37TH CONGRESS, 2d Session. } SENATE. { EX. DOC.

REPORT

OF

THE SUPERINTENDENT

OF THE

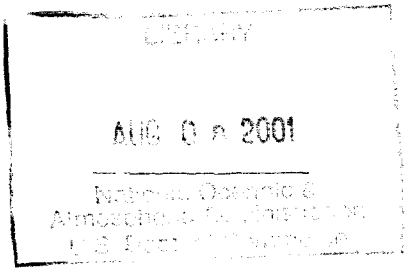
COAST SURVEY,

SHOWING

THE PROGRESS OF THE SURVEY

DURING

THE YEAR 1861.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1862.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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IN THE SENATE OF THE UNITED STATES, *March* 20, 1862.

Resolved, That there be printed, in addition to the usual number, six thousand two hundred copies of the Report of the Superintendent of the United States Coast Survey, of which twelve hundred shall be for the use of the Senate and five thousand copies for distribution by the superintendent.

Attest: J. W. FORNEY, *Secretary*.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

The Report of the Superintendent of the United States Coast Survey.

TREASURY DEPARTMENT, *March* 5, 1862.

SIR: I have the honor to transmit, for the information of the House of Representatives, a report made to this department by A. D. Bache, LL.D., Superintendent of the United States Coast Survey, showing the progress in that work during the year ending November 1, 1861, with the accompanying engraved sketch illustrating the general progress which has been made in the survey of the coast; also the manuscript map of progress, brought up to the same date, in accordance with the act of Congress approved March 3, 1853.

I have the honor to be, very respectfully,

S. P. CHASE,
Secretary of the Treasury.

Hon. HANNIBAL HAMLIN,
President of the Senate and Vice President of the United States.

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A.—ASTRONOMICAL.

REPORT.

COAST SURVEY OFFICE,
Washington, D. C., December 15, 1861.

SIR: In accordance with law and the regulations of the Treasury Department, I have the honor to present my report, showing the progress of the Coast Survey of the United States during the surveying year, from November 1, 1860, to November 1, 1861.

At the first date mentioned the field parties had been arranged, under their respective heads, for duty on the coast of the lower sections of the Atlantic seaboard and the shores of the Gulf of Mexico; and though the temper of the public mind was then stirred, there was nothing on which to reckon hazard in sending the parties and vessels to continue work on the parts of the coast on which they had been respectively engaged. This being so, most of the parties intended for triangulation and topography were sent out, and all were well received. In the midst of events which hurried the national crisis in April last, most of the parties so engaged performed each an average amount of work for the season, and returned with the vessels, instruments, and equipage which had been used in the field. This was in accordance with my instructions, in connexion with which such means as were available had been provided to facilitate the return of the parties when further progress was impracticable. In two instances only were vessels seized and held, as will be again alluded to, with the attendant circumstances. In several others, instruments, which had been either stored with responsible persons at the close of the previous working season, or had been in actual use during the early part of this year, were forcibly taken by lawless persons in arms, and acting under assumed authority. These will also be mentioned again, in connexion with notices of the work done in the localities in which the seizures were made.

As the spring advanced, preparations were made for resuming the unfinished work in the northern sections of the Atlantic coast, and a much larger amount than usual has been performed, by the assignment to duty there of the force which, under other national aspects, would have been employed in the vicinity of Chesapeake bay.

If the events which at one period of the present year, arising out of attempts to disturb the stability of the government, left me room for any gratification, it would be expressed while stating that the field-work of the Coast Survey has not in amount materially fallen behind that of the previous years, considering the circumstances affecting progress in the past as well as now. In the office the aggregate of work done, arising in part out of the exigencies of the military and naval departments of the public service, and enhanced directly by the largely-increased demand for copies of maps and charts, has been much greater than usual. The activity of the office is still maintained, and the early connexion of field parties with the military and naval operations now in progress has given ample scope for constant employment.

Following the course pursued in making up my previous annual reports, a short summary of the general progress made will first be given, followed in order by a summary of that for the year which has just ended.

GENERAL STATEMENT OF PROGRESS.

The general progress sketch (No. 28) which accompanies this report gives at one view a clear idea of the present condition of the survey of the coast. Reference to it will show that the triangulation is continuous from the northeastern boundary of the United States, at the St. Croix river, (Passamaquoddy bay,) along the coast, and including the bays, of twelve of the seaboard States, to the boundary line between North and South Carolina. An unsurveyed interval of less than sixty miles occurs between Little river and Winyah bay, and from thence southward the triangulation is again continuous along the coast of South Carolina, Georgia, and on the eastern coast of Florida, including the bays, harbors, and sounds, to Matanzas inlet, below St. Augustine. North and south of Cape Cañaveral a stretch of about a hundred and sixty miles remains to be surveyed. The triangulation includes Indian River inlet and the course of the river northward as far as the Narrows. From Cape Florida it passes by a connected chain to the Marquesas, and, in a preliminary way, to the Tortugas, embracing the entire line of the Florida keys, and along the Main, with only a small interval, to Cape Sable. Charlotte harbor has been triangulated, and the western coast of the Florida peninsula, from Tampa to Cedar keys, including St. Joseph's bay and Clearwater harbor. From Ocilla river he triangulation is again continuous over St. Mark's harbor, quite through St. George's sound ; in preliminary form, through St. Joseph's bay, (north,) and over St. Andrew's bay. It includes Pensacola harbor and its dependencies, the Perdido entrance, Mobile bay and its approaches, and thence on westward, embraces Mississippi sound and Lake Borgne, and Lake Pontchartrain, as far as New Orleans. A branch of triangulation, connected with this, proceeds southward, through Isle au Breton sound, to the mouths of the Mississippi river. West of the delta it embraces Caillou bay and Atchafalaya and Côte Blanche bays, and the coast of Texas, with Galveston and Matagorda bays, Espiritu Santo, San Antonio, Corpus Christi, and Aransas bays and their dependencies, or, in a continued line, from the High islands to the head of the Laguna Madre.

The same sketch (No. 28) shows the progress in coast topography and hydrography relative to the triangulation. It will be seen that the largest intervals on the Atlantic side are on the coast of Maine and coast of Florida, with smaller gaps along the coast of several of the intermediate States. On the Gulf coast the topography is well up with the triangulation, but the hydrography not so far advanced.

The surveys on the Western coast, though more detached, are not the less important, all the harbors, anchorages, and headlands being included, as may be seen by reference to the sketch already mentioned.

In addition to other means employed for the determination of longitude, mention of which has been made from time to time in my annual reports, we have now added the prospect of the use of the telegraph line to the Pacific coast. Permission having been obtained for the object desired, arrangements are now making for employing the method which has been long in use in the survey, in fixing the longitude of a point on the Western coast.

