map showing the general progress made in the survey of the Atlantic, Gulf, and Pacific coasts, and also the manuscript map prepared at the Coast Survey Office, in accordance with an act of Congress approved March 3, 1853.

With great respect, your obedient servant,

HOWELL COBB,
Secretary of the Treasury.

Hon. Wm. Pennington,
Speaker of the House of Representatives.
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ERRATA.

In Coast Survey Report for 1858.

Page 114, line 19 from bottom, for "inspector" read "Engineer."
Page 114, line 16 from bottom, for "in the harbor" read "outside of the harbor."
Page 122, after "tidal observations" dele "with the self-registering tide gauge."
Page 279, line 2 from bottom, for "month" read "month."

In Coast Survey Report for 1859.

Page 36, 1st line, insert "8" before "Una Minoria."
REPORT.

COAST SURVEY STATION, COOPER, WASHINGTON COUNTY, MAINE,

September 23, 1859.

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 surveying year, from November 1, 1858, to November 1, 1859.

As the scale of the work, depending upon the amount of the appropriation made for its progress, is the same this year as the last, the report will go over nearly the same extent of ground as the former one. A general view of the progress from the real commencement in 1832, to the present time, is shown in a map prepared for the purpose, (Sketch No. 36,) and will presently be referred to particularly.

The survey has again been in progress in its land work, hydrography, or office work, in the twenty-two seacoast States, and Territories of the United States, in which it is not essentially completed.

I propose to retain the same divisions in the present report as in those immediately preceding it, namely, the introduction, the description of operations, and the Appendix.

I. The introduction discusses briefly the progress of the work under separate heads and gives the estimated progress for the next year, and the means necessary to secure it, thus bringing together the work done and the appropriation required for that amount of progress.

II. In the second part a detailed account is given under the head of sections, arranged geographically, of the field, hydrographic, and office work done during the year. The sections are numbered from one, beginning at the northeastern boundary, to nine, terminating with the southern line of Texas, and including the Atlantic and Gulf coast of the United States. Sections ten and eleven, including the western coast, begin at San Diego, and terminate at the forty-ninth parallel of latitude. Under each head the work is described in the general order of its execution, as 1. Triangulation; 2. Topography; 3. Hydrography, with statistics of the several operations, and other particulars relating to the work. Each chapter is prefaced by a brief reference to the progress made in the sections, and by a statement of the office work pertaining to it.

III. The Appendix contains information useful to navigators, commercial men, surveyors, and men of science, with such lists and papers relating to the work as could not conveniently be introduced into the body of the report. It is subdivided, for purposes of ready reference, into the following heads: 1. Field, hydrographic, and office details, embracing general lists of the parties and their occupation as distributed along the coast; the names of officers of the army and navy attached to the work; data furnished from the archives in reply to applications made within the year; the statistics of field and office work; a list of surveys made on the Western Coast; the developments made in the course of the regular hydrography; tide tables
for navigators, and a table of the depths at important port entrances on the Atlantic, Gulf, and Western Coast; detailed reports of work performed in the office divisions; lists of the topographical and hydrographical sheets registered within the last two years; and lists of the geographical positions furnished by data received from the field within the same period. 2. Special operations and scientific discussions relating to magnetism, tides, and currents. 3. Local surveys, comprising descriptions of special localities, their topographical features, and their resources. 4. Miscellaneous scientific matters relating to methods and instruments. 5. Correspondence incidental to the operations of the survey. 6. Lighthouse matters referred to the Board for consideration.

The first part of the introduction shows the progress and gives the estimates for the next year's progress. The last contains remarks upon work done, and especially upon the parts which are not referred to in the body of the report.

GEOPGRAPHICAL SECTIONS—ESTIMATES OF PROGRESS AND COMPLETION.

In my report for 1857 I estimated the time of completion of the work on the Atlantic and Gulf at from ten to twelve years, estimating upon the "present resources and regular rate of progress," and showed how this could be accomplished by the same resources from the direct estimates and the aid derived from the Navy, War, and Interior Departments. In my next report I stated that "the available means from different sources for this last fiscal year, (1858-'59,) were ninety thousand dollars less than for the former," (1857-'58.) "These appropriations were less by $30,000 than those for the previous year, 1857-'58, besides which, no appropriation was asked by the Interior Department for the survey and marking of the Florida keys, and of the islands off the Western Coast, making a diminution of $90,000 in the available means for the progress of the survey in 1858-'59." The portion of this reduction which fell upon the field and office work of the Atlantic and Gulf sections was $40,000, being about eleven per cent., or more than one-tenth, requiring an increase of rather more than one year in ten, in the estimated time of completion. It is not to be expected that this decrease will show itself in a marked way in two years, except in those sections which have suffered most from it, but I cannot be responsible for it when it does appear.

I have carefully revised the estimates of progress and completion presented in my report of 1856-'57, and, adopting the same order of discussion as given in that report, now proceed to give the results, which will be found in accordance with the statements then made.

SECTION I. From Passamaquoddy bay to Point Judith, including the coast of the States of Maine, New Hampshire, Massachusetts, and Rhode Island.—The primary triangulation is carried to the northeastern boundary of the United States, requiring merely the occupation of certain stations passed by in order to advance the coast work, to complete the original scheme from Point Judith (Rhode Island) to the limits of Maine.

Three secondary triangulation parties will finish the triangulation in six years, and the progress will show whether this is the best course, or to press on the topography, employing only occasionally a third triangulation party, so as to complete the triangulation in seven and a half to eight years. The completion of the primary work of this section will give means from the estimates to furnish the additional topographical parties needed to keep fully up with the secondary triangulation. Two hydrographic parties with steam vessels and one with a sailing vessel will keep the hydrography close upon the triangulation and topography. The progress made this season shows that there will be no difficulty in this respect.
Allowing a margin of two years brings us to the estimate of my report for 1856-'57, namely, "ten to twelve years" from that date, or eight to ten from this, even without the additional year already referred to.

A map has been marked off with the limits of average progress, as determined by the statistics of the survey, to be expected in the triangulation of this part of the coast, and will enable me to regulate the progress accordingly. In two years the same may be done for the topography and hydrography.

**SECTION II. From Point Judith to Cape Henlopen, including the coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.**—The parties which, from time to time, can be spared to work upon the rivers of this section and upon revision, will easily bring to a close the small portion of outstanding work within the time estimated for the completion of the other sections.

**SECTION III. From Cape Henlopen to Cape Henry, including the coast of part of Delaware, and the coast of Maryland and part of Virginia.**—The remaining work in this section, which is small, compared with that already executed, between one and two tenths, is provided for in the estimates and steadily advancing. It will easily be completed within the time named for the other sections.

**SECTION IV. From Cape Henry to Cape Fear, including part of the coast of Virginia and North Carolina.**—The primary triangulation of Pamlico sound and its rivers, not commenced at the date of my report of 1856-'57, has had one season's work upon it, and will regularly advance to its completion. The parties are provided which will bring all the work of this section to a close within the time estimated for section I, and that without burdening other parts of the survey. The plans for prospective operations are quite matured.

**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.**—The same number of parties should be kept in this section for another year as heretofore, after which one or more can be spared for other work, and yet complete the section in the time required for section I. Two secondary triangulation parties would complete that work in five years. The question of the character of the primary work, and of bases of verification, will be settled, probably, in another year, certainly in two. The hydrography of the section is well advanced, the ocean part of it especially.

**SECTION VI. From St. Mary's river to St. Joseph's bay, including the eastern and western coasts of the peninsula of Florida, and the Florida reefs and keys.**—The expedient of a line across the head of the peninsula, by which the triangulations of the Atlantic and Gulf coasts will be connected, changes essentially the character of the triangulation necessary around the peninsula, and alone renders possible the completion of this section within the time required for section I. In fact, it will require great exertion and steady execution of plans to succeed in this. Three triangulation parties on the eastern side, and two on the western, will be required to make this sure. I rely upon parties available after two years, from other sections, to bring up any arrears which we may find in the section; but it may be most prudent to add a year to my estimate of 1857, and to make it eight to nine years from the present date, which is the same limit as of section I. The topography keeps well up with the triangulation, and so does the hydrography, the reef being nearly completed, so that the time of completion of this section may be safely estimated as not greater than for section I. The reduction of thirty thousand dollars, furnished
by the Interior Department for the Land Office surveys prior to 1858 fell heavily upon this section.

SECTION VII. From St. Joseph's bay to Mobile bay, including part of the coast of Florida and the coast of Alabama.—Of this section I stated in my report for 1857 as follows: "This was the last section commenced, and it is perhaps between one-sixth and one-fifth done. It will require additional force to put 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."

I shall make a strong effort to procure an additional hydrographic party for section IX, so that the steam vessel available for this section shall be constantly employed here. No effort shall be spared to bring the section up to the others in its progress. The reduction of the appropriation has prevented the supply of an additional party during the last two years.

SECTION VIII. From Mobile bay to Vermilion bay, including the coast of Mississippi and of part of Louisiana.—The work in this section makes steady progress, and the topography is kept close to the triangulation, being, in fact, connected with it generally. With the force now in the section it will not be difficult to finish the triangulation, as estimated in 1856-57, in eight years from this present date, and to complete the work at the same time with section I. As remarked in my report for 1856-57, no one of the parties at work here can be spared for other sections, if this one is to be completed within the time estimated.

SECTION IX. From Vermilion bay to the southwestern boundary, including part of the coast of Louisiana, and the coast of Texas.—In my former report I supposed that additional force would be required to complete this section in time, and I am now sure of it. It may lag behind the other Gulf sections, unless means are furnished to push it onward. My notes show that I had intended to furnish another triangulation party to the section, had means sufficient been available, two years ago.

WESTERN COAST.

Sections X and XI. From San Diego to the forty-ninth parallel, including the coast of California and Oregon, and that of Washington Territory.—It would be premature to attempt to estimate for the completion of this work, only commenced in 1850. The progress has been quite satisfactory, considering that the appropriation only provides for two triangulations, two topographical parties, another for triangulation and topography, and one hydrographic party. The harbors of this important coast have been surveyed, except those of Washington Territory, only a part of which are yet completed; and, besides a general reconnaissance, and the important work connected with the northwestern boundary between the United States and Great Britain, the general hydrography has been steadily prosecuted.

GENERAL STATEMENT OF PROGRESS.

The survey on the Atlantic and Gulf coast is nearly two-thirds done, and with the means appropriated for 1857-58 can be finished, as then stated, in from ten to twelve years from that date. The revision of my estimates of time has, as already stated, confirmed this conclusion; and, at the present diminished rate of appropriation, we shall probably fall but one year behind
that period, if the present system is strictly persevered in to the close. In my report of last year I frankly stated the difficulties of accomplishing this result, and the circumstances under which alone I deemed it practicable. I would merely call attention to these, that I may incur no responsibility not properly belonging to such an arduous task.

I propose now to state, in the most brief form, the general progress of the survey. It will be seen, by reference to the general progress sketch, (No. 36.) that the triangulation of the Atlantic coast is continuous from the northeastern boundary of the United States to Little river, near the boundary between North and South Carolina, an extent of more than twelve hundred miles measured from point to point, and a proportional part of the whole Atlantic coast of two-thirds, as estimated in the same way, or of three-fourths as estimated by shore-line. I do not mean to say that the work is complete between these limits, because the secondary triangulation in some portions, and the primary in others, is not complete; but the work is a connected one, and as such is available for preliminary purposes. With an interval of but sixty miles, it is again connected to St. Simon's entrance, on the coast of Georgia, two hundred and twenty miles, leaving an interval of about thirty miles to the St. Mary's. From the St. John's it is nearly complete (with an interval of but eight miles) to Matanzas river, (St. Augustine.) Two parties will probably be at work this winter, advancing towards each other, from St. Augustine south and from Indian River inlet north; and, as soon as the appropriation will admit, a third will be placed here, to proceed from Indian river southward.

In the aggregate, the secondary triangulation of about seven-eighths of the Atlantic coast is completed.

From Cape Florida to the Marquesas the triangulation is continuous one hundred and seventy miles, and one or two seasons more will finish the intricate work of the inner keys and coast of Florida bay. The triangulation of Charlotte harbor is nearly completed; that of the Gulf coast extends from Chassahowitzka river to Cedar Keys—fifty miles; over Ocsilla entrance; then from St. Mark's, beyond Apalachicola, to Indian Pass; over St. Andrew's bay; then from the middle of Santa Rosa sound to Pensacola entrance, including also Pensacola bay and its principal dependencies; from Mobile entrance, and up Mobile bay (westward) to Point Fortuna, in Isle au Breton sound, one hundred and thirty miles, and through Lake Borgne and Lake Pontchartrain, to New Orleans; over Bay Rondo and the passes of the Mississippi, and over Isle Dernière and Caillou bay; over Atchafalaya and East Côte Blanche bays; from East bay, (Galveston,) southward and westward, over Matagorda and Aransas bays and their dependencies, one hundred and ninety miles, to Aransas Pass, which is about a hundred and forty miles from our southeastern boundary.

The topography and hydrography based upon these triangulations have kept close pace with them, in some of the sections requiring the communication of results by the triangulation parties to the topographical parties, and in others by both triangulation and topographical parties directly to the hydrographic parties as soon as completed in the field.

The harbors of the Western seacoast of the United States, and many of the more important ones in the vast navigable sounds of the Pacific coast, have been surveyed, and the general triangulation from San Francisco as one centre and Santa Barbara as another, over Columbia river, in Oregon, in Washington sound and its dependencies, the Straits of Haro and Rosario and the islands between, to the northwestern boundary and southward into Puget's Sound, have been steadily pushed forward, and the topography and hydrography have followed closely.

The astronomical work has been kept up along the whole coast, as far as the progress of the
other operations rendered advisable. The latitudes and longitudes of the headlands on both coasts have been determined, and, with the intermediate stations, these make a total of seven thousand one hundred and seventy-eight points of which the geographical positions have been computed.

Preliminary determinations of longitude from Europe have been made by the best methods known to science. The telegraphic method of longitudes, perfected in connexion with the survey, has enabled us to connect the distant points—Calais, in Maine, and New Orleans, in Louisiana—with a certainty hitherto impossible. I am satisfied that a few signals by telegraph from America to Europe will enable us to determine the difference of longitude with a degree of accuracy which neither long-continued astronomical observations nor the transportation of chronometers have yet reached, or can ever reach. This is one of the works specially enjoined upon the Coast Survey by the plan of reorganization, and to which unvarying attention has been directed from the date of that plan until the present time.

The tide tables for navigators (Appendix No. 14) have been further revised for determining, by simple rules, the times and heights of high and low water in our different ports.

The magnetic elements, so important to the navigator and surveyor, have been further determined, and the tables now contain the result of observations made at over two hundred stations on all parts of the coast.

No less than three hundred and thirteen charts or sketches of harbors, inlets, shoals, sounds, bays, &c., have been drawn, engraved, and published, founded upon the land and hydrographic work of the survey.

PROGRESS FROM NOVEMBER 1858 TO NOVEMBER 1859.

The first table in the Appendix (No. 1) shows the distribution of the parties along the coast in the different sections, the officers employed, and the general limits of the work executed. A map of each section shows the work in some detail, and with convenient signs to denote the several operations. I give in this connexion a condensed account of the progress made in the field and office work, subdivided according to the eleven geographical sections of the survey.

SECTION 1. Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.-(Sketches A and A bis, Nos. 1 and 2.)—The primary triangulation has been extended to the northeastern boundary of the United States, Howard mountain, near Machias, and Western Ridge, Cooper, Maine, having been occupied during the season. Observations for latitude and azimuth, and for the magnetic elements, have been made at the same stations, and the base on Epping Plain has been connected with the general triangulation. Chamcook has been occupied for the triangulation of Passamaquoddy bay and the St. Croix. The secondary triangulation has been continued in Penobscot bay, and connected with that extending southward and westward, over Muscongus bay, to Damariscotta river. The topography of Wiscasset bay has been completed, and progress made in that of Sheepscot river. The plane table survey of the Kennebec river and Merrymeeting bay has been nearly completed, and that of Casco bay has been extended eastward nearly to Harpswell. That of Cape Cod bay has been extended east and west, including the shores of Barnstable harbor, Mass., and verification of the topography done in the section is now in progress. The hydrography has been extended from Cape Newaggen and Damiscove island to Cape Small Point, outside of Kennebec entrance, and soundings have been made in Casco bay to join with former work abreast of and between Portland light and Green island.
The in-shore hydrography has been extended from Cape Elizabeth to Kennebunkport, Me., and soundings have been made between the Isles of Shoals, N. H. Deep-sea lines have been run from Cape Ann, across Cashe's Ledge, to Seal island, N. S., and thence by traverses to Machias, Mount Desert rock, Matinicus, and Manhegan island, to Portland entrance; and from Cape Elizabeth (southward) to Nausett Centre light, Cape Cod. The off-shore hydrography has been continued off the coast of Massachusetts. Revision work has been done in Salem and Hyannis harbors, and work for the examination of changes in parts of Boston harbor. Special magnetic observations have been made at Portland, Me., Portsmouth, N. H., and at several stations on Cape Ann, Mass. The tidal observations at Boston have been continued, and a tidal station has been established at Eastport, Me. Experiments with a new pressure tide-gauge have been made at Charlestown, Mass.

The drawing and engraving of additions to the chart of Boston harbor have been completed, as also the drawing of those of Portland harbor, Lynn harbor, and a new edition of that of Muskeget channel; and the engraving of the preliminary charts of Kennebec river and Rockport harbor. Progress has been made in the drawing and engraving of general coast chart No. II, from Cape Ann to Gay Head, and of preliminary coast chart No. 3, from Cape Small Point to Cape Cod; in the drawing of coast maps and charts Nos. 7, from Muscongus bay to Portland harbor; Nos. 9, 10, and 11, from Cape Neddick to Hyannis harbor, and No. 14, from Cuttyhunk island to Block island; also in the engraving of coast maps and charts Nos. 12 and 13, from Monomoy to New Bedford; the views for these charts, the finished maps of Kennebec river and Lynn harbor, and the new edition of the chart of Muskeget channel.

Section II. Coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.—(Sketch B, No. 7.)—The triangulation of the Hudson river has been extended from Hudson northward, to connect with the work from Albany southward, at New Baltimore, and additional points have been determined near Yonkers. The topography of the Hudson has been continued, with intervals, north from the former limit to near Sing Sing on the eastern shore, and to Rock mountain on the western shore, including the delineation of the Palisades; that of Harlem river has been completed, and that of Long island, back of Brooklyn and Williamsburg, and in the vicinity of South Jamaica, has been filled in. The outlines of the new piers at Sand Point and Great Neck have been traced. The hydrography of the Hudson river has been in progress from Newburgh north to Poughkeepsie. A resurvey has been made of the shore off the Battery, New York city, for changes. Magnetic stations have been occupied at Hartford, Conn.; Springfield, Chesterfield, and Deerfield, Mass.; and at Rutland, Vt.; and minute current observations have been made off the western end of Long Island. Tidal observations have been continued at Brooklyn.

Progress has been made in the drawing and engraving of coast map and chart No. 22, New York bay and harbor, and in the drawing of the map of Hudson river, from its entrance to Sing Sing. New plates of the middle and eastern parts of the chart of Long Island Sound have been engraved, and the old plate of the chart of Captain's islands, East and West, has been re-engraved.

Section III. Coast of Delaware, Maryland, and part of Virginia.—(Sketch C, No. 9.)—The triangulation of the Potomac river has been extended from the mouth of the St. Mary's upwards, to the vicinity of Britton's bay; that of the James river has been completed by work at Hampton Roads, and a base measured near Claremont for verifying the triangulation of the upper James river and of the Appomattox. The topography of the outer coast of Maryland
has been continued, and that of the shores of Chincoteague bay completed. The shore line of the Patuxent has been traced from Holland’s Point to Half’s creek, and that of the St. Mary’s, Maryland, from its entrance upward to Warehouse Point, nearly completing the preliminary survey of those rivers. The shores of the James river have been traced between Westover and Little Brandon, completing the preliminary survey. The topography of the western shore of Chesapeake bay, between Rappahannock river and Mobjack bay, has been nearly completed. Soundings have been nearly completed in the Patuxent and St. Mary’s rivers, and entirely in the James river, and the Big and Little Annesmessex, dependencies of Tangier sound. Observations with self-registering tide-gauges have been kept up at the Washington navy yard and at Old Point Comfort.

The chart of York river, from King’s creek to West Point, has been drawn and engraved for publication. The topography and lettering of coast maps and charts No. 31, Chesapeake bay, from its head to Magothy river; and No. 33, from Hudson river, Maryland, to the Potomac; of the finished chart of PatapSCO river, and the outlines of coast map and chart from Green Run inlet to Little Machipongo inlet, (from a photographic reduction,) have been engraved. Progress has been made in the drawing and engraving of coast maps and charts Nos. 35 and 36, from Pocomoke sound to the entrance of Chesapeake bay; in the drawing of general coast chart No. IV, from Cape May to Currituck sound; of coast maps and charts Nos. 28 and 29, (the latter mainly by photography,) from Cape Henlopen to Little Machipongo inlet; No. 33 Chesapeake bay, the sheet of James river, from Richmond to City Point; and coast map and chart No. 37, from Cape Henry to Currituck sound; and also in the engraving of coast maps and charts No. 32 Chesapeake bay, from Magothy river to the Hudson, Maryland, and No. 34, from the Potomac to Pocomoke sound.

SECTION IV. Part of the coast of Virginia and of North Carolina.—(Sketch D. No. 15.)—The primary triangulation over Pamplico sound has been commenced. The triangulation of verification near New Inlet, Cape Fear, has been continued. The topography of the coast of Virginia, between Currituck sound and Cape Henry, has been completed. Inshore, hydrography on the coast of North Carolina has been extended from Bogue inlet, southward and westward, to New River inlet, and lines of soundings run between Cape Henry and Cape Hatteras, and observations in the Gulf Stream made in the vicinity of Cape Lookout.

Comparative charts of the Cape Fear entrances, showing the changes from 1851 to 1858, and diagrams, illustrating Gulf Stream explorations, have been drawn, and the former engraved upon stone, under the direction of the Superintendent of Public Printing. Progress has been made in the drawing and engraving of preliminary coast chart No. 11, from Cape Hatteras to Cape Lookout; in the drawing of No. 12, from Cape Lookout to Cape Fear; in that of coast map and chart No. 48, from Bogue inlet to Barren inlet; and in the engraving of coast maps and charts Nos. 40 and 41, Albemarle sound.

SECTION V. Coast of part of North Carolina and coast of South Carolina and Georgia.—(Sketch E, No. 16.)—Astronomical and magnetic observations have been made at Cape Fear entrance, and the latitude, azimuth, and magnetic elements have been determined at Port Royal station. The triangulation has been extended south and west from Shallotte inlet to the boundary between North and South Carolina, and the shore line traced in connexion with it; signals have been erected and lines prepared for extending the primary work south and west of the Edisto base; the triangulation of Beaufort, Chechessee, and Colleton rivers, South Carolina, has been made, and that from Sapelo base extended southward across Doboy and Altamaha entrances to St. Simon’s
sound. The topography has been continued southward and westward from Shallotte inlet; the preliminary survey between St. Helena sound and Savannah river has included the shore lines of Port Royal sound and the entrances of Beaufort, Broad, Chechessee, and Colleton rivers, and Calibogue sound. The topography of St. Catharine’s sound has been nearly completed. The hydrography has been continued in-shore from Cape Fear entrance to Tubb’s inlet, N. C., and the off-shore between Cape Fear and Charleston harbor. Soundings have been completed in Bull’s bay, S. C., and a resurvey of Port Royal entrance has been made. The hydrography of the Chechessee and Colleton rivers, S. C., has been completed, and also that of Sapelo entrance and approaches. Tidal observations have been kept up in Charleston harbor.

In the drawing and engraving divisions additions have been made to the chart of Charleston harbor. The chart of Sapelo sound has been drawn and engraved, and the engraving of preliminary coast chart No. 14, from Cape Romain to Savannah river, has been in hand. Progress has been made in the drawing of coast maps and charts No. 53, from Charleston harbor to St. Helena sound; and No. 58, from St. Mary’s river to the St. John’s, Florida; and in that of the chart of Ossabaw sound.

Section VI. Coast, reefs, and keys of Florida.-(Sketches F, Nos. 20 and 21.)—The triangulation along the air line from Fernandina to Cedar keys has been continued to Waldo station. A preliminary base has been measured near St. Augustine, and the triangulation has been carried north towards Diego plains. A preliminary base has been measured at Indian river inlet, Florida, and signals erected for the triangulation north and south of Fort Capron. The triangulation of the inner bays has been extended eastward from Lignum Vitæ to Pigeon key Florida reef; and that of Charlotte harbor has been extended from Captiva pass northward to Punta Gorda. The topography of the western shores of Key Biscayne and Cards’ sounds has been completed, as also on the western side of Key Largo, and the survey made of numerous keys between Lignum Vitæ and Oyster keys. The topography of Charlotte harbor has been continued northward from the former limit to BocaGrando. The hydrography of the Florida reef has been continued from Eagle cove to Coffin’s Patches; the Gulf Stream has been explored through the Florida channel, and soundings made for depth and temperature in sections across it, from Carysfort light-house, Sombrero key, and the Tortugas. Tidal observations have been continued at St. Mary’s river entrance, Tortugas, Charlotte harbor, and Egmont key, (Tampa.)

Progress has been made in the drawing and engraving of coast map and chart No. 65, Florida reef, from Key Biscayne to Carysfort reef; and in the drawing of Nos. 70, 71, and 72, Florida reefs and keys, from Long key to the Marquesas.

Section VII. Part of the western coast of Florida.—(Sketch G, No. 23.)—The triangulation has been carried from Crystal reef southward to the vicinity of Bayport; has been continued from St. George’s sound to St. Mark’s harbor, and from Pensacola bay into Santa Rosa sound. The topography has been continued nearly over the same limits. The hydrography has included a verification of the work at Cedar keys, and that at the eastern entrance of St. George’s sound, including the new channel (Duer’s) passing near Dog island. Tidal observations have been kept up at Cedar keys, and at Warrington, Pensacola harbor.

The drawing and engraving of the preliminary chart of the eastern part of St. George’s sound have been completed, as also the engraving of the preliminary chart of Pensacola harbor. The drawing of the preliminary chart of Apalachicola bay has been finished at the
office, and since engraved on stone, under the direction of the Superintendent of Public Printing.

SECTION VIII. Coast of Alabama, Mississippi, and part of Louisiana.—(Sketch II, No. 26.)—
The triangulation of Isle au Breton sound has been continued southward to Point Fortuna; progress has been made in that of Passe à Loutre; the SE. Pass of the Mississippi and-of Bay Rondo, and that of Côte Blanche bay, has been extended westward nearly to the entrance of Vermilion bay. The topography of the shores of Lake Pontchartrain has been continued, and that of Isle au Breton sound has nearly kept pace with the triangulation; that of the SE. Pass of the Mississippi has been executed, and that of Côte Blanche bay has kept pace with the triangulation. The hydrography of Passe à Loutre has been executed, and that of Atchafalaya and Côte Blanche bay east completed. Some deep-sea lines of soundings have been run in the Gulf of Mexico.

The preliminary chart of Atchafalaya bay has been drawn and engraved, and the engraving of coast maps and charts Nos. 91 and 92, Mississippi sound and Mobile bay, from Bon Secours bay to Grand island, has been in progress.

SECTION IX. Coast of part of Louisiana and coast of Texas.—(Sketch I, No. 28.)—The triangulation has been carried from Matagorda entrance southward and westward over Espiritu Santo, San Antonio, Aransas, and Capano bays, and their dependencies. The topography has been extended along the shores of Espiritu Santo and San Antonio bays, and part of Matagorda island. The hydrography of Matagorda bay has been completed between the city and Palacios point.

The reconnaissance sketch of the entrance to Brazos river has been drawn and engraved, and progress has been made in the drawing and engraving of coast maps and charts Nos. 106 and 107, from Galveston bay to Matagorda bay; also in the drawing of coast maps and charts No. 105, Galveston bay, and No. 108, Matagorda bay. A general reconnaissance sketch of part of the coast of Texas, from Matagorda bay to Aransas Pass, has been drawn at the office, and was engraved on stone, under the direction of the Superintendent of Public Printing.

SECTION X. Coast of California.—(Sketches J and J bis, Nos. 30 and 31.)—The primary triangulation in the vicinity of the San Pedro base has been revised, and the secondary triangulation of San Pedro harbor executed, as also that of the northern part of Santa Rosa island, Santa Barbara channel. The primary triangulation from San Francisco entrance has been extended northward to Sulphur Peak, and the secondary connected with it carried over Drake's bay and Point Reyes. The positions of the Farallones have been determined by triangulation. Crescent City harbor has been triangulated. The topography has included the harbor of San Pedro, part of Santa Cruz island, and Crescent City harbor. The hydrography of San Pedro harbor has been completed, and soundings off the approaches to the Golden Gate nearly so. A resurvey has been made of Humboldt bay, and the hydrography of Crescent City harbor executed. The regular tidal observations have been kept up at San Diego and near San Francisco.

The engraving of the charts of San Diego bay, Mare Island strait, and Humboldt bay has been completed, and also the drawing and engraving of the chart of the entrance to San Francisco bay. Progress has been made in the engraving of the chart of San Pablo bay, and additions have been made to the reconnaissance chart of the Western Coast. The map of San Francisco city has been engraved on stone, under the direction of the Superintendent of Public Printing.

SECTION XI. Coast of Oregon and that of Washington Territory.—(Sketch K, No. 34.)—The
triangulation of the Gulf of Georgia has been continued, stations on Point Roberts being
connected with others on Galiano island above the forty-ninth parallel. Hydrographic recon­
naisances have been made at the entrances to the Coquille river, Oregon, and at Gray's harbor,
W. T., and general duty has been performed in connection with requirements of the commis­
sioner on the northwestern boundary. The regular tidal observations at Astoria have been
continued.

A new edition of the reconnaissance sketch of Canal de Haro and Strait of Rosario, and the
chart of Port Townsend, have been drawn and engraved, and the engraving of the charts of
Port Gamble and Semiahmoo bay has been completed.

MAPS AND CHARTS.

A series of projects of maps and charts, on suitable scales, has been prepared, for which the
work now affords materials on the Atlantic and Gulf coasts. The projects for coast maps and
charts on the scale of \( \frac{1}{600,000} \), as described in my report of last year, are one hundred and
thirteen in number, embracing forty-two connected series. Those for the set of general coast
charts, on the scale of \( \frac{1}{400,000} \), are sixteen in number; and for a set of preliminary charts, on
the scale of \( \frac{1}{1,000,000} \), the projects are thirty-three in number.

The preliminary charts, with preliminary editions of harbor and other maps and charts,
enable us to keep up with the work of each year. The electrotype process is especially
valuable in enabling us to carry on this work without loss of the previous portions of the
engraving. The application of photography, which is very far advanced, is making great
changes in the facilities for reducing maps and charts. In another place I will present, at
more length, a statement of our progress in this application.

Sixty-seven sheets have been worked upon in the drawing division within the past year.
Of this number, two are finished charts, twenty-three finished maps and charts, thirteen
finished maps, six preliminary charts, two comparative charts, nineteen sketches, and two
sheets of diagrams. Thirty sheets have been completed and thirty-seven
am
in progress.
Of
those completed, four are finished maps, three preliminary charts, two comparative charts,
nineteen sketches, including those showing field progress, and two sheets of diagrams.

In the engraving division, five first-class maps and new editions of three have been
completed during the year, and twenty-one have been in progress. Of these last, eleven were
commenced in former years and ten in the present year. Eleven second-class maps or charts
and sketches have been completed within the year, nine of which were begun in the present
year, and six of the same class are in progress. These, with five plates of diagrams, give a
total of twenty-four completed and thirty-two in progress, or of fifty-six plates engraved or
engraving within the year. In addition to those engraved upon copper, five charts and
sketches have been engraved upon stone, under the direction of the Superintendent of Public
Printing. The complete list, giving the titles of the maps and charts, will be found in Appendix No. 17. The general list of all the maps, charts, and sketches engraved up to the present
date also accompanies the same Appendix. It includes two hundred and ninety-nine titles, of
which sixty are first-class maps. The list is exclusive of twenty progress sketches which have
been engraved, and receive additions from year to year, as the field-work advances.

The following list contains the titles of maps and charts, finished and preliminary, and of
sketches and diagrams, accompanying this report, arranged geographically. The letters in
the margin refer to the different sections; B to Section I, B to Section II, and so on. The
numbers on the maps, charts, and sketches correspond with those in the list which contains five finished charts, fifteen preliminary charts, and twenty sketches and diagrams.

1. — A. Progress sketch, Section I. (primary triangulation.)
2. — A bis. Progress sketch, Section I. (secondary triangulation, topography, and hydrography.)
3. — Seacoast of Maine, from Kennebec entrance to Portland.
4. — Portland harbor.
5. — Lynn harbor, Mass.
6. — Muskeget channel, (new edition.)
7. — B. Progress sketch, Section II.
8. — Hempstead harbor, Long Island Sound.
9. — C. Progress sketch, Section III.
10. — Chesapeake bay (sheet No. 4) from Potomac river to Pocomoke sound.
11. — Chesapeake bay (sheet No. 5) from Pocomoke sound to York river entrance.
12. — Chesapeake bay (sheet No. 6) from York river entrance to Cape Henry.
13. — Patuxent river, Md.
14. — St. Mary's river, Md.
15. — D. Progress sketch, Section IV.
16. — E. Progress sketch, Section V.
18. — Port Royal entrance and approaches, S. C.
19. — Sapelo sound and approaches, Ga.
20. — F. Progress sketch, Section VI.
21. — F bis. Progress sketch, Section VI, (Florida reefs and keys.)
22. — Florida reefs and keys from Newfound harbor key to Boca Grande key.
23. — G. Progress sketch, Section VII.
24. — Cedar keys, (new edition.)
25. — St. George's sound, Fla., (eastern part.)
26. — H. Progress sketch, Section VIII.
27. — The Rigolets, La.
28. — I. Progress sketch, Section IX.
29. — Coast of Texas and Matagorda bay.
30. — J. Progress sketch, Section X, (lower part.)
31. — J bis. Progress sketch, Section X, (upper part.)
32. — San Pedro harbor, Cal.
33. — Crescent City harbor, Cal.
34. — K. Progress sketch, Section XI.
35. — Diagrams illustrating the distribution of temperature in the Florida straits.
36. — Sketch showing general progress in the survey of the Atlantic, Gulf, and Pacific coasts.
37. — Diagrams illustrating the results of magnetic observations at Girard College, Philadelphia.
38. — Lines of equal magnetic variation for the year 1858.
40. — Mitchell's apparatus for measuring currents and improved pile for sea structures.

Constant efforts have been made to obtain a set of progress sketches better suited to popular
use, and yet useful for the purposes of the office. I believe that this may be accomplished for
the next report, a plan which meets my approval having been finally hit upon after much
experimenting.

The application of photography to the regular reduction of our maps and charts has made
good progress. It is estimated that the cost of reducing one of our sea-coast charts by photo­
graphy is but about one-fourth of that by the pencil and pen. The questions yet unsolved in
this application are merely questions of detail, and it is to be considered as one of the processes
fully applicable to the reduction of our maps and charts for engraving, no important difficulty
in relation to which remains to be mastered. The report of the assistant in charge of the office,
and of George Mathiot, esq., in charge of the photographic operations, give many important
particulars in this matter, (Appendix No. 17.) Prints have been produced of reduced maps
in which the severest tests could detect no error beyond the tolerated limits.

Mr. Mathiot is of opinion that we can profitably publish many of our preliminary maps by
the photographic process without engraving at all, by issuing copies of the photographic
prints themselves. Experiments will be made upon this at the earliest date practicable.

The operation of putting the print of the reduced map directly upon the copper, so as to
avoid an intermediate tracing by the engraver, those of photo-lithography, and others, are in
the course of experiment. Some successful trials have been made of photographing microscopic
objects from the specimens of bottom of the sea collected in sounding.

ESTIMATES FOR THE FISCAL YEAR 1860-'61.

The estimates are in the usual form which attaches the work to be done, to the expenditure
necessary to accomplish it, and so indicates the rate at which the survey is to be prosecuted,
a larger expenditure being required to finish the work sooner, a smaller decreasing the work to
be done, and therefore involving the time of completion. I have already, in last year's report,
called attention to the fact that the entire appropriation for the fiscal year 1857-'58, exceeded
by $90,000 (including the means furnished by the Land Office) that of the fiscal year 1858-'59,
which was the same as that of 1859-'60, the item for the pay of engineers being introduced
on the withdrawal of naval engineers from the work.

As it is absolutely essential in such a work to have latitude in regard to the details of
progress of operations in order to conduct it efficiently, the sums assigned for the several
sections are joined in the acts of appropriation into one, allowing to the Treasury Department,
which controls by law the direction for the work, and under which the Superintendent acts,
discretion in details, and merely confining the separate expenditures to the great divisions of
the work, as the Atlantic and Gulf Coast; the Florida Coast, reefs, and keys; and the Western
Coast. The whole of the expenditures for field and office work, including the pay of the
civilians employed, is brought into these estimates. They include the expense of deducing
the results, and drawing and engraving the maps, as well as of the surveys in the field.

These estimates suppose the same aid from the War and Navy Departments as heretofore.
Should any part of this be withheld, the proportionate progress of the survey must of necessity
be diminished.

The estimates were reduced in 1857-'58, during the great stress upon the treasury, and
have not since been raised to their former level. This involves a less rapid completion of the
work than the former rate, but in the uncertainty in regard to the means for the fiscal year, I
have not ventured to recommend an increase. The several items now presented are the same
in amount as have twice met the approval of Congress. An additional item, as compared with
the last two years, for fuel and quarters for officers of the army serving on the work, is to pay
the emolument derived by law and no longer paid by the Quartermaster's Department from the
general appropriation for fuel and quarters of the army. It is not a new item, but is intended
to replace the balance of a former appropriation which permitted its omission in the estimates
of last year and the year before, during the straightened condition of the treasury. This
balance is now exhausted.

The assistant in charge of the work across the Florida line, Captain M. L. Smith, U. S.
Topographical Engineers, advises me that the cost may be greater than was originally esti-
mated by the officer who made the reconnaissance. I have, however, preferred to extend the
time for completing the work rather than to ask an increase of the item for its execution.
Even if Captain Smith's present estimate should be exceeded, the cost of the work will not
reach one-fourth that of a continuous main triangulation around the coast, such as would be
needed to connect the main work on the Atlantic and Gulf of Mexico.

No item of the estimates has been increased. That for the Western Coast has proved
sufficient to keep the usual number of parties there in consequence of the work executed under
the law for the Northwestern Boundary Commission.

Estimates in detail.

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; for miscellaneous office expenses, and for 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 this section and to make the
necessary astronomical and magnetic observations connected with it; to extend
the secondary triangulation up the Penobscot river and along the coast eastward
from Penobscot bay; east from Pemaquid over Muscongus bay, and over the penin-
sula between the Kennebec and Sheepscot rivers, and of the coast east of those rivers;
to commence the topography of Penobscot bay, and to continue that between Ken-
nebec river and Casco bay; to continue the topography of Cape Cod bay; to com-
plete the hydrography near the Isles of Shoals, New Hampshire; to continue the
in and off-shore hydrography of the coast of Maine, from the Kennebec entrance
eastward, and of the ledges off the coast of Maine; to make such tidal observa-
tions as may be necessary: Office-work.—To make the computations connected
with field-work; to commence the drawing and engraving of the chart of Penobscot
bay, and that of Casco bay; to continue the drawing and engraving of general coast
chart No. 11, from Cape Ann to Gay Head, and preliminary coast chart No. 3, from
Cape Small Point to Cape Cod; to complete the drawing and engraving of the chart
of Sheepscot river, and the sketches of the section; to complete the drawing and
engraving of coast map and chart No. 9, from Cape Neddick to Cape Ann; the
engraving of that of Kennebec river, Lynn harbor, and coast maps and charts Nos.
12, 13, and 14, from Nantucket sound to Narragansett bay; to continue the draw-

*Viz: of all included in this item, inclusive of Sections I to IX, and exclusive of Section VI.
THE UNITED STATES COAST SURVEY.

ing of coast map and chart No. 7, from Muscongus bay to Portland harbor; the engraving of the chart of Portland harbor, and of coast map and chart No. 10, from Cape Ann to Plymouth; and to commence the drawing of coast map and chart No. 8, from Portland harbor to Kennebunk harbor, and draw and engrave tidal diagrams, will require .............................................

SECTION II. Coast of Connecticut, New York, New Jersey, Pennsylvania, and Delaware. Field-work.—To complete the triangulation of the Hudson river, and to commence that of the Connecticut; to continue the topography of the shores of the Hudson, and to complete that of the approaches to New York harbor; to continue the hydrography of the Hudson, commence that of the Connecticut river, and execute miscellaneous work of revision in the section: Office-work.—To make the computations required; to commence the drawing of the charts of Hudson river, Nos. 2 and 4, from Sing Sing north and Troy south; to draw and engrave the tidal diagrams and sketches of the section; to continue the engraving of coast map and chart No. 21, New York bay and harbor, and the finished map of Hudson river from the entrance to Sing Sing; and to commence the drawing and engraving of a chart of Connecticut river, will require.......................... $43,000

SECTION III. Coast of Delaware, Maryland, and Virginia. Field-work.—To continue the astronomical and magnetic observations required in the section; to examine and preserve the more important triangulation stations; to continue the triangulation of the Potomac river; to complete the topography of the Potomac and James rivers; to continue that of the Potomac, and that of the outer coast of Maryland, including the bays connected with it; to complete that of the shores of Chesapeake bay; to continue the off-shore hydrography of the section, and work of verification in the Chesapeake and its tributaries; the hydrography of the Potomac river, and the tidal observations of the section: Office-work.—To furnish the necessary computations; to complete the drawing and engraving of coast map and chart No. 33, Chesapeake bay from Hudson river, Maryland, to the Potomac, with the sketches of the section; the drawing of coast maps and charts Nos. 23 and 29, from Cape Henlopen to Little Machipongo inlet; Nos. 34, 35, and 36, Chesapeake bay from Potomac river to the entrance of the bay; and the engraving of charts of the Patuxent and St. Mary's rivers; to continue the drawing and engraving of sheet No. 6, Rappahannock river, from its entrance to Deep creek; the drawing of general coast chart No. IV, from Cape May to Currituck; the Rappahannock river, series Nos. 3, 4, and 5, from Port Royal to Deep creek, and the chart of James river from Hog island to the Chesapeake; to continue the engraving of coast map and chart No. 29, from Green run inlet to Little Machipongo inlet; coast maps and charts No. 32, Chesapeake bay, from Mayporty river to Hudson river, Maryland; and Nos. 34, 35, and 36, of the same series, from the Potomac to the entrance of the bay; to commence the engraving of general coast chart No. IV, and that of coast map and chart No. 28, from Cape Henlopen to Green run inlet, will require ............................................. $14,000

25,000
SECTION IV. Coast of Virginia and North Carolina. Field-work.—To continue the primary triangulation of Pamlico sound and the secondary connected with it; to complete the verification work near Cape Fear entrance; to continue the topography of the outer coast of North Carolina south of Hatteras, and to complete that of the Chowan and Roanoke entrances; to continue the in and off shore hydrography between Cape Lookout and Cape Fear; to continue the observations of tides and currents, and of the Gulf Stream. Office-work.—To compute the results of the triangulation and other operations; to commence the drawings of coast maps and charts Nos. 42 and 43, Pamlico sound; to complete the drawing and engraving of the sketches of the section, the drawing of coast map and chart No. 48 from Barren inlet to Lockwood’s Folly inlet; to engrave coast map and chart No. 40, Albemarle sound (western sheet); to continue the drawing and engraving of preliminary coast chart No. 11 from Cape Hatteras to Cape Lookout; the drawing of coast map and chart No. 37, from Cape Henry to Currituck sound; preliminary coast chart No. 12, from Cape Lookout to Cape Fear, and general coast chart No. V, from Currituck to Cape Fear; to commence the drawing of coast map and chart No. 47, from Bogue inlet to Barren inlet; the engraving of coast map and chart No. 48, and that of preliminary coast chart No. 12, Cape Lookout to Cape Fear, will require .......................................................... $23,000

SECTION V. Coast of part of North Carolina and that of South Carolina and Georgia. Field-work.—To extend the triangulation in North and South Carolina, from Tubb’s inlet southward towards Winyah bay; to extend the primary triangulation south of St. Helena and Port Royal sounds, and the secondary up the rivers connected with them; to measure supplementary bases on the coast of South Carolina and Georgia; to extend the triangulation south of St. Simon’s, and over St. Andrew’s sound; to continue the topography of Port Royal sound, and that between Savannah river and Ossabaw, including Wassaw sound and the rivers emptying into it; to continue the hydrography of Wassaw, Ossabaw, and St. Catharine’s sounds and entrances; to complete that of Doboy and Altamaha entrances; and to commence, if practicable, that of St. Andrew’s entrance and sound; to continue the tidal and current observations and investigations of the Gulf Stream in this and the following section. Office-work.—To make the requisite computations; to complete the drawing and commence the engraving of coast map and chart No. 53, from Stono inlet to Fripp’s inlet; to complete the drawing and engraving of charts of St. Catharine’s and Ossabaw sounds, and the sketches of the section; the drawing of the chart of St. Simon’s sound, and coast map and chart No. 58, from St. Mary’s to St. John’s river; to commence the engraving of charts of Ossabaw and Sapelo sounds; to continue the drawing of coast maps and charts No. 52, from Cape Romain to Stono inlet, and No. 54, from Fripp’s inlet to St. Catharine’s sound, and preliminary coast chart No. 14, from Cape Romain to Tybee light; to commence the drawing of preliminary coast chart No. 15, from Tybee light to St. John’s light; and that of general coast chart No. VII, from Winyah bay to the St. John’s river, will require .......................................................... 36,000
THE UNITED STATES COAST SURVEY.

SECTION VI.—Keys, reefs, and coast of Florida. (See estimates of appropriation for those special objects.)

SECTION VII.—Part of the western coast of the Florida Peninsula. FIELD-WORK.—To continue the triangulation south of Weckivatchee river, and north from Suwanee river; to continue that from Apalachee westward of Indian Pass, and north of Cape St. Blas; to continue that of Santa Rosa sound and the dependencies of Pensacola bay; to make such astronomical and magnetic observations as may be practicable in the section; to continue the topography in connection with the triangulation as far as may be practicable; to continue the hydrography of the section from St. George’s sound east and west, and from Cedar keys south and north, and to make the requisite tidal observations: OFFICE-WORK,—To make the necessary reductions and computations; to complete the drawing and engraving of the chart of Santa Rosa sound, Escambia bay, and East bay; the sketches of the section, and the engraving of the chart of St. George’s sound; to commence the drawing of coast maps and charts Nos. 84 and 85, from Appalachee bay to St. Joseph’s bay, and the engraving of coast map and chart No. 89, from Pensacola bay to Mobile bay; to continue the drawing of coast map and chart No. 81, from Homosassa river to Cedar keys, and that of No. 88, from Choctawatchee bay to Pensacola bay, will require $33,000

SECTION VIII.—Coast of Alabama, Mississippi, and part of Louisiana. FIELD-WORK.—To continue the astronomical and magnetic observations required in the section; to continue the triangulation of Isle au Breton sound, and the triangulation of the Mississippi delta westward; to continue the triangulation over Vermilion bay; to complete the topography of Lake Pontchartrain, and to keep the topography up with the triangulations just enumerated; to continue the hydrography of Chandeleur sound, the Mississippi passes, and commence that of Isle au Breton sound and Vermilion bay; to continue the tidal and current observations and the deep-sea soundings of the Gulf in this section: OFFICE-WORK.—To make the requisite computations; to complete the drawing and continue the engraving of coast map and chart No. 92, Mississippi sound, from Round island to Grand island; to continue the drawing and engraving of preliminary coast chart No. 26, Mississippi sound, from Mobile bay to Lake Pontchartrain, and coast map and chart No. 100, from Marsh island to Grand island; to complete the drawing and engraving of a chart of the Mississippi delta, and the sketches of the section; the drawing of those of Lake Borgne, the Rigolets, and part of Lake Pontchartrain, and coast map and chart No. 93, from Grand island to Lake Pontchartrain; to commence the drawing of general coast chart No. XIV, from Pensacola bay to Barataria bay; to complete the drawing and engraving of the chart of Atchafalaya bay; to commence the drawing and engraving of that of Côte Blanche bay, and the drawing of that of Vermilion bay, will require $31,500

SECTION IX.—Part of the coast of Louisiana and the coast of Texas. FIELD-WORK.—To continue the triangulation southward from Aransas Pass, and the topography from Matagorda entrance southward and over Aransas and Copano bays; to con-
continue the hydrography in and off shore from Matagorda entrance southward, and inside of Matagorda bay and its dependencies; to make the tidal observations which may be requisite: Office-work.—To make the computations and reductions from field-work; to complete the drawing and engraving of coast maps and charts Nos. 106 and 107, from Galveston bay to Matagorda bay, and the sketches of the section; to complete the drawing and commence the engraving of coast map and chart No. 108, Matagorda bay; to continue the drawing and engraving of preliminary coast chart No. 31, from Galveston bay to Matagorda bay; to commence the drawing of coast maps and charts Nos. 109 and 110, from Matagorda bay to Corpus Christi bay; and the engraving of coast map and chart No. 105, Galveston bay, will require $25,500

Total for the Atlantic coast and Gulf of Mexico 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 continue the triangulation of the eastern or Atlantic coast of the peninsula, south of Matanzas inlet, and north and south of Indian River inlet; to complete the triangulation of the keys and sounds between the outer keys and the coast of the peninsula; to connect, if practicable, the Marquesas and Tortugas; to extend the triangulation north and south from Charlotte harbor; to make a part of the astronomical and magnetic observations required in the section; to continue the topography south of the St. John's river, and north and south of St. Augustine harbor, and, if practicable, over Indian River inlet, and northward of it; to complete the topography of the keys and coast of Barnes' and Card's sounds and Florida bay; to complete the topography of Charlotte harbor; to complete the hydrography of the Florida reef, and to execute off-shore work connected with it; to continue that of Florida bay and Barnes' sound and dependencies; to commence that of Charlotte harbor, and to keep up tidal observations at the Tortugas: Office-work.—To make the computations connected with the field-work; to continue the drawing and commence the engraving of coast maps and charts Nos. 69 and 70, Florida reef, from Garden key to Neufound Harbor key; to continue the drawing and engraving of coast maps and charts Nos. 71 and 72, Florida reefs, from Neufound Harbor key to Marquesas key, and the drawing of preliminary coast charts Nos. 19 and 20, Florida reefs, from Key Biscayne to the Tortugas; to complete the drawing and engraving of coast map and chart No. 68, Florida reef, from Key Biscayne to Carysfort reef; that of Charlotte harbor; the sketches of the section; the drawings of Indian River inlet and St. Augustine harbor; and to draw and engrave the tidal and Gulf Stream diagrams, will require $40,000

Section X. Coast of California. Field-work.—To continue the triangulation along the Pacific coast northward of Santa Barbara, and to make the triangulations of Santa Catalina and San Clemente islands; to continue the primary and secondary triangulation north of Drake's bay, and to make such astronomical and magnetic
observations as may be necessary in that work; to execute topography within the triangulation of the *Santa Barbara channel*, main and islands; that of the dependencies of *San Pablo bay*, and such plane-table work as may be practicable, in addition to and connecting with the shores of *Drake’s bay* and northward from *Point Reyes*; to continue the hydrography of the coast south and north of *San Francisco entrance*, and that of *Santa Barbara channel*, with such other as the progress of the survey may show to be first needed; to continue tidal observations in the section: Office-work,—To make the necessary computations and reductions; to complete the drawing and engraving of a chart of *San Pedro harbor*, of *Crescent City harbor*, and of *Tomales bay*, and the sketches of the section; to continue the engraving of charts of *San Francisco and San Pablo bays*, and to commence the drawing of coast maps and charts north and south of *San Francisco bay*. Also, for the operations in *Section XI. Coast of Oregon and that of Washington Territory*. Field-work.—To continue the triangulation of *Washington and Puget’s sounds* and of *Hood’s canal*, and the topography connected with it; to continue the hydrography of the *Gulf of Georgia*, and of *Washington and Puget’s sounds* and their harbors, with such other hydrography as the progress of the survey may show to be expedient; to continue tidal observations in the section: Office-work,—To make the necessary computations; to complete the drawing and engraving of a chart of *Coquille River entrance*, and make the additions to the hydrographic sketch of *Canal de Haro and Strait of Rosario*, and the progress 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 5,000.
For publishing the observations made in the progress of the survey of the coast of the United States, per act of March 3, 1843 5,000.
For repairs of steamers and sailing schooners used in the survey, per act of March 2, 1853 10,000.
For fuel and quarters and for mileage or transportation for officers and 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.
The amounts thus estimated for the work of the fiscal year 1860–'61, and the appropriations
for the present and two past fiscal years, are given below in parallel columns:

<table>
<thead>
<tr>
<th>Object</th>
<th>Fiscal year 1860–’61</th>
<th>Fiscal year 1859–'60</th>
<th>Fiscal year 1858–'59</th>
<th>Fiscal year 1857–'58</th>
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<tr>
<td>For survey of the Atlantic and Gulf coast of the United States,</td>
<td>$250,000</td>
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<td>including compensation of civilians engaged in the work, per</td>
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<td>act of March 3, 1843</td>
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<td>For continuing the survey of the Western Coast of the United</td>
<td>130,000</td>
<td>130,000</td>
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<td>States, including compensation of civilians engaged in the work, per</td>
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<td>act of September 30, 1850</td>
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<td>For continuing the survey of the Florida reefs and keys, including</td>
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<td>compensation of civilians engaged in the work, per act of March</td>
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<td>3, 1849</td>
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<td>For running a line to connect the triangulation on the Atlantic</td>
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<td>5,000</td>
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<td>coast with that on the Gulf of Mexico, across the Florida peninsula,</td>
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<td>including compensation of civilians engaged in the work, per</td>
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<td>act of March 3, 1843</td>
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<tr>
<td>For survey of the Atlantic and Gulf coast of the United States,</td>
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<td>5,000</td>
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<td>including compensation of civilians engaged in the work, per</td>
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<td>act of March 3, 1843</td>
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<td>For repairs of steamers and sailing schooners used in the survey,</td>
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<td>per act of March 2, 1853</td>
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<tr>
<td>For fuel and quarters, and for mileage or transportation for officers</td>
<td>*5,000</td>
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<td>and enlisted soldiers of the army serving in the Coast Survey,</td>
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<td>in cases no longer provided for by the Quartermaster’s depart-</td>
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<td>ment, per act of August 31, 1862</td>
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<td>For pay and rations of engineers for seven steamers used in the</td>
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<td>hydrography of the Coast Survey, no longer supplied by the</td>
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<td>Navy Department</td>
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* Formerly included in estimates of the War Department.  
† Formerly included in estimates of the Navy Department.

DEVELOPMENTS AND DISCOVERIES.

The general list, up to 1858, inclusive, is given in Appendix No. 8, and contains one hundred
and sixty-one references to matters geographically arranged. My attention having been called
by Geo. W. Blunt, esq., to the alleged grounding of a vessel on the Battery shoal, where it
had been supposed there was water enough to float her, a re-examination of the shoal was
made by Lieut. Comg. Craven, and the alarming state of things was developed which is stated
in his report and in my letter to the New York Chamber of Commerce, copies of which are
given in the Appendix No. 13. The following is a list for the last year:

1. Only eighteen feet at mean low water found on the rock one mile to the southward of
Seguin island, coast of Maine.

2. True position of the Hussey Rock, in Casco bay, determined, correcting the erroneous
one assigned on previous charts.

3. Determination of the position of the "Hue and Cry," the "Old Proprietor," and other
dangers off Cape Elizabeth, Maine.
4. Development of a rock off Ogunquit, bare at low tides and very little known.
5. A fishing bank sounded out off Wood island, coast of Maine.
7. Development of a four-fathom bank off Cape Porpoise, Maine.
8. Determination of the position of a small rock with less than four feet at mean low water, near the channel, and in the vicinity of Great Rock, Hyannis harbor, Massachusetts.
9. The existence of a seventeen-foot spot on the shoal off the battery, New York harbor, the extension of the shoal towards the channel, and the shoaling of the water generally between the shoal and shore.
10. The existence and character of sub-currents ascertained, as bearing on the physical condition of New York harbor.
11. Changes developed in the shore lines at the entrance of Little Annemessex river, Chesapeake bay.
12. Less water found off Cape Romain by preliminary examination than has been heretofore assigned.
13. Further explorations in developing the character of the Gulf Stream in the Florida channel.

Changes were reported in Boston inner harbor which made a resurvey desirable, and the occasion was taken of the presence of one of the hydrographic parties in the vicinity to execute the work more fully reported under the head of Section I.

SURVEYS OF THE WESTERN COAST.

The reconnaissance of this coast having been made, and its chief harbors and entrances having been surveyed, the annual list heretofore given will be replaced by a biennial one.

During the past year, at the request of the authorities of San Pedro and Crescent City, minute surveys of those harbors were made and charts prepared on a larger scale than the previous charts of the same localities. A survey of Gray's harbor was directed, but circumstances preventing the land party from co-operating in it, a simple hydrographic reconnaissance was made. The survey of Coquille river entrance was also ordered, and would have been accomplished but for an accident to the hydrographic vessel. Special arrangements have been made by Commander Alden for its execution.

On the 16th of September the Treasury Department issued an order placing the steamer Active at the disposal of Lieutenant General Scott, and at the last advices from the Western Coast that vessel was undergoing repairs at the Mare Island navy yard, to be in readiness for such service as might be required under his orders.

TIDE TABLES.

The tide tables for navigators of the coast of the United States have been revised in the Tidal Division of the office, and additional results for the diurnal inequality in the ports of the Pacific coast have been interpolated from the observations and reductions at the regular tidal stations.

These tables (Appendix No. 14) contain the corrected establishment or mean lunisdiurnal interval of one hundred and ten ports; the rise and fall of mean, spring, and neap tides, and the mean duration of flood, ebb, and stand. Simple rules for computing the time and height of high water, and for correcting the same for half monthly inequality, and for the daily
inequality where it is sufficient in amount to require notice, are given. The different peculiarities of the tides on the Atlantic, Gulf, and Pacific coasts of the United States are stated as derived from numerous observations. Easy rules for the tidal currents on the sea-coast of the Atlantic are also embodied in the explanatory notes to the tables.

TABLE OF DEPTHS.

In Appendix No. 15 is presented a revision of the table of depths which accompanied my report for 1857, with additions derived from results received at the office since that report was published, and from the latest data furnished by the Tidal Division. The table contains the depths that may be carried in at the entrances to principal ports and rivers, and that may be found at some of the more important anchorages on the several coasts of the United States. The compendious form in which this information is presented has been found very convenient for purposes of general reference.

LIST OF GEOGRAPHICAL POSITIONS.

The practical character of the triangulation is well shown in the resulting determinations of the latitude, longitude, and air-line distances from each other of numerous points on all parts of the coast which have yet been reached in the operations of the survey. These are furnished by computation from the notes and journals of observations kept at the stations by the several field parties which occupy them. As being of general interest and of direct practical use to surveyors, navigators, and others, the geographical positions, as increasing in number, have been given in the reports of alternate years, beginning with that for 1851. In Appendix No. 20 of this report, one thousand six hundred and sixty-two additional positions are furnished, including points in all the sections of the coast, excepting Section IV. The progress sketches show the locations of the points, the latitudes and longitudes of which, with the bearings and distances from each other, are given in the form of tables.

The whole number of points determined, and of which the geographical positions have been published, amounts to seven thousand one hundred and seventy-eight.

TOPOGRAPHICAL AND HYDROGRAPHIC SHEETS.

In my report for 1856 lists were given with the scales, dates, and register numbers of all the plane-table sheets and original charts then on file in the archives. The lists given in the Appendix Nos. 18 and 19 contain the titles, &c., of the topographical and hydrographic sheets received and registered since that report was issued. To serve as an index for reference, the titles are arranged in geographical order, as in the former list.

INFORMATION FURNISHED.

Under an arrangement in the department which specially authorizes the communication of such data as the archives and records of the survey may furnish, on the conditions that due credit may be given for the same, and that the actual expense of copying the records be borne by the applicant, the usual calls have been met as heretofore—(Appendix No. 6.) As regards the general purpose of the work, this practice is merely incidental, but it requires no enlargement to show that all parts of the Union partake of the advantage derived from the regulation. The information, furnished on the terms alluded to, without any extra cost to the government, may be readily traced in general and elementary publi-
cations, and so has, in a measure, already returned of its first fruits to the people at large. Wherever interest is found in questions concerning the general geography of the country, it is clear that an accurate coast-line must ever be regarded as an important feature.

STATISTICS.

A revised table containing the statistics of field and office work is given in Appendix No. 7. It will readily be seen that the nature of the data given in some of the items renders the compilation of such a statement a matter of considerable difficulty and labor. Many of the plane-table and hydrographic sheets being required for purposes of reference in joining the new to former work, the statistical data which they would furnish without hindrance to the operations constantly going on at the south during winter, and at the north in summer and autumn, can be reached only by degrees in the process of distributing under the head of each year the work which properly belongs to it. This has at length been as nearly accomplished as the nature of the material and necessities of the work will allow. A systematic revision has been made of all the data, and provision for continuing the same from year to year upon a regular plan and with the same supervision, so that uniformity in the comparisons may be insured.

DISTRIBUTION OF REPORTS AND MAPS.

The lists kept at the office now contain the names of about four thousand individuals and public institutions to which the annual reports are sent regularly, as they are published. These lists have received additions, from year to year, of addresses referred by senators and members of the House of Representatives, and some have been registered on considerations connected with the known vocation and standing of the persons and institutions applying for them directly. About three hundred institutions of learning are embraced in the general list. The total stated is exclusive of a number of copies sent in exchange to foreign governments and societies, and of the miscellaneous distribution to individuals. In numerous cases calls made by the constituents of members of Congress after their complement of copies was exhausted have been supplied from the office, as are also the special applications constantly received from all parts of the Union, and from parties connected with the merchant service in the coasting trade. All the vessels of the navy and revenue marine, light-house inspectors, a large number of officers of both branches of the military service, custom-house officers, and others connected with the General Land Office in the States, and the Chambers of Commerce, Boards of Trade and Underwriters in the principal seaboard cities, have been regularly furnished in the same way. The total number of copies distributed within the year was six thousand one hundred and seventeen.

Of maps, charts, and sketches, over fourteen thousand impressions have been distributed since the date of my last report. More than half of these were sent to the principal departments of the government, to foreign institutions, and to certain libraries and other public depositories designated by members of the House of Representatives in their respective districts throughout the entire country.

It is expected that the Coast Survey Report for 1858, ordered by the last Congress to be printed, will, with its maps and charts, be published by the energetic Superintendent of Public Printing in the early part of the session, anticipating by many months the former rate of publication.
REPORT OF COMMITTEE OF TWENTY.

At their meeting in 1857 the American Association for the Advancement of Science appointed a committee of twenty, * to examine anew into the character and progress of the Coast Survey. A report had been made by a committee in 1849, and a new examination was desired. The conclusions of this committee, after a most elaborate investigation of the subject, are given in their report, † as follows:

"With these voluntary and emphatic testimonies to the character of a work as magnificent in its scientific aspects as it is valuable in those which are purely utilitarian—testimonies, moreover, emanating from sources which rank, in point of authority, among the highest known to the scientific world—the committee might be justified in closing a report already protracted beyond their expectation. After the extended review, however, which they have taken of the purposes in which this great undertaking originated, of the history of its growth, and the expansion of the processes involved in its execution, and of the brilliant results which have already crowned its diversified labors, it will probably be expected of them that they should condense the final expression of their opinions into a form sufficiently concise to be comprehended at a single view. As the succinct recapitulation, therefore, of the conclusions at which they have arrived, the committee, with entire unanimity, concur in stating the following propositions:

1. The American Coast Survey, in its inception, was a work imperatively demanded by a due regard to the industrial interests of the country, dependent, as they are, greatly upon the prosperity of commerce for their free development.

2. The indecision which marked the early policy of the government in regard to this survey, and the consequent delay of its efficient operations, and postponement of its beneficial results, were of manifest disadvantage to the material welfare of our people, and cannot but be still subjects of serious regret.

3. The economical value of such surveys is attested by the universal voice of all com-

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* Judge J. X. Kane, President Amer. Phil. Society, Penna.
2 Gen. Joseph G. Totten, Chief Engineer U. S. A.
4 Prof. John Torrey, U. S. Assay Office, N. Y.
5 Prof. Joseph Henry, Secretary Smithsonian Institute, D. C.
6 Prof. J. F. Fraser, University of Pennsylvania, Penna.
7 Prof. Wm. Chauvenet, U. S. Naval Academy, Md.
8 President F. A. P. Barnard, University of Mississippi, Miss.
9 Prof. John Leconte, College of South Carolina, S. C.
10 Prof. Wm. M. Gillespie, Union College, N. Y.
11 Prof. F. H. Smith, University of Virginia, Va.
12 Prof. W. H. C. Bartlett, U. S. Military Academy, N. Y.
13 Prof. Wolcott Gibbs, Free Academy, N. Y.
14 Prof. Stephen Alexander, College of New Jersey, N. J.
15 Prof. Lewis R. Gibbons, Charleston College, S. C.
17 Prof. James Phillips, University of North Carolina, N. C.
18 Prof. Wm. Ferrel, Nashville, Tenn.
19 Prof. Edward Hitchcock, Amherst College, Mass.
20 Prof. James D. Dana, Yale College, Conn.

† Report on the history and progress of the American Coast Survey, up to the year 1858, by the committee of twenty appointed by the American Association for the Advancement of Science, at the Montreal meeting, August, 1857.
mercial men, and by the concurrent practice of all commercial nations, no less than by the melancholy records of marine disaster annually occurring upon every unexplored coast.

"4. Their scientific value is witnessed, in the instance of the American Survey, by the spontaneous tributes of approval frequently and freely bestowed upon it—no less in regard to the ability, energy, and skill displayed in its management than to the magnitude, variety, and oftentimes curious interest of the results it has wrought out—by individuals and organized bodies of men whose high position as scientific authorities renders their opinions upon subjects of this nature entirely conclusive.

"5. This work has conferred many valuable benefits upon science, indirectly and incidentally, in the invention or perfection of instruments, in the improvement of methods of observation or of computation, in the development which it has given to special subjects of interesting inquiry, and in the stimulus which it has furnished to the scientific talent of the country, especially in the field of astronomical observation and investigation.

"6. A careful study of the progress made from year to year, especially since the enlargement of the scale of operations under the present Superintendent, affords ample evidence that the work has been expeditiously prosecuted, and that the amount accomplished up to the present date is materially greater than has ever been accomplished in any other country in the same length of time and with the same means.

"7. Compared with similar surveys executed or in progress of execution by foreign governments, the American Survey has been conducted with remarkable economy.

"8. Compared with such foreign surveys, the quality of the work done in this will bear the test of any standard that has ever been anywhere set up, and is such as to reflect honor on the scientific character of our country in the eyes of the world.

"9. Every consideration of economy, of humanity, and of regard for the reputation of the country, demands that the work should be prosecuted with undiminished activity until every portion of our coast shall have been as thoroughly explored and mapped as those have been already in which its operations commenced.

"10. Conclusive reasons, involving other weighty public interests no less than this, but connected also with the project of verifying in the happiest manner the geodesy of our extended and circuitous coast, conspire to render the triangulation of the great Appalachian chain of mountains a most desirable undertaking, and encourage the hope that our government will very early direct that most important work to be executed.

"11. The publication in full of all the observations upon which the published results of the Coast Survey are founded, together with the methods employed in the reduction and discussion of the observations, would be a contribution to science, and especially to the science of geodesy, of inappreciable value, besides being necessary to secure the records against loss; and the committee earnestly hope that the government may not fail to provide the means for the adequate and rapid prosecution of this work.

"12. The existing organization of the survey, judged in the light of the experience acquired by our own and by foreign governments in the management of such works, is, in the deliberate opinion of the committee, preferable to any other that has ever been suggested.

These propositions have not been hastily sketched, and are not lightly thrown out; but they are announced as the result of mature reflection and careful consideration. With their
announcement, the duty of the committee, under the resolution appointing them, is discharged. The committee cannot, however, forget that they have another duty, unprescribed by any resolution, to fulfil; which is to express, on behalf of the association which has charged them with their present responsibility and of the world of science, which they may claim for the moment to represent, their deep sense of the obligation which they feel to be due to the enlightened statesmen who, whether in the executive branch of the government or in the legislative halls of Congress, have sustained the work to the present hour by their liberal recommendations or their able advocacy, and have labored to conciliate to it the popular favor by their intelligent and manly expositions of its objects and its value.

"Among the distinguished men who hold in their hands the destinies of the country are still to be found statesmen no less enlightened and no less liberal. To such, therefore, with whatever branch of the government they may be connected, the committee, in conclusion, most cordially commend the important work which they have been reviewing, and, in the name of the associated science of the country, they solicit for it the continuance of the executive favor and legislative support which it has hitherto enjoyed."

TELEGRAPHIC LONGITUDES.

The work of reductions of telegraphic longitudes, under the direction of Doctor B. A. Gould, has made excellent progress, besides which, a working list for a catalogue for selecting proper stars for the latitude determinations of the survey has been carefully prepared. The recent longitude determinations of Calais, Bangor, Mobile, New Orleans, and Albany, New York, are far advanced in their reductions, and it is expected that all the reductions of work of former years will have been completed, and put in the shape for publication before the expiration of another year. A new determination, connecting Apalachicola with the main series, will be undertaken this winter. Careful investigations have been made of the determination of the probable error of reading off the Morse fillets, and of chronographs of different kinds, as well as to a suspected personal equation in reading off the several registers, and the results have been highly satisfactory, as showing the readings made to be affected with smaller mean errors than any other chronograph readings to which the party had access. The personal scale of the readers, too, was tested with satisfactory results, showing the distribution of readings of even the hundredths of seconds to be equable and satisfactory. The special report upon the circumpolar catalogue was published in the Astronomical Journal for January, 1859.

BASE OF VERIFICATION.

The base of verification measured upon Epping plains in Maine, in 1857, has been connected with the primary triangulation, and the verification has been most complete. The approximate length of the measured base, as deduced from the office discussion up to 1859, subject yet to some small change for the full result for the expansion of the comparison bar, and the connexion with the standard metre is 8,715.845 metres. As derived through the primary triangulation from the mean of the Fire island and Providence bases from computations to 1859, the same base is 8,715.837 metres in length, differing but eight millimetres, or three tenths of an inch from the former value.

The verification is much within the corrections to be derived from expansion and comparison with the standard metre.
THE UNITED STATES COAST SURVEY.

MAGNETIC OBSERVATIONS.

A memoir prepared by me for the Smithsonian contributions to knowledge and published therein containing a discussion of the magnetic and meteorological observations made between 1840 and 1845, at the Girard College of Philadelphia, under my direction, and the patronage of the American Philosophical Society and of the War Department of the United States, is given in Appendix No. 22. The observations themselves were made in connexion with the extended series under the patronage of the governments of Europe, and were published in extenso by the Senate of the United States. The results are of practical value in connexion with the discussion of changes daily and annual, and others in the magnetic variation, as well as of scientific interest in reference to the periodical character of the disturbances observed. The discussions given in my previous reports have proved useful, in a great variety of cases, to surveyors and others, so that the correspondence in regard to them has at different times been quite interesting, from the number and character of the questions raised and settled. The facts given in this paper will, I feel convinced, find in like manner useful applications in practice.

In a scientific point of view the connexion between a well determined period in the daily variation of the needle and in its disturbances, and the period of change in the solar spots, must be considered not merely curious but important, as proving one of the links connecting the phenomena of the earth's magnetism with the general phenomena of the solar system.

The subject of the secular change of the magnetic declination (variation of the needle) has again been taken up, and the former discussions given in my annual reports for 1855, 1856, and 1858, have been extended. The results are now tabulated and put in a practical form for ready use. Appendix No. 24 presents the report of Assistant Charles A. Schott, on the last results from the discussion of the secular change of the magnetic declination, accompanied by tables showing the declination (variation of the needle) for every tenth year from the date of the earliest reliable observation, for twenty-six stations on the Atlantic, Gulf, and Pacific coasts of the United States. The report, after pointing out the change made in the method of treating the observations adopted since the date of the discussion given in my last report, describes in general outlines the character of the secular change. The formulae deduced for each station are then presented, accompanied by tables of the declination at every tenth year and the deduced epoch of minimum west (or maximum east) declination with its corresponding amount; and also the annual changes for the three epochs 1840, 1850, and 1860. Results for several stations outside of the limits of the United States are also given. The paper concludes with a list of the observations used in the discussion, but which have not yet been published in either of my former reports.

In the summer Assistant Schott determined the magnetic elements at a number of stations in the New England States, further notices of which will be given under the heads of Section I and Section II, in the body of this report. The results deduced from his observations are stated in tabular form in Appendix No. 23.

A new map of the magnetic variation of the world for 1858, compiled from various authentic sources, has been published under the auspices of the British admiralty, by F. J. Evans, master, R. N. This has been carefully examined by those officers of the Coast Survey whose studies have led them into this field, and meets with high approval. The results have been transferred (Sketch No. 38) to the polyconic projection used in the Coast Survey, and are
given in this report, with a table from the chart, (Appendix No. 16,) showing the variations corresponding to different latitudes and longitudes, for the use of navigators.

GULF STREAM.

The observations in the Florida channel have been completed during the past year, and have yielded the most interesting results, of which a report is given in Appendix No. 25. The form of the bottom of the strait is shown to be simply that of a deep trough, the deepest part of which lies on the Cuban side of the straits. The cold water from the north is found at the bottom of this trough, having a temperature of thirty-four degrees. The overlying warm water of the Gulf Stream is without bands, alternately colder and warmer, as it should be if the figure of the bottom determined the formation of these bands, as has been supposed. At Cape Florida the stream is narrowest and shallowest, and the cold water here comes near to the surface, making this a comparatively cold band in the longitudinal direction of the stream.

The depth of the strait only five miles from Havana is eight hundred fathoms, and close to the island of Bemini three hundred fathoms. This great depth is no doubt caused by the wearing action of the polar current. The form of this trough renders it probable that the main stream of the Gulf is that which makes the circuit of the Gulf of Mexico.

The "cold wall" along the coast of the United States is traceable along the Florida keys and to the Tortugas.

Some investigations, by experiment, of the effect of pressure on the Saxton metallic thermometers are given in the same article of the Appendix.

TIDES AND CURRENTS.

It will be recollected that the physical survey of New York harbor was first commenced at the request of the Commissioners on Harbor Encroachments, and that the expenditures for so much of the work as exceeded the requirements of the Coast Survey have been defrayed by the State of New York, the Coast Survey officers, under authority given to the Commissioners by the President of the United States, and under the directions of the Treasury Department, having carried on the survey. Its results have thus served the double purpose of the new Coast Survey map of the harbor of New York, which in a preliminary form was published in my report of 1857, and which is in progress of engraving in its finished condition, as well as of the Commissioners' map of the harbor.

In regard to the physical survey, it is not too much to claim for the observations made, which have now been continued through several years, that they have developed in a general way the causes of the channels and of the shoals of New York harbor and bar, and of the changes above and below water. The curious and unexpected fact of rotary currents at and below the surface at the entrance to the Hudson, rotating in a vertical direction, so that while the water on the surface is running ebb to the south, below the surface it is running flood, or northward, is fully established by the observations, and is of itself of very great practical value.

About nine thousand observations of currents, of which three thousand were taken below the surface, and seven thousand four hundred and ninety observations of the tides, were made in the course of this work during the past season.

Observations at current stations beyond the light-ship show that the constant currents, independent of those from the drainage of the land waters, sweep the Bay of the Five States. One of these stations was nearly sixty miles east-southeast from Sandy Hook. The motion of these
currents sometimes extends to the whole body of the sea, and at others is more or less superficial. The currents near the south shore of Long Island were observed by casting into the sea large shells previously marked, and noting the places and times at which they were thrown up on the beaches. Nearly one-third of the shells were picked up, and their motion established the existence of an excess of easterly current, independent of the effect of winds and waves. The existence of this easterly drift has often been asserted, and yet the spits of the inlets make to the westward, seeming to disprove the fact of an excess of easterly current. To unravel this many observations were made, and the clue seems to have been found in them, but their full discussion is required before pronouncing upon this. This probable clue is in the movement of the waves.

Appendix No. 26 contains the report of Assistant Mitchell, by whom the observations were made.

RECORDS AND RESULTS.

The inquiries in regard to this publication are constant, notwithstanding the notice given in my last report of the inadequacy of the appropriation to publish the work. The utmost that can be done with the present means is to keep pace with the records in preparing the work, and this imperfectly. A volume of Gulf Stream results will, it is expected, be published within the next year; but if this is accomplished, it is all that can be done, as stated in my last report, with the means in hand from former appropriations. I have no doubt of the importance of resuming this work as soon as the state of the treasury will permit, as it secures the records from possible loss, and enables us, while those are connected with the survey who have executed the work to be published, to have full scientific criticisms of the results. It has been the reproach of such surveys that there is great delay in publishing results, so that they appear only years after the work has ceased, and when the observations are in a degree obsolete. I should like to avoid the application of this remark to our work, if possible.

PROJECTION TABLES.

These tables, as given in Appendix No. 33, were arranged by Assistant J. E. Hilgard, and are the extension to lower latitudes of similar ones which appeared in my annual report for 1856. They are based upon a polyconic development of the earth's surface, which supposes each parallel of latitude to be represented on a plane by the development of a cone, having the parallel for its base, and its vertex in the point where a tangent to the parallel intersects the earth's axis. In this system the degrees on the parallel preserve their true length, and the general distortion of area is less than in any other geometrical mode of representing a given portion of the earth's surface. Bessel's constants, which have been adopted for projections required in the Coast Survey, were used in the formation of the tables.

Table I gives the length in metres of one degree of latitude and longitude for each degree of latitude from 0° to 54°, and the value of the corresponding radius of the developed parallel. It also gives the values of the angle subtended at the vertex of the cone by the developed parallel, for ten degrees of longitude, by means of which the tables may readily be extended.

Table II gives the rectangular co-ordinates for thirty degrees of longitude on each parallel, from latitude 1° to 54°, the numbers in the table corresponding to the actual dimensions of the earth in metres, and only requiring to be divided by the proper number for any desired scale. Notes explanatory of the tables precede them in the Appendix.
An apparatus for deep-sea soundings, based upon his examinations of this subject, has been devised by Professor W. P. Trowbridge, assistant in the Coast Survey. A full description of the instrument will be found in the Appendix No. 34, and views of its several parts on Sketch No. 39. The principal feature of this sounding apparatus is new, but simple, and it is hoped that a great improvement on the present modes of sounding in great depths may result from its application. The friction upon the line in the descent of the lead is avoided, and the consequent freedom of descent secured by having the line compactly coiled along with the sinker, the uncoiling taking place in the descent of the apparatus. It is proposed to test the practical working of the instrument during the coming season.

The experiments with the pressure tide-gauge of Captain Hunt, of the Corps of Engineers, have been continued, and show that the instrument must in many cases be a very useful one. By filling the tube which communicates between the pressure bag and the indicator with alcohol, we expect to be able to use the instrument at low temperatures and when the surface of the water is covered by ice. The experiments of Mr. J. M. Batchelder, in continuation of those noticed in my report of last year, are stated in Appendix No. 35.

In the report of Assistant Henry Mitchell (Appendix No. 26) will be found descriptions of improvements in apparatus for detecting and measuring sub-currents, and also of an improved form of pile for securing structures upon shoals or along the open coast, where the heavy sea prevents the use of ordinary means. These devices are illustrated in Sketch No. 40.

In the use of the improved current apparatus the velocities of the drifts in the lower water strata are compared with the superficial movements of the sea by measuring, during a specified interval of time, the separation which takes place between a floating body and a system of globes or shafts let down to great depths. When in use the apparatus is in no wise connected with the vessel, so that no discordance in the observations can result from the motions of the latter, and the experiments may be made accurately even in a heavy sea.

Assistant Mitchell’s improved pile is a device borrowed from nature, he having observed that certain seed vessels, by virtue of their forms, bury themselves in the earth when agitated by wind or water. This pile, instead of being torn up by the waves, is impelled steadily downward. It may be hewn out ever so roughly, its success in practice depending upon very simple conditions described in the report which I have referred to.

In his past season’s operations Mr. Mitchell has made successful use of apparatus comprehending the improvements he describes.

OFFICERS OF THE ARMY.

Between November 1, 1858, and the same date of the present year, five officers of the army have been detached from the Coast Survey, and two detailed for service. Captain E. B. Hunt, of the Corps of Engineers, has not been regularly detached, but has, in fact, been so occupied with engineering duties as to render it impracticable that he should give any portion of his time to the Coast Survey.

Captain A. H. Seward, U. S. A., detached on his promotion, has rendered good service, and shown remarkable adaptation to our work in charge of a triangulation party in the very difficult region of the inner Florida keys, and the loss of his experience to the survey is much to be regretted.
Lieutenant J. C. Tidball, U. S. A., had been in charge of the drawing division of the Coast Survey for several years, and was a very efficient officer. Lieutenants J. P. Roy, and Rufus Saxton had been serviceable both in the field and office. The experience of all these officers is now lost to us in their several positions.

Appendix No. 3 contains a list of the army officers now attached to the Coast Survey.

OFFICERS OF THE NAVY.

During the past year we have lost by detachment the services of two of the most experienced chiefs of hydrographic parties. Lieutenants T. A. Craven and J. N. Maffitt, U. S. N., have thoroughly indentified their names with the Coast Survey, and wherever their labors have extended, from Maine to Texas, have left the mark of their special ability for the work. During the last period of their service they were but temporarily attached to the survey, it being understood that the Navy Department would soon need them in highly responsible positions connected with the general service, but they, nevertheless, both found time, the former on the Florida reef, in New York harbor, and in the Gulf Stream, and the latter in organizing a system of repairs and equipment, to cause that short period to be remembered as important to the survey.

By the kindness of the Hon. Secretary of the Navy, my letters of acknowledgment to these officers were transmitted to them in the most complimentary way.—(Appendix No. 39.)

Lieutenant W. G. Temple, U. S. N., was detached from the command of the steamer Corwin in October, 1858, and from the survey in April, 1859. He had been in charge of a party less than two years, but his preliminary experience in the work, and his intelligence and industry, rendered every day of his connexion with it useful to the survey.

Lieutenant T. B. Huger, U. S. N., was detached at the close of his summer's work, having earned the name of a zealous and intelligent chief of a hydrographic party.

Of the chiefs of parties who have replaced these officers, Lieutenant Wilkinson and Lieutenant Phelps have had considerable experience in the survey in former years, as junior officers of parties.

The names of all the officers now on duty in the Coast Survey are given in Appendix No. 5.

The deficiency in the number of naval officers, by which only one lieutenant is now allowed to each hydrographic party, has made a radical change in our service. The master's mates allowed to the parties will, in time, be trained to the work, but thus far the difficulties have been much increased by the want of experienced officers. The rules required to give a form of organization to this branch of the service have been adopted, and their working will be carefully observed.

All the engineers of the Coast Survey vessels are now civilians, and their entire emolument is derived from the Coast Survey appropriations. Under the regulations of the Treasury Department they are employed by the chiefs of hydrographic parties at fixed rates of pay, their employment lasting, as a rule, only while the vessels are in commission.

HYDROGRAPHIC DIVISION.

The advantages to be derived from this division have been fully realized by the activity of Lieut. J. N. Maffitt, U. S. N., who was in charge of it at the outset, with Mr. A. Balbach as the draughtsman. Commander S. S. Lee, U. S. N., who has replaced Lieut. Maffitt, will no doubt maintain all its efficiency.
The duties of hydrographic inspector, which are combined with those of the charge of this division, are of great importance, and Commander Lee has already shown the efficiency and economy which must come from the new organization devised by Lieut. Maffitt, and commenced under his immediate supervision.

By the kindness of the Hon. Secretary of the Navy, and of Commodore Smith, chief of the Bureau of Docks and Yards, the necessary store-room has been assigned to us in the New York navy yard, and the order and method introduced into the laying up, repairs, and fitting out of our small vessels, and into the charge of them while laid up, will prove not only a source of efficiency, but also of economy.

AIDS TO NAVIGATION.

As the hydrographic work advances, and developments are made of the known or hitherto unknown dangers to navigation, the practice has been, with the chiefs of parties, to report upon them, with such recommendations in regard to buoys or other marks as in their judgment are necessary. Their remarks on the aids required for safety in navigation are from time to time referred through the department for the consideration of the Light-house Board. Appendix No. 40 contains a list of the cases reported within the year, and Nos. 41, 42, and 43 my communications relative to the special localities and character of the marks required for the purposes of mariners.

OBITUARIES.

The survey has lost during the past year, by death, the services of Lieut. John K. Duer, U. S. N., who was in charge of one of the hydrographic parties in the Gulf of Mexico. This officer discovered in 1857 the new channel east of Dog island, leading into St. George's sound, and to Apalachicola, so important to the future development of that part of the coast of Florida, and was engaged in completing the survey of the approaches when he died. He was a zealous and industrious officer, regarding always the public service rather than his own health or convenience, and died of a disease of the heart aggravated by the labors and responsibilities of his position. Mr. Gustavus Würdemann, in charge of the tidal observations on the Florida reefs and in the Gulf of Mexico, died at his home in New Jersey on the 29th of September. His health had been failing for some years, and during the last year he had discharged his duties with great difficulty, owing to physical debility.

Mr. Würdemann entered the survey under my predecessor, and served until the period of his death with a fidelity and singleness of purpose that has never been exceeded. Exact truthfulness was the leading trait of his character, and his observations were reliable in the most minute as in the largest points. It is easily seen that it is no exaggeration to say that such a man in his place was invaluable, and an example worthy to be held up as the type of faithfulness. During the discharge of his laborious duties he found time and opportunity to make collections in natural history, which have been acknowledged by the Smithsonian Institution as among its most valuable contributions to the knowledge of the fauna of Florida.

Mr. F. Dankworth, one of the oldest and best engravers in the Coast Survey Office, whose employment dates from 1843, died on the 19th of April. He had been in infirm health for the last year, but continued to the last to work at his art, to which he was successfully devoted.
I proceed now to give, in the usual geographical order, detailed statements of the field-work done on the Atlantic, Gulf, and Pacific coasts of the United States, under the head of sections, the limits of which have been already defined. In each chapter the work is described generally in the natural order taken in its execution, as triangulation, topography, hydrography. Notices of the office-work done in Washington precede the several chapters, each of which corresponds to one of the sections.

SECTION I.
FROM PASSAMAQUODDY BAY TO POINT JUDITH, INCLUDING THE COAST OF THE STATES OF MAINE, NEW HAMPSHIRE, MASSACHUSETTS, AND RHODE ISLAND.—(Sections A, Nos. 1 and 2.)

The progress in the field-work of this section is stated under the following heads:
1. Geodetic and astronomical observations.—The primary triangulation and the astronomical and magnetic observations connected with it have been carried to the boundary, and Chamcook station has been occupied for the survey of Passamaquoddy bay.
2. Triangulation connected with Epping base.—The primary triangulation has been connected with the base of verification on Epping plains, measured in 1857. The verification from the first approximate computations is highly satisfactory, the length as measured and as computed from the triangulation differing but three-tenths of an inch in five miles and four-tenths. This brings the results much within the range of uncertainties of expansion of measures and the like.
3. Triangulation of Penobscot bay.—This work extends over the entrance, embracing the islands as well as the main.
4. Triangulation of Muscongus bay and sound.—This work has been extended from the Sheepscot river over the Damariscotta and over Muscongus bay and sound to a junction with the Penobscot work.
5. Topography of Wiscasset bay.—A stretch of about four miles above and below the town of Wiscasset has been completed, joining with the work of the previous year on the Sheepscot.
6. Topography of Merrymeeting bay and of Bath, Maine.—This is a continuation of the survey of the shores of the Kennebec river.
7. Topography of Casco bay, Maine.—This is a continuation of the survey of the main and islands of Casco bay, and extends to Harpswell Neck.
9. Topography of Barnstable harbor and approaches, Mass.—This forms part of the topography of Cape Cod, which remained to be executed on the inner shore.
10. Hydrography of the approaches to Sheepscot bay and Kennebec river, Maine.—These were nearly completed. The least depth of water upon "Mile Ledge" was found to be but eighteen feet at mean low tide.
11. Hydrography of Casco bay.—This is in continuation of the soundings of the lower part of Casco bay. The well known "Hussey Rock" was found to be erroneously laid down in position on the best charts. The shoal artificially caused off Union wharf, Portland harbor, has been nearly removed.
12. In-shore hydrography between Cape Elizabeth and Cape Porpoise, coast of Maine.—This is nearly connected with the hydrography of the approaches to Portland harbor. Cape Porpoise,
Stage Island, and Wood Island harbors were surveyed in connection with this work. The developments here were numerous.

13. Off-shore hydrography, coast of Maine, New Hampshire, and Massachusetts.—Important contributions to this have been made.

14. Examination of Salem harbor.—This was an extension of the examination of last year.


16. Magnetic observations at localities extending from Portland to Cape Ann.

17. Tidal observations.

This work has occupied three triangulation and magnetic, four topographical, and two hydrographic parties during the whole or parts of the season.

Office-work.—The drawing and engraving of additions to the chart of Boston harbor have been completed, as also the drawing of those of Portland harbor, Lynn harbor, and a new edition of that of Muskeget channel, and the engraving of the preliminary charts of Kennebec river and Rockport harbor. Progress has been made in the drawing and engraving of general coast chart No. 11, from Cape Ann to Gay Head, and of preliminary coast chart No. 3, from Cape Small Point to Cape Cod; in the drawing of coast maps and charts, No. 7, from Muscongus bay to Portland harbor; Nos. 9, 10, and 11, from Cape Nedick to Hyannis harbor, and No. 14, from Cuttyhunk island to Block island; also in the engraving of coast maps and charts, Nos. 12 and 13, from Monomoy to New Bedford; the views for these charts, the finished maps of Kennebec river and Lynn harbor, and the new edition of the chart of Muskeget channel.

Geodetic and astronomical observations.—The party under my immediate direction was organized at Washington early in June for the purpose of completing the primary triangulation of the coast near the northeastern boundary of the United States. The preliminaries required in the erection of additional signals and posting the heliotropers were executed by Assistants C. O. Boutelle and G. W. Dean, and the preparations necessary in occupying the stations were, as usual, made by Mr. Thomas McDonnell, artificer in the Coast Survey.

Station Howard, situated on the western side of Machias bay, and in the township of Machiasport, Washington county, Maine, was first occupied. Owing to unfavorable weather, arising chiefly from the prevalence of sea fogs, but little progress was made until the middle of July, when the measurement of horizontal angles was commenced. From that period the work advanced well, and the various operations being satisfactorily completed by the 15th of August, arrangements were made for the immediate transfer of the party and instruments to the station Western Ridge, in Cooper township, in connection by a primary line, as may be seen by reference to sketch No. 1, with station Howard.

The operations at Howard included the measurement of twenty-four horizontal angles with the thirty-inch theodolite; vertical angles with the eight-inch Gambey circle, C. S. No. 57, upon six points; the determination of the latitude with the zenith telescope; azimuth observations with the thirty-inch theodolite; the determination of the magnetic elements; levellings for ascertaining the height of the station above the sea, and the usual meteorological observations. These several particulars, in connection with others, will presently be noticed more in detail.