DIVISIONS OF THE REPORT.

I. The introduction to the report gives, besides a general summary of progress and a synopsis of the progress made during the year, special remarks on subjects connected with the operations of the survey in field and office work.

II. The second division of the report contains detailed descriptions of the work done in each locality, arranged in geographical order, the whole being subdivided into sections, of which six embrace the coast of the United States on the Atlantic, three that on the Gulf of Mexico, and two the coast of the United States on the Pacific. A summary of the progress

made in drawing and engraving maps and charts is given with each of the sections to which they belong.

III. The Appendix contains, in addition to general lists of particulars relating to the progress of the survey, separate articles of scientific interest. For convenience in reference, the items are classified under separate heads, and the titles of all of them are given in a list as one of the indexes of the report. An abstract of the contents and an alphabetical index also accompany the report.

PROGRESS DURING THE SURVEYING YEAR 1860-'61.

The course of public events, while it has in some sections of the coast interrupted the plan laid out for completing their survey, has not, upon the whole, materially lessened the amount of work done during the present as compared with previous surveying years. Work which might have been somewhat longer deferred, without detriment to general interests, has fully replaced the ground that could not be occupied, and, as a result, the following abstract and the detailed report will show that the efficiency of the survey has not been at all impaired, either in comparative progress or in its adaptation to the peculiar circumstances of the government.

In Appendix No. 1 the localities in which the parties have worked are stated in geographical order, and the progress sketches, showing the localities, are arranged in like manner, and combined with such local charts and sketches as it has been deemed expedient to issue with this report. For ease in reference, the numbers of the progress sketches are stated under the heads of sections in the general statement of the progress of the year which will now be given:

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.—(Sketches Nos.* 1, 2, *and* 3.)—The triangulation of Passamaquoddy bay between Deer island and Campo Bello has been executed, and that of Dyer's harbor, Goldsborough bay, and Prospect harbor (coast of Maine) completed. The triangulation of Penobscot bay has been extended northward to the vicinity of Belfast, and that of the coast eastward from the entrance of the Penobscot nearly to Mount Desert island. Mount Monadnoc, in New Hampshire, has been occupied as a primary station for connecting the two primary bases of this and the adjoining section by a *direct* course of triangles, and the magnetic elements have been determined in its vicinity.

The topography has been commenced on the islands of Passamaquoddy bay; that of Rockland harbor and of the western shore of Penobscot bay to South Thomaston has been completed, including the shores of Owl's Head bay and Muscle Ridge channel. The topography of Woolwich peninsula has been extended from the shores of Back river westward nearly to a junction with the survey of the Kennebec opposite to Bath. The detailed plane-table survey of the shores of the Kennebec and Androscoggin rivers has been in progress above their junction; that of the eastern side of Harpswell Neck, and the shore line survey of Casco bay between Freeport and Yarmouth, has been completed. The special topography required for the re-survey of Boston harbor has been in progress, and that of the shore of Cape Cod bay between Barnstable harbor and West Sandwich completed. The topography of the shores of Mount Hope bay has been continued, in connexion with the adjacent parts of the shores of Narragansett bay and Prudence island.

The hydrography of the season has included the channel in Passamaquoddy bay between Deer island and Campo Bello; that of the Kennebec river has been extended from Bath upwards through Merrymeeting bay to Swan island; and that of Casco bay has been nearly completed by soundings between the islands northward and eastward of Portland harbor, and between the harbor and Harpswell Neck. Special observations have been made on the currents in Boston harbor for the re-survey undertaken by the city of Boston. The hydrography of

Barnstable harbor has been executed, and current observations have been made in Cape Cod bay. Asia Rip and Phelps's Bank have been further examined and developed, and three small shoals found in their vicinity have been sounded out. The hydrography of Narragansett bay has been extended between Canonicut island and Rhode Island, and from thence northward to Mount Hope bay. Tidal and magnetic observations have been continued at Eastport, Me., and tidal observations at the Charlestown navy yard, Mass.

The engraving of coast maps and charts, No. 12, Nantucket sound; No. 13, Buzzard's bay and Vineyard sound; and of No. 14, from Point Judith to Block island, has been completed, and additions have been made to the progress sketch of the section. Progress has been made in the drawing and engraving of coast maps and charts, No. 8, Atlantic coast from Seguin island to Kennebunkport; No. 9, from Cape Neddick to Cape Ann; No. 11, from Plymouth harbor to Hyannis harbor; and in the engraving of general coast chart No. II, from Cape Ann to Gay Head; in that of preliminary sea-coast chart No. 3, Cape Small Point to Cape Cod; and on the chart of Portland harbor. The drawing has been continued and the engraving commenced of the charts of the Sheepscot and Kennebec rivers; and the drawing has been commenced of general sea-coast chart No. I, Atlantic coast, Quoddy Head to Cape Cod; of coast map and chart No. 7, Muscongus bay to Portland; and for a finished chart of Barnstable harbor.

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.*—(*Sketch No.* 7.)—Two primary stations have been occupied, viz: Bald hill and Box hill, in Connecticut, for directly connecting the primary base on Epping plains with that on Fire island. Magnetic observations were made at the same stations. The triangulation of the Connecticut river has been extended from its entrance upwards to Goodspeed's landing, and the revision of the secondary work on the coast of New Jersey, from Sandy Hook to Green island. The topography of the Hudson river has been extended during the season above Rhinebeck, and the shore line traced between Fort Montgomery and Fishkill landing and Newburg. The hydrography of the Hudson has been continued between Rhinebeck and Barrytown. Special hydrographic examinations have been made in New York harbor and off Barnegat and Cape May, and a line of soundings has been run north and south off the coast of New Jersey. The hydrography of the channels of the Delaware river in the vicinity of Pea Patch island has been revised for the use of the chief engineer of the army, and supplementary soundings have been made in the Delaware between the mouth of the Schuylkill and Richmond. The regular series of tidal observations has been continued in New York harbor.

The drawing has been completed and the engraving continued for the new edition of coast map and chart No. 21, New York bay and harbor; and the large manuscript map for the commissioners on harbor encroachments has been finished and delivered to the State authorities at Albany. The engraving of the sheet of the Hudson from the river entrance upward to Sing Sing, and the drawing of the adjoining upper sheet, reaching to Poughkeepsie, have been continued, and a new progress sketch of the section has been drawn and engraved.

SECTION III. *Coast of part of Delaware, Maryland, and part of Virginia.*—(*Sketch No.* 10.)—The triangulation of the Potomac river has been extended upwards from Blakistone island, completing the preliminary work to the vicinity of Swan Point. Minute topographical surveys have been made of the environs of Washington city and of the adjoining parts of the District of Columbia, of Montgomery county, Md., and of Fairfax county, Va. The shore line of the Potomac has been traced from Piney Point to Blakistone island, and plane-table reconnaissances and soundings have been made at White House Point, Mathias Point, and Lower Cedar Point, in addition to a general hydrographic reconnaissance of the Potomac between Blakistone island and Georgetown, D. C. The series of tidal observations undertaken at the Washington navy yard has been completed, and the continuous series at Old Point Comfort kept up regularly.

Progress has been made in the drawing of coast maps and charts, No. 29, Atlantic coast

from Isle of Wight, Del., to Chincoteague inlet, Va., and No. 30, from Chincoteague inlet to Great Machipongo inlet, Va.; also in the engraving of the following sheets of the Chesapeake series, viz: No. 32, from Magothy river to Hudson river, Md.; No. 34, from the Potomac river to Pocomoke sound; No. 35, from Pocomoke sound to York river; No. 36, from York river to the entrance of Chesapeake bay; and on that of the sheet of Rappahannock river from Punch Bowl to Occupacia creek. The drawing, lithographing, and engraving of the upper sheet of Patuxent river, from Point Judith to Nottingham; the drawing and engraving of the chart of St. Mary's river, Md.; and the engraving of the Rappahannock sheet from the river entrance to Punch Bowl; of coast maps and charts, No. 31, Chesapeake bay from the Susquehanna to Magothy river; No. 33, Chesapeake bay from the Hudson to the Potomac river, have been completed, as also the photographing and lithographing of the preliminary chart of James river, and the drawing and lithographing of the preliminary chart of the Potomac river. Additions have been made to the progress sketch of the section, and the drawing for a finished chart of the Patuxent river has been commenced.

SECTION IV. *Coast of part of Virginia, and part of North Carolina.—(Sketch No.* 11.)—Supplementary topography for completing the large chart of Albemarle sound has been executed on Roanoke island, on Durant's island, and at the mouths of the Chowan, Cushai, and Roanoke rivers. Soundings have been made on a line off the coast of Maryland and Virginia, and a special examination made in the vicinity of an alleged shoal off the "False cape," southward of Cape Henry. Hydrographic reconnaissances have been made of the inlets leading into Pamplico sound, and a thorough resurvey of the approaches and channel of Hatteras inlet.

The drawing and engraving of additions to the two sheets of Albemarle sound (coast maps and charts Nos. 40 and 41) have been executed, and the drawing of a preliminary chart of the coast of North Carolina, from Oregon inlet to Ocracoke inlet, has been lithographed in the office. The engraving of the sketch of North Landing river (Currituck sound) has been completed, and additions have been made to the progress sketch of the section.

SECTION V. *Coast of part of North Carolina, and coast of South Carolina and Georgia.—(Sketch No.* 13.)—The main triangulation between Port Royal sound and Savannah river has been continued, and the secondary triangulation of the coast of Georgia completed, by a series of stations, which include the Inland passage behind Cumberland island. The detailed topography of Port Royal sound has been resumed, and is now in progress on its northern side, on the sea islands and water passages between them. The hydrography of that sound, and of the rivers passing into it, is also in progress. The regular series of tidal observations at the Charleston custom-house, S. C., was continued until the close of April of the present year.

The drawing has been completed, and the engraving, in preliminary form, of the chart of Ossabaw sound. Additions have been made to the drawing of the preliminary chart of Savannah river, and the engraving of that chart has been continued, the drawing of the hydrography of the rivers comprising the inland passage from St. Helena sound to Beaufort river, and additions to the chart of Port Royal and Broad river have been completed. The engraving of preliminary sea-coast chart No. 14, from Cape Romain, S. C., to Tybee, Ga., has been completed as far as material allows, and the drawing continued. Additions have been made to the progress sketch of the section, and to plates of charts previously engraved. The drawing of general coast charts No. VI, Ocracoke inlet, N. C., to Charleston, S. C.; No. VII, Winyah bay, S. C., to St. John's river, Fla.; of coast maps and charts No. 53, Rattlesnake shoals to St. Helena sound, S. C.; No. 54, Fripp's inlet, S. C., to Ossabaw sound, Ga.; and the engraving of the preliminary charts of Sapelo sound and St. Simon's sound, Brunswick harbor, and Turtle river, have been continued.

SECTION VI. *Coast, keys, and reefs of Florida.—(Sketches Nos.* 14 *and* 15.)—The triangulation of the eastern coast of Florida has been made continuous from Fernandina harbor to the completed survey of the St. John's river; that of Indian river has been extended northward

to the Narrows from Willis's bay, and that of the inside keys of Florida from Pie key to Deep Point, in connexion with stations on the main land to the southward and westward of Barnes's sound; and that of Charlotte harbor has included the passage leading from Punta Rasa, between Pine island and the main. The topography of the eastern coast of Florida has been completed between St. John's river and St. Augustine harbor by a survey, which includes the courses of the North and Guano rivers. The plane-table survey of Indian River inlet, within the triangulation of last season, has been executed, and additional topography done on the keys of Barnes's sound. The topography of the dependencies of Charlotte harbor has been nearly completed. Tidal observations were continued at Fort Clinch (Fernandina, Fla.) until April, and at the Tortugas until May.

The drawing of coast map and chart No. 68, from Key Biscayne to Carysfort reef, has been completed, and additions have been made to the progress sketch of the section. Progress has been made in the drawing and engraving of general coast chart No. X, Florida reef, from Key Biscayne to Marquesas key; in the engraving of coast map and chart No. 71, from Newfound Harbor key to Boca Grande key; of St. Augustine harbor; and in the drawing of coast map and chart No. 58, from St. Andrew's sound, Ga., to St. John's river, Fla.

SECTION VII. *Part of the western coast of the Florida peninsula, and coast of West Florida.*—(*Sketch No.* 16.)—The longitude of Pensacola has been determined by telegraph, in connexion with Mobile, and observations made at the first-named city for latitude, azimuth, and the magnetic elements. The triangulation of the western coast of the peninsula below Cedar Keys has advanced from Bayport southward to the entrance of Tampa bay, and now includes St. Joseph's bay (south) and Clearwater harbor. Progress has been made by opening lines and setting signals for the triangulation of St. Joseph's bay, (north,) and for connecting the surveys of St. George's sound and St. Andrew's bay. Additional stations have been occupied, and the triangulation of Blackwater bay has been extended from Escribano point to Bagdad. The topography of the western coast of Florida peninsula has been completed in the vicinity and including the town of Bayport, making the plane-table survey continuous between it and Cedar Keys.