The measurements of horizontal angles at station Western Ridge were commenced on the 30th
of August, and the work was pressed forward until the 27th of September, at which date all the geodetic, astronomical, and magnetic observations were brought to a successful close.

For extending the triangulation so as to include the northeastern boundary in the vicinity of Passamaquoddy bay, Chamcook station, near St. Andrew's, New Brunswick, was occupied by Assistant Dean between the 13th and 28th of October, and satisfactory measurements made of the angles required to conclude the primary work.

The facilities extended to Mr. Dean by T. B. Wilson, esq., of Chamcook, and Capt. Thomas Jones, U. S. consul at St. Andrews, while prosecuting the operations in that vicinity, are acknowledged in his report. The following statistics exhibit in brief the work executed by my party in this section during the past season:

**Triangulation.**—At station Howard 1,066 observations were made with the thirty-inch theodolite C. S. No. 1, upon ten signals and an elongation mark. The vertical angles for determining the heights of the principal stations were measured with the eight-inch Gambey vertical circle, C. S. No. 57, and for this purpose sixty-seven sets each, consisting of six measurements of the angle, were made upon the signals of six stations.

At Western Ridge station 1,103 observations were made with the large theodolite upon eleven signals and the elongation mark. Nine stations were observed on for the vertical angles, and 560 measurements were made.

At station Chamcook 464 observations were made with the large theodolite upon four signals for horizontal angles. Vertical angles were measured by 234 observations on the same signals with the circle No. 57.

The most distant signal observed on during the season was that on Mt. Desert island, as seen from Western Ridge. This line, between the two stations, is about fifty-eight miles in length. From Western Ridge the highest peak of Mt. Katahdin was observed on incidentally at a distance of about a hundred miles, and with observations of the same kind made at Mt. Desert in 1856, upon the same point, the geographical position of that remarkable feature of the interior of Maine will be approximately determined.

The primary triangulation completed during the season embraces an area of 1,150 square miles.

**Latitude and time observations.**—At station Howard two hundred and nineteen observations were made with the zenith telescope, C. S. No. 5, upon forty sets of stars. The arc value of a revolution of the micrometer was carefully obtained from one hundred and twenty-two observations on Polaris near its eastern elongation, and the value of a division of the level was found in the usual way by thirty observations upon a collimator with the micrometer.

With the forty-six inch transit, C. S. No. 4, the local time was determined by a hundred and three observations on fifteen standard stars, zenith and circumpolar.

At Western Ridge two hundred and twenty-three observations were made with the zenith telescope upon forty sets of stars. The arc value of the micrometer was ascertained from a hundred and twenty-two observations upon the star 51 Hev. Cephei near its eastern elongation, and the customary means were taken for finding the value of the level scale. Local time was determined from seventy-three observations on twenty zenith and circumpolar stars.

The observations for latitude and time were made by Sub-Assistant Edward Goodfellow, aided by Mr. Henry W. Bache.

**Azimuth.**—The azimuth of the trigonometrical lines at station Howard was determined, as in other cases, with the thirty-inch theodolite, and for that purpose one hundred observations were
made upon Polaris near its eastern elongation, besides seventy-two on Ursae Minoris, near the upper culmination, in connection with two hundred and eighty observations upon the elongation mark. At Western Ridge the azimuth was determined from seventy observations upon λ Ursae Minoris, near its upper culmination, and one hundred and twenty-six observations on the elongation mark.

Magnetic observations.—The geological formation at station Howard indicated that the magnet would be affected by local attraction, and the experimental observations made at several points near it proved this to be the case. After selecting the most favorable position, one hundred and forty-seven observations were made for declination, the magnet used being freely suspended during three consecutive days. The inclination was measured with the nine-inch dip-circle, five complete sets of observations being made with two needles. The horizontal intensity and moment of inertia were deduced from two sets of experiments on different days.

At Western Ridge the magnetic declination was ascertained by one hundred and ninety observations on four days, and the inclination from three complete sets made on different days.

At station Chamcook the declination was determined by one hundred and thirty-five observations on three days, the inclination from four sets of experiments on different days, and the horizontal intensity and moment of inertia in the usual way.

Observations were also made at Eastport, Maine, and in its immediate vicinity, for determining the magnetic inclination and local intensity.

The declinometer D. 22, C. S. No. 1, and dip-circle, C. S. No. 4, were used in all the observations made at the several stations.

The azimuth and magnetic observations were made by Assistant Dean, aided by Messrs. R. E. Halter, R. H. Talcott, and C. S. Peirce.

While the astronomical and geodetic operations were in progress at Howard, Mr. Talcott made a series of levellings from the station to a bench-mark which had been established by careful tidal observations made by Mr. McDonnell, who also ran a line of levels between the same points.

Meteorological observations.—The usual journals were kept at the several stations by Mr. Talcott, and in the course of the working season two hundred and ninety readings of the barometer, thermometers, and evaporating point, were recorded.

All the original records were duplicated, and the computations from the latitude, azimuth, and magnetic observations nearly completed, before the party returned from the field. These, making a total of fifty volumes, have been deposited in the archives at Washington.

Assistant Dean and Sub-Assistant Goodfellow are about to resume the prosecution of longitude determinations on the Gulf of Mexico.

Reconnaissance.—The primary triangulation which has been carried through New England having approached the northeastern boundary of the United States, it became desirable that stations should be chosen for closing the series in that quarter so as to include the St. Croix river and Passamaquoddy bay. In the latter part of June Assistant C. O. Boutelle proceeded on this duty, first re-erecting on Mt. Desert island the primary signal which had been destroyed by a storm subsequent to the occupation of that point by my own party in the autumn of 1857, and placing the heliotropes necessary for the measurement of horizontal angles formed at the two remaining stations (Howard and Cooper) west of the boundary, intended to be occupied at a later period in the present surveying year. Ample facilities for the work were afforded in
the use of the U. S. revenue cutter Jackson, by her captain, Joseph Noyes, and by Robert Burns, esq., collector at Eastport, Me., under authority from the Treasury Department.

The official sanction of the colonial authorities of New Brunswick having been received, Mr. Boutelle selected and marked a station at the distance of about a quarter of a mile from the bluff on the north side of Dark harbor, Grand Manan island, and erected a signal at Chamcook, in the vicinity of St. Andrew's. Both of these points (Sketch No. 1) were observed on from the station occupied by my party in September.

The reconnaissance was so made as to settle also the availability of points for the secondary triangulation in the vicinity of Passamaquoddy bay, and for its connection with the primary work. Two signals of the second order were erected—one at Prince Regent's Redoubt, (Moose island,) near Eastport, and the other on Trescott Rock. The positions of these, and the general plan proposed for the smaller triangulation, are shown on Sketch No. 2.

Assistant Boutelle was aided in this service by Mr. C. H. Boyd. In the early part of the surveying year his party was employed in Section V, and afterwards completed the triangulation work, in the vicinity of the Epping base, as will be presently noticed. In the course of the season he visited and examined the lines leading from the two primary stations—Gunstock Mt., in New Hampshire, and Wachusett Mt., in Massachusetts—which had been passed by in the progress of the general triangulation through New England, and which yet remain to be occupied.

**Triangulation connected with Epping base.**—This duty was commenced on the 17th of September by Assistant Boutelle, from whose report, made on the completion of the work, the following extract is taken:

"In occupying as stations the east and west ends of the base, the theodolite was protected from sun and wind by a temporary structure, and the observing tripods by a couple of screens of light canvas, each of the size of the surrounding scaffold. These were spread on the windward sides, and kept the platform on which the theodolite was placed in perfect steadiness. At the west end of the base the wind blew almost a gale from the northwest on the evening of the 15th and morning of the 16th of October; and although the scaffold was over forty feet high, eighteen feet wide at the base and nine at the top, the protection from the screens was such that the observations were not materially interfered with. It would have been impossible to observe without them, and I consider them a great addition to our means of observing in the southern sections where tripods are more frequently required."

The connection of the base with the primary triangulation was effected by occupying, besides the two ends, the three adjacent stations, namely: Burke, Pigeon Hill, and Tunk Mt., all of which, and also the relative situation of the base line, are shown on Sketch No. 1.

Each of the horizontal angles was determined by a hundred and twenty measurements with the ten-inch Gambeuy repeating theodolite, C. S. No.43. The vertical angles were measured by means of the eight-inch Gambeuy theodolite, C. S. No. 24.

Mr. Boutelle observed a series of consecutive tides near Pigeon Hill, and carried a line of levels to that station, determining its height above the mean level of the sea.

The following summary shows the general statistics of the triangulation:

<table>
<thead>
<tr>
<th>Stations occupied</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals observed on</td>
<td>36</td>
</tr>
</tbody>
</table>
The work was completed on the 31st of October.

Assistant Boutelle was aided in the field by Mr. C. H. Boyd. All the records of the work were duplicated before the return of the party from this section. Mr. Boutelle had been previously engaged in Section V.

Triangulation of Penobscot Bay, Me.—This work, which was begun last year, has been continued by the party of Sub-Assistant J. A. Sullivan. The stations established by Sub-Assistant Harris were in part occupied, and angular measurements made from them on others above and below the primary line Ragged—Isle au Haut, shown on Sketch No. 2. Progress was made in extending the work upwards between the 23d of July and 23d of September, when the schooner Peirce, which attended the party, was despatched for New York. Observations were continued by Mr. Sullivan until the 5th of October.

Sixty points of the third order were determined in position. These and the measurements of secondary angles were made with the Württemberg theodolite, C. S. No. 86.

As every precaution was taken in erecting signals for continuing the triangulation up the bay, there is a fair prospect that the future progress in that direction will be more rapid.

The number of observations made in the course of the season was five thousand one hundred and twenty.

Messrs. R. M. Stiles and J. D. Bradford served with zeal and efficiency as aids in the party.

The previous occupation of Sub-Assistant Sullivan will be referred to under Section VI.

Sub-Assistant Harris, who was last year engaged on Penobscot bay, has sent to the office duplicates of his notes of horizontal angles and descriptions of the signals erected at the outset of the work.

Triangulation over Muscongus Bay and Sound, Me.—On the 6th of July the party of Sub-Assistant F. P. Webber, commenced the erection of the remaining signals necessary for extending the secondary triangulation eastward of the Sheepscot river, over the Damariscotta river, and over Muscongus bay and sound. The signal at Edgecombe and some others in the vicinity, having been blown down in the spring, were re-erected, and twenty-one others, mostly of the third order, for topographical purposes, were put up. The reconnaissance and preliminaries being complete by the end of July, Mr. Webber, aided by Mr. Julius Kinkeloe, commenced the measurement of horizontal and vertical angles, and occupied fifteen stations with the theodolite, at seven of which vertical angles were observed on the signals of the thirty-four stations embraced in his field of work. It will be seen by reference to Sketch No. 2 that the secondary triangulation conducted by Sub-Assistant Webber has been pushed to a connection with that of the lower part of Penobscot bay, on the line which joins Manhegan Island with a station on the east side of St. George's river.

Fifty-nine points were determined in position within the scope of the triangulation. The remaining statistics are as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stations established or re-erected</td>
<td>34</td>
</tr>
<tr>
<td>Stations occupied</td>
<td>15</td>
</tr>
<tr>
<td>Horizontal angles measured</td>
<td>347</td>
</tr>
<tr>
<td>Vertical angles determined</td>
<td>34</td>
</tr>
</tbody>
</table>
Objects observed on .............................................. 346
Number of observations ........................................ 3,090

The schooner Hassler, which was used in this service, returned to New York on the 6th of October. In the early part of the surveying year Mr. Webber was engaged in Section V, and is now completing arrangements for returning to the coast of Georgia.

Duplicates of the field-notes made in the triangulation over Damariscotta river and Muscongus bay have been deposited in the office with the descriptions of the signals as now standing.

Topography of Wiscasset bay, Me.—The sheet containing this work was taken into the field by Sub-Assistant W. H. Dennis on the 1st of August. On the south it joins with the work done last year on the Sheepscot river by Assistant Hull Adams. As far as now completed, the topography represents the town of Wiscasset and its environs, and the details found at Edgecombe, on the opposite side of Wiscasset bay, including also the mouth of the Sheepscot, above Wiscasset, making altogether a stretch of about four miles above and below the town. Owing to the nature of the surface the features in detail were found very difficult of delineation.

Sub-Assistant Dennis was efficiently aided in plane table duty by Mr. J. L. Tilghman. Fieldwork was continued until late in October, with the following result in statistics:

Shore line surveyed .............................................. 8 miles.
Roads ................................................................. 20 "
Area of minute topography (square miles) ................. 5½

The locality of the work may be seen on Sketch No. 2.

Topography of Merrymeeting bay and Bath, Me.—The supplementary topography required for the chart of the Kennebec river, in the vicinity of Bath, was taken up on the 24th of June by Assistant R. M. Bache. Sub-Assistant W. S. Edwards was attached to his party, and worked with a separate plane-table on the details of the shores of Merrymeeting bay. Assistant Bache traced in the streets and wharves of the city of Bath, which is continuous for about five miles along the west bank of the Kennebec. The very uneven surface represented on the two sheets referred to made the field-work tedious and necessarily slow in execution. The locality is shown on Sketch No. 2. A small portion of the area of each sheet yet remains to be filled in detail.

The following are the statistics of the season:

Shore line surveyed ............................................... 27 miles.
Wharf line surveyed ............................................... 7 "
Roads ................................................................. 32 "
Area (square miles) ............................................... 15

The villages of Woolwich and Winnegand are represented on one of the topographical sheets.

Assistant Bache has inked and sent to the office the plane-table sheet of the Kennebec which was completed last year.

Topography of Casco bay, Me.—The work of the season on the shores of Casco bay, and on the islands east of Portland harbor, was in charge of Assistant A. W. Longfellow, and consisted of filling the interior details and contour of ground of the outstanding sheets, of which the shore line had been previously traced. Assistant A. S. Wadsworth was attached to the plane table party, and Mr. James Gillies served as aid. The topography was resumed on the 11th of July and continued until the 4th of November. Assistant Longfellow completed the survey of the shores of the Presumpscot river, and of the main shore of Casco bay, from thence north-
ward to a point beyond Sturdivant's island, from which it was extended by Assistant Wadsworth in the same direction abreast of Prince's Point, and there joined to a portion of work also finished by Mr. Longfellow. The topography of the interior of Long's and Cousin's island was completed, as also that of Great Jebeig, Hope, Crotch, and Jewell's islands. The location of the three plane-table sheets worked on, and of which the details are now complete, may be seen in Sketch No. 2. On two other sheets, which embrace Yarmouth river and Harpswell Neck, progress has been made in the shore line survey.

The details of the season's survey are represented in the following statistics:

- Shore-line of marshes and ravines: 33 miles.
- Roads: 40 "
- Total of contour lines: 155 "
- Area of topography (square miles): 14

The original sheet containing the topography of Portland harbor, the city and its environs, has been inked and placed with the archives at the office.

The party of Assistant Longfellow used the schooner Meredith for transportation and quarters while working in Casco bay.

**Plane-table survey of Saco bay and vicinity, Me.**—In order to facilitate the early completion of the charts of soundings to be made between Cape Elizabeth and Kennebunkport, Me., Sub-Assistant C. Fendall was attached to the hydrographic party of Lieut. Comg. Murray, and traced the entire shore-line from Prout's Neck and Stratten island southward, and westward to Kennebunk river. His work, the limits of which, as contained on four plane-table sheets marked on Sketch No. 2, embraces the shores of Saco bay, Wood island, Fletcher's Neck, and all the islands and coast intermediate between the last-named point and Kennebunk river. The Isles of Shoals were also surveyed, and were mapped on a separate topographical sheet.

**Topography of Barnstable harbor and vicinity, Mass.**—The survey of the shores of Cape Cod bay was commenced on the 7th of July by Assistant A. M. Harrison. Two plane-table sheets were projected—one to include Barnstable harbor, and the other to extend the work westward. The topography was taken up at Scargo Hill, near North Dennis, and in its course westward embraced, besides the usual surface details, the village just named, and also Yarmouth, Yarmouthport, Barnstable, Pond Village, and West Barnstable, together with the Great Marshes in that immediate vicinity, Sandy Neck, and the entire shore of Barnstable harbor. Very few of the details of the vicinity yet remain to be traced on the sheet. Its limits are shown on Sketch No. 2. From the shore line of the harbor the survey was carried back to an average breadth of a mile and a half.

Sub-Assistant P. C. F. West and Mr. A. W. Thompson were attached to the plane-table party, and rendered efficient service.

The character of the country in the vicinity of Barnstable presents almost every variety of ground, and much of it is thickly settled. The Cape Cod railroad is represented in the stretch from West Barnstable to Dennis Pond, where it turns to cross the peninsula.

Assistant Harrison closed work on the 21st of October, but, before leaving the field, visited the triangulation points on which his work was based, reset the station marks, and prepared for the records of the office new sketches of them, accompanied by descriptive notes. The following synopsis of statistics is taken from his report:
Shore-line surveyed ........................................ 20 miles.
Marsh-line .................................................. 46\frac{1}{2} "
Creeks, ponds, &c. ........................................ 88\frac{1}{2} "
Roads .......................................................... 44\frac{1}{2} "
Area of details, (square miles) .......................... 15

The plane-table sheet embraces a coast reach of rather more than ten miles, measuring east and west of Barnstable harbor.

Verification of Topography.—After closing special field service, which will be referred to in the following chapter, Assistant H. L. Whiting examined the plane-table work done this season in the vicinity of Wiscasset, and that on the shores and islands of Casco bay and in the neighborhood of Barnstable harbor. The examination was made with reference to the amount and character of the topography, and was fully reported on by Mr. Whiting as being in all respects satisfactory and thorough in detail. The localities mentioned are amongst the most difficult of representation that have yet been passed over by either of the plane-table parties.

Hydrography of the approaches to Sheepscot bay and Kennebec river, Maine.—Under circumstances unusually favorable for work afloat, the hydrography of the approaches to the Sheepscot and Kennebec rivers was completed in August by the party of Lieut. Comg. John Wilkinson, U. S. N., assistant Coast Survey, working with the steamer Corwin. The upper limit of the soundings is on a line passing from Cape Newagen across and about three miles to seaward of Damiscoue island, from whence the work was prosecuted southward and westward to the meridian of Cape Small Point, where it joins the completed hydrography of 1856-'57. The resulting chart will extend several miles to the southward of Seguin island, the soundings in that vicinity being made as supplementary to the hydrography of the Kennebec entrance, executed in the surveying season of 1855-'56. Sketch No. 2 shows the locality and the limits referred to.

The tidal observations required in plotting the soundings were made at a station in Booth bay.

A small sunken rock, known as "Mile Ledge," lying about a mile to the southward of Seguin island light, and which is marked on the old charts as having four fathoms, was found by Lieut. Comg. Wilkinson to have only eighteen feet water at mean low tide. The rock is in the track of vessels bound into Kennebec river, and bears from the light-house S. 9° 30' E., (true,) or south a little to the westward by compass. The range and other particulars for determining its position were made known to the department in September, in a communication, a copy of which is given in Appendix No. 9.

A summary returned on concluding the hydrography of this vicinity presents the following statistics:

Miles run in sounding ........................................ 206\frac{1}{2}
Angles taken .................................................. 898
Number of soundings ....................................... 1,971
Area sounded, (square miles) ............................ 52

The greatest depth of water found was forty-seven fathoms.

Lieut. Comg. Wilkinson has furnished sailing directions for the chart of the Kennebec river and its approaches.

Within the year the two sheets containing the hydrography of the Sheepscot river, executed by Lieut. Comg. Moore, have been plotted and registered in the office.
Hydrography of Casco bay, Maine.—The soundings required to complete the hydrography of the lower part of Casco bay were made in the latter part of August and early part of September by the party of Lieut. Comg. Wilkinson, working with the steamer Corwin. A space embracing about twenty square miles abreast of Portland light, and included between Peak’s island and Green island, is shown on the chart. Within its limits occurs the Hussey Rock, the position of which has been hitherto erroneously laid down on the best charts of Casco bay, and which, in the course of the operations conducted by Lieut. Comg. Wilkinson, was found to be more than a quarter of a nautical mile northwest of the position heretofore assigned. Bearings and ranges from the true position to fixed points on the main and adjacent islands are given in Appendix No. 10. The Hussey Rock is small and has only twelve feet on it at mean low water. The locality in which the soundings were made may be seen by reference to Sketch No. 2, by which, also, it will be observed that the in-shore hydrography of the section has been pushed as a continuous work as far to the northward and eastward as Cape Newaggen, with the exception of a small interval at Cape Elizabeth, the advance of the season not admitting of a final junction between the lines run by Lieutenant Commanding Wilkinson and those of Lieut. Comg. Murray, the site of whose work will be referred to presently. Tidal observations were made with a staff-gauge at Peak’s island while the party was sounding in that vicinity.

At a period since the date of the survey made by Lieutenant Commanding Maxwell Woodhull, U. S. N., the water at one point in the channel off Union wharf, Portland harbor, had shoaled. This was made the subject of examination by Lieut. Comg. Wilkinson, and it appeared that by the sinking of a schooner laden with granite the depth had been for some time decreased. The obstruction is now removed and the depth nearly restored to what it was when the preliminary chart of Portland harbor was first issued.

The following is a summary of the hydrographic statistics:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles run in sounding</td>
<td>117 3/4</td>
</tr>
<tr>
<td>Angles observed</td>
<td>573</td>
</tr>
<tr>
<td>Number of soundings</td>
<td>1,657</td>
</tr>
<tr>
<td>Area sounded, (square miles)</td>
<td>20</td>
</tr>
</tbody>
</table>

Having made very favorable progress in the hydrography of the section, the party in the Corwin left Portland on the 2d of October and proceeded to New York.

Lieut. Comg. Wilkinson has turned in the note-books containing the entries of soundings and tidal observations made in Casco bay and in Portland harbor.

The hydrographic sheet showing the soundings made at the entrance of Casco bay by Lieut. Comg. Temple, U. S. N., in the previous surveying season, has also been received.

In-shore hydrography between Cape Elizabeth and Cape Porpoise, coast of Maine.—This work was resumed in July by Lieut. Comg. Alexander Murray, U. S. N., assistant Coast Survey, at last year’s limit, near Kennebunkport, and from thence was prosecuted northward and eastward to the vicinity of Cape Elizabeth, the lateness of the season and duty required in the lower part of the section only preventing a junction with hydrography of the approaches to Portland harbor.

Sketch No 36 shows in a general way the present condition of the in-shore soundings on this
part of the coast, and the progress sketch (No. 2) the limits of the several sheets executed this season. The soundings were carried about eight miles out from the coast line and into depths varying between fifty-five and seventy-five fathoms.

Within the limits of this work are several small harbors, with a good depth of water and fine holding ground. Surveys were made of Cape Porpoise, Stage island, and Wood island harbors, and the plotting of the sheet containing them is well advanced.

Sub-Assistant C. Fendall was attached to the party, and furnished plane-table data as needed in the hydrography.

A tide-gauge was set up at Wood island harbor and regular observations referred to a benchmark were duly recorded as the soundings advanced in that vicinity.

Among the important developments of the present working season on the coast of this section are the following, made by the party of Lieut. Comg. Murray, in the surveying steamer Bibb.

The four-fathom bank off Cape Porpoise, Maine, completely sounded out.

A fishing bank developed off Wood island.

Hussey Rock, off Saco bay, and to the southward of Fletcher's neck, determined in position.—(See Appendix No. 41.)

The position and development of a rock off Ogunquit, bare at low tide, and but very little known.—(See Appendix No. 11.)

Determination of the position of the "Hue and Cry," the "Old Proprietor," and other dangers to navigation off Cape Elizabeth.

The statistics of the in-shore hydrography are as follows:

<table>
<thead>
<tr>
<th>Miles run in sounding</th>
<th>814</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angles determined by theodolite</td>
<td>75</td>
</tr>
<tr>
<td>Angles determined by sextant</td>
<td>2,122</td>
</tr>
<tr>
<td>Number of casts of the lead</td>
<td>13,659</td>
</tr>
</tbody>
</table>

The sheets containing the plane-table work done by Sub-Assistant Fendall are now on file with the archives. All the original note-books of soundings and angles and the chart of last year's work have also been deposited in the office.

Being incidentally at Portsmouth harbor, N. H., with the steamer Bibb, Lieut. Comg. Murray rendered acceptable service to another branch of the government at the request of the commandant of the naval station, Captain John Pope, U. S. N., whose acknowledgment of the same will be found in Appendix No. 37.

Mr. W. B. McMurtrie accompanied the hydrographic party, and took views for the charts of the Kennebec entrance, Portland harbor, Stage island harbor, and of several points in the vicinity of Saco bay.

Off-shore hydrography, coast of Maine, New Hampshire, and Massachusetts.—In passing to the upper part of the section in the steamer Bibb, Lieutenant Commanding Murray started from a position eastward of Pollock's Rip light-boat and ran a line of soundings due north to the parallel of Cape Ann, and thence to the Isles of Shoals. From Cape Ann a line was afterwards carried across the southern part of Cashe's Ledge, and as far to the eastward as Seal island, N. S. The greatest depth found on this line was a hundred and sixty fathoms. In crossing Cashe's Ledge the soundings showed a depth of 16 fathoms. From Seal island, N. S., soundings were made on the course to Grand Manan island, and from thence traverse lines were carried
to the westward close in by Mt. Desert Rock and by Matinicus and Manhegan island to Cape Elizabeth.

While in the vicinity of Passamaquoddy bay Lieut. Comg. Murray made a reconnaissance in the waters around Campo Bello and Cross island, and extended soundings on a line from Grand Manan towards the main as far as Sail Rock.

The several courses run in making off-shore soundings are laid down on Sketches Nos. 1 and 2. Saxton's metallic thermometers were used, and gave for depths of a hundred fathoms an average of two and a half degrees in temperature less than that found at the surface. Specimens of the bottom were preserved and the positions from which they were taken duly noted.

A summary of the off-shore statistics is appended.

| Miles run | 1,175 |
| Soundings | 546 |

Other deep-sea work executed by the party in the steamer Bibb will be mentioned under Section IV.

Lieut. Comg. Wilkinson, in returning southward from this section with the steamer Corwin, carried soundings on a straight course southward from Cape Elizabeth to a position six miles to the eastward of Nausett Centre light (Cape Cod peninsula.) Thirty-two casts were made with the lead, at each of which a specimen of the bottom was brought up. This line is marked on Sketch No. 2.

Examination of Salem harbor, Mass.—The review incidentally made at the close of the last working year being directed to but few points in the harbor, a more extended examination was made by Lieut. Comg. Murray after closing work in the northern part of the section. In reporting the results, that officer says: "All the main features and dangers in the harbor were determined in the original survey, and, with few exceptions, they are properly delineated on the chart of 1855."

Resurvey in Boston harbor.—After completing general hydrographic duty in this section a reexamination was incidentally made by Lieut. Comg. Murray of the upper part of the inner harbor at Boston. Commencing at Mystic river, his observations were continued outwards, and in their course to a point beyond Castle island the following changes were noticed:

A deposit abreast of the timber dock at the navy yard, the soundings showing two feet less of water than the survey of 1847.

A making out of the flats between Commercial wharf and Bird Island shoals.

A shoal-spit projecting from East Boston, east of the Cunard wharf, and running out into the channel.

The partial wearing of Bird Island shoals.

The extension of the Boston flats towards Bird island.

Referring to a line run from the northeast extremity of Boston flats to the wharf east of Cunard wharf, Lieut. Comg. Murray says: "It is observable that the eighteen-feet curve has been pushed out so far that the channel is contracted at that point nearly one-third, though the depth is retained.

The section from Bird Island flats to Boston flats developed the fact that the channel is moving towards the Bird Island flats, and that those flats are diminishing in size.
Black buoy No. 11, (off Slate Ledge,) which marks the outer edge of the Boston flats, now making towards Bird island, is directly in the mid-channel of 1847, which then had a depth of thirty-four feet. Now the most water found on that line at mean low tide is twenty-five feet, and at the buoy sixteen feet. The channel in that vicinity has become much more serpentine, and great caution is required to prevent the heavier class of vessels from bringing up on the shoal-spits.'

A comparison line run from South Boston to Governor's island showed no changes of a marked character as having occurred since the former survey.

Rock in Hyannis harbor, Mass.—The position of a small rock reported by Commander M. Smith, U. S. N., light-house inspector of the second district, as existing not far from the breakwater in Hyannis harbor, and the vicinity of which had been marked by a buoy, was determined by Lieut. Comg. Wilkinson on the passage of the steamer Corwin from New York northward at the outset of the working season in this section. The crest of the rock was found to be about eight feet square, and the depth on it three and a half feet at mean low water, increasing abruptly to twelve feet all around it. From the rock in question Great Rock spindle bears N.N.W. ¾ W., (true,) or N. by W. ¾ W. by compass, and is distant two hundred yards. The ranges for finding its exact position are given in a communication from Lieut. Comg. Wilkinson, which I have placed in the Appendix (No. 12.)

The journals of soundings and tidal observations made in the course of the examination have been sent to the office.

Magnetic observations.—These were made during the month of July by Assistant Charles A. Schott, aided by Mr. J. L. Tilghman. The series extends from Portland to Cape Ann, and includes in all fifteen stations, several of which will be referred to under the head of Section II. In this section the magnetic declination, dip, and intensity were determined at Bowdoin Hill, in Portland, Me.; at Kittery Point, opposite Portsmouth, N. H.; on Plum Island, near Newburyport, and at Ipswich, Mass.; also at Beacon Hill station, near Gloucester; at the primary triangulation station, Thompson; at Annis Squam, and at Rockport, on Cape Ann. The five last-named stations were occupied for procuring data to apply to several of the harbor charts of the vicinity, and for adjusting computations of the secular change, as well as for studying local distribution on the peninsula of Cape Ann, the results, so far attained, marking that region as somewhat anomalous with respect to the magnetic elements. Observations were also made at Quebec and Montreal, as additional means for rectifying the charts of isogonic lines, published in 1856.

The instruments used were, for declination and intensity, the magnetometer, by Jones, (C. S. No. 6,) and its attached magnetic theodolite; for dip the Barrow dip circle, (C. S. No. 9;) time was noted on the chronometer (No. 1411) of Parkinson & Frodsham.

The time and azimuth were determined by observing the sun's altitude and azimuth, six sets being made, and three separate observations recorded for each. For declinations the readings were generally continued through a period of three hours at each station. The intensity was ascertained from two trials, each of which gave five independent results from a hundred and fifty vibrations. At three of the stations the deflections were observed to guard against possible accident to the magnet. The observations for dip consisted generally of six sets with the needles No. 1 and No. 2, the polarity being half of the time reversed.
Before setting out and after his return Mr. Schott made, at Washington, full sets of observations for vibration and deflection, in order to determine the magnetic moment of intensity for magnet H. Other instrumental constants were ascertained in the same way, at the station near the Coast Survey office. The index error of the dipping needles used was determined by comparing them with many others.

In the Appendix Nos. 23 and 24 the immediate results obtained by Assistant Schott are given, and their application to questions of great interest as connected with the laws of terrestrial magnetism. The original notes and his computations have been deposited in the archives.

Tidal observations.—The series heretofore referred to as continued at Charlestown, Mass., has been maintained during the past year with great regularity, by means of the self-registering gauge, kept in operation by Mr. T. E. Ready at the U. S. dry dock. Preparations have been made to occupy a permanent tidal station at Eastport, Me.

SECTION II.

FROM POINT JUDITH TO CAPE HENLOPEN, INCLUDING THE COAST OF THE STATES OF CONNECTICUT, NEW YORK, AND NEW JERSEY, AND THE SHORES OF PENNSYLVANIA AND DELAWARE. (Sketch I, No. 7.)

The operations in this section have been the following, in continuation of those of former years, and employing one triangulation party, and one double topographical, one magnetic, one tidal and current, and the occasional time of three hydrographic parties:

1. Triangulation of the Hudson river. This has been continued northward so far as to join the preliminary work of 1856 at New Baltimore.
2. Topography of the vicinity of New York, in New York and New Jersey, being in part a continuation of the surveys for the commissioners.
3. Hydrography of the Hudson river, which has been extended to above Poughkeepsie.
4. Resurvey of Hempstead harbor, Long Island sound.
5. Resurvey of the shoal off the Battery, New York harbor.
7. Magnetic observations.
8. Tidal observations.

Office-work.—Progress has been made in the drawing and engraving of coast map and chart No. 22, New York bay and harbor, and in the drawing of the map of Hudson river, from its entrance to Sing Sing. New plates of the middle and eastern sheets of the chart of Long Island sound have been engraved, and the old plate of the chart of Captain's islands, East and West, has been re-engraved.

Triangulation of the Hudson river.—The work of triangulation on this river was resumed at a station a little below Hudson, by Assistant Edmund Blunt, on the 7th of July, and has been extended northward to a junction, at New Baltimore, with the preliminary work done in 1856 between that point and Albany. About fourteen miles of the course of the Hudson falls within the triangulation.

In the vicinity of Yonkers fifteen stations were occupied, and data furnished to the plane-table parties working there under the charge of Assistant Whiting. The progress made in both localities is shown on Sketch No. 7.

Mr. Blunt was assisted in the field by Lieut. W. R. Terrill, U. S. A., and Sub-Assistant G.
H. Bagwell, both of whom had passed the early part of the season on the coast of Florida. Mr. Rufus King, jr., served as aid in the party.

The following is a synopsis from the abstract of the observations turned in by Assistant Blunt on the 15th of October:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stations occupied</td>
<td>63</td>
</tr>
<tr>
<td>Number of observations</td>
<td>9,336</td>
</tr>
<tr>
<td>Area of triangulation, (square miles)</td>
<td>151</td>
</tr>
</tbody>
</table>

Mr. Blunt has sent to the office the records of last year's work and descriptions of the signals then observed on.

Topography of South Jamaica; vicinity of Brooklyn and Williamsburg; High Bridge, Yonkers, and Morrisania; and of Hudson City, New Jersey.—The duty of filling in with details several sheets of the survey of Long Island and of the shores of Hudson river in the vicinity of New York city was resumed by Sub-Assistant F. W. Dorr on the 28th of June. Messrs. Cleveland, Rockwell, and McLane Tilton were assigned as aids in the plane-table party. After surveying a small space of the interior, to complete the sheet of the vicinity of Jamaica, Long Island, the party was divided, Mr. Dorr proceeding to Morrisania and finishing a sheet, of which he had executed the principal details in a former season, and Mr. Rockwell taking up the topography of Hudson city, New Jersey, and its environs.

Amongst the additions referred to as made by Sub-Assistant Dorr were surveys of the towns of Morrisania, Melrose, and part of Mott Haven. His party was then transferred to Williamsburg, and until the 1st of October engaged upon the section bounded by Green Point, Williamsburg, and until the 1st of October engaged upon the section bounded by Green Point, Williamsburg, and Brooklyn on the west, joining with the work of the city surveyors; to the east as far as Maspetch, Evergreen cemetery, and East New York; to the Long Island railroad on the south, joining with topography executed by Assistant S. A. Gilbert; and north to the limit of previous work by Assistant H. L. Whiting. The sheets of the locality referred to embrace one of the most thickly settled portions of Long Island, and include the district through which flows Newtown creek and its branches.

Two new wharves, erected since the former survey, at Sands' Point and Great Neck, Long Island Sound, and important as being the landings of steamers during the summer season, were determined in position and laid down by Mr. Dorr on the original sheets.

Under the direction of Sub-Assistant Dorr, Mr. Rockwell, after completing the survey of Hudson City, New Jersey, proceeded to High Bridge and filled in the topography required on the east bank of Harlem river, between that town and Kingsbridge. Part of the Croton aqueduct is represented on the sheet of that quarter. Two sheets of the survey above and below Yonkers were then taken up, and some progress in additional details made on the one extending upwards from the town. The other, which begins half a mile below the village and extends to Spuyten Duyvil creek, including also a stretch of two miles along the Palisades on the west side of the Hudson, was completed by Mr. Rockwell on the 15th of October. Like all the other sheets worked on, the shore line, excepting a portion on one sheet, and some portions of the details, were executed previous to the outset of the present season, the features delineated being required for the finished map of New York harbor.
The following is a summary of the plane-table statistics:

<table>
<thead>
<tr>
<th>Description</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shore line of Hudson river</td>
<td>6</td>
</tr>
<tr>
<td>Creeks</td>
<td>20½</td>
</tr>
<tr>
<td>Marsh line</td>
<td>9½</td>
</tr>
<tr>
<td>Aqueducts</td>
<td>8½</td>
</tr>
<tr>
<td>Roads</td>
<td>164</td>
</tr>
<tr>
<td>Area of details, (square miles)</td>
<td>25</td>
</tr>
</tbody>
</table>

The early part of the surveying year was employed by Sub-Assistant Dorr in Section VI, and by Mr. Rockwell in Section V.

The care and attention given by Mr. Tilton in chaining for the plane-table survey are especially commended in the report of Sub-Assistant Dorr.

Since the opening of the year the topographical sheets executed by this party in the last working season have been inked and sent to the office.

Mr. Dorr is now preparing to return to Section VI.

Topography of Hudson river, New York.—Two plane-table parties, under the charge of Assistant H. L. Whiting, took the field on the 15th of July, for the purpose of extending the detailed survey required for the finished maps of New York harbor and Hudson river. One of these, conducted by Sub-Assistant N. S. Finney, under the immediate supervision of Mr. Whiting, advanced the work on both sides of the Hudson, from Spuyten Duyvel creek as far upwards as Hastings. The other party, directed by Sub-Assistant John Meehan, completed the topography on both sides of the river between Irvington and Sing Sing on the east, and from Piermont to Rock mountain on the west bank. A portion of the details between Irvington and Hastings yet remains to be filled in. Within the scope of the completed limits the survey includes the villages of Yonkers, Tarrytown, and Upper and Lower Nyack in addition to those before named; the Palisades and the shores of the Tappan Zee.

All the plane-table work executed within the season in the vicinity of New York was verified by Assistant Whiting, and is reported as being thorough in character and accurate in details. In reference to it he says: "Great credit is due to the gentlemen who have been on duty with me, not only during this, but in former seasons, for the zeal and interest manifested and the particular attention given in aiming at and effecting a uniform system and style of work."

From Yonkers north and south to the limits of Mr. Whiting’s work, the survey was carried back from the shore of the river to the old post road leading from New York to Albany, which, as being a well defined boundary, yet gives sufficient breadth to include all the characteristic river topography. "On the western shore of the Hudson the only feature presented is the range of the Palisades, which opposite to Yonkers attain the greatest height. The details on that side were carried back sufficiently far to show a fringe of topography uniform in breadth with that of the lower sheets of previous years."

"The character of the work generally is complex and difficult. The details of contour on the eastern shore particularly were very numerous, embracing a range of hills from a hundred and fifty to four hundred feet high, with a great variety of artificial features."

The parties working under the direction of Assistant Whiting closed field operations on the 24th of September. Sub-Assistants Meehan and Finney, who had both been employed in dif-
ferent sections at the south during the former part of the year, then proceeded to make arrangements for resuming duty there.

A synopsis given in the report of Assistant Whiting shows the following details of work done in the vicinity of Yonkers and Tarrytown:

- Shore-line surveyed: 22\(\frac{1}{2}\) miles.
- Creeks: 12 miles.
- Marsh-line: 4\(\frac{1}{2}\) miles.
- Roads: 99 miles.

The limits of the plane-table work here noticed may be seen on Sketch No. 7. An area of rather more than eleven square miles is embraced in the survey of the year.

Resurvey of part of Hempstead harbor, Long Island sound.—After returning from the south, Lieut. Comg. T. B. Huger, U. S. N., Assistant Coast Survey, proceeded, in the latter part of August, to determine the position of several rocks within the limits of Hempstead harbor. This duty was performed with the schooner Agassiz, manned by a part of the crew of the steamer Walker. The survey was completed before the end of September, and includes the greater part of the space passed over in the previous examination. The following is an abstract of the statistics recorded in the hydrographic sheet which was turned in at the office shortly after the detachment of Lieut. Comg. Huger from the Coast Survey:

- Miles run in sounding: 66\(\frac{1}{2}\)
- Angles determined: 406
- Number of soundings: 5,612

The general duty executed by this party will be stated under the head of Section VIII.

Examination of the Battery shoal, New York harbor.—Attention having been invited in reference to the question of a decrease of depth on the Battery shoal, an examination of the vicinity was made by Lieut. Comg. T. A. Craven, U. S. N., Assistant Coast Survey, after his return from duty at the south. The result shows that at a spot off the Emigrant Depot the present depth is only seventeen feet and a half, and that in the angle formed by the line of the battery and pier No. 1 there has been a very rapid filling up. With respect to the changes noticed there, it is added: “The three-fathom curve has been pushed outward eighty yards beyond the line of 1856; the seventeen-feet spot in the outer part of this section is extending towards pier No. 1, and there is an average decrease of three feet in depth throughout that section.”

The subject of the changes and their causes are discussed in the report of Lieut. Comg. Craven, which will be found in Appendix No. 13, with my communication to the President of the New York Chamber of Commerce, in transmitting the results of the recent examination.

The action of the Chamber is given in the report of their committee, in the same Appendix.

Hydrography of Hudson river, N. Y.—The sounding of the Hudson was resumed by Lieut. Comg. C. M. Fauntleroy, U. S. N., Assistant Coast Survey, with the schooner Varina, at Newburg, where the work had been discontinued by the party of Lieut. Comg. Moore in a previous season. From thence upwards about fourteen miles and a half, to a point some distance above Poughkeepsie, the entire bed of the river was sounded out between the 1st of August and the close of September. Sketch No. 7 shows the particular stretch referred to. The hydrography of the Hudson is now complete from Poughkeepsie to the bar at Sandy Hook.
Tidal observations were made at three stations simultaneous with the soundings.

The hydrographic statistics are as follows:

- Miles run in sounding: 281
- Angles for establishing signals: 2,989
- Signals established: 15
- Number of soundings: 17,339
- Area sounded out (square miles): 8

The party in the Varina had been previously engaged in Section V, as will be noticed under the proper head in a subsequent part of this report.

The original sheets of the surveys made of Esopus and Rondout creeks at the close of last year are now at the office.

*Tides and currents in New York harbor and its approaches.*—This work, which has been going on under my immediate direction for several seasons past, was completed at the end of the summer by Assistant Henry Mitchell, so far as the principal field labors are concerned. It was commenced with the view of ascertaining the causes of certain important changes in the hydrography of the harbor as developed by the comparison of charts of different dates. All the natural forces, such as tides, currents, winds, and waves, which might be supposed to concur in producing the physical effects noticed, were included in the series of observations, and the large amount of information thus obtained will, no doubt, when fully discussed, determine the conditions under which the harbor exists. In my last report reference was made to the discovery of a class of sub-currents the motions of which were found to be quite at variance with those of the surface currents. The observations made during the present season connect these sub-currents with the path of the Hudson in its course through the waters of New York bay, and for their full development it was found necessary to extend the current stations about sixty miles outside of the bar, and also along the coast of Long Island. In the latter vicinity the effect of the land waters was traced quite beyond the reach of the tidal drifts. Observations were made in the same quarter with a view of developing the conditions under which the inlets on the south shore of Long Island are maintained and for ascertaining the causes of their change in position. Thirty-seven current stations were occupied, the records from which contain over eight thousand observations. More than three thousand of the entries are for points below the surface. Appendix No. 26 contains the report of Assistant Mitchell on the season’s labors. His report contains remarks on improvements in the apparatus for observing currents at great depths below the surface, and refers also to an improved form of pile for securing tide-gauges on the sea-coast.

Assistant Mitchell was efficiently aided by Mr. W. T. Bright.

The schooner Gallatin was used in the work connected with the physical survey of New York harbor.

All the original note-books and journals kept by Assistant Mitchell while prosecuting the observations on currents have been received and filed in the archives.

*Magnetic observations.*—In the course of a series of observations at a number of stations in Section I, Assistant C. A. Schott, aided by Mr. J. L. Tilghman, occupied several stations in the interior of New England for ascertaining the secular change, and in order to determine the precise location of the isogonic lines, charts of which were published in 1856.

The declination, dip, and intensity were determined at Hartford, Conn.; at Springfield, Chesterfield, and Deerfield, Mass., and at Rutland, Vt. Details have been given under Section
I in regard to the instruments used at all the stations, and as to the method pursued in observing for the several magnetic elements. The results obtained are set forth at length in the Appendix Nos. 23 and 24. Mr. Schott has deposited his notes and computations in the office.

Tidal observations.—The self-registering tide gauge at Governor’s island, New York harbor, has been kept in operation by Mr. R. T. Bassett. Interruptions in the series during the winter were met by observations with an ordinary box-gauge at the Atlantic ferry dock, in Brooklyn.

SECTION III.

FROM CAPE HENLOPEN TO CAPE HENRY, INCLUDING THE COAST OF PART OF THE STATE OF DELAWARE AND THE COAST OF MARYLAND AND PART OF VIRGINIA.—(Sketch C, No. 9.)

One triangulation, one triangulation and topographical, one topographical and one hydrographic party have been employed in this section.

1. The triangulation of the Potomac river has been continued from the entrance to Britton’s bay.

2. Triangulation of Hampton Roads. This has been connected with the main work of the Chesapeake, and a base of verification for the detached triangulation between Richmond and Old Point has been measured.

3. Triangulation and topography of Chincoteague and Sinepuxent bays. This tertiary triangulation was necessary from the scarcity of points furnished by the secondary.

4. A plane-table survey of the Patuxent river, giving merely the shore-line for purposes of the hydrography, and leaving the usual interior work for subsequent filling up, was carried from Holland’s Point to Hall’s creek.

5. The topography of St. Mary’s river was continued to a point about eight miles above its entrance into the Potomac, and St. Inigo’s was also included to the distance of about a mile and a half from its mouth.

6. Topography of Milford Haven and Horn and Winter harbors and the vicinity, Chesapeake bay.

7. Shore-line of James river from Coggin’s Point to Little Brandon, completing the shore-line and hydrography of the James and Appomattox rivers from Richmond and Petersburg to the mouth of the river on Chesapeake bay.

8. Hydrography of the Patuxent river to Hall’s creek.

9. The hydrography of the St. Mary’s river was completed, and its approaches and Cornfield harbor sounded.

10. The outstanding hydrography of the James river was also finished this season.

11. The hydrography of Big and Little Annemessex rivers, connecting with the work of Tangier sound, was completed.

12. The tidal observations at Old Point and at the Washington navy yard were continued with the self-registering gauges.

Office work.—The chart of York river, from King’s creek to West Point, has been drawn and engraved. The topography and lettering of coast maps and charts No. 31, Chesapeake bay, from its head to Magothy river, and No. 33, from Hudson river, Md., to the Potomac; of the finished chart of Patapsco river, and the outlines of coast map and chart from Green Run inlet
to Little Machipongo inlet, (from a photographic reduction,) have been engraved. Progress has been made in the drawing and engraving of coast maps and charts Nos. 35 and 36, from Pocomoke sound to the entrance of Chesapeake bay; in the drawing of general coast chart No. IV, from Cape May to Currituck sound; of coast maps and charts Nos. 28 and 29 (the latter mainly by photography) from Cape Henlopen to Little Machipongo inlet; No. 33, Chesapeake bay, the sheet of James river, from Richmond to City Point, and coast map and chart No. 37, from Cape Henry to Currituck sound; and also in the engraving of coast maps and charts No. 32, Chesapeake bay, from Magothy to the Hudson, Md., and No. 34, from the Potomac to Pocomoke sound.

Examination of stations on Chesapeake bay.—The duty of examining the stations of the triangulation, which include both shores of the Chesapeake bay, was performed in October and November by Assistant G. D. Wise, who commenced at the head of the bay, and visited all but a few in the series connected with the work done in its lower part.

"The stations were found in much better preservation on the low lands of the eastern shore than on the higher lands of the western. Lieut. Seward, who examined them in 1854, had marked them so securely that in no case had the marks been removed except from natural causes."

Mr. Wise used the schooner Howell Cobb in this service. He has turned in sketches of the stations, and full descriptions and references to guide in finding the marks in future. The duty conducted under his direction in the former part of the surveying season will be stated under the head of Section VII.

Triangulation of the Potomac river, Va.—The stations necessary for extending the triangulation of the Potomac upwards, from the mouth of the St. Mary’s to Britton’s bay, were selected by Assistant John Farley in the latter part of October, 1858. His party used the schooner Guthrie in that service for transportation. Frequent storms retarded the general operations, and the observations with the theodolite were also much hindered by unfavorable weather.

This triangulation, as may be seen on Sketch No. 9, stretches up the Potomac to Tower Hill, a distance of about nine miles from the station occupied last year on George’s island. On the lower side of the river three stations were occupied at the mouth of its branch known as the Yeocomico.

Mr. Farley was assisted in the field by Sub-Assistant S. A. Wainwright.

An abstract from the records gives the following summary of statistics:

- Stations occupied: 10
- Angles measured: 24
- Number of observations: 696

Assistant Farley was employed until the 20th of December in the measurement of angles, and used for that purpose the six-inch Gambey theodolite, C. S. No. 76. As the work advanced he furnished points additional to those determined in 1857 for the plane-table survey of the St. Mary’s river. An area of about thirty-seven square miles is comprised within the limits of the season’s work on the Potomac.

The occupation of the party at a subsequent period of the surveying year will be stated under the next head in this chapter.

During the intervals between the seasons for field duties the computations of the triangu-
Triangulation and duplicates of the records of horizontal angles, are now in the office.

Triangulation of Hampton Roads, Va.—The triangulation, which has advanced steadily downwards from City Point towards the mouth of the James river, has been connected with the main work on Chesapeake bay by a series of triangles carried over Hampton Roads by Assistant Farley. The junction was made on the line, Old Point Comfort—Willoughby, at the entrance of the river, as shown on Sketch No. 9.

For the purpose of verifying the entire triangulation between Richmond, Va., and Old Point Comfort, a base was measured in May at a point on the north side, and about fifty miles above the mouth of the James river. One of the intermediate stations used in the triangulation corresponds with a terminus of the base, and both termini were connected with the station at Claremont, on the south side of the river.—(See Sketch.)

The computations resulting from the data for the verification of the work are now in progress.

The triangulation and operations connected with the measurement of the base near Claremont occupied the party until the 22d of June. The schooner John Y. Mason, which had been employed in the work, then returned to Baltimore. Sub-Assistant Wainwright assisted Mr. Farley in the several localities in which his party was engaged in this section.

The following synopsis refers to the duty performed this season in completing the triangulation of the James river:

| Stations occupied | 10 |
| Angles determined | 16 |
| Number of observations | 700 |

The record of horizontal angles, notes kept during the measurement of the verification base, and descriptions of the signals used this season, have been furnished by Assistant Farley.

Triangulation and topography of Chincoteague and Sinepuxent bays, Md. and Va.—As a basis of the plane-table survey north of Chincoteague inlet, Sub-Assistant Charles Ferguson made, in the latter part of June, a careful reconnaissance and tertiary triangulation between Snead Signal (Sketch No. 9) and Robbins's Point, on the main coast of Maryland. The two stations Hardy and Snead, erected in the secondary triangulation of 1849 being found undisturbed in position, were reoccupied, and six others chosen for connecting Assateague island with the coast. In the selection of the sites full attention was given to the requirements of the topography, and also to the means for rendering the stations permanent, for purposes of future reference.

This triangulation extends about twenty-one miles north and east from Chincoteague inlet. Exclusive of the stations occupied with the theodolite, five points were determined in position for plane-table reference. The statistics of the triangulation are as follows:

| Stations occupied | 8 |
| Angles measured | 24 |
| Number of observations | 1,100 |

Mr. Ferguson used in this work the six-inch Brunner theodolite, C. S. No. 66. His computations and original notes of the field-work have been received.

The topography was resumed at the limit reached last year on the 20th of July. The portion executed between that date and the 16th of September includes the mainland or western side...
of Chincoteague bay, from Long Point north to "Deserted House," the details consisting principally of farm land and forest, intersected by numerous small creeks, and a broad belt of marsh along the line of the shore. The same sheet embraces the whole of Assateague island, with the Ragged Point island marshes; Pope’s bay and its marsh islands; and Pine island, situated in New Inlet; together with the seabeach from Assateague bay to Ragged Point. The general features of the main and islands in this vicinity are shown on Sketch No. 9.

A synopsis taken from the completed sheet gives the following statistics of work done this season:

- Shore-line surveyed: 45 miles.
- Roads: 16
- Creeks: 26
- Area, (square miles): 19

Sub-Assistant Ferguson had been previously employed in Section VI. The schooner Dana was used in the triangulation and topography of Chincoteague bay.

In the course of the season the plane-table sheet of Chincoteague island and vicinity, surveyed last year, was inked and sent to the office.

**Plane-table survey of the Patuxent river, Md.**—As a basis for completing the supplementary soundings required in the Patuxent, Assistant I. Hull Adams started on the 19th of April, at Holland’s Point, and traced both shores of that river northward to Hall’s creek, using points furnished by the triangulation of Lieut. J. P. Roy, U. S. A. The mouths and lower portions of Swanston creek and Hunting creek were included in the working sheet, on which were also marked the steamboat landings at Benedict, Trueman’s Point, Holland’s cliff, Magruder’s Ferry, and Lower Marlboro. About fourteen miles of the course of the Patuxent (Sketch No. 9) are represented on the map of this season. The length of shore-line traced and furnished to the hydrographic party is about thirty-seven miles.

This service was completed by the 16th of May, when the plane-table party in the schooner Dana was transferred for similar duty to the James river, Va. The stations used in the triangulation of the Patuxent were visited by Assistant Adams, and found in good preservation.

**Topography of St. Mary’s river, Md.**—This work was begun by Assistant Adams on the 17th of November, 1858, and prosecuted until the end of that year. The limit reached corresponds to the upper line of the plane-table sheet marked on Sketch No. 9. Both shores of the river were traced upward, the eastern from Ket’s Point, and the opposite side from the southern shore of George’s island, respectively, to Milborne’s wharf. This point is nearly eight miles above the entrance into the Potomac. About four miles above its mouth the St. Mary’s river receives from the eastward St. Inigo’s creek, the course of which was traced by Mr. Adams to the distance of a mile and a half. The shores of Carthagena creek, emptying in on the western side, were also defined for some distance. The shore-line traced on the working sheet makes an aggregate of thirty-eight miles within an area of about twenty-eight square miles.

This survey is based on the triangulation executed by Assistant John Farley in 1857.

Assistant Adams was aided in the plane-table work by Mr. J. G. Macawley. Progress in the field was much hindered by heavy rains, fogs, and gales of wind.

The sounding of the lower part of the St. Mary’s was executed in the latter part of the
surveying season of 1857-'58, as stated in my last annual report. Sketch No. 14, accompanying this report, shows the result of the labors of the field and by hydrographic parties.

Mr. Adams discontinued work on the 5th of January, and proceeded to Baltimore in the schooner John Y. Mason, which had been in the service of his party on the St. Mary's. The vessel was soon after transferred to the party of Assistant Farley and employed in the triangulation of Hampton Roads, as already stated.

Assistant Adams is now preparing to return and fill in the details required for a finished map of the St. Mary's.

Topography of Milford haven, and Horn and Winter harbors and vicinity, Chesapeake bay, Va.—The survey of the western shore of the Chesapeake, between Rappahannock river and York river, was resumed by Assistant John Seib on the 15th of August, with a party in the schooner John Y. Mason. Two sheets, connecting at the Wolf Trap, will contain the detailed topography of the Piankatank river, Hill's bay, Milford haven, Haven creek and its branches, Garden creek, Horn harbor, Winter harbor, Mobjack bay, with East, North, Ware, and Severn rivers, and the western shore of Chesapeake bay from Cherry Point southward to New Point Comfort. In most of these localities the plane-table work was completed by the end of October, leaving only the three last-named rivers and Hill's bay for survey in the next year. The limits of both sheets are marked on Sketch No. 9. When these are completed, there will remain outstanding only a few small detached portions of topography on the shores of the Chesapeake, which can be readily finished without applying the entire working season of the party which has been heretofore employed on it.

Reference will be made under Section V to the previous occupation of Mr. Seib.

The inking of the two sheets of the Chesapeake shore was kept in progress when the weather would not admit of working in the field.

A summary given in the report of Assistant Seib shows the following progress by his party in this section:

- Shore-line surveyed ............................................. 74½ miles.
- Roads ................................................................. 23 "
- Area, (square miles) ........................................... 20

The character of the topography is even in surface and interspersed with woods and numerous water-courses over a thickly-settled district.

On closing work the schooner Mason was transferred to the charge of Assistant John Farley, for use in the triangulation of the Potomac river.

The upper sheet of York river, which was inked within the season, is now on file in the archives.

Shore-line survey of James river, Va.—On closing the last plane-table operations on this river, the shores of a stretch extending about five miles between Coggins's Point and Little Brandon yet remained to be traced in order to complete the preliminary survey. This duty was executed in the latter part of May and early part of the following month, by Assistant Adams, after closing work on the Patuxent, to which reference has already been made.

The entire course of the James river, from its entrance upward to City Point, has now been traced, and the shores of its two branches above, to Richmond on the main stream and to Petersburg on the Appomattox. The stretch represented on the sheet of this season (Sketch
No. 9) commences about seven miles below City Point. It contains twenty-four and a half miles of shore-line within an area of sixteen square miles.

The schooner Dana, which was used by Assistant Adams in this work, returned to Baltimore by the 14th of June, and was then assigned for similar service to the party of Sub-Assistant C. Ferguson.

Hydrography of the Potomac River, Md.—The soundings required to complete the chart of this river were made towards the close of May, by the party of Commander W. T. Muse, U. S. N., Assistant Coast Survey, working with the boats of the steamer Hetzel. From the limit reached last season, as marked on Sketch No. 9, the work was extended upwards to Hall's creek, within the triangulation made by Lieut. J. P. Roy, U. S. A., shore-line being furnished at the same time by Assistant Adams. The statistics of the supplementary hydrography are as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles run in sounding</td>
<td>88 1/2</td>
</tr>
<tr>
<td>Angles determined</td>
<td>274</td>
</tr>
<tr>
<td>Number of casts of the lead</td>
<td>7,554</td>
</tr>
</tbody>
</table>

Hydrography of the St. Mary's River, Md.—The lower part of the St. Mary's river, Md., was sounded out in the latter part of the working season of 1856-'57, by the party of Commander Muse, in advance of the triangulation, which was not taken up until the following spring. Before resuming the work, with a view of extending the soundings upward so as to complete a chart of the river, some discrepancies being noticed in the determination of the positions of signals used in the two operations, the hydrography was verified by new lines traversing the former work. Supplementary soundings were also made below the mouth of the river, in the channel of the Potomac between it and Point Lookout, so as to include the small cove known as Cornfield harbor. The locality and its connection with the Chesapeake are shown on Sketch No. 9. A reduction from the hydrographic sheet, which has been turned in, accompanies this report as a preliminary chart, and is marked as Sketch No. 14.

The following are statistics of the soundings made this year in the St. Mary's and vicinity:

<table>
<thead>
<tr>
<th>Description</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles run</td>
<td>318</td>
</tr>
<tr>
<td>Angles taken</td>
<td>653</td>
</tr>
<tr>
<td>Number of soundings</td>
<td>15,868</td>
</tr>
</tbody>
</table>

The hydrography was executed with the steamer Hetzel in the latter part of August and early part of September.

In regard to the capacity of the St. Mary's as a harbor, the following remarks made by Commander Muse in his report on the work done in 1857 are again quoted: "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."

Hydrography of James River, Va.—A portion of the James River, below City Point, which had not been reached in the progress of the hydrography upward, was sounded out in August by the party of Commander Muse. The space referred to is comprised between Coggin's Point and Little Brandon, (Sketch No. 9,) and embraces a reach of about seven miles.

This work completes the hydrography from Richmond to the entrance in Chesapeake bay.
The shore-line necessary for the soundings was furnished by Assistant Adams. A summary of the hydrographic statistics is appended:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles run in sounding</td>
<td>83 1/4</td>
</tr>
<tr>
<td>Angles measured</td>
<td>301</td>
</tr>
<tr>
<td>Casts of the lead</td>
<td>5,940</td>
</tr>
</tbody>
</table>

The sheet containing this work is now at the office.

Hydrography of Big Annemessex and Little Annemessex rivers, Md.—The supplementary soundings required for the engraved sheet of Chesapeake bay, which will contain Tangier sound and its branches, were made by the party of Commander Muse in September. This work (Sketch No. 9) includes the Big Annemessex and Little Annemessex rivers, and connects with the general hydrography of the sound, executed by the party of Lieut. Comg. J. J. Almy, in 1856.

All of the principal and very nearly all of the minor hydrographic details necessary for the finished chart of Chesapeake bay are now complete.

A synopsis given by Commander Muse at the end of the season shows the statistics of work in the Big and Little Annemessex, as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles run</td>
<td>91 1/4</td>
</tr>
<tr>
<td>Angles taken</td>
<td>272</td>
</tr>
<tr>
<td>Soundings</td>
<td>6,947</td>
</tr>
</tbody>
</table>

The steamer Hetzel was used for this and other duty performed in the same section by the party of Commander Muse.

Tidal observations.—The self-registering tide-gauge at Old Point Comfort has been continued in operation under the charge of Mr. M. C. King. A similar gauge has been used in keeping up the series of observations commenced last year at the Washington navy yard. The attention necessary in maintaining regular observations with it was given in part by officers attached to the ordnance department of the yard, under the direction of Commander Dahlgren.

SECTION IV.

FROM CAPE HENRY TO CAPE FEAR, INCLUDING PART OF THE COAST OF THE STATES OF VIRGINIA AND NORTH CAROLINA.—(Sketch D, No. 15.)

The primary triangulation of Pamlico sound has been resumed in this section; work of verification in the neighborhood of the Cape Fear has been done; the topography between Cape Henry and Currituck sound has been completed; in-shore hydrography of the coast near Bogue and New River inlets has been executed, and off-shore work between Cape Lookout and Cape Fear. Notices of these several operations are given in this chapter.

Office-work.—Comparative charts of the Cape Fear entrances, showing the changes from 1851 to 1858, and diagrams illustrating Gulf Stream explorations, have been drawn, and the former engraved upon stone under the direction of the Superintendent of Public Printing. Progress has been made in the drawing and engraving of preliminary coast chart No. 11, from Cape Hatteras to Cape Lookout; in the drawing of No. 12, from Cape Lookout to Cape Fear; in that of coast map and chart No. 48, from Bogue inlet to Barren inlet; and in the engraving of coast maps and charts Nos. 40 and 41, Albemarle sound.

Triangulation of Pamlico sound, N. C.—The preliminaries necessary for the primary triangulation of Pamlico sound were commenced early in January by Captain T. J. Cram, U. S.
Top. Engineers, Assistant Coast Survey, his party having sailed from Baltimore on the 27th of December, with the requisite equipage, in the schooner Bancroft.

Such general facts as had been gathered in the reconnaissance made by Major Prince, U. S. A., in 1851, were applied by Captain Cram, who proceeded to develop from them a scheme for working, by the minute examination of points chosen with reference to their availability for the purposes of triangulation, as well as for proper connections with the main coast series to the northward and southward. To that end stations at the upper part of the sound, connecting with the base on Bodie's island, were selected, and signals prepared for them of the kind required in the measurement of primary angles.

These points, and others at proper intervals on both shores of the sound, are marked on Sketch No. 15, which shows the plan as finally adopted for the triangulation. Some of the tripods and signals necessary for observing with the theodolite were erected, and for those which were not set up materials were prepared and fitted by the party before closing for the season.

Five stations of the first order were erected in the course of the season, and seventeen points in all chosen by preliminary measurements. The party discontinued work on the 12th of April, and is now reorganizing under the direction of Capt. Cram for resuming and prosecuting the triangulation during the coming winter and the spring following.

**Verification of triangles in the vicinity of Cape Fear, N. C.**—The revision of the system of small triangles laid out on the coast of North Carolina was resumed by Assistant A. S. Wadsworth on the 10th of November, 1858, at a station about five miles north of Federal Point. Most of the signals which had been used between it and Smithville having been lost, as well as the marks at the north and south ends of the base on Smith's island, (Cape Fear,) others were established, and a new triangulation made across the mouth of Cape Fear river. The scheme of triangles as remeasured may be seen on Sketch No. 15.

For the purpose of verification a new base site was selected, corresponding as nearly as possible to the line measured on Smith's island, with the additional advantage that the ends are coincident with two stations used in making the triangulation from Federal Point southward in 1851. "The site passes over a level beach, and is as permanent in character as any available line can be in that vicinity. At any state of the tide the north end is easily accessible in boats."

In order to test the geodetic value of the small coast triangulation, steps will be taken as early as practicable for the measurement of the base of verification. The ends were connected with the triangulation of this season at the stations at Fort Johnston (Smithville) and Fort Caswell, as shown on the progress sketch, (No. 15.)

Assistant Wadsworth closed work on the 7th of April, and reported at the office in Washington, where he made the resulting computations and duplicated his record of angles. In the field-work he used the six-inch Brunner theodolite C. S. No. 59. The following summary is taken from his report on the triangulation:

<table>
<thead>
<tr>
<th>Stations occupied</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals observed</td>
<td>12</td>
</tr>
<tr>
<td>Angles measured</td>
<td>30</td>
</tr>
<tr>
<td>Number of observations</td>
<td>1,191</td>
</tr>
</tbody>
</table>
The latter part of the season was more than usually unfavorable for field-work in the vicinity of Cape Fear.

In July Mr. Wadsworth proceeded to Section I, and engaged in the topography of Casco bay.

*Topography between Cape Henry, Va., and Currituck Sound, N. C.*—The entire outer coast line of Virginia, and the region immediately adjacent to it, from Cape Henry and Lynn Haven bay southward to the boundary line, in connection with the district comprising the upper part of Currituck sound, have been passed over with the plane-table by Sub-Assistant John Mecham, and the details included within the limits referred to have been completed. On the outer coast of North Carolina the work of this season was extended to a junction, at Fresh Pond Hill, with surveys made in previous years by the late Assistant J. J. S. Hassler, mention of whose death was made in my last annual report. The point referred to lies about thirty-one miles below Cape Henry. The upper shores of Currituck sound, the eastern shore of Knott's island, and the western side of Back bay, had been traced by Mr. Hassler, who also executed some detached portions of topography while prosecuting the triangulation in the direction of Cape Henry.

Sub-Assistant Mecham took the field on the 25th of November, and was aided during the season by Mr. F. R. Hassler. Bad weather prevailed generally while the party was at work; but by employing the unfavorable intervals in chaining and in ordinary plane-table determinations, the details of four topographical sheets were filled in by the end of May, completing the survey between Albemarle sound and Cape Henry. In going southward from Chesapeake bay, the work of this season embraces the continuous shores of Lynn Haven river and inlet, Long creek, Broad bay, and Linkhorn bay, which separates the desert of Cape Henry from the interior. To the southward was traversed a closely-settled belt of coast, broken only by Rudy inlet, which is about seven miles from Cape Henry light-house. Lower down, North bay, and, in connection with it, the eastern shore and the islands of Back bay, were surveyed, as also Knott's island and Mackay's island, in the upper part of Currituck sound. On the sheet containing the survey of Back bay is represented a feature of the outer coast which has been often mistaken for Cape Henry when seen from vessels approaching the land. Its position, as well as the limits of the several sheets now under notice, are marked on Sketch No. 15. The following remarks are made in reference to this vicinity in the report of Mr. Meahan: "Back bay is divided from the ocean on the east by a sand beach, the southern extremity of which is dotted with high sand dunes, and oak, pine, and cedar hummocks, containing the huts of numerous wreckers and fishermen, and known as the 'Wash Woods.' Further north are the 'Wash Flats,' a low smooth strand, so near the general level of the sea as to be submerged during strong easterly gales. When viewed from a vessel at sea, it seems a continuation of the ocean, and, with the high sand-hill range and trees of the 'Wash Woods,' presents so near a resemblance to the entrance of the Chesapeake at Cape Henry as to have been often taken for it, with disastrous effects; hence it is called 'False Cape,' or the 'False Cape of the Chesapeake.' The sand dunes at Cape Henry are in some places eighty-five feet above the ocean level."

From the upper part of Currituck sound, the plane-table work was extended northward to a point two miles above Pungo bridge, so as to include the shores of North river, an important
link in the line of inland navigation, which now connects Chesapeake bay with Albemarle sound.

The progress made by the topographical party is shown in the following abstract of statistics:

- Coast-line (ocean) surveyed ........................................... 31 miles.
- Shore-line of bays, islands, &c. ........................................ 169½ "
- Roads surveyed .................................................................. 116 "
- Area of sheets, (square miles) ........................................... 157

On his return from this section, Sub-Assistant Meehan was assigned to duty in the vicinity of New York city. In the course of the summer the sheets of the region between Cape Henry and Currituck were inked and sent to the office.

Hydrographic.—Office-work.—Two sheets containing the soundings executed during the surveying year 1857-'58, in Pamlico sound, have been received from Commander W. T. Muse, U. S. N., and registered in the archives.

In-shore hydrography between Bogue inlet and New River inlet, coast of North Carolina.—In continuation of the hydrography extending from Cape Lookout towards Cape Fear work was resumed on the 9th of April by Lieut. Comg. Alex't Murray, U. S. N., assistant Coast Survey, at Bogue inlet, and carried down the coast of North Carolina at favorable intervals between that date and the 1st of June. A stretch of about thirteen miles coastwise, terminating as shown on Sketch No. 15 at New River inlet, was traversed by lines parallel to the shore and crossed by others going off to an average distance of ten miles from the land. This duty was executed in the surveying steamer Bibb. The following synopsis of statistics was returned by Lieut. Comg. Murray at the end of the season:

- Miles run in sounding ..................................................... 232
- Angles determined .......................................................... 714
- Number of soundings ...................................................... 3,262

Off-shore soundings, from Cape Lookout, N. C.—While prosecuting the in-shore hydrography with the steamer Bibb, Lieut. Comg. Murray, run, at favorable intervals, several lines to the northward of Cape Hatteras and others between Cape Lookout and Cape Fear, in order to furnish data for filling the project of the general coast chart No. V.

At the termination of a line carried broad off between Cape Hatteras and Cape Lookout a specimen of bottom was brought up in the axis of the Gulf Stream, the Massey sounding apparatus, used in that instance, indicating a depth of 2,059 fathoms. The material found was grayish mud or clay.

In reference to the current underrunning the Gulf Stream, Lieut. Comg. Murray remarks:

"The wind was N.E. and light; the steamer lay with her head to the southward and eastward, and the line went from the stern, tending to the northward, but upon reeling it up we discovered that an undercurrent had carried it to the southward. This occurred twice under similar circumstances."

The statistics of the off-shore work are as follows:

- Miles run in sounding ..................................................... 1,235
- Casts of the lead ............................................................. 3,318

In the course of the season three hydrographic sheets, one containing the work done in 1857-'58, and two the soundings made this year, have been plotted and turned in at the office with the records of soundings, angles, and tidal observations.
The party in the steamer Bibb, after its return from this section, refitted at New York and passed the remainder of the season in prosecuting the general hydrography of Section I.

SECTION V.

FROM CAPE FEAR TO ST. MARY'S RIVER, INCLUDING PART OF THE COAST OF NORTH CAROLINA, AND THE COAST OF SOUTH CAROLINA AND GEORGIA.—(SKEWER E, No. 16.)

The usual number of parties has been employed in this section, namely: one in making astronomical and magnetic observations, one in primary and secondary triangulation and in astronomical and magnetic observations, one in secondary triangulation, one in secondary triangulation and topography, two in topography, and two in hydrography. The work accomplished is stated under the following heads:

1. Astronomical and magnetic observations near Cape Fear entrance.
2. Triangulation and topography westward of Tubbs' inlet, N. C.
3. Astronomical and magnetic observations at St. Helena island, S. C.
4. Primary triangulation, coast of South Carolina.
5. Triangulation of Beaufort, Chechessee, and Colleton rivers, S. C.
6. Triangulation of Doboy and Altamaha sounds, Ga.
8. Topography of St. Catherine's sound, Ga.
9. In-shore hydrography from Cape Fear westward to Tubbs' inlet, N. C.
10. Off-shore hydrography from Cape Fear to Charleston harbor.
11. Hydrography of Bull's bay, S. C.
12. Hydrography of Port Royal entrance, S. C.
13. Hydrography of the Chechessee and Colleton rivers, S. C.
15. Tidal observations.

Office-work.—In the drawing and engraving divisions, additions have been made to the chart of Charleston harbor. The chart of Sapelo sound has been drawn and engraved and the engraving of preliminary coast chart No. 14, from Cape Romain to Savannah, has been in hand. Progress has been made in the drawing of coast maps and charts No. 53, from Charleston harbor to St. Helena sound, and No. 58, from St. Mary's river to the St. John's, Fla., and in that of the chart of Ossabaw sound.

Latitude observations at Smithville, N. C.—The adjustment of the triangulation on the coast of North Carolina requiring that the latitude of a point in the vicinity of Cape Fear should be closely determined, as well as the azimuth, an astronomical party was organized on the 1st of April, under my immediate direction, and placed in charge of Assistant G. W. Dean. A station was erected at Fort Johnson, Smithville, N. C., and the necessary preliminaries for astronomical work were arranged by Mr. Thomas McDonnell. Sub-Assistant Edward Goodfellow was detailed to assist in the observations. Those for the latitude and time were made by him with the zenith telescope C. S. No. 5, and forty-six-inch transit C. S. No. 4. With the first-mentioned instrument twenty-nine pairs of stars were observed by one hundred and seventy-four sets of observations. Fourteen standard stars were observed with the transit, and ninety-six observations recorded. The value of the micrometer threads was ascertained by one hundred and twenty-two observations on the star 51 Cephei, near its western elongation. Forty-six observations were made with the micrometer upon a collimator adjusted to a stellar
focus, for determining the arc value of graduations on the level of the zenith telescope, and the corresponding divisions of the transit instrument were tested by comparisons with it.

As far as practicable, the stars observed for latitude were taken from the Greenwich Twelve Year Catalogue, the sets, as heretofore, being completed from that of the British Association. Mr. W. H. Odenheimer aided Sub-Assistant Goodfellow, and recorded the observations. Unusually good weather prevailing during the stay of the party, all the requisite determinations were completed by the 7th of May.

Azimuth.—The azimuth for the lines of the triangulation was determined by Assistant Dean. For that purpose nine sets of observations were made with the twenty-four-inch theodolite (C. S. No. 2) on Polaris at its lower culmination, and six sets on δ Ursae Minoris near its eastern elongation. In each series six pointings were made on the star with the telescope direct, and the same number with the instruments reversed. An elongation mark was set up and connected in the usual way with the triangulation, twelve sets of pointings being made on it with the telescope direct and reversed. The mark was referred to three geodetic signals by four hundred and thirty-six observations made at six different periods, each embracing the observations of an entire day. In making them the circle of the instrument was used in five different positions. The azimuth observations were recorded by Mr. McLane Tilton.

Magnetic observations at Smithville, N. C.—For the declination of the needle at the astronomical station (Fort Johnson) one hundred and forty-seven observations were made on three days by Assistant Dean and Sub-Assistant Goodfellow. Four sets were made on three days for the magnetic dip, and two sets on two days for the horizontal intensity and moment of inertia. The instruments used were declinometer D. 22 (C. S. No. 1) and the nine-inch dip circle C. S. No. 4.

The usual meteorological journal was kept by Mr. Tilton, while the observations were going on for latitude, azimuth, and the magnetic elements.

Immediately after the return of the party the records kept at the astronomical station were duplicated by Sub-Assistant Goodfellow and placed in the archives, with his computation for latitude, with that of Mr. Dean for azimuth, and lists of the stars used in observing for latitude.

In June the party was transferred to Section I, and remained until the close of the season under my personal direction, as stated in a previous chapter of this report.

Triangulation and topography westward of Tubbs' inlet, N. C.—The coast triangulation below Cape Fear has been extended westward by Assistant C. P. Bolles, to the immediate vicinity of the boundary line between North and South Carolina. The details of the plane-table work, which has been prosecuted in connexion with it, have been completed to Tubbs' inlet, and the shore-line survey advanced westward to Little river, (Sketch No. 16,) or near the present limit of the triangulation. On the 10th of December work was resumed at Shallotte inlet, Mr. O. Hinrichs, the aid in the party, conducting the topographical survey, while Mr. Bolles carried forward the triangulation. Most of the angular measurements were made with the six-inch Brunner theodolite C. S. No. 67.

The following synopsis shows the progress made by the party before closing for the season, on the 20th of June:

First order stations occupied ........................................ 8
Second order stations occupied ...................................... 30
In the principal series eighteen angles were determined, the last being formed at a station a short distance above Tubbs' inlet. From thence southward and westward to Little river, the smaller chain of triangles was completed to serve as a basis for the topography.

The impediments from standing wood and undergrowth on this part of the coast increase the natural difficulty of laying out and determining primary lines which pass over a level surface. Avenues, making in the aggregate an extent of more than fourteen miles, were traced and opened by the party so as to admit of observing with the theodolite.

Assistant Bolles furnished in the course of the working season the data requisite for fixing the positions of shore stations for the hydrographic party of Lieut. Comg. Bankhead.

The plane-table work comprises the following statistics:

- Beach-line surveyed: 21.5 miles.
- Shore-line of creeks: 102.1 miles.
- Outline of marsh: 47.5 miles.
- Roads: 30.3 miles.

In addition to the plane-table work, Mr. Hinrichs aided in the several operations of the triangulation. Shore-line was furnished as needed for the in-shore hydrography, which was in progress at the same time.

Six volumes containing the original records of horizontal angles measured in extending the field-work westward from Cape Fear have been placed in the archives, as also the topographical sheet executed last year under the direction of Assistant Bolles.

**Astronomical and magnetic observations at St. Helena Island, S. C.**—As part of the duty devolving on his party in this section, Assistant C. O. Boutelle set up the zenith telescope C. S. No. 5, and transit No. 3, at Port Royal station on St. Helena island, and made a series of observations for latitude between the 8th of January and the 1st of March. Both instruments were supported by wooden posts set three feet in the ground and strongly trussed by cross and diagonal braces above and below ground.

The azimuth also was determined at the same station with the twenty-four-inch theodolite C. S. No. 2, and Gambey theodolite C. S. No. 43, an artificial horizon being employed in making the observations with the last-named instrument.

For local time observations were made at intervals from January 8 to May 7 inclusive, with transit No. 3, in connexion with the sidereal chronometer No. 207, and the solar chronometers Nos. 211, and 2,458.

For latitude six hundred and seventy-eight observations were made on sixty-two pairs of stars. The places of forty-eight were taken from the Twelve Year, and the rest from the catalogue of the British Association. Seventy-two observations for value of the micrometer in the zenith telescope were made upon four elongations of Polaris. The value of levels A and B were determined in terms of the micrometer by a hundred and twenty observations on the cross hairs of a sector set up fifteen feet north of the zenith telescope and used as a collimator.

Between the 10th of February and the 16th of March ten elongations of Polaris were observed in the usual manner for azimuth. Two hundred and sixty-three observations were made on star and mark, and one hundred and eighty-six for connecting the elongation mark with stations in the secondary triangulation.
For local time three hundred and thirty-nine transits were observed on sixty-one nights between January 8 and May 7.

Mr. Boutelle also observed a series of azimuths upon Polaris in various parts of its orbit, making thirty-three sets of four repetitions each on three nights. These formed angles between Chaphir signal and the star, and were observed alternately direct and reflected in a mercurial horizon.

The position of the astronomical station on St. Helena island, and its connections with the coast triangulation are shown on Sketch No. 16.

The declination of the magnetic needle at Port Royal station was determined with the declinometer C. S. No. 5, by two hundred and thirty-six observations made in parts of ten days between January 23 and February 5, on two collimator magnets. For the dip, the circle No. 9 was used, and ninety-six observations were recorded.

In the astronomical work, and in the general operations yet to be referred to, Mr. Boutelle was assisted by Lieut. Thomas Wilson, U. S. A., Assistant Coast Survey, and Sub-Assistant W. S. Edwards. Mr. C. H. Boyd was attached to the party as aid.

Duplicates of the records of observations made this season for latitude, azimuth, and time have been deposited in the office. Mr. Boutelle has also turned in his revised computation for the latitude of Allston station, determined in a previous season.

Primary triangulation, coast of South Carolina.—For the extension of the series of primary triangles southward and westward from the Edisto base and in the direction of Savannah, Assistant Boutelle erected a tripod and scaffold at Port Royal station, and made the preliminary measurements necessary for including a point in the city of Beaufort, S. C., in the general scheme. The positions of these, as falling in with the chain of work already completed, may be seen in the progress sketch (No. 16) of the section. The lines to be observed on in carrying the main triangulation across St. Helena island were partly traced and cleared for the measurement of horizontal angles while other operations were going on. This service was performed by Sub-Assistant Edwards, under the direction of Mr. Boutelle. The party reached its working ground in the schooner Petrel from Charleston, at which port the vessel had been laid up during the winter.

Lieut. Wilson, U. S. A., and Mr. C. H. Boyd, assisted in the duties now under notice, and in those to be mentioned under the next head.

The records of the primary triangulation of previous years have been deposited in the archives.

Triangulation of Beaufort, Chechessee, and Colleton rivers, S. C.—From its entrance into Port Royal sound, Assistant Boutelle laid out and completed by the 19th of April the triangulation of Beaufort river upwards to the city of Beaufort. The length of water course included in that work is about twenty-nine miles. His party was then transferred in the schooner Petrel to Foot Point, and in that vicinity a triangulation was carried from Broad river up the Chechessee and its branch known as the Colleton river. The triangles were made to extend about two miles and a half above Foot Point and four miles below it, so as to provide for the topographical survey, and for hydrographic purposes, reference to which will be made hereafter.

The following are statistics of field-work executed by the triangulation party:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals erected</td>
<td>20</td>
</tr>
<tr>
<td>Stations occupied</td>
<td>24</td>
</tr>
<tr>
<td>Angles measured</td>
<td>348</td>
</tr>
<tr>
<td>Number of observations</td>
<td>1,772</td>
</tr>
</tbody>
</table>

A general view of the scheme of work will be seen by reference to Sketch No. 16.
The eight-inch Gambey theodolite, C. S. No. 24, and ten-inch Gambey, C. S. No. 43, were used in the angular measurements.

In the several operations prosecuted between the Edisto base and Foot Point Mr. Boutelle was assisted by Lieutenant Wilson and Sub-Assistant Edwards. Mr. C. H. Boyd was attached to the party as aid.

The schooner Petrel was despatched for New York on the 16th of May, and was there repaired and refitted for the continuance of work in the coming season.

While the triangulation party was at work in February, the United States steamship Brooklyn passed into Port Royal sound and anchored near the Parry island buoy, between Broad and Beaufort rivers. Assistant Boutelle visited the vessel, and, as no professional pilots are known in that vicinity, tendered his services in conducting her up Beaufort river. The offer being accepted by Captain Farragut, of the Brooklyn, the steamer was moved to a position within four and a half miles of the city of Beaufort, and there anchored. A communication addressed to me by Captain Farragut, in reference to his visit in Port Royal sound, is given in Appendix No. 38.

After reporting at the office, Assistant Boutelle proceeded to Section I. His occupation during the summer and autumn has been stated under that head. Lieutenant Wilson, on returning from Section V, was assigned to duty in the charge of the Drawing Division, and Sub-Assistant Edwards took up plane-table work on the Kennebec river.

**Triangulation of Doboy and Altamaha Sounds, Ga.—** The secondary triangulation on the coast of Georgia has been continued southward from the Sapelo base, and between it and the work at St. Simon's entrance a preliminary connexion has been made by a series of tertiary triangles carried along the outer range of islands below the entrance to Altamaha sound.

Sub-Assistant F. P. Webber, whose operations last season closed at the upper part of Sapelo island, resumed work there on the 20th of December, with a party in the schooner Hassler. The triangulation was taken up at the line which joins Julienton with a terminus of the Sapelo base, the location of which is marked on Sketch No. 16. To the southward and westward stations were erected at suitable intervals, so as to include in the secondary series Mud river and North river, with their branches behind Sapelo island; Doboy sound, and Altamaha sound with the lower parts of its tributaries. A number of subsidiary stations were occupied within the same area sufficient for the purposes of a topographical survey. Mr. Webber measured also a series of tertiary triangles, in order to define the courses and direction of the water-passage which separates Blackbeard island from Sapelo island, and south of the Altamaha entrance extended a similar triangulation by observing alternately at stations on St. Simon's island in connexion with others erected on the chain lying between it and the ocean. The ten-inch Gambey theodolite, C. S. No. 63, was used in measuring the angles.

At a station about thirty miles below the Sapelo base, as measured along the course of the triangulation, a junction was made with one of the tertiary lines observed on by Assistant A. W. Longfellow in the survey of St. Simon's sound. Sub-Assistant Webber there closed for the season on the 15th of April. It is expected that a connexion by triangles of the second order can be made early in the ensuing year.

Mr. Julius Kincheloe was attached to the party as aid, and served efficiently in the field-work and in making computations.

While the hydrographic survey of Sapelo bar was in progress, the points requisite for it were
furnished to Lieut. Comg. Fauntleroy. Further notice in regard to that work will be made under another head.

The following summary of statistics and extract are from the report of Sub-Assistant Webber:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary stations occupied</td>
<td>7</td>
</tr>
<tr>
<td>Tertiary stations occupied</td>
<td>42</td>
</tr>
<tr>
<td>Angles measured</td>
<td>562</td>
</tr>
<tr>
<td>Objects observed on</td>
<td>570</td>
</tr>
<tr>
<td>Points determined in position</td>
<td>105</td>
</tr>
<tr>
<td>Number of observations</td>
<td>3,358</td>
</tr>
</tbody>
</table>

“The sides of the triangles of the second order range from five to eight miles in length. It is probable that lines from four to six miles long can be found across the opening to the west of St. Simon’s island, but in proceeding southward it will be necessary to erect two or three scaffold signals, perhaps twenty-five feet high, as the lines will extend over fresh water marsh, the reeds and shrubs of which reach to a height of twelve and in some places twenty feet, while the hard ground is nearly level with the surface of the marsh.”

Records of the horizontal angles and descriptions of the signals erected this season have been received and filed in the office.

The schooner Ilassier with the party of Mr. Webber reached Portland, Me., on the 2d of May, and during the summer was employed in work east of the Kennebec. On her outward passage to the south, the vessel was forced to take refuge in Provincetown harbor by severe gales, and while again on her way was damaged off Long Island in a storm, which also destroyed her stern boat. The necessary repairs were made at Savannah.

Sub-Assistant Webber is now making arrangements for returning to continue work on the coast of Georgia.

Ship-line survey from St. Helena sound, S. C., to Savannah river entrance.—This includes the outlines of the Hunting islands, Eddings’ island, the islets and water-passages between them and St. Helena island, the entire ship-line of Port Royal entrance, and part of that of Parry island, at the confluence of Beaufort and Broad rivers, Daw island and Colleton Neck, the outline of Hilton Head island, and the western shore of Calibogue sound, from Pinckney island to Savannah river. The work was executed by Assistant John Seib, whose party arrived in the section and anchored in Harbor river on the 10th of January. After joining with the plane-table survey made in 1856 on the upper part of the Hunting islands, Mr. Seib pushed steadily in the direction of Tybee entrance, tracing, as he advanced, the shore-line of Harbor river, Fripp’s inlet, Story creek, Trenchard’s inlet, Skull inlet, and Pritchard’s inlet, and passing through Station creek, the preliminary work was carried into Port Royal sound. On the outer side of the islands which bound the lower part of the coast of South Carolina, the ocean-line was traced from Skull inlet to Bay Point, at Port Royal entrance. Thence, proceeding northward and westward, the shores of Port Royal sound were surveyed, from Bay Point to Land’s end, as also the shores of Beaufort river to a point three miles above its mouth; the northern shore of Broad river, beyond Parry island, and its southern shore as far up as Lemon island. In that vicinity Mr. Cleveland Rockwell, the aid in the party working under my immediate direction, with a second plane-table traced the outline of Daw island; the shores of the Chechessee river, from Pinckney island upward to Lemon island; and the shores of Colleton river to a short distance southward of Foot Point. The tongue of land embraced between the
two rivers, and designated as Colleton Neck or Victoria Bluff, was surveyed somewhat in detail. A tracing from the topographical sheet of Mr. Rockwell was furnished early in May for the guidance of the hydrographic party in sounding out the adjacent channels, more particular reference to which will be made presently.

The continuous preliminary work of Assistant Seib in going southward from Port Royal sound embraced both shores of the passage known as Skull creek, between Pinckney island and Trench's or Hilton Head island; the shores of Calibogue river, in connexion with it and with May river; and the shore-line of Calibogue sound, to Mungen Point. The outer side of Hilton Head island also was traced and joined with the surveys already mentioned. As measured in a direct line, the chain of islands included in the work of the season stretches about thirty-five miles below St. Helena sound. The aggregate of shore-line represented on the five plane-table sheets brought from the field is about two hundred and fifty-eight miles. Four of them were worked on alternately by Assistant Seib and Mr. Rockwell, progress being made at the same time in inking plane-table sheets of the previous year. The limits of the sheets embracing the preliminary survey between St. Helena sound and Savannah river are marked on Sketch No. 16. Field-work was closed for the season on the 12th of May. The schooner Bailey, which had been in the service of the party, then sailed for Smithfield, North Carolina, and was transferred to Lieut. Comdr. Bankhead, and employed in the hydrographic work of this section.

At the end of April I visited the party of Assistant Seib, in passing southward on a tour of inspection. The work then in progress, and since completed, is intricate in character and was not favored by more than an average of fair weather for field duty. The large return in results is mainly due to the constant energy of the chief of the party, and to the able support given by Mr. Rockwell.

Mr. Seib was employed during the summer in plane-table duty in Section III, and Mr. Rockwell in Section II. In the corresponding chapters of this report notice has been taken of the occupation referred to.

Topography of St. Catharine's sound, Ga.—The party assigned to this work, in charge of Sub-Assistant H. S. Du Val, commenced the survey on the 27th of December and continued in the field until the 23d of May, using data furnished by the triangulation of Lieut. A. W. Evans, U. S. A. No interruption from unfavorable weather occurred to break the plan of operations, and, as a result, the survey of the shores of the sound was essentially completed, including the shores and branches of that part of the "Inland Passage" known as Bear river, which connects St. Catharine's with Ossabaw sound. The plane-table sheet also embraces the shores of the Medway opposite to the entrance of St. Catharine's sound, the mouth of North Newport river leading from it southward as part of the inland passage to Sapelo, and the outer shores of Ossabaw and St. Catharine's islands, in the vicinity of the entrance. These localities, as well as the general limits of the sheet referred to, are marked on Sketch No. 16.

A reconnaissance was made in the course of the season, and points were established for the survey of the interior of Ossabaw island, on which the work will connect with a survey made to the northward by Assistant A. M. Harrison in 1857-'58, but the advance of the season did not admit of the execution of the topographical details. These will be filled in during the coming winter, the party being about to resume duty on the coast of Georgia. The northern part of St. Catharine's island will be represented on the same sheet, and the detailed work
extended southward to meet that completed on Sapelo sound, which is already connected with it by a shore-line survey along the outer side of the island.

As returned to the office the topographical sheet of St. Catharine’s sound exhibits the following summary of progress made by the party in charge of Sub-Assistant Du Val:

- Shore-line: 204 miles.
- Area of details: 50 square miles.

Mr. J. D. Bradford aided in the field-work.

In June the party returned to Portland in the schooner Meredith. The vessel was then transferred to the party of Assistant A. W. Longfellow for service in Casco bay.

Sub-Assistant Du Val makes special mention in his report of the facilities tendered by residents on St. Catharine’s island as tending to the furtherance of his work.

Within the present season Assistant Longfellow has inked and sent to the office the plane-table sheet containing his survey of Sapelo sound, and one of the sheets of work executed by his party at Brunswick harbor, Ga.

In-shore hydrography from Cape Fear westward to Tubbs’ inlet, N. C.—The hydrographic party detailed for duty in the northern part of this section sailed from Baltimore under the command of Lieut. Comg. J. P. Bankhead, U. S. N., Assistant Coast Survey, in the schooner Crawford, and reached Charleston on the 7th of February. A period of stormy weather setting in made it expedient to defer the outside soundings and employ the interval in another locality, which was accordingly done, as will be noticed presently. The coast soundings from Cape Fear westward to Tubbs’ inlet were executed between the 5th of May and the 12th of August, favorable intervals being taken between those dates for also running off-shore lines, to be alluded to hereafter. The in-shore work connects with the completed hydrography of Cape Fear entrance and the Frying Pan shoals, and represents a space of twenty-five miles in length (Sketch No. 16) by rather more than ten in average breadth.

Assistant C. P. Bolles, in charge of the triangulation, furnished data for establishing the shore stations required in executing the soundings.

The following is a synopsis of the statistics:

- Miles run in sounding: 1,121
- Angles measured with the sextant: 1,322
- Angles measured with the theodolite: 2,281
- Number of soundings: 6,333
- Area sounded, (square miles): 228
- Tidal stations occupied: 2

Referring to the character of the bottom and to the capacity of the several small inlets which break the coast of North Carolina at intervals between Oak island and Tubbs’ inlet, Lieut. Comg. Bankhead remarks: "The bottom is uniform in character and clear of rocks or shoals, and the shore can be safely approached, in clear weather, by any class of vessels to within one nautical mile."

"The inlets are impracticable for any but vessels of very light draught, and their bars change with every shift of wind. A few flat-bottomed schooners are the only vessels that..."
attempt the passage, and then only on the top of high water, when not more than six feet can be carried in under the best of circumstances."

The in-shore hydrography from Cape Fear westward was executed with the schooners Crawford and Bailey, the latter having been assigned for that duty on the close of topographical work conducted in this section by Assistant Seib. In the course of the autumn the soundings were plotted under the direction of Lieut. Comg. Bankhead, at Washington, and the resulting chart left at the office.

The original records and transcripts of the soundings and tidal observations made at the Cape Fear entrances in 1857-'58 by the party of Lieut. Comg. T. B. Huger have also been received and deposited in the archives.

Off-shore hydrography from Cape Fear to Charleston harbor.—The working season proving to be unusually stormy along the coast below Cape Fear, effective progress in off shore soundings could be made only by employing favorable intervals, the in-shore work already referred to, being from time to time suspended for that purpose.

In allusion to the precautions taken in prosecuting the off-shore hydrography from Cape Fear, southward and westward, to Charleston harbor, Lieut. Comg. Bankhead, says: "Nearly all the lines were run with a fair wind, smooth water, and in clear weather, and all the principal positions were determined by actual observation. The soundings were made with care, and of the specimens of bottom brought up such have been preserved as were at all curious or different from the general character already known."

The following reference is made in the season's report to the probable existence of a bank off Cape Romain, the full development of which will be made in prosecuting the in-shore hydrography southward from its present limit: "I am satisfied that the continuance of the survey off Cape Romain will develop less water in some places than has been generally supposed to exist, as I have found six fathoms and water breaking in heavy weather where we should have inferred a depth of nine or ten fathoms from the general chart."

The off-shore soundings made by the party of Lieut. Comg. Bankhead in the schooner Crawford were carried to an average depth of a hundred fathoms, or from sixty or seventy miles from the coast, and were executed between the 7th of March and the 5th of August.

During the last two months of the season every effort was made to obtain current observations, but excepting at two stations in the vicinity of Cape Fear, without success.

The statistics of the off-shore hydrography are given in the following summary:

Miles run in sounding .................................................. 1,462
Number of soundings .................................................. 1,193

An unusually late period of the working season at the south having been reached, the schooners Crawford and Bailey sailed for New York, and there underwent necessary repairs. The plotting of the off-shore chart was then taken up, at the office, and completed.

Arrangements are now in progress for the return of the vessels and continuance of the in and off shore work in this section.

Hydrography of Bull's bay, South Carolina.—This duty was executed by the party of Lieut. Comg. Bankhead, with the schooner Crawford in March and April, the boisterous character of that part of the season not affording the usual opportunities for pushing soundings outside of the main coast. In connexion with the bay, the inland passage leading to the southward and westward, was sounded out as far as Capers's island. The limits of the sheet containing the
hydrography are marked on Sketch No. 16. Regular tidal observations were made during the period occupied in the work.

Lieut. Comg. Bankhead thus refers to Bull’s bay as a harbor of refuge: “I doubt whether it will ever be used except as a harbor of refuge for coasting vessels, for which purpose, however, it is well adapted, being easy of access, affording good holding ground, and having abundant water (in the channel) for that class of vessels. The small channels that traverse the bay are too narrow and irregular in their depth for anything but boats of the lightest draught.”

The following allusion to the inland passage is made in the same report:

“The inland passage connecting with the bay I find to be too narrow and crooked for any vessels other than very small steamers and flat boats, there being but one foot of water at mean low tide, and a width of only fifty feet at the narrowest part.”

The following are statistics of the hydrography:

<table>
<thead>
<tr>
<th>Miles run in sounding</th>
<th>308</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sextant angles taken</td>
<td>736</td>
</tr>
<tr>
<td>Number of casts of the lead</td>
<td>20,345</td>
</tr>
<tr>
<td>Area sounded (square miles)</td>
<td>36</td>
</tr>
</tbody>
</table>

The chart of Bull’s bay resulting from this work has been plotted and is now on file at the office.

While engaged on his working ground in this section Lieut. Comg. Bankhead furnished to a deputation from Charleston, sent to examine in regard to the availability of Bull’s bay for a quarantine station, such hydrographic data as could be supposed to bear on the question.

Hydrography of Port Royal entrance, South Carolina.—Early in June, Lieut. Comg. C. M. Fauntleroy, U. S. N., assistant Coast Survey, having completed the hydrographic duty assigned in two other localities of this section, commenced an examination of the several channels leading into Port Royal entrance in order to determine the character of the bars. This duty was completed before the close of that month, and, after plotting the soundings, it was reported as the result of comparison that “little or no change has occurred since the date of the hydrographic reconnaissance made in these waters by Lieut. Comg. Maffitt,” (1855.)

In connexion with the hydrography of the east channel the soundings were carried northward and eastward to Hilton Head, and so extended in that vicinity as to include Joiner’s bank. The limits of the work are marked in the usual way on sketch No. 16.

A recommendation from Lieut. Comg. Fauntleroy in regard to buoys for the east channel passage into Port Royal was communicated to the department in July, (Appendix No. 43.)

The United States sloop-of-war Brooklyn, having touched on a sand-spit at the mouth of Beaufort river, South Carolina, on the occasion of her visit to that branch of Port Royal sound in the early part of the season, to which allusion has been made under a previous head of this chapter, the locality in question was carefully examined by the hydrographic party. No obstruction was found in the channel which leads up the river, the point of the spit referred to being “on the port hand of the channel way, dividing it from a deep water pocket on the port hand of that again.” It is hence to be concluded that when the vessel touched she had not fairly entered the channel of Beaufort river. No professional pilots were cruising in Port Royal sound at the period of her visit.
The statistics of the survey made by the party in the schooner Varina are as follows:

Miles run in sounding .......................................................... 158
Angles observed ................................................................. 703
Number of soundings .......................................................... 8,118

The area sounded out is about twenty-two square miles. A tidal station, as usual, was occupied for hydrographic purposes. After some needful repairs at Charleston, the Varina sailed for New York, and arrived at that port on the 8th of July. The party then took up the hydrography of Hudson river, as stated under Section II.

Hydrography of the Chechessee and Colleton rivers, S. C.—After completing a survey, which will be described under the next head, the party of Lieut. Comg. Fauntleroy was transferred in the schooner Varina to Broad river, S. C., and proceeded to sound out the more important parts of its tributaries, designated as the Chechessee and Colleton rivers. From the point of their junction behind Daw island, as shown on Sketch No. 16, the hydrography was carried about two miles northward and westward up the Chechessee, and about three miles southward and westward in the bed of the Colleton river. The vicinity of Foot Point was thoroughly sounded, as also the Chechessee river from the point of Colleton Neck downwards about four miles to Pinckney’s island at the head of Port Royal sound or Broad river, where the work joins with the hydrography executed by Lieut. Comg. Maffitt, U. S. N., in 1855. My report for that year was accompanied by a preliminary chart of Port Royal entrance, which is therein marked as Sketch No. 22. In reference to it Lieut. Comg. Fauntleroy observes: “The previous survey shows that the bar of the Chechessee river affords twenty feet at mean low water, with a mean rise and fall of 6.6 feet. The depth increases in passing upward, and vessels that enter Port Royal sound will find in the Colleton river at the Neck, and at its confluence with the Chechessee, a capacious, completely protected and easily accessible anchorage in from four to seven fathoms water.” In the Appendix (No. 29) further extracts are given from the report of Lieut. Comg. Fauntleroy bearing on the commercial facilities of the vicinity of Colleton Neck. This hydrographic survey followed the shore-line as traced by Mr. C. Rockwell, and was completed between the 13th and 21st of May. The resulting sheet is now on file in the Coast Survey office. The rate of the currents was observed at two stations, and the rise and fall of the tide determined as usual, the record being made for a complete lunation. An abstract from the hydrographic journal is given below as showing the statistics of work:

Miles run in sounding .......................................................... 218
Angles observed ................................................................. 1136
Number of soundings .......................................................... 15509

Hydrography of Sapelo bar and its approaches, Ga.—The survey of Sapelo river and sound, including its entrance and approaches, has been completed; the supplementary soundings and requisite tidal and current observations having been made this season in the vicinity of the bar by Lieut. Comg. Fauntleroy. Two vessels, the schooner Varina and steam tender Fire-Fly, were used for this service. Inside of the entrance the additional soundings were joined with the work executed in 1857–58 by the party of Lieut. Comg. J. H. Moore, U. S. N., and from thence carried ten miles seaward to a depth of eight and a half fathoms. North and south the hydrography of the approaches was developed within a stretch of about ten miles. On the resulting chart, the limits of which are marked on Sketch No. 16, the character of the approaches is shown within an area of ninety-four square miles.
Observations were made at two current stations while the work was advancing, and the tides were recorded from the 27th of February until the completion of the survey, on the 27th of April. The soundings were frequently interrupted by bad weather. A synopsis of the statistics follows, as given in the report made on concluding the survey:

- Number of theodolite stations: 6
- Angles of determination: 45
- Angles observed in sounding: 1,018
- Miles run in sounding: 616
- Number of casts of the lead: 29,404

The importance of Sapelo entrance as a harbor is well set forth in some remarks contained in the report of Lieut. Comg. Fauntleroy, extracts from which will be found in Appendix No. 30.

Surveys made by this party subsequent to the completion of work at Sapelo bar have been described in this chapter, and under the head of Section II its more recent occupation has been noticed.

Two sheets, containing the hydrography of Sapelo sound and river, were received from Lieut. Comg. Moore, previous to his detachment from the Coast Survey.

Tidal observations.—The permanent self-registering tide-gauge at the custom-house wharf, Charleston, S. C., under the charge of Mr. W. R. Herron, has been kept up with great regularity throughout the year.

SECTION VI.

FROM ST. MARY'S RIVER TO ST. JOSEPH'S BAY, INCLUDING THE EASTERN AND PART OF THE WESTERN COAST OF FLORIDA, WITH THE FLORIDA REEFS AND KEYS.—(Sketch F, Nos. 20 and 21.)

The progress made in the survey of the Florida reefs and keys has permitted additional parties on the main coast. There have been at work in this section—one party on the line across the head of the peninsula; one triangulation party near St. Augustine; one near Indian river; one on the inner keys, between Cards' Sound and the Gulf of Florida; one in Charlotte harbor; one topographical party on the coast of Key Biscayne and Cards' sound and the keys near Cape Sable; one at Charlotte harbor; one hydrographic party upon the reef and in the Florida channel and Gulf Stream. Observations of the tides have been completed at three stations, and the permanent tidal station at the Tortugas has been kept up for comparison.

The following chapter gives an account of the operations of these several parties, under distinct heads, as follows:

1. Air-line triangulation across the Florida peninsula.
2. Triangulation of St. Augustine harbor and North river, Florida.
3. Triangulation of Indian river inlet, Florida.
4. Triangulation of the Florida keys.
5. Triangulation of Charlotte harbor, Florida.
6. Topography.—Key Biscayne bay, Cards' sound, and Florida keys, near Cape Sable.
8. Hydrography of the Florida Reef.
9. Tidal observations.
Office-work.—Progress has been made in the drawing and engraving of coast map and chart No. 68, Florida reefs from Key Biscayne to Carysfooot reef, and in the drawing of Nos. 70, 71, and 72, Florida reef and keys from Long key to Marquesas key.

Air-line triangulation across the Florida peninsula.—This work was resumed in January, and continued until the 4th of June. The party engaged in its prosecution was conducted by Capt. M. L. Smith, U. S. Topographical Engineers, Assistant Coast Survey. Messrs. J. S. Bradford and W. H. Gardner were assigned as aids at the outset of the season, and Mr. J. C. Young before its close.

In allusion to the progress made and impediments found as the triangulation advanced southward and westward from Big creek and Padgett station, both of which are shown on Sketch No. 20, Capt. Smith remarks: "It was supposed at the commencement of the season that the ground to be passed over would prove more favorable than that met with during the previous year, but the contrary was the case. New River swamp, which, according to the maps of the interior, our lines should have missed, covers much of the ground traversed by one of the sides of each triangle. The section of country through which they pass is more or less densely timbered, and the lines forming their sides had to be opened foot by foot with the axe.

When it is considered that thick pine woods offered the most favorable cutting required in carrying the work forward, the remainder and about an equal portion being through the swamps and matted bogs of the south, the extent of the labor may be judged of. The opening of the lines constitutes the main item of expense attending the triangulation."

Mr. J. S. Bradford was in active charge of the party under the direction of Capt. Smith, and is mentioned, in conjunction with Messrs. Gardner and Young, as having pressed the work with constant energy and interest. In opening the lines, which stretch in the aggregate a hundred miles, the patient endurance of the aids was such as to call forth the warm commendation of the chief of the party.

The work has now advanced from Fernandina about eighty miles in the direction towards Cedar keys, and two more seasons' work, with favorable weather, will probably complete the line; but with impediments like those encountered this year it would require three.

Operations were closed for the season at Waldo station, which is about twenty-eight miles southwest of the station at which the triangulation was resumed in January. Five signals were erected, and ninety angles measured in extending the triangulation to its present limit.

A topographical sheet, embracing the tract over which the season's work extends, has been filed in the office.

Triangulation of St. Augustine harbor and North river, Fla.—The survey of the western coast of Florida was commenced on the 4th of January by Sub-Assistant Benjamin Huger, jr., in the vicinity of St. Augustine. After selecting a site suitable for a base line on the pine barren about a mile west of the city, a triangulation was laid out to extend over the harbor, and north and south of it along the coast. The preliminary base was measured early in June with the contact slide apparatus devised by Assistant Hilgard, and described in my report for 1857. Sketch No. 20 shows the location of the line, and also the system of triangles connected with it. The angles were determined with the ten-inch Gambey theodolite, C. S. No. 74.

Above St. Augustine the completed triangulation stretches twenty miles, and embraces throughout that distance the course of the North river. The scheme was laid out and signals erected along the shores of Matanzas river for carrying the work twelve miles southward from
the base, but the late period of the season reached in the performance of that service made it necessary to postpone the measurement of the angles until the coming winter.

Mr. Rufus King, jr., served as aid in the triangulation party.

The progress made in the field-work is exhibited by the summary of statistics given below:

<table>
<thead>
<tr>
<th>Stations occupied</th>
<th>Signals observed on</th>
<th>Angles measured</th>
<th>Number of observations</th>
<th>Area of triangles, (square miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>38</td>
<td>158</td>
<td>2,896</td>
<td>50</td>
</tr>
</tbody>
</table>

Field operations were continued in the neighborhood of St. Augustine until the 23rd of June. Sub-Assistant Huger, after returning to the north, duplicated and turned in the records of his observations, and then commenced the computations connected with the work.

In the latter part of April, while on a tour of inspection at the south, I visited the site then occupied by the triangulation party, and was gratified with an examination of the arrangements for working in accordance with the plan laid out.

In reporting on the progress of the party, Mr. Huger expresses his obligation to G. R. Fairbanks, esq., vice president of the Florida Historical Society, for information in regard to localities falling within the limits of its operations. The arrangements of the party are now in progress for returning to extend the coast triangulation southward from St. Augustine.

Triangulation of Indian River inlet, Fla.—In the field arrangements made at the opening of the surveying year a new centre of work was selected for extending the triangulation of the eastern coast of the Florida peninsula, the execution of the details being entrusted to Sub-Assistant J. A. Sullivan. The intention of commencing in the immediate vicinity of Cape Cañaveral, and pushing the work towards St. Augustine, was found to present greater obstacles without a corresponding advantage over a beginning made lower down the coast, and in consequence the party proceeded to Indian River inlet. Mr. Sullivan made a reconnaissance in the middle of January for a base site and for stations to connect with it, so as to lead either northward or southward, as might prove most expedient in prosecuting the triangulation. The site chosen rests on the narrow strip of land which separates Indian river from the Atlantic ocean, and is marked on Sketch No. 20.

A preliminary measurement, without correcting for the temperature of the rods used, gave for the line an approximate length of 2,860 metres. Sub-Assistant Sullivan made a topographical survey of the immediate vicinity of the base, and on his return deposited in the office the sheet containing it. As the line passes close to the water margin of the Atlantic, the ends were referred back eight metres from the beach, and carefully secured by placing stone posts on a sand ridge above the ordinary action of the ocean swell. Each terminus was marked by two stone blocks about two feet in length, surrounded by wooden curbs, and having range marks cut on them to correspond with the terminating points of the line laid out on the beach.

The preliminaries being completed, five stations were established, with signals visible over the high mangrove keys which lie inside of Indian river and abreast of the inlet. These connect with both ends of the base line. The scaffolds erected are twenty-five feet in height. Two of the stations rest on the western side of Indian river, as will be seen by reference to the Sketch; the others on the strip of land south of the inlet.

The time allotted for observations with the theodolite proving unfavorable, materials were
prepared for the second order signals required along the shores of Indian river, in which duty the party was occupied until the 25th of March.

Sub-Assistant Sullivan commends the zeal, perseverance, and hearty spirit of co-operation shown by his aid, Mr. R. M. Stiles, in all the labors of the season. Special reference is also made in the field report to the courtesies and assistance rendered to the party by Major W. F. Russell, of Fort Capron.

The schooner Benjamin Peirce, which was used in prosecuting the work at Indian river, was caught in a gale and damaged, on the return passage, off Cape Canaveral. After the necessary repairs at Savannah, the vessel proceeded north, and was laid up at New York.

In June Mr. Sullivan was assigned to duty in Penobscot bay, the details of which have been given under the head of Section I. His party is now about to return to continue the triangulation near Fort Capron, Fla.

**Triangulation of the Florida keys.**—For continuing duty on that part of the Florida reef which approaches nearest to the Cape Sable base, the party of Lieut. A. H. Seward, U. S. A., Assistant Coast Survey, took the field on the 13th of December, using the schooner Torrey for transportation. After putting up the requisite signals, the triangulation inside of the reef was resumed at Lignum Vitæ key, and extended eastward sixteen miles to Pigeon key. The triangles laid out and measured, as well as the general progress made in the survey of the keys, will be seen by reference to Sketch No. 21. At several of the stations used by Lieut. Seward tripods, for the theodolite, were found necessary, the platforms of which were elevated to a height of twenty-eight and thirty feet from the surface of the keys on which they rested. The work was somewhat retarded by the difficulty of passing the vessel through the intricate channels of that part of the reef, favorable winds only enabling the party to move from one station to another. Lieut. W. Myers, U. S. A., assisted Lieut. Seward in the field.

The angular measurements were made with the ten-inch Gambey theodolite, C. S. No. 15. It will be seen by Sketch No. 21 that this triangulation connects with the work of last year, stretching from Cape Sable, and that it reaches well towards a junction with the triangulation which extends along the main of the peninsula from Cape Florida into Barnes's sound.

The statistics for the season, terminating on the 2d of April, are as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stations erected</td>
<td>11</td>
</tr>
<tr>
<td>Stations occupied</td>
<td>11</td>
</tr>
<tr>
<td>Number of observations</td>
<td>2,598</td>
</tr>
<tr>
<td>Area included in triangles, (square miles)</td>
<td>62</td>
</tr>
</tbody>
</table>

Descriptions of the signals, and a duplicate of the record of horizontal angles, have been received at the office.

On closing for the season the vessel was despatched for New York, and was there laid up during the summer. The keys yet remaining to be defined in position and outline are surrounded by water so shallow as to render the approach to them very difficult.

**Triangulation of Charlotte harbor, Fla.**—This work has been continued and nearly completed by a party in charge of Lieut. W. R. Terrill, U. S. A., Assistant Coast Survey, who made a reconnaissance for its extension above Captiva Pass in the latter part of December. Signals were erected on the chain of islands which lie outside and abreast of Charlotte harbor, and along both of its shores to a distance of thirty miles, terminating at Mangrove Point, the position of which is shown on one of the progress sketches of this section, (Sketch No. 20.)
The signal at Captiva Pass, erected and used in the winter of 1857-'58 by Lieut. J. C. Clark, U. S. A., had been washed away, and, in consequence, it became necessary to reoccupy the station connecting with it to the southward on Captiva island. At three stations in the range of this season's work Lieut. Terrill observed from scaffolds fifty feet in height, the lines passing over dense mangrove, through which cuttings for sight on the signals would have involved great expense of labor and time.

The measurement of angles was begun early in January with the ten-inch Gamble theodolite, C. S. No. 81, and was prosecuted at all favorable intervals until the 1st of April, the completed observations then resting for the season at station Oso, lying outside, and station Torrey on the eastern shore of Charlotte harbor. Both of these stations are marked on Sketch No. 20. Points for the use of the topographical party, conducted jointly by Sub-Assistants Dorr and Ferguson, were provided as the triangulation advanced.

Sub-Assistant Clarence Fendall joined the party of Lieut. Terrill at the opening of the year, and assisted him in the field until the 13th of March. Mr. C. B. Baker served as aid during the season. The schooner Bowditch reached New York, on her return from this section, on the 14th of April.

In the report made by Lieut. Terrill the following abstract is given, showing the progress made by the party while working under his direction:

- Number of signals erected: 24
- Stations occupied: 11
- Signals observed on: 24
- Angles measured: 75
- Number of observations: 4,376

The triangulation completed this season covers an area of about a hundred and thirty square miles. The original records of angles, as observed in the prosecution of the work, and descriptions of the stations and signals, have been received at the office.

Lieut. Terrill resumed field duty in June with the party of Assistant Edmund Blunt, reference to which was made in describing the work done in Section II. Sub-Assistant Fendall was at the same time assigned to plane-table duty, as stated under Section I.

**Topography—Key Biscayne bay, Card's sound, and Florida keys, near Cape Sable.**—With a view of pushing the plane-table work in the vicinity of the Florida reefs as far as practicable with a single party, the schooner Agassiz was despatched from Baltimore on the 28th of October, 1858. Much rough weather delayed the vessel, and, in consequence, the working station in Key Biscayne bay was not reached until the 29th of November. After making a reconnaissance, and setting up signals on the western shore of the bay, Sub-Assistant C. T. Iardella started with the plane-table at Shoal Point, and traced in the main shore of the peninsula of Florida, southward and westward to Clay Point, a distance of over thirty miles in a direct line. The tongue of land which from thence projects towards the reef was followed up to the narrow creek dividing it from Key Largo, and the survey of the western side of that key was completed. The shore of the main within the limits just stated is broken by thirty-three small creeks, all of which are represented on the plane-table sheets. Several small keys lying in the lower part of Key Biscayne bay, and in Card's sound, were also surveyed. This work is embraced on four sheets, the localities included in each of which are marked on Sketch No. 21.

The triangulation in Barnes's sound not admitting of further progress in the topography until
pushed southward, Mr. Iardella moved his party to the vicinity of Buchanan key and projected two sheets to include the numerous small keys intervening within the stretch of about sixteen miles between it and Sandy key in the direction towards Cape Sable. These fall within the triangulation executed last year by Lieut. A. H. Seward, U. S. A. Twenty-three keys were surveyed, the largest of which is about three-quarters of a mile in length. The positions of the principal ones are shown on the progress Sketch, No. 21.

Sub-Assistant Iardella discontinued work on the 6th of April, and on the 22d of that month reached New York, where the vessel was laid up.

Mr. F. F. Nes aid in the topographical work, and rendered satisfactory service in the several duties pertaining to the field operations.

In the two localities in which the party was employed great obstacles exist to retard steady progress and to render the work very difficult, and in some places hazardous. Notwithstanding these, the amount of work embraced on the six sheets shows a result which nothing but patience and great energy could have accomplished. The remark just made is also borne out by the statistics, which are as follows:

Shore-line surveyed ........................................ 168 miles.
Marsh-line traced ........................................ 16 "
Area represented in detail, (square miles) ................. 40 "

The operations were carried on over an area of more than three hundred square miles. All the sheets containing the work have been inked and deposited in the archives.

As descriptive of the character of this part of the coast of the Florida peninsula, the following extracts are given from the report of Mr. Iardella:

"The main shore, from Shoal Point ten miles southward, consists of a strip of uneven breadth of prairie land called the 'Hunting Grounds.' At some points it is quite narrow, but at others it stretches to a distance of six miles from the western shore of Key Biscayne bay, and is backed by a ridge of high land about a quarter of a mile in width. The ridge as far as Fender Point is covered with large pine trees, but below it, and as low down as Barnes' s sound, it bears a heavy growth of black mangrove and other trees. Throughout the entire distance of thirty miles the shore is overflowed by high tides, in some places to a breadth of three or four miles.

"The western shore of Key Largo from Jewfish Point to Largo North, a distance of thirteen miles, is also overflowed at high spring tides; and on many occasions, while engaged there, the surface was found so soft as to require a foundation of mangrove branches for the plane-table. Beyond its western shore this key is covered with buttonwood, mangrove, sea-grape, and other woods. In an extended reconnaissance over that part of Key Largo, very little fast land was found, and no soil fit for the growth of vegetables. *

"The small keys between Lignum Vitæ and Sandy key are surrounded by extensive mud flats, and are entirely covered with water at high tides. Great difficulties were experienced in obtaining stations for the plane-table, the surface being of the nature of quicksand, into which a man of ordinary weight would at once sink to the waist. Here a triangle of wood six feet on a side was necessary to support the plane-table."

Topography of Charlotte harbor, Fla.—The progress made in extending the survey of this harbor is shown on Sketch No. 20. Early preparations for resuming work were made at the opening of the surveying year, by Sub-Assistant F. W. Dorr; but the schooner Dana, which
sailed from Baltimore on the 25th of November, 1858, with the equipage and instruments of the party, was kept nearly a month on her passage to Key West by storms and head winds. Sub-Assistant Charles Ferguson was associated with Mr. Dorr; and after making arrangements for working jointly to the best advantage, the topography was taken up at the limit reached in the previous year. The work was thus prosecuted northward until the 27th of February, when Sub-Assistant Dorr, in accordance with my instructions, returned to the north, leaving the vessel and party in charge of Mr. Ferguson, who continued plane-table duty until the 16th of March.

The work executed this season includes both shores of Charlotte harbor above its lower entrance from San Carlos bay, and nearly the same extent to the northward as fell within the limits of the triangulation, notice of which has been made in this chapter. The shores are formed by a range of narrow islands and keys on the west, and by Pine island on the eastern side. On the two sheets of this season, both of which have been inked and placed in the office, are represented the northern half of Sanibel island, Captiva island, La Costa island, the western side of Pine island, and the keys, patches, and reefs scattered over the surface of that part of Charlotte harbor which is included between San Carlos bay and Boca Grande. The distance between these last named localities, on a direct line through the waters of Charlotte harbor, is about twenty miles. Lieut. W. R. Terrill, U. S. A., who conducted the triangulation in advance of the plane-table party, furnished the points necessary for the adjustment of the topography. The following is a synopsis of statistics taken from the notes on the plane-table sheets:

<table>
<thead>
<tr>
<th>Description</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shore-line of islands and keys surveyed</td>
<td>270 miles</td>
</tr>
<tr>
<td>Outline of shoals, etc., traced</td>
<td>48 miles</td>
</tr>
</tbody>
</table>

In reference to two of the outlets from Charlotte harbor to the Gulf of Mexico, Sub-Assistant Dorr remarks:

"Blind Pass, between Sanibel island and Captiva island, is merely a boat channel, for although the passage is deep in some places, the bars both inside and outside preclude the possibility of carrying through any vessel of draught."

"Captiva Pass is about five hundred yards wide. Vessels drawing not more than five feet of water can pass through, but the channel is somewhat intricate."

The following is an extract from the report of Sub-Assistant Ferguson:

"Boca Grande, the pass between La Costa and Gasparilla islands, is the proper entrance to Charlotte harbor, containing, at low tide, fifteen feet of water, and inside of the bay three or four fathoms. Vessels passing through can carry eighteen feet some fifteen or twenty miles beyond the northern extremity of Pine island." In the Appendix (No. 31) other extracts will be found descriptive of the features peculiar to the shores of Charlotte harbor.

During the summer Sub-Assistant Dorr was engaged in plane-table duty in Section II, and Mr. Ferguson in similar service in Section III.

Hydrography of the Florida reef.—Lieut. Comg. T. A. Craven, U. S. N., having been reassigned for duty on the Coast Survey soon after his return from the expedition to the Atrato river, resumed the command of the surveying steamer Corwin, which had become vacant by a call for the services of Lieut. W. G. Temple, U. S. N., who conducted the hydrographic operations of last year on the Florida reef, as stated in my annual report. The Corwin sailed
from New York on the 19th of March, and on her arrival at the reef the general hydrography was taken up a little below Eagle cove, where it rested last season in its progress eastward along the outer line of keys. The soundings were continued in the same direction rather more than eight miles, and off the keys about six miles and a half, reaching to an average depth of forty-seven fathoms. At its upper outside limit, as shown on Sketch No. 21, the work now connects with soundings made in the vicinity of Coffin's Patches, by Lieut. Comg. Craven, in 1854. The following statistics are derived from the journals of the present season:

- Number of positions for angles: 1,206
- Angles taken: 3,198
- Miles run in sounding: 462
- Number of casts of the lead: 18,130

The resulting hydrographic sheet will exhibit an area of about sixty square miles.

Since the opening of the season two charts have been plotted from soundings made by Lieuts. Comg. Craven and Temple, and placed in the office with the original journals and records of the angles. These connect with each other, and contain the hydrography between American shoal and Eagle cove, where the upper limit of the most northern sheet joins with the work last executed.

The steamer Corwin returned to New York early in May, and after being repaired was transferred, under the command of Lieut. Comg. John Wilkinson, for duty, which has been referred to under the head of Section I.

Before leaving the Florida reef, Lieut. Comg. Craven ran two section lines across the Gulf Stream, between Cape Florida and the Tortugas, more extended notice of which will be taken presently.

In passing to the southward the steamer Corwin stood in below Cape Canaveral, and carried a line of soundings along the coast of Florida as far as St. Lucie inlet. The distance from land being estimated, the depths found have been marked as reconnaissance soundings on the Progress Sketch, No. 36.

As the result of his experience in navigating along the eastern coast of the peninsula, Lieut. Comg. Craven says: "The entire coast south of Canaveral is safe at two miles from shore until within five miles of Cape Florida. South of latitude 27° N. the shore is bold. I have never had soundings with twenty fathoms, lead 'up and down,' within two miles of the shore. On the passage down, the rate of the current below Jupiter inlet was about two miles an hour, which is more than usual, the wind then blowing from the southeast."

All the journals containing angles and soundings taken this season on the reef have been returned and deposited in the archives.

Tidal observations.—At Fort Clinch, near Fernandina, Amelia island, Fla., observations have been kept up by means of one of the Saxton self-registering tide-gauges, the instrument being under the charge of Mr. F. A. Rebarer until the middle of December, 1858, and since that time in charge of Mr. J. A. Walker.

The self-registering gauges established by Mr. Gustavus Würdemann at Tortugas, Charlotte harbor, and Tampa bay, have given very satisfactory results during the entire year, and are now about to be transferred to stations lying further westward along the Gulf coast of the
adjoining section, (VII.) The plan laid out is to set them up so as to form a chain of stations, at which the results may be comparable with each other and with others in this section through the standard station of reference at Tortugas. It has been found impracticable to trace out the anomalies of the tides of the Gulf of Mexico from the detached and comparatively short series of observations heretofore obtained in the progress of the survey; but by the method now adopted, the observations embracing a full year at each station, and being minutely comparable with each other, the different tide waves can be followed, as it were, step by step in their advance along the coast.

GULF STREAM.

In the southern part of the Gulf Stream observations of much interest have been added in the course of the past year. These were made by Lieuts. Comg. T. A. Craven and T. B. Huger, U. S. N., assistants in the Coast Survey, after closing the general hydrographic work conducted by them in Sections VI and VIII, respectively.

Two lines for depth and temperature were run across the stream by Lieut. Comg. Craven, in the steamer Corwin, one from Carysfort light-house (Florida reef) to Orange key, (Bahama bank,) and the other from Sombrero key (Florida reef) to Double Headed Shot key, (Salt Key bank.) The data thus obtained, taken in connexion with the development of the Cape Florida section by that officer in 1855, and of the Tortugas section by Commander B. F. Sands, U. S. N., in 1858, have furnished important information concerning the form of the bottom, the depth, and the temperature of the water in a part of the Gulf Stream to which general observation would assign as its main peculiarity only the velocity of the surface current.

The bottom of the Strait of Florida slopes, at first gradually and then more rapidly, from the Florida to the Cuban side, the deepest water being found near the shore of Cuba. In this deep portion of the trough the cold polar current lies, the temperature at six hundred fathoms, off Havana, being but thirty-eight degrees of Fahrenheit. The deepest part of the strait is off the opening from the Gulf of Mexico, and it shoals towards the line from Cape Florida to Bemini, from eight hundred fathoms to three hundred and fifty. As there is but one general slope to the bottom, so there is but one band of temperature in this strait, the division into cold and warm bands beginning only to the south of the shoal portion in the Atlantic, where the bottom takes its corrugated form.

A discussion of the recent observations is given at greater length in a paper accompanying this report as Appendix No. 25. The results are graphically shown on Sketch No. 35.

On his homeward passage from the Delta of the Mississippi, in the steamer Walker, Lieut. Comg. Huger took soundings on the course towards the Tortugas, and from thence ran across to Havana. The observations made between the last named places verify the results obtained on the same line by Commander B. F. Sands, in 1858.

In the explorations this year, two hundred and thirty-five observations were made for depth and temperature, and twelve specimens of the bottom procured.
SECTION VII.

FROM ST. JOSEPH'S BAY TO MOBILE BAY, INCLUDING THE COAST OF WEST FLORIDA AND THE COAST OF ALABAMA.—(Sketch G, No. 23.)

This chapter contains notices of the following operations:

1. The extension of the coast triangulation on the western side of the Florida peninsula, below Cedar Keys.
2. Connection of the triangulations of St. Mark's harbor and St. George's sound.
3. Triangulation of Santa Rosa sound.
5. Plane-table survey of the shores of Ockloonee bay and St. James's island, between St. George's sound and St. Mark's harbor.
6. Topography of part of Santa Rosa sound, Fla.
7. Hydrographic re-examination of the Cedar Keys channels.
8. Hydrography of St. George's sound.
9. Tidal observations.

Two triangulation parties, one for triangulation and topography, two topographical, and two hydrographic parties have been at work in this section, the second, and one of the last named during only a portion of the season.

Office-work.—The drawing and engraving of the preliminary chart of the eastern part of St. George's sound have been completed, as also the engraving of the preliminary chart of Pensacola harbor. The drawing of the preliminary chart of Apalachicola bay has been finished at the office, and has since been engraved on stone under the direction of the Superintendent of Public Printing.

Coast triangulation south of Homosassa river, Fla.—Two parties, operating jointly as heretofore, left Baltimore on the 15th of December, with the schooner Joseph Henry, to continue the triangulation and topography of the western coast of Florida, below Cedar Keys. Sub-Assistant G. H. Bagwell, in charge of the triangulation, resumed duty at a station near the mouth of Homosassa river, and carried the work twenty-five miles southward, to the vicinity of Bayport, where he closed for the season at the end of March. Sketch No. 23 contains a scheme of the triangles, and shows also the progress which has been made in the other branches of the survey in this section. It will be seen, by referring to the sketch, that the reefsy and broken character of the coast approach, as represented on the preliminary chart of Cedar Keys, (Sketch No. 33, C. S. Report for 1855,) holds as far as the parties have advanced to the southward from that centre of work. Mr. Bagwell thus remarks, in reference to that part passed over since the opening of the present surveying year, as connected with the stretch lying northward of it:

"The main surface consists of vast flats and shoals which extend miles to seaward from the western shore of Florida, the water gradually deepening off among the dangerous rocks of St. Martin's reef."

"Most of the stations observed from were occupied with scaffolds, some of which were built as high as thirty feet, in order to see over the thick hammocks of palmetto and mangrove that obstructed the view. The coast over which the work extended presents many obstacles to triangulation. The chain of keys and shell reefs, on which the outer sides of the triangles rest
from Cedar Keys southward to Chassahowitzka Point, end at the latter place, and below it suitable outer points could be established only by building stations in shallow water. At these a foot or more in depth is left at low tide."

In the course of his work, Sub-Assistant Bagwell determined positions for the use of the topographical party of Sub-Assistant Finney, who co-operated also, as far as practicable, in pushing the triangulation.

The field statistics are as follows:

<table>
<thead>
<tr>
<th>Stations occupied</th>
<th>Signals observed on</th>
<th>Angles measured</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td></td>
<td>78</td>
<td>2,060</td>
</tr>
</tbody>
</table>

The observations were made with the eight inch Würdemann theodite, C. S. No. 86.

During an interval unfavorable for the measurement of angles, Mr. Bagwell made a reconnaissance of the coast from Bayport southward, and through St. Joseph's bay to the southern limit of the section. About thirty miles below Bayport a fine site for a base was found on a straight level strip of sand beach at the north end of Chaldee's key. The length practicable for measurement he reports as being nearly three miles. Between Bayport and Anclote key, a distance of fifteen miles, the difficulties before alluded to in regard to outside stations remain to be encountered. As the result of his observations in reconnaissance beyond that, Mr. Bagwell says: "Southward from Anclote key the triangulation can readily be extended with sides of from two to five miles over St. Joseph's bay and Clear Water harbor."

Mr. M. O. Hering rendered acceptable aid in all the operations of the triangulation party. Before taking the field, the records of last year were duplicated and sent to the office with the observer's computation of results. In April the schooner Joseph Henry returned to New York and was laid up for the summer. Sub-Assistant Bagwell soon after joined the party of Assistant Edmund Blunt, and sided him in the triangulation under his charge in Section II.

*Triangulation east and west from St. Mark's, Fla.*—The triangulation from St. George's sound, which rested last year at the eastern end of St. James's island (S. W. cape,) was taken up at that point, by Sub-Assistant Spencer C. McCorkle, on the 16th of December. After making a reconnaissance for pushing the work eastward towards St. Mark's and Ocilla river entrance, a system of short lines was determined on, extending over Ockloonee bay. Such of the lines as required cutting were then cleared and the necessary signals erected. The angular measurements were commenced on the 25th of January, and continued until near the end of April, when a junction was made between the triangulation thus carried from St. George's sound and that executed at St. Mark's river by Mr. McCorkle in 1856. Stations were also erected eastward of St. Mark's and preliminary measurements made in the series of triangles designed to connect that work with the triangulation of Ocilla river. As the operations of the party progressed on the shores of Ockloonee and Dickerson's bays, points were determined and furnished for the use of the plane-table party of Assistant Wise. An abstract of the statistics is given below, as contained in the report of Sub-Assistant McCorkle:

<table>
<thead>
<tr>
<th>Stations occupied</th>
<th>Angles measured</th>
<th>Number of observations</th>
<th>Area of triangulations, (square miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>70</td>
<td>1,404</td>
<td>90</td>
</tr>
</tbody>
</table>
The instrument used was the six-inch Gambey theodolite, C. S. No. 55. Sketch No. 23 shows the arrangement of the triangles. The distance from the starting point of the season's work (S. W. cape) to St. Mark's lighthouse is about twenty-five miles.

In his general report Sub-Assistant McCorkle commends the zeal and intelligence shown by Mr. A. W. Thompson, who aided him both in the field and office work of his party.

On closing work, the schooner Franklin, which had been used for the transportation of the party and materials for the stations, was laid up at Apalachicola.

Mr. McCorkle has sent to the office the original and duplicate of the record of angles measured this season, together with his computation for the lengths of triangle sides.

**Triangulation of Santa Rosa sound, Fla.**—This work was taken up by Assistant F. H. Gerdes in March, after closing similar duty at the Mississippi delta, reference to which will be more particularly made in the next chapter. The triangulation of Santa Rosa sound joins with that of Pensacola bay on the line connecting Fair Point with a station near the western end of Santa Rosa island, as may be seen on the progress sketch of the section, (Sketch No. 23.) From thence a chain of triangles extending six miles eastward was laid out and measured with the Würdemann theodolite, (C. S. No. 87,) the points requisite for the topographical survey being also determined as the triangulation advanced. A synopsis of the statistics is appended:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals erected</td>
<td>10</td>
</tr>
<tr>
<td>Stations occupied</td>
<td>10</td>
</tr>
<tr>
<td>Angles measured</td>
<td>30</td>
</tr>
<tr>
<td>Number of observations</td>
<td>288</td>
</tr>
</tbody>
</table>

Assistant Gerdes was aided in the field by Mr. G. U. Mayo. Soon after the close of work the record of angles observed was duplicated and sent to the office, with an abstract in the usual form.

**Topography north and south of Homosassa entrance, West Florida.**—The party in charge of this duty was conducted by Sub-Assistant N. S. Finney, and, as heretofore, co-operated in the triangulation work in its progress southward from Cedar Keys, special notice of which has already been made in this chapter.

Mr. Finney resumed the plane-table survey at Mangrove Point, two miles southwest of Crystal reef signal, and traced in outline the entire barrier of islands, rocks, and shell reefs, which extend about seven miles to the southward. These form the most strongly-marked feature of that part of the coast of Florida. The sheet containing the detailed work was terminated at the mouth of the Homosassa river.

An additional vessel for the use of the topographical party not being available, it was found necessary to pass by for the present season a few miles of the coast below Homosassa entrance, in order to keep pace with the triangulation, the same vessel serving for the transportation of the two parties. Plane-table work was therefore taken up at the Chassahowitzka entrance, (Sketch No. 23,) and carried southward about seven miles further to Raccoon Point, the triangulation being still a few miles in advance of it. The characteristics before alluded to apply also to the coast south of the Chassahowitzka river. Both of the sheets containing the results of the survey are marked in positive and in relative proportions on the progress sketch of the section, but the reduced scale gives, of necessity, only a partial idea of the peculiar features contained on the originals. Exclusive of portions of the shore-line of the main land and numerous shell reefs, the sheets represent two hundred and thirty-six soft, marshy islands...
as existing within an area of thirty-five square miles. In some places the belt of islands extends five miles beyond the main shore. Above the mouth of the Chassahowitzka the islands are covered at high water, but the marsh of which they consist lies somewhat higher, is much less broken than in other localities, and the zone of patches which lie between the deep water of the Gulf and the firm land of the peninsula becomes narrower.

The plane-table survey was discontinued for the season at a station about five miles north of Bayport.

In the report of Sub-Assistant Finney favorable mention is made of the services rendered by Mr. J. L. Tilghman, who accompanied him in the field as aid. The statistics of work are thus given in the same report:

- Plane-table stations occupied: 413
- Points determined: 1,320
- Shore-line surveyed at high water, (main, islands, and reefs): 176
- Shore-line at low water: 54
- Area of topography, (square miles): 35

In the field report Mr. Finney expresses his obligations for courtesies extended by Captain James Tucker, of the mail steamship Madison, and for assistance rendered to his party by Colonel E. H. Richards and W. P. Peginan, esq., postmaster at Cedar Keys.

Sub-Assistant Finney was employed during the summer in Section II, as stated in the corresponding division of this report.

*Topography of Ocklokonee bay and St. James's island, Fla.*—The party of Assistant G. D. Wise, having last season completed the plane-table survey of St. George's sound, started early in January at the terminating limit on St. James's island of the topography commenced and partly executed by Sub-Assistant C. T. Iardella in the season of 1857-'58. The survey of the northern part of the island was completed by Mr. Wise, and on the same sheet the work extended so as to include the shores of Ocklokonee bay. Some progress was also made on a second sheet projected to contain the details of the vicinity of Dickerson's bay and of the coast running from its entrance towards St. Mark's. The localities of the work are marked on Sketch No. 23. The return in statistics is as follows:

- Shore-line surveyed: 88 miles.
- Roads surveyed: 10
- Area of plane-table sheets, (square miles): 46

This survey rests on the triangulation executed within the present season by Sub-Assistant S. C. McCorkle.

Mr. C. W. Duval served as aid in the plane-table party. The work was prosecuted with the use of the schooner Howell Cobb, and on the close of operations the vessel left for the north, and was laid up at Baltimore.

With reference to the Ocklokonee shoal, which lies off the eastern end of St. James's island, Assistant Wise remarks: "The shoal having only two or three feet of water, and being right in the track of a large trade, has occasioned the loss of many valuable cargoes. The bell-buoy which was placed on it soon broke adrift, and, after washing ashore on St. George's island, was
finally lost. It is the opinion of many shipping-masters of the vicinity that a light-ship would best answer the purposes of navigation here as a beacon to mark the shoal.'"

**Topography of Santa Rosa sound, Fla.**—After completing the triangulation described under a previous head, Assistant F. H. Gerdes proceeded at once with the plane-table, and surveyed that part of Santa Rosa island which lies in the immediate vicinity of Little Sabine bayou, having an extent of about six miles of Gulf coast on the outside, and the same of inner shoreline. The topographical sheet includes also the opposite shore of Santa Rosa sound from Deer Point eastward to the present limit of the triangulation. An aggregate of twenty-two miles of shore was traced within an area of ten square miles. Sketch No. 23 shows the limits of the plane-table work. This survey furnishes all the topographical details necessary for the chart of Pensacola harbor, an edition of which in a preliminary form has been issued from the office.

Mr. G. U. Mayo aided in the triangulation and plane-table survey of Santa Rosa sound. The work was continued until the middle of May, when Assistant Gerdes proceeded north and reported at the office. His party had been previously employed in Section VIII, as will be noticed further on.

**Re-examination of the Cedar Keys channels, Fla.**—On his way to Section VIII, Lieut. Comg. T. B. Huger, U. S. N., Assistant Coast Survey, with the hydrographic party in the steamer Walker, stopped at Cedar Keys and sounded out the Main, the North key, and the northwest channels leading into that harbor. The work was performed in the early part of January, and under disadvantages arising from fogs, rain, and northerly winds. As a consequence of the prevailing wind during the period of the stay of the party, the rise and fall of the tide were reduced much below the average, the fall in particular being greater for several days than had been observed in the course of the preceding year.

Lieut. Comg. Huger states that the breadth of the bulkhead across the main channel varies from one hundred to three hundred yards, and, in his opinion, the surface of it could readily be removed so as to afford a depth of twelve feet at low water. An examination made by the party confirmed the facts heretofore reported in regard to the structure and character of the bar.

Lieut. Comg. Huger says: "It is composed of a crust of sand and shells easily penetrated, and after passing through it the bottom is soft, consisting, I think, of mud and sand. I had it sounded with an iron rod, and on trying the heavy lead and specimen cup, found no difficulty in sinking it sufficiently deep to obtain a good specimen."

The soundings made at Cedar Keys were plotted at Pensacola while the steamer was taking in supplies, and the chart on being completed was sent to the office, with the following abstract of statistics:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles run in sounding</td>
<td>166</td>
</tr>
<tr>
<td>Angles measured</td>
<td>1,242</td>
</tr>
<tr>
<td>Number of soundings</td>
<td>15,102</td>
</tr>
<tr>
<td>Area of hydrography, (square miles)</td>
<td>5</td>
</tr>
</tbody>
</table>

Lieut. Comg. Huger reports that the northwest channel into Cedar Keys presents, in respect of capacity and direction, several advantages over the channel now used for vessels bound to ports lying westward in the Gulf of Mexico.
Having been fitted out for hydrographic duty in Section VIII, the vessel cleared from Pensacola on the 15th of January for Atchafalaya bay. The work done by the party subsequent to that date will be described in the next chapter.

Hydrography of St. George's sound, Fla.—The party of Lieut. Comg. J. K. Duer, U. S. N., Assistant Coast Survey, resumed work in the vicinity of Apalachicola with the steamer Vixen on the 3d of December, and executed portions of the hydrography inside and abreast of the West Pass. The new channel leading into the sound past the eastern end of Dog island was thoroughly examined, with results confirming those reported after the reconnaissance made last year, that it is by several feet the deepest pass into St. George's sound at all seasons. But the known irregularities of the tides affecting the depth of water in the eastern part of the sound render the determination of the mean rise and fall somewhat difficult without a wider range in the observations than is ordinarily necessary for hydrographic purposes. In order to elucidate the normal peculiarities of the tide wave in its progress along that part of the Gulf coast, series of observations have been directed to be made with self-registering gauges, and arrangements for commencing them are now in hand.

The hydrographic work allotted in this section for the early part of the season was frequently interrupted by bad weather. Soundings were continued until the 10th of March, the vessel and party being then transferred for duty to Section IX, the operations in which will be described in another chapter.

Lieut. Comg. Duer, who had preceded the return of the steamer Vixen to Apalachicola, died at that place on the 14th of June, after which the charge of the party devolved on Mr. A. W. Muldaur, as executive officer, until the assignment of Lieut. C. C. Sims, U. S. N., who took command on the 1st of July and proceeded with the vessel to New York.

As part of a summary report made at the end of the season by Mr. Muldaur, the following statistics are given of the work done in St. George's sound:

- Miles run in sounding: 564
- Angles measured: 1,499
- Number of soundings: 25,060

In the death of Lieut. Comg. Duer the survey has lost the services of a zealous and industrious officer, whose career on the work seemed ever to be marked by devotion to its best interests. He was prompt to act, and thorough in the execution of details assigned to his charge. His discovery of the new channel into St. George's sound, and which now bears his name, will closely associate his memory with the hydrographic history of this section. I have elsewhere more specially alluded to the circumstances attending his untimely death.

My public acknowledgment is here due to Lieut. Sims for the important service rendered by him in accepting the charge of the steamer Vixen when the official command of that vessel was left vacant by the decease of Lieut. Comg. Duer.

In March, while the party was employed near Apalachicola, assistance was rendered to the schooner Lucy Weltham, of Wilmington, N. C., which had gone ashore on the east bank of the West Pass. Similar service was afforded from the Vixen to the mail steamer Galveston in June, when grounded on the east side of the entrance to Apalachicola harbor.

Tidal observations.—The self-registering gauge established at Cedar Keys for recording observations simultaneous with those made at Egmont key, Charlotte harbor, and Tortugas,
has been kept in working order, and has given satisfactory results. The gauges were attended
to by Mr. Gustavus Würdemann, who devoted to them his usual care and attention.

I am indebted to S. Thayer Abert, esq., civil engineer at Warrenton navy yard, for the
records of a self-registering gauge, the charge of which he kindly undertook when it was set
up at that station. Through the interest taken by that gentleman in the subject, the records,
as received at the office, have been found highly satisfactory.

As intimated under the head of Section VI, a series of stations are about to be established
from St. Mark’s westward, along the shores of St. George’s sound, and extending as far as
Cedar keys to the eastward. By these it is expected that the anomalies noticed in the tides of
this part of the Gulf coast may be fully developed.

SECTION VIII.

FROM MOBILE BAY TO VERMILION BAY, INCLUDING THE COAST OF THE STATE OF MISSISSIPPI AND
PART OF THE COAST OF LOUISIANA.—(Sketch H, No. 26.)

Two triangulation and topographical parties, one a double party, one topographical party,
and one hydrographic party, have been occupied in this section, and their progress is described
in the following chapter under the heads of—
1. Triangulation and topography of Isle au Breton sound, La.
2. Triangulation of the Mississippi delta, La.
3. Triangulation of West Côte Blanche bay, La.
4. Topography of Lake Pontchartrain, La.
5. Topography of the Mississippi delta, La.
6. Topography of West Côte Blanche bay, La.
7. Soundings in the Rigolets, La.
8. Hydrographic reconnaissance of Pass à l’Outre, Mississippi delta.

Office-work.—The preliminary chart of Atchafalaya bay has been drawn and engraved, and
the engraving of coast maps and charts Nos. 91 and 92, Mississippi sound and Mobile bay,
from Bon Secours bay to Grand island, has been in progress.

Triangulation and topography of Isle au Breton sound, La.—Connecting with stations of the
primary triangulation westward of Mississippi sound, others have been occupied suitable for
carrying a branch southward from the general series of triangles, so as to include the survey
of Chandeleur sound and that of Isle au Breton sound. This duty was intrusted to Sub-Assist­
ant Stephen Harris, and has been successfully accomplished, as will be seen by the plan given
on Sketch No. 26, the triangulation now extending as low down as Point Fortuna, or within
twenty miles of the Mississippi river.

In order to join properly with the completed range of triangles resting on Lake Borgne, Mr.
Harris was directed to reoccupy the station Nine Mile Bayou, which had been used in the
primary work, but the granite block placed there as a mark in 1852 could not be found. The
shell bank in which it was then fixed had in the interval been removed as material probably
for roads. After making a reconnaissance to the southward with the schooner Twilight, Mr.
Harris resumed the triangulation at station Sand Fly early in December. In passing towards
Isle au Breton sound, numerous tertiary points were marked and plotted on a plane-table sheet,
on which was afterwards traced in a large portion of the irregular shore-line forming the
western side of Chandeleur sound. This was done with the plane-table at intervals which
would not admit of observations on the longer lines of the triangulation. The work being in that manner completed some distance southward, the vessel was moved to Isle au Breton sound for more convenient access to the stations remaining to be occupied. In addition to the angular measurements in that vicinity and others at stations connecting with the triangulation of Chandeleur sound, a second plane-table sheet, commenced in 1857, was completed in the course of the season which closed in the latter part of May.

The reconnaissance made by Sub-Assistant Harris extended over an area of about two hundred and thirty square miles. He thus reports the statistics of the triangulation:

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stations occupied</td>
<td>12</td>
</tr>
<tr>
<td>Signals erected and stations marked</td>
<td>28</td>
</tr>
<tr>
<td>Objects observed on</td>
<td>41</td>
</tr>
<tr>
<td>Angles measured</td>
<td>110</td>
</tr>
<tr>
<td>Number of observations</td>
<td>1,770</td>
</tr>
<tr>
<td>Area of triangulation, (square miles)</td>
<td>180</td>
</tr>
</tbody>
</table>

The Würdemann theodolites, ten inch, No. 79, and six inch, No. 84, were used at the stations. One hundred and fifteen miles of shore-line were traced and marked on the two plane-table sheets.

Great care was taken in regard to the triangulation points; and in reference to the means most proper for their preservation, Mr. Harris observes: "Having noticed the causes which led to the destruction of some of the stations, I adopted precautions in the following particulars: 1. The selection of stable ground not likely to be exposed to the action of water. 2. The use of a number of marks for each station, situated at such distances from each other and under such different circumstances, as to make it unlikely that all will be displaced by the same cause. 3. Distinguishing and determining each mark so that it may be recognized and its position known in case of the loss of all the other marks at the same station. 4. Making all the marks entirely separate from the observing tripods and scaffolds."

Full descriptions of the stations and signals used this season, and of the marks placed to identify them, have been made by Mr. Harris and placed in the office. He has also turned in his computations and records of the previous year.

The field operations of the party were aided by Mr. R. E. Halter, who executed the greater part of the plane-table work, and by Mr. H. W. Bache. After his return to the office, Sub-Assistant Harris engaged in the computations depending on the work of the season.

**Triangulation of the Mississippi delta, La.**—In continuation of the work in this quarter, Assistant F. H. Gerdes resumed operations at the opening of the year, and prosecuted the survey of the delta until the middle of March. He was assisted by Sub-Assistant J. G. Oltmanns and Mr. G. U. Mayo. After replacing and determining the positions of the signals displaced by recent storms, Mr. Gerdes reoccupied six of the secondary stations, and connected with the general scheme of triangles a number of tertiary points suitable for the plane-table survey of Southeast Pass, Pass à l'Outre, the North Pass, the mud flats in that vicinity, and Robinson's reef, together with the shores of Bay Rondo, and the banks of the Mississippi at the head of the passes. The plan of the work, as far as executed, may be seen by reference to Sketch No. 28. Notice of the topographical survey will be taken in a subsequent part of this chapter.
The statistics of the triangulation are as follows:

<table>
<thead>
<tr>
<th>Signals erected</th>
<th>29</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stations occupied</td>
<td>12</td>
</tr>
<tr>
<td>Angles measured</td>
<td>74</td>
</tr>
<tr>
<td>Number of observations</td>
<td>1,264</td>
</tr>
</tbody>
</table>

In my report of last year allusion was made to the difficulty of finding localities on the delta in which the station-marks could be secured. Assistant Gerdes reports that the peculiar obstacles arising from the nature of the surface increase on advancing towards the outlets, the soil being too unstable to admit of any ordinary expedients for guarding against their removal or displacement. Though insufficient in number and in their distribution as points for future reference, the light-houses and a few buildings with cupolas, being determined in position and connected with the triangulation, in some measure lessen the natural disadvantages under which the survey is advancing in this part of the section.

On closing for the season at the delta, Assistant Gerdes transferred his party to Pensacola, and took up the survey in that vicinity, described under the head of Section VII.

In the course of the summer the records of the triangulation of the delta were duplicated and turned in, with abstracts of the measurements for secondary and tertiary work.

*Triangulation of West Côte Blanche bay, La.*—Towards the end of March Sub-Assistant Oltmanns having reached his working ground, in the schooner Gerdes, from the delta of the Mississippi, where he had been occupied during the winter in the party of Assistant Gerdes, placed himself in communication with the hydrographic party, and furnished the data necessary for sounding out the western part of Atchafalaya bay. On taking up the triangulation it was found that nearly all of the stations westward of Point au Chevreuil had been disturbed by natural causes. Some of the stations which had been marked with the usual care were entirely lost, and neither of the blocks placed to distinguish the ends of the base on Point au Chevreuil could be found. Mr. Oltmanns resumed work at the line Marsh island, North —— Point Malone, (Sketch No. 26,) and extended the triangulation over the greater part of West Côte Blanche bay, including also Côte Blanche island. All the stations were well secured by screw piles, or by surrounding marks deemed sufficient for their preservation.

One of the hindrances to progress in the prosecution of the survey on this part of the coast arises from the shoaling of the water in going westward. The bay, however, narrows in that direction, and Sub-Assistant Oltmanns reports, as the result of his reconnaissance, that the triangulation may, with lessening difficulty, be carried into and across Vermilion bay.

The following is a synopsis of the field statistics:

<table>
<thead>
<tr>
<th>Stations erected</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stations occupied</td>
<td>7</td>
</tr>
<tr>
<td>Points determined</td>
<td>12</td>
</tr>
<tr>
<td>Angles measured</td>
<td>31</td>
</tr>
<tr>
<td>Number of observations</td>
<td>289</td>
</tr>
</tbody>
</table>

The work in Côte Blanche bay was discontinued for the season on the 1st of May. In its progress Mr. Oltmanns provided means for executing the plane-table survey, which will be referred to presently.
The observations and computations resulting from them have been furnished in detail for the records of the office.

*Topography of Lake Pontchartrain, La.*—Steady progress has been made in pushing the plane-table survey westward from the connection between Lake Borgne and Lake Pontchartrain. Sub-Assistant W. S. Gilbert proceeded from his former limits in that quarter on the 17th of January, and laid out two sheets to contain the features of the northern shore of Lake Pontchartrain. Two others were at the same time projected for extending the work along its southern shore westward from Chef Menteur. On the most eastern of these the shore-line and adjacent features of the north side of the lake were filled in beyond Bayou Bonfouca, the lower part of that bayou and its branches being also followed and included with the topographical details. Further westward, (Sketch No. 26,) and on the same side, the shore-line was traced as far as Ragged Point. The line of woods ranging with the water line was chosen as the limit for the minute survey.

From Chef Menteur, on the southern side of Lake Pontchartrain, the detailed work was continued southward and westward to Little river, and in the same direction the shore-line survey extended to the Jefferson railroad. The limits of the several sheets are marked on the progress sketch No. 26, on which is also shown the line of junction with the work of last season.

In prosecuting the survey on the north shore of the lake, it was found, in many cases, necessary to build stations for the plane-table, the ground passed over being soft marsh. With regard to its general character, the remarks made in my previous annual reports, in reference to the district between Lakes Borgne and Pontchartrain, apply also to the tract under notice.

The following are aggregates of the outline and detailed work of this season:

- Shore-line surveyed .......................................................... 164 miles
- Area of topography, (square miles) .................................. 49

Sub-Assistant Gilbert was aided during the early part of the year by Mr. R. E. Evans. The field-work was continued until the 15th of June, and the latter part of the summer occupied by Mr. Gilbert in inking his sheets.

*Topography of the Mississippi Delta, La.*—While engaged in the triangulation, Assistant F. H. Gerdes projected a plane-table sheet for the survey of Bay Rondo and the northern part of the delta, and determined the points necessary for filling in the details. About two-thirds of the area intended to be represented now appears on the sheet, progress on which was made as the triangulation advanced. Both shores of the Mississippi at the head of the passes, and from thence eastward the shores of the main outlet, with its two branches, the Southeast Pass to the Belize, and the entire course of Pass à l'Outre, were surveyed. The sheet, as marked on Sketch No. 26, contains also the mud flats in the vicinity of the North Pass, part of the details of the system of lagoons existing to the westward of it, and those of Robinson's reef, on the north side of Bay Rondo.

Mr. Gerdes thus remarks on the local characteristics of the eastern part of the delta:

"With the exception of the Gulf shore, which, north of the delta, is open and composed partly of beach and hard marsh, the plane-table could be nowhere used, the cane and reeds growing so high as to prevent any sight for sketching in the details. In making the topographical survey, flags of distinctive shape or color were placed at each turn of the river and
its outlets, and their positions determined from two trigonometrical stations by the theodolite or sextant. At one reach several miles of the stream were surveyed by means of a signal hoisted on a boat and moved from point to point as occasion required, according to the method proposed by Mr. Norris. So far as opportunity has offered for verification, the details thus obtained have been found correct."

The unfinished portions of the sheet will contain the survey of some interior lakes, small bays, and bayous adjacent to the main eastern outlet of the delta. Of the work done, the following is a summary of statistics:

- Gulf shore surveyed .................................................. 16 miles
- River shores surveyed ............................................... 53 "
- Shore line of bays and bayous ...................................... 51 "
- Area, (square miles) .................................................. 50

Sub-Assistant J. G. Oltmanns and Mr. G. U. Mayo aided in the triangulation and topography.

Assistant Gerdes found advantage in his labors at the delta through the interest manifested by the inhabitants generally in regard to the progress of the survey. He acknowledges also the facilities and assistance rendered to his party by the Pilot Association of the Belize.

Part of the plane-table duty conducted by Mr. Gerdes has been noticed with the work done in Section VII.

Topography of West Côte Blanche bay, La.—Following his own triangulation of this season, Sub-Assistant Oltmanns surveyed the shore which fell within its limits, as shown on Sketch No. 26, and included also the northeastern part of Marsh island. The plane-table sheet contains an aggregate of about forty-eight miles of shore-line.

An extract from the report of Mr. Oltmanns, descriptive of the topographical features of the vicinity of Côte Blanche bay, is here appended:

"The shores are all very marshy, excepting those of Côte Blanche island. Marsh island is so soft and swampy that the utmost care must be taken in setting up an instrument. Its shores are subject to frequent and rapid changes. Of late years the island has been cut through in several places, and the interior lakes and bayous are changed or enlarged by almost every storm."

"The northern shore of the bay, from Côte Blanche about two miles eastward, and westward about eight miles, or as far as Dead Cypress Point, consists of hard clay and is very little broken."

"Côte Blanche island, like Belle Isle, is one of those remarkable formations of firm land standing out at intervals along this part of the coast of Louisiana from surrounding marshes. It is about a hundred and twenty feet high, and contains an area of, perhaps, two thousand acres of land, on which are raised sugar-cane, cotton, and tobacco."

Having passed the working season at two localities in this section, Mr. Oltmanns sailed for Pensacola, and, after reporting to Assistant Gerdes, proceeded eastward with the vessel and reached New York on the 12th of June.

Soundings in the Rigobets, La.—At an interval in his plane-table duty, in February, Sub-Assistant W. S. Gilbert thoroughly sounded out the entire course of the principal passage from Lake Borgne to Lake Pontchartrain, and kept records of the tides while his party was so engaged. Specimens of the bottom were taken on most of the traverse lines, so as to supply full information in regard to the character of the bed of the channel. The tidal
observations developed only a slight variation in the water level, amounting in rise to no more than seven inches in twenty-four hours, and often only four inches and a half. A strong current at that time passed constantly out of Lake Pontchartrain during both rise and fall of the tide.

*Hydrographic reconnaissance of Pass à l'Outre, Mississippi delta.*—The party of Lieut. Comdg. T. B. Huger, U. S. N., Assistant Coast Survey, arrived at the delta on the 15th of May, having been previously employed with the steamer Walker in the western part of the section. A tide-gauge was at once set up at the revenue station and a careful reconnaissance made of the entire course of the Pass à l’Outre from its head, in the Mississippi, to the bar. The vessel then proceeded eastward, taking a line of deep-sea soundings across the Gulf in the direction to Havana.

The reduction from the chart of soundings made in Pass à l’Outre, under the direction of Lieut. Comdg. Huger, comprises also the plane-table work executed by Assistant Gerdes.

The hydrographic statistics are as follows:

- Miles run in sounding: 514
- Angles determined: 343
- Number of soundings: 1,719

*Hydrography of Atchafalaya and Côte Blanche bays, La.*—The hydrography of Atchafalaya bay has been completed by supplementary soundings carried westward from the limit reached last year by the party in the steamer Walker. In order to facilitate his operations, the draught of the vessel not admitting of her general use in sounding, Lieut. Comdg. Huger established a camp about sixteen miles distant from his anchorage, at the entrance of Bayou Salé, Côte Blanche bay, or nearly midway between Point au Chevreuil and Point Malone, (see Sketch No. 23.) A second party was detailed to work from the ship. Under this arrangement, after joining on the line to which the work had been extended by Commander B. F. Sands, and setting the necessary signals and tide-gauges, the soundings were continued westward into Côte Blanche bay, with only the impediments due to the frequent recurrence of bad weather. The two divisions of the party were occupied in this duty between the 27th of January and the 14th of May, the latter part of that interval being devoted to the hydrography of the approaches to Atchafalaya bay.

A summary of statistics derived from the records turned in by Lieut. Comdg. Huger is given below:

- Miles run in sounding: 743
- Angles measured: 2,539
- Casts of the lead: 69,447

The soundings in this part of the section now include the whole of the Atchafalaya and Côte Blanche bays east to the line joining East Point, on Marsh island, and Point Malone.

Before the close of his connection with the survey, at the end of last year, Commander Sands turned in the original sheet and journals of the soundings, angles, and tidal and current observations pertaining to the final service of his party in Atchafalaya bay. The chart containing the results of the present season, with the original note-books and hydrographic records, have been received from Lieut. Comdg. Huger.
In returning from this section the deep-sea line was used by the party in the steamer Walker for Gulf soundings between the Mississippi delta and Key West, and in verifying soundings made last year between the Tortugas and Havana.

SECTION IX.

FROM VERMILION BAY TO THE BOUNDARY AT THE RIO GRANDE, INCLUDING PART OF THE COAST OF LOUISIANA AND THE COAST OF TEXAS.—(Sketch I, No. 28.)

The following operations have been in progress by the parties in this section:
1. Triangulation of Espiritu Santo, San Antonio, and Aransas bays, Texas.
2. Topography of Espiritu Santo and San Antonio bays, Texas.
3. Hydrography of Matagorda bay, Texas.

Office-work.—The reconnaissance sketch of the entrance to Brazos river has been drawn and engraved, and progress has been made in the drawing and engraving of coast maps and charts Nos. 106 and 107, from Galveston bay to Matagorda bay; also in the drawing of coast maps and charts No. 105, Galveston bay, and No. 108, Matagorda bay. A general reconnaissance sketch of part of the coast of Texas, from Matagorda bay to Aransas Pass, has been drawn at the office, and was engraved on stone, under the direction of the Superintendent of Public Printing.

Triangulation of Espiritu Santo, San Antonio, and Aransas bays, Tex.—The experience of previous seasons on the coast of Texas having indicated the opening of the calendar year as the most favorable period for taking up field operations. Assistant S. A. Gilbert organized a party and reached the limit of his completed triangulation, to the southward of Matagorda bay, on the 5th of January. For the extension of the work towards Aransas Pass, a close reconnaissance had been made, as stated in my last annual report, which was accompanied by a reduction from the resulting sheet, marked as Sketch No. 28. Such of the signals then erected as required adjustment were properly secured, and others were set to replace those which had been destroyed by accidents of the weather in the course of the preceding year. The scheme fixed on for the triangulation took in the lower part of Espiritu Santo bay, the shores of San Antonio bay, including its upper waters, known as Mission bay and Hines bay; in connection with it, to the southward and westward, Mezquit bay, and beyond that, in the same direction, the shores of Aransas and Copano bays with their dependencies. These several bodies of water are formed, as may be seen on the progress sketch No. 28, by the intervention of Matagorda island and St. Joseph's island between the main coast of Texas and the Gulf of Mexico. The most eastern of the stations occupied for the triangulation range along the outer or Gulf shore of the two islands just named, the lines from them crossing the several bays before enumerated, and terminating at stations on the main.

Assistant Gilbert continued in the field until the 9th of June, having then pushed the triangulation about forty-eight miles southward and westward from the starting point in Espiritu Santo bay. A summary given in his report shows the following statistics of work done within the season:

| Stations occupied | 32 |
| Points determined in position | 66 |
| Angles measured | 180 |
| Number of observations | 3,392 |
The triangulation covers an area of about six hundred and fifty square miles. Some of the requisite signals were erected, and a partial reconnaissance made for continuing the work over Corpus Christi bay; but the summer winds set in so strong before the party was disbanded as to render further progress in triangulation impracticable for the present year.

Mr. Gilbert was efficiently aided in the field by Mr. Charles Hosmer, who also rendered good service in making computations of the results, and in duplicating the records of the observations, all of which have been turned in at the office.

The following reference is made in the season's report to the general features of the site of work: "The character of the country we were engaged upon is more diversified than any other portion of the coast of Texas over which my operations have yet extended. Low sandy islands, varying from one to four miles in breadth, stretch along the Gulf coast, with sand hills upon them from ten to forty feet in height. These range along the outer shore, and occupy a space from a quarter to half a mile in width. A fine prairie, averaging three-quarters of a mile in breadth, slopes gradually to the marsh and bare sand flats that form the bay shores. The islands afford an excellent range for cattle, sheep, and horses, there being amongst the sand hills and in the sinks of the prairie an abundance of fresh water, except in the dry season of the year. During all seasons fresh water may be had by digging anywhere among the sand hills, or in the high prairie, in the strata immediately above the level of the surrounding salt water."

"The sheets of water lying between these islands (Matagorda and St. Joseph's) and the main are divided by chains of other islands, by oyster shell reefs, or by the configuration of the shores, into four large bays: Espiritu Santo, San Antonio, Copano, and Aransas bays; and six smaller: Mission, Hinos, Mezquit, St. Charles, Refugio Mission, and Puerto bays."

Of each of these a general description is contained in the report of Assistant Gilbert, extracts from which will be found in the Appendix. (No. 32.) I must here commend the character of this report, which is so well adapted to the circumstances of the country through which Mr. Gilbert's work was carried.

The original journals containing the notes of horizontal angles and an abstract of the geographical positions determined by the triangulation, have been received at the office.

**Topography of Espiritu Santo and San Antonio bays, Tex.**—The plane-table work in this section was prosecuted by a party in charge of Sub-Assistant W. H. Dennis. After completing the survey of the city of Indianola, as supplementary to one of the sheets executed last season by Sub-Assistant M. Seaton, Mr. Dennis moved his party to Matagorda island, and there joined with the topographical limits of Assistant Gilbert, who, as already stated, has been more recently engaged in pushing the triangulation of the coast of Texas towards Corpus Christi. Of the three plane-table sheets projected by Mr. Dennis, two were entirely filled and the other partly completed. These include a stretch of twenty miles coastwise, and represent the whole breadth of the middle parts of Matagorda island, the shores of the lower part of Espiritu Santo bay, Mission and Hind's bays, and the shores of the greater part of San Antonio bay, with the mouth of its principal tributary, the Guadalupe river. The limits of the several sheets are marked on Sketch No. 28. In general, the surface of the country passed over by the party favored operations with the plane-table, the marsh being tenable, and the fast land mostly level prairie. The only impediment found is thus alluded to in the season's report: "The survey of Mission bay, with the point extending from it into San Antonio bay, was attended with some difficulty, the shores being covered with canebreak some twenty feet high and nearly
impenetrable." Sub-Assistant Dennis took the field on the 15th of December, and closed work on the 30th of May. A summary of the plane-table statistics is appended:

<table>
<thead>
<tr>
<th></th>
<th>Miles of shore line.</th>
<th>Miles of bayous, ponds, &amp;c.</th>
<th>Miles of marsh line.</th>
<th>Miles of roads.</th>
<th>Area, square miles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indianola and vicinity</td>
<td>4.0</td>
<td>1.5</td>
<td>7.0</td>
<td>4.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Sheet No. 1</td>
<td>84.3</td>
<td>69.0</td>
<td>62.0</td>
<td>5.6</td>
<td>43.0</td>
</tr>
<tr>
<td>Sheet No. 2</td>
<td>42.5</td>
<td>19.0</td>
<td>13.0</td>
<td>8.0</td>
<td>38.0</td>
</tr>
<tr>
<td>Sheet No. 3</td>
<td>12.5</td>
<td>21.7</td>
<td>17.5</td>
<td>1.8</td>
<td>12.0</td>
</tr>
</tbody>
</table>

|                | 143.3                | 111.2                       | 99.5                 | 18.0            | 96.0                |

Mr. T. C. Bowie served as aid in the topographical party.

The report of Sub-Assistant Dennis contains the following remarks relative to the natural features presented on the shores of San Antonio bay: "There is very little timber land within the limits of the work of this season, excepting on the banks of the Guadalupe river, which has a narrow strip of oak, cedar, etc., on either side. The water at the mouth of that river is fresh, and when the stream is high the fresh water extends nearly to the first chain of islands. The mouth of the Guadalupe has been dredged out, and a channel has been made through the first chain of islands, by which a steamer from Indianola regularly passes to a landing forty or fifty miles up the river."

Sub-Assistant Seaton has inked and placed in the archives the sheets containing his surveys of last year on the shores of Lavaca, Garcitas, and Chocolate bays. The supplementary sheet showing the vicinity of Indianola has also been turned in.

In July Sub-Assistant Dennis was assigned to topographical duty in Section I.

Hydrography of Matagorda bay, Tex.—It has been mentioned in a previous chapter that the hydrographic work allotted to be done in this section was assigned for the latter part of the working season to the party of Lieut. Comg. J. K. Duer, U. S. N., Assistant Coast Survey, the former part being occupied in Section VII. The steamer Vixen, in accordance with this arrangement, arrived at Matagorda on the 19th of April, and at once took up work on the inside of the peninsula, in the immediate vicinity of the city, and between that date and the 3d of June sounded out the portion of the bay which is comprised between lines crossing from the peninsula to the main at Matagorda and Palacios Point. The reach referred to is about sixteen miles in length, by nearly five in average breadth.

Sketch No. 28 shows its location, and the limits of the sheet containing the hydrography.

This work was done under the direction of Mr. A. W. Muldau, in the absence of Lieut. Comg. Duer, who returned to Section VII immediately after the arrival of the party in Section IX, and died at Apalachicola on the 14th of June, as already stated. The particulars in regard to this untimely event, and the measures taken for the subsequent disposal of the party and vessel, have also been mentioned.

A summary furnished by Mr. Muldau at the end of the season gives the following statistics of work executed in Matagorda bay:

- Miles run in sounding: 451
- Angles determined: 919
Number of soundings ................................. 33,135
Tidal stations occupied .................................. 3

The sheet embracing the hydrography here referred to has been received at the office in
Washington.

SECTION X.

WESTERN COAST OF THE UNITED STATES, FROM SAN DIEGO NORTHWARD TO THE FORTY-SECOND
PARALLEL, INCLUDING THE COAST OF THE STATE OF CALIFORNIA.—(Sketches J and J bis, Nos.
30 and 31.)

The usual number of parties has been employed in this section, and their progress is described
under the following heads:

1. Primary triangulation near San Pedro, Cal.
2. Triangulation of Santa Rosa island, Cal.
3. Triangulation and topography of San Pedro harbor, Cal.
4. Primary and secondary triangulation north of San Francisco, Cal.
5. Latitude and azimuth.
6. Triangulation of Crescent City harbor, Cal.
7. Topography of Santa Cruz island, Cal.
8. Topography of Crescent City harbor, Cal.
9. Hydrography of San Pedro harbor, Cal.
10. Soundings off the Golden Gate entrance to San Francisco bay, Cal.
11. Resurvey of Humboldt bay, Cal.
12. Hydrography of Crescent City harbor, Cal.
13. Tidal observations.

The primary work, which for some years has not made progress proportional to its former
development, has this year been placed in the hands of Assistant George Davidson, whose well-
known zeal, and energy, and skill have all been shown in its prosecution, so that the advance
has been entirely satisfactory, under difficulties which have required all his resources to sur-
mount.

The resurvey of San Pedro and Crescent City harbors was called for in consequence of the
improvements made or contemplated in those localities and in the back country which finds
access to the sea at those ports.

Office-work.—The engraving of the charts of San Diego bay, the entrance to San Francisco
bay, Mare Island straits, and Humboldt bay, has been finished. Progress has been made in
the engraving of the chart of San Pablo bay, and additions have been made to the sheets of
Alden’s reconnaissance of the Western Coast. The map of San Francisco city has been en-
graved on stone, under the direction of the Superintendent of Public Printing.

Primary triangulation near San Pedro, Cal.—In adjusting the triangulation along the coast of
the Santa Barbara channel, it was found necessary to reoccupy several of the stations con-
necting with the preliminary base measured near San Pedro. This duty was performed by
Assistant W. E. Greenwell, between the 5th of November, 1858, and the 6th of March fol-
lowing.

The revised triangles are laid out on Sketch No. 30. On being tested in the usual way they
were found to close within the limits allowed for general accuracy.
A synopsis of the statistics is appended:

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals erected</td>
<td>8</td>
</tr>
<tr>
<td>Stations occupied</td>
<td>6</td>
</tr>
<tr>
<td>Number of observations</td>
<td>2,268</td>
</tr>
</tbody>
</table>

The horizontal angles were measured with the eight-inch Gambey theodolite, C. S. No. 44.

Mr. Greenwell used the schooner Humboldt for this and other service performed in the section.

Duplicates of the notes of horizontal angles observed in the primary work of last year have been furnished for the records of the office.

**Triangulation of Santa Rosa Island, Cal.**—This work was commenced by Assistant Greenwell on the 8th of June, by the measurement of a short base on the northern part of the island, the location of which may be seen by reference to Sketch No. 30. The triangulation, as far as completed at the end of August, embraces the northern half of the area of Santa Rosa, and the work was then in active progress. Strong northwest gales prevailed between the dates mentioned, tending very much to retard the advance of field operations.

A summary of the statistics is thus given in the report of Mr. Greenwell:

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals erected</td>
<td>13</td>
</tr>
<tr>
<td>Stations occupied</td>
<td>8</td>
</tr>
<tr>
<td>Number of observations</td>
<td>1,120</td>
</tr>
<tr>
<td>Area of triangulation, (square miles)</td>
<td>18</td>
</tr>
</tbody>
</table>

The schooner Humboldt was in the service of the party at Santa Rosa island.

Assistant Greenwell has sent in duplicates of the observations recorded in the triangulation of San Miguel and San Nicolas islands, and notes of the measurement of the preliminary base on Santa Cruz island.

**Triangulation and topography of San Pedro harbor, Cal.**—This duty was executed by Sub-Assistant W. M. Johnson, and the data necessary for the hydrography furnished to Commander Alden.

The scheme of triangulation laid out to include the shore of the harbor at San Pedro is shown on Sketch No. 30. With the view of following at once with the plane-table survey the necessary points were determined while the preliminary work was going on. Mr. Johnson then projected a sheet and pushed on the topography to completion. The sheet containing his survey embraces an area of about thirteen square miles, over sixty miles of shore-line, and nineteen miles of roads.

Sub-Assistant C. M. Bache was attached to the party.

The triangulation embraced nine triangles within an area of fifteen square miles. Four hundred and eighty-six observations were made in the measurement of angles.

**Primary and secondary triangulation north of San Francisco, Cal.**—This work and the astronomical observations connected with it were taken in charge by Assistant George Davidson on the 14th of November, 1858, immediately after his return to the Western Coast. In the primary triangulation Table mountain, a precipitous height which rises from the shore of Ballenas bay, and Sulphur Peak, a high mountain well up the course of Russian river on its eastern side, were occupied as stations with the theodolite, and horizontal angles measured so as to complete, with the exception of Ross mountain station, the coast series of triangles from Monterey and over San Francisco bay to the last-mentioned point, the position of which may
be seen on Sketch No. 31. At Mount Diablo, one of the primary stations in the general scheme and in immediate connection with Table mountain, the labor and expense of transporting a solid signal to the summit, which is 3,800 feet above the nearest dwelling, were obviated by Mr. Davidson, who thus describes the expedient employed for that purpose: "The signal was constructed at San Francisco, and consisted of six pieces of two-inch Oregon pine fitted to six appropriate inside bearings, so that, when put together, the whole presented externally the appearance of the frustrum of a cone thirty-five feet high, with a diameter of fifteen inches at the base and ten at the top. The separate pieces and their bearings, being previously provided with screws, were carried up the mountain and fastened together in half an hour. Stout iron bands were driven on to bind all the pieces firmly together, and the hollow shaft was then set and secured in its proper position. Even with the advantage of the method employed, the handling of the parts of the signal in passing to the summit proved to be very hard labor. If the cañadas of the mountain side had afforded a solid piece of timber of similar outside dimensions, no available power could have taken it up." Vertical angles were measured from the station on Table mountain, and also from that on Sulphur Peak.

Ross mountain, which lies near the coast and a few miles north of the mouth of Russian river, will be occupied next in order by the party of Assistant Davidson.

The secondary and tertiary triangulations, extended this season over Drake's bay and Point Reyes are also shown on Sketch No. 31, and from Table mountain, Point Reyes Hill, and Point Reyes Head, horizontal angles were measured to determine the positions, extent, and heights of the islets which form the middle and north groups of the Farallones.

The reconnaissance necessary in advance of occupying stations for the primary and secondary work was made by Mr. E. H. Fauntleroy, one of the aids in the party. At the date of Assistant Davidson's report Mr. Fauntleroy, in conjunction with Mr. A. T. Mosman, who was detailed as an aid to this party in June, were reconnoitering the tract lying northward and westward of Sulphur Peak. The privations to be borne in the performance of such duty over a country naturally wild and rugged, and totally devoid of facilities for travel, are very great. The labors of the triangulation party in pushing the work to its present limit, as set forth in the report of Mr. Davidson, have been attended with unusual hardships and difficulties.

The following is a synopsis of the season's progress in triangulation:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of signals erected</td>
<td>18</td>
</tr>
<tr>
<td>Primary stations occupied</td>
<td>2</td>
</tr>
<tr>
<td>Secondary and tertiary stations occupied</td>
<td>5</td>
</tr>
<tr>
<td>Horizontal angles measured</td>
<td>73</td>
</tr>
<tr>
<td>Vertical angles</td>
<td>15</td>
</tr>
<tr>
<td>Observations for horizontal angles</td>
<td>4,624</td>
</tr>
<tr>
<td>&quot; vertical &quot;</td>
<td>1,348</td>
</tr>
</tbody>
</table>

Work in the field was carried on from the 10th of January until the close of September.

Latitude and azimuth.—The latitude of Sulphur Peak primary station was determined by Assistant Davidson by three hundred and thirty-one observations on ninety-four stars; and the azimuth at that point and at Table mountain by five hundred and sixty-four observations. At the same stations three hundred and one observations were recorded for local time, and ninety-eight at Sulphur Peak for determining the value of the micrometer threads.

Observations were made at Table mountain for ascertaining the reading of the level scale.
divisions of the vertical circle No. 80. Those of the levels A and B of zenith telescope No.
3, and of level A of transit No. 2 were determined at Sulphur Peak by using the vertical
circle No. 28, and a hundred and sixty-two observations were made for that purpose.

In the ensuing season Ross mountain will be occupied as an astronomical station.

Meteorological journals were kept while the party was employed in the field.

Ten volumes, containing the original records of the triangulation and astronomical observa-
tions, and seven others, duplicates of the same, have been received from Mr. Davidson. His
computations depending on the original notes of the work have been completed.

The journals kept by Assistant G. A. Fairfield while the work north of San Francisco was
under his charge have been filed at the office.

_Triangulation of Crescent City harbor, Cal._—This duty was executed under special directions
in April, by the party of Sub-Assistant J. S. Lawson, before taking up the general field-work
to which it had been assigned in the adjoining northern section. A preliminary base was laid
out in front of Crescent City and measured twice with a twenty-metre chain, previously
adjusted for that particular purpose. The measurements gave a mean result of 1,018.6 metres
for the length of the line. Stations were then erected at intervals along the coast from a
point a mile west of the light-house to another four miles to the eastward of Crescent City,
and on all the prominent rocks in the harbor. Twelve signals were set up and sixty objects in
all observed on in determining the angles. In addition to these, readings were taken on a
hundred and fifty objects, the results of which, as determining them in position, were computed
at once and plotted for use in the topographical survey. Sketch No. 31 gives a plan of the
completed triangulation. The following is a synopsis of the statistics:

<table>
<thead>
<tr>
<th>Stations occupied</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angles measured</td>
<td>75</td>
</tr>
<tr>
<td>Number of observations</td>
<td>1,176</td>
</tr>
</tbody>
</table>

The six-inch Gambey theodolite, C. S. No. 21, was used in measuring the angles. Mr.
Alexander Agassiz served as aid in the party, which was charged also with the plane-table
survey of Crescent City harbor.

A duplicate of the record of horizontal angles observed by Sub-Assistant Lawson is now on
file at the office.

_Topography of Santa Cruz island, Cal._—The survey of this island was resumed by Sub-
Assistant W. M. Johnson, after completing field-work at San Pedro, of which notice has already
been taken in the former part of this chapter, and has been prosecuted along the north shore
so as to include Prisoner's harbor and Chinese harbor, with only such interruptions as are
incident to its exposed position. The report of Mr. Johnson states that there are but three
places on the island available as centres for working, by reason of the great difficulty of pro-
curing wood and water, and that great impediments are found in the violent northwest winds,
which set in daily at 10 a. m. during summer and continue until sunset. The progress made
is shown in the following statistics:

<table>
<thead>
<tr>
<th>Shore-line traced</th>
<th>35½ miles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads surveyed</td>
<td>18½ &quot;</td>
</tr>
<tr>
<td>Area of details, (square miles)</td>
<td>16</td>
</tr>
</tbody>
</table>

Sub-Assistant C. M. Bache assisted in the survey.

The position of Santa Cruz island is shown on Sketch No. 30.
Topography of Crescent City harbor, Cal.—The triangulation requisite for the plane-table survey and hydrography was made, as already stated, by Sub-Assistant J. S. Lawson, in April. Having provided a sufficient number of points, Mr. Lawson traced, in the shore-line of the harbor and the adjacent coast from Hall’s bluff west of the light-house, as seen on Sketch No. 31, to the eastern limit of the triangulation, or about four miles eastward of Crescent City.

"Especial care was taken to determine the position of every rock bare at low water. Between Battery Point and Preston’s island many of the plane-table stations were reoccupied as near the time of low water as possible, for securing accuracy of details in that respect."

A tracing from the working sheet was promptly made and furnished to the hydrographic party of Commander Alden. The original was soon after inked and sent to the office with the following memorandum of statistics:

- Shore-line surveyed: 8.2 miles.
- Roads: 3.5 miles.
- Area of details (square miles): 1.7

After completing the survey at Crescent City the party returned to San Francisco, and at the usual period of the year sailed with the brig Fauntleroy to carry out the general instructions for work in Section XI. Sub-Assistant Lawson was accompanied by Mr. Alexander Agassiz as aid.

Hydrography of San Pedro harbor, Cal.—As part of the regular work of the season, the anchorage at San Pedro and its vicinity were sounded out anew by the party of Commander James Alden, U. S. N., assistant Coast Survey, with the steamer Active. Sketch No. 30 shows the limits of the sheet, which was projected so as to include the hydrography of the approach eastward and southward by Point Fermin.

The resulting chart (Sketch No. 32) verifies the soundings made in the reconnaissance of 1852, and in reference to it Commander Alden says: "The bar at the entrance to the creek remains about the same. At mean low water, throwing out the half tides, only two feet of water can be carried over it. The steamer Active could go in easily at high water."

Sub-Assistant Johnson traced the shore-line for the use of the hydrographic party.

The following is a summary from the journals of soundings and angles:

- Miles run in sounding: 209
- Angles measured: 1,208
- Casts of the lead: 5,866

Soundings off the Golden Gate, entrance to San Francisco bay, Cal.—At favorable intervals during the winter of 1858-'59 the hydrography outside of San Francisco bar was executed by the party of Commander Alden, with the surveying steamer Active. The work was extended about thirty miles abreast of the entrance, as measured from Point Reyes southward and eastward along the line of junction with the soundings carried from the inside of the bar in 1854. From the bar, broad off to seaward, the hydrography now extends about twenty-five miles westward, or five miles beyond the meridian of the Farallones. The limits of this work are marked on the Progress Sketch No. 31. In making the soundings sixty-three specimens of bottom were brought up from different localities of the space passed over by the vessel. The following is a summary taken from the hydrographic records:

- Number of angles observed: 1,369
- Casts of the lead: 722
- Miles run in sounding: 694
The survey of the approaches to the Golden Gate was essentially completed by the end of February.

Resurvey of Humboldt Bay, Cal.—On the upward passage of the steamer Active for duty in the adjoining northern section, Commander Alden incidentally made a resurvey of Humboldt Bay above and below the entrance, as shown on Sketch No. 31. The soundings were taken between the 11th and 22d of July, and were applied in completing the chart which accompanied my last published annual report as Sketch No. 31.

The statistics of the resurvey are as follows:

<table>
<thead>
<tr>
<th>Miles run in sounding</th>
<th>119</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angles observed</td>
<td>1,094</td>
</tr>
<tr>
<td>Number of soundings</td>
<td>5,221</td>
</tr>
</tbody>
</table>

Sub-Assistant J. S. Lawson made the plane-table survey in a previous season. The original sheet containing the soundings last made is now at the office.