Progress has been made in the drawing of coast map and chart No. 81, Gulf coast from Chassahowitzka river, Fla., to Cedar Keys, and in the engraving of important additions to the chart of the western part of St. George's sound. The drawing and engraving of the preliminary chart of Cedar Keys, (new edition;) of Escambia and Santa Maria de Galvaez bays, (in preliminary form;) and the drawing of Apalachicola bay, have been completed, and additions have been made to the progress sketch of the section.

SECTION VIII. *Coast of Alabama, Mississippi, and part of Louisiana.*—(*Sketch No.* 18.)—Progress has been made in determining points by triangulation for the plane-table survey of the Southwest Pass, (Mississippi delta.) Tidal observations were continued until April at Great Point Clear, (Mobile bay,) and also at Isle Dernière. A series commenced at the Mississippi delta was continued until February.

The drawing and engraving of the preliminary chart of Passe à Loutre, (Mississippi delta,) and the engraving of coast map and chart No. 92, Gulf coast from Round island to Grand island, have been completed. The drawing has been continued on coast map and chart No. 93, Lake Borgne to Lake Pontchartrain; and additions have been made to the plates of lines of deep-sea soundings in the Gulf of Mexico, and progress sketch of the section.

SECTION IX. *Coast of part of Louisiana and coast of Texas.*—(*Sketch No.* 19.)—The triangulation of the coast of Texas has been extended from Stevenson's Point northward and eastward to the High islands, including the intervening bayous. Supplementary topography has been executed completing the detailed surveys of the shores of St. Charles, Copano, and Aransas bays. Tidal observations were continued at Calcasieu, La., until May, when the instruments were seized by unauthorized persons and the observer arrested.

The drawing and engraving of coast map and chart No. 107, Gulf coast from Oyster bay to Matagorda bay; the engraving of coast map and chart No. 106, Galveston bay to Oyster bay; and the drawing of coast map and chart No. 108, Matagorda and Lavaca bays, and of general coast chart No. XVI, Galveston bay to the Rio Grande, have been continued. Additions to the progress sketch of the section have been made.

SECTION X. *Coast of California.—(Sketches Nos. 20 and 21.)*—The triangulation required for connecting the Santa Barbara islands with stations on the main coast of California has been in progress. The topography from Point Piedras southward, including the shores of Half Moon bay, has been commenced, to make the plane-table survey complete between San Francisco entrance and the southern part of Monterey bay. The plane-table survey of the coast of California has been extended northward of Point Reyes to embrace the shores of Tomales bay, and the hydrography of that bay and its approaches has been completed. Tidal observations have been kept up at San Diego and San Francisco, with self-registering tide gauges.

The drawing has been completed, and the engraving, in preliminary form, of the chart of Drake's bay; the drawing of the map of Napa creek, and that of the chart of the approaches to San Francisco bay, has been completed; and the engraving has been continued on the chart of San Pablo bay. Additions have been made to the progress sketches of the section, and to plates of charts previously engraved.

SECTION XI. *Coast of Oregon and that of Washington Territory.—(Sketch No. 24.)*—The triangulation of the greater part of Coose bay, Oregon, has been completed, and connected with a preliminary base measured this season; the topography of that bay is well advanced, and the hydrography is now in progress. Observations have been made at Coose bay and at Gray's harbor, W. T., for latitude and azimuth. The preliminary base at Gray's harbor has been remeasured and marked, and the topography of the shores of the harbor completed.

The drawing has been completed and the engraving commenced of the chart of Coquille river, Oregon, and additions have been made to the progress sketch of the section.

MAPS AND CHARTS.

In the divisions of the Coast Survey office immediately concerned in the preparation and distribution of maps and charts more than the usual force has been employed, to meet the increased demand for information in regard to the coast and harbors of the United States. This has not been limited merely to points which have recently become the sites of actual warfare. The inquiry has been general, and has been promptly met as to the exigencies of the military and naval departments and defensive purposes of the seaboard States, but not with reference to the numerous calls arising from the interest felt by intelligent men at large for precise geographical information. Aside from its questionable expediency in a time like this, such a course presents difficulties in discriminating in all cases those to whom the annual reports and maps and charts might with propriety be distributed as heretofore. No pains have been spared in securing this result within limits of entire safety to national interests, the cases of applicants who were not well known having been referred to the representative of the congressional district from which the application had been mailed.

In order to meet the call for charts from the Naval Observatory to supply national vessels, two lithographic presses have been set up in the Coast Survey office, and an aggregate of more than two thousand copies of maps and charts printed from them.

The entire number of separate charts and sketches now completed, including, as well as those that are engraved, the lithographs referred to, is three hundred and twenty-eight, exclusive of seventeen plates of progress sketches.

Seventy-nine sheets have been worked on in the Drawing Division within the past year. Of this number, three are finished charts, twenty-one finished maps and charts, nineteen are

sketches, and twenty maps and sketches drawn for lithographic transfer. Fifty-eight sheets have been completed, and twenty-one are in progress. Of those completed, seven are finished maps, and the others preliminary charts and sketches.

In the Engraving Division nine first class maps and new editions of two have been completed during the year, and twenty are in progress.

Eight plates of second class charts and sketches and six diagrams have been engraved, and six are still in progress, and various additions and corrections to five plates previously issued have been engraved.

This gives a total of twenty-three completed and twenty-six in progress, or of forty-nine engraved or engraving within the year.

Twenty separate maps and sketches have been made and printed by the lithographic process at the office.

The following list contains the titles of charts and sketches which accompany this report. They are arranged geographically, and for convenience are numbered, the progress sketches and some of the charts being referred to under the several sections in the body of the report by corresponding numbers:

1.—A. Progress sketch, Section I, (primary triangulation.)
2.—A. bis. Progress sketch, Section I, northern part, (secondary triangulation, topography, and hydrography.)
3.—A. bis. Progress sketch, Section I, southern part, (secondary triangulation, topography, and hydrography.)
4.— Kennebec river, Me.
5.— Barnstable harbor, Mass.
6.— Mount Hope bay, R. I.
7.—B. Progress sketch, Section II.
8.— New York bay and harbor, (new edition.)
9.— Hudson river, from Haverstraw to Poughkeepsie.
10.—C. Progress sketch, Section III.
11.—D. Progress sketch, Section IV.
12.— North Landing river, (head of Currituck sound, Va.)
13.—E. Progress sketch, Section V.
14.—F. Progress sketch, Section VI, (Florida peninsula.)
15.—F. bis. Progress sketch, Section VI, (Florida reefs and keys.)
16.—G. Progress sketch, Section VII.
17.— Cedar Keys, (new edition.)
18.—H. Progress sketch, Section VIII.
19.—I. Progress sketch, Section IX.
20.—J. Progress sketch, Section X, (Pacific coast, from San Diego to San Luis Obispo.)
21.—J. bis. Progress sketch, Section X, (Pacific coast, from San Luis Obispo to Bodega head.)
22.— Petaluma and Napa creeks, (San Pablo bay, Cal.)
23.— Tomales bay, Cal.
24.—K. Progress sketch, Section XI.
25.— Coquille River entrance, Oregon.
26.— Koose bay, Oregon.
27.— Washington sound, W. T., (new edition.)
28.— General progress sketch, Atlantic, Gulf, and Western coast.
29.— Diagram illustrating phenomena of the solar eclipse of July, 1860.
30.— Charts of isogonic lines for the coast of Virginia, North Carolina, South Carolina, Georgia, and for the Gulf of Mexico.
31.— Diagrams illustrating the results of experiments on the expansion of drawing paper.

ESTIMATES FOR THE FISCAL YEAR 1862-'63.

The estimates for the next fiscal year are but little more than one-half of those of the present year. They will enable us to continue the regular work of the survey wherever our parties can move freely, to continue the working up of the information in regard to the coast already collected, and important to the government and its officers, civil, naval, and military, to collect new information indispensable to the movements of our fleets, and to preserve the essential organization of the survey, which has shown itself so variously useful both in the past and present.

During the past year I have kept steadily in view the directions approved by the department, as far as circumstances permitted, and have been generally successful in their execution, as my detailed report will show. I was aware that, under any circumstances, the information to be gathered must be of great value, and, with a proper flexibility in the conduct of the field and office work, might be immediately available to the country. These details belong to my annual report.

The survey was, as usual, in progress in every seaboard State and Territory of the United States, either in work in the field, or afloat, or in the office, pressing forward to completion according to a determined plan, which would have finished it on the Atlantic and Gulf coast in some eight years. In November, the exigencies of the treasury prevented the regular supply of funds for the southern parties, and in some cases their organization, until the development of the rebellion showed that the property of the survey was not safe in certain of the States. Two of our vessels were seized in Charleston harbor, and directions were necessarily given to the assistants in the survey to leave their several localities of work whenever they were molested in its execution, or the property of the government was in jeopardy. These instructions were well carried out, the assistants waiting until the necessity for removal was apparent. Insignificant losses of property only were sustained, except in the case of a vessel seized in Aransas harbor, Texas, having put in there from unseaworthiness. The survey has thus made considerable progress on the southern coast, notwithstanding the untoward circumstances of the time. During the spring and summer the parties were removed to the northern sections, and worked there in full force, and with full means, so that this part of the survey has advanced more than in its usual proportion. The call for the services of the officers of the army and navy being imperious, the operations generally have been executed by the civilians. The advantages of the organization of the work, which have often been stated, were never so fully displayed as in this exigency. The regular work was carried on systematically, though upon a reduced scale. The navy found on its roll, officers who had a knowledge of the harbors and coasts from service on the survey. To the army list were returned officers skilled in reconnaissance, and in the other various operations of the survey, and familiar with the coast and its shore-lines. The vessels of the survey, both steam and sail vessels, were ready in the emergency for the revenue and naval services, and were freely yielded to their use.

The material in the Coast Survey office was rapidly put in the shape of hydrographic notes, and by lithographic and photographic processes the unpublished maps and charts, and memoirs of the coast, were placed at the disposal of the departments of the government, and of the officers engaged in consultations in regard to or in the execution of operations along the coast. The calls for copies of charts of harbors and of the coast of the United States from the active chief of the hydrographic office, to distribute to the vessels of our navy, have been numerous, and have taxed greatly the resources of the office.

In the five months preceding the first of November, some six thousand copies of maps and charts have been supplied to the hydrographic office for the use of the navy. Copies of me-

moirs and accompanying charts have been furnished to government officers. I shall in my annual report call your attention to the expressions by the highest authorities of the several services to the great importance of the information furnished by the Coast Survey. The direction of its usefulness has been modified by circumstances, but its extent has been rather increased than diminished.

The topographical surveys made by the assistants of the Coast Survey, in co-operation with the accomplished officers of topographical engineers, have supplied rapidly, maps essential to the operations of the army. Especially has this been the case in the neighborhood of the capital, where the immediate completion of the map of the District of Columbia, and of its approaches, was called for by the military authorities, and executed by authority of the Secretary of the Treasury, under the joint direction and at the joint cost of the Coast Survey and of the military authorities.

The Atlantic coast triangulation is now complete, with an interval of some sixty miles, from Passamaquoddy, in Maine, to Matanzas inlet, south of St. Augustine, Florida. The gap between Cumberland sound, Georgia, and the St. John's river, Florida, was filled up last season. The line of coast thus triangulated, measured in the most general way, is not less than 1,590 miles. The extension of the surveys in Florida, of the Florida reefs and keys and coast, Louisiana, and Texas, and in the Gulf generally, will be stated in detail in my annual report. The hydrography, and perhaps other portions of the work, may be readily extended—filling up present deficiencies—by vessels of the Coast Survey accompanying the fleets. The advantage of a regular system by which efforts shall be directed to completing the charts on the coast will be readily appreciated. I have introduced into the estimates such amounts as may be usefully and economically employed for these objects, and am prepared to submit to you the strongest evidence of their importance and practicability, should there be any doubt in relation to them.

The progress on the Pacific coast has been satisfactory, embracing an extension of the usual work in California, Oregon, and Washington Territory. The diminution of the appropriation, and the changes in the officers serving there, have made certain abatements from the progress of previous years, which it will be my duty to state in my annual report, notwithstanding which, the progress has been, as above stated, satisfactory. The Secretary of the Navy has consented to the detail of an experienced and enterprising officer for the hydrography on the Pacific coast, to replace the able officer formerly engaged there, a great boon to the survey, when the necessity for the exercise of every resource in this important and extensive field is considered.

The completion of the telegraph line between San Francisco and Washington will afford us the most admirable and simple means of determining the difference of longitude between these points, with an accuracy much beyond that attainable by any other known method. The intelligent president of the line will give us every facility for this purpose. In this connexion I may mention that the observations of the Pleiades occultations are yielding, under Professor Peirce's computations, the most promising results for longitude between America and Europe.