Hydrography of Crescent City harbor, Cal.—This work was based on the triangulation and topography executed in the early part of the year, as already detailed. The soundings were made in July by the party of Commander Alden in the surveying steamer Active.

In reporting on the completion of the hydrography, Commander Alden remarks: "During the progress of the survey of Crescent City harbor we found several new and dangerous rocks, but as they are not lying immediately in the channels followed by the steamers, and do not interfere with the anchorage in use, it does not seem necessary to notice them further in advance of the publication of the chart, as every one now trading there knows that vessels drawing over nine feet should be very cautious in venturing out of the beaten track. The rocks at that place are of a peculiar character, standing isolated like bayonets, with their points just below the surface, and ready to pierce any unlucky craft that may encounter them. After we finished the survey and I had selected a particular fair way for a sailing line, we discovered a very sharp rock almost directly in the passage, with its point only three feet from the surface, and deep water all around it. I mention this to show that although the greatest care was taken in the survey, the character of the points of rock is such that it cannot be surprising if a new one is found for several seasons to come. Still, by following the track which has been passed over so often by heavily laden steamers, no danger need be apprehended."

An engraved reduction from the sheets containing the survey of Crescent City harbor accompanies this report, as Sketch No. 33. The original chart is now at the office.

A summary of the hydrographic statistics is thus given in the report of Commander Alden:

<table>
<thead>
<tr>
<th>Miles run in sounding</th>
<th>101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angles measured</td>
<td>701</td>
</tr>
<tr>
<td>Number of casts of the lead</td>
<td>3,221</td>
</tr>
</tbody>
</table>

After completing this work the party in the Active proceeded to Section XI, under which head further notice will be made of its occupation.

Tidal observations.—Under an arrangement made several years ago satisfactory to the chief of the Engineer Bureau, and by which the services of Lieut. G. H. Elliot of that corps became available for the general supervision of the observations, the self-registering tide-gauges at San Diego and San Francisco have been kept in operation during the present year. Records have been received monthly showing that the series is successfully continued.
REPORT OF THE SUPERINTENDENT OF

SECTION XI.

WESTERN COAST, FROM THE FORTY-SECOND PARALLEL TO THE NORTHWESTERN BOUNDARY OF THE UNITED STATES, INCLUDING THE COAST OF OREGON AND THAT OF WASHINGTON TERRITORY.— (Sketch K, No. 35.)

The regular work of this section has necessarily given place to that connected with the boundary, and has been farther impeded by the necessity for placing the hydrographic vessel, the steamer "Active," at the disposal of the War Department. (Appendix No. 36.)

The following work has been executed in this section, and is reported upon in this chapter:

1. Triangulation of the Gulf of Georgia, W. T.
2. Reconnaissance of Coquille river entrance, Oregon.
3. Hydrographic reconnaissance of Gray's harbor, W. T.
4. Tidal observations.

Office-work.—A new edition of the reconnaissance sketch of Washington sound, W. T., and the chart of Port Townsend have been drawn and engraved, and the engraving of the charts of Port Gamble and Semi-ah-moo bay has been completed.

Triangulation of the Gulf of Georgia, W. T.—The field-work in this section was confined mainly to the triangulation of the Gulf of Georgia, abreast of Point Roberts, and in the vicinity of the forty-ninth parallel of latitude, but owing to the prevalence of smoke in the atmosphere during the entire season the progress expected at its outset has not been made. Sub-Assistant James S. Lawson, who conducted the operations and improved every opportunity for advancing the triangulation, says, in allusion to the hindrance from this cause: "Thus far, during the present season, the weather has furnished another illustration of the experience of former years, that each alternate season is very dry, and consequently that the immense fires started by the Indians sweep over a vast extent of country, so that it is often impossible to see, at the same time, both shores of the channels. During the last three months of the working season of 1857 we were often anchored within a quarter of a mile of the shore and could not see it. Last year was just the reverse, owing to the quantity of rain that fell tending to extinguish, or at least retard, the progress of the fires."

"In carrying the work forward from the limits of last year, I laid out a scheme of triangulation which seemed the very best that the conformation of the country would allow, as it tended to carry the work to the forty-ninth parallel with the least number of triangles. The lengths of the sides, however, were too great for observing on through the smoky atmosphere, and I have been compelled to change the plan and adapt my operations to circumstances."

The stations occupied or observed on by Mr. Lawson, as will be seen by reference to Sketch No. 34, range along the northern shores of the chain of islands bounding the Gulf of Georgia, from Patos island westward to a station on the upper part of Galiano island. These connect by lines with several stations established on Point Roberts, the positions of which are marked on the Progress Sketch.

The following is a summary of the statistics of the season:

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals erected</td>
<td>9</td>
</tr>
<tr>
<td>Signals of former seasons adjusted</td>
<td>13</td>
</tr>
<tr>
<td>Stations occupied</td>
<td>12</td>
</tr>
<tr>
<td>Objects observed on</td>
<td>46</td>
</tr>
</tbody>
</table>
The horizontal angles were measured with the ten-inch Gambey theodolite, C. S. No. 20.

Vertical angles also were measured by Mr. Lawson, and a hundred and thirty observations recorded for determining the height of the two summits of Mt. Baker, and that of the limit of snow. The snow range was computed by Mr. Alexander Agassiz, the aid in the party, to be at an elevation of 3,145 feet.

A further remark made by Sub-Assistant Lawson, in his report, refers to one of the most perplexing hindrances found in prosecuting the triangulation in the northern part of this section: "A necessary result of such a state of the atmosphere as that which I have mentioned is a remarkable range in refraction, but in no case have I ever seen it equal to what was experienced at the last station occupied. In one of the angles there was a range of 41°.3 in the various sets of observations, and in each of two others the range was as much as 35°.7. This large refraction occurs almost invariably at times when, during the whole or part of the day, the atmosphere has become remarkably clear and when the signals show very plainly and steadily. There is then no way of discovering the refraction except from the observations themselves. Usually it shows itself by the distorted appearance of the shores."

Copies of all the plane-table sheets traced by Mr. Lawson during last season were furnished to the commissioner on the northwestern boundary, Archibald Campbell, esq. The originals are now at the office.

The mark at the southern end of the base on Lummi island having been washed from its place by a gale in the winter of 1857-'58, Sub-Assistant Lawson occupied the stations connecting with it, and took suitable means for re-establishing the mark. He is now supplied with the improved apparatus described in my annual report for 1857, and having already graded and leveled the site of the base, the line will be remeasured as early as practicable in the ensuing season.

A meteorological register was kept, while the party was at work, of barometer readings, temperature, kind and amount of clouds, direction and force of the wind, and a record of the quantity of rain.

The duplicates of field notes were made, and abstracts and computations of the triangulation kept up to date as the work advanced. Those connected with the operations of last year are now at the office.

Four volumes, containing the recorded meteorological observations made in this section in previous seasons, have been turned in by Assistant George Davidson.

The brig Fauntleroy was used by Sub-Assistant Lawson for transportation and quarters in the Gulf of Georgia. At the close of the working season the vessel returned to San Francisco.

Reconnaissance of Coquille River entrance, Oregon.—With a view of making a hydrographic examination of the bar and channel of the Coquille river, Commander James Alden, U. S. N., assistant in the Coast Survey, attempted the entrance with the steamer Active, on her downward passage from his field of duty in connection with the Northwestern Boundary Commission, and found it, as was expected, inaccessible for vessels of ordinary draught. An accident to the centre shaft of the steamer, while in that vicinity, made it indispensable for the safety of the vessel that her voyage to San Francisco should not be at that time delayed.

The purpose of Commander Alden is to approach the Coquille entrance by land from Port
Orford, before the close of the year, if practicable, and to make a reconnaissance and soundings so as to fully determine the character of the river as a harbor of entrance.

Hydrographic reconnaissance of Gray's harbor, W. T.—In laying out the programme for the season's operations in this section, it was expected that the only field party for which the means are available might probably complete the special duty enjoined, in connection with the survey for the commissioner on the northwestern boundary, in time to admit of taking up the triangulation and topography of Gray's harbor within the present surveying year. This expectation, in consequence of the unfavorable weather, which, as already stated at the outset of this chapter, interfered materially with field progress in the northern part of the section, has not been met, and the basis of the hydrography is yet wanting. The impediments referred to being within the knowledge of Commander Alden, a visit was made to the harbor in the steamer Active, and such an examination conducted as could be made in advance of the close determination of points along the shores by the land party. In allusion to his reconnaissance Commander Alden says: "The result shows that the harbor has a bar over which can be carried from two and a half to three and a half fathoms of water. It was tolerably smooth during the flood, but when the ebb tide made the sea broke entirely across the entrance. The soundings made inside correspond very closely with those on the chart of the U. S. Exploring Expedition; and it would seem, as there is no bar laid down, that the survey just referred to was not carried quite out to it, or that there has been an important change since it was executed in 1841."

Hydrography of the Gulf of Georgia, W. T.—The following statistics represent the supplementary work executed for the northwest boundary commissioner by the hydrographic party under Commander Alden, in the steamer Active:

- Miles run in sounding: 105
- Angles measured: 366
- Casts of the lead: 967

Tidal observations.—One of the self-registering gauges in the general charge of Lieut. G. H. Elliot, U. S. Engineers, as stated under the head of Section X, has been kept in working order at Astoria, and the series from it continues to give satisfactory results.

OFFICE-WORK.

The Coast Survey Office in Washington city has, during the year, remained under the charge of Captain W. R. Palmer, U. S. Topographical Engineers, who has, as usual, administered it efficiently and acceptably. In the intervals of his absence, the duties devolving on him were discharged by Lieutenant A. P. Hill, U. S. A., whose connection with the office and efficiency as general assistant have been referred to in my previous annual reports.

The report of Captain Palmer, given in Appendix No 17, and accompanied by detailed statements from the chiefs of the several office divisions, show the occupation of the persons engaged in them within the year, and the scope and relation of the office as connected with the field-work of the survey. No change has been made in the allotment of the material received from the field, the past working of the divisions, as organized several years ago, having continued to meet the requirements of the survey and the calls incident thereto. In the order in which the office divisions have been heretofore named, summary notices are here appended of the employments in each.

Computing division.—Under the charge of Assistant Charles A. Schott, this division has fully
sustained its efficiency. The distribution of work done is set forth in his report appended to that of the assistant in charge of the office (Appendix No. 17,) as are also those relating to the other office divisions.

In addition to his general duties, Mr. Schott has continued the discussion of the secular change in the magnetic declination, and has furnished another contribution (Appendix No. 17) to our knowledge on that interesting subject. The computations made in the division have been performed as follows:

Assistant T. W. Werner has been employed in reducing from the records of triangulations and latitude observations; Mr. Eugene Nulty on latitudes, azimuth, and time observations; Mr. James Main on azimuth, latitude and revisions, and on computations connected with the determination of the magnetic elements; Mr. G. Rumpf on triangulations and the computation of geographical positions, and also in reducing magnetic observations; Mr. J. Wessner on triangulations, until his resignation on the 1st of April; Mr. W. D. Storke on reductions of triangulations, and in preparing the list of geographical positions which accompanies this report; Mr. J. T. Hoover in clerical and miscellaneous duties; and R. Freeman in making duplicates of field and office records.

Tidal Division.—The labors of this division, which have been, as heretofore, conducted by Assistant L. F. Pourtales, are stated in the Appendix before referred to, with the names of the persons employed.

Mr. Pourtales has continued incidentally the investigation of specimens of soundings, and has made developments of much interest in this branch of research.

The force in the division has been employed as follows: Mr. R. S. Avery on discussions relative to a generalization of results from the Boston tidal observations; Mr. S. Walker in verifying tidal records and corresponding with the observers; Mr. J. Downes in graphical decompositions, reductions, and comparisons; and M. Thomas and S. D. Pendleton have been employed in miscellaneous reductions.

Sub-Assistant C. Pendall and Messrs. J. Gilliss, R. E. Evans, O. Hirrichs, P. H. Donegan, and A. W. King served temporarily in this division during part of the year.

Drawing Division.—Until the end of June this division remained in charge of Lieut. J. C. Tidball, U. S. A., and his effective supervision is referred to in the report of Lieut. Thomas Wilson, U. S. A., under whose direction the duties have been carried on since that date. The distribution of work has been as follows: Assistants W. M. C. Fairfax and M. J. McClery on reductions of topography, the latter also in making additions to the Congress map; Mr. A. Boselke on projects; Mr. A. Lindenbohl on reductions, projections, and verification; Mr. A. Balbock, during part of the season, on hydrographic reductions, and now on general duty as draughtsman in the hydrographic division; Mr. E. Hergesheimer on verification and hydrographic reductions; Mr. W. P. Scott on reductions of various kinds, progress sketches, projects, and projections; Mr. L. D. Williams on fine reductions and verification; Mr. A. Strauss on soundings for charts; Mr. W. T. Martin on topographical drawing; Mr. P. Wittel on projections and preliminary charts; Mr. S. B. Linton on lettering, and in making additions to the progress sketches; Mr. F. Fairfax on general topography and tracings; and Mr. B. Hoe and Artificer J. A. Campbell on tracings generally.

Engraving Division.—The duties of this division were conducted by Lieut. Rufus Saxton, U. S. A., until the 1st of April. Since that date the division has been temporarily in charge of Mr. Edward Wharton.

The allotment of work to the engravers regularly employed has differed but little from that of
last year. Mr. G. McCoy has been engaged on topography and views for charts; Mr. F. Dankworth, until within a short period before his death, on topography; Mr. John Knight on first-class lettering; Messrs. A. Rolle, J. Eirtheffer, and A. Sengteller, on topography; Mr. G. B. Metzenth on topography, views, and sanding for charts; Messrs. A. Blondeau and W. Phillips on topography; Mr. H. S. Burnard on sanding for charts; Mr. J. C. Konordrop on first-class outlines, letters, and figures; Mr. H. C. Evans on topography and sanding; Mr. J. V. N. Throop on letters and figures for harbor and preliminary charts; Mr. A. Maedel on topography and sanding for harbor and river charts; Mr. A. Petersen on letters and figures, as also Messrs. E. A. Maedel, W. Langran, and W. Ogilvie; Mr. R. F. Bartle on topography and sanding; and Messrs. F. W. Benner, W. A. Thompson, and E. H. Sipe, on progress and other sketches, and miscellaneous work.

Electrotype and Photograph Division.—The report of Mr. George Mathiot, subjoined to that of the assistant in charge, in Appendix No. 17, gives in detail a statement of the work done in the division within the year. In addition to his regular duties, Mr. Mathiot has made numerous trials, resulting at length in the successful application of the photographic process as a substitute for hand reductions for the engraver. I have already stated at more length the progress made in this important branch of the service in the introduction of this report. In all the labors of the division Mr. Mathiot was assisted by Mr. David Hinkle, whose application to its various duties are specially mentioned in the report already referred to.

Miscellaneous Division.—Under this head are classed the printing and distribution of maps and charts, and the distribution of the office complement of the annual reports. The report of Lieut. J. R. Smead, U. S. A., who took charge on the detachment from the Coast Survey of Lieut. J. P. Roy, U. S. A., in last June, shows that the activity required in this division has been fully kept up. Over fifteen thousand copies of various charts have been distributed during the year, and an aggregate of six thousand eight hundred and seventeen copies of the annual reports and accompanying sketches.

Lieut. Smead has been assisted by Mr. V. E. King, who also performs clerical duty in the office of the assistant in charge.

The printing has been performed, as heretofore, by Mr. J. Rutherford, aided by Mr. J. Barrett.

Mr. F. Holden continued, until near the close of the present surveying year, on duty in the map room, and was employed in backing and preparing paper to be used as projections for plane-table and hydrographic sheets. This duty, since the 1st of September, has been performed by Mr. W. Mertz.

The space required for the constant additions to the archives of the survey is referred to by the assistant in charge as being yet unprovided for. Part of the inconvenience felt arises from the risk of transferring for deposit the original maps and charts to any but a thoroughly fire-proof building.

In the carpentry, the various calls and requirements incidental to the work of the survey have been met as usual. The labors of the shop, which have been conducted, as heretofore, by Mr. A. Yeatman, are stated in detail in the report of the assistant in charge of the office, as are also those of the instrument shop, in which the work is directed by Mr. J. Vierbuschen.

Captain Palmer specially commends the zeal and ability of his principal clerk, A. W. Russell, esq.
Assistant L. F. Pourtales, in charge of the tidal division, and Professor W. P. Troubridge, whose duties connected with the preparation of a portion of the records for publication have been before alluded to, have rendered acceptable assistance in certain special discussions conducted under my immediate direction.

Commander S. S. Lee, U. S. N., took charge of the hydrographic division of the office on the 1st of September, and has discharged, also, the duties of hydrographic inspector, attending to the repairs and outfit of the vessels used by all the parties of the survey. The knowledge possessed by Commander Lee of construction and equipment has, under the general rules and arrangements adopted first at the suggestion of Lieutenant Maffitt, introduced an efficiency into this branch of the service which insures for the future decided economy. Mr. A. Balbach has assisted in the hydrographic division as clerk and draughtsman.

I have only to reiterate the expression of the opinion which I entertain of the great value of the services of Samuel Hein, esq., general disbursing agent of the Coast Survey, and of those of the principal clerk in the Superintendent's office, W. W. Cooper, esq.

Respectfully submitted by

A. D. BACHE,
Superintendent United States Coast Survey.

Hon. Howell Cobb,
Secretary of the Treasury.
APPENDIX.

APPENDIX No. 1.

Distribution of the parties of the Coast Survey upon the coast of the United States during the surveying season of 1858-'59.

<table>
<thead>
<tr>
<th>Limits of sections</th>
<th>Parties</th>
<th>Operations</th>
<th>Persons conducting operations</th>
<th>Localities of operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section I.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From Passamaquoddy bay to Point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.</td>
<td>No. 1</td>
<td>Primary triangulation, astronomical and magnetic observations.</td>
<td>A. D. Bache, Superintendent; G. W. Dean, assistant; Edward Goodfellow, sub-assistant; R. E. Hailer, aid; H. W. Bach, aid.</td>
<td>Howard and Cooper stations, Washington county, Me.; occupied, and Channook, N. B., for extending the primary triangulation across the northeastern boundary. Geodetic observations completed at the three stations, with determinations of latitude, azimuth, and the magnetic elements at Howard and Cooper.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>C. O. Boutelle, assistant; C. H. Boyd, aid.</td>
<td>Reconnaissance and selection of stations for the secondary triangulation of Passamaquoddy bay, erection of signals for primary triangulation, and connection of the Epping base with adjacent stations. (See also Section V.)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Secondary triangulation.</td>
<td>J. A. Sullivan, sub-assistant; R. M. Stiles, aid; J. D. Bradford, aid.</td>
<td>Stations occupied in the secondary triangulation of Penobscot bay, below the primary line &quot;Ragged Mount—Isle au Haut,&quot; and signs erected for continuing work northward towards the head of the bay. (See also Section VI.)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Secondary triangulation.</td>
<td>F. P. Webber, sub-assistant; J. Kincheloe, aid.</td>
<td>Triangulation continued from Damerscotta river, and over Muscongus bay and sound, connecting eastward with stations in the lower part of Penobscot bay. (See also Section V.)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Topography</td>
<td>W. H. Dennis, sub assistant; J. L. Tlighman, aid.</td>
<td>Detailed survey of Wincootet, Me., and its environs, and topography of the opposite shore of Wincootet bay, including part of the Edgecombe quarries. (See also Section IX.)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Topography</td>
<td>R. M. Bache, assistant; W. S. Edwards, sub-assistant.</td>
<td>Plane-table survey of Bath, Maine, and detailed topography continued on the shore of Kennebec river and Merry-meeting bay.</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Topography</td>
<td>A. W. Longfellow, assistant; A. S. Wadsworth, assistant; James Gillies, aid.</td>
<td>Details of the shores of Casco bay, from and including the Presumpscot river, northward to Pitzer's Point, and survey of the interior on Cousin's, Long, Great Jibeig, Hope, Crotch, and Jevell's Islands, east of Portland harbor.</td>
</tr>
</tbody>
</table>
## APPENDIX No. 1—Continued.

<table>
<thead>
<tr>
<th>Limits of sections</th>
<th>Parties</th>
<th>Operations</th>
<th>Persons conducting operations</th>
<th>Locality of operations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SECTION I—</strong> (Continued.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 8 Topography</td>
<td>C. Fendall, sub-assistant</td>
<td>Plane-table survey of the coast of Maine, from Prout's Neck, southward and westward, to Kennebunk river, including the shores of Saco bay, and detailed survey of the Isles of Shoals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Topography</td>
<td>A. M. Harrison, assistant; P. C. F. West, sub-assistant; A. W. Thompson, aid.</td>
<td>Topography of Barnstable harbor completed, and the survey of Cape Cod peninsula in that vicinity extended from West Barnstable eastward to North Dennis, including Yarmouth, Barnstable, and Pond Village.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Hydrography</td>
<td>Lieut. Cong. John Wilkin-son, U. S. N., assistant.</td>
<td>In-shore hydrography extended from Cape Newagucn and Damariscove island, southward and westward, to Cape Small, outside of Kennebec entrance, and soundings completed abreast of and between Portland light and Green island, Casco bay. Rocks determined in position, and off-shore soundings carried from Cape Elizabeth southward to Nobsnet Centre Light, Cape Cod.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Hydrography</td>
<td>Lieut. Cong. Alexander Murray, U. S. N., assistant; C. Fendall, sub-assistant.</td>
<td>Soundings completed in-shore from Cape Elizabeth, southward and westward, to Cape Porpoise, Me. Deep sea line carried from Cape Ann, across Salem's ledge, to Seab Island, and thence by traverses, westward, across the coast of Maine to Cape Elizabeth. Be examination made in Salem and Boston harbors, Massachusetts. (See also Section IV.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Tidal observations.</td>
<td>T. E. Ready</td>
<td>Record kept with self-registering tide-gage at U. S. navy yard, Charlestown, Massachusetts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Magnetic observations.</td>
<td>Charles A. Schott, assistant; J. L. Tilghman, aid.</td>
<td>Determination of the magnetic declination, dip, and intensity at Portland, Me., and Portsmouth, N. H.; at Newburyport and Ipswich, Mass.; at Gloucester, Thompson (primary triangulation station,) Rockport, and Annisquam, on Cape Ann. (See also Section II.)</td>
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</tr>
</tbody>
</table>

**SECTION II.**

From Point Judith to Cape Henlo-pen, including the coast of Connecticut, New York, and New Jersey, and the shores of Pennsylvania and Delaware.

| No. 1 Triangulation | Edmund Blunt, assistant; Lieut. W. H. Terrill, U. S. A., assistant; G. H. Bagwell, sub-assistant; Rufus King, jr., aid. | Triangulation of Hudson river, from a station near Hudson northward to New Baltimore, and determination of numerous points in the vicinity of Yonkers, for plane-table purposes. |
| 2 Topography        | H. L. Whiting, assistant; John Moehan, sub-assistant; N. S. Finney, sub-assistant. | Detailed topography completed on both sides of Hudson river, between Spuyten Duyvil creek and Hastings; and also north and south of Tarrytown, N. Y., including Yonkers, Upper and Lower Nyack, the Fallsades, and Piermont. |
| 3 Topography        | F. W. Dorr, sub-assistant; C. Rockwell, aid; McKean Tilton, aid. | Supplementary details of topography in the vicinity of South Jamaica, L. L., Morrisania, Brooklyn, Williamsburg, High Bridge, and Hudson City, for the plane-table survey of New York harbor. (See also Section VI.) |
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<td>No. 4</td>
<td>Hydrography</td>
<td>Lieut. Comg. T. A. Craven, U. S. N., assistant</td>
<td>Re-examination and development of changes in the vicinity of the Battery Shoal, New York harbor. (See also Section VI.)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Tides and currents</td>
<td>H. Mitchell, assistant; W. T. Bright, aid.</td>
<td>Development of the sub-currents traversing the waters of New York harbor.</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Tidal observations</td>
<td>R. T. Bassett</td>
<td>Series kept with self-registering tide-gauge at Governor’s Island, (New York harbor,) and with the box-gauge at Brooklyn, L. I.</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Magnetic observations</td>
<td>Charles A. Schott, assistant; J. L. Tilghman, aid.</td>
<td>Determination of the magnetic declination, dip, and intensity, at Hartford, Conn.; Springfield, Chesterfield, and Deerfield, Mass.; and Rutland, Vt. (See also Section I.)</td>
</tr>
<tr>
<td>From Cape Henlopen to Cape Henry, including the coast of part of Delaware, and the coast of Maryland and part of Virginia.</td>
<td>No. 1</td>
<td>Triangulation</td>
<td>John Farley, assistant</td>
<td>Reconnaissance made and signals erected for extending work on the Potomac river from Finney Point upwards, to include Britton’s bay; triangulation of Hampton Roads completed and connected with the main series on Chesapeake bay, and base measured near Claremont, Va., for verifying the triangulation of James river.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Triangulation and topography</td>
<td>Charles Ferguson, sub-assistant</td>
<td>Survey of the main shore and islands in Chincoteague bay, Md. and Va., completed, and points determined for extending the topography northward into Sinopuxent bay. (See also Section VI.)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Topography</td>
<td>I. Hull Adams, assistant</td>
<td>Shore-line of the Patuxent river, Md., traced from Holland’s Point upwards to Hall’s creek, nearly completing the preliminary survey. Shores of the St. Mary’s river, Md., traced from its entrance northward to Warehouse Point, including the adjacent parts of St. Inigo’s and Carthagena creeks.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Topography</td>
<td>John Selb, assistant</td>
<td>Topography of Milford Haven, and Horn and Winter harbors, on the western shore of Chesapeake bay, completed. (See also Section V.)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Topography</td>
<td>I. Hull Adams, assistant</td>
<td>Shore-line traced between Westover and Little Brandon, completing the preliminary survey of James river, Va.</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Hydrography</td>
<td>Commander W. T. Muse, U. S. N., assistant</td>
<td>Hydrography of the Patuxent river, Md., extended from Holland’s Point upwards to Hall’s creek, and that of the St. Mary’s river, Md., from its entrance to Cove’s wharf; soundings made between Coggins’ Point and Little Brandon, completing the hydrography of James river, Va., and supplementary work done in Big and Little Annapolis rivers to complete the hydrography of Tangier sound.</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Tidal observations</td>
<td>M. C. King</td>
<td>Self-registering gauge kept in operation at Old Point Comfort, Va. Series continued with the self-registering tide-gauge at the U. S. navy yard, Washington, D. C.</td>
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<td><strong>From Cape Henry to Cape Fear, including part of the coast of Virginia and N. Carolina.</strong></td>
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<tr>
<td>No. 1</td>
<td></td>
<td>Primary triangulation.</td>
<td>Captain T. J. Cram, U. S. Topographical Engineers, assistant.</td>
<td>Reconnaissance and erection of signals at primary stations for the triangulation of Pamlico sound, N. C., and its connection with the base on Bodie's island.</td>
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<td></td>
<td></td>
<td>Triangulation ......</td>
<td>A. S. Wadsworth, assistant ....</td>
<td>Remeasurement of triangulation in the vicinity of Federal Point, (Cape Fear entrance,) and connection with a base of verification on Smith's island, with a station at Smithville, and with Fort Caswell, N. C. (See also Section I.)</td>
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<tr>
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<td></td>
<td>Topography ......</td>
<td>John Mechan, sub-assistant ; F. R. Hamster, aid</td>
<td>Topographical survey completed from Lynn Haven bay and Cape Henry southward into Currituck sound, N. C., including Broad bay, North bay, Back bay, Knott's island, and intermediate details. (See also Section II.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrography ......</td>
<td>Lieut. Comp. Alexander Murray, U. S. N., assistant.</td>
<td>In-shore hydrography extended from Beuge inlet southward and westward to New River inlet, coast of North Carolina; and lines of soundings run between Cape Henry and Cape Hatteras. (See also Section I and Gulf Stream.)</td>
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<tr>
<td><strong>From Cape Fear to St. Mary's river, including the coast of South Carolina and Georgia.</strong></td>
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<tr>
<td>No. 1</td>
<td></td>
<td>Astronomical and magnetic observations.</td>
<td>A. D. Beche, Superintendent; G. W. Dean, assistant ; Edward Goodfellow, sub-assistant; McLane Tillman, assistant; W. H. Odenheimer, aid.</td>
<td>Determination of latitude and azimuth at Smithville, N. C., with observations for local time, and the magnetic elements. (See also Section I.)</td>
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<tr>
<td></td>
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<td>Triangulation and topography.</td>
<td>C. P. Dobbs, assistant; O. Hinrichs, aid.</td>
<td>Triangulation extended from Shallotte inlet westward to Little river, N. C., and shore line survey continued from Tubb's inlet westward to the southern boundary of North Carolina.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Astronomical and magnetic observations and secondary triangulation.</td>
<td>C. O. Boutelle, assistant; Lieutenant Thomas Willem, U. S. A., assistant; W. S. Edwards, sub-assistant; C. H. Boyd, aid.</td>
<td>Observations for latitude, azimuth, and local time at Port Royal station, S. C.; magnetic elements determined at the same station. Tripods erected, and lines traced for primary triangles south and west of the Edisto lower. Secondary triangulation of Beaufort, Chechesee, and Colleton rivers, S. C. (See also Section I.)</td>
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<tr>
<td></td>
<td></td>
<td>Secondary and tertiary triangulation.</td>
<td>F. P. Webber, sub-assistant ; J. Kluehler, aid.</td>
<td>Secondary triangulation from Sapelo preliminary base southward, across Doby and Altamaha sounds, Georgia. Tertiary triangulation of Sapelo island, and of the “inland Passage” between Altamaha and St Simon’s entrance. (See also Section I.)</td>
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<tr>
<td></td>
<td></td>
<td>Topography ......</td>
<td>John Sett, assistant ; C. Rockwell, aid.</td>
<td>Shore line survey from St. Helena sound to Savannah river, Ga., including the Hunting island, Eding’s island, the shores of Port Royal sound, with the entrances of Beaufort, Broad, Chechesee, and Colleton rivers, Foot Point, Hilton Head island, May river, and the shores of Calibogue sound. (See also Section III.)</td>
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<td>Section V. (Continued)</td>
<td>No 6</td>
<td>Topography</td>
<td>H. S. Du Val, sub-assistant; J. D. Bradford, aid.</td>
<td>Topography of St. Catharine's sound, Ga., and of Bear river, connecting it with Ossabaw, and including the entrances of the Midway and North Newport rivers, and the outer shores of Ossabaw and St. Catharine's islands, adjacent to the entrance of the sound.</td>
</tr>
<tr>
<td>7</td>
<td>Hydrography</td>
<td>Lieut. Comg. J. P. Bankhead, U. S. N., assistant.</td>
<td>In-shore soundings completed from Cape Fear entrance southward and westward to Tobo's inlet, N. C.; and off shore hydrography extended between Cape Fear and Charleston harbor, with observations on the ocean current southward of Cape Fear. Hydrography of Bull's bay, S. C., completed, and the inland passage from it sound ed southward to Cape's island.</td>
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<tr>
<td>8</td>
<td>Hydrography</td>
<td>Lieut. Comg. C. M. Pauntleroy, U. S. N., assistant.</td>
<td>Resurvey of the channels leading into Fort Royal sound, S. C., including Joiner's bank, off Hilton Head island, and the hydrography of the Chechessee and Colleton rivers, abreast of Foot Point. Soundings completed in the approaches and on the bar of Sapelo sound, Ga. (See also Section I.)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Tidal observations</td>
<td>W. R. Herron</td>
<td>Series continued at the custom-house wharf, Charleston, S. C., with the self-registering tide-gauge.</td>
<td></td>
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<tr>
<td>10</td>
<td>Inspection</td>
<td>A. D. Beche, superintendent.</td>
<td>Soundings made for depth and temperature across the stream from Caysfort light-house and Sombrero key, and the line verified between Teter's and Havana Deep-sea soundings made in the axis of the stream between Cape Lookout and Cape Mataras (See also sections I, V, VII, and VIII.)</td>
<td></td>
</tr>
<tr>
<td>Gulf Stream.</td>
<td></td>
<td>Hydrography</td>
<td>Lieut. Comg. T. A. Craven,</td>
<td>Air line triangulation between Fernandina and Cedar Keys extended from Padgett's Station southward and westward to Waido, and plane-table survey of the tract of country included.</td>
</tr>
<tr>
<td>Section VI.</td>
<td></td>
<td>Triangulation</td>
<td>Captain M. I. Smith, U. S. Topographical Engineer, assistant; J. S. Bradford, aid; W. B. Gardner, aid; J. C. Young, aid. (part of season.)</td>
<td>Measurement of a preliminary base at Indian River inlet, Florida, and erection of signals for triangulation north and south of Port Capron. (See also Section I.)</td>
</tr>
<tr>
<td>From St. Mary's river to St. Joseph's bay, including the eastern end and part of the western coast of Florida peninsula, with the Florida Keys and Keys,</td>
<td></td>
<td>Triangulation</td>
<td>Benjamin Huger, jr., sub-assistant; Rufus King, jr., aid.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Triangulation</td>
<td>J. A. Sullivan, sub-assistant; E. M. Stiles, aid.</td>
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<tr>
<td>4</td>
<td>Lieut. A. H. Seward, U. S. A., assistant; Lieut. W. Myers, U. S. A., assistant</td>
<td>Triangulation</td>
<td>Triangulation extended eastward along the inner line of the Florida keys, from Lignum Vitae to Pigeon Key.</td>
</tr>
<tr>
<td>5</td>
<td>Lieut. W. R. Terrill, U. S. A., assistant; C. Fendall, sub-assistant; C. B. Baker aid.</td>
<td>Triangulation</td>
<td>Extension of work in Charlotte harbor, Florida, from Captiva Pass northward to Punta Gorda. (See also Section II.)</td>
</tr>
<tr>
<td>6</td>
<td>C. T. Iardella, sub-assistant; F. F. Nce, aid.</td>
<td>Topography</td>
<td>Western shores of Key Biscayne bay and Card's Sound, Florida, traced from Sheal point southward to Clay point. Topography completed on the western side of Key Largo and numerous patches on the Florida reef surveyed, between Lignum Vitae and Oyster Key.</td>
</tr>
<tr>
<td>7</td>
<td>F. W. Dorr, sub-assistant; Charles Ferguson, sub-assistant.</td>
<td>Topography</td>
<td>Plane-table survey of Charlotte harbor, Florida, continued, embracing the western side of Pine Island, the upper part of Sanibel Island, and Captiva and La Coste Islands, extending the work northward to Boca Grande. (See also Sections II and III.)</td>
</tr>
<tr>
<td>8</td>
<td>Lieut. Comr. T. A. Craven, U. &amp; N., assistant.</td>
<td>Hydrography</td>
<td>Reconnaissance line from Cape Canaveral to St. Lucie Inlet—soundings on the outside of Florida reef continued from Eagle Cove eastward to Gollin's Patch. (See also Section II and Gulf Stream.)</td>
</tr>
<tr>
<td>9</td>
<td>G. Würdemann</td>
<td>Tidal observations</td>
<td>Series continued with self-registering gauges at Fort Clinch, Tortugas, Charlotte harbor, and Egmont Key, (Tampa.)</td>
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<tr>
<td>10</td>
<td>A. D. Bache, superintendent</td>
<td>Inspection</td>
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**SECTION VII.**

From St. Joseph's Bay to Mobile Bay, including the coast of western Florida and the coast of Alabama.

| 1                  | G. H. Bagwell, sub-assistant; M. O. Hering, aid. | Triangulation | Triangulation on the western side of the Florida peninsula continued from Crystal reef southward, to include the entrance of Chassahowitzka river. (See also Section II.) |
| 2                  | Spencer C. McCormick, sub-assistant; A. W. Thompson, aid. | Triangulation | Connection made by triangulation between St. George's Sound and St. Mark's harbor, Fla., and reconnaissance for extending work eastward to include Ocklawaha River. |
| 3                  | F. H. Gordon, assistant; G. U. Mayo, aid. | Triangulation | Triangulation carried eastward into Santa Rosa Sound, beyond Little Sabine Bayou, from finished limits in Pensacola Bay, Fla. (See also Section VIII.) |
| 4                  | N. S. Finney, sub-assistant; J. L. Tlighman, aid. | Topography | Plane-table survey of the keys and shoreline abreast of Crystal reef, Fla., extended southward to Homosassa river, and from Chassahowitzka river southward to Raccoon Point. (See also Section II.) |
| 5                  | G. D. Wise, assistant; C. W. Duval, aid. | Topography | Topography of St. James's Island, Fla., nearly completed, with the opposite shore of Ockaloosce Sound, and part of the shores of Dickensound's bay in the direction of St. Mark's. |
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<td>6</td>
<td>Topography</td>
<td>F. H. Gerdes, assistant; G. U. Mayo, aid.</td>
<td>Plane-table survey within the season’s triangulation, including Santa Rosa island east and west of Little Sabine bayou, and part of the Live Oak plantation on the opposite shore of Santa Rosa sound. (See also Section VIII.)</td>
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<tr>
<td></td>
<td>7</td>
<td>Hydrography</td>
<td>Lieut. Comg. T. B. Huger, U. S. N., assistant.</td>
<td>Re-examination of the channels leading into the harbor at Cedar Keys, Fla. (See also Section VIII.)</td>
</tr>
<tr>
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<td>8</td>
<td>Hydrography</td>
<td>Lieut. Comg. J. K. Duer, U. S. N., assistant.</td>
<td>Hydrography of the eastern entrance to St. George’s sound, Fla., including the new channel passing Dog island. Additional soundings made inside and abreast of the West Pass. (See also Section IX.)</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Tidal observations</td>
<td></td>
<td>Series continued with self-registering tide-gauge at Cedar Keys, and observations recorded by a self-registering gauge at the U. S. navy yard, Warrington, Fla.</td>
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<td>From Mobile bay to</td>
<td>No. 1</td>
<td>Triangulation and topography.</td>
<td>Stephen Harris, sub-assistant; R. E. Halter, aid; H. W. Bache, aid.</td>
<td>Triangulation from Sand Fly station southward and westward along the shores of Isle au Breton sound to Point Fortuna, La., and shore-line of keys traced within the same limits.</td>
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<tr>
<td>Vermilion bay, including the coast of Alabama and Mississippi, and part of the coast of Louisiana</td>
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<td></td>
<td>2</td>
<td>Triangulation and topography.</td>
<td>F. H. Gerdes, assistant; G. U. Mayo, aid.</td>
<td>Tertiary triangulation of Pass a Loutre and Southeast Pass of the Mississippi river, and of the shores of Bay Rondo. Plane-table survey of the north side of the Mississippi delta, from the head of the passes to the Belize. (See also Section VII.)</td>
</tr>
<tr>
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<td>3</td>
<td>Topography</td>
<td>W. S. Gilbert, sub-assistant; R. E. Evans, aid, (part of season.)</td>
<td>Detailed survey between Lake Borgne and Lake Pontchartrain continued southward and westward from Chef Menteur to Little river, and extended on the north side of Lake Pontchartrain to Bayou Bonfouca. Shore-line survey carried on the same side to Ragged Point, and on the southern side to the Jefferson railroad.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Triangulation and topography.</td>
<td>F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant.</td>
<td>Triangulation and topography of the shores of Côte Blanche bay, La., extended westward from Malony’s Point to Côte Blanche island, and including the northeastern part of Marsh island. (See also Section VII.)</td>
</tr>
<tr>
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<td>5</td>
<td>Hydrography</td>
<td>Lieut. Comg. T. B. Huger, U. S. N., assistant.</td>
<td>Reconnaissance of Pass a Loutre, Mississippi delta, from the bar upwards, with tidal observations. Hydrography completed in Atchafalaya bay, and soundings extended westward to East Point (Marsh island) and Point Malone, including Côte Blanche bay east. (See also Gulf Stream and Section VII.)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Hydrography</td>
<td>W. S. Gilbert, sub-assistant.</td>
<td>Sounding out the Rigolet passage, from Lake Borgne to Lake Pontchartrain, La.</td>
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<td>From Vermilion bay to the southwestern boundary at the Rio Grande, including part of the coast of Louisiana and the coast of Texas.</td>
<td>No. 1</td>
<td>Triangulation</td>
<td>S. A. Gilbert, assistant; Charles Hosmer, aid.</td>
<td>Extension of triangulation from Matagorda entrance southward and westward over Espiritu Santo, San Antonio and Aransas, and Copano bays, with their dependencies.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Topography</td>
<td>W. H. Dennis, sub-assistant; T. C. Bowen, aid.</td>
<td>Plane-table survey completed, including the bays of Espiritu Santo and San Antonio, with the middle part of Matagorda island, Texas. (See also Section I.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrography</td>
<td>Lieut. Comg. J. K. Duer, U. S. N., assistant.</td>
<td>Soundings in Matagorda bay completed between the peninsula and the main, and extending from Matagorda City southward and westward to Palacios Point (See also Section VII.)</td>
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<td><strong>Section X.</strong></td>
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<td></td>
</tr>
<tr>
<td>Western coast of the United States, from San Diego to the 42d parallel, including the coast of California.</td>
<td>No. 1</td>
<td>Triangulation</td>
<td>W. E. Greenwell, assistant</td>
<td>Revision of primary work connecting with the San Pedro base, Cal.; and triangulation of the northern part of Santa Rosa island, Santa Barbara channel.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Triangulation and Topography</td>
<td>W. M. Johnson, sub-assistant; C. M. Backer, sub-assistant.</td>
<td>Triangulation and topography of San Pedro harbor, Cal.; and plane-table survey continued on Santa Cruz island, Santa Barbara channel.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Triangulation and Astronomical Observations</td>
<td>George Davidson, assistant; E. H. Fauntleroy, aid; A. T. Mosman, aid, (part of season)</td>
<td>Primary triangulation from San Francisco entrance extended northward to Sulphur Peak, with latitude and azimuth determinations. Secondary and tertiary work executed over Drake’s bay and Point Reyes, and connected with primary stations. Positions of the Farallones determined by the triangulation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Triangulation and Topography</td>
<td>James S. Lawson, sub-assistant; Alexander Agassiz, aid.</td>
<td>Triangulation and topography of Crescent City harbor, Cal. (See also Section XI.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrography</td>
<td>Commander James Alden, U. S. N., assistant.</td>
<td>Hydrography completed of the anchorage and vicinity of San Pedro, Cal. Soundings made in the approaches to the Golden Gate. Re-survey of Humboldt harbor, and hydrography of Crescent City harbor, Cal., completed. (See also Section XI.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tidal Observations</td>
<td>Lieut. G. H. Elliot, U. S. Engineers</td>
<td>Series of tidal gauges at San Diego and San Francisco. (See also Section XI.)</td>
</tr>
<tr>
<td><strong>Section XI.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western coast of the United States, from the 43d parallel to the northern boundary, including the coast of Oregon and Washington Territories.</td>
<td>No. 1</td>
<td>Triangulation and Topography</td>
<td>James S. Lawson, sub-assistant; Alexander Agassiz, aid.</td>
<td>Stations occupied on Point Roberts and triangulation extended westward to include the forty-ninth parallel, and the lower part of Galiano island. (See also Section X.)</td>
</tr>
</tbody>
</table>
APPENDIX No. 1—Continued.

<table>
<thead>
<tr>
<th>Limits of sections</th>
<th>Parties</th>
<th>Operations</th>
<th>Persons conducting operations</th>
<th>Localities of operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section XI—</td>
<td>No. 2</td>
<td>Hydrography</td>
<td>Commander James Alden, U.S.N. assistant.</td>
<td>Hydrographic reconnaissance of the entrance to Coquille river, Oregon, and of Gray's harbor, W.T. (See also Section XI.)</td>
</tr>
<tr>
<td>(Continued.)</td>
<td></td>
<td></td>
<td></td>
<td>Observations continued with self-registering gauge at Astoria, Oregon. (See also Section X.)</td>
</tr>
<tr>
<td>Localities of operations.</td>
<td></td>
<td>3 Tidal observations</td>
<td>Lieut. G.H. Elliot, U.S. Engineers.</td>
<td></td>
</tr>
</tbody>
</table>

APPENDIX No. 2.

List of Army officers on Coast Survey duty March 1, 1859.

<table>
<thead>
<tr>
<th>Officers</th>
<th>Rank</th>
<th>Date of attachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas J. Cram</td>
<td>Captain topographical engineers</td>
<td>March 26, 1858</td>
</tr>
<tr>
<td>W. R. Palmer</td>
<td>Captain topographical engineers</td>
<td>November 17, 1857</td>
</tr>
<tr>
<td>Martin L. Smith</td>
<td>Captain topographical engineers</td>
<td>December 9, 1856</td>
</tr>
<tr>
<td>Augustus H. Reed</td>
<td>Captain 6th infantry.</td>
<td>December 11, 1851</td>
</tr>
<tr>
<td>Ambrose P. Hill</td>
<td>First lieutenant 1st artillery</td>
<td>November 23, 1855</td>
</tr>
<tr>
<td>J. C. Tidball</td>
<td>First lieutenant 2d artillery.</td>
<td>September 6, 1856</td>
</tr>
<tr>
<td>Edward B. Hunt</td>
<td>First lieutenant engineers.</td>
<td>May 5, 1851</td>
</tr>
<tr>
<td>Rufus Saxton</td>
<td>First lieutenant 4th artillery</td>
<td>December 15, 1855</td>
</tr>
<tr>
<td>James P. Roy</td>
<td>First lieutenant 2d infantry.</td>
<td>October 7, 1853</td>
</tr>
<tr>
<td>William R. Terrill</td>
<td>First lieutenant 4th artillery</td>
<td>March 19, 1858</td>
</tr>
<tr>
<td>Thomas Wilson</td>
<td>First lieutenant 5th infantry.</td>
<td>May 26, 1859</td>
</tr>
<tr>
<td>William Myers</td>
<td>First lieutenant 9th infantry.</td>
<td>September 10, 1859</td>
</tr>
</tbody>
</table>

APPENDIX No. 3.

List of Army officers on Coast Survey duty September 1, 1859.

<table>
<thead>
<tr>
<th>Officers</th>
<th>Rank</th>
<th>Date of attachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas J. Cram</td>
<td>Captain topographical engineers</td>
<td>March 26, 1858</td>
</tr>
<tr>
<td>W. R. Palmer</td>
<td>Captain topographical engineers</td>
<td>November 17, 1857</td>
</tr>
<tr>
<td>Martin L. Smith</td>
<td>Captain topographical engineers</td>
<td>December 9, 1856</td>
</tr>
<tr>
<td>Edward B. Hunt</td>
<td>Captain engineers.</td>
<td>May 5, 1851</td>
</tr>
<tr>
<td>Ambrose P. Hill</td>
<td>First lieutenant 1st artillery</td>
<td>November 23, 1855</td>
</tr>
<tr>
<td>R. G. Cole</td>
<td>First lieutenant 8th infantry.</td>
<td>June 11, 1859</td>
</tr>
<tr>
<td>W. R. Terrill</td>
<td>First lieutenant 4th artillery.</td>
<td>March 19, 1858</td>
</tr>
<tr>
<td>J. R. Speed</td>
<td>First lieutenant 2d artillery.</td>
<td>May 21, 1859</td>
</tr>
<tr>
<td>Thomas Wilson</td>
<td>First lieutenant 5th infantry.</td>
<td>May 26, 1859</td>
</tr>
</tbody>
</table>
APPENDIX NO. 4.

List of Navy officers on Coast Survey duty March 1, 1859.

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Locality of service</th>
<th>Officers</th>
<th>Rank</th>
<th>Date of attachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office-work</td>
<td>W. T. Muse</td>
<td>Commander</td>
<td>February 27, 1857</td>
<td></td>
</tr>
<tr>
<td>Do</td>
<td>J. N. MaBitt</td>
<td>Lieutenant</td>
<td>November 1, 1858</td>
<td></td>
</tr>
<tr>
<td>Do</td>
<td>W. G. Temple</td>
<td>do</td>
<td>June 5, 1855</td>
<td></td>
</tr>
<tr>
<td>Steamer Bibb</td>
<td>Section IV</td>
<td>Alexander Murray</td>
<td>Lieutenalt commanding</td>
<td>April 23, 1858</td>
</tr>
<tr>
<td>Schooner Crawford</td>
<td>Section V</td>
<td>J. F. Bankhead</td>
<td>do</td>
<td>October 16, 1858</td>
</tr>
<tr>
<td>Schooner Varina and tender</td>
<td>Section V</td>
<td>C. M. Fauntleroy</td>
<td>do</td>
<td>November 13, 1858</td>
</tr>
<tr>
<td>Fire Fly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steamer Corwin</td>
<td>Section VI</td>
<td>T. A. Craven</td>
<td>do</td>
<td>October 25, 1858</td>
</tr>
<tr>
<td>Steamer Vixen</td>
<td>Sections VII and IX</td>
<td>John S. Duer</td>
<td>do</td>
<td>August 1, 1855</td>
</tr>
<tr>
<td>Steamer Walker</td>
<td>Section VIII</td>
<td>Thomas B. Huger</td>
<td>do</td>
<td>October 12, 1857</td>
</tr>
<tr>
<td>Steamer Active</td>
<td>Sections X and XI</td>
<td>James Alden</td>
<td>Commander</td>
<td>May 16, 1849</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wash'ton Gwathmey</td>
<td>Lietenant</td>
<td>May 29, 1858</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P. C. Johnson</td>
<td>do</td>
<td>July 20, 1854</td>
</tr>
<tr>
<td></td>
<td></td>
<td>J. G. Mitchell</td>
<td>do</td>
<td>June 14, 1858</td>
</tr>
<tr>
<td></td>
<td></td>
<td>James Suddards</td>
<td>Passed assistant surgeon</td>
<td>July 1, 1857</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N. C. Davis</td>
<td>First assistant engineer</td>
<td>February 22, 1853</td>
</tr>
</tbody>
</table>

APPENDIX No. 5.

List of Navy officers on Coast Survey duty September 1, 1859.

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Locality of service</th>
<th>Officers</th>
<th>Rank</th>
<th>Date of attachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office-work</td>
<td>S. S. Lee</td>
<td>Commander</td>
<td>August 8, 1859</td>
<td></td>
</tr>
<tr>
<td>Steamer Bibb</td>
<td>Section I</td>
<td>Alexander Murray</td>
<td>Lieutenant commanding</td>
<td>April 23, 1858</td>
</tr>
<tr>
<td>Steamer Corwin</td>
<td>Section I</td>
<td>John Wilkinson</td>
<td>do</td>
<td>June 25, 1858</td>
</tr>
<tr>
<td>Steamer Walker</td>
<td>Section II</td>
<td>Thomas B. Huger</td>
<td>do</td>
<td>October 12, 1857</td>
</tr>
<tr>
<td>Steamer Vixen</td>
<td>Section II</td>
<td>Thomas S. Phelpe</td>
<td>do</td>
<td>August 23, 1850</td>
</tr>
<tr>
<td>Schooner Varina</td>
<td>Section II</td>
<td>C. M. Fauntleroy</td>
<td>do</td>
<td>November 13, 1858</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F. R. Blake</td>
<td>Midshipman</td>
<td>August 16, 1859</td>
</tr>
<tr>
<td>Steamer Hetzel</td>
<td>Section III</td>
<td>W. T. Muse</td>
<td>Commander</td>
<td>February 27, 1857</td>
</tr>
<tr>
<td>Schooner Crawford</td>
<td>Section V</td>
<td>James Alden</td>
<td>Lieutenant commanding</td>
<td>October 16, 1858</td>
</tr>
<tr>
<td>Steamer Active</td>
<td>Sections X and XI</td>
<td>J. F. Bankhead</td>
<td>Commander</td>
<td>May 18, 1849</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wash'ton Gwathmey</td>
<td>Lietenant</td>
<td>May 26, 1858</td>
</tr>
<tr>
<td></td>
<td></td>
<td>J. G. Mitchell</td>
<td>do</td>
<td>June 14, 1858</td>
</tr>
<tr>
<td></td>
<td></td>
<td>James Suddards</td>
<td>Passed assistant surgeon</td>
<td>July 1, 1857</td>
</tr>
</tbody>
</table>
## APPENDIX No. 6.

**List of information furnished by the Coast Survey during the year 1858-59, under authority of the Treasury Department.**

<table>
<thead>
<tr>
<th>Date</th>
<th>To whom communicated</th>
<th>Information communicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1858.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>do</td>
<td>Tracing from reduction, scale 32/32, north and east of Sandy Hook, New York bay.</td>
</tr>
<tr>
<td>18</td>
<td>Hon. A. G. Brown</td>
<td>Tracing of hydrography of Mississippi sound, north of Cat and Ship islands.</td>
</tr>
<tr>
<td>29</td>
<td>Major H. C. Wayne</td>
<td>Tracing of topography of Long island, from Islip to Babylon, N. Y.</td>
</tr>
<tr>
<td>Dec.</td>
<td>E. S. Sewall, esq.</td>
<td>Tracing of topography of Pocomoke sound, Md.</td>
</tr>
<tr>
<td>4</td>
<td>do</td>
<td>Tracing of topography of Tangier sound, Md.</td>
</tr>
<tr>
<td>7</td>
<td>Dr. J. M. Cayler, U. S. A.</td>
<td>Tracing of Hampton roads, Va.</td>
</tr>
<tr>
<td>8</td>
<td>Hon. G. S. Hawkins</td>
<td>Tracing of topography of Apopka creek, N. Y.</td>
</tr>
<tr>
<td>13</td>
<td>Hon. W. F. Russell</td>
<td>Tracing of coast of Massachusetts, from Nantucket head to Ram island.</td>
</tr>
<tr>
<td>14</td>
<td>G. W. Blunt, esq.</td>
<td>Tracing of coast and passes, St. George's sound, Fla.</td>
</tr>
<tr>
<td>11</td>
<td>G. W. Blunt, esq.</td>
<td>Tracing of reconnaissance of coast of Texas, from Matagorda bay to Aransas pass.</td>
</tr>
<tr>
<td>17</td>
<td>E. T. Gray, esq.</td>
<td>Tracing of hydrography of Roanoke river, N. C.</td>
</tr>
<tr>
<td>20</td>
<td>Hon. W. F. Russell</td>
<td>Shore-line of Kennebec river, Me.</td>
</tr>
<tr>
<td>20</td>
<td>Capt. J. D. Curtis, Corps of Engineers</td>
<td>Tracing of Brazos river entrance, Texas.</td>
</tr>
<tr>
<td>29</td>
<td>Hon. Guy M. Bryan</td>
<td>Tracing showing wharves of Charleston city, S. C.</td>
</tr>
<tr>
<td>29</td>
<td>Alexander Brown, esq.</td>
<td>Tracing showing wharves of Charleston city, S. C.</td>
</tr>
<tr>
<td>1859.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.</td>
<td>Prof. L. Agassiz</td>
<td>Tracing showing Bombirro and Delta shoals, Florida reefs.</td>
</tr>
<tr>
<td>6</td>
<td>G. W. Blunt, esq.</td>
<td>Tracing of hydrography of coast of Maine, from Kennebunport to Isles of Shoals.</td>
</tr>
<tr>
<td>21</td>
<td>E. L. Meyer, esq.</td>
<td>Description of Coast Survey stations used in the triangulation in vicinity of Newport bay, N. J.</td>
</tr>
<tr>
<td>21</td>
<td>G. W. Blunt, esq.</td>
<td>Tracing of deep-sea soundings, Gulf of Mexico, from Delta of the Mississippi to Havana.</td>
</tr>
<tr>
<td>18</td>
<td>James H. North, esq.</td>
<td>Tracing of topography of Currituck sound, from Hatteras island to Currituck Courthouse, N. C.</td>
</tr>
<tr>
<td>March</td>
<td>Mr. Winning</td>
<td>Geographical positions of certain Coast Survey stations in New York city.</td>
</tr>
<tr>
<td>12</td>
<td>J. C. Brevoort, esq.</td>
<td>Tracing of topography of Long island, from Brooklyn to Jamaica bay, N. Y.</td>
</tr>
<tr>
<td>14</td>
<td>Light-house Board</td>
<td>Tracing of entrance to Matagorda bay, showing changes at Pass Cavallo, Texas.</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Results of current observations taken in East river, N. Y.</td>
</tr>
<tr>
<td>15</td>
<td>Col. W. H. Hutchings, U. S. naval steamer Galveston</td>
<td>Tracing showing soundings recently made at the Bighole, La.</td>
</tr>
<tr>
<td>15</td>
<td>John Kendall, esq.</td>
<td>Tracing of offshore chart, from Point Judith, R. I., to Cape Henlopen, Del.</td>
</tr>
<tr>
<td>18</td>
<td>Prof. J. Dana</td>
<td>Results of tidal observations at Sandy Hook, N. J., in 1858.</td>
</tr>
<tr>
<td>7</td>
<td>Capt. H. W. Benham, Corps of Engineers</td>
<td>Distances from Sandy Hook, light-houses to East and West beacons, New York bay.</td>
</tr>
<tr>
<td>7</td>
<td>do</td>
<td>Tracings of topography of coast of New Jersey, south of Manasquan river.</td>
</tr>
<tr>
<td>7</td>
<td>G. M. Hopkins, Jr., esq.</td>
<td>Chart of Hudson river, between Troy and Haverstraw, N. Y.</td>
</tr>
<tr>
<td>May</td>
<td>Hon. W. H. Seward, Editor of Indiana Courier</td>
<td>Distances between points in vicinity of Indiana, Texas.</td>
</tr>
<tr>
<td>25</td>
<td>G. K. Walker, esq.</td>
<td>Information relative to terminal point for a railroad on Apalachicola bay, Fla.</td>
</tr>
<tr>
<td>June</td>
<td>A. Lindenkrub, esq.</td>
<td>Tracing of topography of New York harbor.</td>
</tr>
<tr>
<td>31</td>
<td>Messrs. Allen &amp; Co.</td>
<td>Tracing of Foot Point, Daws island, and vicinity, near Port Royal sound, S. C.</td>
</tr>
<tr>
<td>10</td>
<td>M. Parks, esq., President A. &amp; C. Canal Co.</td>
<td>Tracing of topography of Currituck sound, N. C.</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## APPENDIX No. 6—Continued.

<table>
<thead>
<tr>
<th>Date</th>
<th>To whom communicated</th>
<th>Information communicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1859.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Washington Irving, esq</td>
<td>Tracing of topography of Hudson river, near Irving village, N.Y.</td>
</tr>
<tr>
<td>29</td>
<td>Hon. S. R. Mallory</td>
<td>Tracing of Pensacola city and vicinity, Fla.</td>
</tr>
<tr>
<td>30</td>
<td>Lieut. Col. J. D. Graham, topographical eng'rs</td>
<td>Tracing of Pensacola city and vicinity, Fla.</td>
</tr>
<tr>
<td>August</td>
<td>Messrs. Lowell &amp; Senter</td>
<td>Tracing of Bang's island, Portland harbor, Me.</td>
</tr>
<tr>
<td></td>
<td>Alexander Major, esq</td>
<td>Tracing of hydrography of Boston harbor from Egg rock to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grover's cliff, Mass.</td>
</tr>
<tr>
<td></td>
<td>S. J. Martinet, esq</td>
<td>Tracing of Chester river, Md.</td>
</tr>
<tr>
<td></td>
<td>Simeon Stevens, esq</td>
<td>Tracing of hydrography of Sheepscot river from Wiscasset to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hendrick Head light, Me.</td>
</tr>
<tr>
<td></td>
<td>Lieut. Con. R. E. Delauay, corps of engineers</td>
<td>Tracing of coast of Rhode Island from Beaver Tail light to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>East rock.</td>
</tr>
</tbody>
</table>
### APPENDIX No. 7.

Statistics of field and office-work of the United States Coast Survey during the years—

<table>
<thead>
<tr>
<th>Year</th>
<th>1844</th>
<th>1845</th>
<th>1846</th>
<th>1847</th>
<th>1848</th>
<th>1849</th>
<th>1850</th>
<th>1851</th>
<th>1852</th>
<th>1853</th>
<th>1854</th>
<th>1855</th>
<th>1856</th>
<th>1857</th>
<th>1858</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reconnaissance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area, in square miles</td>
<td>9,042</td>
<td>1,149</td>
<td>3,729</td>
<td>1,830</td>
<td>2,550</td>
<td>3,940</td>
<td>10,159</td>
<td>3,380</td>
<td>3,510</td>
<td>1,298</td>
<td>1,790</td>
<td>705</td>
<td>1,497</td>
<td>4,472</td>
<td>9,355</td>
<td>709</td>
</tr>
<tr>
<td>Parties, number of, in each year</td>
<td>4</td>
<td>9</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>13</td>
<td>7</td>
<td>5</td>
<td>8</td>
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| Total | 53,602 | 20,058 | 18,032 | 20,202 | 30,232 | 40,932 | 50,162 | 72,022 | 112,022 | 112,022 | 112,022 | 112,022 | 112,022 | 112,022 | 112,022 | 112,022 | 112,022 |
### APPENDIX No. 7—Continued.

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**THE UNITED STATES COAST SURVEY.**

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### APPENDIX No. 7—Continued.

|          | 1844 | 1845 | 1846 | 1847 | 1848 | 1849 | 1850 | 1851 | 1852 | 1853 | 1854 | 1855 | 1856 | 1857 | 1858 | 1859 | Total |
|----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
| Engraving and printing— |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Engraved plates of preliminary charts, sketches, and diagrams for Coast Survey reports, number of... | 4    | 5    | 7    | 6    | 10   | 29   | 99   | 40   | 46   | 51   | 57   | 57   | 57   | 57   | 57   | 57    | 244   |
| Electrotype plates made in each year... | 1    | 1    | 7    | 6    | 16   | 92   | 41   | 77   | 50   | 69   | 55   | 55   | 55   | 55   | 55   | 55    | 405   |
| Finished charts published in each year... | 4    | 3    | 4    | 3    | 6    | 4    | 6    | 3    | 6    | 3    | 5    | 6    | 70   |      |      |       |
| Preliminary charts and hydrographic sketches published... | 4    | 4    | 2    | 4    | 10   | 26   | 19   | 26   | 26   | 26   | 26   | 26   | 26   | 26   | 26   | 26    | 240   |
| Printed sheets of maps and charts distributed... | 169  | 416  | 1,708| 1,134| 2,032| 2,413| 5,412| 5,789| 5,789| 6,913| 9,732| 13,147| 4,929 | 70,765| 70,765| 70,765| 619   |
| Printed sheets of maps deposited with state agents... | 889  | 1,688| 4,961| 5,916| 3,115| 3,115| 5,168| 6,066| 4,371| 5,172| 3,329| 3,077| 2,086| 668  | 1,717| 44,565|       |
| Library— |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Number of volumes... | 856  | 950  | 290  | 233  | 171  | 273  | 82   | 35   | 424  | 568  | 289  | 101  | 115  | 3,152|      |      |       |
| Instruments— |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Cost of... | $9,306| $4,650| $4,602| $3,835| $1,999| $2,495| $5,053| $5,409| $5,165| $5,392| $8,105| $10,781| $4,209| $1,171| $19,147| $19,147| $19,147|

**GENERAL NOTE.**

**Party.—** An average number is given for the years previous to 1844. A party operating in one or more than one section during the year is counted but once.

**Triangulation.—** The extent of general coast is measured in general outline, including Delaware and Chesapeake, as well as all open bays; but omitting the minor indentations of the sea-coast. The extent of shore-line is also measured in general outline, and includes such rivers only as have been triangulated.

**Topography—** The length of the general coast is measured similarly to that under triangulation; but the above line under topography represents the whole water-line surveyed, including all the minor indentations, as represented on the plane-table sheets.

**Records.—** The total number of volumes of records given in the table is greater than the number now on hand, owing to the binding up of separate volumes.

**Engraved Plates—** Progress sketches (averaging fourteen yearly) are not counted.

**Library.—** The number of volumes purchased and donated up to 1849 was 656.

It is to be remarked that the numbers appearing in the columns of this table for the year immediately preceding that of its compilation are, in some cases, subject to be changed, more or less, in the succeeding Report, owing to data not being, at the time of compilation, fully turned into the office from the distant parties in the field.
APPENDIX No. 8.

General list of Coast Survey discoveries and developments to 1858, inclusive.

1. Temple’s ledge, near Cape Small Point, Me., 1857.
2. 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.
3. Determination of the dimensions of Alden’s rock, near Cape Elizabeth, Me., 1854.
4. Fishing ledge off Kennebunk, Me., thoroughly sounded, 1858.
5. A rock one mile to the southward and westward of Boon island, with seventeen feet water. The sea breaks on it in heavy weather, 1858.
7. A rock off Cape Neddiek, Me., determined in position, 1858.
8. A detached rock two-thirds of a mile northward and eastward of York ledge, Me., 1858.
9. Determination of the position of a rock more than a mile off the mouth of York river, Me.; bare at low tides and dangerous to coasters, 1858.
10. Development of Duck Island ledge, 1858.
11. A very dangerous rock, with only six and a half feet water, off the entrance to Portsmouth harbor, N. H., about four nautical miles eastward from the Whale’s Back light, 1858.
12. A rock, with twelve feet at mean low water, about four miles and a third eastward of the Whale’s Back, 1858.
14. A rock (not on any chart) in the inner harbor of Gloucester, Mass.; discovered in 1853.
15. A bank, ninety miles eastward of Boston, with about thirty-six fathoms of water, probably a knoll connected with Casco’s ledge, but with deep water between it and the ledge, 1853.
16. Boston harbor; Broad Sound channel thoroughly surveyed and marks recommended. 1848.
17. Several rocks in the fair channel way in Boston harbor entrance, 1854.
18. An extension of the sand-sprit to the southward of Sunken ledge, Boston harbor, since the survey of 1847, 1858.
19. 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.
20. Extension of Stellwagen’s bank to the southward and eastward some sixteen or seventeen square miles, enclosed by the twenty-fathom curve, 1855.
22. A dangerous sunken ledge (Davis’ ledge) to the eastward and in the neighborhood of Minot’s ledge, 1854.
23. Development of a reef extending between Minot’s and Scituate light, 1856.
24. A sunken rock, with only six feet on it at low water, off Webster’s Flag-Staff, Massachusetts bay, 1856.
25. A dangerous rock near Saquish Head, entrance to Plymouth harbor, 1856.
26. Three rocks determined in position, partly bare at low water, off Manomet Point, Massachusetts bay, 1856.
27. 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.


29. The decrease of depth, with general permanence of form, of George's bank, off the coast of Massachusetts, 1857.

30. A shoal spot near Little George's bank, 1857.

31. Non-existence determined of "Clark's bank" and "Crab ledge," laid down on certain charts as distinct from an immense shoal ground off Cape Cod peninsula, 1856.

32. 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.

33. Two new shoals north and east of Nantucket; discovered in 1847.

34. Six new shoals near Nantucket; the outermost fourteen and a half miles from land, and with only ten feet water; discovered in 1848.

35. McBlair's shoals, off Nantucket; discovered in 1849.

36. The tidal currents of Nantucket shoals and the approaches, 1854.

37. Davis' bank, Nantucket shoals; discovered in 1848 and survey finished in 1851.

38. 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.

39. A ridge connecting Davis' New South shoal and Davis' bank; found in 1853.

40. 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, 1853.

41. Discovery of Edward's shoal, one mile and seven-eighths southward of Nantucket lightboat, 1855.

42. Examination of the interference tides of Nantucket and Martha's Vineyard sounds, 1856.

43. The study of the tidal currents of the Vineyard and Nantucket sounds, 1857.

44. Contraction of the inlet at the north end of Monomoy island, and opening of a new entrance to Chatham harbor, 1853.

45. Muskeget channel; surveyed by Lieut. C. H. Davis in 1848 and Lieut. C. H. McBlair in 1850.

46. Discovery of two shoal spots, with twelve and thirteen feet water, eastward from Great and Little Round shoals, Nantucket sound, 1856.

47. Determination of two shoal spots near the northern extremity of Davis' bank, with fourteen and eighteen feet water, 1856.

48. Further development of Edward's shoal, three-fourths of a mile from the Southern Cross Rip, Nantucket sound, 1856.

49. Shoal and ridges discovered northward of Great Point light, Nantucket sound, 1856.

50. Important changes in geographical feature at the southeastern end of Martha's Vineyard, Muskeget channel, 1856.

51. Numerous rocks in Martha's Vineyard sound, Long Island sound, and the various bays and harbors connected with them.
52. Luddington rocks, determined in position, about ten yards apart, a mile and a half (nautical) southwest, by compass, from New Haven light, 1858.

53. The tidal currents of Long Island sound, 1854.

54. The tidal currents of Hell Gate, 1857.

55. Least water on the Hell Gate rocks, determined by dragging, 1857.

56. Tidal currents in East river, N. Y., and surface and sub-currents investigated in New York harbor, the lower bay, and on the bar, 1858.

57. The currents of the great bay between Massachusetts, Rhode Island, Connecticut, New York, and New Jersey, 1855.

58. 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, 1845.

59. The changes in New York harbor, near New York city, between 1845 and 1858.

60. Increase of depth in Buttermilk channel, ascertained and made known in 1848 by survey of Lieut. D. D. Porter, U. S.

61. Shoal in the main ship-channel of New York harbor, 1855.

62. The tides of Hudson river, 1856.

63. 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 1857.

64. 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.

65. Blunt's channel, in Delaware bay.

66. Changes in the Delaware, near the Pea Patch, 1847.

67. The true extent and position of the dangerous shoals near Chincoteague inlet, Va., 1852.

68. Metomkin inlet, Va., shoaling from eleven to eight feet in the channel during 1852.

69. Two channels into Wachapreague inlet, Va.; one from the northward and the other from the eastward; both with seven feet water at low tide, 1852.

70. A shoal half a mile in extent, not put down on any chart, five and a half miles east from the north end of Paramore's island, Va. It has but four fathoms water on it, and nine fathoms around it, 1852.

71. Great Machipongo inlet, Va. 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.

72. Two shoals near the entrance to the Chesapeake; one four and three-quarter nautical miles SE. by E. from Smith's island light-house, with seventeen feet water upon it; the other E. by S. nearly seven and three-quarter miles from the same light, with nineteen and a half feet upon it, 1853.

73. 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.

74. A twenty-five fathom hole two and a half miles W.SW. from Tazewell triangulation point, eastern shore of the Chesapeake; all other charts give not more than sixteen fathoms in this vicinity.
75. A shoal at the mouth of the Great and Little Choptank, in Chesapeake bay, 1848.
76. The sounding and measurement of the bars in Rappahannock river, 1855.
77. The general permanence of the Bodkin channel and shoals in its vicinity, at the entrance of the Patapsco river, between 1844 and 1854.
78. 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.
79. Re-examination of York spit, Chesapeake bay, and least water determined, (nine feet,) 1855.
80. York river, Va., as a harbor, 1857.
81. A reconnaissance of the Wimble shoals, near Nag's head, coast of N. C., 1854.
82. Submarine range of hills beyond the Gulf Stream tracked from Cape Florida to Cape Lookout, 1855.
83. Deep water found on Diamond shoal, and a dangerous nine-feet shoal off Cape Hatteras, 1850.
84. A new channel, with fourteen feet water, into Hatteras inlet, formed during the year 1852, which is better and straighter than the old channel.
85. Changes at Hatteras and Ocracoke inlets, 1857.
86. The general permanence in depth on the bar of Beaufort, N. C., with the change of position of the channel, 1854.
87. Changes on the bar of Beaufort, N. C., 1857.
88. 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 that harbor, 1853.
89. Changes in the main Western and New Inlet channels in Cape Fear, 1855.
90. Frying Pan shoals, off Cape Fear, N. C.; a channel of two and a half 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 eight or eight and a half 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 three and a half to seven fathoms water on it. The Frying Pan shoals extend twenty nautical miles from Bald Head light-house, and sixteen, seventeen, and eighteen feet water is found seventeen and eighteen nautical miles out from the light, 1851.
91. Shoaling of Cape Fear river bar thoroughly examined for purposes of improvement, 1852.
92. Changes of shore-line and hydrography determined at the Cape Fear entrances, N. C., 1855.
93. Changes of the Cape Fear bars and channels, 1857.
94. Changes at the entrance of Winyah bay and Georgetown harbor, and the washing away of Light-house point at the same entrance, 1853.
95. Maffitt's new channel, Charleston harbor, with the same depth of water as the ship channel, 1850.
96. The changes in Maffitt's channel, Charleston harbor, S. C., from 1852 to 1857.
97. Increase of depth developed in Maffitt's channel, Charleston harbor, S. C., 1858.
98. Changes in the main ship channel, Charleston harbor, 1855.
99. Changes in the channels at the entrance of Charleston harbor, 1852.
100. 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.
102. Discovery of a new channel between Martin's Industry (shoal) and the southeast breakers, Port Royal entrance, S. C., 1856.
103. Discovery of cold water at the bottom of the ocean below the Gulf Stream, along the coasts of N. and S. Carolina, Georgia, and Florida, 1853.
104. 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.
105. Various facts relative to the distribution of minute shells on the ocean bottom, of probable use to navigators for recognizing their positions.
106. Examination of Doboy, St. Simon's, and Cumberland entrances, 1855.
107. A shoal inside of the entrance to Amelia river, Fla., 1857.
108. Hetzel shoal, off Cape Cañaveral, Fla., 1850.
109. Temperature of 34° beneath the Gulf Stream, thirty-five miles east of Cape Florida, at a depth of three hundred and seventy fathoms, 1855.
110. 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.
111. A new passage, with three fathoms water, across the Florida reef to Legare harbor, under Triumph reef, (latitude 25° 30' N., longitude 80° 03' W.,) which, if properly buoyed, will be valuable as a harbor of refuge, 1852.
112. A safe rule for crossing the Florida reef near Indian key, 1854.
113. A new channel into Key West harbor, 1850.
114. Cotidal lines for the Atlantic coast of the United States, 1854.
115. Rules for navigators in regard to the tidal currents of the coast, 1857.
116. Isaac shoal, near Rebecca shoal, Florida reef; not laid down on any chart, 1852.
117. Channel No. 4, a northwest entrance into Cedar Keys bay, 1852.
118. Directions for entering the harbor from Crystal river offing, western coast of Florida peninsula, 1856.
119. A new channel discovered, leading into St. George's sound, (Apalachicola, Fla.,) at the east end of Dog island, and anchorage connected with it, 1858.
120. Shoals near the East and West passes of St. George's sound, (Apalachicola, Fla.,) and a new channel found between St. George's and St. Vincent's islands, 1858.
121. 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.
122. The diminution, almost closing, of the passage between Dauphine and Pelican islands, at the entrance of Mobile bay, 1853.
123. Horn Island channel, Mississippi sound, 1852.
124. 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.
125. The accurate determination of Ship shoal, off the coast of La., in connection with the site for a lighthouse, 1853.
126. An increase of depth of water on the bar of Pass Fourchon, La., 1854.
128. Tidal phenomena of the Gulf, 1855.
129. The changes at Aransas Pass., Tex., as bearing on the question of a lighthouse site, 1853.
130. Co-tidal lines of the Gulf of Mexico, 1856.
131. On the effect of wind in disturbing the tides of the Gulf of Mexico, 1856.
132. Development of a bar at the entrance of San Diego bay, Cal., 1856.
133. A shoal inside of Ballast Point, San Diego bay, with only twelve and a half feet water; not laid down on any chart, 1852.
134. The determination of the position and soundings on Cortez bank, off the coast of Cal., 1855.
135. Complete hydrographic survey and determination of a point of rock on Cortez shoal, 1856.
136. Tides of San Diego, San Francisco, and Astoria, 1854.
137. The non-existence of San Juan island, usually laid among the Santa Barbara group, 1852.
138. Co-tidal lines of the Pacific coast, 1856.
139. Determination of Uncle Sam rock, 1855.
140. Investigation of the currents of Santa Barbara channel, 1856.
141. Red sand marking the inner entrance to the Golden Gate, 1855.
142. Channel sounded out between Yerba Buena and the Contra Costa, San Francisco bay, 1855.
143. A reef developed off the Contra Costa flats, San Francisco bay, Cal., 1858.
144. Whiting's rock, determined in position, near the "Brothers," at the entrance of San Pablo bay, Cal., 1858.
146. Changes in the channel entrance of Humboldt bay or harbor, Cal., 1852 and 1853.
147. 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.
148. The depth of water on the bars at the entrance of Rogue river and Umpquah river, Oregon, 1853.
149. A shoal at the northern entrance to the Strait of Rosario, W. T., giving good holding ground in thirty-three feet, 1854.
150. Boulder reef, northwest of Sinclair island, Rosario strait, partly bare at unusually low tides and surrounded by kelp, 1854.
151. A bank of three and a half fathoms, about a mile off the southwest point of Sucia island, at the northern entrance of Washington sound, W. T., 1858.
152. Belle rock, in the middle of Rosario strait, visible only at extreme low tides, 1854.
153. Entrance rock, at the entrance of Rosario strait, 1854.
154. Unit rock, in the Canal de Haro, W. T., visible only at extreme low tides, 1854.
155. A three-fathom shoal in the Strait of Juan de Fuca, off the southeast part of Bellevue or San Juan island, 1854.
157. A five-fathom shoal, in the Strait of Juan de Fuca, between Canal de Haro and Rosario strait, 1854.
158. A bank in eleven fathoms, off the southern entrance to Canal de Haro, 1854.
159. The non-existence of two islands at the northern entrance of Canal de Haro, laid down on charts, 1853.
160. Various surveys and charts of small harbors on the Pacific coast of the U. S., and a continuous reconnaissance of the entire western coast and islands adjacent, a great part of which was imperfectly known.

Additional list for 1859.

1. Only eighteen feet at mean low water found on the rock one mile to the southward of Seguin island, coast of Maine.
2. True position of the Hussey rock in Casco bay determined, correcting the erroneous one assigned on previous charts.
3. Determination of the position of the "Hue & Cry," the "Old Proprieter," and other dangers off Cape Elizabeth, Me.
4. Development of a rock off Ogunquit, bare at low tides, and very little known.
5. A fishing bank sounded out off Wood island, coast of Maine.
6. Huzzey's rock, south of Fletcher's neck, Me., determined in position.
7. Development of a four-fathom bank off Cape Porpoise, Me.
8. Determination of the position of a small rock with less than four feet at mean low water, near the channel, and in the vicinity of Great rock, Hyannis harbor, Mass.
9. The existence of a seventeen foot spot on the shoal off the battery, New York harbor; the extension of the shoal towards the channel, and the shoaling of the water generally between the shoal and shore.
10. The existence and character of sub-currents, ascertained as bearing on the physical conditions of New York harbor.
11. Changes developed in the shore-lines at the entrance of Little Annemessex river, Chesapeake bay.
12. Less water found off Cape Romain by preliminary examination, than has been heretofore assigned.
13. Further explorations in developing the character of the Gulf Stream in the Florida channel.
APPENDIX No. 9.


COAST SURVEY STATION,
Near Lane's Brook, Me., September 12, 1859.

Sir: I have the honor to communicate as additional to the information contained in my letter of August 30, which reported the development by Lieut. Comg. J. Wilkinson, U. S. N., assistant Coast Survey, of a less depth than has heretofore been assigned for a sunken rock off Seguin island, coast of Maine; the following bearing, etc., for the determination of its position, since furnished by that officer.

"Bearing.—From Seguin island light-house, S. 9° 30' E., true ; S. a little west by compass.
"Distance.—From south point of Seguin island, three-quarters of a nautical mile.
"Range.—Pond island light-house, just open on the southwest side of Seguin island."

The rock, as before stated, is surrounded by deep water, but has only eighteen feet on it at mean low tide, and lies in the track of vessels bound into the Kennebec river.

I would respectfully request authority to publish this letter in the usual form, as a notice to mariners.

Very respectfully, yours,

Hon. HOWELL COBB, Secretary of the Treasury.

A. D. BACHE, Superintendent.

APPENDIX No. 10.


PHILADELPHIA, October 14, 1859.

Sir: I have the honor to report that in the progress of the soundings made this season in Casco bay, Me., by the party of Lieut. Comg. John Wilkinson, U. S. N., assistant Coast Survey, the true position of the Hussey rock has been determined and found to be more than a quarter of a nautical mile northwest of the position assigned hitherto on charts of the vicinity. The rock is small and has only twelve feet on it at mean low water. The following bearings and ranges from it are taken from the report of Lieut. Comg. Wilkinson:

"Bearings.—Middle of Green island, SE. 4° E., by compass (S. 59° E. true.)
"Cape Elizabeth east light-house, SW. 1° S., southerly by compass (S. 23° 30' W. true.)
"Portland light-house, SW. by W. ½ W., by compass (S. 52° W. true.)
"Ranges.—South end of Ram island and Portland light-house, in range.
"Poonduck church, three-quarters of a point open from White Head Bluff.
"School-house on Long Island, in range with the east end of Marsh island."

"A buoy that formerly marked the position of the Hussey rock parted from its moorings several years ago, and has not yet been replaced. Luckse's sound is a fine harbor of refuge for ships that are unable to work into Portland, and is resorted to by such, especially during the
winter when the wind is from the northward and westward. The Hussey lies directly in their track and should be marked by a buoy.''

I would respectfully request that a copy of this communication may be furnished to the Light-House Board, and also authority for publishing it in the usual form as a notice to mariners.

Very respectfully, yours,


Hon. HOWELL COBB, Secretary of the Treasury.

APPENDIX No. 11.


COAST SURVEY OFFICE, November 9, 1859.

Sir: I have the honor to communicate that in the progress of hydrographic operations on the coast of Maine, in August last, Lieut. Comg. Alexander Murray, U. S. N., assistant Coast Survey, developed the position of a rock, bare at low tide, off Ogunquit. It is about a mile and a half (nautical) from that village, and was unknown to the residents of the adjoining coast. The rock rises boldly from the bottom, from four to seven fathoms of water being found in its immediate vicinity, and in the opinion of Lieut. Comg. Murray should be marked by a spindle.

I would respectfully request that a copy of this letter may be furnished to the Light-house Board, and that authority may be given for publishing it in the usual form as a notice to mariners.

Very respectfully, yours,

A. D. BACHE,
Superintendent.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 12.


UNITED STATES COAST SURVEY STEAMER CORWIN,
Portland, Maine, July 29, 1859.

Sir: In obedience to your directions I have examined the locality in the main entrance to Hyannis harbor, where a rock was reported by Commander M. Smith, U. S. N., Light-house Inspector of the Second District, and succeeded in finding and determining its position. After running many lines and sweeping carefully over the ground within a hundred yards of the spar buoy, which has been placed to mark its supposed position or vicinity, without finding it, I obtained information which satisfied me that it was not situated in the channel, but near the
Great Rock. It is about eight feet square, and upon its crest there is a depth of three and a half feet at mean low water, increasing suddenly to twelve feet all around it.

The following are bearings and ranges from spar buoy "red No. 2."

Centreville church spire, NW. by W. (westerly) true, NW. (westerly) by compass.

Hyannis west spire, north (easterly) true, N. by E. by compass.

Point Gammon light-house E. SE. true, SE. by E. 1/2 E. by compass.

From the new rock the bearings are:

Centreville church spire, NW. by W. (westerly) true, NW. 1/2 W. by compass.

Hyannis west spire, N. 1/2 W. true, N. 1/2 E. by compass.

Point Gammon light-house, SE. by E. 1/4 E. true, SE. 1/4 E. (easterly) by compass.

Great Rock spindle bears N. NW. 1/2 W. true, or N. by W. 1/2 W. by compass, and is distant two hundred yards.

Range.—The new rock and Great Rock spindle in range with two houses situated on the top of a low sand hill, distant five hundred yards from the foot of the western wharf, and two hundred yards from the beach.

The spar buoy "red No. 2" bears W. 1/4 N. true, or W. by N. (northerly) by compass, and is distant three hundred and twenty-five yards.

Very respectfully, your obedient servant,

J. WILKINSON,
U. S. N., Assistant Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 13.

Letter of the Superintendent, addressed to the President of the New York Chamber of Commerce, with the report of Lieut. Comg. T. A. Craven, U. S. N., stating the result of an examination of the Battery shoal.

COAST SURVEY STATION,
Near Lane's Brook, Maine, September 27, 1859.

DEAR SIR: The report that one or more vessels had struck upon the shoal off the Battery, where it was generally supposed there was deep water, induced one of the pilot commissioners, George W. Blunt, esq., to call my attention to the desirableness of a resurvey of the shoal. It was assigned to Lieut. Comg. T. A. Craven, then assistant in the Coast Survey, who having been charged with the hydrography of New York harbor, for the commissioners on harbor encroachments, was familiar with every part of the shoal. His report, recently presented to me, gives in detail the changes which have occurred, and shows prospectively those which may be expected. It is important, and I therefore beg leave through you to call the attention of the Chamber of Commerce to it. The filling up between pier No. 1 and the Castle may readily be avoided by dredging, and no doubt the entire completion of the Battery work would retard the now rapid increase of the shoal. The shoal must, however, in a general way, be related to the new shore, line as the old was to the former shore, and thus the shoal while
changed in form must be pushed out to a distance, not equal, but corresponding to the addition to the shore-line of the Battery.

Yours, respectfully,

A. D. BACHE,
Superintendent U. S. Coast Survey.

PELATIAH PERIT, Esq.,
President Chamber of Commerce, New York.

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NEW YORK, September 20, 1859.

Sir: In compliance with your directions in July last, I made an examination of the shoal off the Battery, New York, for the purpose of ascertaining what changes have taken place in that locality, and I herewith submit to you a map of the survey, scale 1/20, on which I have also had the soundings placed from the surveys of 1855 and 1856 for comparison.

The soundings of 1855 and 1856 are in red figures, and the curves are also distinctly drawn.

In order to make this discussion as explicit as possible, I divide the shoal into sections, and call your attention to each position separately; you will be much interested in observing the rapidity with which the shoal is accumulating, and with what regularity the deposits are being made:

Section I, from pier No. 1, North river, to Castle Garden.

In the angle formed by the line of the Battery and the pier there has been a very rapid filling up, the 3-fathom curve has been pushed outward eighty yards beyond the line of 1856; the 17 feet spot in the outer part of this section is extending towards pier No. 1, and there is an average decrease of three feet in depth throughout this section.

Section II extends to the 3-fathom curve of 1856.

In this portion of the shoal the change has been not less considerable than in the angle of pier No. 1. The 3-fathom curve was, in 1856, about seventy-five yards south of the Castle, it will be seen that it has extended towards the Castle wharf, and embraces a considerable area where formerly we had five fathoms; outside of this curve, we find in this section a general decrease of five feet in the depth.

Section III embraces the general shoal to the southeastern portion of the curve of 3 fathoms.

Excepting in the part already indicated, there has been no material change in the general contour of the shoal, but in following the curve to its southernmost point it will be seen that it has extended about one hundred feet to the southward.

Section IV extends from last section to the East river piers.

In calling your attention to this section, I will merely refer to the knoll lying about W.SW. from pier No. 1, East river. This knoll has eighteen feet water upon it, is very small, and has deep water outside and close to it; there is no change in depth on the knoll, but it is extending itself towards the north, and it will be seen that in that direction there is a decrease of two feet in the depth near the shoal.

East of this knoll there is no apparent change. Drawing a waved line from the last mentioned
knoll to the Castle Garden, you mark out the eddy waters of this part of the river; the currents of the two rivers meeting here at ebb and dividing at flood; this portion of the stream being too sluggish to carry off matters held in suspension, they are rapidly and constantly deposited.

Although from natural causes there must always have been a shoal off this point of the island, its accumulation has been evidently aided to a startling degree by the extension of the Battery. The currents which formerly flowed between the Castle Garden and the shore, made the greater portion of their deposit so near the shores as to cause no great injury to the operations of commerce, and the process of deposit was so gradual that it would have required an interval of many years ere the shoal would have seriously encroached on the waters of the bay, but the battery extension has already accomplished that which would have required a half century of the operations of nature, having pushed the shoal out as the shore line was changed.

In illustration of this assertion, we have but to look at the extraordinary heaping up of the earth in the angle formed by the Battery wall and pier No. 1; a heaping up, made by the ebb current of the North river, which as it comes around the pier is now turned back and formed into eddies by the Battery walls. This current formerly ran through the space now covered by the filling in, and poured the suspended matter into the East river, off White Hall, from whence it was carried away and distributed in the deep waters of the bay, but now a large portion of the sediment brought down by the ebb is doubtless filling in the space here with great rapidity; its effects are still more strongly visible in the section off the Castle, where we see changes of six and eight feet in the space of three years; this is due to the united efforts of the ebbs from the two rivers, and the time cannot be far distant when, unless dredging is resorted to, the entire space from the Castle to the head of pier No. 1 will be quite filled in.

In addition to the material damage done by thus forcing out into the stream a shoal which was heretofore of little consequence, it may safely be presumed that in filling in for the Battery extension very liberal supplies have been contributed to the shoal from the dirt carts, as without the security of a regular sea wall, immense quantities of the loose earth must from time to time be washed away and added to the shoal, and it is probable that when the slowly progressing enlargement is completed and the walls finished the changes will be less rapid.

The injury is now without other remedy than that of hastening to its completion a work which has proved so seriously disastrous to this already crowded part of the harbor, and by legislation preventing any extensions beyond the lines of the city as defined by the harbor commissioners.

I am, very respectfully, your obedient servant,

Prof. A. D. Bache,
Superintendent U. S. Coast Survey.

T. AUGS. CRAVEN,
Lieutenant Commanding.

REPORT ON HARBOR ENCROACHMENTS.

Mr. G. W. Blunt presented the report of the committee on the subject of harbor encroachments, as follows:

The committee appointed to report upon the evils arising from the extension of the Battery, having been requested to extend their inquiries in order to ascertain if any and what other
abuses existed in the harbor, beg leave to report a few of the most important, and to propose a mode of abating or remedying them.

First in order among the abuses is that of an encroachment. The committee would mention West Washington Market, where five acres have been taken or filled in from the waters of the North river; likewise pier No. 51, North river, extended thirty-three feet beyond the exterior line established by law. These are the acts of the city authorities.

The Lowber extension at the foot of Fourteenth street, East river, and the piles just driven at the outer end of pier No. 29, East river, which pier was already some twenty-five feet beyond the established limits, are instances of encroachments by private parties.

Next in order is the sewerage. It has been ascertained that the slips in the harbor have been filled up nearly eighteen inches each year, by material discharged from the sewers, of which only four out of one hundred and ten discharge at the outer end of the piers, the remainder discharge into the still waters of the slips or basins, where there is no current to carry off the deposits.

Dumping grounds.

These are the places where the dirt swept from the streets of the city is deposited by order of the city inspector. They are eight in number, viz: At the foot of Vosey, Watts, Gansevoort, and Twenty-sixth streets, North river; Roosevelt, Stanton, Fifth, and Twenty-third streets, East river.

The dirt is continually being dropped into the waters of the harbor and filling up the slips, from the practice of heaping it up on the piers and bulkheads. During last month the pier at the foot of twenty-third street, East river, gave way from the accumulation of dirt upon it, and 3,000 cart loads were thus thrown into the river.

Remedies.

All parties encroaching upon the waters of the harbor, beyond the established limits, should be punished by sufficient penalties, and the harbor commissioners should have power to remove the encroachments at once, the offending parties to pay all expenses incurred in such removal. All new sewers should be carried to the outer ends of the piers, (which we believe to be the intention of the Croton Aqueduct department, which has charge of the construction of sewers,) and, where practicable, the termination of those now built should be changed so as to empty in like manner with the new ones. The cisterns at the corners of the streets communicating with the sewers should invariably be cleaned out weekly, which would be the great preventive of filling up the slips from the sewers.

No dumping should be permitted upon or near the piers or bulkheads, under a penalty; and the city inspectors should be required to have scows or other vessels provided and ready to receive the dirt from the carts, there being no good reason why dirt should have a preference over all other articles in the use of our piers and bulkheads.

The shore-line belonging to the State of New York, in the harbor of New York, under the control of the harbor commissioners, is over seventy miles in extent; no part of it can be extended into the rivers beyond the established limits, without doing injustice to the harbor and injustice to those who respect the law.

An instance is before us in the case of pier No. 51, North river, extended beyond the line as above stated; the comptroller of the city having allowed the lessee of pier 52 one thousand dollars reduction on his rent, on account of the damage done to him by the illegal extension.
The committee would recommend to the chamber that application be made to the legislature to legalize the remedies suggested in this report, and to the corporation of this city, that measures be taken to finish the extension of the Battery at once.

In closing their report, the committee would bear testimony to the great and continued interest shown by Professor A. D. Bache, Superintendent of the United States Coast Survey, for the preservation of our harbor, in having obtained and furnished to it all the information necessary to the forming of an intelligent opinion upon the subject under consideration.

GEORGE W. BLUNT.
ROBERT L. TAYLOR.
CHARLES H. MARSHALL.
ROBERT B. MINTURN.
ROYAL PHELPS.
JOHN D. JONES.
GEORGE OPDYKE.
RUSSELL STURGIS.

NEW YORK, November 1, 1859.

APPENDIX No. 14.

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 October, 1859.)

The following tables will enable navigators to ascertain the time and height of high and low water in some of the principal ports of 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 on 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, 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 the 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 from 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 the 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 of the dry dock in the Charlestown navy yard is fourteen feet \( \frac{1}{6} \) (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 \( \frac{1}{6} \) (or 13.97 feet) above mean low water. The letters U. S. C. S. are cut in the same stone.

*This term was introduced by the Rev. Dr. Whewell, who has done so much for the investigation of the laws of the tides.*
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 10/16 (10.13 feet) above mean low water.

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### TABLE I.

Tide table for the coast of the United States.

<table>
<thead>
<tr>
<th>PORT</th>
<th>STATE</th>
<th>DIFFERENCE BETWEEN TIME OF HIGH AND TIME OF LOW WATER</th>
<th>RISE AND FALL</th>
<th>MEAN DURATION OF</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
<td>New York</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
</tr>
<tr>
<td>Hudson River</td>
<td></td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
<td>11:30</td>
</tr>
</tbody>
</table>

*From Major J. D. Graham’s observations.
<table>
<thead>
<tr>
<th>PORT.</th>
<th>STATE.</th>
<th>DIST. BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER</th>
<th>RISE AND FALL</th>
<th>MEAN DURATION OF—</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>k. m. k. m.</td>
<td>k. m.</td>
<td>k. m.</td>
</tr>
<tr>
<td>LONG ISLAND SOUND.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watch Hill</td>
<td>Rhode Island</td>
<td>9</td>
<td>0</td>
<td>6.93</td>
</tr>
<tr>
<td>Stonington</td>
<td>Connecticut</td>
<td>9</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>Little Gull Island</td>
<td>New York</td>
<td>9</td>
<td>28</td>
<td>107</td>
</tr>
<tr>
<td>New London</td>
<td>Connecticut</td>
<td>9</td>
<td>28</td>
<td>53</td>
</tr>
<tr>
<td>New London</td>
<td>do</td>
<td>11</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Sag Harbor</td>
<td>do</td>
<td>11</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Oyster Bay</td>
<td>New York</td>
<td>11</td>
<td>7</td>
<td>51</td>
</tr>
<tr>
<td>Sand Point</td>
<td>do</td>
<td>11</td>
<td>29</td>
<td>21</td>
</tr>
<tr>
<td>New Rochelle</td>
<td>do</td>
<td>11</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Throgs Neck</td>
<td>do</td>
<td>11</td>
<td>29</td>
<td>29</td>
</tr>
</tbody>
</table>

|      |    |    |    |    |    |    |    |    |    |

| COAST OF NEW JERSEY. | | | | | | | | |
| Cold Spring Inlet | New Jersey | 7 | 29 | 51 | 4.4 | 5.4 | 3.5 | 6 | 6.48 | 6.19 |
| Cape May Landing | do | 8 | 19 | 47 | 4.8 | 6.9 | 4.3 | 6.11 | 6.15 | 6.20 |

|      |    |    |    |    |    |    |    |    |    |

| DELAWARE BAY AND RIVER. | | | | | | | | |
| Delaware Breakwater | Delaware | 8 | 0 | 50 | 3.5 | 4.5 | 3.0 | 6 | 6.15 | 6.25 |
| Hopper's Cape May | New Jersey | 8 | 32 | 43 | 4.0 | 6.3 | 3.0 | 6 | 6.96 | 6.0 |
| Egg Island Light | do | 9 | 4 | 51 | 5.0 | 7.0 | 5.1 | 5 | 6.15 | 6.37 |
| Mahon's River | Delaware | 9 | 25 | 48 | 5.9 | 6.9 | 5.0 | 6 | 6.11 | 6.86 |
| Newcastle | do | 11 | 53 | 24 | 5.5 | 6.9 | 6.6 | 5 | 6.43 | 6.47 |
| Philadelphia | Pennsylvania | 13 | 44 | 44 | 9.0 | 8.8 | 5 | 4 | 6.50 | 7.6 |

|      |    |    |    |    |    |    |    |    |    |

| CHEAPAEAKE BAY AND RIVER. | | | | | | | | |
| Old Point Comfort | Virginia | 8 | 17 | 69 | 2.5 | 2.0 | 2.0 | 6 | 6.15 | 6.25 |
| Point Lookout | Maryland | 18 | 58 | 43 | 1.4 | 1.9 | 0.7 | 6 | 6.10 | 6.25 |
| Annapolis | do | 17 | 4 | 40 | 2.9 | 1.0 | 0.6 | 6 | 6.11 | 6.15 |
| Bedlin Light | do | 18 | 8 | 48 | 1.0 | 1.3 | 0.6 | 6 | 7.6 | 7.5 |
| Baltimore | do | 18 | 36 | 44 | 1.3 | 1.5 | 0.6 | 6 | 6.33 | 6.44 |
| Washington | Dist. of Columbia | 19 | 10 | 52 | 3.0 | 3.4 | 9.6 | 6.57 | 6.49 | 6.49 |
| James River, (City Point) | Virginia | 14 | 27 | 1 | 2.8 | 2.9 | 2.5 | 6 | 6.88 | 6.32 |
| Richmond | do | 16 | 54 | 1.8 | 2.9 | 2.4 | 6 | 7.21 | 7.25 |
| Topsham Neck | do | 15 | 58 | 46 | 1.6 | 1.9 | 1.9 | 6 | 7.6 |

|      |    |    |    |    |    |    |    |    |    |

| COAST OF NORTH AND SOUTH CAROLINA, GEORGIA, AND FLORIDA. | | | | | | | | |
| Hatteras Inlet | North Carolina | 7 | 4 | 57 | 2.0 | 2.2 | 1.9 | 6 | 7.7 | 7.7 |
| Beaufort | do | 7 | 36 | 50 | 2.8 | 3.3 | 2.2 | 6 | 6.11 | 6.10 |
| Bald Head | do | 7 | 36 | 34 | 4.3 | 5.9 | 3.4 | 6 | 6.17 | 6.31 |
| Salisbury | do | 7 | 19 | 36 | 4.5 | 5.5 | 3.6 | 6 | 6.68 | 6.96 |
| Wilmington | do | 7 | 6 | 1 | 3.7 | 3.1 | 2.2 | 6 | 6.45 | 7.40 |
| Georgetown entrance | South Carolina | 7 | 56 | 43 | 3.8 | 4.7 | 2.7 | 6 | 6.19 | 6.25 |
| Bull's Island Bay | do | 7 | 15 | 57 | 4.8 | 5.7 | 3.7 | 6 | 6.50 | 6.6 |
| Charleston, (Custom house wharf) | do | 7 | 36 | 45 | 5.1 | 6.0 | 4.3 | 6 | 6.19 | 6.7 |
| St. Helena sound | do | 7 | 8 | 1 | 3.9 | 7.4 | 5.9 | 6 | 6.13 | 6.14 |
| Fort Pulaski, (Savannah entrance) | Georgia | 7 | 90 | 43 | 7.0 | 8.6 | 5.9 | 5 | 6.49 | 6.35 |
| Savannah, (Dry Dock wharf) | do | 8 | 12 | 51 | 8.5 | 7.6 | 5.5 | 5 | 7.82 | 7.9 |
| Doboy Light house | do | 7 | 33 | 55 | 8.6 | 7.8 | 5.4 | 6 | 6.50 | 6.50 |
| St. Simons | do | 7 | 43 | 49 | 8.8 | 8.2 | 5.4 | 6 | 6.46 | 6.16 |
| Fort Clinch | Florida | 7 | 53 | 1 | 5.5 | 6.7 | 5.3 | 6 | 6.37 | 6.37 |
| St. John's River | do | 7 | 39 | 48 | 6.5 | 5.5 | 3.7 | 6 | 6.24 | 6.35 |
| St. Augustine | do | 8 | 21 | 43 | 4.4 | 4.9 | 3.6 | 6 | 6.3 | 6.11 |
| Cape Florida | do | 8 | 34 | 31 | 1.6 | 1.6 | 1.5 | 6 | 6.0 | 6.35 |
| Indian Key | do | 8 | 18 | 40 | 1.6 | 2.4 | 1.9 | 6 | 6.36 | 6.48 |
| Sand Key | do | 8 | 40 | 1.2 | 2.0 | 0.6 | 6 | 6.31 | 5.55 | 13 |
The table below provides information on the rise and fall of mean tides,
mean duration of high water, and the intervals between the transit of the moon
and the time of high water.

<table>
<thead>
<tr>
<th>PORT</th>
<th>STATE</th>
<th>Lat.</th>
<th>Long.</th>
<th>Date</th>
<th>Time</th>
<th>Rise and Fall</th>
<th>Duration</th>
<th>Mean Low Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>KEY WEST</td>
<td>Florida</td>
<td>26° 49' N</td>
<td>82° 20' W</td>
<td>April 12</td>
<td>02:15</td>
<td>3.4 feet</td>
<td>2.1 hours</td>
<td>3.4 feet</td>
</tr>
<tr>
<td>Tamp Bay (Esegunt Key)</td>
<td>Florida</td>
<td>27° 23' N</td>
<td>82° 45' W</td>
<td>April 13</td>
<td>02:15</td>
<td>3.4 feet</td>
<td>2.1 hours</td>
<td>3.4 feet</td>
</tr>
<tr>
<td>Cedar Keys (Depot Key)</td>
<td>Florida</td>
<td>27° 25' N</td>
<td>82° 47' W</td>
<td>April 14</td>
<td>02:15</td>
<td>3.4 feet</td>
<td>2.1 hours</td>
<td>3.4 feet</td>
</tr>
<tr>
<td>St. Mark's</td>
<td>Florida</td>
<td>27° 28' N</td>
<td>82° 50' W</td>
<td>April 15</td>
<td>02:15</td>
<td>3.4 feet</td>
<td>2.1 hours</td>
<td>3.4 feet</td>
</tr>
</tbody>
</table>

**Notes:**
- The mean interval in column 3 has been increased by 12h. 56m. (half a mean lunar day) for some of the ports in Delaware river and Chesapeake bay, so as to show the succession of times from the mouth. Therefore, 12h. 56m. ought to be subtracted from the establishments which are greater than that quantity 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.
- Example I.—It is required to find the time of high water at New York on November 5, 1854. The American Almanac gives 04h. 00m. as the time of transit of the moon on that day. The mean interval for New York, from Table I, column 3, is 8h. 13m., which, as the transit was at 04h., is, roughly, the time of high water. The moon being full, the height is that of spring tides of column 6, viz: 5.4 feet. If the soundings on the chart are reduced to low water spring tides, 5.4 feet are 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 of 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 four feet ten inches.
- Example II.—Required the time of high water at Boston on January 23, 1851. From the
American Almanac we find the time of the moon's southing or transit, on that day, 5h. 18m. a. m., and from Table I the mean interval at Boston dry dock is 11h. 27m.

We have then 5h. 18m. time of transit;
To which add 11 27 mean interval from Table I.

16 45 time of high water, or 4h. 45m. p. m.

If the Greenwich Nautical Almanac is used, add 2m. 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 4h. 44m. 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 minutes, one minute. The time of transit on the date assumed in the preceding example is 17h. 9m. of the 22d, or 5h. 9m. a. m. of the 23d, to which add nine minutes; the correction just found gives 5h. 18m., 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 4h. 45m. p. m., time of high water.

By subtracting the duration of flood tide we obtain the time of the preceding low water, 10h. 32m. a. m., recollecting that 4h. 45m. p. m. is the same as 16h. 45m. reckoned from midnight.

The height of this tide, corresponding to the transit of 5h., 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:

10h. 58m. p. m., time of low water January 23.

Sum 17 11 or 5h. 11m. on January 24.

On 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 ebb together, and their sum to the time of high water found, thus:

6h. 13m. duration of ebb tide, from Table I.

6 13 duration of flood from Table I.

Sum 12 26 duration of whole tide.

4 45 p. m., January 23, time of high water.

Sum 17 11 or 5h. 11m. 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:

4h. 45m. p. m., or 16h. 45m. from midnight, is the time of high water.

12 26 duration of flood and ebb tide.

4 19 a. m. of the 23d for the preceding high water.
The duration of the flood and the ebb being reckoned from the middle of one stand or slack water to the middle of the next, the time of beginning of stand or flood will be found by subtracting half the duration of stand or slack water given by column water to the middle of the next, the time of beginning 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.*

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>h. m.</td>
<td>h. m.</td>
<td>h. m.</td>
<td>h. m.</td>
<td>h. m.</td>
<td>h. m.</td>
<td>h. m.</td>
<td>h. m.</td>
<td>h. m.</td>
<td>h. m.</td>
</tr>
<tr>
<td>0</td>
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<td>8 50</td>
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**TABLE III.**

*Showing the rise and fall of tides, and corrections to be applied to determine the depth at high water of soundings on charts referred to mean low water, and to low water spring tides.*

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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 intervals 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 the Oh. of transit, midnight of the calendar day, or full of the moon, to 11 hours. The numbers for change of the moon correspond to those of Oh., and for 13 hours (or 1A. 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 afterwards, 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 quarters. 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 1A. 24m., astronomical reckoning, or 1A. 24m. p. m., calendar time. From Table II, we have, under the heading of New York, for 1A. 30m., (the nearest number to the 1A. 24m. in the table,) 8A. 10m.

Thus, to 1A. 24m., 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 2, and we must have gone back to the transit of the day before, and computed with it, to obtain the tide of October 1.

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 tides on 1st 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 6h. 0m.; and of ebb, from column 9, is 6h. 25m.; the sum is 12h. 25m.

To 9h. 34m. p. m., October 1, time of high water found,

Add 12 25 duration of flood and ebb.

Sum 21 59, or 9h. 59m. 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 height of the two successive high waters occurring one a. m. the other p. m. of the same twenty-four hours, and the intervals from the next preceding transit of the moon are very different. The 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.

In Puget Sound the inequalities for the interval of high water and for the height of low water follow this rule, but those for the interval of low water and height of high water disappear about one day before the moon's declination is greatest, and are greatest about four or five days before the greatest declination.

When the moon's declination is north, the highest of the two 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 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 12 noon, for example, the tide-gauge marked 8.7 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 $b$ 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. They are 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 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, and to those for San Francisco similar tables have been added for San Diego, Astoria, and Port Townsend. For the other places on the Western Coast given in Table I the following rules will give sufficiently close approximations.

To obtain the times of high or low water for San Pedro, Cuyler's harbor, and San Luis Obispo, compute first the time for San Diego, by Table IV, V, or VIII; then add to the time thus obtained 30 minutes, to obtain the time for San Luis Obispo, and subtract 13 minutes for Cuyler's harbor. At San Pedro the time of high or low water is sensibly the same as at San Diego.

For Monterey, South Farallon, Mare island, Benicia, Ravenswood, and Bodega, compute first the time for San Francisco, then subtract from the time thus obtained 1 h. 44 m. for Monterey, 1 h. 29 m. for the South Farallon, and 49 m. for Bodega, and add 34 m. for Mare island, 1 h. 4 m. for Benicia, and 30 m. for Ravenswood. For Thunderbolt bay, Port Orford, and Neah harbor, compute first the time for Astoria, then subtract from it 40 m. for Humboldt bay, 1 h. 16 m. for Port Orford, and 9 m. for Neah harbor.

For Steilacoom and Semi-ah-moo bay, compute first the time for Port Townsend, and add to it 57 m. for Steilacoom, and 1 h. for Semi-ah-moo. The approximation will be only a rough one for Steilacoom.

For the heights, Tables VI, VII, and IX for San Diego, can be used without change for San Pedro, Cuyler's harbor, and San Luis Obispo. These tables for San Francisco are also applicable to Monterey, South Farallon, and Bodega. For Mare island, add 1.2 foot, for Benicia, 0.9 foot, and for Ravenswood, 2.7 feet to the quantities for San Francisco.

For Humboldt bay, Port Orford, and Neah harbor, the tables for Astoria may be used, subtracting 1.7 foot for Humboldt bay, and 1.0 foot for Port Orford. For Neah harbor, the tables will give approximate results without change.

For Semi-ah-moo bay, add one foot to the quantities in the tables for Port Townsend. For Steilacoom, a rough approximation may be obtained by adding 4.6 feet to them.
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THE UNITED STATES COAST SURVEY.
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**SOUTH DECLINATION—DAYS FROM MOON'S GREATEST DECLINATION.**

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**NORTH DECLINATION—DAYS FROM MOON'S GREATEST DECLINATION.**

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THE UNITED STATES COAST SURVEY.

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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, Cal., on the 7th February, 1853.

1st. The time of the moon's transit at Greenwich, from the Nautical Almanac, is 11h. 41m.; the longitude of San Francisco 8h. 10m.; requiring a correction of 16m. to the time of transit for San Francisco, which is thus found to be 11h. 57m.

2d. The moon's declination is south, and at the time of transit about two days after the greatest. Entering Table IV we find 12h. (or 0h.) of transit, the nearest number to 11h. 57m., which the table gives; and following the line horizontally until we come to two days after the greatest declination we find 13h. 14m.

To 11h. 57m., time of transit of the moon, February 7, San Francisco,

Add 13 14 from column 0h. transit and two days after greatest declination.

The sum 25 11 or 1h. 11m., 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:

11h. 1m., time of transit February 6, 1853,

13 31 number for 11h. transit and one day from greatest declination.

Sum 24 32 time of high water 0h. 32m. a. m. February 7.

The height of high water.—The height of high water is obtained in a similar manner by the use of Table VI and Table 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.

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TABLE VI.—SAN DIEGO.

<table>
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<th>Time of moon's transit</th>
<th>SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.</th>
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#### TABLE VI.—ASTORIA.

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#### TABLE VI.—PORT TOWNSEND.

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**NOTE.** The columns in the table represent the number of days from the moon's greatest declination, with each row indicating a specific time of moon's transit.
TABLE VII.—PORT TOWNSEND.

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<thead>
<tr>
<th>Time of moon's</th>
<th>SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Before—</td>
</tr>
<tr>
<td>1</td>
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<tr>
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</tbody>
</table>

Note.—To use these tables with a chart on which the soundings are referred to mean low water, subtract 1.3 feet from the numbers in the tables from San Diego to Astoria, 1.7 feet for Neah Bay chart, 2.3 for Port Townsend, and 2.7 for Suisun Bay and Rio Vista.

Example VI.—In Example V, to obtain the height of tide on February 7, the declination being south, we enter Table VI, for San Francisco, with 0° of transit, and two days after greatest declination, and find that the tide will be 4.5 feet above the mean of the lowest low water, or that 4.5 feet are to be added to the soundings of a chart reduced to the mean of the lowest lows of each day. If the soundings of the chart were given for mean low water, then 1.2 feet ought to be subtracted from the Tables VI and VII; thus, in this example, it would be 3.3 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.

Tables 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.

TABLE VIII.—SAN DIEGO.

<table>
<thead>
<tr>
<th>Days from moon's</th>
<th>SOUTH DECLINATION.</th>
<th>SOUTH DECLINATION.</th>
<th>Days from moon's</th>
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<tbody>
<tr>
<td>Low water.</td>
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<td>Low water.</td>
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<tr>
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<td>(Large.)</td>
<td>(Large.)</td>
<td>(Small.)</td>
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<td>10 29</td>
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<td>10 08</td>
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<tr>
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TABLE VIII.—SAN FRANCISCO.

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<tr>
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TABLE VIII.—ASTORIA.

<table>
<thead>
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<th>Days from month's</th>
<th>SOUTH DECLINATION.</th>
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<tbody>
<tr>
<td></td>
<td>Low water. (Small.)</td>
<td>High water. (Large.)</td>
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<tr>
<td></td>
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<tr>
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<td>5 56</td>
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<td>6 11</td>
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<td>6 35</td>
</tr>
<tr>
<td></td>
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<td>6 35</td>
</tr>
</tbody>
</table>
The days from the 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 of Diagram I. The third contains the numbers to be added to the same to give the second or large high water of Diagram I. The fourth, the numbers to be added to the same to give the second or large low water of Diagram I. The succeeding columns give the numbers to be used in the same way for north declination, to obtain the low water (large) of Diagram II; the high water (small) and the low water (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 waters $b c$ 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.—SAN DIEGO.

#### SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER.

<table>
<thead>
<tr>
<th>Days from moon's greatest declination.</th>
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<tbody>
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<td>3.8</td>
<td>3.9</td>
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<td>2.6</td>
<td>2.7</td>
<td>2.8</td>
<td>2.9</td>
</tr>
</tbody>
</table>

#### LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.

<table>
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<tr>
<th>Days from moon's greatest declination.</th>
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<tr>
<td>Hours of moon's transit.</td>
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<td>9</td>
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**TABLE IX.—SAN DIEGO.** Continued.
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<tr>
<th>TABLE IX.—SAN FRANCISCO.</th>
<th>TABLE IX.—SAN FRANCISCO—Continued.</th>
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</table>

**From moon's greatest declination.**

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<th>Days from moon’s greatest declination.</th>
<th>Days from small water to large high water.</th>
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**From small water to large high water.**

<table>
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<th>Days from moon’s greatest declination.</th>
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**From large high water to small low water.**

<table>
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**From large low water to small high water.**

<table>
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TABLE IX.—ASTORIA—Continued.

**SMALL EBBS, OR FROM SMALL HIGH WATER TO SMALL LOW WATER.**

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**FROM LARGE LOW WATER TO LARGE HIGH WATER.**

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</table>

**TABLE IX.—ASTORIA—Continued.**

**LARGE EBBS, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.**

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<th>Days from moon's greatest declination.</th>
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<th>After—</th>
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<tr>
<td>1</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

**FROM LARGE LOW WATER TO SMALL HIGH WATER.**

<table>
<thead>
<tr>
<th>Days from moon's greatest declination.</th>
<th>Before—</th>
<th>After—</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE IX.—PORT TOWNSHEND.

<table>
<thead>
<tr>
<th>Days from moon's greatest declination.</th>
<th>Days from moon's greatest high water.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong></td>
<td><strong>After</strong></td>
</tr>
<tr>
<td>Hours of moon's transit.</td>
<td>Hours of moon's transit.</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>2.5 4.0 5.5 7.0 8.5 10.0 11.5 13.0 14.5 16.0 17.5 19.0 20.5 22.0 23.5</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>7.5 9.0 10.5 12.0 13.5 15.0 16.5 18.0 19.5 21.0 22.5 24.0 25.5 27.0 28.5</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>4.5 6.0 7.5 9.0 10.5 12.0 13.5 15.0 16.5 18.0 19.5 21.0 22.5 24.0 25.5</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>2.5 4.0 5.5 7.0 8.5 10.0 11.5 13.0 14.5 16.0 17.5 19.0 20.5 22.0 23.5</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>2.5 4.0 5.5 7.0 8.5 10.0 11.5 13.0 14.5 16.0 17.5 19.0 20.5 22.0 23.5</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>2.5 4.0 5.5 7.0 8.5 10.0 11.5 13.0 14.5 16.0 17.5 19.0 20.5 22.0 23.5</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
<tr>
<td>2.5 4.0 5.5 7.0 8.5 10.0 11.5 13.0 14.5 16.0 17.5 19.0 20.5 22.0 23.5</td>
<td>Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl. Fl.</td>
</tr>
</tbody>
</table>

**Example VII.**—Thus, in Example VI, the high water of February 7 was found to be 3.3 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, for San Francisco, with 0h. of moon's transit, and two days after the greatest declination in the first part of the table, and find 1.9 foot, 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 3.0 feet, which is the rise of the large high above the small low water; the difference between 1.9 and 3.0 or 1.1 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.
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 the moon's zero declination. At all other times there is but one high water in the day, with a long stand of from 6 to 9 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 rendered quite irregular.
TABLE X.
Rise and fall at several stations on the Gulf of Mexico.

| STATIONS                                      | MEAN RISE AND FALL OF TIDES |             |             |
|-----------------------------------------------|----------------------------|-------------|
|                                               | Mean.                      | At moon’s   | At moon’s   |
|                                               |                            | greatest    | least       |
|                                               | ft.                        | declination.| declination.|
| 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 TIDES 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 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.

<table>
<thead>
<tr>
<th>Time before or after high water.</th>
<th>NEW YORK.</th>
<th>OLD POINT COMFORT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.m.</td>
<td>h.m.</td>
<td>h.m.</td>
</tr>
<tr>
<td>0 0</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0 30</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>1 0</td>
<td>0.94</td>
<td>0.93</td>
</tr>
<tr>
<td>1 30</td>
<td>0.89</td>
<td>0.86</td>
</tr>
<tr>
<td>2 0</td>
<td>0.80</td>
<td>0.72</td>
</tr>
<tr>
<td>2 30</td>
<td>0.72</td>
<td>0.59</td>
</tr>
<tr>
<td>3 0</td>
<td>0.60</td>
<td>0.45</td>
</tr>
<tr>
<td>3 30</td>
<td>0.49</td>
<td>0.31</td>
</tr>
<tr>
<td>4 0</td>
<td>0.39</td>
<td>0.10</td>
</tr>
<tr>
<td>4 30</td>
<td>0.28</td>
<td>0.10</td>
</tr>
<tr>
<td>5 0</td>
<td>0.18</td>
<td>0.02</td>
</tr>
<tr>
<td>5 30</td>
<td>0.09</td>
<td>0.00</td>
</tr>
<tr>
<td>6 0</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>6 30</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

TIDES IN COASTING.

By observing the time of high water and low water along the coast we find the places at which they are the same. The map of co-tidal lines (Sketch No. 65, C. S. Rep., 1857,) shows that it is high water nearly at the same hour all along the coast from Sandy Hook to Cape Cañaveral; 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 Cañaveral. 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 navigators 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 Jersey, the line of XII hours is nowhere more than 18 miles from the coast; that of XI½ nowhere more than 35 miles; that of XI¼ nowhere more than 48; and XI nowhere more than 110. The distance 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 from Table A, where the first column gives the name of the place, and the second, third, fourth, fifth, respectively, the distances of the co-tidal lines of XII, XI½, XI¼, and 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 XI½ and XI¼ hours.

A.

<table>
<thead>
<tr>
<th>Names of locations</th>
<th>Distance from coast, measured on perpendicular to co-tidal lines.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At XII hours.</td>
</tr>
<tr>
<td>Barnegat</td>
<td>12</td>
</tr>
<tr>
<td>Cape May</td>
<td>2</td>
</tr>
<tr>
<td>Cape Henlopen</td>
<td>15</td>
</tr>
<tr>
<td>Assateague</td>
<td>18</td>
</tr>
<tr>
<td>Cape Henry</td>
<td>7</td>
</tr>
<tr>
<td>Cape Hatteras</td>
<td>12</td>
</tr>
<tr>
<td>Ocracoke inlet</td>
<td>8</td>
</tr>
<tr>
<td>Cape Lookout</td>
<td>11</td>
</tr>
<tr>
<td>Beaufort entrance, North Carolina</td>
<td>7</td>
</tr>
<tr>
<td>Cape Fear</td>
<td>6</td>
</tr>
<tr>
<td>Cape Roman</td>
<td>6</td>
</tr>
<tr>
<td>Charleston light</td>
<td>10</td>
</tr>
<tr>
<td>Port Royal entrance</td>
<td>6</td>
</tr>
<tr>
<td>Tybee entrance</td>
<td>5</td>
</tr>
<tr>
<td>St. Mary's entrance</td>
<td>12</td>
</tr>
<tr>
<td>St. John's entrance</td>
<td>17</td>
</tr>
<tr>
<td>Cape Canaveral</td>
<td>16</td>
</tr>
<tr>
<td>Cape Florida</td>
<td></td>
</tr>
</tbody>
</table>

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 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.
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, a 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 to the southward and off shore, he would know 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 time 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 to the south of it, as shown by the lines on the chart accompanying this paper.—(See Sketch No. 65, C. S. Rep., 1857.) 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.

<table>
<thead>
<tr>
<th>Names of stations</th>
<th>Co-tidal hour at 10, 20, and 30 nautical miles from the coast, perpendicular to the coast.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ten miles off.</td>
</tr>
<tr>
<td>Sandy Hook</td>
<td>12 0</td>
</tr>
<tr>
<td>Barnegat</td>
<td>11 57</td>
</tr>
<tr>
<td>Cape May</td>
<td>12 5</td>
</tr>
<tr>
<td>Cape Henlopen</td>
<td>12 7</td>
</tr>
<tr>
<td>Assateague</td>
<td>12 5</td>
</tr>
<tr>
<td>Cape Henry</td>
<td>11 45</td>
</tr>
<tr>
<td>Cape Hatteras</td>
<td>11 47</td>
</tr>
<tr>
<td>Ocracoke inlet</td>
<td>11 45</td>
</tr>
<tr>
<td>Cape Lookout</td>
<td>11 55</td>
</tr>
<tr>
<td>Beaufort entrance, North Carolina</td>
<td>11 58</td>
</tr>
<tr>
<td>Cape Fear</td>
<td>11 45</td>
</tr>
<tr>
<td>Cape Henry</td>
<td>11 52</td>
</tr>
<tr>
<td>Charleston light</td>
<td>11 57</td>
</tr>
<tr>
<td>Port Royal entrance</td>
<td>11 55</td>
</tr>
<tr>
<td>Tybee entrance</td>
<td>12 8</td>
</tr>
<tr>
<td>St. Mary's entrance</td>
<td>12 7</td>
</tr>
<tr>
<td>St. John's entrance</td>
<td>12 8</td>
</tr>
<tr>
<td>Cape Casaveral</td>
<td>13 10</td>
</tr>
</tbody>
</table>
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 that 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 will 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 6 hours 15 minutes, and then the ebb for another 6 hours 15 minutes, and so on. It is the simplest of all rules that has thus come out of this investigation. That remarkable change of the temperature between the waters of the inshore cold current, and 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 distance 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 shows these distances, measured at right angles and on the parallels.
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 on the 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 time 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.

### Table E: Co-tidal hours on sailing lines between New York and—

<table>
<thead>
<tr>
<th>Off—</th>
<th>Newport</th>
<th>New Bedford</th>
<th>Nantucket</th>
<th>Boston</th>
<th>Portsmouth</th>
<th>Portland</th>
<th>Halifax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy Hook</td>
<td>16 16</td>
<td>16 16</td>
<td>16 16</td>
<td>16 16</td>
<td>16 16</td>
<td>16 16</td>
<td>16 16</td>
</tr>
<tr>
<td>Throg's Point</td>
<td>13 48</td>
<td>13 48</td>
<td>12 48</td>
<td>12 48</td>
<td>12 48</td>
<td>12 48</td>
<td>12 48</td>
</tr>
<tr>
<td>Fisher's Island</td>
<td>12 16</td>
<td>12 16</td>
<td>12 16</td>
<td>12 16</td>
<td>12 16</td>
<td>12 16</td>
<td>12 16</td>
</tr>
<tr>
<td>Block Island</td>
<td>16 10</td>
<td>16 10</td>
<td>16 10</td>
<td>16 10</td>
<td>16 10</td>
<td>16 10</td>
<td>16 10</td>
</tr>
<tr>
<td>Monomoy</td>
<td>14 35</td>
<td>14 35</td>
<td>14 35</td>
<td>14 35</td>
<td>14 35</td>
<td>14 35</td>
<td>14 35</td>
</tr>
<tr>
<td>Cape Cod</td>
<td>15 00</td>
<td>15 00</td>
<td>15 00</td>
<td>15 00</td>
<td>15 00</td>
<td>15 00</td>
<td>15 00</td>
</tr>
<tr>
<td>Cape Ann</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 two hours and forty-five 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 two hours and twenty 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 one hour and forty 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 shore 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 sound. 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 greatest 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 Cañaveral, 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 long been 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 XII3 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. 15.

Report of the Superintendent of the United States: extracted from the list of 1857 and revised with additions and lost data.

#### Table showing the depth of water in the channels of certain harbors, rivers, and anchorages on the coasts of the

<table>
<thead>
<tr>
<th>Place</th>
<th>Depth at Low Water</th>
<th>Depth at High Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
<td>10 ft.</td>
<td>12 ft.</td>
</tr>
<tr>
<td>New Haven</td>
<td>8 ft.</td>
<td>10 ft.</td>
</tr>
<tr>
<td>Portland, Maine</td>
<td>6 ft.</td>
<td>8 ft.</td>
</tr>
<tr>
<td>Providence</td>
<td>4 ft.</td>
<td>6 ft.</td>
</tr>
<tr>
<td>Newport, Mass.</td>
<td>3 ft.</td>
<td>5 ft.</td>
</tr>
<tr>
<td>Boston, Mass.</td>
<td>2 ft.</td>
<td>4 ft.</td>
</tr>
<tr>
<td>Newburyport</td>
<td>1 ft.</td>
<td>3 ft.</td>
</tr>
<tr>
<td>Newport, R.I.</td>
<td>0 ft.</td>
<td>2 ft.</td>
</tr>
</tbody>
</table>

#### Notes:

- The depth in channel may vary between 8 and 10 feet.
- A small amount, with 3 feet left in the middle of the channel, is open at all times.
- The depth of water is given at all times, but the figures are subject to change.
- The channel may vary between 6 and 8 feet.
- The depth of water is given at all times, but the figures are subject to change.

---

**Depth of Water in Channels, etc.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth at Low Water</th>
<th>Depth at High Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
<td>10 ft.</td>
<td>12 ft.</td>
</tr>
<tr>
<td>New Haven</td>
<td>8 ft.</td>
<td>10 ft.</td>
</tr>
<tr>
<td>Portland, Maine</td>
<td>6 ft.</td>
<td>8 ft.</td>
</tr>
<tr>
<td>Providence</td>
<td>4 ft.</td>
<td>6 ft.</td>
</tr>
<tr>
<td>Newport, Mass.</td>
<td>3 ft.</td>
<td>5 ft.</td>
</tr>
<tr>
<td>Boston, Mass.</td>
<td>2 ft.</td>
<td>4 ft.</td>
</tr>
<tr>
<td>Newburyport</td>
<td>1 ft.</td>
<td>3 ft.</td>
</tr>
<tr>
<td>Newport, R.I.</td>
<td>0 ft.</td>
<td>2 ft.</td>
</tr>
</tbody>
</table>

---

**Limit between which depths are given:**

- New York: 10 ft. - 12 ft.
- New Haven: 8 ft. - 10 ft.
- Portland, Maine: 6 ft. - 8 ft.
- Providence: 4 ft. - 6 ft.
- Newport, Mass.: 3 ft. - 5 ft.
- Boston, Mass.: 2 ft. - 4 ft.
- Newburyport: 1 ft. - 3 ft.
### Delaware River

- Main ship channel, passing Delaware Breakwater
- Off Breakwater light house
- Main ship channel, passing Goose Island to entrance of Bombay Hook light
- Western Breakwater, strong Peggy wind
- Breakwater channel, passing Waway Light
- Main ship channel, passing Bombay Hook light
- Opposite Bombay Hook City
- Up to Philadelphia Creek Light
- Opposite Camden Light
- Off Hug Point
- Between Heads Point and Gloucester Point
- From Greenwich Light up to Philadelphia
- Entrance to sound at entrance of New Jersey head
- From Hamburger Point to Camden Point
- South of Camden Point (one mile and a half)
- Up to North Point range
- From Hamburger Point to James river, entering to the north sound at South New Jersey main ground
- From Hampton Roads to James river, entering to the south sound at South New Jersey main ground
- York river, Va.
- Elizabeth river, Va.
- Eastern area, N. C.
- Entrance
- Anchorage in Hampton Roads
- From Hampton Roads to New Point Comfort
- Anchorage near Philadelphia Channel
- Anchor point Sound
- Entrance to Light House Point
- From light house point to line joining Newark Point and ship bank, near the mouth of Little Cayman sound
- Thence up the sound to Martinez Point
- Anchorage near the mouth of Rappahannock River
- Anchor point Sound
- North river, N. C.
- Bennett river, N. C.
- Cape Fear
- New River bar
- Georgetown
- Entrance to Winyah Bay, East and Southeast Point
- Bull's bay
- AlbemarleSound
- New Point Comfort
- North Edisto
- St. Helena Sound
- Fort Royal
- South Channel
- Tybee Entrance
- Savannah
- Beaufort, N. C.
- Doboy bar (Inlet)
- Jong Island
- St. Simons
- Tybee island
- St. Mary's
- St. John's river, Fla.
- Florida reefs

### Limits between which depths are given.

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Spring tide</th>
<th>Neap tide</th>
<th>Authorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low water</td>
<td>High water</td>
<td>Low water</td>
<td>High water</td>
</tr>
<tr>
<td>Delaware River</td>
<td>15.5</td>
<td>18.3</td>
<td>15.3</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>8.6</td>
<td>10.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Cape Fear</td>
<td>7.9</td>
<td>10.5</td>
<td>7.5</td>
</tr>
<tr>
<td>North Edisto</td>
<td>12.2</td>
<td>15.0</td>
<td>12.0</td>
</tr>
<tr>
<td>St. Helena Sound</td>
<td>7.7</td>
<td>10.0</td>
<td>7.4</td>
</tr>
<tr>
<td>Tybee Island</td>
<td>15.6</td>
<td>15.5</td>
<td>14.2</td>
</tr>
<tr>
<td>Savannah</td>
<td>14.4</td>
<td>15.4</td>
<td>14.0</td>
</tr>
<tr>
<td>Beaufort, N. C.</td>
<td>8.7</td>
<td>11.6</td>
<td>8.4</td>
</tr>
<tr>
<td>Doboy bar, (Inlet)</td>
<td>11.5</td>
<td>14.7</td>
<td>11.5</td>
</tr>
<tr>
<td>St. Simons</td>
<td>7.7</td>
<td>10.0</td>
<td>7.4</td>
</tr>
<tr>
<td>Tybee Island</td>
<td>15.6</td>
<td>15.5</td>
<td>14.2</td>
</tr>
<tr>
<td>St. Mary's</td>
<td>15.6</td>
<td>15.5</td>
<td>14.2</td>
</tr>
<tr>
<td>St. John's River, Fla.</td>
<td>15.6</td>
<td>15.5</td>
<td>14.2</td>
</tr>
</tbody>
</table>

### Authorities

- C. R., from 1840 to 1844, inclusive.
- C. R., from 1840 to 1844, inclusive.
- United States Coast Survey.

### Notes

- Soundings varying between 10 and 12 fathoms.

---

**APPENDIX No. 15—Continued.**
### REPORT OF THE SUPERINTENDENT OF APPENDIX No. 15—Continued.

<table>
<thead>
<tr>
<th>Places</th>
<th>Limits between which depths are given</th>
<th>Low water</th>
<th>Mean</th>
<th>High water</th>
<th>Spring tides</th>
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</thead>
<tbody>
<tr>
<td>Key West</td>
<td>Main ship channel to middle buoy on channel</td>
<td>Port</td>
<td>Port</td>
<td>Port</td>
<td>1855 and 1861.</td>
</tr>
<tr>
<td></td>
<td>From channel to entrance</td>
<td>30</td>
<td>22.5</td>
<td>20.5</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>On course N.W. and W. (light on O'Hara's buoy)</td>
<td>29</td>
<td>23.1</td>
<td>21.9</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>From course to channel to entrance</td>
<td>30</td>
<td>23.1</td>
<td>21.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>At channel entrance</td>
<td>27</td>
<td>22.5</td>
<td>21.1</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Rock Key channel</td>
<td>26</td>
<td>22.0</td>
<td>20.8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Main channel</td>
<td>27</td>
<td>23.1</td>
<td>21.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>West channel</td>
<td>30</td>
<td>22.5</td>
<td>20.5</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Northw. channel on opposite side</td>
<td>23</td>
<td>23.1</td>
<td>21.9</td>
<td>16</td>
</tr>
<tr>
<td>Torugas</td>
<td>Over bar</td>
<td>12</td>
<td>13.3</td>
<td>11.9</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Over bar</td>
<td>19</td>
<td>14.0</td>
<td>12.6</td>
<td>16</td>
</tr>
<tr>
<td>Tampa bay</td>
<td>Channel between Egmont and Passage Key</td>
<td>10</td>
<td>13.0</td>
<td>11.6</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Channel up to entrance</td>
<td>8</td>
<td>11.6</td>
<td>10.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Cedar Keys</td>
<td>11</td>
<td>13.0</td>
<td>11.5</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Northwest channel over bar</td>
<td>11</td>
<td>13.6</td>
<td>12.0</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Over bar</td>
<td>8</td>
<td>11.9</td>
<td>11.5</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Channel at Middle bar</td>
<td>12</td>
<td>14.2</td>
<td>12.8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>In mid-channel, off light house</td>
<td>13</td>
<td>17.2</td>
<td>15.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Up to Port of Mark's</td>
<td>14</td>
<td>19.2</td>
<td>17.8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Middle sound</td>
<td>14</td>
<td>14.2</td>
<td>12.8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>In mid-channel, off bar</td>
<td>13</td>
<td>15.5</td>
<td>14.2</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>On course</td>
<td>13</td>
<td>15.0</td>
<td>13.7</td>
<td>16</td>
</tr>
<tr>
<td>Apalachee</td>
<td>Over bar</td>
<td>10</td>
<td>15.0</td>
<td>13.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>In mid-channel, off bar</td>
<td>10</td>
<td>15.0</td>
<td>13.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Mass ship channel, over bar</td>
<td>12</td>
<td>14</td>
<td>12.6</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Wreck channel, over bar</td>
<td>7</td>
<td>8</td>
<td>6.6</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>West Pass, over bar</td>
<td>9</td>
<td>11</td>
<td>9.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Port bar</td>
<td>32.5</td>
<td>23.5</td>
<td>21.2</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>From bar to navy yard</td>
<td>27</td>
<td>26.3</td>
<td>24.0</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Off north of Pensacola</td>
<td>10</td>
<td>8.2</td>
<td>6.8</td>
<td>16</td>
</tr>
<tr>
<td>Mobile bay and river</td>
<td>Over bar</td>
<td>11</td>
<td>10.2</td>
<td>8.8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Main ship channel in Port Morgan</td>
<td>27</td>
<td>36.3</td>
<td>30.3</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>To upper flood</td>
<td>13</td>
<td>12</td>
<td>11.2</td>
<td>12</td>
</tr>
<tr>
<td>Mississippi sound</td>
<td>From Grant's Pass to Pensacola main wharf</td>
<td>7.5</td>
<td>8.7</td>
<td>7.3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Island Pass, over bar</td>
<td>15</td>
<td>13.2</td>
<td>11.8</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Authorize flood</td>
<td>19</td>
<td>20.3</td>
<td>18.7</td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td>Off north of Pensacola main wharf</td>
<td>8</td>
<td>9</td>
<td>7.7</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Ship channel, over bar</td>
<td>10.5</td>
<td>15.0</td>
<td>13.6</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Authorize, Main-of-war bar</td>
<td>15</td>
<td>17.3</td>
<td>16.0</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Ship channel</td>
<td>15</td>
<td>19.1</td>
<td>17.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>South Pass</td>
<td>14</td>
<td>13.3</td>
<td>12.0</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Shell Bank channel</td>
<td>15</td>
<td>16.5</td>
<td>15.1</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>South Sound</td>
<td>9.5</td>
<td>10.5</td>
<td>9.3</td>
<td>10.7</td>
</tr>
<tr>
<td>Ship Island harbor</td>
<td>Ship channel</td>
<td>18</td>
<td>20.3</td>
<td>18.7</td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td>Northwest channel</td>
<td>15</td>
<td>19.1</td>
<td>17.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Authorize flood</td>
<td>19</td>
<td>20.3</td>
<td>18.7</td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td>Ship channel</td>
<td>15</td>
<td>19.1</td>
<td>17.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>South Pass</td>
<td>14</td>
<td>13.3</td>
<td>12.0</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>North Pass</td>
<td>9.5</td>
<td>10.5</td>
<td>9.3</td>
<td>10.7</td>
</tr>
<tr>
<td></td>
<td>South Channel</td>
<td>9.5</td>
<td>10.5</td>
<td>9.3</td>
<td>10.7</td>
</tr>
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<td>10.5</td>
<td>9.3</td>
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<td></td>
<td>North entrance</td>
<td>9.5</td>
<td>10.5</td>
<td>9.3</td>
<td>10.7</td>
</tr>
<tr>
<td></td>
<td>South Channel</td>
<td>15</td>
<td>19.1</td>
<td>17.7</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>South entrance</td>
<td>12</td>
<td>14.5</td>
<td>13.2</td>
<td>15.5</td>
</tr>
<tr>
<td></td>
<td>West Channel</td>
<td>7.5</td>
<td>8.7</td>
<td>7.3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>West bar opposite of Grand Pass</td>
<td>12</td>
<td>15.9</td>
<td>14.7</td>
<td>16.4</td>
</tr>
<tr>
<td></td>
<td>Grand passage to Isabella island</td>
<td>27</td>
<td>28.4</td>
<td>26.7</td>
<td>28.8</td>
</tr>
<tr>
<td></td>
<td>Channel north of Ship Island, one mile from bend of barrier bar</td>
<td>14</td>
<td>15.4</td>
<td>13.7</td>
<td>15.8</td>
</tr>
<tr>
<td>Derisier or East Island</td>
<td>West Channel</td>
<td>8</td>
<td>9.6</td>
<td>8.0</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>Channel north of Ship Island, one mile from bend of Derisier bar</td>
<td>6.5</td>
<td>8.1</td>
<td>6.5</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td>From channel to opposite main wharf</td>
<td>48</td>
<td>49.0</td>
<td>46.3</td>
<td>50.0</td>
</tr>
<tr>
<td>Aucathalia bay</td>
<td>By shallow</td>
<td>2.5</td>
<td>3.4</td>
<td>2.5</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>From entrance of Channel bar</td>
<td>40</td>
<td>43.2</td>
<td>41.6</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>From entrance of Channel bar to opposite main wharf</td>
<td>27</td>
<td>28.3</td>
<td>26.5</td>
<td>28.8</td>
</tr>
<tr>
<td></td>
<td>North Channel</td>
<td>15</td>
<td>19.1</td>
<td>17.7</td>
<td>16</td>
</tr>
<tr>
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* The highest tides occur at the moon's greatest declination, and are applied in the column headed "spring tide."
### Least Water in Channel Way

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* Notes: Low water levels are given in feet above mean low water.

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Note: teammates are either directly available on the coast or can be obtained by note (as) boat at low tide.
APPENDIX No 16.

Table for navigators, showing the variation of the compass for the year 1858, compiled from the general chart of F. J. Evans, R. N.—(See Sketch No. 38.)

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REPORT OF THE SUPERINTENDENT OF
### APPENDIX No. 16—Continued.

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**THE UNITED STATES COAST SURVEY**

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173
APPENDIX No. 16—Continued.

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**REPORT OF THE SUPERINTENDENT OF**
## APPENDIX No. 16—Continued.

### EAST LONGITUDE.

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### VARIATION OF THE COMPASS.

| No. | APPENDIX |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-----|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|     |          |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

**THE UNITED STATES COAST SURVEY**

116
APPENDIX No. 17.


COAST SURVEY OFFICE, October 1, 1859.

DEAR SIR: In conformity with the instructions of the Superintendent, I have the honor to submit herewith the usual annual reports of the chiefs of the different divisions of the Coast Survey office. These reports narrate with critical exactness the amount of work executed in this office since my first report, dated one year ago.

It will doubtless be apparent to the Superintendent, from a close examination of these reports, that the quantity of work done has been so great that it could only have been accomplished by steady industry and attention to duty on the part of those engaged in it.

The character of the work and the execution of the finished maps, in my judgment, merit high praise; yet the loss of some three or more able assistants during the past year is severely felt by this office; industry, zeal, and intelligence on the part of those who have succeeded to their duties will soon, I hope, enable them to thoroughly fill the places of their predecessors.

Three officers of the army, viz: First Lieut. J. C. Tidball, 2d artillery, First Lieut. R. Saxton, 4th artillery, and First Lieut. J. P. Roy, 2d infantry, have been detached from duty within the past year, and two officers only, viz: First Lieut. J. R. Smead, 2d artillery, and First Lieut. Thomas Wilson, 5th infantry, have been assigned to duty here.

I shall now refer to the different divisions of this office in their order of precedence, commencing with the—

Computing Division.—This division, the varied labors of which includes all the computations and comparisons necessary in the primary, secondary, and tertiary triangulations, the astronomical, chronometric, and magnetic observations, measurements of bases, and, in addition, many incidental calculations, remains under the charge of its experienced chief, Assistant C. A. Schott.

One of the computers (Mr. J. Wiessner) resigned on the 1st of April last, to join one of the western exploring expeditions. The report herewith submitted will furnish the Superintendent with the details of occupation of his six assistants and himself during the past year.

Tidal Division.—The tidal division is under the charge of Assistant L. F. Pourtales, who is assisted by five regular computers, and such “aids” as may be available from time to time in the intervals of their field service; their names and occupation are given in the annexed report of the chief of the division. In addition to the regular duties of this division, in reducing and furnishing to the office the requisite tidal data for our charts, it has other special occupations under the immediate direction of the Superintendent, as will be seen by reference to Appendix No. 27.

Drawing Division.—This division, First Lieutenanit J. C. Tidball, 2d artillery, in charge until 30th of June last, has not only promptly executed the various demands that have been constantly made upon it, in the projecting, upon the sheets required by the parties in the field, of the astronomical and trigonometrical points, in the furnishing of many tracings for the different departments and bureaus of the government, for office use, for public corporations, and for
many private citizens, (these latter tracings being given only with the sanction of the honorable Secretary of the Treasury,) but has also with a reduced force gained a further advance upon the engraving. In the language of First Lieutenant T. Wilson, 5th infantry, who, three months since, succeeded to the charge of this division, "Confidence is felt in its ability to meet in a prompt and satisfactory manner every demand that can be made upon it."

The Superintendent will doubtless concur with me in the expression of regret which all who have been associated with him feel at the loss to this office of the services of First Lieutenant J. C. Tidball, 2d artillery. He received orders to join his regiment on the 12th of August last, thus dissolving his connection with this work.

Lieut. Wilson's report, hereto annexed, and the lists accompanying it, will acquaint the Superintendent with the progress of the division, and the special occupation of each of the draughtsmen during the past year.

**Engraving Division.**—The division of the Coast Survey office to which I deem it my duty most particularly to invite the attention of the Superintendent at the present time is that of the engraving, which, notwithstanding the increase in force in various grades of engravers a few years since, is hardly at the present time able to keep up with the Drawing Division. A thorough study of the details of this subject will, no doubt, enable us to apply the remedy. As you have this subject under special consideration, I do not deem it necessary at present to enlarge upon it.

The charge of this division for the first half of the year continued with First Lieut. Rufus Saxton, U. S. A., when his detail by the War Department for duty at the United States Military Academy, at West Point, deprived this office of his valuable services.

During the past six months Mr. Edward Wharton succeeded to the duties of Lieut. Saxton. His zeal and industry merit my commendation.

**Electrotype Division.**—Under the direction of Mr. George Mathiot, chief electrotypist, assisted by Mr. D. Hinkle, this division has made during the present year eighty-seven copies of engraved plates, eighty-three being for the use of this office and four for other departments of the government, thus preserving unimpaired our original or standard plates, and using, in lieu of them, the electrotypes for printing.

I had the honor to state, in my previous report, that increased success had followed the experiments in photography, especially with a view to its use in the preparation of the reductions from the original plane-table sheets, and I have now the satisfaction of stating that, to a great extent, these reductions have proved successful. I would instance that of coast chart No. 29, from Green Run inlet to Little Machipongo inlet, Virginia, a proof of which was submitted to the Superintendent on the 28th of July last, after having been engraved from the photographic reduction. I have examined with care the criticisms of both the Drawing and Engraving Divisions upon it; it has been pronounced accurate. The cost of this reduction did not exceed one-fourth the cost of making the same reduction by hand.

Two other reductions, viz: San Pablo, California, and New York bay and harbor, also having been subjected to the closest criticism of experts in both the Drawing and Engraving Division, and proving accurate, are being now engraved as received from the photographer.

The report of the chief electrotypist, hereto appended, promises additional results by the use of photography in other branches of the survey.
Archives and Library.—The arrangement for the archives continues unchanged. The very limited space remaining for the records of the survey at the date of the last annual report is being rapidly filled, and great inconvenience is felt from the want of sufficient room for the proper disposal of those turned in from day to day, from the various field and hydrographic parties. There have been added to the library, during the calendar year 1859, one hundred and sixteen volumes, of which fifty were presented to the survey from home departments and institutions, and from those of foreign governments.

Miscellaneous division.—As stated in my last annual report the miscellaneous division, consisting of the printing and distribution of maps, charts, and Coast Survey Reports, had only then been organized less than a year and had improved upon its previous separate working. The experience of the year exhibits a large advancement upon the results then stated, without an increase in the number of its employés. The number of impressions from Coast Survey maps, charts, and sketches printed, amounting to over fifteen thousand, including proofs for distribution, quarterly records, &c., against near twelve thousand of the previous year. With this increase, still, the number of impressions taken is scarcely up to the demand made upon the office by our sale agents and for the distribution to libraries and other institutions authorized by the Treasury Department, which amounted in the last year to far more than double the number distributed in the previous year, including seven thousand eight hundred impressions of thirteen charts, sent to the principal departments of the government to foreign institutions, &c., and to certain libraries and other public depositories designated by members of the House of Representatives in their respective districts throughout the entire country.

The distribution of the Superintendent's Annual Report for 1857, from the time of its reception from the congressional binders, was made in less time than in any previous year. The annual report for the past year, it is confidently hoped, will be ready for distribution by the commencement of the coming session of Congress. It will, doubtless, be a source of much regret to those who have heretofore received the results of the operations of the Coast Survey in this form, that the number of extra copies ordered by Congress was reduced to five thousand from the twenty thousand, heretofore distributed by members of Congress direct to their constituents, and from this office to foreign governments and institutions, the libraries of our vessels-of-war, of colleges, and scientific institutions, and to individuals interested in science, commerce, and navigation throughout the Union.

This division is under the charge of First Lieut. J. R. Smead, U. S. A., who, in June last, relieved his predecessor, First Lieut. J. P. Roy, U. S. A., the valuable services of the latter having been called for by the War Department.

I would respectfully call the attention of the Superintendent to the details of work as reported by Lieut. Smead, which is hereto submitted.

Carpentry.—The carpenters' work necessary for the use and transportation of instruments for the surveying parties has been at all times during the year promptly executed. There have been made twelve new stands and thirty-three fine cases for instruments; twenty-six drawing and plane-table boards; seven large cases for books, maps, and copper-plates; five large vats, and eighteen frames for electrolyte and photograph purposes; patterns for castings, and one hundred and forty-three packing boxes; the wood-work for two self-registering tide-gauges, and new instruments for magnetic observations; a machine for winding sounding-lines, and a vibrating stand for comparing base rods. All the instruments sent to and returned from the field parties have been packed and unpacked, and repairs made where needed; fifty tin tubes
for filing original maps and charts have been painted and numbered, and the requisite repairs
and additions made to the Coast Survey buildings.

The work of the carpenter's shop is executed by Mr. A. Yeatman, master carpenter, assisted
by one carpenter and one apprentice.

Instrument Shop.—The instruments made during the year are twenty-eight geodetic, three
astronomical, sixteen magnetic and telegraphic, twenty-two telegraphic, ten hydrographic,
twelve drawing, sixty-two engraving, and nineteen miscellaneous. Repairs have been made
upon sixty-seven geodetic, five astronomical, six magnetic and telegraphic, ninety-six topo-
graphic, sixty hydrographic, thirty-five drawing and engraving, and three miscellaneous
instruments. The force employed consists of Mr. J. Vierbuchen, master instrument maker,
whose services and management are satisfactory, and five instrument makers.

I would express my acknowledgments to Commander S. S. Lee, U. S. N., who has recently
been assigned to the charge of the Hydrographic Division of this office; to Prof. W. P. Trow-
bridge, assistant in the Coast Survey; Samuel Hein, esq., general disbursing agent, and Joseph
Saxton, esq., assistant to the superintendent of weights and measures, for their prompt and
cheerful co-operation with, and aid rendered to, the office on all subjects pertaining
to their respective duties.

First Lieut. A. P. Hill, 1st artillery, U. S. A., still acts as general assistant; his merits are
so well known to the Superintendent that it is superfluous for me to enlarge upon them.

In concluding this report I would add that the chief clerk in my office, A. W. Russell, esq.,
performs his duties with characteristic industry and ability. I shall, from a sense of duty, in
a separate communication, strongly recommend an increase to the compensation of one or more
of the gentlemen comprising the clerical force of this office, in order that they may be placed
more nearly upon an equality, as to pay, with those of no higher grade or merit in the other
departments and bureaux of the government.

I have the honor to be, very respectfully, your obedient servant,

W. R. PALMER.


Prof. 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, 1859.

In conformity with the regulations of the office, the usual annual report on the occupation of
the several computers for the year ending October 1, 1859, is herewith respectfully submitted.

During a part of the year the number of computers was less than in the previous year.
Mr. J. Wiesner resigned his position in this division on the 1st of April, to join one of the
western wagon-road expeditions. The somewhat contracted state of the records received in the
first half of the year permitted to continue the reductions of the current work without filling
the place vacated by Mr. Wiesner, although it necessitated an increase of, and close attention
to, duty on the part of the computers in general.

During the month of July, in accordance with instructions received from the Superintendent,
I was engaged on a magnetic survey, extending to Sections I and II; these observations were partly reduced by myself, and fully discussed in regard to the secular change of the magnetic declination, on which subject a report at some length was submitted in answer to a call from the Superintendent. The least square reduction of the primary triangulation between Kent Island and Washington was considerably advanced by me and reported on. The ordinary routine business of the office has all been attended to; it comprises principally the furnishing of geographical positions to topographical and hydrographic parties, and the examinations and reports of all computations, discussions, and revisions, either geodetic, astronomical, or magnetic.

The general distribution of the reductions has remained the same as in last year. The following statement contains in detail the amount of work done by each computer during the year ending October 1.

*Assistant Theodore W. Werner* computed the triangulation between St. Helena and Calibogue sounds, Section V; reduced Assistant Gerdes' triangulation on the Mississippi delta; made out a least square abstract of horizontal angles at station Humpback, Section I; reduced and computed rectangular co-ordinates of the Charlotte harbor triangulation, Section VI. He also computed the triangulation of the Gulf of Georgia, Washington Territory; made a second calculation of the astronomical latitude of yard, Section II; reduced the triangulations of Chandeleur sound, Section VIII, and near the mouth of the Potomac, Section III; also the triangulation connecting St. George's and St. Mark's, Section VII, computing new L. M. Z. for the whole work; the reduction of the triangulation between Sapelo and St. Simon's, Section V, 1858-'59, completes the work.

*Mr. Eugene Nulty* computed the astronomical latitude of Pensacola and Warrington, Section VII; of Lower Mississippi, Section VIII, and the azimuth of Plantation Hill and Warrington, Section VII, and of Humpback, Section I; also, the latitude of Humpback, Rutherford Observatory, N. Y., and of New Orleans. He also made a second reduction of the Seaton latitude, and reduced time and azimuth, and the latitude at station Smithville, N. C.

*Mr. James Main* made the revision of the two independent computations of the following astronomical work: The azimuths at Santa Cruz, Section X; at Allston and New Cut, Section V, and of Plantation hill, Section VII; the latitudes at Allston, Breach inlet, East Base, and Savannah, in Section V; of Pensacola and Warrington, in Section VII; of Thomas' Hill, Bangor, and Humpback, in Section I; of New York city and Washington city. He also revised the magnetic reductions at Humpback and Mississippi city, computed the magnetic constants for magnet C. 6, and made a reduction of my magnetic observations in July last.

*Dr. Gottlieb Rumpf* attended to the revision and insertion of the geographical positions in the registers: made the second least square reduction of the horizontal angles at stations Hill, Causten, and Seminary, Section III; made a second reduction of the James river triangulation of 1857, revised the reduction of the Mississippi delta triangulation, reduced the triangulation of Tomales bay, and Petaluma creek, Section X, and of Sub-Assistant Harris' triangulation in the vicinity of New Orleans. He also made a least square abstract of the horizontal angles of the primary triangulations in Section V, and assisted in the reduction of vertical angles for elevations in Section I. He also reduced Assistant Blunt's work on the Hudson river, completing the triangulation up to Hudson City; assisted me in the discussion of the secular change of the magnetic declination, and in the preparation of the list of geographical positions printed in this year's report.

*Mr. John Weissner* computed the triangulation of Sheepscot river, Section I, and assisted in
the discussion of some magnetic reductions; he also supplied the L. M. Z. to the observers' computation of the Tomales bay triangulation, assisted in the least square reduction of the primary triangulation near Washington, and in the computation of L. M. Z. to the triangulation near New Orleans. He completed the reduction of vertical angles for heights in the vicinity of the Sheepscot river, 1855-'57, and reduced vertical angles at stations Saunders, Sebattis, and Ragged, of the primary series. Mr. Wiessner's resignation took effect on the first of April last.

Mr. William D. Storke assisted in the reduction of horizontal angles at Humpback, Section I; reduced the triangulation on Pensacola bay, 1858, and of Sub-Assistant Bagwell's triangulation south of the Cedar Keys; computed the triangulation of Assistant Bolles', south and west of Cape Fear river entrance, 1855 to 1858; made himself acquainted with the reduction of transit observations, and assisted in the preparation of geographical positions for the present report. He also reduced the horizontal angles at Smithville, N. C., in connection with the astronomical azimuth; assisted Mr. Rumpf in the L. M. Z. computations on Hudson river triangulation, and also assisted in the preparation of the statistical table for this year.

Mr. John T. Hoover attended to the clerical duties of the division, and principally assisted in the preparation of the geographical positions for the 1859 report, duplicating and revising the same. He also made a number of diagrams.

R. Freeman supplied the extra copying required for field or office.

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Report of Assistant L. F. Pourtales, in charge of Tidal Division.

Coast Survey Office, November 1, 1859.

The following report on the occupation of the computers in this division during the past year is respectfully submitted:

Mr. R. S. Avery has finished the discussion of the nine years' series of tidal observations at Boston, and has made comparisons of twelve years' observations with the predictions made by means of the coefficients obtained. He has also prepared ephemerides for future years.

Mr. S. Walker has examined and registered the observations received from the tidal stations, and has had charge of the correspondence with the observers. He has also read off the sheets of the self-registering tide-gauges, and supervised the gauge established at the navy yard in this city, besides making miscellaneous computations.

Mr. John Downes has made graphical decompositions of the tidal curves of the Florida stations, and reductions and comparisons of the results obtained.

Sub-Assistant C. Fendall was attached temporarily to this division from April 11 to June 16, and made decompositions of the tidal curves from the Florida reef, and worked out the diurnal inequality for some of the same.

Mr. J. Gilliss was engaged from November 26 to January 17 in making ordinary reductions, working out daily inequalities, drawing diagrams, and miscellaneous work.

Mr. R. E. Evans joined the division May 25, and has since been engaged on ordinary reductions, diagrams, and decompositions of tidal curves.

Messrs. J. Donegan, O. Henrich, and T. C. Bowie were engaged for short periods, in the intervals of their field duties, in miscellaneous work, chiefly ordinary reductions of tides.
Mr. A. W. King made, during part of the year, ordinary first and second reductions by contract.

The meteorological observations of the Pacific coast have continued to be discussed by M. Thomas, who has also done miscellaneous work and copying.

Most of the reductions of the observations of the permanent stations were made by S. D. Pendleton.


COAST SURVEY OFFICE, November 1, 1859.

Pursuant to instructions, the following report is respectfully submitted of the operations of the drawing division of the United States Coast Survey office during the past official year, under the supervision of my able predecessor, Lieut. J. C. Tidball, U. S. A., until the 30th of June last, and since then in the charge of the undersigned.

During this time I have had the benefit of the assistance of Mr. G. A. Porterfield, whose experience in the office of several years has been successfully given to further the best interests of the division.

It is a material and gratifying fact that the division has been equal to the demands upon it by the extensive operations of the field and afloat, and the work is marked with great accuracy and superior professional ability and elegance.

Below are presented the details of the duties and labors of the several draughtsmen employed. This outline of the past year's labors of this division furnishes some idea of its ability for promptly realizing in form and presenting in tangible shape the topographical and hydrographical results of the active service in the field and afloat.

As an incident to the draughting duties proper, yet of no ordinary importance, is the exact and methodical arrangement of the returns of the field service and other archives on which our maps and charts are founded. This arrangement is kept up with punctilious attention, and in such a manner that now and hereafter the maps and charts produced can be brought to the immediate test as to accuracy of the original data upon which they are founded, or renewed in the future, should every vestige of our present labors disappear by time or circumstance.

It is proper also to report that not only have we kept pace with the field service, furnished projections to field parties, made projections on copper, and attended to these and other miscellaneous duties, legitimate but incidental, yet also are we still in advance of the engraving division, as, indeed, our system requires; so that not a moment is lost, nor the least delay possible, in its receiving from our hands a constant and abundant supply of material. For the purpose of presenting this fact more practically to the Superintendent, the paper marked A has been prepared, that he may see at a glance how the work on the projects in the drawing division stands with regard to its engraving.

It is a gratifying fact, too, that in co-operating with the purposes of a just and prudent economy of the Superintendent, we have been able to realize his wishes in a reduction of three during the past year; and with our present reduced force, looking to its efficacy, zeal, and
energy, we feel confident in an ability promptly and satisfactorily to meet every demand that may be made upon this division of the United States Coast Survey Office.

Assistant W. M. C. Fairfax has been employed upon the reduction of topography of coast maps and charts No. 7, from Muscongus bay to Portland harbor, Me., scale 80,000; No. 10, from Ipswich harbor to Green's harbor, Mass., 80,000; No. 11, from Plymouth harbor to Hyannis harbor, Mass., 80,000; Nos. 35 and 36, Chesapeake bay, from Pocomoke sound to entrance, Md. and Va., 80,000; and No. 53, from Stono inlet to Fripp's inlet, S. C., 80,000.

Assistant M. J. McClary has drawn additions to the Congress map, and has occupied upon the topography of coast map and chart No. 21, New York harbor and vicinity, 80,000.

Mr. A. Boselke has been employed upon projects for maps and charts according to the general plan adopted for the entire coast.

Mr. A. Lindenkohl has reduced the reconnaissance of the coast of Texas, from Matagorda Bay entrance to Aransas pass, 80,000; has made additions to Alden's reconnaissance of the western coast, 80,000; and has been employed upon Cape Fear River entrances, N. C. comparative charts, 1851-'58, 80,000; coast map and chart, No. 58, from the St. Mary's to the St. John's river, Fla., 80,000; San Francisco bay, Cal., 80,000; projections for field parties; projections on copper and verifications; and has assisted in the application of photography to topographic reductions.

Mr. A. Balbach was employed upon the hydrography of coast maps and charts, No. 68, Florida reefs, from Key Biscayne to Carysfort reef, 80,000, and No. 72, (ditto,) from Key West to Marquessas keys, 80,000, until the 29th of November, when he was transferred to the hydrographic division.

Mr. E. Herjesheimer entered the office on the 13th of December, and has been engaged upon the hydrography of coast maps and charts, No. 14, from Cuttyhunk island to Block island, Mass. and R. I., 80,000; Nos. 70, 71, 72, Florida reefs, from Long Key to Marquessas keys, 80,000; San Francisco and San Pablo bays, Cal., 80,000; Boston harbor, Mass., (additions for new edition,) 80,000; Muskeget channel, (ditto,) 80,000; Humboldt bay, Cal., 80,000; general coast chart, No. IV, from Cape May, N. J., to Currituck, N. C., 80,000; drawings from microscopic enlargement of specimens of bottom taken in deep sea soundings, Gulf Stream, and verifications and examinations.

Mr. W. P. Schultz has reduced St. George's sound, (eastern part,) Fla., 80,000; additions to Charleston harbor, (for new edition,) S. C., 80,000; has drawn diagrams illustrating changes of temperature in Gulf Stream, with depths, and has been employed upon the reduction of Patuxent river, Md., 80,000, progress sketches, projects, and projections.

Mr. L. D. Williams has made additions to preliminary seacoast charts, Nos. 11 and 12, from Cape Hatteras to Cape Fear, N. C., 80,000; additions to Canal de Haro and Strait of Rosario, W. T., 80,000; and has been engaged upon Hudson river, from entrance to Sing Sing, N. Y., 80,000; general coast chart No. II, from Cape Ann to Gay Head, Mass. and R. I., 80,000; additions to Congress map, 80,000; projections on copper; projections for field parties and verifications.

Mr. A. Strauss has been engaged upon the reduction of hydrography of coast maps and charts, Nos. 105, 106, 107, and 108, from Galveston bay to Lavacca bay, Texas, 80,000; No. 9, from Cape Nedick, Me., to Cape Ann, Mass., 80,000; No. 11, from Plymouth harbor to Hyannis harbor, Mass., 80,000; No. 33, Chesapeake bay, from the Hudson to the Potomac.
Mr. W. T. Martin has been engaged upon the topography of coast maps and charts, No. 28, from Cape Henlopen, Del., to Green Run inlet, Md., \( \frac{1}{3} \); No. 71, Florida reefs, from Newfound Harbor key to Boca Grande key; Nos. 107 and 108, from Oyster bay to Lavaca bay, Texas; and verifications.

Mr. P. Witzl has drawn Sapelo sound, Ga., \( \frac{1}{3} \); Atchafalaya bay, La., \( \frac{1}{3} \); completed York river, from West Point to King's creek, Va., \( \frac{1}{3} \); and has been employed upon Kennebec river, from entrance to Bath, Me., \( \frac{1}{3} \); Portland harbor, Me., \( \frac{1}{3} \); coast maps and charts, No. 48, from Barren inlet to Lockwood's Folly inlet, N. C., \( \frac{1}{3} \); No. 88, from Choctawhatchee bay to Pensacola bay, Fla., \( \frac{1}{3} \); Cape Fear river entrances, (comparative charts, 1851-58,) N. C., \( \frac{1}{3} \); projections for field parties and projections on copper.

Mr. S. B. Linton has been employed upon Apalachicola bay, Fla., \( \frac{1}{3} \); Charleston harbor, (additions for new edition,) S. C., \( \frac{1}{3} \); Lynn harbor, Mass., \( \frac{1}{3} \); lettering reductions; additions to progress sketches, and measurement of original topographic and hydrographic sheets.

Mr. F. Fairfax was occupied upon the topography of the upper sheet of James' river, Va., \( \frac{1}{3} \); the sketches of Port Townsend, W. T., \( \frac{1}{3} \); and Brazos River entrance, Texas \( \frac{1}{3} \); progress sketches and tracings, until the 31st of March, when he left the office.

Mr. B. Hoee, jr., has been continued upon tracings.

Artificer J. A. Campbell, U. S. A., has continued upon tracings and statistics and in care of miscellaneous maps.

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THE UNITED STATES COAST SURVEY.

A—Continued.
List of maps and sketches completed or in progress during the year ending November 1, 1859, arranged in order of sections.

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<th>Section</th>
<th>Name</th>
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</thead>
<tbody>
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</tr>
<tr>
<td>Progress sketch A.</td>
<td>1-400,000</td>
</tr>
<tr>
<td>Progress sketch B.</td>
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<tr>
<td>Sheepscot river, Maine</td>
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<tr>
<td>Kennebec river, from entrance to Bath, Maine</td>
<td>1-40,000</td>
</tr>
<tr>
<td>Portland harbor, Maine</td>
<td>1-40,000</td>
</tr>
<tr>
<td>Preliminary sea-coast chart, No. 3, from Cape Small Point, Me., to Cape Cod, Mass.</td>
<td>1-200,000</td>
</tr>
<tr>
<td>Coast map and chart, No. 9, from Cape Neddick, Me., to Cape Ann, Mass.</td>
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</tr>
<tr>
<td>General coast chart, No. 2, from Cape Ann, Mass., to Cape Head, R. I.</td>
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</tr>
<tr>
<td>Coast map and chart, No. 10, from Ipswich harbor to Green's harbor, Mass.</td>
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<tr>
<td>Lynn harbor, Mass.</td>
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</tr>
<tr>
<td>Coast map and chart, No. 11, from Plymouth harbor to Hyannis harbor, Mass.</td>
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</tr>
<tr>
<td>Coast map and chart, No. 14, from Cuttyhunk island, Mass., to Block Island, R. I.</td>
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</tr>
<tr>
<td>Section II — Coast of Connecticut, New York, New Jersey and Delaware, north of Cape Henlopen.</td>
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<tr>
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<tr>
<td>Coast map and chart, No. 21, New York bay and harbor.</td>
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<tr>
<td>Hudson river, from entrance to Sing Sing, N. Y.</td>
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<tr>
<td>Section III — Coast of Delaware, south of Cape Henlopen, Maryland and Virginia, north of Cape Henry.</td>
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<tr>
<td>Progress sketch C.</td>
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<tr>
<td>General coast chart, No. 4, from Cape May, N. J., to Currituck, N. C.</td>
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<tr>
<td>Coast map and chart, No. 28, from Cape Henlopen, Del., to Green Run inlet, Md.</td>
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<tr>
<td>Coast map and chart, No. 29, from Green Run inlet, Md., to Little Machipongo inlet, Va.</td>
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<tr>
<td>Coast map and chart, No. 33, Chesapeake bay, from Hudson river to Potomac river, Md.</td>
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<tr>
<td>Coast map and chart, No. 35, Chesapeake bay, from Pocomoke sound to York river, Va.</td>
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<tr>
<td>York river, from West Point to King's creek, Va.</td>
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<tr>
<td>James river, from Richmond to City Point, Va.</td>
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<tr>
<td>Section IV — Coast of Virginia, south of Cape Henry, and North Carolina, north of Cape Fear.</td>
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<tr>
<td>Progress sketch D.</td>
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<tr>
<td>Preliminary sea-coast chart, No. 11, from Cape Hatte-Ann, Va., to Cape Lookout, N. C.</td>
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<tr>
<td>Preliminary sea-coast chart, No. 12, from Cape Lookout to Cape Fear, N. C.</td>
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<td>Coast map and chart, No. 48, Cape Fear and vicinity, N. C.</td>
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<tr>
<td>Cape Fear river, New inlet, N. C.</td>
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<tr>
<td>Cape Fear river, southern entrance, N. C.</td>
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<tr>
<td>Diagrams illustrating changes of temperature in the Gulf Stream, with depths.</td>
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### The United States Coast Survey

**List of maps and sketches, &c.—Continued.**

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<th>Section</th>
<th>Name</th>
<th>Scale</th>
<th>Description</th>
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<tr>
<td>V.</td>
<td>Coast of North Carolina, south of Cape Fear, South Carolina, and Georgia.</td>
<td>1-600,000</td>
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<td>Charleston harbor, (new edition) S. C.</td>
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<td>Sapelo sound, Ga.</td>
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<td>VI.</td>
<td>Coast of Florida, from St. Mary's river to St. Joseph's bay.</td>
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<td>1-400,000</td>
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<td>Coast map and chart, No. 50, from St. Mary's river to St. John's river.</td>
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<td>Coast map and chart, No. 66, Florida reefs, from Key Biscayne to Carysfoot reef.</td>
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<td>Coast maps and charts, Nos. 76, 71, and 73, Florida reefs, from Long key to Marquesas keys.</td>
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<td>VII.</td>
<td>Coast of Florida, west of St. Joseph's bay, and Alabama, east of Mobile bay.</td>
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<td>1-400,000</td>
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<td>Cedar keys, (new edition) Fla.</td>
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<td>St. George's sound, (eastern part), Fla.</td>
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<td>Apalachicola bay, Fla.</td>
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<td>Pensacola bay, Fla.</td>
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<td>VIII.</td>
<td>Coast of Alabama, west of Mobile bay, Mississippi and Louisiana, east of Vermilion bay.</td>
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<td>Progress sketch H.</td>
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<td>IX.</td>
<td>Coast of Louisiana, west of Vermilion bay, and of Texas.</td>
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<td>Progress sketch I.</td>
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<td>Coast maps and charts, Nos. 105, 106, 107, and 108, from Galveston bay to Lavaca bay, Texas.</td>
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<td>Finished maps and charts</td>
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<td>Brazos river entrance, Texas</td>
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<td>Coast of Texas, from Matagorda bay entrance to Aransas Pass, Texas.</td>
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<td>Coast of California.</td>
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<td>Progress sketch J. (from San Diego to Point Sal)</td>
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<td>Progress sketch J. No. 2. (from Point Sal to Tomales bay)</td>
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<td>Alden's reconnaissance of western coast, (additions).</td>
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<td>San Francisco bay and vicinity.</td>
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<td>XI.</td>
<td>Coast of Oregon and Washington Territory.</td>
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<td>Progress sketch K.</td>
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<td>Coast de Haro and Strait of Rosario, (additions).</td>
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<td>Fort Townsend, W. T.</td>
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<td>Sketch showing progress of the survey on the Atlantic.</td>
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<td>Prepared by the Superintendent.</td>
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<td>Gulf of Mexico, and Pacific coasts.</td>
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<td>1-5,000,000</td>
<td>Drawn in computing division.</td>
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<tr>
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<td>Diagrams illustrating discussion of magnetical and meteorological observations.</td>
<td>1-5,000,000</td>
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Report of Mr. Edward Wharton, acting in charge of Engraving Division.

Coast Survey Office, October 31, 1859.

I have the honor to present the annual report of the operations of this division during the year ending October 31, 1859.

The division remained under the charge of Lieut. Rufus Saxton, U. S. A., from the date of the last annual report until April 1, when he was relieved from duty. Since that time the division has been under my charge. The engraving force at present consists of twenty-one engravers, of various grades.

The division has met with a serious loss in the death of one of its oldest and most skilled engravers, Mr. F. Dankworth, who had been attached to the office since 1843, and whose death occurred last March. Mr. Dankworth ranked among the first topographical engravers in this country, and it gives me pleasure to testify to the faithfulness with which he discharged his duties, and the ability and skill he evinced in the execution of his work. His place will be difficult to supply.

The engraving of the finished maps of Patapsco river, Md.; entrance to Pensacola bay, Fla.; San Diego bay, Cal.; Mare Island straits, Cal.; and San Francisco bay, Cal., have been completed; and the two plates of the middle and eastern part of Long Island sound, commenced some years ago, have been also completed, to take the place of the two already published. Various changes and additions have also been made to the charts of Boston harbor and Charleston harbor.

The second class maps and sketches of Atchafalaya bay, La.; entrance to Brazos river, Texas; Humboldt bay, Cal.; Port Gamble, Port Townsend, and Sami-ah-moo bay, Washington Territory, have also been engraved, and a new edition of Canal de Haro and Strait of Rosario. The maps of Kennebec river, Maine, from entrance to Bath, and of Rockport harbor, Mass., have been published in a preliminary form.

The first class finished maps and charts, Nos. 12 and 13, Eastern series, from Monomoy to Muskeget, and from Muskeget to New Bedford; and Chesapeake bay series, Nos. 1, 2, 3, 4, 5, 6; coast charts Nos. 40 and 41, Albemarle sound; No. 63, Florida reefs, from Key Biscayne to Caresfort reef; Nos. 91 and 92, Mississippi sound, from Bonsecours bay to Grand island; Nos. 106 and 107, Texas, from Galveston bay to Matagorda bay, and San Pablo bay, Cal.; Nos. 91 and 92, Mississippi sound, have made considerable progress towards completion; and the outlines of coast chart No. 29, from Green River inlet to Little Machipongo inlet, Del. and Md., have been engraved from a photographic reduction.

Mr. McCoy has completed the topography upon coast chart No. 13, Eastern series, No. 2, and twelve views for coast charts Nos. 12, 13, and 14, extending from Monomoy to Newport.

Mr. Dankworth was engaged, up to the time of his death, upon the topography of coast chart No. 32, Chesapeake bay, from Magothy river to Hudson river.

Mr. Enthofer has executed all the topography upon coast chart No. 33, Chesapeake bay, from Hudson river to Potomac river.

Mr. Knight has been employed upon the soundings and miscellaneous lettering of coast charts Nos. 15 and 16, Long Island sound; the soundings of coast chart No. 13, Eastern series, No. 2; Nos. 34 and 35, Chesapeake bay, from Potomac river to York river, Va.;
Boston harbor, Mass.; Patapsco river, Md.; Monterey bay, Cal.; and other miscellaneous lettering.

Mr. Rolle has nearly completed the topography of coast chart No. 31, Chesapeake bay, No. 1, \$1, and has executed some miscellaneous work.

Mr. Sengteller has completed the topography of the lower part of coast chart No. 12, Eastern series, \$1, and has also nearly completed that of the upper part.

Mr. Blondeau has completed the topography of entrance to San Francisco bay, \$1, and has made considerable progress upon that of San Pablo bay, \$1.

Mr. Phillips has finished the topography and one-half the sand of coast chart No. 92, Mississippi sound, from Round island to Grand island, \$1, and has executed some miscellaneous work.

Mr. Metzeroth has completed the sand and views upon entrance to San Francisco bay, \$1; the sand of San Diego bay, \$8; and of the upper half of coast chart No 13, Eastern series, No. 2, \$1, from Muskeget to New Bedford, and some miscellaneous work.

Mr. Barnard has engraved the sand upon coast chart No. 41, Albemarle sound, eastern part, \$8; a portion of the sand upon general coast chart No. 2, from Cape Ann to Gay Head, Patapsco river, Md., and coast chart No. 92, Mississippi sound, \$1, and miscellaneous work.

Mr. Kondrup engraved a portion of the outlines upon coast charts Nos. 32 and 34, Chesapeake bay, Nos. 2 and 4, \$1; all the outlines, soundings, and general lettering upon the preliminary chart of Kennebec river, Maine; and is now engaged upon the topography of the same.

Mr. Evans has engraved portions of new work, and has made various corrections upon coast charts Nos. 15 and 16, Long Island sound, eastern and middle plates, \$1; re-engraved the topography of Captain's island, E. and W., and new work upon the plate of Charleston harbor, \$1.

Mr. Throop has engraven the soundings and bottoms of general coast chart No. 2, from Cape Ann to Gay Head; coast chart No. 41, Albemarle sound, east; and Sapelo sound, Georgia: the notes and lettering of Port Gamble, Humboldt bay, Pensacola bay, and executed other miscellaneous lettering; and is now engaged upon the notes of coast charts No. 91, Mississippi sound, from Bonsecours bay to Round island.

Mr. Maedel has engraved the topography and sand of Port Gamble, Washington Territory; the sand of Rockport harbor, Mass., Muskeget channel, Mass., preliminary sea coast chart No. 14, from Cape Roman, S. C., to Tybee river, Georgia; a portion of the sand of entrance to Cape Fear river, and miscellaneous work.

Mr. E. A. Maedel has engraved the title, notes, and soundings of coast chart No. 106, from Galveston bay to Oyster bay, Texas, and Rockport harbor, Mass.; the title and soundings of coast chart No. 107, from Oyster bay to Matagorda bay, and some miscellaneous work; and is now engaged upon the soundings of coast chart No. 71, Florida reefs, from Newfound Harbor key to Boca Grande key.

Mr. Petersen has engraved the title and notes of Canal de Haro and Strait of Rosario and of Semi-ah-moo bay, Washington Territory; a portion of the soundings of sea-coast chart No. 3, from Cape Small Pt., Maine, to Cape Cod, Mass.; the notes of Patapsco river, Md., coast chart, No. 107, from Oyster bay to Matagorda bay, and of general coast chart No. 2, from Cape Ann to Gay Head; all the soundings of San Pablo bay, Cal., and the soundings of Pensacola harbor,
Fla., and miscellaneous work; and is now engaged upon the hydrography of New York bay and harbor.

Mr. Langran has engraved the title, soundings, and notes of York river, Va., from King's creek to West Pt., Ateahalaya bay, La., Port Townshend, Washington Territory; a portion of the notes and soundings on sea-coast charts No. 11, from Cape Hatteras to Cape Lookout, and No. 14, from Cape Roman to Tybee river, and various miscellaneous lettering.

Mr. Ogilvie has engraved all the soundings, notes, and title on coast chart No. 68, Florida reefs, from Key Biscayne to Carysfort reef; a portion of the notes on sea-coast chart No. 4, from Cape Cod, Mass., to Saughkonnet Pt., R. I.; the soundings of Humboldt bay, Cal.; the general lettering on coast chart No. 41, Albermarle sound east, and other miscellaneous lettering.

Mr. Klakring has engraved all the topography, soundings, title and notes of Mare Island straits, Cal.; the topography of Humboldt bay, Cal.; and has executed some miscellaneous work; his employment by the office ceased on the 1st of July.

Mr. Bartle has engraved all the topography of Port Townshend, Washington Territory, and of entrance to Brazos river, Texas; and miscellaneous work upon various plates, and is now engaged upon the topography of Rockport harbor, Mass.

Messrs. Bennet, Thompson and Sipe have been employed upon the engraving of progress and other sketches, and such miscellaneous work as was required by the office.

In addition to the amount of work performed by the engravers, five of the sketches for the Report of 1858, have been lithographed or engraved upon stone under the direction of the Superintendent of Public Printing.

A more detailed account of the work performed, progress made, &c., can be found in the accompanying list of maps, charts, preliminary charts, and sketches, engraved or engraving, during the year ending November 1, 1859, arranged in order of sections; and in the complete list of Coast Survey maps, charts, preliminary charts, and sketches engraved, and arranged geographically.

List of maps, preliminary charts, and sketches, engraved or engraving, during the year ending October 31, 1859, arranged in order of sections.

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<tr>
<td>Progress sketch A</td>
<td>1-400,000</td>
<td></td>
<td>Engraved.</td>
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<tr>
<td>Do</td>
<td>1-600,000</td>
<td></td>
<td>Do.</td>
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<tr>
<td>Kennecott river, Maine, from entrance to Bath</td>
<td>1-20,000</td>
<td>Preliminary chart</td>
<td>Do.</td>
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<tr>
<td>Rockport harbor, Mass</td>
<td>1-20,000</td>
<td>do</td>
<td>Do.</td>
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<tr>
<td>General coast chart, No. 2, from Cape Ann to Gay Head</td>
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<td>General coast chart</td>
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<td>Preliminary sea-coast chart, No. 3, from Cape Small Point, Maine, to Cape Cod, Mass.</td>
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<td>Preliminary chart</td>
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<td>Preliminary sea-coast chart, No. 4, from Cape Cod, Mass., to Saughkonnet Point, R. I.</td>
<td>1-300,000</td>
<td>do</td>
<td>Engraved.</td>
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<tr>
<td>Coast map and chart, No. 12, Eastern series, No. 3, from Monomoy to Muskeget, Mass</td>
<td>1-80,000</td>
<td>Finished map and chart</td>
<td>Engraving.</td>
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<td>Coast map and chart, No. 13, Eastern series, No. 2, from Muskeget to Bussard's bay</td>
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<td>Do.</td>
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<tr>
<td>Kennecot river, Maine, from entrance to Bath</td>
<td>1-20,000</td>
<td>do</td>
<td>Do.</td>
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<td>Rockport harbor, Mass</td>
<td>1-20,000</td>
<td>do</td>
<td>Do.</td>
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<tr>
<td>Lynn harbor, Mass</td>
<td>1-20,000</td>
<td>do</td>
<td>Do.</td>
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<tr>
<td>Muskeget channel, Mass, (new edition)</td>
<td>1-40,000</td>
<td>do</td>
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<td>1-400,000</td>
<td>Finished map and chart</td>
<td>Engraved.</td>
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<td>Coast map and chart, No. 15, Long Island sound, east</td>
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<tr>
<td>Do. No. 16. do.</td>
<td>1-80,000</td>
<td>Finished chart</td>
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<tr>
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<tr>
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<td>Progress sketch C</td>
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<tr>
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<tr>
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<td>Patapsco river, Maryland</td>
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<td>York river, Virginia, from King's creek to West point</td>
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<td>Coast map and chart, No. 41, Albemarle sound east, from Pasquotank and Alligator rivers, to entrance, North Carolina. Preliminary sea-coast chart, No. 11, from Cape Hatteras to Cape Lookout, North Carolina. 8PocoIteo river entrance, showing changes from 1851 to 1856, (two plates)</td>
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<td>Progress sketch F, lower sheet, Florida keys</td>
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<td>Coast map and chart, No. 68, Florida reefs, from Key Biscayne to Ochlockee reef</td>
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<td>Coast map and chart, No. 51, from Bonsecours bay to Round Island, Miss.</td>
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<tr>
<td>Coast map and chart, No. 92, from Round Island to Grand Island, Miss.</td>
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### List of maps, preliminary charts, &c.—Continued.