The estimates include, as usual, separate items for the Atlantic and Gulf coast, Florida reefs, and Western coast, but they do not suppose the usual facilities from the War and Navy Departments by the detail of officers, except to the very limited extent of the present detail. The civil organization is taken at its present numbers, reduced by voluntary military service, and by other reductions which will be made to the very point where efficiency would be impaired, in the confident expectation that this endeavor to meet the circumstances of the country will be appreciated, and that further reductions, which would certainly impair the value of the work, will not be made.

In 1856–'57 the appropriation for the Coast Survey was $535,000; in 1858–'59, $452,800; the exigencies of the treasury in 1860–'61 caused a reduction to $402,800. The estimates now presented are for $299,000, or less by $103,800 than the appropriation of last year. The reduction is twenty-four per cent. of the amount then appropriated, and thirty-four per cent. of the amount now estimated.

It will enable us to keep the office up to the necessary point of efficiency for communicating information, indispensable to the government, and to continue the field-work and surveys afloat, at the desirable points of progress.

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 astronomical and magnetic observations connected with it; to continue the triangulation of *Passamaquoddy bay*, to extend the secondary triangulation from *Penobscot bay* and the *Fox islands* along the coast towards *Mount Desert*, from *Englishman's bay*, eastward, and up the *Penobscot river;* to continue the topography of *Passamaquoddy bay* and *Eastport harbor, Me.;* to commence that of *Goldsborough harbor, Me.;* to continue that of the approaches to *Penobscot bay*, and of *Rockland, Rockport, and Camden harbors, Me.;* to continue that of the *Kennebec and Sheepscot rivers, Me.*, and to connect the surveys; to complete that of *Cape Cod bay, Mass.;* to continue that of *Bristol Neck and the islands and main of Narragansett bay in R. I. and Mass.;* to continue the in and off shore hydrography of the coast of Maine, including *Passamaquoddy, Muscongus, and Penobscot bays*, and the ledges off the coast; to continue the tidal and magnetic observations at *Eastport and Portland*, and to make tidal observations in connexion with the hydrography: OFFICE-WORK.—To make the computations required by the field-work; to commence the drawing of *Damariscotta entrance, Me.; Rockland harbor, Me.; Eastport harbor, Me.; Bristol harbor and approaches, R. I.; Mount Hope bay and part of Narragansett bay, R. I.;* to continue that of general coast chart No. I., *Quoddy head, Me., to Cape Cod, Mass.;* coast map and chart No. 8, *Seguin island to Kennebunkport, Me.;* coast map and chart No. 7, *Muscongus bay to Portland, Me.;* coast map and chart No. 9, *Kennebunkport, Me., to Cape Ann, Mass.*; coast map and chart No. 11, *Plymouth to Hyannis, Mass.;* to complete the *Sheepscot and Kennebec rivers, Me., Barnstable harbor, Mass.;* general coast chart No. II, *Cape Ann to Gay Head;* to commence the engraving of preliminary sea-coast chart No. 2, *Isle au Haut to Cape Elizabeth, Me., Barnstable harbor, Mass.;* coast map and chart No. 7, *Muscongus bay to Portland, Me.;* coast map and chart No. 10, *Ipswich to Green harbor, Mass.;* to continue that of coast map and chart No. 8, *Seguin island to Kennebunkport, Me.;* coast map and chart No. 9, *Kennebunkport to Cape Ann, Mass.;* coast map and chart No. 11, *Plymouth to Hyannis, Mass.;* to complete *Sheepscot and Kennebec rivers, Me.;* general chart No. II, *Cape Ann to Gay Head, Mass.;* preliminary sea-coast chart No. 3, *Cape Small point to Cape Cod, Mass.*, and *Portland harbor, Me.*, will require 61,000

* Viz: of all included in this item, inclusive of sections I to IX, and exclusive of section VI.

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.* FIELD-WORK.—To continue the triangulation of the rivers of *Connecticut* and the verification of triangulation on the sea-coast of *New Jersey;* to commence the topography of the shores of *Connecticut river;* to continue that of the *Hudson;* to commence that of the sea-coast of *New Jersey*, (verification;) to continue the hydrography of the *Hudson river* and the verifications off the coast of *New Jersey;* to continue the tidal observations in the section: OFFICE-WORK.—To make the requisite computations; to commence the drawing of *Hudson river* No. 3, *Poughkeepsie to near Hudson;* to continue *Hudson river* No. 2, *Sing Sing to Poughkeepsie;* to complete coast map and chart No. 21, *New York bay and harbor*, *Hudson river* No. 1, from the *entrance to Sing Sing;* to commence the engraving of *Hudson river* No. 2, *Sing Sing to Poughkeepsie;* to continue that of coast map and chart No. 21, *New York bay and harbor;* to complete *Hudson river* No. 1, from the *entrance to Sing Sing;* and coast map and chart No. 25, *Delaware bay and river*, (new survey,) will require $17,500

SECTION III. *Coast of part of Delaware and that of Maryland, and part of 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, if practicable, the survey of the *Potomac* to replace the reconnaissance map; to complete the surveys of the *District of Columbia and approaches*, and, if practicable, of *James river* and the lower part of *Chesapeake bay;* and to continue the off-shore hydrography of the section: OFFICE-WORK.—To make the reductions and computations required; to commence the drawing of *Potomac river, Md.*, (upper sheet;) *Potomac river, Md.*, (lower sheet;) to continue that of coast map and chart No. 30 bis, between *Great Machipongo inlet and Cape Henry;* coast map and chart No. 30, *Chincoteague inlet to Great Machipongo inlet, Va.;* coast map and chart No. 36, *Chesapeake bay, York river, to entrance of bay, Va.*; general coast chart No. IV, *Cape May to Currituck, Va.;* to complete coast map and chart No. 35, *Chesapeake bay, Pocomoke sound, to York river, Va.; Patuxent river, Md.*, (lower sheet;) coast map and chart No. 29, *between Green run inlet and Little Machipongo inlet, Va.*; to commence the engraving of *Potomac river, Md.*, (upper sheet;) *Potomac river, Md.*, (lower sheet;) general coast chart No. IV, *Cape May to Currituck, Va.;* to continue that of coast map and chart No. 36, *Chesapeake bay, York river, to entrance of bay, Va.;* coast map and chart No. 29, between *Green river inlet and Little Machipongo inlet, Va.;* to complete coast map and chart No. 35, *Chesapeake bay, Pocomoke sound to York river, Va.;* coast map and chart No. 32, *Chesapeake bay, Magothy river to Hudson, Va.;* and coast map and chart No. 34, *Chesapeake bay, Potomac river to Pocomoke sound, Va.*, will require 13,500