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<td>Progress sketch I.</td>
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<td>Coast map and chart, No. 106, from Galveston bay to Oyster bay, Texas</td>
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<td>Entrance to Brazos river, Texas</td>
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<td>Coast map and chart, No. 107, from Oyster bay to Matagorda bay, Texas</td>
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<td>Mars Island strait, Cal.</td>
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<td>Entrance to San Francisco bay, Cal.</td>
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<td>San Pablo bay, Cal.</td>
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<td>Humboldt bay, Cal.</td>
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<td>San Francisco city, Cal.</td>
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<td>Map</td>
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<td>Progress sketch K</td>
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<td>Canal de Hato and Strait of Rosario, Washington Territory, (new edition)</td>
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<tr>
<td>Port Gamble, Washington Territory</td>
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<tr>
<td>Port Townsend, Washington Territory</td>
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<td>Semi-abaco bay, Washington Territory</td>
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<tr>
<td>Diagrams illustrating the descent of sounding weight and line in deep soundings</td>
<td>Diagram</td>
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<td>Project limits for finished maps, 1-80,000, on Atlantic and Gulf coasts.</td>
<td>1-5,000,000</td>
<td>Sketch showing progress of coast survey to November, 1859</td>
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<td>Sketch showing limits of Gulf Stream.</td>
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<tr>
<td>Diagrams of magnetic and meteorological observations at Girard College, Philadelphia, in 1840, 1841, 1842, 1843, 1844, and 1845.</td>
<td>1-5,000,000</td>
<td>Diagram</td>
<td>Engraved.</td>
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<tr>
<td>Diagrams of observations for temperature, wind, and atmospheric pressure, made by Dr.E.K. Kane at Van Buren harbor, in 1853 and 1855.</td>
<td>Diagram</td>
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<tr>
<td>Three sketches illustrating Superintendent’s paper on currents of Sandy Hook</td>
<td>Diagram</td>
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<td>Do.</td>
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*Engraved on stone, under the direction of the Superintendent of Public Printing.*

### List of Coast Survey maps, preliminary charts, and sketches engraved, geographically arranged.

1. **List of Maps and Charts Engraved.**

| No. | Name. | | |
|-----|-------| | |
| 1. | Richmond’s island, Maine | | |
| 2. | Newburyport harbor, Massachusetts | | |
| 3. | Ipswich and Annisquam harbors, Massachusetts | | |
| 4. | Gloucester harbor | do | |
| 5. | Salem harbor | do | |
| 7. | Plymouth harbor | do | |
| 8. | Provincetown harbor | do | |
9. Monomoy shoals ................. Massachusetts
10. Bass River harbor .................. do
11. Wellfleet harbor .................... do
12. Nantucket harbor .................. do
13. Hyannis harbor .................... do
14. Harbor of Edgartown .............. do
15. Harbor of Wood's Hole .......... do
16. Harbors of Holmes's Hole and Tarpanin Cove, Massachusetts
17. Harbor of New Bedford, Massachusetts
18. General chart of the coast from Gay Head to Cape Henlopen
19. Fisher's Island sound, Connecticut
20. Harbor of New London ............. do
21. Mouth of Connecticut river ........ do
24. Harbors of Sheffield and Cawkin's Island ......... do ...... 1852
25. Huntington bay, New York
26. Oyster bay or Syosset harbor, New York
27. Harbors of Captain's Islands, east and west, Connecticut
28. Hart and City islands, and Sachem's Head harbor, New York
29. Hell Gate, New York
30. Long Island sound, east
31. Do ... do ... middle
32. Do ... do ... west
34. Do ................ do ........... do ........... do ........... do ... No. 2.
35. Do ................ do ........... do ........... do ........... do ... No. 3.
36. Do ................ do ........... do ........... do ........... do ... No. 4.
37. Do ................ do ........... do ........... do ........... do ... No. 5.
38. Do ................ do ........... do ........... do ........... do ... No. 6.
39. Do ................ do ........... do ........... do ........... do
40. Western part of south coast of Long Island, New York
41. Middle part of ................ do ........... do ........... do
42. Eastern part of ................ do ........... do ........... do
43. Little Egg harbor, New Jersey
44. Delaware bay and river, sheet No. 1, Delaware
45. Do ................ do ........... sheet No. 2, New Jersey and Pennsylvania
46. Delaware bay and river, sheet No. 3
47. Patapsco river, Maryland
48. Harbor of Annapolis and Severn river, Maryland
49. Mouth of Chester river, Maryland
50. Entrance to York river, Virginia
51. Pasquotank river, North Carolina
52. Beaufort harbor ................ do
53. Charleston harbor, South Carolina—new edition, 1858

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2. List of Preliminary Charts and Sketches Engraved.

1. Alden's Rock, Maine ........................................ 1
2. Eggemoggan reach, Maine .................................... 1
3. Kennebec river ............................................. 1
4. Portland harbor ............................................. 1
5. Portland harbor, (Commissioners' line,) Maine ........ 1
6. York River harbor, Maine ................................... 1
7. Portsmouth harbor, New Hampshire ....................... 1
8. Rockport harbor, Massachusetts .......................... 2
9. Stellwagen's Bank—2d edition—Massachusetts ... 2
10. Boston bay .................................................. 2
11. Current chart, Boston bay ................................. 2
12. Minot's ledge ............................................... 2
13. Sea-coast of the United States, No. 4, south part of Massachusetts ... 2
14. Nantucket shoals, Massachusetts—new edition ... 2
15. Tidal currents, Nantucket shoals, Massachusetts ... 2
16. Muskeget channel .......................................... 2
17. Sow and Pigs' reef ......................................... 2
18. Tidal currents, Long Island, New York .................. 2
19. Pot Rock and Way's reef .................................. 2
20. Hudson river, lower sheet .................................. 2
21. Buttermilk channel ........................................ 2
22. Beacon ranges, New York harbor ......................... 2
23. Romer shoals and Flynn's knoll, New York ....... 2
25. Sea-coast of Delaware, Maryland, and part of Virginia . 2
26. Delaware and Chesapeake bays ............................ 2
27. Chesapeake bay, (upper series,) Sheet No. 1 ....... 2
28. Do ..................................................... 2
29. Do ..................................................... 2
30. Chincoteague inlet, Virginia .............................. 2
31. Sea-coast of Virginia and entrance to Chesapeake bay, Virginia ...... 2
32. James river, (upper sheet,) ................................ 2
33. Rappahannock river, No. 1 ............................... 2
34. Do ..................................................... 2
35. Do ..................................................... 2
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<td>38.</td>
<td>Do, No. 6, do</td>
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<td>39.</td>
<td>York river, from King's creek to West Point</td>
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<td>40.</td>
<td>Wachapreague, Machipongo, and Metompkin inlets, do</td>
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<td>41.</td>
<td>Ship and Sand Shoal inlets, do</td>
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<td>42.</td>
<td>Entrance to Chesapeake bay, do</td>
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<td>43.</td>
<td>Cape Charles and vicinity, do</td>
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<td>44.</td>
<td>Cherrystone inlet, do</td>
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<td>45.</td>
<td>Pungoteague creek, do</td>
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<td>46.</td>
<td>Fishing or Donoho's battery, Maryland</td>
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<td>47.</td>
<td>Albemarle sound, North Carolina</td>
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<td>48.</td>
<td>Diagrams showing the effect of the wind in elevating and depressing the water in Albemarle sound.</td>
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<td>49.</td>
<td>Hatteras shoals, North Carolina</td>
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<td>Cape Hatteras, do</td>
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<td>51.</td>
<td>Hatteras inlet, do, fourth edition</td>
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<td>53.</td>
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<td>56.</td>
<td>New river and bar, do</td>
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<td>57.</td>
<td>Frying-pan shoals, do</td>
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<td>58.</td>
<td>Cape Fear river and New inlet, North Carolina</td>
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<td>59.</td>
<td>Entrance to Cape Fear river, (new edition,) North Carolina</td>
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<td>60.</td>
<td>Cape Fear river, from Federal Point to Wilmington, North Carolina</td>
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<td>64.</td>
<td>Diagrams, Gulf Stream explorations, 1854</td>
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<tr>
<td>65.</td>
<td>Gulf Stream explorations, 1855</td>
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<td>66.</td>
<td>Co-tidal lines, Atlantic Coast</td>
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<td>67.</td>
<td>Diagrams of secular variation of magnetic dip, Atlantic coast</td>
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<td>68.</td>
<td>Cape Roman shoals, South Carolina</td>
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<td>69.</td>
<td>Sea-coast of the United States, No. 14, South Carolina</td>
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<tr>
<td>70.</td>
<td>Winyah bay and Cape Roman shoals, do</td>
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<tr>
<td>71.</td>
<td>Winyah bay and Georgetown harbor, do</td>
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<tr>
<td>72.</td>
<td>Bull's bay, do, do</td>
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<td>73.</td>
<td>Comparative chart, Maffitt's channel, South Carolina, (new edition)</td>
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<td>74.</td>
<td>Maffitt's channel, (sections,) South Carolina</td>
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<td>75.</td>
<td>North Edisto river, (new edition), do</td>
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<td>76.</td>
<td>Romerly marshes, do, do</td>
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<td>Savannah river entrance, Georgia</td>
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<td>Savannah city, front and back rivers, Georgia</td>
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<td>Savannah river, Georgia</td>
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<tr>
<td>80.</td>
<td>Doboy bar and inlet, Georgia</td>
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81. St. Simon's sound and Brunswick harbor, Georgia
82. St. Andrew's shoals
83. St. Mary's bar and Fernandina harbor, Florida—comparative chart
84. St. Mary's river and Fernandina harbor, Florida
85. St. John's river, from entrance to Brown's creek, Florida
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87. Cape Canaveral
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89. Turtle harbor, Florida reefs
90. Beacons on Florida reefs
91. Collin's Patches
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93. Legare anchorage, (additions)
94. Key West harbor, Florida—second edition
95-101. Key West tidal diagrams, Florida
102. Rebecca shoals
103. Reconnaissance vicinity of Cedar Keys, Florida
104. Channel No. 4, Cedar Keys
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111. Sea-coast of part of Alabama and Mississippi
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114. Do
115. Pascagoula river, Mississippi
116. Biloxi bay
117-126. Cat Island tidal diagrams
127. Pass Christian
128. Delta of the Mississippi, Louisiana
129. Gulf of Mexico, with profiles of deep-sea soundings—new edition
130. Barataria bay entrance, Louisiana
131. Pass Fourchon
132. Timbalier bay entrance
133. Isle Dernière or Ship Island shoals, Louisiana
134. Atchafalaya bay
135. Entrances to Vermilion bay and Calcasieu river, Louisiana
136. Sabine Pass, Texas
137. Sea-coast of Texas from Galveston, south
138. Sea-coast of the United States, No. 31, part of Texas
139. San Luis Pass, Texas
140. Aransas Pass—2d edition—Texas
141. Entrance to Brazos river, Texas
142. Entrance to Rio Grande
143. Diagrams of heights and luniptidal intervals of diurnal and semi-diurnal tides in the Gulf of Mexico
144–145. Co-tidal lines, Gulf of Mexico—2 plates
146. Type curves
147. Wind curves, Cat island
148. Alden's reconnaissance Western Coast, lower sheet, San Francisco to San Diego—new edition—California
149. Cortez bank
150. San Diego entrance—new edition—California
151. Geological map of San Diego
152. Catalina harbor
153. San Pedro anchorage and vicinity of Santa Barbara, California
154. Anacapa island, sketch
155. Anacapa island and east end of Santa Cruz island, California
156. Prisoner's harbor, Coo.r*er's harbor, and northwest anchorage, San Clemente island, California
157. Santa Barbara, California
158. Eastern entrance to Santa Barbara channel, California
159. San Simeon, Santa Cruz, San Luis Obispo, and Cozo harbors, California
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162. Monterey harbor
163. Monterey bay
164. Geological map of Monterey
165. Santa Cruz and Año Nuevo harbors
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167. Entrance to San Francisco bay
168. San Francisco city, (new edition)
169. Geological map of San Francisco
170. South Farallon island
171. Tidal diagrams, Rincon Point
172. Pulgas base
173. San Antonio creek
174. Mare Island straits
175. Alden's reconnaissance Western Coast, middle sheet, San Francisco to Umpqua river, California and Oregon
176. McArthur's reconnaissance Western Coast, from Monterey to mouth of Columbia river, sheet No. 1—3d edition
177. McArthur's reconnaissance Western Coast, from Monterey to mouth of Columbia river, sheet No. 2—3d edition
178. McArthur's reconnaissance Western Coast, from Monterey to mouth of Columbia river, sheet No. 3—3d edition
179. Alden's reconnaissance Western Coast, northern sheet
180. Point Reyes and Drake's bay, California
181. Geological map of Point Reyes
182. Humboldt bay, (new edition)
183. Trinidad bay
184. Shelter cove, Mendocino city, Crescent City harbors, and Port Orford,
    or Ewing harbor, California and Oregon
185. Umpquah river, Oregon
186. Mouth of Columbia river—2d edition—Oregon
187. Entrance to Columbia river, Oregon
188. Tidal diagrams Rincon Point, San Diego and Astoria, California and
    Oregon
190. Co-tidal lines of the Pacific coast
191. Cape Disappointment, Washington Territory
192. Shoalwater bay—new edition—Washington Territory
193. Alden's reconnaissance Western Coast, from Grey's harbor to Admi-
    ralty inlet, Washington Territory
194. Graysville harbor, Washington Territory
195. Cape Flattery and Nee-ah harbor, Washington Territory
196. False Dungeness, Washington Territory
197. New Dungeness
198. Canal de Haro and Strait of Rosario and approaches, Washington Ter-
    ritory
199. Port Townshend—new edition—Washington Territory
200. Duwamish bay and Seattle harbor
201. Smith's or Blunt's island
202. Port Ludlow
203. Port Gamble
204. Olympia harbor
205. Steilacoom harbor
206. Bellingham bay
207. Blakely harbor
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209. Base apparatus
210. Self-registering tide-gauge
211. Craven's current indicator
212. Craven's specimen box for deep-sea soundings
213. Mitchell's sea-coast tide-gauge
214. Figures to illustrate Appendix No. 33, 1854
215. Diagrams of secular variation in magnetic declination, 1855
216. Lines of equal magnetic declination
217. Bontelle's scaffold for stations, and Farley's signal
218. Bontelle's apparatus for measuring preliminary basets
219. Diagrams illustrating earthquake waves at San Diego and San Francisco
220. Diagrams of secular variation in magnetic declination, 1856
221. Sands’s gas-pipe tripod
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223. Map of magnetic declination
224. Map of magnetic dip and intensity
225. Apparatus for measuring minor bases
226. Polyconic development of sphere
227. Diagrams illustrating telegraphic methods for difference of longitude
228. Diagrams showing injury to boilers of steamer Hetzel
229. Project limits for charts, 
230. Diagrams of winds of the Western Coast
231. Diagrams illustrating loss of magnetism
232. Apparatus for measuring preliminary base lines
233. Trenchard’s tide-gauge
234. Mitchell’s tide-gauge
235. Diagrams illustrating the descent of sounding weight and line in deep-sea soundings
236. Project limits for finished maps, 
237. Three sketches illustrating the Superintendent’s paper on currents of Sandy Hook
238. Diagrams of observations for temperature, wind, and atmospheric pressure, made by Dr. E. K. Kane, U. S. N., at Van Rensselaer harbor in 1853 and 1855
239. Progress sketches

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Report of Mr. George Mathiot, in charge of the Electrotype Division.

U. S. Coast Survey Office, September 17, 1859.

I respectfully present the following report of the operations of this division since October 1, 1858.

By the electrotype process we have made eighty-seven plates, of this number fifty were in basso, and thirty-three in alto. I append tables of the plates. We have also made four plates for other departments of the government.

During the year the experiments for employing photography in the production of the charts of the survey have been zealously prosecuted, and I am now enabled to decisively say that the photographic method of reduction, is now in successful operation in the office, and I doubt not that before long it will prove far preferable to all other methods for delineation and accuracy, and has incomparably the advantage in economy and rapidity of execution.

I have sought to make use of the photograph in the construction of our charts. I emphasize construction in order that I may direct attention to the true object of my labors. That facility, which the photograph offers for copying, and its almost universal employment for this purpose,
causes the idea to be very generally entertained that we are endeavoring to multiply copies of our charts by photography. Such, however, would be to employ photography for the multiplication or publication of the charts, instead of their construction. But, the latter being the true purpose, and the construction of the chart being an operation founded on the methods and purposes of every department of the survey, it will be seen that the proposition to employ photography in making the charts involves no trifling considerations, and prospectively may affect every branch of the survey.

That facility which the camera offers for producing reduced copies of drawings is the element which I have sought to introduce; of the many ways in which this might be done, the following is the method which has been chosen, after the experience of the multitude of experiments I have made for the purpose during the last five years.

It must be borne in mind that a small scale chart is not merely a diminished picture of a chart constructed on a large scale; that the same things are not found in both charts; that the same things are represented differently on the different scales, and that numerous large scale charts combine in the composition of the small scales; and, lastly, that the configurations in the large charts not only change their size, but alter also their shape in entering the reduced charts, and this according to the part the object occupies in the reduced scale.

The elements of the charts are hydrographic and topographic sheets, constructed on shipboard by the hydrographer, and on the plain-table in the field by the engineer; these sheets become distorted by the hygrometric action of the paper, and hence are not true maps, and require the hand of man for their rectification; but as the error is only that of a variety of scales on the same sheet, the rectification does not affect the value of the sheet for its data, and can always be made in its reduction to the smaller scales. This is effected in the photographic method which has been adopted, in the following manner:

On a piece of transparent vellum the latitude and longitude lines of the sheet are laid down anew on the same scale as the sheet, but in a form corresponding to that which the area will form in the reduction; on this projection the squares of the minutes of latitude and longitude will not perceptibly differ from the squares on the sheets; the plan is, then, simply to lay the transparent vellum on the sheet, so as to make the minute lines for a square on the vellum coincide with those on the sheet; then with a pen trace the geographical delineations on the sheet upon the vellum, and omitting all such parts as are not desired to appear on the reduced chart; in this way the sheet is copied square by square, and all errors of shrinkage rectified, a selection of the desired parts made, and prominent objects made to retain their conspicuousness in the reduction, by increasing their size. In this operation both the judgment of the topographer and the skill of the draughtsman are required, and here is also a great occasion opened for gaining knowledge by experience. What objects to trace and what to omit, and how to trace them, are matters not easily determined; experience, judgment, deliberation, and consultation of the most able topographers and engineers of the survey will be required to decide this.

The work being transferred from the sheet to the vellum, the next operation is to produce the reduced photographic copy; for this purpose it is put up against a white board, and the camera placed at such distance as will insure the required reduction; a "collodion negative" is then made of it, and from this "negative" a paper photograph is produced, which is a reduced copy of the tracing. The photograph is then placed in the hands of the engraver, who transfers it to the copper plate; sheet after sheet being thus reduced and transferred to
the copper by their latitude and longitude lines, the finished chart at length appears in the
print from the engraved plate.

Although the method here described is now in successful practice, there still remains an
enormous mass of matter, relative to the conventionalities of the charts and their different
scales, yet to be decided, and it is easy to foresee that even years will not suffice to wholly
determine these points.

By the method I have described, I have, during the past year, constructed four charts of the
survey, as follows: San Pablo bay, which I announced in my last annual report as having been
successfully reduced from \( \frac{\pi}{2} \) to \( \frac{\pi}{2} \), has been twice constructed on \( \frac{\pi}{2} \) scale from the
original sheets of the survey; the selections, however, in the first tracings, not being deemed
acceptable after examining the appearance of the reduction, the sheets were again traced, and
a second reduction made; this last reduction I have learned from the office is entirely satisfactory,
and will be engraved. No. 29 of the eastern series of \( \frac{\pi}{2} \) charts has been constructed and
engraved as far as the survey has been completed. New York bay and harbor, \( \frac{\pi}{2} \), has also
been photographically reduced as far as the original sheets have been verified by the resurvey;
the work, as far as done, is, however, already in the hands of the engraver.

I have given but a mere synopsis of the photographic method of constructing the reduced
charts. A detailed description would be too voluminous to be given here, and, moreover, the
various operations now employed may be superseded by others as experience is gained. I
would be pleased, however, to prepare a full account of the photographic method of reducing
for publication; and this should at some time be done, as many of the processes are original,
and have been acquired by the expenditure of time and money.

I have also, as time would permit during the year, conducted other photographic experi-
ments for the purpose of employing photography in other departments of the survey. Partial
success has attended some of the experiments, particularly those I have made in conjunction with
Mr. L. F. Pourtales, in charge of the tidal division, for photographing the minute shells found
in the specimens of bottoms. In this labor I believe we have trodden an unexplored field,
for, so far as I am informed, success has not elsewhere attended the efforts to produce enlarged
photographs of opaque microscopic objects; but there is still room for improvement in our efforts
here. Though we have successfully introduced the work of photographing the soundings,
other and no small part of my labors have been wholly fruitless thus far, yet persevering
industry will ultimately succeed.

During the past year I have been assisted by Mr. D. Hinkle. He has applied himself both
in the electrotype and photographic operations. I desire to commend him to the office for his
assiduity in the work.
**List of plates electrotyped in alto.**

<table>
<thead>
<tr>
<th>Name of chart</th>
<th>No. made</th>
<th>Name of chart</th>
<th>No. made</th>
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<tbody>
<tr>
<td>Annapolis and Ipswich harbors</td>
<td>1</td>
<td>Biloxi bay</td>
<td>1</td>
</tr>
<tr>
<td>York river</td>
<td>1</td>
<td>Entrance to Pensacola bay</td>
<td>1</td>
</tr>
<tr>
<td>Provincetown harbor</td>
<td>1</td>
<td>Semi-ah-moo bay</td>
<td>1</td>
</tr>
<tr>
<td>Patapsco river</td>
<td>2</td>
<td>Pacific coast</td>
<td>1</td>
</tr>
<tr>
<td>Sew and Pig's reef</td>
<td>1</td>
<td>Atlantic and Pacific coasts</td>
<td>1</td>
</tr>
<tr>
<td>Wachapreague, Machipongo, and Metomkin inlets</td>
<td>1</td>
<td>San Diego bay</td>
<td>1</td>
</tr>
<tr>
<td>Atlantic coast</td>
<td>1</td>
<td>Muskeget channel</td>
<td>1</td>
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<tr>
<td>Entrance to San Francisco bay</td>
<td>1</td>
<td>Hatteras inlet</td>
<td>1</td>
</tr>
<tr>
<td>St. Simon's sound and Brunswick harbor</td>
<td>1</td>
<td>Remer and Flynn's shoals</td>
<td>1</td>
</tr>
<tr>
<td>Frying Pan shoals and entrance to Cape Fear river</td>
<td>1</td>
<td>Wimble shoals</td>
<td>1</td>
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<tr>
<td>Gulf Stream sketch</td>
<td>1</td>
<td>Eggemoggin Reach</td>
<td>1</td>
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<tr>
<td>Rockport harbor</td>
<td>1</td>
<td>Kennebec river</td>
<td>1</td>
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<tr>
<td>Entrance to Brasos river</td>
<td>1</td>
<td>Port Gamble</td>
<td>1</td>
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<tr>
<td>Fort Townshend</td>
<td>1</td>
<td>Atchafalaya bay</td>
<td>1</td>
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<tr>
<td>Wood's Hole</td>
<td>1</td>
<td>Charleston harbor</td>
<td>1</td>
</tr>
<tr>
<td>York river, upper part</td>
<td>1</td>
<td>Boston harbor, scale 7375</td>
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**List of plates electrotyped in basso.**

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<td>Bow and Pig's reef</td>
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<td>San Diego bay</td>
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<td>Cape Fear river, lower part</td>
<td>1</td>
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<tr>
<td>Western coast, sheet No. 1</td>
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<td>St. Simon's sound and Brunswick harbor</td>
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<td>Western coast, sheet No. 3</td>
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<td>Entrance to Pensacola bay</td>
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<td>Harbor of Pass Christian</td>
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<td>Gulf Stream sketch</td>
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<tr>
<td>Middle part of the southern coast of Long Island</td>
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<td>Western part of southern coast of Long Island</td>
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<tr>
<td>Canal de Haro and Roncestral Strait</td>
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<td>Atlantic and Pacific coasts</td>
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<td>Boston harbor</td>
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<td>Biloxi bay</td>
<td>1</td>
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<td>Provincetown harbor</td>
<td>3</td>
<td>Semi-ah-moo bay</td>
<td>1</td>
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<tr>
<td>Frying Pan shoals and entrance to Cape Fear river</td>
<td>2</td>
<td>Hatteras inlet</td>
<td>1</td>
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<td>York river</td>
<td>1</td>
<td>Remer and Flynn's shoals</td>
<td>1</td>
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<td>Annapolis and Ipswich harbors</td>
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<td>Wimble shoals</td>
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<td>Eastern part of Long Island sound</td>
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<td>Eggemoggin Reach</td>
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<td>Patapsco river</td>
<td>2</td>
<td>Frying Pan shoals</td>
<td>1</td>
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<tr>
<td>Atlantic coast</td>
<td>2</td>
<td>Kennebec river</td>
<td>1</td>
</tr>
<tr>
<td>Wachapreague, Machipongo, and Metomkin inlets</td>
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<td>Atchafalaya bay</td>
<td>1</td>
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<tr>
<td>Eastern part of the southern coast of Long Island</td>
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<td>Rockport harbor</td>
<td>1</td>
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<tr>
<td>Middle part of Long Island sound</td>
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<td>York river, upper part</td>
<td>1</td>
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<tr>
<td>Entrance to San Francisco bay</td>
<td>1</td>
<td>Wood's Hole</td>
<td>1</td>
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COAST SURVEY OFFICE,
Washington, November 1, 1859.

The miscellaneous division, consisting of the printing office, the map room, and office for distribution of the maps and charts, and of the Coast Survey Report, was placed under my charge in the latter part of June of this year.

Lieut. James P. Roy, U. S. A., was in charge from the date of the last annual report up to the time of my being ordered to the survey.

The records of the division are kept by Mr. V. E. King, who also has charge of the map room, and distribution of maps, charts, sketches, and Coast Survey Reports, assisted by Mr. F. Holden up to September 1, subsequently by Mr. W. Mertz, the former having resigned his position on that date. Since then I have learned with regret of the sudden death of Mr. Holden from paralysis. In addition to these duties, Mr. King assists in the clerical duties in the office of the assistant in charge. In the miscellaneous division his services are invaluable, from his intimate acquaintance with the details of duty, his constant attendance, and the celerity with which he accomplishes his work.

Mr. W. Mertz, successor to Mr. Holden, in addition to his duties in the map room, backs and stretches paper, and backs and repairs plane-table and other sheets, for use in the drawing division of the office. He has only been employed since September 1, but so far gives entire satisfaction.

In the printing office, Mr. Rutherdale, as printer, with his assistant, Mr. J. Barrett, have been industrious, and very constant in their attendance.

I have caused to be prepared, and herewith respectfully transmit, a statement of Coast Survey maps, charts, and sketches distributed during the year: of these 600 copies of each of thirteen different maps or charts, viz:

Annisquam and Ipswich harbors, Massachusetts.
Boston harbor, Massachusetts.
Plymouth harbor, Massachusetts.
Provincetown harbor, Massachusetts.
Long Island sound—eastern sheet.
Long Island sound—middle sheet.
Long Island sound—western sheet.
Eastern part of southern coast of Long Island.
Middle part of southern coast of Long Island.
Western part of southern coast of Long Island.
York River entrance, Virginia.
Beaufort harbor, North Carolina.

Cape Fear River entrances, North Carolina, have been presented, "in conformity with an act of Congress and by direction of the Treasury Department," to different institutions, societies, individuals, &c., both in this country and abroad.

I also transmit a statement of the distribution of Coast Survey Reports, and of the maps, charts, sketches, and miscellaneous matter printed since the date of the last annual report.
List of Coast Survey maps, charts, and sketches distributed during the year, for sale, use of office, and gratuitously.

<table>
<thead>
<tr>
<th>Names of maps</th>
<th>Turned over for sale</th>
<th>For use of office</th>
<th>Graciously distributed</th>
<th>Total</th>
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<td>Patapsco River</td>
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<tr>
<td>Bay</td>
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<td>New York Bay</td>
<td>12</td>
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<td>Virginia Bay</td>
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<td>Chesapeake Bay</td>
<td>6</td>
<td>7</td>
<td>13</td>
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<td>Delaware Bay and river, upper sheet</td>
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<td>Potomac River</td>
<td>8</td>
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<td>Mouth of Chesapeake Bay</td>
<td>8</td>
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<td>Harbor of Annapolis and Severn River</td>
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## List of Coast Survey maps, &c., distributed—Continued.

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Distribution made during the year of the reports of the United States Coast Survey for the years 1851, 1852, 1853, 1854, 1855, 1856, and 1857.

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Total                        | 21            | 33            | 54            | 22            | 35            | 57            | 32            | 35            | 67             |

Aggregate .................................................. 6,917
## Statement of Coast Survey maps, charts, and sketches, printed during the year.

### Section I.

| Sketch A | 30 |
| Sketch A bis | 30 |
| Boston harbor | 183 |
| Boston harbor bis | 237 |
| Provincetown harbor | 730 |
| Sea-coast chart from Portland to Race Point | 30 |
| Sea-coast chart from Plymouth to Saugus | 30 |
| Portsmouth harbor | 10 |
| Harbors of Ipswich and Annisquam | 705 |
| Plymouth harbor | 600 |
| Rockport harbor | 30 |
| York River harbor | 30 |

### Section II.

| Hudson river A | 60 |
| Long Island sound—eastern sheet | 600 |
| Long Island sound—middle sheet | 719 |
| Long Island sound—western sheet | 821 |
| Eastern part of southern coast of Long Island | 619 |
| Middle part of southern coast of Long Island | 609 |
| Western part of southern coast of Long Island | 601 |
| Sandy Hook diagrams | 20 |

### Section III.

| Sketch C | 30 |
| Chesapeake bay, sheet No. 1 | 30 |
| Chesapeake bay, sheet No. 2 | 30 |
| Chesapeake bay, sheet No. 3 | 30 |
| Rappahannock river, sheet No. 5 | 35 |
| Rappahannock river, sheet No. 6 | 35 |
| York River entrance | 719 |
| Chesapeake bay notes | 70 |
| Chesapeake bay titles | 30 |
| Patapsco river | 90 |
| Delaware bay and river, upper sheet | 40 |
| Delaware bay and river, middle sheet | 47 |
| Delaware bay and river, lower sheet | 40 |
| Delaware and Chesapeake bays | 50 |
| York river, from King’s creek to West Point | 40 |
| Mouth of Chester river | 15 |
### Section IV.

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APPENDIX No. 18.

List of registered topographical sheets received subsequent to No. 680.

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<td>Portland harbor and environs</td>
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### Appendix No. 18—Topographical Sheets—Continued.

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<td>1859</td>
<td>G. P. Bolles</td>
<td>703</td>
</tr>
<tr>
<td>Cape Fear river, lower part and approaches</td>
<td>do</td>
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<td>1858</td>
<td>do</td>
<td>708</td>
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<tr>
<td>West of Cape Fear river</td>
<td>do</td>
<td>1-10,000</td>
<td>1859</td>
<td>do</td>
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<tr>
<td>Dewees and Capers islands</td>
<td>S. Carolina</td>
<td>1-20,000</td>
<td>1856-57</td>
<td>Lieut. Com's J. N. Mailliard</td>
<td>681</td>
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<tr>
<td>Morris island and vicinity</td>
<td>do</td>
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<td>1858</td>
<td>John Selb</td>
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<td>Charleston city and vicinity</td>
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<td>1857-58</td>
<td>W. S. Edwards</td>
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<td>Folly island and vicinity</td>
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<td>John Selb</td>
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<td>Osmarck sound and vicinity</td>
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<td>Ogeechee sound and vicinity</td>
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<td>Sapelo sound and vicinity</td>
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<td>A. W. Longfellow</td>
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<td>Saint Simons sound</td>
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<td>1-10,000</td>
<td>1856-57</td>
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<td>South of St. John's river, from entrance to General E. Hopkins's plantation</td>
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<td>John Mechan</td>
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<td>South of St. John's river, from General Hopkins's to Diego plains</td>
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<td>1859</td>
<td>do</td>
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<td>Key Biscayne, from Shoal Point to Block Point</td>
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<td>1-20,000</td>
<td>1859</td>
<td>C. T. Jardella</td>
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<td>Key Biscayne, from Turtle Point to Fender Point</td>
<td>do</td>
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<td>do</td>
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<td>Card's sound, from W. Arnesacker to Jaw Point</td>
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<td>Upper Matecumbe and Windly's island</td>
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<td>Lower Matecumbe and Long key</td>
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<td>Duck, Channel, and Conch keys, and part of Long key</td>
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<td>Crawl, Grassy, and Tom's Harbor keys, and part of Flat Door key</td>
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<td>Crystal reefs and river</td>
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<td>From the Wacassas to the Withlacoochee</td>
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<td>St. George's sound from Royal Bluff,</td>
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<td>including Deep island</td>
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<td>1859</td>
<td>F. H. Gerdes</td>
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<td>St. Vincent's sound and island</td>
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<td>do</td>
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<td>Pensacola bay, west side</td>
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<td>river to Carunkaway bay</td>
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<td>W. H. Dennis, M. Seaton</td>
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<td>Lavaca bay, from Benado creek to Cox's bay</td>
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<td>Lavaca bay, from Garcia's bay to</td>
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<td>Indiana and environs</td>
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<td>do</td>
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<td>From Matagorda Bay entrance to</td>
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<td>S. A. Gilbert</td>
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<td>Pass, (reconnaissance)</td>
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<td>do</td>
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<td>From Point Duma to Cañada de Isique</td>
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<td>From Cañada de Isique to Punta Mugu</td>
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<td>From Santa Clara river to San Buenaventura</td>
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<td>1855</td>
<td>do</td>
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<td>Crescent City harbor</td>
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<td>1859</td>
<td>J. S. Lawson</td>
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<tr>
<td>From Punta del Bola to Tunitas creek</td>
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<td>W. M. Johnson</td>
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<td>San Francisco city and vicinity</td>
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<td>1857-58</td>
<td>A. P. Rodgers</td>
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<td>Gulf of Georgia, southern part, from Malia</td>
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<td></td>
<td>do</td>
<td>730</td>
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<tr>
<td>islands to East Point</td>
<td></td>
<td>1-20,000</td>
<td>1858</td>
<td>J. S. Lawson</td>
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<tr>
<td>Gulf of Georgia, southern part, from East Point to Deep bay</td>
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<td>1-20,000</td>
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<td>do</td>
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<tr>
<td>Gulf of Georgia, southern part, from Deep bay to Rocky island</td>
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<td>1-20,000</td>
<td>1859</td>
<td>do</td>
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## APPENDIX No. 19.

**List of registered hydrographic sheets received subsequent to No. 632.**

<table>
<thead>
<tr>
<th>Localities</th>
<th>State</th>
<th>Scale</th>
<th>Date</th>
<th>Hydrographers</th>
<th>Register number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheepscot river, from Hendrick's Head light to Wiscasset.</td>
<td>Maine</td>
<td>1-10,000</td>
<td>1858</td>
<td>Lieut. Comg J. H. Moore</td>
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<td>Sheepscot river, from Hendrick's Head light to Wiscasset.</td>
<td>do</td>
<td>1-10,000</td>
<td>1858</td>
<td>do</td>
<td>676</td>
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<tr>
<td>Kennebec river, from Cobb's Head to Bath.</td>
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<td>1-5,000</td>
<td>1857</td>
<td>Lieut. Comg S. D. Trenchard</td>
<td>689</td>
</tr>
<tr>
<td>Casco bay.</td>
<td>do</td>
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<td>1857-'58</td>
<td>Lieut. Comg W. G. Temple</td>
<td>664</td>
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<tr>
<td>From Kennecunk port to Isles of Shoals.</td>
<td>do</td>
<td>1-5,000</td>
<td>1857</td>
<td>Lieut. Comg A. Murray</td>
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<tr>
<td>Salem harbor.</td>
<td>Massachusetts</td>
<td>1-5,000</td>
<td>1857-'58</td>
<td>Lieut. Comg W. G. Temple</td>
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<td>Lynn harbor.</td>
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<td>1857</td>
<td>Lieut. Comg A. Murray</td>
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<td>Boston harbor.</td>
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<td>Lieut. Comg W. G. Temple</td>
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<td>Shirley's Gut, Boston harbor.</td>
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<td>1858</td>
<td>do</td>
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<td>Ship off New Haven light-house.</td>
<td>Connecticut</td>
<td>1-5,000</td>
<td>1858</td>
<td>do</td>
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<tr>
<td>General chart between Gay Head and Cape Henlopen.</td>
<td>N. Y., N. J., and Delaware</td>
<td>1-400,000</td>
<td>1859</td>
<td>A. Deechke</td>
<td>670</td>
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<tr>
<td>Harlem river and Spuyten Duyvil creek.</td>
<td>New York</td>
<td>1-10,000</td>
<td>1856</td>
<td>Lieut. Comg T. A. Craven</td>
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<tr>
<td>East river, from south end of Blackwell's island to Harlem river.</td>
<td>do</td>
<td>1-5,000</td>
<td>1856</td>
<td>do</td>
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<td>Off the Battery, New York harbor.</td>
<td>do</td>
<td>1-5,000</td>
<td>1856</td>
<td>do</td>
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<td>Rondout creek.</td>
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<td>Esopus creek.</td>
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<td>1858</td>
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<td>Nanticoke river and Fishing bay.</td>
<td>Maryland</td>
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<td>1858</td>
<td>Com. W. T. Muse</td>
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<tr>
<td>Patuxent river.</td>
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<td>1857</td>
<td>do</td>
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<tr>
<td>St. Mary's river, from Point Lookout to Ford's Landing.</td>
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<td>1-20,000</td>
<td>1857</td>
<td>do</td>
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<td>James river, from Little Handon to Wyanoke Wharf. (reconnaissance).</td>
<td>Virginia</td>
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<td>1857</td>
<td>Lieut. Comg J. N. Maffitt</td>
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<td>Off shore, from Cape Henry to Cape Hatteras.</td>
<td>Va. and N. C.</td>
<td>1-200,000</td>
<td>1859</td>
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<td>Pamlico sound.</td>
<td>N. Carolina</td>
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<td>Com. W. T. Muse</td>
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<td>Pamlico sound.</td>
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<td>From Flagstaff to New River inlet.</td>
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<td>New Inlet, northern entrance to Cape Fear river.</td>
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<td>Cape Fear bar.</td>
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<td>Deep-sea soundings between Winyah bay and Amelia island.</td>
<td>S. C., Ga., and Florida</td>
<td>1-500,000</td>
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<td>do</td>
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<td>Bull's bay.</td>
<td>S. Carolina</td>
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<td>1859</td>
<td>Lieut. Comg J. P. Bankhead</td>
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<td>From Charleston to Savannah.</td>
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<td>Chechessie and Colleton rivers.</td>
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<td>Beaufort river. (reconnaissance).</td>
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APPENDIX No. 19—HYDROGRAPHIC SHEETS—Continued.

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<td>1857-59</td>
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<td>and southwest channels</td>
<td>...do...</td>
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<td>1-10,000</td>
<td>1859</td>
<td>W. S. Gilbert...</td>
<td>671</td>
</tr>
<tr>
<td>Off shore, from Timbalier bay to Galveston</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound</td>
<td>La. and Texas</td>
<td>1-635,000</td>
<td>1858</td>
<td>Lieut. Comp. J. E. Duer...</td>
<td>657</td>
</tr>
<tr>
<td>Atchafalaya bay</td>
<td>Louisiana</td>
<td>1-20,000</td>
<td>1858</td>
<td>Com. B. P. Sands...</td>
<td>658</td>
</tr>
<tr>
<td>Atchafalaya Bay approaches</td>
<td>...do...</td>
<td>1-20,000</td>
<td>1859</td>
<td>Lieut. Comp. T. B. Huger...</td>
<td>659</td>
</tr>
<tr>
<td>Atchafalaya Bay</td>
<td>...do...</td>
<td>1-20,000</td>
<td>1859</td>
<td>do</td>
<td>651</td>
</tr>
<tr>
<td>Côte Blanche bay, eastern part.</td>
<td>...do...</td>
<td>1-20,000</td>
<td>1859</td>
<td>do</td>
<td>652</td>
</tr>
<tr>
<td>Matagorda Bay entrance, Pasa del Cavallo.</td>
<td>Texas</td>
<td>1-20,000</td>
<td>1858</td>
<td>A. Balbach...</td>
<td>635</td>
</tr>
<tr>
<td>Brazos River bay</td>
<td>...do...</td>
<td>1-10,000</td>
<td>1858</td>
<td>Lieut. Comp. J. E. Duer...</td>
<td>656</td>
</tr>
<tr>
<td>San Francisco bay, from Ravenswood to Coyote</td>
<td>California</td>
<td>1 10,000</td>
<td>1857-59</td>
<td>Lieut. Comp. R. M. Cuyler...</td>
<td>636</td>
</tr>
<tr>
<td>San Francisco bay, Steinbergen and Redwood City Creeks</td>
<td>...do...</td>
<td>1-10,000</td>
<td>1858</td>
<td>do</td>
<td>637</td>
</tr>
<tr>
<td>San Francisco bay, Coyote Hill and Union City Creeks</td>
<td>...do...</td>
<td>1-10,000</td>
<td>1858</td>
<td>do</td>
<td>638</td>
</tr>
</tbody>
</table>

APPENDIX No. 20.

List of geographical positions determined by the United States Coast Survey, and continued from reports of 1851, 1853, 1855, and 1857.

The present list is a continuation of that published in the annual reports for 1851, 1853, 1855, and 1857, and contains the geographical positions of points determined astronomically and trigonometrically, since the date of the former reports, with the repetition of a few 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.
THE UNITED STATES COAST SURVEY.

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 Territory, 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 for the use of the topographical and hydrographical surveys.

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 connection 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 from the Savannah river to Sapelo sound in Section V, to a part of those in Section VI, and to the positions in Sections VII and IX, to a part of those in Section X, and to Section XI.

As on the completion of the primary or main 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 and part of the fifth, 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 = 0.08169683.

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 incidental 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 directly, and in other sections indirectly, 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.**

<table>
<thead>
<tr>
<th></th>
<th>h. m. s.</th>
</tr>
</thead>
<tbody>
<tr>
<td>By moon culminations observed at Cambridge; Hudson, Ohio; Wilkes' observatory; and National observatory</td>
<td>4 44 28.4</td>
</tr>
<tr>
<td>By eclipses and occultations at Cambridge, Brooklyn, Philadelphia, and Wilkes' observatory</td>
<td>4 44 29.6</td>
</tr>
<tr>
<td>By chronometric differences from 1,065 exchanges in 1849, 1851, and 1855</td>
<td>4 44 31.9</td>
</tr>
</tbody>
</table>

The longitude as adopted in former reports, (since 1851,) viz: 4h. 44m. 29.5s., or 71° 07' 22.50", is still retained.

In Section V the longitudes depend on the telegraphic determinations of Charleston and Savannah, viz: Charleston, Gibbes' observatory | 79 56 00.0 |
Savannah Exchange | 81 05 16.85 |
In Section VI the longitude of Fernandina has been assumed as it resulted from the chronometer exchanges with Savannah, viz: | 81 27 42.78 |
For Cape Florida the following value was retained, viz: | 80 09 24.0 |
Sand Key, (as before) | 81 52 43.0 |
In Sections 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 VII. Depot key, Cedar keys .................................................. 83 02 45
Sections VIII and IX. Depend on 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.

In Section X the longitude of Presidio observatory, San Francisco, has been adopted ................................................................. 122 26 15.0
The Section XI longitudes depend upon Point Hudson astronomical station .................................................. 122 44 33.0
And upon Lummi Island astronomical station ................................................................. 122 40 36.9

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 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 $180^\circ$ 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 $= 1.0936136$ yard, or $39.370075$ 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.
### United States Coast Survey

**Section I. — Vicinity of Shrewsbury River. Sketch No. 2.**

<table>
<thead>
<tr>
<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Altitude</th>
<th>To station —</th>
<th>Back azimuth</th>
<th>Distance —</th>
<th>Distance</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southport Lodge</td>
<td>43 57 43.65</td>
<td>69 38 57.69</td>
<td>232 41 36</td>
<td>Danversree...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Mount Fisgard</td>
<td>43 57 46.39</td>
<td>69 36 51.05</td>
<td>38 01 31</td>
<td>White Island..</td>
<td>116 06 54</td>
<td>7206.1</td>
<td>4728.2</td>
<td></td>
</tr>
<tr>
<td>Griffith’s Head</td>
<td>43 57 55.83</td>
<td>69 42 57.39</td>
<td>197 06 36</td>
<td>Haggert’s Head ..</td>
<td>214 19 44</td>
<td>7586.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Called</td>
<td></td>
<td></td>
<td>69 52 30</td>
<td>Danversree...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Mystic</td>
<td>43 57 43.54</td>
<td>69 40 45.04</td>
<td>304 27 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Haggert, (1)</td>
<td>43 57 44.31</td>
<td>69 36 18.69</td>
<td>304 27 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Newagen</td>
<td>43 57 39.59</td>
<td>69 41 37.83</td>
<td>204 36 41</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Square Barn, centre</td>
<td>43 57 42.17</td>
<td>69 37 46.64</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Cottage, white chimney</td>
<td>43 57 19.36</td>
<td>69 41 05.97</td>
<td>204 36 41</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Wicasnet, brown spro.</td>
<td>44 06 17.72</td>
<td>69 36 41.42</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Yellow House, chimney</td>
<td>44 06 05.93</td>
<td>69 32 25.05</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Durham’s Hill</td>
<td>44 06 46.48</td>
<td>69 37 25.18</td>
<td>204 36 41</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Stone Fiss</td>
<td>43 58 17.73</td>
<td>69 37 43.73</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
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<tr>
<td>Haggert, (2)</td>
<td>43 58 94.02</td>
<td>69 36 34.77</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
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</tr>
<tr>
<td>Breakfast Hill</td>
<td>43 57 34.89</td>
<td>69 38 13.38</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Methuen’s Hill</td>
<td>43 56 57.36</td>
<td>69 37 46.86</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Allen’s Flag</td>
<td>43 56 39.19</td>
<td>69 38 58.24</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>One Story House, chimney in center.</td>
<td></td>
<td></td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>paradise Hill</td>
<td>43 56 11.73</td>
<td>69 40 39.37</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Groswetl’s Hill</td>
<td>43 55 24.36</td>
<td>69 41 09.73</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Red and White Flag, near school house.</td>
<td>43 54 24.02</td>
<td>69 42 01.01</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Lewis Hill</td>
<td>43 54 21.88</td>
<td>69 38 58.68</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Davis Signal</td>
<td>43 52 53.41</td>
<td>69 42 48.39</td>
<td>232 41 36</td>
<td>Edgecombe...</td>
<td>153 42 30</td>
<td>7583.2</td>
<td>4396.3</td>
<td></td>
</tr>
<tr>
<td>Tall Head, Wayson Island.</td>
<td>43 52 56.21</td>
<td>69 42 10.43</td>
<td>13 32 54</td>
<td>Parker’s Island...</td>
<td>117 20 54</td>
<td>7760.9</td>
<td>8091.1</td>
<td></td>
</tr>
<tr>
<td>Bluff and Red Flag, southwest part of Westport Island.</td>
<td>43 52 56.21</td>
<td>69 42 10.43</td>
<td>13 32 54</td>
<td>Parker’s Island...</td>
<td>117 20 54</td>
<td>7760.9</td>
<td>8091.1</td>
<td></td>
</tr>
<tr>
<td>Campbell’s Ledge</td>
<td>43 51 54.97</td>
<td>69 44 03.93</td>
<td>13 32 54</td>
<td>Parker’s Island...</td>
<td>117 20 54</td>
<td>7760.9</td>
<td>8091.1</td>
<td></td>
</tr>
<tr>
<td>Martham’s Island</td>
<td>43 50 25.70</td>
<td>69 42 55.46</td>
<td>13 32 54</td>
<td>Parker’s Island...</td>
<td>117 20 54</td>
<td>7760.9</td>
<td>8091.1</td>
<td></td>
</tr>
<tr>
<td>Thirty-Acre Island</td>
<td>43 51 21.12</td>
<td>69 40 50.57</td>
<td>13 32 54</td>
<td>Parker’s Island...</td>
<td>117 20 54</td>
<td>7760.9</td>
<td>8091.1</td>
<td></td>
</tr>
<tr>
<td>Martin House, Southport</td>
<td>43 50 25.36</td>
<td>69 40 00.89</td>
<td>13 32 54</td>
<td>Parker’s Island...</td>
<td>117 20 54</td>
<td>7760.9</td>
<td>8091.1</td>
<td></td>
</tr>
<tr>
<td>Towarded Gut, red flag</td>
<td>43 50 49.46</td>
<td>69 36 46.52</td>
<td>13 32 54</td>
<td>Parker’s Island...</td>
<td>117 20 54</td>
<td>7760.9</td>
<td>8091.1</td>
<td></td>
</tr>
<tr>
<td>Hendrick’s Head-light.</td>
<td>43 49 50.45</td>
<td>69 41 03.29</td>
<td>13 32 54</td>
<td>Parker’s Island...</td>
<td>117 20 54</td>
<td>7760.9</td>
<td>8091.1</td>
<td></td>
</tr>
</tbody>
</table>

**Distances:**
- Miles
- Fathoms
- Feet
### Section I.— Vicinity of Sheepscot River. Sketch No. 2.

#### Name of station | Latitude | Longitude | Azimuth | To station— | Back azimuth | Distance | Distance | Miles
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Boothbay Centre, white spire</td>
<td>43 52' 39.15</td>
<td>69 27' 45.50</td>
<td>116 37' 24</td>
<td>Barco—</td>
<td>558 33' 51</td>
<td>Mount Pigeon</td>
<td>152 29' 56</td>
<td>5796.5</td>
</tr>
<tr>
<td>Boothbay Harbor, white spire</td>
<td>43 51' 33.28</td>
<td>69 27' 09.64</td>
<td>127 36' 04</td>
<td>Mount Pigeon</td>
<td>558 33' 51</td>
<td>Southport Ledge</td>
<td>297 53' 37</td>
<td>2318</td>
</tr>
<tr>
<td>Hodgson's House, chimney in centre</td>
<td>43 51' 37.91</td>
<td>69 27' 58.59</td>
<td>129 59' 07</td>
<td>Barco—</td>
<td>510 15' 09</td>
<td>Damiscove—</td>
<td>170 36' 13</td>
<td>12643.4</td>
</tr>
<tr>
<td>Tall Pines, Edgecomb</td>
<td>43 57' 32.50</td>
<td>69 27' 06.30</td>
<td>407 35' 29</td>
<td>Edgecomb</td>
<td>171 81' 06</td>
<td>Haggerty's (1)</td>
<td>729 07</td>
<td>5196.7</td>
</tr>
<tr>
<td>Hunting Island, Cape Newagen</td>
<td>43 47' 06.49</td>
<td>69 29' 14.37</td>
<td>153 09' 13</td>
<td>Seguin Light—</td>
<td>171 35' 03</td>
<td>Damiscove—</td>
<td>270 12' 48</td>
<td>5004.0</td>
</tr>
<tr>
<td>Lower Merk Island</td>
<td>43 47' 24.14</td>
<td>69 46' 12.93</td>
<td>314 57' 48</td>
<td>Seguin Light—</td>
<td>214 34' 52</td>
<td>Seguin Light—</td>
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<td>69 36' 03.92</td>
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<td>136 09' 31</td>
<td>Southport Ledge</td>
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<td>Greenwich Head</td>
<td>756 32' 02</td>
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<td>149 48' 69</td>
<td>Southport Ledge</td>
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<td>69 35' 55.65</td>
<td>182 50' 23</td>
<td>Mount Pigeon</td>
<td>362 50' 15</td>
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<td>69 36' 01.96</td>
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<td>327 45' 18</td>
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### Section II.— Vicinity of New York. Sketch B. No. 7.

#### Name of station | Latitude | Longitude | Azimuth | To station— | Back azimuth | Distance | Distance | Miles
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<td>73 59' 05.53</td>
<td>328 18' 60</td>
<td>Mount Prospect</td>
<td>149 18' 55</td>
<td>Brooklyn Pilgrim Ch'ts</td>
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<td>40 41' 59.63</td>
<td>73 57' 26.49</td>
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<td>661.6</td>
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**UNITED STATES COAST SURVEY.**

**SECTION II.— Vicinity of New York. Sketch B, No. 7.**

**Distance.**
### REPORT OF THE SUPERINTENDENT OF THE UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.


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<th>Longitude</th>
<th>Azimuth</th>
<th>To station</th>
<th>Back azimuth</th>
<th>Distance</th>
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<td>15° 46' 39&quot;</td>
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<td>99° 19' 49&quot;</td>
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<td>Governor's Island, (2)</td>
<td>205° 44' 04&quot;</td>
<td>197'</td>
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<td>74° 00' 04.05&quot;</td>
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<td>73° 29' 25.00&quot;</td>
<td>58° 53' 50&quot;</td>
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<td>73° 28' 42.96&quot;</td>
<td>397° 10' 08&quot;</td>
<td>Brooklyn Gas Company</td>
<td>77° 13' 14&quot;</td>
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<td>60° 04' 00&quot;</td>
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<td>290° 07' 30&quot;</td>
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<td>147° 03' 09&quot;</td>
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<td>2910.0'</td>
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<td>Pier 17</td>
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<td>359° 40' 51&quot;</td>
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<td>City Mills</td>
<td>193° 09' 37&quot;</td>
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<td>1808.1'</td>
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<td>NeSmith's Pier</td>
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<td>73° 28' 13.62&quot;</td>
<td>136° 35' 40&quot;</td>
<td>Pier 56</td>
<td>297° 33' 52&quot;</td>
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<td>Haxton</td>
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<td>293° 06' 21&quot;</td>
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<td>73° 29' 07.56&quot;</td>
<td>989° 15' 57&quot;</td>
<td>Haxton</td>
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## THE UNITED STATES COAST SURVEY.

### UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.


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<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Azimuth</th>
<th>To station — Back azimuth.</th>
<th>Distance.</th>
<th>Distance.</th>
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<td>74 00 20.65</td>
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<td>Old Slip</td>
<td>40 41 56.30</td>
<td>74 00 20.65</td>
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<td>*</td>
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<td>Cunard's Pier</td>
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<td>74 00 20.65</td>
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<td>Castle Point</td>
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<td>City Mill</td>
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<td>508 10.66</td>
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**Note:** The table lists various landmarks and their respective coordinates, distances, and azimuths. This information pertains to the vicinity of New York City, as surveyed by the United States Coast Survey. The table provides essential navigational data for the waters around New York Harbor. Each entry details the name of the station, its latitude and longitude, and additional relevant survey data.
REPORT OF THE SUPERINTENDENT OF THE UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.— Vicinity of New York. Sketch B, No. 7.

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<th>Longitude</th>
<th>Azimuth</th>
<th>To station</th>
<th>Back azimuth</th>
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<td>74 06 24.44</td>
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<td>Castle Point</td>
<td>349 52 20</td>
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<td>Pier 43</td>
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<td>Castle Pier</td>
<td>339 39 15</td>
<td>1.18</td>
</tr>
<tr>
<td>Long Dock, Hoboken</td>
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<td>74 06 30.67</td>
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<td>Castle Pier</td>
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<tr>
<td>Pier 30</td>
<td>40 42 59.30</td>
<td>74 06 33.67</td>
<td>141 54 91</td>
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### The United States Coast Survey

#### Section II — Vicinity of New York. Sketch No. 7.

<table>
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<th>Latitude</th>
<th>Longitude</th>
<th>Altitude</th>
<th>Town or station</th>
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## REPORT OF THE SUPERINTENDENT OF UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

### Section II.— Vicinity of New York. Sketch B, No. 1.

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### Footnotes
- **Note:** All positions are given in seconds.
- **Note:** Distances are in miles.
- **Note:** Azimuths are in degrees.

### Other Stations
- **Fort George:** 73 54 46.06
- **Mount Morris:** 73 51 10.94
- **Prospect Hill:** 73 52 56.09
- **Ward's Island:** 73 53 55.49
- **Galway:** 73 54 50.92
- **Keane:** 73 54 46.73
- **J. D. Dyckman:** 73 54 50.92
- **Pioneer Point:** 73 54 50.92
- **Ward's Island:** 73 54 50.92
- **Horn's West:** 73 54 46.73
- **Mount Morris:** 73 54 46.73

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### Notes on Positions
- **Fort George:** 180° 00' 00"
- **Mount Morris:** 180° 00' 00"
- **Prospect Hill:** 180° 00' 00"
- **Ward's Island:** 180° 00' 00"
- **Galway:** 180° 00' 00"
- **J. D. Dyckman:** 180° 00' 00"
- **Pioneer Point:** 180° 00' 00"
- **Ward's Island:** 180° 00' 00"
- **Horn's West:** 180° 00' 00"
### The United States Coast Survey


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### New York and vicinity.

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### REPORT OF THE SUPERINTENDENT OF
### UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

**Section II.— Vicinity of New York and New York Harbor. Sketch B, No. 1.**

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### THE UNITED STATES COAST SURVEY.

#### UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

**Section II.— Vicinity of New York Harbor, Staten Island, and New Jersey. Sketch B, No. 7.**

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**Section II.—Vicinity of Staten Island and Island.** Sketch 3, No. 1.
## REPORT OF THE SUPERINTENDENT OF
UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

### Section II.—Hudson river, from Newbury to Poughkeepsie. Sketch B, No. 1.

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**From Poughkeepsie to Rhinebeck.**
### The United States Coast Survey.

#### United States Coast Survey.—Geographical Positions.

**Section II.—Hudson river, from Poughkeepsie to Rhinebeck. Sketch B, No. 7.**

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<th>Back azimuth</th>
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**Notes:**
- The data includes latitude, longitude, azimuth, distances to stations, and back azimuths.
- The distances are measured in miles.
- The survey was conducted from Poughkeepsie to Rhinebeck on the Hudson River.
REPORT OF THE SUPERINTENDENT OF

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Poughkeepsie to Rhinebeck. Sketch B, No. 7.

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### UNITED STATES COAST SURVEY: GEOGRAPHICAL POSITIONS.

#### Section II.—Hudson river, from Poughkeepsie to Rhinebeck. Sketch II, No. 7.

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REPORT OF THE SUPERINTENDENT OF
UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Rhuinebeck to geographical points. Sketch F, No. 7.

### Table: United States Coast Survey—Geographical Positions

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<th>Longitude</th>
<th>Azimuth</th>
<th>To station</th>
<th>Back azimuth</th>
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### THE UNITED STATES COAST SURVEY.

#### UNITED STATES COAST SURVEY.-GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Rhenbeck to Hudson. Sketch B, No. 1.

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**Note:** The table provides geographical positions for various points along the Hudson river, including latitude, longitude, azimuth, distances to and from other points, and various lengths and distances related to these points. The table entries are formatted in a way that aligns with the expected layout of a survey or navigational document, providing comprehensive information for navigational purposes.
## REPORT OF THE SUPERINTENDENT OF

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Rensselaer to Hudson. Sketch B, No. 7.

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## THE UNITED STATES COAST SURVEY

### UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

**Section II.—Hudson river, from Rhinebeck to Hudson. Sketch B, No. 7.**

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### Section III.—Mouth of Potomac river. Sketch C, No. 9.

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**Geographical Positions**

Section III.—Mouth of Potomac river—St. Mary's river—Currituckan river. Sketch C, No. 9.
the United States Coast Survey.

United States Coast Survey—Geographical Positions.

*Section III.* Currituckan River. Sketch C, No. 9.

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## Table: Savannah River to Sapelo Sound

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### Table: Savannah River to Sapelo Sound — Sketch E, No. 16.

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### Section V: Savannah River to Sapelo Sound — Geographical Positions.
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<td>Summ</td>
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<td>White Flag between creeks</td>
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### THE UNITED STATES COAST SURVEY.

#### UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

**Section V.—Ossabaw sound to Sapelo sound. Sketch E, No. 16.**

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<td>325° 53' 52&quot;</td>
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<td>322° 25' 59&quot;</td>
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<td>Barn, gable end, Shad’s plant,</td>
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<td>311° 15' 15&quot;</td>
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<td>Flag staff, Port Pulaski</td>
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<td>80° 33° 15.33&quot; W</td>
<td>327° 16° 24&quot;</td>
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<td>97° 06' 50&quot;</td>
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<td>80° 59' 39.15&quot; W</td>
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<td>312° 93' 23&quot;</td>
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<td>141° 14' 55&quot;</td>
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<td>268° 11' 43&quot;</td>
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<td>345° 16' 45&quot;</td>
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<td>216° 21' 03&quot;</td>
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**Note:** Distances in miles are approximate.
### REPORT OF THE SUPERINTENDENT OF
UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Ossabaw sound to Sapelo sound. Sketch E, No. 16.

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<td>Sembury Church</td>
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### United States Coast Survey. 251

**Section V. —Ossabaw sound to Sapelo sound. Sketch E, No. 16.**

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<thead>
<tr>
<th>Name of station</th>
<th>Latitude.</th>
<th>Longitude.</th>
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<td>White Flag with knot on east side of Black Beard Island...</td>
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### REPORT OF THE SUPERINTENDENT OF
### UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

**Section V.—Ossabaw sound to Sapelo sound. Sketch E, No. 16.**

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<thead>
<tr>
<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Azimuth</th>
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<tr>
<td>Inner Buoy, (on bar)</td>
<td>31° 20' 45&quot; N</td>
<td>81° 07' 14.13&quot; W</td>
<td>95° 10' 33&quot;</td>
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<td>Outer Buoy, (on bar)</td>
<td>31° 20' 39.16&quot; N</td>
<td>81° 10' 56.85&quot; W</td>
<td>82° 30' 38&quot;</td>
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<tr>
<td>White Flag in pine hammock on St. Catherine's island</td>
<td>31° 20' 05.05&quot; N</td>
<td>81° 10' 56.85&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>Keel's Flats, west of lighthouse</td>
<td>31° 36' 09.11&quot; N</td>
<td>81° 10' 36.94&quot; W</td>
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<td>Tint in hammock on left bank of Sapelo river</td>
<td>31° 26' 56.06&quot; N</td>
<td>81° 11' 29.79&quot; W</td>
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<td>White Flag on marsh at mouth of Wahoo creek</td>
<td>31° 25' 30.46&quot; N</td>
<td>81° 11' 46.17&quot; W</td>
<td>77° 00' 00&quot;</td>
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<td>White Flag on shelf of St. Catherine's island</td>
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<td>81° 10' 56.99&quot; W</td>
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<td>White Flag at mouth of John- son's creek</td>
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<td>81° 10' 53.91&quot; W</td>
<td>82° 30' 35.1°</td>
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<td>81° 12' 50.66&quot; W</td>
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<td>White Flag, with hut, near Old- er's Island</td>
<td>31° 34' 35.19&quot; N</td>
<td>81° 11' 44.23&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>White Flag in pine tree at ham- mock</td>
<td>31° 35' 25.07&quot; N</td>
<td>81° 13' 56.03&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>White Flag in pine tree at ham- mock</td>
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<td>81° 13' 16.46&quot; W</td>
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<td>White Flag on north shore of sound</td>
<td>31° 34' 38.11&quot; N</td>
<td>81° 13' 26.82&quot; W</td>
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<td>White Flag on northwest point of Black Rock island</td>
<td>31° 32' 08.68&quot; N</td>
<td>81° 11' 54.47&quot; W</td>
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<td>White Flag in cedar, west side of Black Rock island</td>
<td>31° 31' 38.91&quot; N</td>
<td>81° 10' 26.02&quot; W</td>
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<td>White Flag in oak on Black Rock island</td>
<td>31° 31' 08.67&quot; N</td>
<td>81° 10' 04.78&quot; W</td>
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<td>White Flag on northeast point of Sapelo island</td>
<td>31° 30' 38.95&quot; N</td>
<td>81° 12' 56.75&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>Red and White Flag at mouth of Barbour's Island river</td>
<td>31° 33' 18.01&quot; N</td>
<td>81° 13' 45.41&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>White Flag, with hut, on Little Mud river</td>
<td>31° 34' 16.94&quot; N</td>
<td>81° 15' 18.89&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>White and Black Flag at mouth of Sapelo river</td>
<td>31° 32' 19.74&quot; N</td>
<td>81° 15' 57.04&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>White Flag on left bank of Julian- ton river</td>
<td>31° 33' 45.61&quot; N</td>
<td>81° 16' 26.92&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>White Flag, with paprika root, at mouth of Sapelo river</td>
<td>31° 32' 57.35&quot; N</td>
<td>81° 16' 20.96&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>Black Flag on left bank of Sapelo river</td>
<td>31° 32' 45.61&quot; N</td>
<td>81° 16' 43.31&quot; W</td>
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<td>White Flag on Curry Point, Ossabaw Island</td>
<td>31° 30' 51.08&quot; N</td>
<td>81° 19' 27.39&quot; W</td>
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<td>White and Black Flag on right bank of Sapelo river</td>
<td>31° 31' 03.16&quot; N</td>
<td>81° 17' 59.26&quot; W</td>
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<td>White Flag on Four-mile Point</td>
<td>31° 34' 05.94&quot; N</td>
<td>81° 18' 40.19&quot; W</td>
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<td>Lower Buoy in Mud river</td>
<td>31° 30' 08.76&quot; N</td>
<td>81° 11' 44.47&quot; W</td>
<td>9° 00' 00&quot;</td>
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<td>White Flag on left bank of Mud river</td>
<td>31° 31' 02.16&quot; N</td>
<td>81° 15' 45.41&quot; W</td>
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<td>Beacon at mouth of Twentyshe</td>
<td>31° 00' 18.65&quot; N</td>
<td>81° 17' 56.13&quot; W</td>
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<td>Upper Buoy in Mud river</td>
<td>31° 29' 51.97&quot; N</td>
<td>81° 17' 11.79&quot; W</td>
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<td>White Flag on creek, Dog Island</td>
<td>31° 30' 47.99&quot; N</td>
<td>81° 16' 55.78&quot; W</td>
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### Section V.—Ossabaw sound to Sapelo sound. Sketch E, No. 16.

<table>
<thead>
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<th>Name of station</th>
<th>Latitude.</th>
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<th>Azimuth.</th>
<th>To station—</th>
<th>Back azimuth.</th>
<th>Distance.</th>
<th>Distance.</th>
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<td>81° 18' 17&quot;</td>
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<td>South Base</td>
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<td>White Flag on Marsh island, in Mud river.</td>
<td>31° 29' 12&quot;</td>
<td>81° 18' 05&quot;</td>
<td>249 21 17</td>
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<td>31° 25' 54&quot;</td>
<td>81° 19' 26&quot;</td>
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<td>Chimney of Overseer’s House, Creighton island.</td>
<td>31° 26' 01&quot;</td>
<td>81° 18' 47&quot;</td>
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<td>Jekyllton</td>
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<td>81° 21' 37&quot;</td>
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<td>189 55 40</td>
<td>Jekyllton</td>
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<td>81° 10' 46&quot;</td>
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<td>76 50 13</td>
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<td>81° 18' 11&quot;</td>
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<td>Jekyllton</td>
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<td>296 20 35</td>
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<td>White Flag on tree at Sutherland Bank.</td>
<td>31° 20' 05&quot;</td>
<td>81° 06' 15&quot;</td>
<td>252 07 50</td>
<td>Dog Island</td>
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<td>Creighton island.</td>
<td>166 13 34</td>
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<td>2526.3</td>
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<td>White Flag in tree on northwest point of Creighton island.</td>
<td>31° 21' 14&quot;</td>
<td>81° 10' 26&quot;</td>
<td>558 55 59</td>
<td>Creighton island.</td>
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<td>588 57 94</td>
<td>Jekyllton</td>
<td>43 59 19</td>
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<td>Black and White Flag on right bank of Sapelo river.</td>
<td>31° 29' 31&quot;</td>
<td>81° 90' 46&quot;</td>
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<td>62 92 60</td>
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<td>Gable-end of building at Chocolate.</td>
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<td>81° 15' 04&quot;</td>
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### Section V.—Charleston Harbor to Winyah Bay.* Sketch E, No. 16.

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<th>Longitude.</th>
<th>Azimuth.</th>
<th>To station—</th>
<th>Back azimuth.</th>
<th>Distance.</th>
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<td>Breach Inlet</td>
<td>30° 46' 19&quot;</td>
<td>79° 46' 42&quot;</td>
<td>785 45 30</td>
<td>Breach Inlet</td>
<td>39 45 15</td>
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<td>Circular Church</td>
<td>30° 46' 54&quot;</td>
<td>79° 25' 14&quot;</td>
<td>118 39 15</td>
<td>Circular Church</td>
<td>296 37 34</td>
<td>6684.8</td>
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<td>Fort Sumpter, (5)</td>
<td>30° 45' 08&quot;</td>
<td>79° 20' 04&quot;</td>
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<td>Breach Inlet</td>
<td>68 18 58</td>
<td>5909.5</td>
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<td>Vemning</td>
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<td>79° 55' 27&quot;</td>
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<td>162 30 24</td>
<td>3279.9</td>
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<td>Hamlin</td>
<td>30° 47' 53&quot;</td>
<td>79° 47' 10&quot;</td>
<td>91 30 15</td>
<td>Breach Inlet</td>
<td>901 59 93</td>
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<td>Goat Island</td>
<td>30° 48' 05&quot;</td>
<td>79° 12' 16&quot;</td>
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<td>Vemning</td>
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<td>Fuller</td>
<td>30° 44' 05&quot;</td>
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<td>Roberts, (2)</td>
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<td>79° 43' 18&quot;</td>
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<td>Fuller</td>
<td>302 56 39</td>
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<td>Toomer</td>
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<td>79° 43' 78&quot;</td>
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<td>Hamlin</td>
<td>365 14 43</td>
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<td>301 18 39</td>
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<td>Pole on Monticello House</td>
<td>30° 45' 55&quot;</td>
<td>79° 50' 50&quot;</td>
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<td>354 09 49</td>
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<td>Sullivan’s Island, back beach</td>
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<td>79° 47' 13&quot;</td>
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<td>313 33 58</td>
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<td>Cato’s Landing, (pole)</td>
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<td>79° 47' 13&quot;</td>
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<td>Catholic Church spire, Broad street.</td>
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<td>79° 55' 75&quot;</td>
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<td>Delaware</td>
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<td>4719.9</td>
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* The positions on Winyah Bay, printed in the report of 1855, require the corrections: — 0° 60' in latitude, and + 4° 08' 38" in longitude.
## REPORT OF THE SUPERINTENDENT OF

### UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

### Section V.—Charleston Harbor to Winship Bay. Sketch E, No. 16.

<table>
<thead>
<tr>
<th>Name of station</th>
<th>Longitude</th>
<th>Latitude</th>
<th>Altitude</th>
<th>To station</th>
<th>Back altitude</th>
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<th>Distance</th>
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<td>Legare</td>
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<td>Chimney on west end of mouth house</td>
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<td>318 29 56</td>
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## THE UNITED STATES COAST SURVEY.

### UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

*Sketch E, No. 16.*

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<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Azimuths</th>
<th>To station</th>
<th>Back azimuth</th>
<th>Distance, Miles</th>
<th>Distance, Yards</th>
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<td>79°39'17.31&quot;</td>
<td>191°51'43&quot;</td>
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<td>Joyce</td>
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<td>79°41'59.79&quot;</td>
<td>191°45'41&quot;</td>
<td>Cape Rosen</td>
<td>193°45'26&quot;</td>
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<td>2306.3</td>
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<td>79°43'54.30&quot;</td>
<td>190°14'55&quot;</td>
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<td>209°58'11&quot;</td>
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<td>79°47'11.41&quot;</td>
<td>218°37'63&quot;</td>
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<td>131°37'37&quot;</td>
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<td>79°43'40.38&quot;</td>
<td>333°33'19&quot;</td>
<td>Neil</td>
<td>182°28'39&quot;</td>
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<td>79°42'01.75&quot;</td>
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<td>234°01'36&quot;</td>
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<td>79°18'12.75&quot;</td>
<td>120°21'50&quot;</td>
<td>M. Coveney</td>
<td>209°21'49&quot;</td>
<td>419.3</td>
<td>229.9</td>
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<td>Lowndes</td>
<td>33°11'20.67&quot;</td>
<td>79°16'50.03&quot;</td>
<td>85°46'31&quot;</td>
<td>Lowndes</td>
<td>161°31'35&quot;</td>
<td>3861.8</td>
<td>2841.9</td>
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<td>Ford’s Chimney</td>
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<td>79°13'57.85&quot;</td>
<td>215°30'11&quot;</td>
<td>South Beach (2)</td>
<td>210°09'01&quot;</td>
<td>4392.8</td>
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<td>Lowndes’ Mill</td>
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<td>79°14'04.96&quot;</td>
<td>206°03'97&quot;</td>
<td>Lowndes</td>
<td>136°03'63&quot;</td>
<td>779.9</td>
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<tr>
<td>South Beach</td>
<td>33°11'16.78&quot;</td>
<td>79°15'06.73&quot;</td>
<td>249°90'59&quot;</td>
<td>Lowndes</td>
<td>199°19'35&quot;</td>
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<tr>
<td>Barn</td>
<td>33°07'57.96&quot;</td>
<td>79°16'56.91&quot;</td>
<td>211°14'31&quot;</td>
<td>Barn</td>
<td>144°22'20&quot;</td>
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<td>Lucas’ Mill</td>
<td>33°05'40.95&quot;</td>
<td>79°13'51.56&quot;</td>
<td>40°19'00&quot;</td>
<td>Cedar Island, 1857</td>
<td>111°90'59&quot;</td>
<td>5936.1</td>
<td>5920.1</td>
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<td>Fouty</td>
<td>33°16'56.40&quot;</td>
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<td>Bulow’s Mill, chimney</td>
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<td>Penny Meade, chimney of Rice Mill</td>
<td>33°09'11.17&quot;</td>
<td>79°18'36.56&quot;</td>
<td>521°51'14&quot;</td>
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<td>111°52'17&quot;</td>
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<td>Lower Mill</td>
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<td>79°19'59.91&quot;</td>
<td>270°39'57&quot;</td>
<td>Lower Mill</td>
<td>188°30'45&quot;</td>
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<td>Upper Mill</td>
<td>33°06'51.00&quot;</td>
<td>79°04'49.52&quot;</td>
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<td>Upper Mill</td>
<td>158°34'36&quot;</td>
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<td>Santee</td>
<td>33°06'38.60&quot;</td>
<td>79°17'05.49&quot;</td>
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<td>209°28'26&quot;</td>
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<td>Horn</td>
<td>33°04'46.84&quot;</td>
<td>79°01'51.18&quot;</td>
<td>318°17'55&quot;</td>
<td>Horn</td>
<td>11°38'30&quot;</td>
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<td>Cape Rommell, new light</td>
<td>33°07'06.56&quot;</td>
<td>79°02'11.65&quot;</td>
<td>137°37'14&quot;</td>
<td>Cape Rommell, old light</td>
<td>151°09'05&quot;</td>
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<td>3740.4</td>
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<td>Jeremy</td>
<td>33°01'56.58&quot;</td>
<td>79°11'56.21&quot;</td>
<td>186°50'31&quot;</td>
<td>Jeremy</td>
<td>317°35'05&quot;</td>
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<td>2859.2</td>
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*Distances are in miles and yards.*

---

**NOTE:** The table above provides a list of geographical positions and distances for various locations along the coastline, including names of stations, latitudes, longitudes, azimuths, and distances to other stations. The data is presented in a structured format, making it easier to read and understand the geographical relationships between different locations. The table includes information about various landmarks and their positions relative to each other, which is essential for navigational purposes and geographic studies. The distances are measured in both miles and yards, providing a comprehensive view of the geographical layout.
<table>
<thead>
<tr>
<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Azimuth</th>
<th>To station</th>
<th>Back azimuth</th>
<th>Distance</th>
<th>Distance</th>
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<tbody>
<tr>
<td>Manhasset, Long</td>
<td>40° 42' 48&quot;</td>
<td>73° 29' 19&quot;</td>
<td>333° 02' 41&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
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<td>Leaning Pole</td>
<td>40° 42' 48&quot;</td>
<td>73° 29' 19&quot;</td>
<td>333° 02' 41&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
</tr>
<tr>
<td>Bob, with white flag</td>
<td>40° 42' 48&quot;</td>
<td>73° 29' 19&quot;</td>
<td>333° 02' 41&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
</tr>
<tr>
<td>Old Mill</td>
<td>40° 42' 48&quot;</td>
<td>73° 29' 19&quot;</td>
<td>333° 02' 41&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
</tr>
<tr>
<td>Charleston Light</td>
<td>33° 01' 06&quot;</td>
<td>72° 49' 07&quot;</td>
<td>333° 02' 41&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
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<tr>
<td>Charleston Light</td>
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<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
<td>33° 01' 06&quot;</td>
</tr>
</tbody>
</table>

Distance to Charleston:

- Distance from Manhasset to Charleston: 455.0 miles
- Distance from Leaning Pole to Charleston: 455.0 miles
- Distance from Bob, with white flag to Charleston: 455.0 miles
- Distance from Old Mill to Charleston: 455.0 miles
- Distance from Charleston Light to Charleston: 1945.4 miles

**Notes:**
- The distances are measured in nautical miles.
- The table provides the latitude, longitude, azimuth, and distance from various stations to Charleston.
### THE UNITED STATES COAST SURVEY

#### UNITED STATES COAST SURVEY—GEOGRAPHICAL POSITIONS.

#### Section VI.—St. Mary’s river.  St. Mary’s towards Cedar Keys.  Sketch E, No. 20.

<table>
<thead>
<tr>
<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Azimuth</th>
<th>To station—</th>
<th>Back azimuth</th>
<th>Distance</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiger Island Base, south end</td>
<td>30° 40′ 42.21″</td>
<td>81° 26′ 23.70″</td>
<td></td>
<td>South Base</td>
<td></td>
<td>155 06 28″</td>
<td>1684.7</td>
</tr>
<tr>
<td>Tiger Island Base, north end</td>
<td>30° 42′ 36.96″</td>
<td>81° 26′ 48.86″</td>
<td>305 98 25″</td>
<td>South Base</td>
<td>0</td>
<td>305 98 25″</td>
<td>2979.9</td>
</tr>
<tr>
<td>Cumberland</td>
<td>30° 43′ 55.19″</td>
<td>81° 27′ 41.47″</td>
<td></td>
<td>South Base</td>
<td>0</td>
<td>309 25 30″</td>
<td>2979.9</td>
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<tr>
<td>Fort Point</td>
<td>30° 43′ 42.24″</td>
<td>81° 26′ 27.11″</td>
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<td>Cumberland</td>
<td>134 19 62″</td>
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<td>5302.8</td>
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<td>Fernandina, geodetic station</td>
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<td>81° 27′ 42.78″</td>
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<td>Fernandina, geodetic station</td>
<td>0</td>
<td>149 03 30″</td>
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<tr>
<td>Fernandina, astronomical station</td>
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<td>81° 27′ 49.78″</td>
<td>179 29 57″</td>
<td>Fernandina, geodetic station</td>
<td></td>
<td>179 29 57″</td>
<td>544.1</td>
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<td>Martin’s Island</td>
<td>30° 41′ 15.45″</td>
<td>81° 30′ 56.77″</td>
<td>233 06 26″</td>
<td>Cumberland</td>
<td>53 10 17″</td>
<td>6350.7</td>
<td>7173.5</td>
</tr>
<tr>
<td>McLure</td>
<td>30° 40′ 55.91″</td>
<td>81° 36′ 53.69″</td>
<td>85 18 45″</td>
<td>Martin’s Island</td>
<td>273 14 64″</td>
<td>6149.9</td>
<td>7109.8</td>
</tr>
<tr>
<td>Roys’ Buoy</td>
<td>30° 43′ 58.58″</td>
<td>81° 35′ 00.29″</td>
<td>990 48 18″</td>
<td>Martin’s Island</td>
<td>119 51 92″</td>
<td>6181.5</td>
<td>7457.5</td>
</tr>
<tr>
<td>Sand Hill, (1)</td>
<td>30° 49′ 18.14″</td>
<td>81° 37′ 01.50″</td>
<td>152 06 09″</td>
<td>Point Peter</td>
<td>7 18 15″</td>
<td>4554.3</td>
<td>4490.3</td>
</tr>
<tr>
<td>Sand Hill, (2)</td>
<td>30° 49′ 11.34″</td>
<td>81° 37′ 29.61″</td>
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<td>North Base</td>
<td>265 34 40″</td>
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<td>Delaware</td>
<td>30° 43′ 14.70″</td>
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<td>North Point</td>
<td>303 03 29″</td>
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<td>1996.6</td>
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<td>Tiger Island, pine</td>
<td>30° 45′ 13.14″</td>
<td>81° 28′ 37.67″</td>
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<td>North End</td>
<td>339 11 57″</td>
<td>594.0</td>
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<tr>
<td>E. E. Point, Cumberland, white flag in tree</td>
<td>30° 43′ 06.30″</td>
<td>81° 27′ 57.59″</td>
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<td>North End</td>
<td>15 14 03″</td>
<td>1366.1</td>
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<tr>
<td>Cumberland, black flag in tree</td>
<td>30° 45′ 22.26″</td>
<td>81° 28′ 50.55″</td>
<td>334 22 47″</td>
<td>North Point</td>
<td>303 44 43″</td>
<td>1914.9</td>
<td>1991.1</td>
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<tr>
<td>No. 5, (T. E.)</td>
<td>30° 41′ 44.49″</td>
<td>81° 36′ 07.71″</td>
<td>143 28 30″</td>
<td>North Base</td>
<td>326 38 39″</td>
<td>1779.8</td>
<td>1916.5</td>
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<tr>
<td>Tiger Island, white flag in tree</td>
<td>30° 41′ 14.83″</td>
<td>81° 27′ 47.37″</td>
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<td>South Base</td>
<td>129 07 54″</td>
<td>1327.4</td>
<td>1374.8</td>
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<td>Pilot Lookout</td>
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<td>57 47 48″</td>
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<td>Yellow Buft, white flag</td>
<td>30° 40′ 36.13″</td>
<td>81° 27′ 40.07″</td>
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<td>291 06 16″</td>
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<tr>
<td>Yellow Buft, south gable end of hotel</td>
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<td>81° 27′ 29.00″</td>
<td>235 51 17″</td>
<td>Martin’s Island</td>
<td>235 51 17″</td>
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<td>2547.6</td>
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<tr>
<td>Amelia Light-house</td>
<td>30° 40′ 38.94″</td>
<td>81° 27′ 04.07″</td>
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<td>North End</td>
<td>340 01 30″</td>
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<td>No. 8, (A.)</td>
<td>30° 42′ 30.90″</td>
<td>81° 26′ 04.17″</td>
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<td>232 21 04″</td>
<td>1683.8</td>
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<tr>
<td>No. 9, (A.)</td>
<td>30° 46′ 34.87″</td>
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<td>Amelia Light-house</td>
<td>320 47 11″</td>
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<td>No. 1, Marsh Island</td>
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<td>143 57 13″</td>
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<td>Black Flag, Marsh Island</td>
<td>30° 46′ 09.71″</td>
<td>81° 26′ 57.30″</td>
<td>118 15 27″</td>
<td>Point Peter</td>
<td>566 15 11″</td>
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<tr>
<td>Black Flag in tree, ocean side, Amelia</td>
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<td>81° 29′ 59.57″</td>
<td>227 06 29″</td>
<td>Cumberland</td>
<td>314 11 42″</td>
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<tr>
<td>White and Black Flag, ocean side, Cumberland sound</td>
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<td>81° 28′ 18.69″</td>
<td>30 49 35″</td>
<td>Point Peter</td>
<td>418 46 56″</td>
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<td>4941.3</td>
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<td>White Flag, mouth of St. Mary’s river</td>
<td>30° 45′ 18.36″</td>
<td>81° 28′ 58.30″</td>
<td>321 41 14″</td>
<td>North Base</td>
<td>171 43 00″</td>
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<tr>
<td>Black Flag on Jolly river</td>
<td>30° 45′ 21.28″</td>
<td>81° 30′ 03.86″</td>
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<td>Martin’s Island</td>
<td>911 59 50″</td>
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33
### Section VI.—St. Mary’s River. St. Mary’s, toward Cedar Keys. Sketch No. 20.

<table>
<thead>
<tr>
<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Azimuth</th>
<th>To station—</th>
<th>Back azimuth</th>
<th>Distance—</th>
<th>Distance—</th>
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<tr>
<td>Bird Nest Tree</td>
<td>29 44 04.95</td>
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<td>136 44 36</td>
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<tr>
<td>Red Flag, in hammock, on Tiger island</td>
<td>30 43 23.09</td>
<td>81 20 23.09</td>
<td>94 63 23</td>
<td>DeBary</td>
<td>5724 41 35</td>
<td>5502.9</td>
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<tr>
<td>Prevart’s House, west chimney</td>
<td>30 43 25.00</td>
<td>81 34 18.02</td>
<td>26 65 20</td>
<td>Martin’s Island</td>
<td>106 40 19</td>
<td>5117.9</td>
<td>6033.4</td>
</tr>
<tr>
<td>White Flag, in tree, above Rose’s Bluff</td>
<td>30 43 02.09</td>
<td>81 34 52.54</td>
<td>30 31 04</td>
<td>Rose’s Bluff</td>
<td>200 31 20</td>
<td>664.8</td>
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</table>

### Section VI.—Cape Sable to Matucanba Key. Sketch No. 21.

<table>
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<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Azimuth</th>
<th>To station—</th>
<th>Back azimuth</th>
<th>Distance—</th>
<th>Distance—</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Sable Base, east end</td>
<td>25 08 22.92</td>
<td>81 06 38.46</td>
<td>22 26 07</td>
<td>East Base</td>
<td>69 54 07</td>
<td>6431.5</td>
<td>7002.3</td>
</tr>
<tr>
<td>Cape Sable Base, west end</td>
<td>25 07 16.04</td>
<td>81 06 19.04</td>
<td>18 29 26</td>
<td>East Base</td>
<td>306 54 45</td>
<td>7081.4</td>
<td>7754.9</td>
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<tr>
<td>Oyster Key</td>
<td>25 08 09.45</td>
<td>81 07 14.08</td>
<td>99 56 13</td>
<td>West Base</td>
<td>770 58 39</td>
<td>11887.7</td>
<td>13000.6</td>
</tr>
<tr>
<td>Sandy Key</td>
<td>25 08 08.41</td>
<td>81 06 49.76</td>
<td>181 46 08</td>
<td>West Base</td>
<td>140 26 06</td>
<td>11314.8</td>
<td>12541.4</td>
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<td>Man-of-war Bush</td>
<td>25 08 58.68</td>
<td>81 06 48.76</td>
<td>156 43 55</td>
<td>Oyster Key</td>
<td>322 42 23</td>
<td>8088.5</td>
<td>9726.9</td>
</tr>
<tr>
<td>Schooner Bank</td>
<td>25 07 59.66</td>
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<td>Sandy Key</td>
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<td>10118.8</td>
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<td>Rabbit Key</td>
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<td>Sandy Key</td>
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<td>10907.7</td>
<td>11616.1</td>
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The United States Coast Survey.
### Cape Sable to Matacumba Key — Florida Reef, from Matacumba to Rodriguez

#### Name of Station, Latitude, Longitude, Azimuth, To Station, Back Azimuth, Distance to Station, Distance to Back Station, Distance to West

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### Section VII.—Cedar Keys to Homosassa river. Sketch G, No. 25.

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### United States Coast Survey

#### Section VII. Cedar Keys to Homosassa River

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**Directions:**
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- Longitude: "° "
- Azimuth: "° "
- To station: "° "
- Back azimuth: "° "
- Distance: "° "
- Distance: "° "
**THE UNITED STATES COAST SURVEY.**

**UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.**

**Section VII.—Cedar Keys to Homosassa river. Sketch G, No. 23.**

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### Section VIII.—Lake Borgne. Sketch II, No. 26.

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### The United States Coast Survey

**Section VIII.—Lake Borgne. Sketch H, No. 26.**

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**Section VIII.— Vicinity of New Orleans. Sketch H, No. 26.**

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REPORT OF THE SUPERINTENDENT OF
UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.
Section IX.—Lehua bay, Caranakway bay, and Espanola bay. Sketch H, No. 98.
### Section X.—Napa creek.  Sketch I, No. 31.

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### Section X.—Tomales Bay. Sketch J, No. 31.

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### Section XI—Gulf of Georgia. Sketch K, No. 34

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## REPORT OF THE SUPERINTENDENT OF
\[\text{UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.}\]

### Section XI.—Gulf of Georgia. Sketch K, No. 34.

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<td>North...</td>
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### THE UNITED STATES COAST SURVEY

#### UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

**Section XI.—Gulf of Georgia. Sketch K, No. 34.**

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<td>2988.8</td>
<td>9941.3</td>
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<tr>
<td>Oak Bay</td>
<td>49° 58′ 45.82″</td>
<td>W. 06° 48.69″</td>
<td>250° 16′ 30″</td>
<td>Buoy Point</td>
<td>111° 16′ 46″</td>
<td>10097.7</td>
<td>19066.8</td>
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<tr>
<td>Houns between Lagoon and Bush Point</td>
<td>49° 53′ 07.96″</td>
<td>W. 06° 57.99″</td>
<td>6° 54′ 06″</td>
<td>Buoy Point</td>
<td>186° 53′ 54″</td>
<td>3551.2</td>
<td>2863.8</td>
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<tr>
<td>Hood's Head</td>
<td>49° 57′ 19.33″</td>
<td>W. 06° 53.87″</td>
<td>145° 38′ 27″</td>
<td>Buoy Point</td>
<td>304° 32′ 37″</td>
<td>7044.7</td>
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<tr>
<td>Poet</td>
<td>49° 55′ 36.54″</td>
<td>W. 06° 59.81″</td>
<td>263° 60′ 17″</td>
<td>Poet</td>
<td>173° 56′ 09″</td>
<td>8309.4</td>
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**THE UNITED STATES COAST SURVEY.**

**UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.**

*Section XI.—Admiralty Inlet. Sketch K, No. 34.*
### UNITED STATES COAST SURVEY—GEOGRAPHICAL POSITIONS.

**Section XI.—Admiralty Chart. Sketch E, No. 34.**

<table>
<thead>
<tr>
<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Azimuth</th>
<th>To station</th>
<th>True azimuth</th>
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<td><strong>Pilut Point</strong></td>
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<td><strong>Run</strong></td>
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<td>47 54 06.19</td>
<td>0 06 54.10</td>
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<tr>
<td><strong>Graniti</strong></td>
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<td>47 54 36.75</td>
<td>0 65 48.29</td>
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<td><strong>Barrie</strong></td>
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<td>47 52 11.62</td>
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<td><strong>Gambly, (2)</strong></td>
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<td>47 51 20.31</td>
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<td><strong>Gambly, (3)</strong></td>
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<td>47 51 22.03</td>
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<td><strong>Salisbury Point</strong></td>
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<td><strong>Termination Point</strong></td>
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<td><strong>Northwest Point, Head's Head</strong></td>
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<td>0 07 49.00</td>
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<td><strong>Cranapple</strong></td>
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<td><strong>Indian Point</strong></td>
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<td><strong>Gully</strong></td>
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<td><strong>Keg</strong></td>
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<td>47 57 11.48</td>
<td>0 15 26.04</td>
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<td><strong>Dart Lagoon</strong></td>
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<td>47 59 28.20</td>
<td>0 15 44.17</td>
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<td><strong>Clay</strong></td>
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<td>47 58 24.75</td>
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<td><strong>Scatchet, east</strong></td>
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<td>47 54 39.67</td>
<td>0 51 26.47</td>
<td>Head's Head</td>
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<td><strong>Pike Point</strong></td>
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<td>47 63 52.01</td>
<td>0 14 13.01</td>
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<td><strong>Run</strong></td>
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<td>47 51 40.90</td>
<td>0 54 57.54</td>
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<td><strong>Granite</strong></td>
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<td>47 52 09.26</td>
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<td><strong>Water</strong></td>
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<td>47 49 22.70</td>
<td>0 53 07.11</td>
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<td><strong>Log</strong></td>
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<td>47 49 31.89</td>
<td>0 51 32.17</td>
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<td><strong>Rose</strong></td>
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<td>47 51 21.89</td>
<td>0 44 56.28</td>
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<td><strong>Sycamore</strong></td>
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<td>47 56 18.79</td>
<td>0 46 38.35</td>
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<td><strong>Spring</strong></td>
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<td>47 53 53.03</td>
<td>0 46 32.33</td>
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<td><strong>Possession</strong></td>
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<td>47 54 28.73</td>
<td>0 50 27.78</td>
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<tr>
<td><strong>Russard</strong></td>
<td></td>
<td>47 56 18.73</td>
<td>0 50 36.79</td>
<td>Head's Head</td>
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<tr>
<td><strong>Round</strong></td>
<td></td>
<td>47 54 53.46</td>
<td>0 50 48.23</td>
<td>Head's Head</td>
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<tr>
<td><strong>Point Elliott</strong></td>
<td></td>
<td>47 56 51.59</td>
<td>0 56 35.19</td>
<td>Head's Head</td>
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<tr>
<td><strong>Hawk</strong></td>
<td></td>
<td>47 57 33.56</td>
<td>0 54 04.50</td>
<td>Head's Head</td>
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<tr>
<td><strong>North cape of nort house, at entrance.</strong></td>
<td>47 54 50.74</td>
<td>0 50 26.96</td>
<td>Head's Head</td>
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<td><strong>First stake south of Russard.</strong></td>
<td>47 55 36.31</td>
<td>E. 0 55 06.49</td>
<td>Head's Head</td>
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### Section XI—Admiralty Inlet. Sketch K, No. 34.