SECTION IV. *Coast of part of Virginia and of part of North Carolina.* FIELD-WORK.—To complete, if practicable, the primary triangulation of *Pamplico sound*, and the secondary triangulation connected with it; to make the necessary magnetic observations; to complete the topography of the outer shore of *North Carolina south of Hatteras, to Core sound;* to continue the in and off shore work of the sea-coast of *North Carolina*, and of the sounds, and the observations of tides and currents, and of the *Gulf Stream:* OFFICE-WORK.—To make computations from the field data; to commence the drawing of coast map and chart No. 38, *Payne's Hill, Va., to Bodies Island Light, N. C.;* to continue that of general coast chart No. V, *Currituck sound to Cape Fear, N. C.;* general coast chart No. VI, *Ocracoke to Charleston, S. C.;* coast map and chart No. 37, *Cape Henry to Currituck*

sound, N. C.; to commence the engraving of coast map and chart No. 46, *Cape Lookout to Bogue inlet;* general coast chart No. V, *Currituck sound to Cape Fear, N. C.;* coast map and chart No. 37, *Cape Henry to Currituck sound, N. C.;* and coast map and chart No. 48, *Barren inlet to Lockwood's Folly inlet, N. C.*, will require $15,000

SECTION V. *Coast of part of North Carolina and that of South Carolina and Georgia.* FIELD-WORK.—To execute such work of triangulation, topography, and hydrography as may be practicable in the section, filling up the places not yet embraced in the surveys: OFFICE-WORK.—To continue the computations from field records; to commence the drawing of coast map and chart No. 56, *Sapelo sound to St. Simon's sound, Ga., Wassaw sound, Ga., Doboy sound, Ga., St. Catharine's sound, Ga.;* to continue that of coast map and chart No. 53, between *Stono inlet and Fripp's inlet, S. C.;* coast map and chart No. 54, *Fripp's inlet, S. C., to Ossabaw sound, Ga.;* general coast chart No. VII, *Winyah bay, S. C., to St. John's river, Fla.;* to complete *Savannah river, Ga.;* to commence the engraving of coast map and chart No. 53, *Stono inlet and Fripp's inlet, S. C.;* coast map and chart No. 54, *Fripp's inlet to Ossabaw sound, Ga., Coosaw river, S. C., Wassaw sound, Ga., Doboy sound, Ga., St. Catharine's sound, Ga.;* and to complete lines of deep-sea soundings will require 16,000

SECTION VI. *Coast, keys, and reefs of Florida.* (See estimates of appropriation for those special objects.)

SECTIONS VII, VIII, and IX. *Part of the western coast of Florida, northern coast of Florida, coasts of Alabama, Mississippi, Louisiana, and Texas.* FIELD-WORK.—To continue such portions of triangulation, topography, and in and off shore hydrography as may be practicable in filling up the portions unsurveyed of these coasts, (contemplates the employment of two steamers and two sailing vessels:) OFFICE-WORK.—To make computations; to continue the drawing of coast map and chart No. 84, *Ocilla river to Crooked river, Fla.;* coast map and chart No. 85, *St. George's sound,* (eastern part;) coast map and chart No. 88, *Choctawhatchee bay to Pensacola bay, Fla.;* general coast chart No. XIII, *Waccassassa river to Choctawhatchee river, Fla.;* to commence *Mobile bay,* upper part, (resurvey;) coast map and chart No. 96, *Delta of the Mississippi, La.;* to continue general coast chart No. XIV, *Choctawhatchee river to the Mississippi delta, La.;* to commence *Corpus Christi bay, Texas;* coast map and chart No. 109, *Matagorda bay to Aransas pass, Texas;* coast map and chart No. 110; to continue general coast chart No. XVI, *Galveston to the Rio Grande, Texas;* to commence the engraving of coast map and chart No. 81, *Chassahowitzka river to Cedar Keys, Fla.;* to complete lines of deep-sea soundings, *Gulf of Mexico;* to commence *Mobile bay,* upper part, (resurvey;) coast map and chart No. 93, *Lake Borgne to Lake Pontchartrain, La.;* coast map and chart No. 100, *Point au Fer to Marsh island, La., Corpus Christi bay, Texas;* general coast chart No. XVI, *Galveston to the Rio Grande, Texas;* to continue coast map and chart No. 108, *Matagorda and Lavaca bays, Texas;* coast map and chart No. 107, *Oyster bay to Matagorda bay, Texas;* and to complete coast map and chart No. 106, *Galveston bay to Oyster bay, Texas,* will require 36,000

Total for the Atlantic coast and Gulf of Mexico 178,000

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

SECTION VI. *Coast, keys, and reefs of Florida.* FIELD-WORK.—To continue, if practicable, the surveys of the eastern coast of the peninsula from the present limits; to complete the triangulation and topography of the southern keys and coast of the peninsula from *Card's sound* to the work at *Cape Sable;* to complete the hydrography of the reefs, and to run off-shore lines from the reef and coast of the section; to continue the magnetic observations at *Key West* and the tidal observations at the *Tortugas:* OFFICE-WORK.—To compute results from field records; to commence the drawing of coast map and chart No. 59, *St. John's river to St. Augustine, Fla.;* coast map and chart No. 73, the *Tortugas, Fla.;* topography of *Charlotte harbor, Fla.;* to continue coast map and chart No. 58, *St. Andrew's sound, Ga., to St. John's river, Fla.;* to commence the engraving of coast map and chart No. 73, the *Tortugas, Fla.;* topography of *Charlotte harbor, Fla.;* coast map and chart No. 69, *Garden key to Lower Matacumbe key, Fla.;* coast map and chart No. 70, *Long key to Big Pine key, Fla.;* to continue general coast chart No. X, *Florida reefs and keys, Key Biscayne to Marquesas keys;* and to complete coast map and chart No. 71, *Newfound Harbor key to Boca Grande key,* will require $11,000

SECTION X. *Coast of California.* FIELD-WORK.—To continue the triangulation from the *Santa Barbara* base northward and westward towards *Point Conception,* and to complete that of the islands off *Santa Barbara channel;* to continue the triangulation from *Bodega* northward; to make astronomical and magnetic observations in connexion with the triangulation; to continue the topography in connexion with the *Santa Barbara and San Francisco* triangulations; to complete that between *San Francisco and Monterey,* and to extend that north from *Bodega;* to continue the hydrography off and in shore along the coast from the previous limits; to continue the tidal observations at *San Diego and San Francisco:* OFFICE-WORK.—To continue the computations and reductions of the field-work; to commence the drawing of *Tomales bay, Cal.,* soundings off *Humboldt bay, Cal.;* to continue that north of *San Francisco entrance,* including *Drake's bay, Cal.;* to complete *Santa Cruz island, Cal., Petaluma creek, Cal., Napa creek, Cal.;* to commence the engraving of *Tomales bay, Cal.,* soundings off *Humboldt bay, Cal., Petaluma and Napa creeks, Cal., Santa Cruz island, Cal.;* to complete *San Pablo bay, Cal.* Also for the operations in—