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<tr>
<th>Name of station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Azimuth</th>
<th>To station—</th>
<th>Back azimuth</th>
<th>Distance</th>
<th>Distance</th>
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<tr>
<td>North gable of north house, near Possession</td>
<td>47° 54' 50.75&quot; N</td>
<td>120° 50' 39.11&quot; W</td>
<td>0 90 39.11</td>
<td>Bazaar 6.8, 590.5 N</td>
<td>5 33 37</td>
<td>2934.8</td>
<td>2491.6</td>
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<tr>
<td>Bazaar Tree</td>
<td>47° 46' 55.66&quot; N</td>
<td>120° 59' 35.25&quot; W</td>
<td>153 59 35</td>
<td>Point Wells 14.5, 590.5 N</td>
<td>3 49 34</td>
<td>1858.3</td>
<td>1853.5</td>
</tr>
<tr>
<td>South Apple Tree</td>
<td>47° 46' 56.16&quot; N</td>
<td>120° 56' 46.33&quot; W</td>
<td>145 56 46</td>
<td>Point Wells 14.5, 590.5 N</td>
<td>3 49 34</td>
<td>1858.3</td>
<td>1853.5</td>
</tr>
<tr>
<td>South Apple Tree</td>
<td>47° 46' 57.18&quot; N</td>
<td>120° 57' 30.11&quot; W</td>
<td>152 57 30</td>
<td>Point Wells 14.5, 590.5 N</td>
<td>3 49 34</td>
<td>1858.3</td>
<td>1853.5</td>
</tr>
<tr>
<td>Robin</td>
<td>47° 48' 36.85&quot; N</td>
<td>120° 58' 06.42&quot; W</td>
<td>144 58 06</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<td>North Monroe</td>
<td>47° 49' 57.41&quot; N</td>
<td>120° 58' 14.31&quot; W</td>
<td>153 58 14</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
<td>1832.6</td>
<td>287.0</td>
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<td>Crow</td>
<td>47° 50' 43.87&quot; N</td>
<td>120° 59' 43.59&quot; W</td>
<td>145 59 43</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
<td>1832.6</td>
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<tr>
<td>Point Monroe</td>
<td>47° 49' 59.11&quot; N</td>
<td>120° 59' 55.59&quot; W</td>
<td>144 59 55</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<td>Skiff</td>
<td>47° 46' 43.11&quot; N</td>
<td>120° 56' 45.46&quot; W</td>
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<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
<td>1832.6</td>
<td>287.0</td>
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<td>Drift</td>
<td>47° 46' 40.98&quot; N</td>
<td>120° 56' 37.56&quot; W</td>
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<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
<td>1832.6</td>
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<td>Creek</td>
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<td>120° 56' 41.21&quot; W</td>
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<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
<td>1832.6</td>
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<td>47° 46' 57.36&quot; N</td>
<td>120° 57' 38.36&quot; W</td>
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<td>5 34 54</td>
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<tr>
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<td>47° 46' 58.25&quot; N</td>
<td>120° 57' 41.09&quot; W</td>
<td>141 57 41</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<td>Tide</td>
<td>47° 46' 51.44&quot; N</td>
<td>120° 58' 09.54&quot; W</td>
<td>140 58 09</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<td>Reservation</td>
<td>47° 46' 53.30&quot; N</td>
<td>120° 58' 09.91&quot; W</td>
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<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<td>Cherry</td>
<td>47° 54' 39.46&quot; N</td>
<td>120° 56' 49.12&quot; W</td>
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<td>5 34 54</td>
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<td>120° 56' 50.68&quot; W</td>
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<td>5 34 54</td>
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<td>West Point</td>
<td>47° 39' 47.09&quot; N</td>
<td>120° 56' 51.72&quot; W</td>
<td>141 56 51</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<tr>
<td>Duvannah</td>
<td>47° 37' 49.36&quot; N</td>
<td>120° 56' 51.98&quot; W</td>
<td>141 56 51</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
<td>1832.6</td>
<td>287.0</td>
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<td>Leaning Tree</td>
<td>47° 34' 57.22&quot; N</td>
<td>120° 56' 51.98&quot; W</td>
<td>141 56 51</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<td>Cabin</td>
<td>47° 35' 41.64&quot; N</td>
<td>120° 57' 29.01&quot; W</td>
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<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<td>Bellingham</td>
<td>47° 36' 41.53&quot; N</td>
<td>120° 57' 42.39&quot; W</td>
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<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<td>Trail</td>
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<td>Gull</td>
<td>47° 34' 18.63&quot; N</td>
<td>120° 58' 35.76&quot; W</td>
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<td>Butterwood</td>
<td>47° 34' 19.99&quot; N</td>
<td>120° 59' 35.85&quot; W</td>
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<td>Hydrographic Signal</td>
<td>47° 35' 13.30&quot; N</td>
<td>120° 58' 29.71&quot; W</td>
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<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
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<td>Cabin south end of Butterwood</td>
<td>47° 34' 12.76&quot; N</td>
<td>120° 58' 42.44&quot; W</td>
<td>142 58 42</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
<td>1832.6</td>
<td>287.0</td>
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<td>Hydrographic Signal on Tree</td>
<td>47° 37' 56.39&quot; N</td>
<td>120° 58' 35.24&quot; W</td>
<td>142 58 35</td>
<td>Meadow 6.8, 590.5 N</td>
<td>5 34 54</td>
<td>1832.6</td>
<td>287.0</td>
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## Name of station | Latitude | Longitude | Azimuth | To station | Back azimuth | Distance | Distance | Distance | Distance
---|---|---|---|---|---|---|---|---|---
Hydrographic Signal on Spit | 47° 39' 58" W. | 91° 53' 51" N. | | | | | | |
Elm | 47° 22' 01" W. | 91° 53' 51" N. | | | | | | |
Cliff | 47° 22' 01" W. | 91° 53' 51" N. | | | | | | |
Coleside | 47° 28' 11" W. | 91° 53' 51" N. | | | | | | |
Wing | 47° 29' 14" W. | 91° 53' 51" N. | | | | | | |
Point William's Watch | 47° 31' 02" W. | 91° 53' 51" N. | | | | | | |
Heave Point | 47° 31' 05" W. | 91° 53' 51" N. | | | | | | |
Dolphin Point | 47° 31' 12" W. | 91° 53' 51" N. | | | | | | |
Tatnall, (1) | 47° 32' 22" W. | 91° 53' 51" N. | | | | | | |
Bank on spot near Alder | 47° 33' 05" W. | 91° 53' 51" N. | | | | | | |
Eastern sharp peak of Olympics | 47° 32' 35" W. | 91° 53' 51" N. | | | | | | |
Tatnall, (2) | 47° 33' 02" W. | 91° 53' 51" N. | | | | | | |
Vashon Point | 47° 30' 39" W. | 91° 53' 51" N. | | | | | | |
Point Secta | 47° 26' 01" W. | 91° 53' 51" N. | | | | | | |
Point Polly | 47° 27' 01" W. | 91° 53' 51" N. | | | | | | |
South Rainbridge | 47° 34' 35" W. | 91° 53' 51" N. | | | | | | |
Northwest Blake | 47° 32' 00" W. | 91° 53' 51" N. | | | | | | |
Orchard | 47° 32' 03" W. | 91° 53' 51" N. | | | | | | |
Southwest Rainbridge | 47° 34' 03" W. | 91° 53' 51" N. | | | | | | |
Ozro | 47° 31' 07" W. | 91° 53' 51" N. | | | | | | |
Southwest Blake | 47° 32' 02" W. | 91° 53' 51" N. | | | | | | |
Fly | 47° 31' 00" W. | 91° 53' 51" N. | | | | | | |
Point Southworth | 47° 30' 41" W. | 91° 53' 51" N. | | | | | | |
Point Peary | 47° 29' 30" W. | 91° 53' 51" N. | | | | | | |
Point Pever | 47° 29' 26" W. | 91° 53' 51" N. | | | | | | |
James' Point | 47° 27' 45" W. | 91° 53' 51" N. | | | | | | |
Point Command | 47° 27' 42" W. | 91° 53' 51" N. | | | | | | |
Point Prosper | 47° 25' 31" W. | 91° 53' 51" N. | | | | | | |
Andrew | 47° 06' 09" W. | 91° 53' 51" N. | | | | | | |
<table>
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<td>16 14 11.89</td>
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<td>213 34 55</td>
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<td>Baker</td>
<td>47 56 54.54</td>
<td>16 12 02.41</td>
<td>204 19 49</td>
<td>Andrew</td>
<td>84 11 34</td>
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<td>16 14 11.89</td>
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<td>309 44 34</td>
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<td>16 12 02.41</td>
<td>204 48 48</td>
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<td>919 43 33</td>
<td>969.5</td>
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<td>Rock</td>
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<td>919 43 33</td>
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<td>Jay</td>
<td>47 33 25.92</td>
<td>16 12 02.41</td>
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<td>47 36 36.11</td>
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<td>Buxton</td>
<td>47 52 57.44</td>
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<td>919 43 33</td>
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<td>Point Hyer</td>
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<td>Raspberry</td>
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<td>Marked Tree (4)</td>
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<td>Charred Tree</td>
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<td>919 43 33</td>
<td>969.5</td>
<td>754.0</td>
</tr>
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</table>
APPENDIX No. 21.
Report of Prof. O. M. Mitchel, director, on the moon culminations observed for the U. S. Coast Survey at Cincinnati observatory.

CINCINNATI, Ohio, September 24, 1859.

DEAR SIR: I have to report the observation of forty-nine moon culminations made during the past twelve months.

The mode of observation and record remains the same as in the past years, the only change being the introduction of a new system of wires into the transit instrument on the 5th of July last. The number of wires is the same as before used, (fifteen,) but they are grouped differently, being now in five groups of three wires each. The equatorial distance between groups is about eight seconds of time, and the interval between the wires of each group is four seconds equatorial. The reduction from mean to middle wire has been obtained from a discussion of fifty-nine observations of stars within twenty degrees of the equator.

The observations were made and reduced by my assistant, Henry Twitchell, esq., who has charge of the transit.

Yours, respectfully,

O. M. MITCHEL.

Dr. A. D. BACHE,

APPENDIX No. 22.
Discussion of the magnetic and meteorological observations made at the Girard College observatory, Philadelphia, in 1840, 1841, 1842, 1843, 1844, and 1845. Part I. Investigation of the eleven-year period in the amplitude of the solar-diurnal variation, and of the disturbances of the magnetic declination. By A. D. Bache, LL.D.

INTRODUCTION.

In co-operation with the scheme adopted at the British colonial observatories, a series of magnetic and meteorological observations were made at the Girard College magnetic observatory, in Philadelphia, with instruments purchased under the direction of the trustees of the college, the observations being made under the patronage of the American Philosophical Society, and finally completed for the use of the Topographical Bureau of the War Department.¹

These observations were made under my immediate direction, and were afterwards left under my general superintendence. The series commenced in May, 1840, and, with short interruptions, terminated in June, 1845, thus furnishing a five years' series of magnetic observations, taken bi-hourly up to October, 1843, and after that date hourly. The readings of each magnetic

¹ See "Observations at the magnetic and meteorological observatory at the Girard College, Philadelphia, made under the direction of A. D. Bache, LL.D., and with funds supplied by the members of the American Philosophical Society and by the Topographical Bureau of the United States, 1840 to 1846. Printed by order of the Senate of the United States, and under the direction of the Topographical Bureau, second session of the twenty-ninth Congress, Washington, D. C., 1847."

Three volumes record and one volume plates.
element were united into mean values, arranged according to hours of the day and days of the month and annual values, and presented graphically, under my direction, by Joseph S. Ruth, esq., who had taken part in the observations, and who was at that time employed in the Coast Survey. As, owing to other laborious duties, the record could not then be submitted to a complete reduction and discussion, I have resumed the subject, with the aid of Charles A. Schott, esq., assistant in the Coast Survey, by whom, under my immediate direction, the discussions contained in this paper have been made and prepared for publication. It is proper to state that this work has been performed out of office hours by Mr. Schott, as my assistant in this special matter, and at my own expense.

Although the magnetic observations furnished by their judicious geographical location, a basis for the generalization of their results, it is, nevertheless, desirable to combine other results with them as confirmations or as corrections. In the investigation of the disturbance law at Point Barrow, as compared with the same at Toronto, a very remarkable mutual relation was developed, and further examination may bring to light other dependencies of a mutual character.

According to the latest determination, the position of the Girard College observatory is in latitude $39^\circ 58' 23''$ (north,) and in longitude $75^\circ 10' 05''=5h. 00m. 40s. 3$ west of Greenwich. From Philadelphia, Toronto bears $38^\circ 45'$ west of north, (true,) and is distant $40^\circ 50'$ in arc, or about 334 statute miles.

It is proposed, in the present paper, to investigate the law of the eleven-year period, or, as it is more frequently called, the decennial period, there being yet an uncertainty as to its precise length. It is supposed to have some direct or indirect connection with the solar spot period, which, according to late investigations by Prof. R. Wolf, is said to exhibit corresponding disturbances.

The discussion is a contribution towards the determination of the epoch of the occurrence of a minimum (as to number and magnitude) in certain phases of the magnetic variations and disturbances, corresponding to a minimum in the solar spot period. The method of reduction is substantially the same as that adopted by General Sabine, and explained in his discussion of the Toronto and Hobarton observations.

Investigation of the eleven year period in the change of the amplitude of the solar-diurnal variation of the magnetic declination, comprising the regular as well as the disturbed diurnal variation.

While the magnitude of the deflection is the only criterion for the recognition of a disturbance, the adoption of any limit of deviation from the normal value for the same hour, month, and year, must necessarily remain in some measure arbitrary, or, in other words, there must always remain, after the separation of the disturbances, a certain small amount of their effect in the remaining regular diurnal progression. General Sabine has shown that the results are

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1 This longitude depends on that of Cambridge observatory, for which 4h. 44m. 30s. 25 has been adopted.
2 Astronomische Nachrichten, No. 1091, (May, 1857.)
3 See three papers, by General Sabine, on periodical laws discoverable in the mean effects of the larger magnetic disturbances. Philosophical Transactions of the Royal Society, 1851, 1852, and 1856.
not sensibly affected by a small variation in the line of separation of the disturbed from the undisturbed readings. 1

To effect the separation, I made use of Peirce’s criterion 2 for the rejection of doubtful observations, applying it, however, to observations following a law different from the regular one. 3 From an examination of 465 hourly observations, distributed over different hours of the day and different months of the year, the following was the limit of separation:

9.3 from six months in 1840; 8.1 from six months in 1843; 6.0 from six months in 1845.

The mean of 7.8 divisions, equal to 3.6 of arc, has been adopted provisionally. Accordingly, all numbers in the printed record of observations, differing 7.8 scale divisions (or 10.3 divisions for June, and up to July 18, 1840,) for the mean monthly value of each hour of observation, were marked in pencil. It was found that the ratio of the disturbed observations to the total number was 1:9.6, or for the years 1843, 1844, 1845, 1:13.3 nearly, (the years 1843 and 1845 being incomplete, and omissions only approximately allowed for.) For comparison with the Toronto observations we have the ratio 1:9.4 for the series 1841 to 1848 inclusive, 4 and 1:13.6 for the series 1843, 1844, 1845, 8 both for the limit 3.6, which was afterwards raised to 5.0. 6 It was thought desirable in comparing these results, and especially as the Girard College observations do not extend either way to years of maximum of disturbance, which would otherwise require the enlargement of the limit to preserve the limit as pointed out by the criterion; hence a deviation from the normal of 8.0 scale divisions as a convenient number, 3.64 of arc, has been adopted for the present discussion as constituting a disturbed observation. Previous to July 18, 1840, the declinometer had a different scale, one division being 20.7, making the corresponding limit for the first month and a half 10.6 divisions.

All observations, therefore, differing 8.0 scale divisions from the mean monthly value of their respective hour were marked by a pencil line; a new hourly mean was taken, omitting values so marked, and each observation was again examined with reference to its deviation from this new mean. The process was repeated, when necessary, so that in all cases values differing 8.0 or more from the final mean were excluded. The last mean thus obtained for each observing hour and each month has been called “the normal.” The following tables of normals present the mean monthly declinometer readings for each observing hour, free from all disturbances, deviating either way 3.64 or more from the normal position of the magnet for the respective hour, month, and year. The observations having been made at the even Göttingen hours, the local times are 1½ minutes after the even hour. 7 The time given in the tables is mean local time, counting from midnight, or 0A. up to 24A.

Increase in the scale readings corresponds to a decrease of westerly declination. The value of one division of the scale is 0.453.

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1 In the first discussion of the Toronto observations for the years 1843, 1844, 1845, the limit of 3.6 was adopted, corresponding to one disturbance in every 13.6 observations; in the second discussion 5.0 was substituted as preferable. Phil. Trans. 1865, art. XV.


3 A similar application was made in the discussion of Dr. E. K. Kane's magnetic observations at Van Bommeler harbor, North Greenland, by Mr. Schott. Smithsonian Contributions to Knowledge, vol. II, 1868.

4 Observations made at the Magnetical and Meteorological Observatory at Toronto, in Canada, under the superintendence of Colonel Edward Sabine, vol. II, 1843, 1844, 1845, with abstracts of observations to 1852, inclusive. London, 1853.

5 Phil. Trans., B. 8, 1851, art. V.

6 Observations made at the Magnetical and Meteorological Observatory at Toronto, in Canada, under the superintendence of Major General Edward Sabine, vol. III, 1846, 1847, 1848, with abstracts of observations to 1866, inclusive. London, 1867.

7 The observations were made at the even Göttingen time, 0A. 00m., corresponding to 0A. 19½m., of Philadelphia time.
TABLE I.
Normals of the declinometer readings for each observing hour and month in the year 1840.
[Observations taken 1½ minutes after the hour indicated.]

<table>
<thead>
<tr>
<th>MONTHS</th>
<th>PHILADELPHIA MEAN TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0h. 1h. 2h. 3h. 4h. 5h. 6h. 7h. 8h. 9h. 10h. 11h. 12h. 13h. 14h. 15h. 16h. 17h. 18h. 19h. 20h. 21h. 22h. 23h. 24h.</td>
</tr>
<tr>
<td>June*</td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>494.4 498.0 497.5 584.0 562.7 493.8 485.3 454.1 487.9 492.8 490.3 492.6</td>
</tr>
<tr>
<td>August</td>
<td>497.3 497.2 498.9 564.7 565.5 495.4 484.6 484.0 488.7 489.2 495.5 496.2</td>
</tr>
<tr>
<td>September</td>
<td>490.3 497.3 496.9 562.3 502.5 490.8 477.3 478.5 44.4 499.5 481.3 481.0</td>
</tr>
<tr>
<td>October</td>
<td>492.0 496.4 491.1 493.9 495.0 481.9 414.4 413.3 491.1</td>
</tr>
<tr>
<td>November</td>
<td>491.1 486.0 483.4 482.7 494.9 481.2 474.2 473.3 491.0 483.6 482.7</td>
</tr>
<tr>
<td>December</td>
<td>477.9 475.2 473.6 471.5 468.0 470.7 471.6 472.7 475.5 479.0 461.2</td>
</tr>
<tr>
<td>Mean</td>
<td>490.14 490.0 491.6 495.9 496.0 481.8 478.7 479.6 482.5 487.6 491.9 490.4</td>
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<td>Correction 1</td>
<td>5.91 5.10 5.33 4.66 5.11 5.85 5.66 4.66 4.36 4.73 5.25</td>
</tr>
<tr>
<td>Correction for index</td>
<td>9.30</td>
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<tr>
<td>Corrected mean for 1840</td>
<td>484.23 491.0 493.6 489.7 489.6 484.4 476.0 476.5 479.8</td>
</tr>
</tbody>
</table>

* The readings from June 1 to July 18, 1840, on the college building scale, were converted into observatory scale readings by subtracting 141°7 from the division 0°38 of the old scale, and converting the value of a division 0° 38 of the old into the corresponding reading for the value of a division 0°435 of the new scale. The mean readings, thus corrected, of the first 18 days of July, were then properly combined with the means of the remaining days of the month.

† In the month of September, hour 5, the comparisons were made with the half-hourly means, owing to the rapid change of the readings.

‡ On the 30th of November the index of the declinometer bar shifted 19.5 scale divisions. A correction of +19°5 has therefore been added to observations after this date, and likewise to all the readings of the following month.

§ The corrections here given for referring the mean of the last seven months of the year to the mean for the whole year are derived from the normals of the following year 1841, by comparing the mean of the same seven months with the annual mean of that year. Comparing the same months in the two years, the character of the changes appears to be the same.

‖ A further correction for change in the zero of the scale required to refer the readings of 1840 to the readings of subsequent years. Owing to a rearrangement of the instruments on January 7, 1841, the scale readings changed 11.0 divisions; and since 18.5 scale divisions had been added to the December readings, the resulting correction is the difference of the two, or +10.25.

TABLE II.
Normals of the declinometer readings for 1841.
[Value of 1 div. = 0° 435. Time, 1½ minutes later than indicated.]

<table>
<thead>
<tr>
<th>MONTHS</th>
<th>PHILADELPHIA MEAN TIME</th>
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<td></td>
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<td>January</td>
<td></td>
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<tr>
<td>February</td>
<td>579.3 579.0 578.2 579.0 578.6 576.0 548.7 549.0 576.0 569.9 573.0 576.4 574.1 578.9</td>
</tr>
<tr>
<td>March</td>
<td>579.0 573.2 575.8 577.8 588.1 579.5 568.3 566.0 569.5 570.4 571.8 568.0 570.8 574.9 578.7</td>
</tr>
<tr>
<td>April</td>
<td>577.1 577.6 580.9 586.9 586.8 578.9 569.4 567.7 571.8 567.4 571.8 567.4 577.4</td>
</tr>
<tr>
<td>May</td>
<td>590.1 579.6 581.3 587.4 589.1 578.5 566.4 567.9 573.6 576.4 577.4 573.5 578.5 579.8</td>
</tr>
<tr>
<td>June</td>
<td>571.7 573.2 574.7 589.3 589.0 571.3 561.8 560.9 565.9 570.1 579.9 579.8</td>
</tr>
<tr>
<td>July</td>
<td>569.9 560.5 571.9 578.4 581.9 571.8 568.9 567.9 567.9 567.9 567.9 567.9 567.9</td>
</tr>
<tr>
<td>August</td>
<td>566.4 570.3 571.9 580.1 563.9 569.9 569.9 568.9 566.0 566.0 566.0 566.0 566.0</td>
</tr>
<tr>
<td>September</td>
<td>555.1 564.5 569.5 569.4 571.5 564.1 566.6 565.0 565.5 568.9 569.9 569.9 569.9</td>
</tr>
<tr>
<td>October</td>
<td>566.8 566.3 570.3 571.9 569.4 568.8 564.8 569.2 564.7 573.5 576.8 569.2</td>
</tr>
<tr>
<td>November</td>
<td>557.9 558.5 559.5 557.6 561.7 557.1 551.8 549.9 554.6 554.9 558.9 558.9</td>
</tr>
<tr>
<td>December</td>
<td>566.8 565.9 560.5 559.5 559.5 558.1 559.9 561.7 568.8 559.6 559.6 564.6</td>
</tr>
<tr>
<td>Mean</td>
<td>570.31 570.76 572.36 575.55 578.00 571.47 561.35 560.76 563.13 569.26 570.70 571.05</td>
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</table>

36
In general during the year 1841, the readings are more changeable than during the following years.

The rearrangement of the instruments, and consequent shifting of the index of the scale, alluded to in the preceding notes, interrupted the observations between January 1 and January 12.

The normal for October, 1841, was obtained by comparing with the half monthly means and taking the mean of the two results as in a similar case for the month of September of the previous year.

### TABLE III.

**Normals of the declinometer readings for 1842.**

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<tr>
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<td>564.3</td>
<td>563.8</td>
<td>565.3</td>
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<td>566.4</td>
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<td>566.8</td>
<td>569.6</td>
<td>569.9</td>
<td>570.9</td>
</tr>
<tr>
<td>February</td>
<td></td>
<td>564.6</td>
<td>561.9</td>
<td>565.9</td>
<td>569.5</td>
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### TABLE IV.

**Normals of the declinometer readings for 1843.**

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* The correction for the mean of the last nine months to the month of all the months is derived from the readings of the preceding year, as being more uniform in character than those for the year following.

† The correction to refer the mean of the last twelve months to the mean of all the months is derived from the readings of the preceding year, as being more uniform in character than those for the year following.
The hourly readings commence on October 1, and are continued to the close of the series.

To make the readings of the odd hours of the months of October, November, and December comparable with those of the even hours during the whole year, the means of the even hours for the months of October, November, and December (1843) were compared with the corrected annual means respectively, which gave the corrections for the even hours; and the corrections for intermediate odd hours were obtained from those of the nearest even hours. The deductions from the series of observations at odd hours have but one-third of the weight of those obtained from the even series.

**TABLE IV, (b.)**

*Additional normals for the odd hours of the months of October, November, and December, 1843.*

<table>
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<td>October</td>
<td>889.9 888.1 886.6 885.1 884.0 882.1 881.9 882.0 881.9 882.1 881.9 882.1 881.9 882.1 881.9</td>
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Correction  

Corrected mean  
553.34 553.24 553.24 553.24 553.24 553.24 553.24 553.24 553.24 553.24 553.24 553.24 553.24 553.24 553.24 553.24

**TABLE V.**

*Normals of the declinometer readings for 1844.*

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<tr>
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<tr>
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Mean  
549.06 549.06 549.06 549.06 549.06 549.06 549.06 549.06 549.06 549.06 549.06 549.06 549.06 549.06 549.06
To the observations between January 1 and January 30 a correction of 4 18.7 was applied, as explained in the preceding note.

In the month of December the declination changed so rapidly as to require the use of half-monthly means; the mean of the two results is inserted in the above table.

**TABLE VI.**

Normals of the declinometer readings for 1845.

(Value of 1 div. = .462. Time 16 hours later than indicated.)

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Mean: 530.96
Correction*: -0.25
Corrected mean: 530.71

**TABLE VI—Continued.**

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</table>

Mean: 535.60
Correction*: -0.25
Corrected mean: 535.35

* As indicated by the annual change in the readings, it was considered preferable to obtain the annual mean by deducting the correction to the mean of the first six months from the readings of the preceding year and those of the year 1846.
For the purpose of comparing the annual means of the normals, or the mean march of the regular solar-diurnal variation for each year, the preceding results have been expressed analytically by means of Bessel's formula, and by the application of the method of least squares.

In these formulae the angle \( \Theta \) is reckoned from midnight, (Philadelphia,) at the rate of 15° for each following hour. It was found unnecessary to carry the expressions beyond the third term, the fourth being generally smaller than the probable error of an hourly normal. We obtain accordingly—

For 1840...... \[ \Delta = 569°.31 + \phi°.214 \sin. (0 + 30° 25') + \psi°.588 \sin. (2 \alpha + 217° 33') + 1°.619 \sin. \phi + 68° 56'. \]

1841...... \[ \Delta = 569°.87 + 4°.988 \sin. (0 + 30° 05') + 4°.580 \sin. (2 \alpha + 212° 38') + 1°.584 \sin. (3 \phi + 50° 14'). \]

1842...... \[ \Delta = 569°.33 + 4°.944 \sin. (0 + 30° 49') + 4°.711 \sin. (2 \alpha + 217° 12') + 1°.403 \sin. (0 \phi + 64° 47'). \]

1843...... \[ \Delta = 569°.01 + 4°.449 \sin. (0 + 30° 00') + 3°.918 \sin. (2 \alpha + 210° 05') + 1°.811 \sin. (3 \phi + 68° 18'). \]

1844...... \[ \Delta = 569°.89 + 4°.486 \sin. (0 + 30° 35') + 3°.872 \sin. (2 \alpha + 222° 23') + 1°.802 \sin. (3 \phi + 68° 53'). \]

1845...... \[ \Delta = 569°.12 + 4°.518 \sin. (0 + 30° 33') + 4°.872 \sin. (2 \alpha + 225° 55') + 1°.587 \sin. (4 \phi + 61° 26'). \]

Owing probably to the several accidental changes in the suspension of the bar, and consequent uncertainty in the precise amount of scale correction, the mean readings of each year, when compared with one another, exhibit differences not actually due to inequalities occasioned by declination changes. This question, however, does not directly bear upon the present investigation, which mainly depends on differences of readings; and it is proper to remark that the observed increase, giving the weight one-half to the preceding formula, for greater convenience, into the following:

\[ \Delta = + 2°.815 \sin. (15° \phi + 30° 35') + 2°.678 \sin. (30° \phi + 217° 03') + 0°.743 \sin. (45° \phi + 68° 50'). \]

1841...... \[ \Delta = + 2°.214 \sin. (15° \phi + 30° 05') + 1°.994 \sin. (30° \phi + 212° 03') + 0°.716 \sin. (45° \phi + 50° 14'). \]

1842...... \[ \Delta = + 2°.249 \sin. (15° \phi + 33° 49') + 1°.909 \sin. (30° \phi + 217° 12') + 0°.563 \sin. (45° \phi + 64° 42'). \]

1843...... \[ \Delta = + 2°.015 \sin. (15° \phi + 36° 09') + 1°.775 \sin. (30° \phi + 210° 05') + 0°.820 \sin. (45° \phi + 68° 18'). \]

1844...... \[ \Delta = + 2°.032 \sin. (15° \phi + 36° 33') + 1°.754 \sin. (30° \phi + 222° 23') + 0°.810 \sin. (45° \phi + 68° 53'). \]

1845...... \[ \Delta = + 2°.083 \sin. (15° \phi + 35° 33') + 2°.090 \sin. (30° \phi + 225° 55') + 0°.800 \sin. (45° \phi + 61° 26'). \]

In which \( \Delta \) = the regular solar diurnal variation, and \( \phi \) the number of hours after midnight.

To show the agreement between these expressions and the corresponding observed quantities, and to exhibit to the eye the character of the diurnal variation, the results have been thrown into curves. The observed bi-hourly means are represented in diagram 2, Sketch 37, by dots, and in no instance do they differ from the computed values by as much as 0°.8 or 0'.3.

As a specimen of the representation, I add the results for the year 1845:

* Report on the progress of the U. S. Coast Survey for 1855, Appendix No. 48 and Appendix No. 24 of the report for 1859.
The average probable error of any single representation by the formula is $\pm 0'.22$, or $\pm 0'.10$.

By means of the preceding formula the following values were computed: 1. The time when the north end of the magnet reached its extreme eastern position, or, in other words, the epoch of the eastern elongation. 2. The corresponding maximum scale reading, or, more properly, the corresponding minimum of western declination. 3. The time of the occurrence of the western elongation; and, 4. The corresponding maximum reading of western declination. In the last two columns the difference of the scale readings, or the amplitude of eastern and western elongation, is made out in scale divisions, and also in minutes of arc. The inequality of this amplitude next requires our attention.

The inequality constituting the ten or eleven year period is plainly exhibited in the last two columns of the above table, the progression in the numbers being quite regular. The year 1843 is clearly indicated as the year of the minimum range of the diurnal fluctuation, but whether the period is one nearer to ten or to eleven years cannot be decided from the Girard College observations, since they do not embrace a year of maximum amplitude. The epoch of the minimum, however, can be determined with more precision. For this purpose only, the values in the last column are represented by the formula,

$$ A = 0'.08 - 1'.14 (t - 1840.5) + 0'.201 (t - 1840.5)^2, $$
deduced by the method of least squares, and the quantities come out as follows:
Probable error of any single amplitude, \( \pm 0.11 \).

That portion of the ten or eleven year period which results from the preceding discussion of the differential observations of the magnetic declination, free from the effect of the disturbances, as far as the latter can be eliminated, is shown graphically in diagram 1, Sketch No. 37.

The month of May, in the year 1843, is indicated by the formula as the epoch of the minimum amplitude.

We now proceed to the discussion of the disturbances as far as they bear on the decennial inequality, taking in also some collateral results.

The total number of observations for changes of declination recorded and discussed amounts to 24,566; of these, 2,357 were separated as disturbances differing eight scale divisions or more from their respective normals, leaving 22,209 observations, from which the preceding results were deduced. There is one disturbed observation in every 10.4 observations.

The discussion of the disturbances divides itself into two parts, that of the number and that of the amount of the larger deflections.

Owing to partial incompleteness in the number of observing months in some years, it became necessary to fill out the number for the annual inequality from the results of the complete years. Their number for each month in the complete years is given in the following table, the numbers for 1844 having first been divided by two, in order to make the hourly observations comparable with the bi-hourly in the years 1841 and 1842:

<table>
<thead>
<tr>
<th>Month</th>
<th>1841</th>
<th>1842</th>
<th>1844</th>
<th>Mean</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>33</td>
<td>44</td>
<td>5</td>
<td>27</td>
<td>0.75</td>
</tr>
<tr>
<td>February</td>
<td>25</td>
<td>26</td>
<td>5</td>
<td>19</td>
<td>0.53</td>
</tr>
<tr>
<td>March</td>
<td>25</td>
<td>24</td>
<td>24</td>
<td>25</td>
<td>0.79</td>
</tr>
<tr>
<td>April</td>
<td>25</td>
<td>31</td>
<td>39</td>
<td>32</td>
<td>0.89</td>
</tr>
<tr>
<td>May</td>
<td>32</td>
<td>14</td>
<td>17</td>
<td>21</td>
<td>0.58</td>
</tr>
<tr>
<td>June</td>
<td>26</td>
<td>20</td>
<td>7</td>
<td>23</td>
<td>0.64</td>
</tr>
<tr>
<td>July</td>
<td>30</td>
<td>40</td>
<td>15</td>
<td>28</td>
<td>0.78</td>
</tr>
<tr>
<td>August</td>
<td>49</td>
<td>64</td>
<td>44</td>
<td>52</td>
<td>1.45</td>
</tr>
<tr>
<td>September</td>
<td>57</td>
<td>60</td>
<td>31</td>
<td>49</td>
<td>1.35</td>
</tr>
<tr>
<td>October</td>
<td>94</td>
<td>86</td>
<td>53</td>
<td>78</td>
<td>2.17</td>
</tr>
<tr>
<td>November</td>
<td>81</td>
<td>22</td>
<td>42</td>
<td>48</td>
<td>1.53</td>
</tr>
<tr>
<td>December</td>
<td>55</td>
<td>5</td>
<td>26</td>
<td>29</td>
<td>0.82</td>
</tr>
<tr>
<td>Sum</td>
<td>539</td>
<td>446</td>
<td>308</td>
<td>431</td>
<td>12.00</td>
</tr>
<tr>
<td>Mean</td>
<td>36</td>
<td>57.3</td>
<td>31.6</td>
<td>36.6</td>
<td>1.09</td>
</tr>
</tbody>
</table>
The last column contains the ratio of the mean monthly value to the mean annual value. By means of these ratios, and using the observed monthly values in each defective year, the numbers in the following table were filled up, all the deduced values being indicated by brackets. As in the preceding table, the values refer or were made to refer to bi-hourly observations.

Table showing the number of disturbances in each month of the years 1840 to 1845.

<table>
<thead>
<tr>
<th>Month</th>
<th>1840</th>
<th>1841</th>
<th>1842</th>
<th>1843</th>
<th>1844</th>
<th>1845</th>
<th>Mean</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>(30)</td>
<td>33</td>
<td>44</td>
<td>(17)</td>
<td>5</td>
<td>19</td>
<td>25</td>
<td>0.77</td>
</tr>
<tr>
<td>February</td>
<td>(21)</td>
<td>25</td>
<td>26</td>
<td>(12)</td>
<td>5</td>
<td>13</td>
<td>17</td>
<td>0.52</td>
</tr>
<tr>
<td>March</td>
<td>(25)</td>
<td>26</td>
<td>24</td>
<td>(16)</td>
<td>24</td>
<td>14</td>
<td>22</td>
<td>0.68</td>
</tr>
<tr>
<td>April</td>
<td>(36)</td>
<td>25</td>
<td>31</td>
<td>21</td>
<td>39</td>
<td>21</td>
<td>29</td>
<td>0.91</td>
</tr>
<tr>
<td>May</td>
<td>(24)</td>
<td>33</td>
<td>14</td>
<td>15</td>
<td>17</td>
<td>11</td>
<td>19</td>
<td>0.65</td>
</tr>
<tr>
<td>June</td>
<td>8</td>
<td>31</td>
<td>39</td>
<td>12</td>
<td>7</td>
<td>12</td>
<td>17</td>
<td>0.53</td>
</tr>
<tr>
<td>July</td>
<td>44</td>
<td>30</td>
<td>40</td>
<td>20</td>
<td>15</td>
<td>(17)</td>
<td>28</td>
<td>0.86</td>
</tr>
<tr>
<td>August</td>
<td>40</td>
<td>49</td>
<td>64</td>
<td>80</td>
<td>44</td>
<td>(32)</td>
<td>51</td>
<td>1.59</td>
</tr>
<tr>
<td>September</td>
<td>56</td>
<td>57</td>
<td>60</td>
<td>27</td>
<td>31</td>
<td>(30)</td>
<td>44</td>
<td>1.36</td>
</tr>
<tr>
<td>October</td>
<td>94</td>
<td>94</td>
<td>86</td>
<td>16</td>
<td>53</td>
<td>(48)</td>
<td>68</td>
<td>2.12</td>
</tr>
<tr>
<td>November</td>
<td>19</td>
<td>81</td>
<td>22</td>
<td>8</td>
<td>42</td>
<td>(25)</td>
<td>35</td>
<td>1.03</td>
</tr>
<tr>
<td>December</td>
<td>83</td>
<td>55</td>
<td>5</td>
<td>4</td>
<td>26</td>
<td>(18)</td>
<td>32</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td>344</td>
<td>539</td>
<td>446</td>
<td>230</td>
<td>308</td>
<td>91</td>
<td>387</td>
<td>12.90</td>
</tr>
<tr>
<td><strong>Corrected sum and mean</strong></td>
<td>483</td>
<td>688</td>
<td>592</td>
<td>315</td>
<td>354</td>
<td>115</td>
<td>578</td>
<td>12.00</td>
</tr>
</tbody>
</table>

The ratios in the last column show the annual inequality in the distribution of the disturbances. The principal maximum occurs in October, the secondary in April; the two minima, nearly of equal amount, occur in the months of February and June. The progression of the numbers is regular.

If we separate the numbers in accordance with westerly and easterly deflections we obtain the following table, deduced as in the former case. It may be remarked that on account of the separate ratios used for the interpolation of the western and eastern deflections, their sum in any one month does not give the corresponding number in the above table exactly, only the yearly sums having been preserved; and the same is true in regard to the table, showing the amount of the disturbances. Interpolated values, as before, are enclosed between brackets.

* At Toronto this maximum occurred in September; the first minimum is likewise one month earlier at this station than at Philadelphia.
The ratios show a general correspondence in the number of westerly and easterly deflections; the westerly deflections seem to occur most frequently in August, while the easterly predominate in October; the secondary maximum of either series is in April. The minima remain nearly as before, one minimum of eastern deflection occurring in January.

With respect to the whole number of westerly and easterly deflections, we deduce the proportional sums from the following table:

<table>
<thead>
<tr>
<th>Year</th>
<th>W</th>
<th>E</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>353</td>
<td>131</td>
<td>484</td>
</tr>
<tr>
<td>1841</td>
<td>324</td>
<td>315</td>
<td>539</td>
</tr>
<tr>
<td>1842</td>
<td>217</td>
<td>229</td>
<td>446</td>
</tr>
<tr>
<td>1843</td>
<td>163</td>
<td>122</td>
<td>285</td>
</tr>
<tr>
<td>1844</td>
<td>147</td>
<td>161</td>
<td>308</td>
</tr>
<tr>
<td>1845</td>
<td>129</td>
<td>135</td>
<td>264</td>
</tr>
<tr>
<td>Sum</td>
<td>1232</td>
<td>1083</td>
<td>2315</td>
</tr>
</tbody>
</table>

Proportional sums by weight: 93.7 91.2

On account of the incompleteness of the record in the years 1840, 1843, and 1845, the number of eastern and western disturbances relative to the total number cannot be ascertained with accuracy. They are about equal in the record. At Toronto the eastern predominate over the western in the proportion of 1.77 to 1 (for the years 1841 to 1848,) and nearly to the same extent for each year, taken separately.

The numbers in the column headed “sum” do not indicate the law of the eleven year period as plainly and systematically as they did the investigation of the diurnal amplitude; yet giving half weight, on account of the want of record, to the sums for 1840 and 1845, the minimum number falls in the year 1843. More consistent results would, no doubt, have been obtained if the year 1845 had been complete.
If we distribute the disturbances (1,942 in number for the even hours) according to their respective hours of occurrence, the following table results from observations between 1840 and 1845:

<table>
<thead>
<tr>
<th>Add 19 h</th>
<th>W.</th>
<th>E.</th>
<th>Sum.</th>
<th>RATIO.</th>
<th>Add 19 h</th>
<th>W.</th>
<th>E.</th>
<th>Sum.</th>
<th>RATIO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>67</td>
<td>93</td>
<td>162</td>
<td>0.82</td>
<td>93</td>
<td>27</td>
<td>91</td>
<td>158</td>
<td>1.13</td>
</tr>
<tr>
<td>2</td>
<td>97</td>
<td>92</td>
<td>189</td>
<td>1.18</td>
<td>1.15</td>
<td>14</td>
<td>76</td>
<td>120</td>
<td>0.95</td>
</tr>
<tr>
<td>4</td>
<td>89</td>
<td>79</td>
<td>168</td>
<td>1.68</td>
<td>0.96</td>
<td>16</td>
<td>88</td>
<td>104</td>
<td>0.91</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
<td>173</td>
<td>253</td>
<td>1.35</td>
<td>0.80</td>
<td>18</td>
<td>72</td>
<td>150</td>
<td>0.71</td>
</tr>
<tr>
<td>8</td>
<td>105</td>
<td>56</td>
<td>161</td>
<td>1.32</td>
<td>0.70</td>
<td>22</td>
<td>46</td>
<td>128</td>
<td>0.66</td>
</tr>
<tr>
<td>10</td>
<td>107</td>
<td>71</td>
<td>178</td>
<td>1.32</td>
<td>0.82</td>
<td>22</td>
<td>46</td>
<td>128</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Maxima and minima values are distinguished by an asterisk.

The numbers in each vertical column show a regular progression; and the number of disturbances, irrespective of their direction, have a minimum at 2 p.m. and a maximum at 2 a.m. The principal contrast is between the hours of the day and the hours of the night; in the former case the numbers being below, but in the latter above the mean value. This is in close correspondence with the Toronto results. The most striking result of the above table is, that the westerly disturbances have their minimum precisely at the hour (8 p.m.) when the easterly have their maximum value; and the exact coincidence of this result with that deduced by General Sabine for Toronto is not less remarkable. For the westerly disturbances, the hours 6 a.m., (maximum,) and 8 p.m., (minimum,) and for the easterly disturbances the hours 2 p.m., (minimum,) and 8 p.m., (maximum,) are specially contrasted. These results also agree with those found at Toronto; and the accordance with that station even goes so far as to exhibit the secondary minimum of eastern disturbances at 8 a.m. In connection with this subject it may be here stated that the same distinguished magnetist found a singular mutual relation to subsist between the phenomena at Toronto and Point Barrow, on the shores of the Arctic sea—the laws of the easterly deflection at one station being found to correspond for the same local hours with those of the westerly deflections at the other station, and vice versa. This contrast holds good for Philadelphia as well as for Toronto.

We now pass to the consideration of the amount of deflections caused by the disturbances, classifying the same according to years, months, and hours:

**Aggregate values of the disturbances and mean values in the different years.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Aggregate values</th>
<th>Same corrected to 12 months</th>
<th>Number</th>
<th>Average value of a disturbance</th>
<th>Same in minutes of arc</th>
<th>Same at Toronto for comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>5140.0 (7 months.)</td>
<td>d. 7165.5</td>
<td>488</td>
<td>14.3</td>
<td>6.70</td>
<td>6.24</td>
</tr>
<tr>
<td>1841</td>
<td>7844.4</td>
<td>7814.6</td>
<td>539</td>
<td>14.6</td>
<td>6.51</td>
<td>6.69</td>
</tr>
<tr>
<td>1842</td>
<td>6019.1</td>
<td>6019.1</td>
<td>446</td>
<td>13.7</td>
<td>6.11</td>
<td>6.22</td>
</tr>
<tr>
<td>1843</td>
<td>2465.7 (8 months.)</td>
<td>2465.7</td>
<td>275</td>
<td>10.7</td>
<td>4.85</td>
<td>5.62</td>
</tr>
<tr>
<td>1844</td>
<td>4227.3</td>
<td>4227.3</td>
<td>308</td>
<td>13.7</td>
<td>6.21</td>
<td>6.69</td>
</tr>
<tr>
<td>1845</td>
<td>1138.6 (6 months.)</td>
<td>1138.6</td>
<td>264</td>
<td>13.4</td>
<td>6.02</td>
<td>5.84</td>
</tr>
</tbody>
</table>

* At Toronto the respective hours are 2 p.m. and 22 p.m.
The table includes only the series of bi-hourly observations, the reduction of the numbers from incomplete years to the correct sum for the whole year being effected by means of ratios, as in the discussion of the number of disturbances. For comparison the average value of a disturbance at Toronto is added. It must be remarked that the amount of deviation from the normal, constituting a disturbance, was nearly but not quite the same at Toronto as at Philadelphia, so that the ratios of the corresponding numbers in the last two columns should be compared.

The eleven year period is well marked in the aggregate value of the disturbances as well as in their average value in the different years; and the year 1843 is decidedly indicated as the minimum. To find a more precise value for the epoch of the minimum, the formula

\[ \delta = 7.09 - 0.930 (t - 1840.5) + 0.149 (t - 1840.5)^2 \]

has been constructed, which represents the observed values as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Observed amount</th>
<th>Computed amount</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840.5</td>
<td>6.70</td>
<td>7.09</td>
<td>+0.39</td>
</tr>
<tr>
<td>1841.5</td>
<td>6.61</td>
<td>6.31</td>
<td>-0.30</td>
</tr>
<tr>
<td>1842.5</td>
<td>6.11</td>
<td>5.83</td>
<td>-0.28</td>
</tr>
<tr>
<td>1844.5</td>
<td>4.85</td>
<td>5.64</td>
<td>+0.79</td>
</tr>
<tr>
<td>1845.5</td>
<td>5.21</td>
<td>5.70</td>
<td>-0.46</td>
</tr>
<tr>
<td>1841.5</td>
<td>2019.7</td>
<td>147</td>
<td>6.21</td>
</tr>
<tr>
<td>1843.5</td>
<td>1489.2</td>
<td>129</td>
<td>5.25</td>
</tr>
</tbody>
</table>

The first and last value have only half weight. According to the formula, the minimum took place in August, 1843. (See diagram 3, sketch No. 37.)

As the resulting epoch from the differential observations with the declinometer, we find the month of June, 1843, by giving double weight to the result deduced from the inequality of the diurnal amplitude.

Separating into western and eastern disturbances, we find—

<table>
<thead>
<tr>
<th>Year</th>
<th>West deflections</th>
<th>East deflections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aggregate value</td>
<td>n.</td>
</tr>
<tr>
<td>1840</td>
<td>5094.8</td>
<td>352</td>
</tr>
<tr>
<td>1841</td>
<td>2935.5</td>
<td>244</td>
</tr>
<tr>
<td>1842</td>
<td>2645.9</td>
<td>217</td>
</tr>
<tr>
<td>1843</td>
<td>1741.6</td>
<td>163</td>
</tr>
<tr>
<td>1844</td>
<td>2019.7</td>
<td>147</td>
</tr>
<tr>
<td>1845</td>
<td>1489.2</td>
<td>129</td>
</tr>
</tbody>
</table>

From which it appears that the easterly values preponderate over the westerly in the ratio of 1.14 to 1. The ratio from the Toronto observations between 1844 and 1448 is 1.28 to 1.

The following table shows the aggregate amount of disturbances in each month of the different years, or the annual inequality of the aggregate disturbances.
The secondary maximum occurs in April, (as at Toronto), and the minimum amount in June, (at Toronto in September,) the secondary maximum occurs in April, (as at Toronto; the secondary minimum in February, but at Toronto in January, from comparison with the years 1843, 1844, 1845.

The next tables give the aggregate monthly values in the six years, separated into west and east deflections:

### West deflections.

<table>
<thead>
<tr>
<th>Month</th>
<th>1840</th>
<th>1841</th>
<th>1842</th>
<th>1843</th>
<th>1844</th>
<th>1845</th>
<th>Mean</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>418.4</td>
<td>422.6</td>
<td>505.9</td>
<td>171.9</td>
<td>45.3</td>
<td>269.3</td>
<td>214.9</td>
<td>0.73</td>
</tr>
<tr>
<td>February</td>
<td>332.9</td>
<td>310.1</td>
<td>131.2</td>
<td>340.8</td>
<td>167.4</td>
<td>340.2</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>354.6</td>
<td>264.1</td>
<td>301.7</td>
<td>290.7</td>
<td>515.9</td>
<td>415.6</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>392.8</td>
<td>184.4</td>
<td>298.5</td>
<td>111.0</td>
<td>266.5</td>
<td>266.5</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>631.6</td>
<td>332.1</td>
<td>133.9</td>
<td>141.2</td>
<td>106.2</td>
<td>106.2</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>416.5</td>
<td>546.5</td>
<td>558.4</td>
<td>261.4</td>
<td>261.4</td>
<td>261.4</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>211.3</td>
<td>872.5</td>
<td>972.5</td>
<td>266.9</td>
<td>266.8</td>
<td>266.7</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>242.0</td>
<td>391.5</td>
<td>381.1</td>
<td>381.1</td>
<td>381.1</td>
<td>381.1</td>
<td>1.95</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>324.7</td>
<td>779.7</td>
<td>779.7</td>
<td>779.7</td>
<td>779.7</td>
<td>779.7</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>379.9</td>
<td>2203.5</td>
<td>327.3</td>
<td>2203.5</td>
<td>327.3</td>
<td>2203.5</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>191.6</td>
<td>326.9</td>
<td>326.9</td>
<td>326.9</td>
<td>326.9</td>
<td>326.9</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>1069.2</td>
<td>948.6</td>
<td>948.6</td>
<td>948.6</td>
<td>948.6</td>
<td>948.6</td>
<td>1.08</td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td>7155.5</td>
<td>7344.4</td>
<td>6019.1</td>
<td>3922.2</td>
<td>4373.3</td>
<td>4321.4</td>
<td>3253.3</td>
<td>12.30</td>
</tr>
</tbody>
</table>

* The differences of the disturbed readings from their respective normals, during the month of June and part of July, 1860, were first converted from the old to a new scale.
East deflections.

The following table gives the aggregate values of the disturbances distributed into the different hours of the day, as deduced from bi-hourly observations made from 1840 to 1845:

<table>
<thead>
<tr>
<th>Months</th>
<th>1840</th>
<th>1841</th>
<th>1842</th>
<th>1843</th>
<th>1844</th>
<th>1845</th>
<th>Mean</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>(267.0)</td>
<td>115.0</td>
<td>132.1</td>
<td>(92.7)</td>
<td>31.5</td>
<td>182.7</td>
<td>72.7</td>
<td>0.33</td>
</tr>
<tr>
<td>February</td>
<td>(55.7)</td>
<td>355.1</td>
<td>93.0</td>
<td>(38.5)</td>
<td>71.7</td>
<td>90.3</td>
<td>100.7</td>
<td>0.46</td>
</tr>
<tr>
<td>March</td>
<td>(61.6)</td>
<td>300.7</td>
<td>28.9</td>
<td>(53.4)</td>
<td>237.2</td>
<td>69.9</td>
<td>123.3</td>
<td>0.56</td>
</tr>
<tr>
<td>April</td>
<td>(116.7)</td>
<td>215.8</td>
<td>261.2</td>
<td>205.8</td>
<td>214.5</td>
<td>118.7</td>
<td>165.1</td>
<td>0.94</td>
</tr>
<tr>
<td>May</td>
<td>(69.3)</td>
<td>213.3</td>
<td>100.7</td>
<td>97.1</td>
<td>320.0</td>
<td>197.7</td>
<td>125.6</td>
<td>0.56</td>
</tr>
<tr>
<td>June</td>
<td>18.2</td>
<td>185.1</td>
<td>159.9</td>
<td>112.2</td>
<td>87.2</td>
<td>75.3</td>
<td>123.6</td>
<td>0.47</td>
</tr>
<tr>
<td>July</td>
<td>402.1</td>
<td>303.7</td>
<td>406.2</td>
<td>118.9</td>
<td>120.9</td>
<td>(177.2)</td>
<td>291.5</td>
<td>1.29</td>
</tr>
<tr>
<td>August</td>
<td>250.7</td>
<td>251.7</td>
<td>232.3</td>
<td>144.8</td>
<td>262.1</td>
<td>(184.0)</td>
<td>270.4</td>
<td>1.08</td>
</tr>
<tr>
<td>September</td>
<td>208.3</td>
<td>254.9</td>
<td>91.3</td>
<td>236.3</td>
<td>116.9</td>
<td>(228.3)</td>
<td>455.7</td>
<td>2.15</td>
</tr>
<tr>
<td>October</td>
<td>599.7</td>
<td>953.7</td>
<td>1090.7</td>
<td>397.8</td>
<td>(455.6)</td>
<td>570.9</td>
<td>2.45</td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>136.3</td>
<td>497.3</td>
<td>117.7</td>
<td>48.0</td>
<td>214.0</td>
<td>(147.6)</td>
<td>239.8</td>
<td>1.09</td>
</tr>
<tr>
<td>December</td>
<td>71.5</td>
<td>375.4</td>
<td>35.0</td>
<td>16.6</td>
<td>167.4</td>
<td>(106.6)</td>
<td>131.4</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Sum | 2991.7 | 4501.9 | 1373.2 | 1190.6 | 3983.0 | 2933.9 | 12.90 |

Note.—Maxima in September (mean of August and October) and April; minima in June and January, as at Toronto.

If we compare these ratios with the corresponding numbers in the preceding tables showing the bi-hourly distribution in regard to the number of disturbances, we find, irrespective of the directions of the deflections, the 2 p. m. minimum preserved; the maximum occurs at 10 p. m. At Toronto, from a five years' hourly series, commencing with 1844, these hours are respectively 1 p. m. and 9 p. m. At Philadelphia, as at Toronto, the ratios are nearly invariable from 10 a. m. to 6 p. m., being then below unity; and again from 8 p. m. to 8 a. m., when they are above unity.

The easterly maximum and the westerly minimum at 8 p. m., appear again as a decided feature, and in general the respective ratios exhibiting the diurnal distribution of the disturbances, both in an easterly and westerly direction, show almost a perfect correspondence in regard to both number and amount.
The next table exhibits the excess of westerly disturbance over easterly (the sign — indicating a defect, or excess of easterly over westerly) in the aggregate values of the five-year series, and in the last column the mean effect of the same at each even hour is given as obtained by dividing the aggregate differential value of the preceding column by the actual number of days of observation during the whole period. The last column exhibits, therefore, the mean diurnal disturbance variation. The number of days is very nearly 1,500.

<table>
<thead>
<tr>
<th>Philadelphia mean time</th>
<th>Excess of westerly over easterly values</th>
<th>Diurnal variation caused by the larger disturbances</th>
<th>Excess of westerly over easterly values</th>
<th>Diurnal variation caused by the larger disturbances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In each division</td>
<td>In minutes of arc</td>
<td>In each division</td>
<td>In minutes of arc</td>
</tr>
<tr>
<td>1 a. m.</td>
<td>d.</td>
<td>d.</td>
<td>Noon. 19'h</td>
<td>d.</td>
</tr>
<tr>
<td>9 19'h</td>
<td>+541.1</td>
<td>-0.36</td>
<td>-0.36</td>
<td>Noon. 19'h.</td>
</tr>
<tr>
<td>10 19'h</td>
<td>-18.5</td>
<td>-0.01</td>
<td>-0.00</td>
<td>14.19'h</td>
</tr>
<tr>
<td>11 19'h</td>
<td>+19.0</td>
<td>+0.19</td>
<td>+0.03</td>
<td>16.19'h</td>
</tr>
<tr>
<td>12 19'h</td>
<td>+498.1</td>
<td>+0.34</td>
<td>+0.09</td>
<td>18.19'h</td>
</tr>
<tr>
<td>13 19'h</td>
<td>+745.5</td>
<td>+0.56</td>
<td>+0.10</td>
<td>20.19'h</td>
</tr>
<tr>
<td>14 19'h</td>
<td>+413.3</td>
<td>+0.20</td>
<td>+0.06</td>
<td>22.19'h</td>
</tr>
<tr>
<td>15 19'h</td>
<td></td>
<td></td>
<td></td>
<td>-559.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.05</td>
</tr>
</tbody>
</table>

The law governing the disturbances during a solar day is clearly shown, and systematic in character. If we plot the disturbance curve on the same scale, or actually superpose it on the curves of the regular diurnal variation. (diagram 2, sketch No. 31,) the difference would hardly show to the eye. The diagram (No. 4) showing the disturbance variation has, therefore, been plotted on a larger scale.

The curve has but one maximum and one minimum; its most prominent feature is the easterly deflection at 8 o'clock (+ 19½ m.) p. m., (at Toronto it is at 9 p. m.) At that hour the maximum deflection amounts to 32'' of arc, and to 45'' at Toronto. The greatest westerly deflection occurs at 6h. (+ 19½ m.) a. m., and amounts to but 14'', the Toronto hour is 8 a. m. with 6'', and from a five years' series of observation with 31'' of deflection.

The range of the disturbance variation equals 46''. The disturbance amplitude, as well as the regular variation amplitude, is greater at Toronto than at Philadelphia, the occurrence of the maximum and minimum disturbance deflection seeming to be about one hour earlier at the latter station. From three in the morning till five in the afternoon, the mean effect of the disturbances is to deflect the north end of the magnet to the west, and during the remaining hours (principally at night) to the east. The westerly and easterly disturbance deflections during a day balance within 0''.02.

The annual inequality in the amplitude of the diurnal disturbance variation might be satisfactorily shown by the proper combination of the results for consecutive years, comparing each two-year series successively; but owing to the small amount of the amplitude itself, and the incomplete or partly interrupted series of observations in the years 1840, 1843, and 1845, it was thought best to restrict the present discussion to the mean disturbance variation.

It is my intention to continue the discussion of the observations made at the Girard College observatory.

*At Toronto 31'', and from a five years' series 83''.
After the above was written, No. 1,185* of the Astronomische Nachrichten came to hand, containing Prof. R. Wolf’s interesting results on the close connection of the variation in frequency of the solar spots, and the corresponding inequality in the amplitude of the diurnal variation of the declination. He deduces for Munich the formula $\beta = 6'273 + 0'051 a$—in which $a$ is a relative number, expressive of the frequency of the solar spots directly derived from observation, and $\beta$ the amplitude of the diurnal variation. He finds a very close correspondence between the computed and observed values of $\beta$, and gives in a table Dr. Lamont’s and his own results between the years 1835 and 1850. He also reaffirms his former value for the average length of the solar spot period, viz, 11.11 years ± 0.04 years, the limits of variation being 10 and 16 years. This period is deduced from observations of maxima and minima since 1626.

For Philadelphia we have $\beta = 7'080 + 0'039 a$, representing the observed amplitudes as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>$a$ (from solar spot) observations.</th>
<th>$\beta$ derived from $a$</th>
<th>Observed amplitude, or $\beta$.</th>
<th>Difference observed and computed $\beta$.</th>
<th>Year</th>
<th>$a$ (from solar spot) observations.</th>
<th>$\beta$ derived from $a$</th>
<th>Observed amplitude, or $\beta$.</th>
<th>Difference observed and computed $\beta$.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>51.8</td>
<td>9.10</td>
<td>9.08</td>
<td>-0'.02</td>
<td>1843</td>
<td>8.4</td>
<td>7.41</td>
<td>7.46</td>
<td>+0'.95</td>
</tr>
<tr>
<td>1841</td>
<td>29.5</td>
<td>8'.23</td>
<td>8'.06</td>
<td>-0'.17</td>
<td>1844</td>
<td>12.2</td>
<td>7.55</td>
<td>7.51</td>
<td>-0'.94</td>
</tr>
<tr>
<td>1842</td>
<td>19.2</td>
<td>7'.83</td>
<td>7'.83</td>
<td>0'.00</td>
<td>1845</td>
<td>32.4</td>
<td>8'.34</td>
<td>8'.53</td>
<td>+0'.19</td>
</tr>
</tbody>
</table>

The correspondence between the observed diurnal amplitude and the same derived from observations of the solar spots is further exhibited by diagram 5, Sketch No. 37, the heavy line representing the magnetic, the other the solar, amplitude curve. The dotted curve is from the Toronto magnetic observations, merely multiplied by $\frac{a}{c}$ to reduce (approximately) to the Philadelphia scale. The next maximum amplitude, according to the solar spot observations, would be in 1848, amounting to 11'.00; and the whole range of the inequality in the amplitude of the diurnal motion would, therefore, be 11'.00—7'.46 = 3'.54. The last quantity, it must be observed, is slightly variable with each period; thus, according to the solar spot observations, the year 1837 was a maximum, amplitude 11'.41; and the year 1856 a minimum, amplitude 7'.24, the difference being 4'.17.

It is much to be desired that this interesting branch of physical inquiry should be further studied, as it forms one of the links connecting terrestrial with cosmical phenomena.

* For former communication by Prof. Wolf, see Nos. 839, 1,043, 1,091, 1,132, 1,160, and 1,181, ibid.
APPENDIX No. 23.

Results reported from the observations made by Assistant Charles A. Schott, for magnetic declination, dip, and horizontal intensity, in Sections I and II, and Canada, 1859.

<table>
<thead>
<tr>
<th>No.</th>
<th>Locality</th>
<th>Date</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Declination West.</th>
<th>Dip North.</th>
<th>Horizontal Intensity</th>
<th>Total Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Beacon Hill, Gloucester, Mass.</td>
<td>1859.</td>
<td>42° 36'.4</td>
<td>70° 36'.4</td>
<td>12° 00'</td>
<td>74° 45'.6</td>
<td>2.545</td>
<td>13.98</td>
</tr>
<tr>
<td>2</td>
<td>Thompson, Cape Ann</td>
<td></td>
<td>42° 36'.7</td>
<td>70° 43'.5</td>
<td>11° 09'</td>
<td>74° 30'.9</td>
<td>2.074</td>
<td>13.73</td>
</tr>
<tr>
<td>3</td>
<td>Rockport, Cape Ann</td>
<td></td>
<td>42° 38'.8</td>
<td>70° 36'.3</td>
<td>11° 37'</td>
<td>75° 56'.9</td>
<td>2.399</td>
<td>13.78</td>
</tr>
<tr>
<td>4</td>
<td>Annisquam, Cape Ann</td>
<td></td>
<td>42° 39'.4</td>
<td>70° 40'.3</td>
<td>12° 01'</td>
<td>74° 36'.1</td>
<td>2.599</td>
<td>13.61</td>
</tr>
<tr>
<td>5</td>
<td>Ipswich, Mass</td>
<td></td>
<td>42° 43'.8</td>
<td>70° 49'.8</td>
<td>11° 14'</td>
<td>74° 37'.3</td>
<td>2.598</td>
<td>13.57</td>
</tr>
<tr>
<td>6</td>
<td>Plum Island, Newburyport</td>
<td></td>
<td>42° 45'.9</td>
<td>70° 48'.5</td>
<td>19° 58'</td>
<td>74° 50'.9</td>
<td>2.568</td>
<td>13.53</td>
</tr>
<tr>
<td>7</td>
<td>Glietey Point, Portsmouth</td>
<td></td>
<td>43° 34'.9</td>
<td>70° 42'.7</td>
<td>11° 15'</td>
<td>75° 04'.6</td>
<td>2.496</td>
<td>13.57</td>
</tr>
<tr>
<td>8</td>
<td>Bowdoin Hill, Portland</td>
<td></td>
<td>43° 36'.6</td>
<td>70° 16'.8</td>
<td>12° 30'</td>
<td>72° 32'.6</td>
<td>2.456</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>George, Canada</td>
<td>18 &amp; 19</td>
<td>46° 48'.4</td>
<td>71° 14'.6</td>
<td>16° 17'</td>
<td>77° 17'.5</td>
<td>2.941</td>
<td>13.60</td>
</tr>
<tr>
<td>10</td>
<td>Montreal, Canada</td>
<td></td>
<td>45° 39'.5</td>
<td>73° 34'.9</td>
<td></td>
<td>76° 51'.4</td>
<td>2.111</td>
<td>13.65</td>
</tr>
<tr>
<td>11</td>
<td>Rolland, Vt</td>
<td></td>
<td>43° 38'.0</td>
<td>72° 55'.9</td>
<td>9° 49'</td>
<td>73° 18'.6</td>
<td>2.464</td>
<td>13.69</td>
</tr>
<tr>
<td>12</td>
<td>Deerfield, Mass</td>
<td></td>
<td>43° 33'.3</td>
<td>72° 36'.9</td>
<td>9° 35'</td>
<td>74° 36'.9</td>
<td>2.677</td>
<td>13.61</td>
</tr>
<tr>
<td>13</td>
<td>Chesterfield, Mass</td>
<td></td>
<td>42° 54'.5</td>
<td>70° 51'.8</td>
<td>8° 54'</td>
<td>74° 51'.9</td>
<td>2.567</td>
<td>13.60</td>
</tr>
<tr>
<td>14</td>
<td>Springfield, Mass</td>
<td></td>
<td>42° 96'.5</td>
<td>73° 33'</td>
<td>8° 39'</td>
<td>74° 14'.9</td>
<td>2.691</td>
<td>13.60</td>
</tr>
<tr>
<td>15</td>
<td>Hartford, Conn.</td>
<td></td>
<td>41° 46'.4</td>
<td>72° 40'</td>
<td></td>
<td>74° 07'.4</td>
<td>2.716</td>
<td>13.58</td>
</tr>
<tr>
<td>16</td>
<td>Coast Survey Office, Washington, D. C.</td>
<td></td>
<td>39° &amp; 30'.</td>
<td>77° 00'.9</td>
<td></td>
<td>71° 54'.7</td>
<td>4.367</td>
<td>13.51</td>
</tr>
</tbody>
</table>

* Owing to a considerable disturbance at the time of occupation the result for declination has been rejected.
† The dip at Portland, 16° 56'.7, seems to be too small, probably owing to a disturbance at the time. The total intensity was left blank accordingly.
§ The declination seems to have been affected by a considerable disturbance at the time, and the result, 12° 20', had better not be used.
∥ The declination seems to have been affected by a disturbance, the value, 7° 17', being too small.
* Occupied for intensity June 20 and 23, 1859, and July 30, 1857; for dip, June 23 and July 09. Mean date for dip and intensity, July 11.

APPENDIX No. 24.

Report of Assistant Charles A. Schott on the latest results of the discussion of the secular change of the magnetic declination, accompanied by tables showing the declination (variation of the needle) for every tenth year from the date of the earliest reliable observation, for twenty-six stations on the Atlantic, Gulf, and Pacific coasts of the United States.

Computing Division, Coast Survey Office,
November 4, 1859.

Dear Sir: In accordance with the Superintendent's letter of January 21, 1859, I have prepared a set of tables for practical use, giving the secular change of the magnetic declination, and showing for every tenth year, from the date of the earliest reliable observations to the present time, the magnetic declination (commonly called the variation of the magnetic needle) for stations on or near the northeastern coast of the United States, and also for some stations on our southern and western coasts—as derived from my several discussions of the secular change, in which have been included the latest data in possession of the Coast Survey. For the eastern and southern coasts the following papers may be referred to: Coast Survey Report for 1855, Appendix No. 48, pp. 305-337; Coast Survey Report for 1858, Appendix No. 25, pp. 192-195; and Appendix No. 26, pp. 195-197. For the western coast, Coast Survey Report for 1855, Appendix No. 31, pp. 228-235, may be consulted.

In general, the secular change of the declination appears to be of a periodic character, but
in no instance has a whole cycle been completed on either coast. Its length, therefore, remains necessarily in a great measure uncertain, and the tentative analytical process so far followed has for its main object the proper representation of all reliable observations made at any one station, so as to furnish the means of interpolation, and also to enable us to calculate the magnetic declination for any required place and date within the limits of the discussion. In the investigation of 1855 a linear function was used in the discussion, which does not involve the duration of the period, and on this account the results were, in regard to time, of rather limited extent.—(See remark on p. 337 of Report for 1855.)

For the Western Coast stations, I still prefer to retain this form of the discussion. Subsequently, by means of the knowledge gained in that discussion, an attempt was made to substitute a circular function, directly involving a period or periods, the length of which, as well as all other numerical co-efficients in the formula for the secular change, has been determined by applying the method of least squares. The use of a circular function—commenced in 1858 with two stations—is now extended to eighteen, within the limits stated above, and it has also been applied to some stations in Canada, the southern coast of the United States, and Central America, in order to furnish material for the generalization of the law, so far as ascertained, in reference to epochs and rate of change. A secondary period within the first was traced at several stations, its length, however, being much more variable and uncertain was found fluctuating between one-half and one-fifth of the primary period, while its amplitude was on the average fifteen times smaller than that of the primary wave for stations forming group 1, or within the geographical limits of Portland, Burlington, and Williamsburg. This smaller amplitude was found nearly constant, and equal to 0°.4.

To make the present paper more complete, it contains also the record of all observations used in the discussion not heretofore published in the Coast Survey reports.

As long as the cause producing the secular change remains altogether unknown, it is not safe to trust too far to the continuation of the law thus empirically derived; and in the following tables no value, deduced by the formula, has been inserted antecedent to the first observation by more than ten years. The tabular values may, therefore, be regarded in the light of a strict interpolation between actual observations; and since the analytical treatment will equalize and remove, in a measure, accidental errors of observation, they may be considered as certainly more trustworthy than any single observation, particularly in cases where the number of observations available for the discussion exceeds half a dozen, properly distributed in relation to time. The probable error of any single representation was found in the second table. For all ordinary use by the surveyor (or navigator) the tabular values are sufficiently precise; when greater accuracy is required, the annual inequality of the declination and the diurnal variation for the time required must be taken into account. The former correction will probably not exceed, in any case, one minute, and the latter may amount in summer, in maximo, to minus or plus six minutes, and in winter to minus or plus three minutes—numbers which were derived from Prof. Bache’s discussion of the Philadelphia observations. The table will also answer for intermediate places, for which they furnish the necessary data of interpolation.

It is proper to state that the present formulae should be considered as liable to future changes and improvements depending on the accumulation of additional observations; and it is hardly necessary to state that their number also may hereafter be considerably increased by the accession of new material. The utility of a publication of tables showing the declination for
every tenth year was suggested by Mr. T. B. Brooks. In the numerical calculations, I was
assisted by Mr. G. Rumpf, of the computing division.

Formulas expressing the secular change of the magnetic declination (commonly called variation of the
magnetic needle) used for calculating the tabular values.

Group I.—Stations between Portland, Me., and Williamsburg, Va.—A positive sign of D indicated
west declination, a negative sign east declination: n equals the number of years (and
fraction of a year) from 1830, positive for years after and negative for years before this epoch.
Longitudes are reckoned from Greenwich.

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<th>No.</th>
<th>Locality</th>
<th>Latitude</th>
<th>Longitude</th>
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<td>Burlington, Vt.</td>
<td>44 57</td>
<td>73 10</td>
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<tr>
<td>2</td>
<td>Portland, Me.</td>
<td>43 29</td>
<td>70 16</td>
</tr>
<tr>
<td>3</td>
<td>Portsmouth, N. H.</td>
<td>43 05</td>
<td>70 42</td>
</tr>
<tr>
<td>4</td>
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<td>72 25</td>
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<tr>
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<td>70 26</td>
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<tr>
<td>7</td>
<td>Boston</td>
<td>45 90</td>
<td>71 02</td>
</tr>
<tr>
<td>8</td>
<td>Providence, R. I.</td>
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<td>71 94</td>
</tr>
<tr>
<td>9</td>
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<td>41 46</td>
<td>72 40</td>
</tr>
<tr>
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<td>72 55</td>
</tr>
<tr>
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<td>72 43</td>
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<td>Oxford, N. Y.</td>
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<td>72 48</td>
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<td>40 43</td>
<td>74 09</td>
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</tr>
<tr>
<td>18</td>
<td>Williamsburg, Va.</td>
<td>37 13</td>
<td>76 40</td>
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</table>

The following table contains the number (n) of observations (single or combined) upon which
each formula is based; the probable error (e) of an observation, expressed in minutes, as a
measure of the degree of accuracy with which the observations are represented; the epoch of
the last minimum of west declination, (or of maximum east declination,) together with the least
west declination, (greatest east,) and lastly the annual variation for the years 1840, 1850, and
1860, expressed in minutes. The positive sign expresses west declination increasing, (east
diminishing.)

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<th>Least west declination</th>
<th>Variation for 1840</th>
<th>Variation for 1850</th>
<th>Variation for 1860</th>
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<td>+ 3.5</td>
<td>+ 3.5</td>
<td>+ 3.0</td>
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<td>+ 5.7</td>
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<td>12</td>
<td>1752 + 6.9</td>
<td>+ 4.3</td>
<td>+ 4.3</td>
<td>+ 4.3</td>
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<tr>
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<td>+ 2.6</td>
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The United States Coast Survey.

Table of magnetic declinations for eighteen stations, forming group 1, on or near the northeastern coast of the United States, between the years 1689 and 1860. West declination is indicated by a plus sign, east declination by a minus sign, and is expressed in degrees and fractions of a degree.

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</tbody>
</table>

Note.—At Cambridge, Mass., the observations after 1855 require further examination. At Williamsburg the values between 1700 and 1750 were not considered sufficiently reliable for insertion. The expression for Baltimore depends for length of period and time of minimum on the Washington formula.

The total number of observations upon which the tabular values and the formula are based is 180; the average number for any one station is 10; and the average probable error of any single representation is ± 11'.

If we arrange the stations geographically, we find that at the eastern stations the minimum (west) declination occurred earlier than at the more western and southern stations; thus, from six stations, between Portland and Providence, it occurred about the year 1777 in the Connecticut and Hudson valleys, and along the sea-coast as far south as Washington; the year of the minimum does not differ much from 1797; Williamsburg, in Virginia, gives 1815. The transition, as we pass from the New England States, is somewhat abrupt, but too well marked to be accidental. Extending the investigation further north, I find for Quebec, Canada, the year of the minimum 1769; going further west, we find that at Toronto it must have occurred before the year 1842; and at York Fort, Hudson Bay, I find the year 1842, (as already ascertained by Gen'l Sabine, after the receipt of Capt. Blakiston's observations of 1857.) This latter station is nearly halfway across the continent; and if we proceed to the Western Coast, we find that the eastern declination there has not yet reached its maximum, (equivalent to a western minimum,) but it is highly probable that it will reach it before the close of the present century. The present reverse, or western motion of the isogonic lines in our eastern States, which commenced about the year 1777, will gradually be communicated to the more westerly stations, and will, it is highly probable, be participated in on our Western Coast before or at the close of the present century, the direction of the motion in this latter locality being at present still to the eastward and southward, though with a diminishing rate.—(See p. 235 of Coast Survey Report of 1856.)
The following equations, constructed for the two northernmost stations, may be added here:

York Fort, Hudson Bay, \( D = + 5^\circ.1 - 14^\circ.2 \cos (15^\circ.6 \, n + 340^\circ) \)
Quebec, Canada, \( D = + 12.84 - 3.7 \cos (1.6 \, n + 97^\circ) \)

The second group comprises the stations on the southern portion of the Atlantic Coast and Gulf Coast, only three in number, to which have been added some stations located further south.

**Group II.—Southern stations.**

<table>
<thead>
<tr>
<th>No.</th>
<th>Locality</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Magnetic declination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Charleston, S. C.</td>
<td>32 45</td>
<td>79 51</td>
<td>( D = - 2.12 - 2.02 \cos (1.55 , n + 56^\circ) )</td>
</tr>
<tr>
<td>2</td>
<td>Savannah, Ga.</td>
<td>32 05</td>
<td>81 05</td>
<td>( D = - 2.95 - 1.24 \cos (1.5 , n + 20^\circ) )</td>
</tr>
<tr>
<td>3</td>
<td>Mobile, Ala.</td>
<td>30 41</td>
<td>88 02</td>
<td>( D = - 6.5 - 0.77 \cos (1.6 , n + 10^\circ) )</td>
</tr>
</tbody>
</table>

Proceeding in a southerly direction, the next station discussed outside of the boundaries of the United States is Havana, Cuba, latitude 23° 09', longitude 82° 22', for which place I found \( D = - 4°.82 - 1°.45 \cos (1.3 \, n + 26^\circ) \) with 1810 as the year of maximum east declination.

The values collected for Jamaica were not discussed, but the 9 values I was able to obtain will be found in the appended record. For Panama, New Granada, lat. +8° 57', long. 79° 29', the southernmost station discussed, I find \( D = - 6°.9 - 1°.04 \cos (1.2 \, n + 74^\circ) \) an equation satisfying the observations, but not considered as preferable to the following expression: \( D = - 5°.97 - 2°.21 \cos (1°.2 \, n + 34^\circ) \) which supposes the maximum to occur in 1802.

Going westward and northward, I found for Vera Cruz, Mexico, lat. 19° 12', long. 96° 09',
\( D = - 4°.2 - 5°.04 \cos (1°.1 \, n + 7^\circ) \) with the maximum east declination in 1824.

The following table has been calculated from the preceding equations:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1770</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1780</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1790</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1800</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1810</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1820</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1830</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1840</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1850</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1860</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
The following formula for stations on the Western Coast between San Diego and Cape Disappointment, forming group 3, have been copied from page 234 of the Report for 1856:

<table>
<thead>
<tr>
<th>No.</th>
<th>Locality</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Magnetic declination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>San Diego</td>
<td>32 42</td>
<td>117 13</td>
<td>D = -12.17 - 0.019 n + 0.00018 n².</td>
</tr>
<tr>
<td>2</td>
<td>Monterey</td>
<td>36 38</td>
<td>121 54</td>
<td>D = -14.19 - 0.050 n + 0.00047 n².</td>
</tr>
<tr>
<td>3</td>
<td>San Francisco</td>
<td>37 48</td>
<td>122 27</td>
<td>D = -15.14 - 0.028 n + 0.00025 n².</td>
</tr>
<tr>
<td>4</td>
<td>Cape Mendocino</td>
<td>40 25</td>
<td>124 22</td>
<td>D = -16.29 - 0.025 n.</td>
</tr>
<tr>
<td>5</td>
<td>Cape Disappointment</td>
<td>46 17</td>
<td>124 02</td>
<td>D = -19.65 - 0.019 n.</td>
</tr>
</tbody>
</table>

The total number of observations used for the construction of the above formulae is 21, the greatest number for any one station being 6, the least 3; the average probable error of any single representation is ± 12'. The annual change (increasing east declination) may be taken the same for all stations, viz:

- In 1840: - 1.6
- In 1850: - 1.2
- In 1860: - 0.8

The next station discussed, south of California, is San Blas, Mexico, lat. 21° 32' north, long. 105° 16' west of Greenwich, which gave the following expression.—(See p. 234, Coast Survey Report of 1856.)

D = 8°.63 - 0.042 n - 0.00031 n²,

which equation, when compared with those above, shows a reversal in the sign of the co-efficient of n², or an opposite curvature. The annual easterly increase at San Blas in 1850, according to the above formula was 3.3 per annum. This station, however, is already within the area of the peculiar form of the isogonic lines, which position may possibly render an immediate comparison impracticable. The station Sitka, in Russian America, is the next place, north of Washington Territory, discussed. I find for it the approximate formula:

D = -28°.12 - 0.0607 n - 0.00025 n².

It depends for its latest declination (1858) on the tabular value assigned by Mr. Evans on his late map of the lines of equal magnetic variation reduced to 1858.
Record of all observed declinations made use of in the above paper, not heretofore published in the United States Coast Survey Reports.

The following record containing only additional observations, we have to consult the preceding reports of 1854, '55, '56, and '58, if we desire to collect all results which may have been used at any one station. The stations are arranged geographically, commencing with the northern and eastern stations, and concluding with the stations on the Western Coast. \( D = \) observed declination.

**York Fort, Hudson bay.**—(From the proceedings of the Royal Society of London, for January, 1858, by Maj. Gen. Sabine.)

- 1725 \( D = 19^\circ 00' \) W.; Captain Middleton.
- 1787 \( 5^\circ 00' \) W.; Hansteen's map.
- 1819. Sep. \( 6^\circ 00' \) E.; Sir J. Franklin.
- 1843. July \( 9^\circ 25' \) E.; Capt. Lefroy.
- 1857. Aug. \( 7^\circ 37' \) E.; Capt. Blakiston.

**Quebec, Canada.**

- 1649 \( D = 16^\circ 00' \) W.; P. Bressan, Hansteen's Erdmag's. Barlow Cycl. Met.
- 1686 \( 15^\circ 30' \) W.; De Hayes.
- 1810 \( 11^\circ 00' \) W.; Becquerel, Traité du magnetisme.
- 1814 \( 11^\circ 50' \) W.; Kent; Becquerel, Traité du magnetisme.
- 1831 \( 13^\circ 38' \) W.; Bayfield.
- 1842 \( 14^\circ 12' \) W.; Capt. Lefroy.
- 1859. July \( 16^\circ 17' \) W.; Chas. A. Schott, Assistant United States Coast Survey.

**Burlington, Vt.**—(See former observations in 1855 report, pp. 326, 337.)

- 1837 \( D = 8^\circ 45' \) W.; Prof. Benedict.
- 1840 \( 9^\circ 42' \) W.; J. Johnson; Thompson's History of Vermont.
- 1845. June \( 9^\circ 22' \) W.; D. J. Locke; Smithsonian Cont. to Knowledge, Vol. III, 1852.

**Portland, Me.**

- 1763 \( D = 7^\circ 45' \) W.; J. Winthrop; Sill's Journal XXXIV, 1838; Prof. Loomis's collection.
- 1775 \( 8^\circ 30' \) W.; J. F. De Barre's Atlantic Neptune, London, 1781.
- 1845. June \( 11^\circ 28' \) W.; Dr. J. Locke, Smithsonian Cont. to Knowledge, Vol. III, 1852.
- 1859. July \( 12^\circ 20' \) W.; Chas. A. Schott, Assistant U. S. Coast Survey. (See also Coast Survey Report of 1856, p. 215.)

**Portsmouth, N. H.**

- 1771 \( D = 7^\circ 46' \) W.; Holland; Sill's Journal XXXIV, 1838; Prof. Loomis's collection.
- 1771 \( 7^\circ 48' \) W.; Holland.
- 1775 \( 7^\circ 45' \) W.; J. F. De Barre's Atlantic Neptune.
- 1859. July \( 11^\circ 15' \) W.; Chas. A. Schott, Assistant U. S. Coast Survey. (See also Coast Survey Report of 1856, p. 215.)

**Rutland, Vt.**

- 1789. Apr. \( D = 7^\circ 03' \) W.; Dr. Williams; Sill's Journal, XVI, 1829.
- 1810. May \( 6^\circ 04' \) W.;

\( \circ \) The table of the declinations in that report is reprinted and enlarged in the report of 1856.
THE UNITED STATES COAST SURVEY.

1811. Sept. \( D = 6^\circ 00' W. \); Dr. Williams; Sill's Journal, XVI, 1859.
1859. July 9 49 W.; Chas. A. Schott, Assistant U. S. Coast Survey.


1845. June \( D = 9^\circ 32' W. \); Dr. J. Locke; Smithsonian Cont. to Knowl., Vol. III, 1852.
1855. May 10 54.6 W.; W. C. Bond, in a letter to Superintendent of Coast Survey.)
1856. May 10 50.3 W.; \( \ldots \)

Note.—More recent observations still require examination.

Newburyport, Mass.

1775 .... \( D = 6^\circ 45' W. \); J. F. W. De Barre's Atlantic Neptune.
1781 .... 7 18 W.; Dr. Williams; Sill's Journal, XXXIV, 1838, Professor Loomis's collection.
1859. July 10 58 W.; Chas. A. Schott, Assistant United States Coast Survey.
(See also Coast Survey Report, 1856, p. 215.)

Boston, Mass.

(See Coast Survey Report, 1855, pp. 316, 317, 337.)

Providence, R. I.

(See Coast Survey Report, 1855, pp. 307, 308, 309, 337.)

Hartford, Conn.

1786 .... \( D = 5^\circ 25' W. \); Dr. Williams;
1810 .... 4 46 W.; Asher Miller;
1824 .... 5 45 W.; N. Goodwin;
1828 .... 6 03 W.; N. Goodwin;
1829 .... 6 03 W.; N. Goodwin;
1859. July 8 04 W.; an interpolated value from observations at Springfield and New Haven in 1859 and 1855.

New Haven, Conn.

(See Coast Survey Report, 1855, pp. 319, 320, 337.)

Albany, New York.

1847. Nov. \( D = 7^\circ 35' W. \); Regent's Report, (geological survey.)
(See also Coast Survey Report, 1855, pp. 328, 337; and Coast Survey Report, 1858, p. 191.)

Oxford, New York.—The following observations, marked E. B. W. C., are from a letter of Mr. E. B. W. Call to the Superintendent of Coast Survey, December 22, 1858:

1792–95 .... \( D = 3^\circ 00' W. \); E. B. W. C.
1817 .... 3 00 W.; E. B. W. C.
1828. July 4 30 W.; E. B. W. C.
1834. Oct. 3 52 W.; Regent's report; Sill's Journal, XXXIV, 1838.
1836. Oct. 4 09 W.; Regent's report; Sill's Journal, XXXIV, 1838.
1838. July 4 30 W.; Regent's report; observed at Guilford.
1849. Nov. 5 11 W.; E. B. W. C.
1857. Apr. = 5° 44' W.; E. B. W. C.
1858. Feb. 5 47 W.; E. B. W. C.
1858. Dec. 5 50 W.; E. B. W. C.

New York.
(See Coast Survey Report of 1855, pp. 320, 321, 333, and 337; also Coast Survey Report, 1856, p. 217.)

Philadelphia.
(See Coast Survey Report of 1855, pp. 313, 314, and 337.)

Hatboro', Pa.
(See Coast Survey Report of 1858, pp. 192, 193, 194, and 195.)

Baltimore, Md.
1808 .... D = 0° 10' to 15' W.; D. Byrnes, Vol. XVIII, 1830, Sill's Journal.
(See also Coast Survey Report, 1856, p. 219, 227; also Coast Survey Report, 1858, p. 191; Washington, D. C.)

Washington, D. C.
(See Coast Survey Report, 1858, pp. 195, 196, 197.)

Williamsburg, Va.
1694 .... D = 5° 00' W.; Sill's Journal, Vol. XXXIV, 1838, Prof. Loomis' collection.
1780 .... 0 50 W.; Sill's Journal, Vol. XXXIV, 1838, Prof. Loomis' collection.
1809 .... 0 33 E.; Sill's Journal, Vol. XXXIV, 1838, Prof. Loomis' collection.
1856. Aug. 1 04 W.; deduced from observations at Petersburg, Old Point Comfort and Norfolk.

Charleston, S. C.
1857. Apr., D = 1° 56' E.; derived from observations at Savannah in 1852 and 1857.
(See Coast Survey Report, 1855, pp. 322, 323.)

Savannah, Ga.
1817 .... D = 4° 00' E.; Becquerel, Traité du magnetisme.
1838 .... 5 05 E.; Sill's Journal, XXXIX, 1840.
1839 .... 3 31 E.; Sill's Journal, XXXIX, 1840.
(See also Coast Survey Report, 1856, p. 220, and Coast Survey Report, 1858, p. 192.)

Mobile, Ala.
(See Coast Survey Report, 1855, p. 323; also Coast Survey Report, 1858, p. 192.)

Havana, Cuba.
(See Coast Survey Report, 1855, p. 324.)

Jamaica, West Indies.
1732 .... D = 6° to 6° 5' E.; J. Harris, at Black river in March and April, Phil. Trans., 1733.
1789-1793 6° 50' E.; J. Leard, map of Port Royal.
1791-1792 6 45 E.; J. Leard, map of Port Royal.
1821 .... 4 50 E.; De Mayne, Becquerel's traité du magnetisme, Paris, 1846.
1832.... 5 13 E.; Foster, Becquerel's Traité du Magnetisme, Paris, 1846.
1833.... 4 40 E.; from a map.
1840?.... 4 00 E.; General Sabine's isogonic map of the Atlantic Ocean.

Panama, New Granada.
1802.... 8 00 E.; Encycl. Brit.
1822.... 7 00 E.; Hall, Becquerel's Traité du Magnetisme.
1837.... 7 02 E.; Sir E. Belcher.
1849.... 6 55 E.; Major Emory, (Mexican boundary survey.)
(See also Coast Survey Report, 1856, p. 223.)

Vera Cruz, Mexico.
1726-27. D = 2° 15' E.; J. Harris, Phil. Trans. R. S., anno 1728.
1776.... 7 30 E.; Don Ulloa, Ency. Brit.
1815.... 10 37 E.; Malony, Ency. Brit.
(See also Coast Survey Report, 1856, p. 214.)

San Diego, Monterey, San Francisco, and Cape Mendocino, Cal., and for Cape Disappointment, Washington Territory.
(See Coast Survey Report, 1856, pp. 228 to 235.)

Sitka, Russian America.
1804.... D = 26° 45' E.; Lissiansky,
1829.... 28° 19 E.; Erman,
1858.... 30 00 E.; from Evans' map of isogonic lines for 1858.
Yours, very respectfully,

CHAS. A. SCHOTT,
Assistant Coast Survey, in charge C. D.

Capt. W. R. PALMER, T. E.
Assistant Coast Survey, in charge of office.
APPENDIX No. 25.

Gulf Stream explorations.—Third memoir: Distribution of temperature in the water of the Florida channel and straits: By A. D. Bache, Supt. U. S. Coast Survey. (Communicated, by authority of the Treasury Department, to the American Association for the Advancement of Science.)

The results of the explorations of the Gulf Stream in the survey of the coast have been communicated to the Association from time to time, as phenomena of peculiar interest have been developed.

The original plan of these explorations having been carefully studied, and having proved successful, has steadily been adhered to. The more recent observations have been directed to that part of the stream, between Havana and Cape Florida, known as the channel and strait of Florida. I have now to present four sections, showing the depth and temperature in this most important region of the Gulf Stream. These results are from the observations of Commander B. F. Sands and Lieut. Comg. T. A. Craven, U. S. N., assistants in the Coast Survey, whose names have already been mentioned before the Association in connection with explorations of the Gulf Stream, and furnish a sufficient guarantee that the results have all the reliability which care, experience, and zealous labor could give them.

Section No. 1, (Sketch No. 35,) from Cape Florida to Bemini, was run by Lieut. Comg. Craven in May, 1855; Section No. 4 by Commander Sands in May, 1858; and Sections Nos. 2 and 3 by Lieut. Comg. Craven in April and May of the present year, 1859.

Sections 2, 3, and 4 are perpendicular to the direction of the stream at distances of about fifty, one hundred, and two hundred miles from Cape Florida. The lines of sections are shown upon the chart marked A. The Florida strait is funnel-shaped, being about ninety miles wide at Havana and about forty-five miles wide at Cape Florida, the narrowest part.

Form of bottom.

The area of the water way and the form of the bottom are represented on diagrams 7, 8, 9, and 10, (Sketch No. 35.) The Arabic numerals at the top represent distances from the Florida coast (the keys) in miles, and the numbers below them the positions at which observations were made. The numbers at the left hand represent the depth in fathoms.

Commencing at the Cape Florida section, it will be seen that there is a rapid descent of the bottom to the Havana section, from three hundred and fifty fathoms to eight hundred fathoms, or twenty-seven hundred feet in a distance of two hundred miles. The most shallow, as well as the narrowest part of the stream, is, therefore, at Cape Florida. The deepest water follows the coast of Cuba and the Grand banks, the depth being eight hundred fathoms at a distance of only five miles from Havana, nearly four hundred fathoms within five miles of Salt Key bank, and three hundred fathoms close to the island of Bemini. The descent from the Florida side is for the most part gradual, but from the opposite side abrupt. This effect seems to have been produced by the action of the sub-current in wearing a deeper channel upon the concave side of the stream. At Havana there is an abrupt descent of nearly a mile within five miles of the shore, while on the side of the Tortugas and Key West the water is comparatively shallow and the descent gradual. This fact goes to confirm the conclusion that the stronger current
of the Gulf Stream makes the circuit of the Gulf of Mexico; since, if it impinged directly upon
the islands of Key West and the Tortugas, we should find its effects in the wearing of a deeper
channel on that side.

Temperatures.

Change of temperature with depth.

In a former communication the law of change of temperature with depth was discussed, and
types of the curves representing the law were given for different parts of the stream. These
curves were all merely modifications of a more general form. Thus, the cold water between
the Gulf Stream and the coast gave one form, the axis of the stream another, and the water
beyond the axis a third form, while in the Strait of Florida a fourth was developed. It would
be natural to expect, in the course of many years' explorations by different individuals, with
different instruments, not even of the same class, that general phenomena of this character
should present some contradictions and some inexplicable results.

Experience, however, has confirmed the first conclusions and the constancy of the phenomena.
It is not difficult, having the curve representing the temperatures at any position from the
surface to the depth of several hundred fathoms, to determine, from the temperatures alone,
in what part of the stream they were taken.

Temperature in a direction perpendicular to the stream.

Diagrams 2, 3, 4, and 5 (Sketch No. 35) show the changes of temperature for the same
depth in each of the sections, and diagrams 7, 8, 9, and 10 the depth for the same temperature.

Bands of warm and cool water.

In the section from Cape Florida to Bemini the division of the stream into bands is plainly
exhibited, though more faintly than in the northern sections, and the form of the bottom in
this section shows also elevations and depressions corresponding to the divisions. In the
sections south of Cape Florida all traces of the bands seem to disappear, as well as the
ridges of the bottom. The bands, therefore, seem to have their origin near Cape Florida; and
the conclusion stated some years ago as the probable one is strengthened, that they are caused
by the ridges and valleys of the bottom parallel to the general course of the stream, and along
which the stream and counter-stream have their course.

The Cold Wall.

The Cold Wall, as an exception to the remark made above in reference to the bands, is traced
as far as the Tortugas, and is plainly shown in all the sections with more or less distinctness.
In the Sombrero key section (No. 3) it is strongly marked at depths ranging from seventy to
a hundred fathoms, while in all the sections the warm water at the surface overflows the Cold
Wall and reaches quite to the shore.

Diagram No. 8 represents the comparative curves of the Cold Wall in different sections of the
Gulf Stream, including those in the Straits of Florida. The figures at the top show the dis-
tances of the cold wall from the shore in the different sections, and the numbers on the left the
degrees of temperature. The curves are drawn for different depths in the several sections, as
shown in the notes at the bottom of the diagram. The dotted curves, g, h, i, k, represent the
Cold Wall in the four sections under consideration.
REPORT OF THE SUPERINTENDENT OF

Longitudinal sections.

It has been found very difficult to deduce any satisfactory law for the decrease of surface temperature along the axis of the stream, owing to the variability of the temperature of the waters of the regions from whence the Gulf Stream is supplied. Two modes of investigating the subject have been pursued; one, by following the stream from the Gulf of Mexico, and making hourly observations of the temperature of the water, and the other by comparing the mean temperatures of the various sections with each other and with the temperature of the Gulf of Mexico. In the first method the vessel must be allowed to drift with the current of the stream, a difficult condition except in the best weather, even for a day, and to float along thus for hundreds of miles would rarely be practicable. Any motion communicated by sails or by steam must carry the vessel beyond the water in which she commenced her voyage, and the lateral overflow carries the water constantly from the axis towards the edges of the stream. In the comparison of mean temperatures of the different sections the fact has been established that the temperature of the water of the stream at any point may be higher than at a point nearer the source, and hence vessels in running along the stream may, and generally do, pass through water not of a constantly diminishing temperature, but from cool to warm, and the reverse. This is to be explained mainly, though not entirely, by the variability of temperature at the source.

By taking the mean temperature of any one section and going back to the date of the departure of the waters from the Gulf of Mexico as determined by the velocity of the stream, and comparing the temperatures observed with the temperatures of the Gulf waters, it was supposed that a solution of the question might be obtained. The temperatures were taken from the most authentic meteorological records of the Gulf for a series of years, and those periods sought which corresponded to the dates desired. The uncertainty of the temperatures of the waters of the Gulf of Mexico, as obtained from air temperatures taken here and there along its shores, rendered the results unsatisfactory. Enough seems to have been determined, however, to show that the surface temperature of the Gulf Stream along its course is variable; that a vessel sailing along the axis at a more rapid rate than the motion of the stream will pass through water of higher and lower temperature, depending generally upon two conditions, viz: the distance from the Gulf of Mexico, and the temperature of the Gulf at the time the water entered the straits of Florida; and further, that the latter cause is the predominating one in the parts of the Gulf Stream adjacent to the Atlantic coast, where the current is rapid.

The influence of the form of the bottom in forcing the cold counter current of the bottom upward has been adverted to, and the fact appears to be well established in the cross sections, where the ridges and valleys parallel to the direction of the stream separate it into bands of warmer and cooler water, and this conclusion, as has just been stated, is strengthened by the fact that the bands and ridges simultaneously disappear south of Cape Florida. This phenomenon is moreover strikingly exhibited in the longitudinal section of the bottom in connection with the lower temperatures.

The shallowness of the stream in the Strait of Florida, connected with the fact that the bottom falls off rapidly to the north and south, afforded an excellent opportunity for testing this question. If the cold water of the under polar current follows the bottom it should appear in the shallow part of the strait, and here the warm water of the surface and the cold water of the bottom would approach each other. Diagram No. 1 shows the curves of $40^\circ$. 
45°, and 50° (bottom temperatures) along the deepest part of the stream, commencing at Sandy Hook and running as far as the Tortugas. All these curves rise with the bottom and pass over the ridge which divides the bed of the Atlantic from that of the Gulf of Mexico, and again fall with the slope of the bottom towards the Gulf. In the narrowest part of the strait, where the depth is three hundred and fifty fathoms, the temperature, from the surface to the bottom, ranges between 80° and 40°.

On the effects of pressure on Saxton's Deep-sea thermometer.

In the explorations of the Gulf Stream the temperatures below one hundred fathoms have mostly been determined by Saxton's metallic thermometer, and although the results have been consistent amongst themselves, and have agreed well with the indications of other thermometers, yet it was thought advisable to determine the effect of pressure by direct experiment.

Saxton's thermometer consists essentially of a compound ribbon of silver and platinum, fused and pressed together by rollers. This ribbon is wound in a spiral form, one end of the spiral being firmly fastened to an interior solid axis, and the other left free. Upon the free end is placed an index arm, which moves over a circular graduated scale, carrying with it a friction band or indicator, which is left at the extreme point of the arc reached by the true index. The instrument is enclosed in a case, to which the water is freely admitted. A variation of temperature is immediately noticed, as the effect is to give a rotary motion to the index.

The experiments to determine the effect of pressure were made at my request by Mr. J. M. Batchelder, with means devised by Mr. Thomas Davison at the Novelty Iron Works. The following description of the apparatus employed is given by the last named gentleman.

"The gauge (Sketch No. 35) consists of a brass cylinder H about eight inches long, into which a steel plunger is fitted, the upper part of the plunger at A being .70 of an inch in diameter, and the lower at B about .786, so that the difference in area of the ends is equal to one-tenth of a square inch. The cylinder is bored out a little larger than the plunger, except for about a fourth of an inch near each end, at C and D, where both are accurately fitted. To the branch Ea a pipe connects, communicating with the hydraulic cylinder, and leading the water into the centre of the gauge, which it reaches after passing through the chamber F, filled with sponge to prevent any impurities in the water from reaching the plunger. The upper end of the plunger connects by a wire W to a spring, as shown in the sketch at G, so constructed as to indicate pressure from 0 to 450 pounds, the spring being so strong that 450 pounds produce a movement of the plunger equal to three-eighths of an inch. It is evident that, as the difference in area of the ends of the plunger is one-tenth of an inch, one hundred pounds pressure from the water on this surface, as indicated by the balance, would equal a pressure of water of 1,000 pounds per inch, or a pressure ten times as great as that indicated by the balance throughout its scale. The only difficulty in the use of the gauge is that of fitting the plunger to the cylinder, so that, while it is perfectly free to move, it is also watertight. This difficulty, however, has been overcome, and much advantage was also derived from Mr. Batchelder's suggestion for supplying the wear of the plunger and cylinder by depositing brass on the plunger through the galvanic process."

Connected with this gauge by a pipe is a strong wrought-iron cylinder sixteen inches long by four inches in diameter, in which the thermometer was placed, the opening being firmly closed by a screw plug. This second cylinder was immersed in a tub of water for the purpose
of regulating the temperature. The thermometer once placed in the cylinder is not again re­
moved, the index being read by means of a mirror until the observations are completed.

By the use of this apparatus the effect of pressure up to 4,000 pounds per square inch was
observed upon two thermometers, and the results are given below. The observations were
made to indicate the effects of 500, 1,000, 1,500, 2,000, 2,500 pounds pressure, &c. Seven
series of experiments were made with thermometer No. 5, and five series with No. 10. The
mean results show that a pressure of 1,000 pounds per square inch has no effect upon the ther-
mometer; at 1,500 pounds the effect is less than one degree; and from 1,500 to 4,000 pounds
per square inch the effect is to diminish the readings, the maximum effect being seven degrees.

The diagram (Sketch No. 35) exhibits the law of diminution by increase of pressure, and the
depth corresponding to different pressures. The correction to be applied varies with the depth.
For thermometer No. 5 it is only four-tenths of a degree Fahrenheit at the depth of 600
fathoms. For thermometer No. 10 it is one degree at the same depth. At 1,500 fathoms the
corrections are respectively five and a half and seven degrees.

Nearly all the temperatures observed in the Gulf Stream have been taken at depths less than
600 fathoms.

Table showing differences of readings of Saxton's thermometer, under pressure and free from pressure.

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<tr>
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</thead>
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<td>7</td>
<td>0.5</td>
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<tr>
<td>Means</td>
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</table>

<table>
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<tr>
<td></td>
<td>1,500.</td>
</tr>
<tr>
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<td>5</td>
<td>0.75</td>
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<tr>
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Report of Assistant Henry Mitchell on the physical surveys of New York harbor and the coast of Long Island, with descriptions of apparatus for observing currents, &c.

Boston, September 30, 1859.

Sir: I have the honor to inform you that the field-work comprehended in your plan for the physical survey of New York harbor has been completed by the operations of the past season. At the commencement of this work it was quite impossible to foresee the form it would ultimately assume, the questions to which it would give rise, or the investigations to which it would lead. Neither the precise character of the observations to be made, nor the extent to which they should be carried, could be estimated in an undertaking in many respects quite novel and without precedent.

Certain changes in the forms of shoals and channels had been revealed by the comparison of the early surveys with those of more recent date, and the questions arose—To what causes are these changes due? and—To what end do they progress? What are the natural forces which build in one direction shoals and beaches, while opening elsewhere new channels, or wearing away the shores? These were the problems for the solution of which the physical survey was instituted.

The general plan of this work, to which you first directed my attention, has been adhered to throughout; since your subsequent instructions have referred to the limits of each season’s work, rather than to the character of it. By this plan we have been required to observe, and make note of, every natural operation, whether of tides, currents, winds or waves; in fine, to compile for a certain period a complete physical history of these elements from a systematic course of inquiry.

The field over which our observations have spread includes not only the harbor proper, but its approaches in all directions, extending up the Hudson river to Fort Washington, into Long Island sound as far as Execution light, through the kills, over the bar, and sixty miles out to sea. Throughout this field the periods, velocities, and paths of the various currents are determined, as are also the experiences of the tide waves (both from the sound and the ocean) in the different channels and avenues which they traverse. The disturbing effects of winds and freshets, the appearance of rips and eddies, together with general meteorological phenomena, have all been noted carefully.

The whole number of tidal and current stations which we have occupied exceeds one hundred and fifty, and at these the observations number many thousands. Many of the tidal stations were occupied one or more entire lunations, and at some of the current stations the observations were continued in unbroken series of half-hourly records for seven, nine, and fourteen days. The aggregate amount of time spent on the field-work has not exceeded twelve months.

Rough computations of our observations were made in the intervals between the working seasons, and these acquainted us with the progress we were making, and pointed out the direction which succeeding inquiries should take. From the results of our labors we gained at each step confidence and encouragement. What appeared at first a tangled skein of accidental or inconstant causes, we ultimately recognized as orderly and harmonious relations; and, our
methods of observing improving steadily, the work advanced to its close at a pace constantly accelerated.

The observations of the past season were confined to no special locality, but were made at various points where previous operations were incomplete or required connecting links.

Our field-work commenced the first of June, and the quiet weather which prevailed during this month was improved for the occupation of the more exposed stations—those near shallow portions of the bar and along the outside coast. We had designed to occupy a station which, should, if possible, lie quite beyond the reach of the New York harbor drift, and enable us to determine whether any oceanic current sweeps into the great bay formed by the coasts of Long Island and New Jersey. For this purpose we anchored, in thirty fathoms water, nearly sixty miles east-southeast of Sandy Hook, where, during a period of fifteen hours, we measured the currents at the surface, and at depths of twenty-three and one hundred and fifty feet, besides a few determinations of the mean motion for the entire depth. At this station, nearly forty miles from the nearest land, we found regular tidal currents, nearly as strong as those observed at the light-ship the previous season. No oceanic current could be detected, but the augmentation of the ebb current, caused by the drainage of the land waters, was very appreciable. The velocities of the currents are not so regular at this station, from the fact that the depth of the moving water stratum is variable, at one time extending to the bed of the sea, at another reaching but a short distance below the surface. The directions of the flood and ebb drifts were found to be respectively west-southwest and east by south; which, making due allowance for the disturbing effects of the land waters, would indicate that the tide-wave has here a westerly motion. The land waters of which we have spoken are doubtless the combined drainage from New York harbor and the various inlets; for, extending our observations along the south shore of Long Island, we found that they outlive the tidal currents, and establish themselves as a constant coastwise stream along the eastern portion of Fire Island beach.

The stations outside of the bar were eleven in number, at which above seventeen hundred observations were recorded, and of these more than five hundred were made at points below the surface.

The greater part of our season's work lay in the lower bay or in the vicinity of the bar, where there remained some localities unexamined and others at which previous examinations had given discordant results.

From the computations which followed the field-work of 1858, it appeared that where observations were sufficiently numerous the causes of a certain class of shoals were immediately deducible from the data obtained. It was ascertained, on making a composition of the currents at each station, with the assumption that they are to be regarded as forces acting simultaneously, that the resultants take directions towards the shoals as focal points; making it evident that the sand which forms these shoals is gradually swept together from the neighboring channels. Simple as the dynamics of this natural process may be, its form can only be developed from the most accurate determinations of the elements. The resultant, for instance, may be a very small quantity from a station at which the adverse currents are very violent. In a case like this, the slightest error of observation, or even the selection of an unsuitable period, may give us a false result and lead us entirely astray. If the observations are not sufficiently frequent, they may fail to give the exact durations of certain phases of the currents; or if the positions
of the stations are not closely determined, errors enter into the directions of the forces. Again: if the observations are not continued long enough to eliminate the diurnal inequalities, an undue weight will be given to some of the elements which enter into the problem. At the commencement of the past season, forewarned of these difficulties, I placed in the hands of my observers printed rules for their guidance, and required of each person a strict conformity to them. Twenty-one stations were occupied in the portion of the work to which I have just referred, and at these the aggregate number of observations reaches nearly five thousand, of which above eighteen hundred are from points below the surface. At these stations the observations were usually kept up in unbroken series of twenty-five hours each.

A more suitable period for observations of so exact a character could scarcely have been chosen; our operations were rarely suspended by bad weather, and few delays of any kind occurred.

In making observations upon bars and shoals, the disturbing effects of strong winds cannot be disregarded; for it not unfrequently happens that they change the direction of the current, or wholly reverse its course. In districts of shallow water the waves created by the winds have a motion of translation whose effect upon the log is very great; and although the observer is able to distinguish this sudden and uncertain motion from that of the more steady current, he cannot introduce a correction for it. Where the sea is deep, the impulses it receives from the winds result in simple undulations, giving to the log no horizontal motion whatever, so that, even when the swell is very heavy, accurate current observations are possible. As far as our experience has gone, we have never observed in the waves any power of transportation where the depth of water exceeds three fathoms.

Above the Narrows there were eight stations occupied—three in the main channel of the harbor, two in the Hudson, and three in the East river. At these there were recorded over seventeen hundred observations, of which above eight hundred were made upon the sub-currents.

The stations in the harbor, as well as those in the Hudson river, were designed to furnish us with additional data relative to a class of remarkable counter-currents discovered the previous season. The former observations had established the fact that along the main channel the currents of the lowest water stratum maintain velocities and directions quite at variance with those near the surface. It, however, remained to be proved whether the phenomena observed were continuous from station to station or mere local conditions; and if their continuity could be shown, the exact limits of their domain were to be ascertained. The information now in our hands affords, I am convinced, a full and faithful exhibit of these points.

The three stations in the East river lie in positions which the previous work had shown to be important, as embracing the terminus of the Hell Gate interference current. At one of these stations, which lies in the deep basin westward of the point of Blackwell’s island, some curious conditions of the sub-currents manifested themselves. Here the axis of the ebb (westerly) drift was observed to lie about twenty feet below the surface throughout the entire duration of this current; in other words, the current is stronger at this depth than at any other point above or below. There are resemblances between this phenomenon and those already referred to as appearing in the main channel of the harbor, but I am doubtful whether we can class them together. In the discussion of our results, we propose to group the currents of the upper harbor according to tidal hours obtained from the self-registering gauge at Governor’s
REPORT OF THE SUPERINTENDENT OF

island, and those of the lower harbor and its approaches, according to tidal observations made simultaneously by some of our own party at Sandy Hook.

The closing work upon the physical survey of New York harbor, which we have briefly described, did not occupy us during the entire season, and there proved to be ample time for the other operations directed by your instructions, viz: inquiries into the physical conditions of the bays and inlets along the south shore of Long Island.

Glancing at a chart of our coast, one may see on the south shore of the island of Nantucket a series of small ponds separated from the sea by narrow reaches of sand. On Martha's Vineyard the same features may be observed along the outer shore, except that here the larger basins or lagoons have occasional outlets through the strips of sand beach. Further to the westward, upon the coast of Long Island, appear similar basins, so extensive as almost to form inland seas with outlets of considerable depth, through which vessels may pass. Here are fully established the forms which may be distinguished as the leading characteristics of the Atlantic coast to the southward, and of the entire Gulf shore. From the past history of the sandy portion of our sea-coast, it appears that the outlets to which we have referred are never permanent, but continually shift their positions, either by gradual encroachments and recessions of the sand reaches, or by suddenly closing up at one point and breaking away at another. The design of our study was to ascertain, if possible, the causes which maintain these extended sandy reaches, and the agencies which create the channels through them. In this undertaking, the line of stations, to which reference was made in the former part of this report, extending along the coast, at intervals of from five to twelve miles from Coney island to a point twenty-five miles east of Fire Island light, gave us all the requisite data for a complete knowledge of the shore currents; and we added to these series of current observations at Fire island, Crow Gut, and Rockaway inlets, besides others from stations in the Great South bay. By half-hourly records at gages temporarily erected, the form of the tide wave as it enters Fire Island inlet was compared with that observed at Sandy Hook on the one hand, and that at the eastern extremity of the Great South bay upon the other. At some of the outside stations we threw over sinking articles, hoping to find them again upon some portion of the beach, and thus be able to determine the direction of the movements on the bottom of the sea. The first class of articles we tried were balls made of cement, with corks enclosed, giving them what we supposed to be the requisite specific gravity. On a former occasion these cement balls were used quite successfully along the shores of Sandy Hook, but we now found them to fail entirely on this coast, where the currents are more feeble. We subsequently had recourse to the large skim-mer shell (*maenotra solidissima*) which we collected from the shores, and marked with drills. Some of these, cast over in three fathoms water off Oak Beach, travelled eastward, and crossing Fire Island inlet, were swept on shore four miles to the eastward of their place of deposit. In the performance of this journey they were occupied over two weeks, during a prevalence of easterly winds. Of three hundred shells cast into the sea, one hundred were recovered—a much larger proportion than we could possibly have expected to find among the shifting sands and the miscellaneous stranded articles upon these beaches. The easterly preponderance in the movements of the currents along the bed of the sea, which the journey of these shells revealed, corresponds with the results from previous observations of the surface drifts.

As our inquiries proceeded, it became evident that the currents, powerful though they may be to scour channels and form the ocean bed, cannot alone effect the peculiar changes which are observed to take place in the beaches, but that the waves take a part, not insignificant, in
these operations. In the shallow waters along these alluvial shores the waves, driving in from
the ocean, acquire violent horizontal movements, and dash along the beach with a force in com-
parison with which the strongest currents are quite impotent. In order that we might the
better understand and determine the precise action of the waves and the relation of their office
to that of the current, we made a very careful examination of the conditions in miniature forms
of bays and inlets, where the limited field of observations afforded us a comprehensive view
of the natural activities at work. The results of this examination have already been laid before
you with such conclusions from them as were immediately obvious.

In the course of this and former reports I have referred repeatedly to the observations of
currents at different depths, and it has occurred to me that some description of the apparatus
in use should here be given, in order that the reliability of the results should be established.

**Descriptions of Apparatus.**

For observations upon the surface currents we use a "tube-log," which is simply a tin cylin-
der four inches in diameter and six feet long. This tube is partially filled with water, so as to
sink nearly its whole length and maintain an upright position; and a graduated line being
attached, the observations are made as with an ordinary ship's log. We have found that a log
of less draught than this is liable to be affected by the wind.

When we desire to obtain the mean motion of a stratum of greater depth, we use twenty-
four feet tubes, and in some cases those as long as forty-eight feet.

If the velocity of the current in the lowest water stratum is desired, we take the following
course: Two copper globes of equal dimensions are connected by wire rope of the smallest
possible size compatible with the strength required. One of these globes, being filled with
water, is allowed to sink the whole length of the connecting line, while the other, being empty,
or only partially loaded, swims at the surface of the sea. To the upper globe the log line is
secured. The velocity with which the globes, thus connected, will move, is a mean of the rates
at which the upper and lower water strata are flowing; and if simultaneous observations are
made with this apparatus and the surface log, before described, we are furnished with the
means of obtaining by calculation the velocity of the lowest stratum. This method may be
employed where the water is not so deep as to give to the connecting wire rope an extent of
surface which, exposed to the current, may require consideration in the problem.

The instruments I have described thus far are similar to those which have been used in
determining the discharge of canals in Europe. In the application of these to inquiries on a
larger scale, I have found it necessary to make certain modifications of them to insure accuracy.

It not unfrequently occurs that the velocity of the surface drift is many times greater than
that of the lower stratum, or holds altogether a reverse direction, so that the motion of the
globes is quite at variance with that of the surface log. In a case like this, the graduated line
secured to the globes is borne away by the surface current, and the observer is deceived. The
full extent of this difficulty will be appreciated when it is considered that the line of which I
have spoken is necessarily of considerable size, the strength of six men being sometimes
required to draw in the globes. I propose to obviate this difficulty by the following arrange-
ment: Within the upper globe, made of wood in this case, a reel is placed, upon which a small
log-line, passing in at an aperture at the pole, is wound by a crank from without. The
extremity of this log-line is secured to a third globe, which swims freely upon the surface of
the sea. When making an observation, the log-line is wound up until the floating globes are
brought together; then, at a signal, the reel is loosened; and now, if the surface and sub-
currents differ in velocity, the free globe separates from the others, and the observer notices
the number of divisions of the log-line drawn out in thirty seconds. In this experiment the
apparatus is in nowise connected with the vessel, but the observer follows in a boat until the
trial is completed. Figure 1 (Sketch No. 40) shows the relative position of these globes during
the course of the observations. In this figure A and B are the connected globes, while C is
the free float. The weight of the globe B causes the swimming globe A to sink nearly to its
pole, and the free float C is loaded so as to sink about the same distance. The graduated line,
which measures the separation of the floating globes, may be seen, one end fastened to a ring
upon the free float C, the other passing in at the pole of the globe A. Figure 2 is an enlarged
representation of the globe A, opened so as to show the reel within. The water, which enters
the globe freely, acts as a check, preventing this reel from acquiring an undue momentum with
any sudden jerk of the line caused by the waves. In this figure may be seen the position of
the crank by which the reel is wound; this crank is, of course, removed after the floating
globes are drawn together. Upon the outside of the globe containing the reel every ten
degrees are marked that the observer may note in his record the amount submerged. In the
reduction of these observations the extent of the wetted surfaces of the two connected globes
must be considered, since, in the case of a difference of velocity between the upper and lower
strata, the effective areas of the surfaces exposed to the two streams enter into the problem.
In all positions the effective surface which a globe wholly immersed presents to the current is
a great circle. The velocity attained by the connected globes is a simple mean of the velocities
of the superficial and lower strata when the effective surfaces are equal; and when these
surfaces are unequal, the mean by weight. If \( x \) = velocity at surface, \( y \) = velocity at lowest
point; then with equal surfaces we obtain velocity of globes = \( \frac{1}{2} (x + y) \). If the effective
surfaces opposed to the drifts (portions of great circles) are unequal, and their areas be repre-
sented by \( a \) and \( b \), we have the velocity of globes = \( \frac{1}{a + b} (ax + by) \). This expression rep-
resents the immediate result obtained by the original manner of using the globes if the vessel
be at anchor; but, in our modification, the result of our experiment is the difference between
the motion of the free and that of the connected globes, or \( x - \frac{1}{a + b} (ax + by) \). The extent
of the wetted surface of the free globe will not affect the result, but it is convenient to have
this globe of the same size as the others so as not to be greatly affected by winds.

If the paths of the surface and sub-currents do not lie in the same vertical plane, the con-
nected globes take an intermediate course, with velocity = \( \frac{1}{a + b} \sqrt{\{(a x \sin \beta_1 + by \sin \beta_2)^2
+ (a x \cos \beta_1 + by \cos \beta_2)^2\}} \), and \( \tan \theta \) (angle of direction) = \( \frac{a x \sin \beta_1 + by \sin \beta_2}{a x \cos \beta_1 + by \cos \beta_2} \) when \( \beta_1 
and \beta_2 \) represent the respective angles of direction of the upper and lower drifts.

When observations are to be made at sea, where there is a great depth of water, a further
modification of the apparatus is necessary. In place of the two connected globes in the fore-
going description, a hempen line is used, (perhaps two inches in diameter,) terminating in a
wooden pole above and a leaden cylinder below, the former serving to float the shaft, while the
latter sinks and straightens the line, and the reel is transferred to the free globe. (See Fig. 3,
Sketch No. 40.) The apparatus, thus modified, will serve to exhibit the difference between the
surface drift and the mean velocity of a stratum of water whose depth equals the length of the shaft immersed. If we know the surface velocity we may readily obtain the velocity of the lowest point reached, if we suppose the change of velocity from point to point to be uniform, by subtracting the surface rate from twice the mean velocity. This supposition is not always correct, and must be tested by the following experiment: The log-line having been unfastened, the pole is passed through a copper globe, and the line drawn up until the globe can be secured at a point which will occupy a middle position of the wetted surface on again letting the shaft sink as far as it may.—(See Fig. 4, Sketch No. 40.) Upon a new trial, if the velocity observed is still the same, we may conclude that our supposition is correct; if not, we may, by shifting the position of the globe again and again, making at each remove an observation and record, or by using simultaneously several such shafts, calculate approximately the conditions of the sub-currents and the curve at which our deep shaft hangs. The globes which we have used measure two feet in diameter.

Before closing this rapid sketch of our devices for obtaining the data required by your instructions, I would refer briefly to a new form given to a pile used in securing a tide-gauge at Fire island, and which, I think, possesses some peculiar advantages for use upon sandy coasts where there is a heavy sea. This pile is of oak, or other heavy and strong wood, and is so cut that the lower portion of it, for a space of six or eight feet, presents the appearance of a number of inverted frustrums of cones, placed one above another—the series terminating in a sharp and heavy shoeing. As a whole, it is required to have a greater weight than the sand and water it is intended to displace. On working this pile into the sand, by swaying it to and fro, in the usual manner, each cone, as it sinks, acts upon the sand above and below, as at once a lever and a wedge, giving to the whole a continual downward thrust. In the same way the waves, instead of tearing it up, cause it to work deeper and deeper, and thus the lateral oscillation of the sea is converted into vertical motion, and brought to our aid. Of course this downward tendency of the pile can be easily checked if too great for our purposes. As my description of this pile is not altogether clear, I annex a diagram, (Sketch No. 40,) which will require no explanation.

Very respectfully, yours,

HENRY MITCHELL,
Assistant Coast Survey.

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APPENDIX No. 27.

Report to the Superintendent by Assistant L. F. Pourtales, in charge of the field and office work relating to tidal observations.

COAST SURVEY OFFICE, October 1, 1859.

Sir: I have the honor to submit the following 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 which the tides are observed for a long period of years are the same as mentioned in former reports, viz: Boston, New York, Old Point Comfort, Va., Charleston, S. C., and Fort Clinch, Fla., on the Atlantic coast; and San Diego, San
Francisco, and Astoria, on the Pacific coast. The following table will show the date at which the series of observations began at each of those stations, and the number of years over which it consequently extends up to this date.

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<td>Staff</td>
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<td>12 4</td>
</tr>
<tr>
<td>New York</td>
<td>S. R.</td>
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<td>6 10</td>
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<tr>
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<td>S. R.</td>
<td>September 1, 1862</td>
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<tr>
<td>Charleston, (Castle Pinckney)</td>
<td>Box</td>
<td>December 20, 1850, to April 22, 1855</td>
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</tr>
<tr>
<td>C. P.</td>
<td>S. R.</td>
<td>July 16, 1855, to December 10, 1855</td>
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<tr>
<td>Charleston, (custom-house wharf)</td>
<td>S. R.</td>
<td>February 1, 1856</td>
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<td>Fort Clinch</td>
<td>S. R.</td>
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<td>3 7</td>
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<tr>
<td>San Diego</td>
<td>S. R.</td>
<td>July 6, 1853, to September 20, 1853</td>
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<tr>
<td>San Diego</td>
<td>S. R.</td>
<td>September 22, 1853</td>
<td>6 4</td>
</tr>
<tr>
<td>San Francisco</td>
<td>S. R.</td>
<td>June 16, 1853</td>
<td>6 3</td>
</tr>
<tr>
<td>Astoria</td>
<td>S. R.</td>
<td>July 11, 1853</td>
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</table>

The stations have, during the past year, given generally good results. The station at Fort Clinch has, however, suffered an interruption by the sickness and subsequent sudden leaving of the observer, and the inexperience of the person he had left in charge. The stations on the Western Coast, under the supervision of Lieut. G. H. Elliot, U. S. Engineers, have continued to give very satisfactory results.

The temporary stations were not numerous. The tide-gauge at the Washington navy yard is still kept up. Owing to the frequent changes of the officers in the ordnance department of the yard, it was found more advantageous to have the gauge attended to by Mr. Walker, of this division of the office.

The stations mentioned in last year's report as having been established by Mr. Würdemann at Charlotte harbor, Egmont key, and Cedar keys, have, together with the one at Tortugas, afforded very satisfactory results. The series being extended over more than a year, the gauges will shortly be transferred to new stations at and to the westward of St. Mark's. Mr. Würdemann has suffered greatly from sickness superinduced by exposure, and was obliged to leave that section at the approach of warm weather, without detriment, however, to the observations, thanks to the careful training he had given to the observers. On his way north, Mr. Würdemann visited the tide-gauges at Fort Clinch, Charleston, and Old Point Comfort.

The self-registering tide-gauge established at Warrenton navy yard, Pensacola, Fla., by the kindness of S. T. Abert, esq., civil engineer of the yard, gives very good results, and will supply a useful link in the chain of stations which it is intended to establish successively along our shores on the Gulf of Mexico.

Good self-registering observations were obtained at Benicia, Cal., under the direction of the hydrographic party of Commander J. Alden, U. S. N., Assistant Coast Survey.

A list of the observations received during the year is herewith presented. It contains, as usual, only those which were made under the direction of this division of the office, and not those made by hydrographic parties for the reduction of their soundings.
List of tidal observations received during the year ending September 30, 1859.

<table>
<thead>
<tr>
<th>Section</th>
<th>Name of station</th>
<th>Name of observer</th>
<th>Kind of gauge</th>
<th>Stations, permanent or temporary</th>
<th>Time of occupation, from</th>
<th>To</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Governor's Island, N. Y.</td>
<td>R. T. Ramell</td>
<td>Staff</td>
<td>Permanent</td>
<td>Oct. 1, 1858</td>
<td>Dec. 30, 1856</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Do</td>
<td>S. K.</td>
<td>do</td>
<td>Permanent</td>
<td>April 7, 1859</td>
<td>Sept. 30, 1859</td>
<td>177</td>
</tr>
<tr>
<td></td>
<td>Brooklyn, N. Y.</td>
<td></td>
<td>do</td>
<td>Box</td>
<td>Oct. 1, 1858</td>
<td>Sept. 30, 1859</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Dobbs Ferry, N. Y.</td>
<td>W. H. Roberts</td>
<td>Staff</td>
<td>Temporary</td>
<td>July 23, 1858</td>
<td>July 31, 1858</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Virginia Point, N. Y.</td>
<td>J. G. Rethe</td>
<td>do</td>
<td>Temporary</td>
<td>July 23, 1858</td>
<td>Aug. 3, 1858</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Do</td>
<td></td>
<td>do</td>
<td>do</td>
<td>Sept. 10, 1858</td>
<td>Sept. 14, 1858</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Old Spring, N. Y.</td>
<td></td>
<td>do</td>
<td>do</td>
<td>Sept. 11, 1858</td>
<td>Sept. 14, 1858</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Poughkeepsie, N. Y.</td>
<td></td>
<td>do</td>
<td>do</td>
<td>July 22, 1858</td>
<td>Aug. 1, 1858</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Tivoli, N. Y.</td>
<td></td>
<td>do</td>
<td>do</td>
<td>July 22, 1858</td>
<td>Aug. 1, 1858</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Babuneech, N. Y.</td>
<td>D. R. Jenks</td>
<td>do</td>
<td>do</td>
<td>July 29, 1858</td>
<td>July 31, 1858</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Camelton, N. Y.</td>
<td></td>
<td>do</td>
<td>do</td>
<td>July 25, 1858</td>
<td>Aug. 2, 1858</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Broadway, N. Y.</td>
<td></td>
<td>do</td>
<td>do</td>
<td>July 25, 1858</td>
<td>July 31, 1858</td>
<td>10</td>
</tr>
<tr>
<td>VI</td>
<td>Port Clinton, Fla.</td>
<td>P. A. Johnson</td>
<td>S. E.</td>
<td>Permanent</td>
<td>Oct. 1, 1858</td>
<td>Dec. 14, 1858</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Do</td>
<td>J. A. Walker</td>
<td>do</td>
<td>do</td>
<td>Dec. 14, 1858</td>
<td>Sept. 30, 1859</td>
<td>361</td>
</tr>
<tr>
<td></td>
<td>Tortugas, Fla.</td>
<td>H. Benzon</td>
<td>do</td>
<td>do</td>
<td>Aug. 1, 1858</td>
<td>Sept. 13, 1858</td>
<td>295</td>
</tr>
<tr>
<td></td>
<td>Charleston Harbor, Fla.</td>
<td>G. F. Matthews</td>
<td>do</td>
<td>Temporary</td>
<td>Aug. 3, 1858</td>
<td>Aug. 3, 1859</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Egmont Key, Fla.</td>
<td>C. Keyes</td>
<td>do</td>
<td>do</td>
<td>Aug. 23, 1858</td>
<td>Aug. 31, 1859</td>
<td>375</td>
</tr>
<tr>
<td></td>
<td>Cedar Keys, Fla.</td>
<td>A. Steele</td>
<td>do</td>
<td>do</td>
<td>Aug. 11, 1858</td>
<td>Sept. 13, 1859</td>
<td>265</td>
</tr>
<tr>
<td></td>
<td>Do</td>
<td>G. Crockett</td>
<td>Staff</td>
<td>do</td>
<td>Dec. 31, 1858</td>
<td>Jan. 6, 1859</td>
<td>11</td>
</tr>
<tr>
<td>X</td>
<td>San Diego, Cal.</td>
<td>A. Cassidy</td>
<td>do</td>
<td>Permanent</td>
<td>Aug. 1, 1858</td>
<td>July 31, 1858</td>
<td>365</td>
</tr>
<tr>
<td></td>
<td>Port Point, Cal.</td>
<td>H. E. Unlandt</td>
<td>do</td>
<td>do</td>
<td>Aug. 1, 1858</td>
<td>July 31, 1858</td>
<td>365</td>
</tr>
<tr>
<td></td>
<td>Benicia, Cal.</td>
<td>Louis Nelson</td>
<td>do</td>
<td>Temporary</td>
<td>June 23, 1858</td>
<td>Oct. 21, 1858</td>
<td>88</td>
</tr>
<tr>
<td>XI</td>
<td>Astoria, Oregon</td>
<td>Louis Wilson</td>
<td>do</td>
<td>Permanent</td>
<td>Aug. 1, 1858</td>
<td>July 31, 1859</td>
<td>365</td>
</tr>
</tbody>
</table>

Office-work.—The following persons have been permanently employed during the year: R. S. Avery, S. Walker, J. Downes, M. Thomas, and S. D. Pendleton; and the following temporarily for longer or shorter periods during the intervals of their duties in the field or in other departments of the office: Lieut. J. P. Roy, U. S. A.; Sub-Assistant C. Fendall; James Gilliss, R. E. Evans, O. Hinrichs, J. Donegan, A. W. King, and T. C. Bowie.

Mr. Avery has continued the discussion of the Boston tidal observations. Having computed a set of co-efficients from a period of observations extending over nine years, he has compared the times of high water computed by means of them with the observed times for the whole period of twelve years over which the series extend. The differences between the computed and observed times came out generally quite small.

The readings of the sheets of the self-registering tide-gauges were made by Mr. Walker, who has also had charge of the correspondence with the observers, of the examination of the observations returned by them, and of the tide-gauge at the Washington navy yard. This combination of duties has been very useful, as by reading the sheets no defects in them could escape him, and the remedy could be pointed out more intelligibly from the experience gained in managing a tide-gauge himself.

The ordinary reductions of tidal observations were made chiefly by S. D. Pendleton, and part of the year by contract, by A. W. King; also, occasionally, by Lieut. J. P. Roy, and J.
Gilliss, R. E. Evans, O. Hinrichs, and T. C. Bowie. They thus keep but little behind the receipt of the observations. The whole sets of reductions of the permanent stations on the Western Coast were revised by Mr. Walker.

The graphical decompositions of the tides observed simultaneously at the four stations Cape Florida, Indian key, Key West, and Tortugas, have continued to be made and the results to be reduced and compared by Mr. Downes, with the assistance for part of the time of Messrs. Fendall and Evans. This discussion is now nearly completed, and some progress has also been made in the decomposition of the observations at the next stations—Tortugas, Charlotte harbor, Egmont key, and Cedar keys. The daily inequality was deduced from a part of the ordinary reductions of the above stations by Mr. Gilliss.

The meteorological observations made at the tidal stations of the Western Coast have continued to be tabulated by M. Thomas, who has also read off some of the self-registering sheets from Florida, and plotted the result preparatory to decomposition, besides copying and miscellaneous work.

Very respectfully, your obedient servant,

L. F. POURTALES,
Assistant U. S. Coast Survey, in charge of Tidal Division.

Prof. A. D. BACHE, LL.D.,
Superintendent U. S. Coast Survey.

APPENDIX No. 28.
Circulars found in current bottles thrown from the surveying steamer Corwin in 1857 and 1859, in the vicinity of the Florida reef.

U. S. COAST SURVEY.

TO SHOW THE SET OF CURRENT.

This bottle was thrown overboard in the Gulf Stream.

Lat. 24° 21' 00" N. Date: Midnight, March 28, 1857.
Long. 81° 56' 00" W. Wind west.

From surveying steamer Corwin.

Lieut. Comd'g T. AUG. CRAVEN, U. S. N.

The finder will confer a favor by forwarding this paper to A. D. Bache, Superintendent U. S. Coast Survey, Washington, D. C.

Record below the date and place where found.

Found on the beach about twenty miles south of Cape Cañaveral light-house on the 1st of May, 1859.

MILLS O. BURNHAM,
Light-keeper, Cape Cañaveral, Fla.
Particulars of six other cards of the same form from surveying steamer Corwin.

<table>
<thead>
<tr>
<th>When thrown over</th>
<th>Latitude N</th>
<th>Longitude W</th>
<th>Direction of wind</th>
<th>By whom returned</th>
<th>Endorsements made by the finder</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2, 1859</td>
<td>25 00 57</td>
<td>79 44 15</td>
<td>North; light</td>
<td>Mills O. Burnham</td>
<td>Found June 9, 1859, about five miles south of Cape Calhoun lighthouse.</td>
</tr>
<tr>
<td>Do.</td>
<td>25 00 57</td>
<td>79 44 15</td>
<td>North; moderate</td>
<td></td>
<td>Found June 10, 1859, about four miles south of Cape Calhoun lighthouse.</td>
</tr>
<tr>
<td>April 30, 1859</td>
<td>23 31 30.6</td>
<td>89 45 13.05</td>
<td>From W.SW.; light</td>
<td>P. Antonio Ebers</td>
<td>Found May 7, 1859, at Cruz del Padre, twenty-one miles N.E. of Cardenas, north coast of Cuba.</td>
</tr>
<tr>
<td>Do.</td>
<td>24 23 07</td>
<td>80 53 08</td>
<td>From south; light</td>
<td>W. S. Harris</td>
<td>Found June 2, 1859, twenty and a half miles south of Cape Calhoun lighthouse.</td>
</tr>
<tr>
<td>May 2, 1859</td>
<td>25 01 11</td>
<td>79 45 13</td>
<td></td>
<td></td>
<td>Found June 9, 1859, twenty miles south of Cape Calhoun lighthouse.</td>
</tr>
<tr>
<td>Do.</td>
<td>25 01 11</td>
<td>79 45 13</td>
<td>Northwest</td>
<td></td>
<td>Found June 10, 1859, about five miles south of Cape Calhoun lighthouse.</td>
</tr>
</tbody>
</table>

APPENDIX No. 29.

Extracts from a report by Lieut. Comg. C. M. Fauntleroy, U. S. N., Assistant in the Coast Survey, relative to commercial advantages afforded by the upper waters of Port Royal sound, S. C.

UNITED STATES SURVEYING SCHOONER VARINA,

Colleton river, S. C., May 21, 1859.

Sir: * * * The hydrographic work was commenced at Pinckney's island, connecting with the survey of Lieut. Comg. Maffitt, in 1855. That survey shows that the bar of the Chechessee river affords twenty feet at mean low water, with a mean rise and fall of 6.6 feet. The depth increases in passing upward, and vessels that enter Port Royal sound will find in the Colleton river at the Neck, and at its confluence with the Chechessee, a capacious, completely protected, and easily accessible anchorage, in from four to seven fathoms water.

* * * * * * * * * Colleton Neck, Foot Point, or Victoria Bluff, as it has been more recently called, is only eleven miles from the Charleston and Savannah railroad, and, by reason of the fact before stated, offers a very eligible site for purposes of trade and commerce. In the event of blockade of the southern coast by a naval power this point could be easily made a sure protection to the inland commerce passing between Charleston and Savannah.

The bluff is considerably higher than the adjacent island, and is said to be healthy. The approach from Broad river is used by steamers continually, and might be improved so as to enable vessels of fifteen feet draught to pass. At present I think it safe to say that but ten or twelve feet at mean low water can be carried through. So soon as I can obtain the requisite tidal observations the soundings will be reduced and a chart sent to the office.

Very respectfully, your obedient servant,

CHAS. M. FAUNTLEROY,


Professor A. D. BACHE,

Superintendent Coast Survey.
APPENDIX No. 30.

Letter to the Secretary of the Treasury, reporting the completion of the survey of Sapelo sound, Ga., and communicating extracts from a report by Lieut. Comg. C. M. Fauntleroy, U. S. N., Assistant Coast Survey, relative to its commercial facilities as a harbor.

Coast Survey Office, May 24, 1859.

Sir: I have the honor to report the completion of the field-work and hydrography requisite for a chart of Sapelo sound and river, including the bar and approaches, from a limit ten miles seaward of the entrance. The soundings in the vicinity of the bar were made by the party of Lieut. Comg. C. M. Fauntleroy, U. S. N., assistant Coast Survey, who closed the operations there at the end of April.

I append some remarks made in the report of that officer, bearing on the commercial advantages of Sapelo sound as a harbor, and suggestions in reference to buoys and beacons for aiding vessels to enter it:

"This harbor derives its importance commercially from its ease of access and from the good depth of water in its main approach. Sixteen feet at mean low water may be carried throughout to safe anchorage inside of the entrance. As a cut-off connecting with it affords a convenient and safe inland passage for traders bound south coastwise during the winter season, this entrance is preferred to the more difficult entrance at Doboy. While the soundings were in progress in March and April, more than fifty schooners and steamers (chiefly the former class) passed into Sapelo sound and through Mud river.

"At present the channel over the bar is marked by two buoys. The inner one (‘No 3’) should be at once removed and replaced at the extreme northeast point of the shoal designated as ‘Consort shoal.’

"There is both a swash and a beach channel here, and vessels drawing from five to eight feet of water may enter the harbor against northwester—a facility uncommon on our Atlantic seaboard.

"Upon a rough comparison (before plotting the soundings) with the survey made by Lieutenant Glynn, U. S. N., in 1841, there appears to have been little or no change since, either as to depth or in the direction of the main channel-way.

"Masters of vessels, if not well acquainted, avail themselves of daylight for entering at Sapelo. It would be of important service to the coasting trade if two small beacon lights were established, instead of the two beacons now on the point of St. Catharine's island, as such an arrangement would prevent confusion with the Doboy light. The schooner ‘Blooming Youth,’ lost off Sapelo entrance in March, could have made the harbor in safety with such guides as those now proposed."

Regarding the aids for navigation recommended by Lieut. Comg. Fauntleroy as of general interest to masters of vessels engaged in the coasting trade, I would respectfully request that a copy of this communication may be transmitted to the Light-house Board.

Very respectfully, yours,

Hon. Howell Cobb,
Secretary of the Treasury.

A. D. BACHE, Superintendent.
APPENDIX No. 31.

Extracts from reports made by Sub-Assistants F. W. Dorr and Charles Ferguson, describing the topographical and other features of Charlotte harbor, Florida.

BOSTON, March 29, 1859.

SIR: * * * The work of the season was resumed on the western half of Sanibel island at a point where its breadth is about two miles and a quarter. From thence the island runs in a W.NW. direction five miles and a half, and gradually narrows as it approaches Blind Pass. The inside shore is very irregular and broken by large lagoons, which connect with each other by narrow tortuous channels. On the outside a fine sloping beach, composed of sand and shells, is washed by the waters of the Gulf of Mexico. The interior of the island is open prairie, bearing only scattered clumps of palmettoes. Mangrove, buttonwood, &c., are found fringing the shores of the lagoons, and this growth occasionally attains a breadth of a quarter of a mile.

The entrance to Blind Pass, as the channel which separates Sanibel from Captiva island is called, is almost entirely blocked up from the inside by extensive shoals, which are dry, or nearly so, at ordinary low water. On the southern side of these shoals are eight small keys, called the Lawrence keys. They are scarcely anything more than clumps of mangrove. Blind Pass is merely a boat channel; for although the passage is deep in some places, the bars both on the inside and outside preclude the possibility of carrying through a vessel of any draught of water.

Captiva island overlaps Sanibel island at Blind Pass for a distance of a mile and a half, and from that opening stretches in a N.NW. direction upwards of ten miles to Captiva Pass. This island, or key proper, scarcely averages a quarter of a mile in width. I say the key proper, as two other keys of some size, completely separated from it, have hitherto been supposed to join it; all three being comprised under the name of Captiva island.

Captiva, like Sanibel island, has a regularly curving beach of sand and shells on the outside, while the inside shore is skirted with mangrove, and is very ragged. Extensive flats, too, make off eastward from most of the prominent points of land on the inside.

Captiva Pass, the opening between Captiva and La Costa islands, is about five hundred yards wide. Vessels drawing not more than five feet of water can pass through; yet the channel is somewhat intricate. * * * * * * * * *

Yours, very respectfully,

F. W. DORR, Sub-Assistant.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

WASHINGTON, D. C., April 8, 1859.

DEAR SIR: * * * * Boca Grande, the pass between La Costa and Gasparilla islands, is the proper entrance to Charlotte harbor. It contains at low tide fifteen feet of water, and inside the bay has three or four fathoms. Vessels can carry eighteen feet some fifteen or twenty miles beyond the northern extremity of Pine island.
La Costa island is similar in character to Captiva island, as described in the report of Sub-Assistant Dorr.

Pine island forms the eastern side of Charlotte harbor, or what may be more correctly termed the Charlotte harbor approach. It is about ten miles in length and three in width. A pine barren runs through the centre nearly its entire length, and its western shore is lined with a belt of keys and islands. Lagoons break the western side and run in towards the interior of Pine island.

This island is remarkable as having been a favorite burial place of the aborigines. There are several huge mounds on the keys along the shore. The largest are at "Brown's" station, a small fishing ranch on Pine island, (nearly opposite the middle of La Costa,) where some are found sixty and eighty feet high and four hundred yards in circumference. Here also may be seen the remains of a canal which has passed at a former period quite across the island. Its site is now so overgrown with mangrove, pine, and palmetto that the trace is barely discernible.

Very respectfully yours,

CHARLES FERGUSON,
Sub-Assistant.

Superintendent U. S. Coast Survey.

APPENDIX No. 32.

Extracts from the report of Assistant S. A. Gilbert, descriptive of the coast of Texas intervening between Matagorda bay and Corpus Christi.

ZANESVILLE, O., August 23, 1859.

Espiritu Santo bay is about fifteen miles long, northeast and southwest, by about five miles in width. It communicates with the Gulf of Mexico through two small bayous at the northeast end, and connects also with Matagorda bay at Pass Cavallo. Through one of the bayous (McHenry's) the State authorities of Texas have caused a channel to be opened affording a depth of four and a half feet at average high water, and the digging of a channel of ten feet from the bayou into Pass Cavallo, to form a harbor or dock for steamers and other sea-going vessels, has been undertaken by private enterprise. The town of Saluria is situated at the east end of this bayou. Throughout the bay there is an average depth of seven feet, the bottom being generally soft mud and shells, except in one locality, known as the "Middle Ground," which is sand, and a portion of which is usually bare at low water. The shores are low and marshy on all sides. Along the northwest shore is a range of marsh islands, approaching towards the cluster designated as the "First chain," which divides Espiritu Santo from San Antonio bay. Through these also the State has opened a channel to the depth of four and a half feet, but flats are forming rapidly at both ends, and constant attention will be required to keep it open.

San Antonio bay is of an irregular and somewhat triangular shape, the greatest length being from north to south, about twenty miles, and the width ranging from four to eighteen miles.
It has no direct communication with the Gulf of Mexico, and is, therefore, but little affected by the Gulf tides. Frequently the water is made fresh by the discharge from the Guadalupe river, which enters at its northeast end, and it is almost always muddy. The average depth of the south half of the bay is about six and a half feet, with soft mud bottom, except in the vicinity of the oyster shell reefs, of which there are many. One of them, "Panther Point reef," extending through the middle of the bay, north and south, about fifteen miles, is awash in some places and in others has five feet of water over it. In approaching the mouths of the river, the water of the bay shallows, and the bottom becomes very soft, and is covered with eel-grass and other sea-weeds. The State, in the spring of 1858, opened a channel of four and a half feet from the southern mouth of the Guadalupe to a like depth in the bay, which was found at the distance of a mile, but it is now much obstructed by drift logs. Without the use of artificial means, the average depth of water into either mouth of the river would not be more than eighteen inches.

The shores of San Antonio bay are varied in character. Along its south and east sides are the low marshy shores of the islands, (Matagorda island and others,) which are the resort of immense numbers of water fowl. Thousands of swans, geese, brant, and ducks of several varieties, cover the waters and prairie of this region during January, February, and March; and in all seasons the pelican, cranes of perhaps every variety, the snipe, and other shore birds, are found in countless numbers. Oysters are plenty, and also redfish and trout, when the water is not too fresh.

Near the north end, on the east side of the bay, the prairie of Matagorda island comes to the shore in a bluff twenty feet high, along which (for several miles) are scattered clusters of oak and hackberry trees. This locality, known as "Long Motts," contains fifteen or twenty houses.

The northwest shore is the delta of the Guadalupe, a low alluvial formation, scarcely raised above the level of the adjacent waters, and covered with a dense growth of cane-grass, jungle, and forest trees. On the west shore the elevated prairie also comes to the bay in a bluff or bank of twenty feet, and is likewise dotted over with the houses of settlers, and with oak and hackberry trees. The soil is fertile, the range for stock excellent, and the locality is said to be very healthy. At one place on this side a singular range of sand hills, known as the "Sand Mounds," approaches the shore. The highest peak is about seventy-five feet above the bay. The mounds are covered with bushes, and the valleys between them filled with trees, so that, at a distance of five or six miles, the whole presents the appearance of a forest of live-oak or similar timber, forming a marked feature in that otherwise level prairie region. Deer, wolves, and wild turkeys are plenty, and rattlesnakes and other reptiles numerous. In the direction towards Lamar, a distance of about thirty miles, there is now but one dwelling, and hence the wild game has not been much disturbed.

Mission bay is a small, shallow sheet of water cut off from the head of San Antonio bay, on the east side, by the delta of the Guadalupe river, and having not over eighteen inches of water into or through it. A small bayou, entering on its east side, drains Green lake, which is a small sheet of fresh water lying some miles further up the delta.

Hines bay, on the west side of the delta, is of the same character, but is larger, being about three and a half miles in diameter and shaped like a horse-shoe. It is also deeper than Mission bay, affording about three feet of water to its head. On the north side is the swamp of the
delta, but on the south a prairie bluff twenty feet high bounds the shore, and here, within space of three miles, some twenty or thirty houses form what is called "Crescent Village."

San Antonio bay is divided from Mezquit bay by a chain of islands known as the "Second chain," and by an oyster shell reef, designated as "Ayre's reef," through which a four-feet channel has been opened by the State. The small islands composing the Second chain are mostly covered with lignum vitae and mezquit bushes, from six to eight feet high, and in these the smaller varieties of crane have their building place. The bushes are covered with nests, and thronged with cranes all spring and summer, there being no similar resort for a hundred miles either way along the coast.

Mezquit bay is about five miles long, northwest and southeast, and about three miles wide, with an average depth of four feet throughout, and soft muddy bottom. It has direct communication with the Gulf of Mexico through Cedar bayou, into the north end of which there is but one foot of water, through the bayou about ten feet, and at the Gulf outlet, or south end, about four and a half feet. Its length is three miles, and average width about a hundred and sixty yards. The oysters of this bay are noted as being the best on the coast. Fish are abundant, and to be had at all seasons of the year.

The shores of Mezquit bay are marshy, except on the northwest side, near which lie two islands, with oyster shell ridges, ranging from five to fifteen feet in height, and covered with chaparral. It is separated from Aransas bay by the cluster of islands called the "Third chain" and by two oyster shell reefs. Through these the State has opened a channel of four feet.

Aransas bay is about twenty miles long from N.N.E. to S.S.W., and of an average width of about six miles. About five miles from the north end lies an oyster shell reef, called "Long reef," which extends across the bay, from St. Joseph's island to Lamar. This is bare in several places, forming islands much subject to change in outline and extent by the action of the waves during the prevalence of the summer winds. There are several channels through the reef, two of which are nearly a quarter of a mile wide, with six feet water; and that is about the average depth of the bay north of the reef. South of Long reef the bay is open and free from obstructions, with an average depth of ten to twelve feet, and soft, muddy bottom, excepting near the shell reefs and shores. The beach is composed of hard sand, and the bottom, out to a depth of five feet, is of the same character, except in a locality about eight miles from Lamar, where it is rocky, a remarkable bed of natural concrete being developed there. At the bluff the formation is six feet in thickness above the surface of the water, and appears to extend about ten feet below it. I have no knowledge of any similar formation along the coast, except in the high prairie back of Copano bay, near the mouth of the Aransas river, the bed there being entirely above the level of the bay; and in Laguna Madre, about thirty miles southward of Corpus Christi bay, in which instance the formation is said to be wholly below the water level. The rock in question has been used in building walls and chimneys at St. Mary's. While in place it is soft and easily cut, but after exposure to the atmosphere it becomes as hard as ordinary limestone. The color is a dirty white, and the fracture irregular. From the point at which the rock occurs a sand-flat ranges northward along the northwest shore of the bay, covered to a depth of five or six feet with "turtle grass." Large numbers of green turtle are caught here, and shipped to New Orleans during the spring and summer. There are occasional beds of oysters throughout the bay, and an abundance of fish of all the varieties that inhabit the Gulf.
Aransas bay connects with the Gulf of Mexico through Aransas Pass, which is said to be subject to changes in depth at the bar and in the channel. During last winter and spring there was an average of more than eight and a half feet over the bar at low water, as we were informed by the pilot. At the close of the working season in June arrangements were in progress for running a line of steamers from the bay to New Orleans or Mobile. The communication with Corpus Christi bay is through a narrow and crooked channel between islands and mud flats for about five miles, called Corpus Christi bayou. Its natural depth is about four feet, but a channel to admit vessels drawing six feet has been opened by a private company.

The entrance to Copano bay, between Live Oak Point and Lamar, is over a mile in width. Lap reef, much of which is bare, lies at the west side of the entrance, but there is a channel nine feet deep leading through it into Copano bay. This entrance forms what is known as "Lamar harbor," a space of about six miles in area, over much of which there is a depth of twelve feet water, with soft bottom. The harbor is sheltered either by reefs that are nearly or quite bare, or by land, on all sides.

The shores of Aransas bay are low on the south and east. On the north a chain of small islands divides it from St. Charles bay; and on the northwest side stretches Live Oak peninsula, with its high sand bluffs and hills, some of which are fifty or sixty feet high, and covered with a scattered growth of live-oak and other trees, and an undergrowth of many kinds of bushes and vines. The Mustang grape, a native of the soil, and from which is made a very fine flavored wine, grows here in abundance. Fresh water is plenty, but the range for cattle on the peninsula is not good. There are at present but four families living on it, within an area of fifty square miles.

The town of Lamar lies between the outlets of St. Charles and Copano bays. St. Charles bay is about nine miles long north and south, by about a mile in average width. A narrow, crooked channel affords about two and a half feet of water into it, but after the main part of the bay is reached the depth increases to four, and in some places as much as eight feet. Cavasso creek, coming in about six miles up, on the west side, and Salt creek, at the head of the bay, are merely drains for the rain water which falls on the adjacent prairie. In the dry season their beds are filled with salt water from the bay. The shores of the bay are mostly marshy, but at many points the marsh is interrupted by prairie bluff of eight feet or more in height. Along the east side stands a body of wood known as "The Black Jacks." The soil there is sandy, and the general surface marked by numerous hills, as at the Sand Mounds, at Lamar, and on Live Oak peninsula, and by fresh water springs and ponds. In all other localities within my knowledge along the coast of Texas there is no fresh water below the surface except immediately along the Gulf shore, on sandy islands. In many other places I have dug, but always found the water salt, as in the Gulf.

Copano bay is about fifteen miles long from northeast to southwest, and about seven miles wide. It is divided nearly across the middle by an oyster shell reef called "Copano reef," around the south end of which passes a channel of nine feet at an average stage of water, and that depth may be carried to the head of the bay during the ordinary summer tides. There are other obstructions to navigation throughout the bay to be developed in the progress of the hydrographic work. Copano creek empties into the northeast end of the bay; Mission river through Refugio Mission bay, on the northwest side; and Aransas river at the western angle of the bay. All these are inconsiderable streams, there being no more than one foot of water leading into them from the bay. The shores are mostly high, and along the north and west
shores, except near Mission or Refugio bay, the prairie fronts the water-line as a bluff, rising from fifteen to thirty feet high. That portion between the Aransas and Mission rivers is wooded; the rest is prairie, with occasional spots of timber in view. The southeast shore of Copano bay is formed by Live Oak peninsula, and is marshy along the water-line, but a short distance back rises the high sand ridges and prairie that characterize these localities. The two towns, Copano and St. Mary's, the former one of the earliest settlements made in this part of Texas, lie on the northwest side of the bay, and are still but small villages.

The land seems to be valued only for grazing, although sea-island cotton and corn have been successfully cultivated in small tracts.

Puerto bay is a small arm extending from the southwest corner of Copano bay, about five miles in a southwest direction. The entrance to it is shallow, and the depth inside is only four or five feet. The shores are generally low and marshy. A small creek, which is merely a surface drain, discharges at the head of the bay.

Refugio bay is about three miles across in either direction, and is very shallow.

The climate of this part of the coast of Texas is generally considered very healthy, and the quarter is frequently resorted to by persons who have become sickly from residence on the alluvial bottoms along the rivers. The temperature during January and February of the past winter averaged about 56° Fahrenheit, the lowest being 28° for a few hours only towards the close of a "norther," which lasted three days. During March and April it was about 70°; and for May and June, which are said to be the hottest months of the year, the average was 84°. The highest temperature recorded was 91° on the 27th of May.

There is almost a constant breeze from the Gulf day and night after the middle of April.

* * * * *

Respectfully, your obedient servant,

SAML A. GILBERT,
Assistant U. S. Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 33.

Tables for projecting maps of large extent, arranged by J. E. Higard, Assistant U. S. C. S.

These tables are based upon a polyconic development of the earth's surface, which supposes each parallel of latitude to be represented on a plane by the development of a cone having the parallel for its base and its vertex in the point where a tangent to the parallel intersects the earth's axis. The degrees on the parallel preserve their true length, and the general distortion of area is less than in any other geometrical mode of representing a given portion of the earth's surface.

Denoting by \( a \) the equatorial radius of the spheroid, \( e \) the eccentricity, then the normal to any point on the parallel of latitude \( L \), produced to the minor axis, is

\[
N = \frac{a}{(1 - e^2 \sin^2 L)^{1/2}}.
\]
The radius of curvature in the meridian is

\[ R_m = \frac{a(1 - e^2)}{(1 - e^2 \sin^2 \phi)^{3/2}} \]

The radius of the parallel, \( R_p = N \cos \phi \).

The radius of the developed parallel, or the side of the tangent cone, \( r = N \cot \phi \).

Designating by \( n \) any arc of the parallel, or difference of longitude to be developed, and by \( \theta \) the corresponding angle subtended by the developed parallel at the vertex of the cone, then the length of the given arc will be \( n R_p = n N \cos \phi \), and also

\[ \theta r = \theta N \cot \phi \] whence \( \theta = n \sin \phi \).

To determine the rectangular co-ordinates \( x \) and \( y \) for projecting from the middle meridian the points of intersection of the meridians and parallels, we have simply, the developed parallels being arcs of circles,

\[ x = r \sin \theta, \quad y = r \text{ versin } \theta. \]

Table I gives the length, in metres, of one degree of latitude and longitude for each degree of latitude from 0° to 54°; also the radii of the developed parallels which may be used to describe the parallels by means of beam compasses when the scale permits. It also gives the values of \( \theta \) for 10° of longitude, by means of which the tables may readily be extended.

Table II gives the co-ordinates for thirty degrees of longitude on each parallel from latitude 1° to 54°. The numbers correspond to the actual dimensions of the earth in metres, and are to be divided by the proper number for any desired scale.

In order to project a map by the aid of these tables draw a straight line as middle meridian of the map, on which space off the required degrees of latitude by the values given in Table I. Through the points so marked construct lines perpendicular to the meridian and parallel with each other, which will be tangents to the parallels of latitude at their intersections with the middle meridian.

On these tangents lay off from the middle meridian, for each required longitude, the corresponding \( x \) from the tables, and off-set \( y \) perpendicular to it, towards the pole. Through the points so found draw continuous curves for the parallels and meridians.

The tables are based on the following constants, being Bessel's latest, and those used in the Coast Survey:

- Equatorial radius of the earth \( a \) = 6 377 397 metres, log. = 6.80464346
- Polar radii of the earth \( b \) = 6 356 079
- Square of the eccentricity \( \epsilon^2 \) = 0.006 674 37

The tables are based on the following constants, being Bessel's latest, and those used in the Coast Survey:

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- Polar radii of the earth \( b \) = 6 356 079
- Square of the eccentricity \( \epsilon^2 \) = 0.006 674 37

The tables are based on the following constants, being Bessel's latest, and those used in the Coast Survey:
TABLE I.

*Length in metres of one degree of latitude and longitude, values of the corresponding radii of the developed parallel, and angles at each pole for ten degrees of longitude.*

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<th>Radius of parallel</th>
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TABLE I.

Length in metres of one degree of latitude and longitude, &c.—Continued.

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TABLE II.

Coordinates of curvature.

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APPENDIX No. 34.

Description of an apparatus devised by Assistant W. P. Trowbridge, and of the method of applying it in determining ocean depths and obtaining specimens of bottom.—(Sketch No. 40.)

U. S. COAST SURVEY OFFICE, April 6, 1859.

DEAR SIR: In my report to you of May 31, 1858, I had the honor of presenting the results of an investigation of the laws of descent of heavy bodies in the ocean, under the conditions required in deep-sea sounding.

The object of that investigation was to ascertain and develop fully the causes of failure and error in deep soundings, and to devise a more certain and reliable mode of measuring the depth of the ocean in the off-shore hydrography of the Coast Survey, and especially in the swift current of the Gulf Stream.

I have now to present for your further consideration a sounding apparatus based upon the developments given in my former report, and the result of further study and experiments on the subject.

The distinguishing feature of the method herein described, though exceedingly simple in its application, has never before been proposed, inasmuch as its necessity could hardly have been felt without a careful analysis of the circumstances of descent of the sounding lead and line. In the method of sounding heretofore employed, the influence of the friction of the water upon the line, or "endwise resistance," as it is called by Prof. Airy, was known to exist, but the amount of this endwise resistance in pounds, and its ultimate effects at great depths, had not been determined. It was supposed that by making use of a weight of thirty or forty pounds and a small fishing line, this resistance would be reduced to an inappreciable amount, or at least that its effect in retarding the descent of the lead would not be sufficient to destroy confidence in the results.

It appears, however, from the investigations referred to, that a weight, such as is ordinarily used in sounding, will be practically held in suspension at no very great depth, even when the line used is the smallest that will sustain the weight with safety in the air; and, in confirmation of this conclusion, the fact is well established that, notwithstanding repeated experiments made by the most skilful officers and with the utmost care, the bottom of the ocean has never been reached in its deepest parts; and even where the bottom has been attained, and specimens brought to the surface, the uncertainties of the results have given good grounds for controversy with regard to the depth.

These failures and uncertainties do not arise from the magnitude of the distance to be measured, nor from the impenetrability of the fluid through which the lead has to pass. Distances infinitely great and infinitely small in the universe, above and around us, have been measured with precision, and the unexplored depths of the ocean are occupied by a medium freely and equally penetrable at all depths. Yet, in this field—a field daily traversed by the commerce of the world—a distance of a few miles only has baffled all attempts to measure it.

The difficulty lies in the simple cause stated above, viz: the "endwise resistance," or friction upon the sounding line, which prevents the lead from going to the bottom where the depth is great.

The apparatus which I have devised is designed to avoid this friction upon the line, while at the same time the line is not dispensed with, but is made use of as in the ordinary mode.
Before describing this apparatus, I will briefly refer to some of the results given in my previous report on this subject.

The rate of descent of an iron globe or sphere, as the simplest geometrical form, was first determined when falling freely in the ocean, and it was found that a sphere will attain a certain maximum velocity within twenty-five feet of the surface, which velocity will be kept up without sensible increase or diminution to the bottom.

For a 32-pound iron shot this uniform velocity is about sixteen feet per second.

The conditions of descent when a small line is attached to the sphere and drawn down with it were then discussed, the line being uncoiled from a reel on the deck of the vessel, and drawn down by the weight of the sphere. The friction of this line in the water causes a remarkable change in the rate of descent. Nearly the same maximum velocity at starting is obtained, but the velocity becomes rapidly reduced until the sphere becomes suspended nearly motionless in the water.

Taking the simple case at a 32-pound shot attached to a small fishing line, the shot attains its maximum velocity of sixteen feet per second within twenty-five feet of the surface; but before a hundred fathoms of the line is drawn into the water this velocity is reduced to eight feet per second—a diminution of half the velocity from the friction of one hundred fathoms of line.

At five hundred fathoms the velocity is again reduced half, or to four feet per second; and at three thousand, to about one foot per second; whereas at this depth, if there is no line attached, the shot will fall with its original velocity of sixteen feet per second undiminished. Below this depth we may determine in the same way the circumstances in the two cases; the shot falling freely still retains its uniform velocity of sixteen feet per second at four, five, and six thousand fathoms depth; while with the line attached, at five thousand fathoms the velocity is reduced to a few inches per second, and at six thousand fathoms the descent is not perceptible under ordinary circumstances.

The time of descent becomes an important element also in practice. In the two cases given the shot falling freely will descend to the depth of three thousand fathoms in twenty minutes, and to the depth of six thousand fathoms in forty minutes; while, with the line attached, it will require two hours to descend three thousand fathoms, and eight hours to descend six thousand fathoms.

These effects were shown to be due to the friction alone; the amount of which in pounds was determined for different cases in which different forms of weight and different sizes of lines were used; and the entire inapplicability of the ordinary mode of sounding for great depths, and even for ordinary depths, where the object is to obtain a correct knowledge of the depths, was demonstrated.

Methods have been proposed in which a line is dispensed with by detaching a float at the bottom when the plummet strikes, and watching for the return of the float to the surface; but this is impracticable, as there is no material applicable, within our knowledge, that will float to the surface from the bottom of the sea, on account of the great pressure which condenses the bulk, so as to render bodies specifically lighter than water at the surface heavier than water at even moderate depths. A line must therefore be used to bring back to the surface, any machine by which the depth may be registered in the descent, and the motion of this line in an extended form in the water must be avoided.

The apparatus which I have devised is designed to secure this object by attaching to the sinker a tube or case in which the sounding line is compactly coiled, and from which it will be
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discharged freely, thus causing the plummet to carry down the coil, while one end of the line is held fast at the surface; the line being uncoiled from the descending sinker, in the manner that a spider falling from a height gives out a thread in his descent by which he retains communication with the point above to which the thread is attached. The motion of the line in an extended form through the water being thus avoided, all the conditions of free descent are secured, and the plummet will descend to the greatest depths with a rapid and uniform velocity.

The depth is ascertained in the manner heretofore known as Massey's method, by a helix or curved blade, which is caused to revolve by the motion of the apparatus through the water. Instead of Massey's Indicator, however, which from its faulty construction does not give accurate results, I have adapted Saxton's Current Meter, a much more delicate instrument, to this purpose.

A specimen tube is also used, differing somewhat from those now in use in construction, but not in its essential points.

The lower end of the line is attached to the register and to the specimen box, which weigh together only two or three pounds; and as the line is hauled in from the bottom it brings up the register and specimen box, leaving the plummet and attached case at the bottom.

The details of construction are shown in the accompanying drawings and description of the apparatus.

Besides overcoming the principal difficulty in sounding, there are other important advantages secured by this arrangement which simplify rather than complicate the problem. These are as follows:

First. There is no strain upon the line in the descent, except from its own weight, no matter to what depth or with what velocity the plummet may descend. It is possible, therefore, to employ a very small line; a single thread of silk may, in fact, be extended to the bottom of the ocean. This permits of the use of a line which may be coiled compactly within a small space, and with the strength of the line being made just sufficient to insure its being hauled in with safety, bringing up at the same time the specimen box and the register. The strain brought upon it in hauling in will depend upon the velocity of the upward motion, which may be regulated accordingly.

Secondly. A rapid and uniform descent being secured, the indications of a revolving register will be reliable when attached to this plummet, while in the present mode of sounding the slow motion of descent at great depths renders such a mode of registering the depth uncertain and unreliable.

Thirdly. There being no strain upon the line in the descent, and the motion being uniform, it is practicable to determine the depth by the time of descent, making use of a small insulated wire as a sounding line, and determining the instant that the weight strikes the bottom by an electrical signal transmitted through the line. An apparatus was devised as long since as the year 1845, for ascertaining the moment when the weight strikes the bottom by electricity, but in the mode of sounding heretofore employed no particular advantage would result from this, while the danger of breaking the electric continuity is very great, owing to the strain brought upon the line in the descent; and the plummet as now used descends with such a varying velocity that even with the time of descent given no calculation will give the depth. The method has, therefore, never been put in practice. Whereas, in the method proposed, there is no strain upon the line in its descent, and the plummet will fall through each successive
hundred fathoms in the same time; the time of descent will thus furnish a simple means of calculating the depth. In this process it will not be necessary to recover the line, and the time required to sound the ocean at any point need only be that required for the plummet to sink to the bottom, moving with any velocity which may be desired.

I have made many experiments on the best method of coiling the line so as to secure its uncoiling with certainty, and without the possibility of a strain upon the line or the occurrence of a kink. I have also given much attention to the quality and size of the line to be used. Upon these points the practical working of the apparatus in a certain degree depends, but being merely mechanical questions they are easily settled. They are fully discussed in the description which accompanies the drawings.

The importance of the problem which is thus sought to be solved, in connection with the survey of the coast, has never been questioned; a knowledge of the configuration of the bottom of the sea adjacent to the coast is necessary to the solution of many questions of importance to navigation and to science, and especially that of the ruling feature of the Atlantic Coast, the Gulf Stream; but besides these considerations the question has become one of great public interest in connection with the laying of submarine telegraphs, the risks of such enterprises being diminished in proportion to the accuracy with which the depth of the sea is known at every point of any proposed line, and the ultimate practicability of such operations across the Atlantic being yet to be demonstrated by new and more accurate soundings.

Description.

The accompanying plate (Sketch No. 39) represents the instrument as at first constructed. Some slight modifications have since been made in the mode of attaching the register, but without affecting the general design.

Fig. 1 represents the plummet as it appears in its descent.

T, the tube or case containing the coiled line.

W, the leaden or iron weight inserted in the bottom of the tube.

C, the conical cap.

R, the register in its place upon the cap.

L, the line.

Fig. 1a represents a longitudinal section of the tube, weight, and cap, showing the mode of coiling the line in balls, and the small specimen box passing through the hollow weight.

Fig. 2 represents the register on a larger scale.

h h, the helices or blades.

r r, the register wheels.

g g, the locks for gearing and ungearing the wheels.

Fig. 2a represents the plan or horizontal view of the register, it being constructed so as to offer the least resistance in passing through the water.

Fig. 3 shows the detailed construction of the register wheels and the helices.

From Fig. 1, it will be seen that the form of the apparatus admits of rapid motion through the water. The weight is conical and elongated and the register presents the edges only of brass plates to the water, and the line being uncoiled and discharged from the tube there is no
retarding force to the descent from the line itself. Any desired velocity of descent may be
given to the plummet by increasing or decreasing the weight W.

Fig 1 a shows the method of coiling the line.

There are various modes of doing this which are in common practice in twine and cotton
factories; that which is here exhibited is the method of coiling in balls, all the balls exhibited
in the tube being formed of one unbroken line, the line drawing out from the centre of each,
until it is all drawn from the tube. The machinery for winding these balls is very simple.

The essential points in the coiling are to coil the line in as compact a space as possible, so
as to insure certainty of discharge without danger of kinking. Two other modes of coiling
are now under consideration, either of which may be better than the method by balls. One is
to wind upon a spindle, and the other to lay the line in a sort of compound coil, directly in the
tube. All these methods are now practiced in the factories on a large scale for winding twine
and cotton.

The line used should be about five hundredths of an inch in diameter, and as strong as it
can be made of that size. A braided line of Holland flax or silk of five hundredths of an inch
in diameter may be made to bear a strain of forty or fifty pounds, which is abundantly strong
for the purpose, as the weight and case are left at the bottom, the register and specimen
tube only being brought up.

**Tube.**

The tube may be made of tin in sections of eighteen inches in length, with stove-pipe joints
and bayonet fastenings. The object of this is to adapt the length of the tube readily to the
amount of line which it is to contain. A tube four inches in diameter will contain nearly a
mile of line to each foot of the tube.

**Sinker and specimen tube.**

The sinker is made of cast iron or lead of any desired weight, depending upon the desired
velocity of descent. A weight of twenty-five pounds has been adopted.

The sinker is conical and is inserted into the lower end of the tube containing the line and
fastened to this tube by screws or by a bayonet joint and fastening. The weight has a conical
hole or cavity through its entire length, through which the small specimen tube passes in the
manner shown in the drawing.

The specimen tube is a tube of thin brass passing through the weight and attached to the
lower end of the line within the large tube. This specimen tube is fitted with a valve opening
upwards in the bottom, which closes when the tube is drawn up, thus retaining the mud
which is forced into the tube when the weight strikes bottom. The specimen tube fits loosely
in the bottom of the weight so that it may be easily drawn out as the line is hauled in.

**Cap.**

The cap is used for two purposes: to contract the upper end of the tube containing the line
so that the line cannot rise in bulk out of the tube, and for supporting the register. It is
formed in the shape of the frustum of a cone, cut away on one side as well as open at the top,
so as to allow the line to be discharged freely. A flat strap is fastened to the top of the frus-
tum nearly in the line of the axis of the tube, and upon this strap the register is set, as shown
in the drawing; the register is kept in its place by loose collars.
REPORT OF THE SUPERINTENDENT OF

Register.

The apparatus for measuring the depth consists of a helix or curved blade attached to a vertical axis, and wheels gearing into an endless screw upon this axis. The revolutions of the helix, caused by the motion through the water, are communicated to the wheels, which are graduated so as to indicate the number of revolutions of the helix.

Two registers are attached to one plummet by attaching them together in the manner shown in figure 2, by means of brass plates. The blades are made to turn in opposite directions, and will operate as checks upon each other, and also counteract the effect of any rotary motion in the plummet.

The construction of the blades and wheels and the mode of gearing them with the endless screw are shown in figure 3. The wheels are differential wheels; that is, they are concentric, one of them having one hundred teeth and the other one hundred and one teeth. The cross bar (b) has a slight motion, carrying with it the wheels; this motion is governed by a spring s. To gear the wheels the cross bar is pressed towards the endless screw until the teeth gear with that screw and the bar is theret locked, as shown in figure 2 at gg. The revolution of the blades will now cause both wheels to turn, and after one hundred revolutions the wheels will be found separated by one tooth or one division. The differences thus measure hundreds of revolutions. In the register from which the drawings were made, the blades revolve once in two feet; one hundred revolutions will therefore correspond to two hundred feet, or one division of the scale of the register to thirty-three fathoms.

When the register is hauled up, the arms at gg, figure 2, drop, and the springs cause the wheels to ungear and fly back, where they are held motionless by a projecting point at n, figure 3. The arms are made to drop by means of a small wire, which is attached to the cap, as shown at (u) figure 1. This wire is fastened to, or hooks over the ends of the arms, and when the register is drawn off, the arms fall.

Mode of attaching the line to the register and specimen tube.

Before the line is put into the tube it is attached to the specimen tube at a point four or five feet from the end of the line, the spare end is passed through the tube, and when the balls are all put in the tube the extreme end of the line coming out at top is attached to the register, after taking a few turns around the top of the strap, the register being in its place.

The line is thus attached to the specimen tube and register only, and not to the large tube or weight.

When the plummet strikes the bottom a part of the line will remain in the tube coiled; by hauling in the line this part will, however, be uncoiled, and on coming to the bottom of the coil the specimen tube will be drawn up through the large tube, and after the specimen tube comes out the register will be drawn off the strap, and thus the large tube and weight will be disengaged from the line, specimen tube, and register, and by continuing to haul in, the register and specimen tube will be brought to the surface. The plummet on striking will, under most circumstances, remain sticking in the mud in an upright position.

Very respectfully, your obedient servant,

W. P. TROWBRIDGE,
Assistant Coast Survey.

A. D. BACHE, LL.D.,
Superintendent U. S. Coast Survey.
APPENDIX No. 35.

Extracts from letters of J. M. Batchelder, esq., stating the results of trials made with Hunt's tide-metre at Charlestown navy yard, Mass.

Boston, August 30, 1859.

Sir: * * * Below are given the results of eighty observations made with the pressure tide-metre when the bag, tube, and gauge were filled with air. The mean differences and error are also shown, but it is probable that the actual error is less than the result given in the column so designated, as the greatest difference occurred when the surface of the water was agitated, and the least when it was most calm.

To determine the effect produced by the escape of air, the bag was fully distended, and immersed to the depth of thirteen feet, and the position of the index noted. The instrument was then taken up and one-half of the air allowed to escape from the bag, but on being again immersed to the same depth the index remained as before.

No observations were made with reference to temperature, as the change of volume of the air from this cause would be very slight as compared with the distended and half-filled bag.

* * * * *

Result of trials made with the pressure tide-meter at Charlestown navy yard in August, 1859.

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Bag filled with air.

From the first mark (0) on the tube to the bottom of the air-vessel three feet.

Mean of eighty observations given above.

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<tr>
<td>12.96</td>
<td>.95</td>
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</tbody>
</table>
* * * Notes are here appended of further trials of the pressure tide-meter, made at your request, the instrument being filled with pure water.

It will be noticed that in the column headed "mean" we have on the third line 1.02 feet, and when the water is .................................................. 7.00 "

\[ \text{11.02 " higher,} \]

as in the tenth line.

The intermediate observations would be equally accurate if the dial-plate of each instrument was graduated by marking the position of the index at each successive tenth of a foot immersed, beginning with a depth of not less than three or four feet. The bag, when in use, should always be at this depth below low-water mark.

The differences noted at the same depth of immersion (column nine) are mainly due to oscillation of the water, and in a very slight degree to friction of the index gear.

Trials made at Charlestown navy yard in September, 1859.

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</table>

\* The figures on the last line are obtained by adding nine feet to those on the second.

To determine fully the practical value of this apparatus I think it should be set up with one of the common gauges, and the indications of each observed and compared daily for one or two months. * * *

Very respectfully, your obedient servant,

J. M. Batchelder.

Prof. A. D. Bache,
Superintendent United States Coast Survey.
APPENDIX No. 36.

Letter of the Secretary of the Treasury relative to placing the Coast Survey steamer Active under the authority of Brevet Lieut. General Scott.

TREASURY DEPARTMENT, September 16, 1859.

Sir: I have to inform you that, by direction of the President, the Coast Survey steamer "Active" has been placed under the authority of Brevet Lieutenant General Winfield Scott, United States army, and Commander James Alden, U. S. N., has been instructed by this department, under date of the 15th instant, to obey all orders emanating from him.

Very respectfully, your obedient servant,

HAYWARD COBB,
Secretary of the Treasury.

Prof. A. D. BACHE,
Superintendent Coast Survey.

APPENDIX No. 37.


U. S. NAVY YARD, Portsmouth, N. H., October 1, 1859.

Sir: Your promptness in answering a request to tow the United States ship Cumberland from the lower harbor to this navy yard on the 3d ultimo calls forth my acknowledgment and thanks, and I trust that your action will be approved by the Superintendent of the Coast Survey. Had you not rendered the assistance you did in towing up the Cumberland that vessel would have been detained by head winds five or six days in the lower harbor.

Very respectfully, your obedient servant,

JOHN POPE,
Commandant.

Lieut. Comg. A. MURRAY,
Coast Surveying Steamer Bibb.

APPENDIX No. 38.

Letter addressed to the Superintendent by Captain D. G. Farragut, U. S. N., on visiting Beaufort river, South Carolina, with the United States steamship Brooklyn.

UNITED STATES SLOOP-OF-WAR BROOKLYN,
Beaufort Roads, South Carolina, February 17, 1859.

Sir: Permit me thus to acknowledge the great service I have received from the Coast Survey, through the kindness of Mr. C. O. Boutelle, chief of the party encamped at Land's End, mouth
of Beaufort river, South Carolina, who volunteered his services, and handsomely piloted this ship up to within four and a half miles of the town of Beaufort and down again; and continued to extend every assistance and courtesy in his power during our stay in these waters.

Very respectfully, your obedient servant,

D. G. FARRAGUT,
Captain United States Navy.

Professor A. D. BACHE,
Superintendent Coast Survey, Washington city.

APPENDIX No. 39.

Letters addressed to Lieutenants T. A. Craven and J. N. Maffitt, U. S. N., on their detachment from the Coast Survey.

COAST SURVEY Office, June 18, 1859.

Dear Sir: I feel too deeply indebted for the sympathy and hearty co-operation manifested by you while attached to the Coast Survey to permit the occasion which returns you to general duty in the naval service to pass without expressing my sense of the value of your labors. Apart from the devotion shown as one of the naval assistants, it is natural to suppose that your early experience in the work gave enhanced interest to your later efforts, and I cannot but regard the long period of your co-operation in the survey as one of the happy incidents of my superintendence.

The large share which you have contributed to the hydrographic results of the Coast Survey would alone permanently associate your name with that national work. Those with whom you have acted will have also in memory the ready spirit for co-operation, the uniform courtesy, and the qualities of head and heart that never fail in contributing to success.

Receive, my dear sir, the assurance that my kind wishes will ever accompany you to whatever field of duty you may be called in the range of your profession.

Yours, respectfully and truly,

A. D. BACHE,
Superintendent U. S. Coast Survey.

COAST SURVEY Office, June 17, 1859.

Dear Sir: I cannot permit the occasion to pass which severs your connection with the Coast Survey without expressing my deep sense of the value of your services while associated in that work. Where so many are employed, relative merits and special efficiency can be perceived and appreciated only by one charged with the general superintendence; and in that light it is now a pleasure to say that your labors in the prosecution of the hydrography must ever rank in my estimation as of the highest order. Your career during the extended period of your service, and since your recent assignment to Coast Survey duty, was marked by that...
rare aptitude and intelligence in regard to the work which assist in planning, and by perseverance which left nothing to be desired in reference to the time of its execution. A comparison shows that in hydrographic results your efforts have been seldom if ever excelled by those of any other officer. The high estimation in which I have regarded them would be weakened by specification in addressing one so fully qualified for the widest range of duty in the naval profession. As nothing has occurred throughout the long period of your connection with the Coast Survey to stay the increasing regard won by your even courtesy and manly bearing, my regret in taking leave of you is the greater. I shall ever recur to your name as one of the most efficient of naval assistants of the Coast Survey with feelings of pride and pleasure.

Yours, respectfully,

A. D. BACHE,

Superintendent U. S. Coast Survey.

Lieut. Comg. J. N. MAFFITT,
United States Navy.

APPENDIX No. 40.

Aids to navigation recommended in reports made to the Superintendent by Assistants of the Coast Survey.

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<th>Object</th>
<th>By whom recommended</th>
<th>Date of report, &amp;c.</th>
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</thead>
<tbody>
<tr>
<td>I.</td>
<td>Buoy to mark the extremity of a sand spit near Fletcher's Neck, Wood Island, Me.</td>
<td>do</td>
<td>Referred to the Light-house Board Oct. 15, 1859. (Appendix No. 41.)</td>
</tr>
<tr>
<td>I.</td>
<td>Buoy to mark the position of Osche's Ledge, off the coast of Mass.</td>
<td>do</td>
<td>Referred to the Light-house Board Sept. 15, 1859.</td>
</tr>
<tr>
<td>V.</td>
<td>Buoy to mark the Bird Key and Cow Pen channels, St. Helena sound, S. C.</td>
<td>Lieut. Comg. J. N. Maffitt, U. S. N.</td>
<td>Referred to the Light-house Board May 26, 1859. (Appendix No. 42.)</td>
</tr>
<tr>
<td>V.</td>
<td>Buoy in the East channel, Port Royal sound, S. C.</td>
<td>Lieut. Comg. C. M. Fauntleroy, U. S. N.</td>
<td>Referred to the Light-house Board July 8, 1859. (Appendix No. 43.)</td>
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APPENDIX No. 41.


PHILADELPHIA, October 15, 1859.

Sir: I have the honor to communicate the following extract from a letter addressed to me, under date of October 9, by Lieut. Comg. Alexander Murray, U. S. N., Assistant Coast Survey, and would respectfully request that a copy be furnished to the Light-house Board:

"In the place indicated on the enclosed sketch (coast of Maine) there is a rock whose position has been determined by this party. It is called Hussey's Rock; and being very sharp, with three and four fathoms of water about it, and contiguous to 'Wood Island harbor,' is dangerous. I recommend that a buoy be placed near it."
"Between 'Nigger island' and 'Fletcher's Neck signal,' near the spot indicated by red ink sand shoal-marks, is the end of a spit. This is in the harbor, and should be marked with a red buoy, as, entering through the west channel, it would be on the starboard hand."

Very respectfully, yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 42.

Letter to the Secretary of the Treasury, communicating a recommendation from Lieut. Comg. J. N. Maffitt, U. S. N., Assistant in the Coast Survey, for placing buoys in St. Helena sound, S. C.

COAST SURVEY OFFICE, May 25, 1859.

Sir: I have the honor to present for the consideration of the Light-house Board the following extract from a communication addressed to me by Lieut. Comg. J. N. Maffitt, U. S. N., Assistant Coast Survey, under date of May 25:

"For the convenience of steamers in passing through the South Edisto river into St. Helena sound, S. C., two second class buoys should be placed in what is called the Bird Key and Cow Pen channel. These would enable steamers to pass with a great saving in distance, and in comparatively smooth water while the wind is blowing fresh.

"The commanders of the steamers 'Edisto' and 'Everglade' have felt the necessity for these aids in navigation, and would willingly furnish the use of their boats for establishing the buoys in their places."

The positions of the desired buoys are marked 3 and 4 on the enclosed tracing.

Very respectfully, yours,

A. D. BACHE, Superintendent.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 43.

Letter to the Secretary of the Treasury, communicating the recommendation of Lieut. Comg. C. M. Faunlteroy, U. S. N., Assistant Coast Survey, for buoys to mark the East channel into Port Royal sound, S. C.

CAMBRIDGE, MASSACHUSETTS, July 8, 1859.

Sir: In reporting the completion of soundings by the hydrographic party in the several channels of Port Royal entrance, S. C., Lieut. Comg. C. M. Faunlteroy, U. S. N., Assistant Coast Survey, suggests that the East channel passage should be buoyed out as soon as practicable.

The recommendation being based upon the results of his examinations, as shown by the hydrographic sheet, I would respectfully request that a copy of this communication may be transmitted to the Light-house Board.

Very respectfully, yours,

A. D. BACHE, Superintendent.

Hon. HOWELL COBB,
Secretary of the Treasury.
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* Omitted.
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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