SECTION XI. *Coast of Oregon and that of Washington Territory.* FIELD-WORK.—To continue the triangulations of *Washington sound,* and of the *Gulf of Georgia,* and of *Puget's sound,* and *Hood's canal,* and the topography and hydrography connected with them; to complete the hydrography of the harbors of the coast; to continue the magnetic and tidal observations required in the section: OFFICE-WORK.—To compute results; to commence the drawing of *San Juan island, Koos bay, Oregon; Gray's harbor, W. T.,* soundings off *Cape Blanco, Oregon,* soundings off *Port Orford, Oregon;* to continue that of *Washington sound, W. T.;* to commence the engraving of *San Juan island, Koos bay, Oregon, Gray's harbor, W. T.,* soundings off *Cape Blanco, Oregon,* soundings off *Port Orford, Oregon;* to continue that of *Washington sound, W. T.,* and the section sketches, will require 100,000

The other items of appropriation asked are small; the items for the line across the Florida peninsula, for fuel and quarters of army officers, and for the pay of engineers, being omitted, for reasons already stated. Those items called for are:

For publishing the observations made in the progress of the survey of the coast of the United States, by act of March 3, 1843	$5,000
For repairs of steamers and sailing schooners used in the survey, by act of March 2, 1853	5,000

The amounts thus estimated for the work of the fiscal year 1862–'63, and the appropriations for the present year, are given in parallel columns:

Object.	Estimated for fiscal year 1862–'63.	Appropriated for fiscal year 1861–'62.
For survey of the Atlantic and Gulf coasts of the United States, including compensation of civilians engaged in the work, per act of March 3, 1843	$178,000	$230,000
For continuing the survey of the western coast of the United States, including compensation of civilians engaged in the work, per act of September 30, 1850	100,000	110,000
For continuing the survey of the Florida reefs and keys, including compensation of civilians engaged in the work, per act of March 3, 1849	11,000	25,000
For completing the line to connect the triangulation on the Atlantic coast with that on the Gulf of Mexico, across the Florida peninsula, including compensation of civilians engaged in the work, 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, including compensation of civilians engaged in the work, per act of March 3, 1843	5,000	5,000
For repairs of steamers and sailing schooners used in the survey, per act of March 2, 1853	5,000	10,000
For fuel and quarters, and for mileage or transportation, for officers and enlisted soldiers of the army serving in the coast survey, in cases no longer provided for by the quartermaster's department, per act of August 31, 1852	----------	*5,000
For pay and rations of engineers for seven steamers used in the hydrography of the Coast Survey, no longer supplied by the Navy Department	----------	†12,800
Total	299,000	402,800

* Formerly included in estimates of War Department. † Formerly included in estimates of the Navy Department.

DEVELOPMENTS AND DISCOVERIES.

The list given in Appendix No. 6 is made up by additions from year to year of the discoveries and developments incident to the progress of the hydrographic work generally, but including also changes found and reported by the land parties, as in the case of alteration of shore-line either by the encroachment of the sea in any locality, or the contrary. It could not be expected that the lessened means of pushing the hydrographic work, arising, in part, from the necessary occupation of the Coast Survey vessels in revenue and other government service during the greater part of the year, but chiefly from the withdrawal of officers whose attention had been mainly given to their importance, should furnish as many items as usual of special developments. Such as have been made are here enumerated, and will also be found appended to the general list before referred to. The existence of points of rock in Sandy bay, Mass., was made known through Mr. W. P. G. Bartlett, of Cambridge. In sounding in smooth water, and in the only weather suitable for continuous hydrography, such obstacles would be struck

with the lead only by the merest accident. The method employed for determining the exact position of the dangers referred to is stated under the head of hydrography, in Section I.

1. Determination of the positions of four points of rock in Sandy bay, (Cape Ann,) Mass.

2. Special investigation of the currents of Boston harbor.

3. The currents of Cape Cod bay observed with reference to their physical effects on the shores.

4. Discovery of three small banks off the Nantucket shoals, in the vicinity of Phelps's bank, and further development of the extent of that shoal ground.

5. Development, by soundings, of a ridge lying sixteen miles off Barnegat, N. J., with eleven to thirteen fathoms of water, and sixteen fathoms between it and the coast.

6. Special examination made and changes noted in the vicinity of the Five Fathom bank, off Cape May.

7. Hydrographic changes developed in the Delaware river at the Bulkhead shoal, near Fort Delaware; at the bar off Fort Mifflin; and opposite to Philadelphia.

8. Development of important changes in the hydrography of the bar and channels of Hatteras inlet, N. C.

HYDROGRAPHIC NOTES.

During the past season I have prepared a series of hydrographic notes of the coast for the especial use of the War and Navy Departments. In these I have been aided by the experienced assistants of the Coast Survey, and especially by Carlile P. Patterson, hydrographic inspector, Professor W. P. Trowbridge, assistant, C. O. Boutelle, assistant, and F. H. Gerdes, assistant. These notes have been furnished, through the depot of charts and instruments of the navy, to such officers as the superintendent of that establishment deemed it proper to supply; also directly from the Coast Survey to bureaus of the War and Navy Departments, and to officers in charge of expeditions. To these notes all the maps of localities which could be rapidly prepared are attached.

The first copies of the notes were submitted to the blockade conference, referred to in the report of the honorable Secretary of the Navy, and consisting of Capt. S. F. DuPont, U. S. N., the undersigned, Superintendent of the Coast Survey, Brigadier General Barnard, U. S. A., and Commander Chas. H. Davis, U. S. N.

SPECIAL SURVEYS.

To meet the purposes for investigation of a commission, consisting of the chief engineer, General Joseph G. Totten, Commander Charles H. Davis, and myself, authorized to advise in regard to the preservation of Boston harbor, a resurvey of parts of the harbor was commenced last year, as stated in my annual report. The work required has been continued, and has included the revision of some further portions of the topography, and a thorough examination of the currents of the inner harbor and those of Charles river. The objects sought are the causes of hydrographic changes which have occurred, and the study of them is not the less interesting because complex and laborious. To the patience and zeal of Assistant Henry Mitchell, who has conducted throughout all the observations required by a physical survey, much credit is due for his steady and thorough attention to the objects kept in view by the commissioners. In addition to the observations recorded last season, numerous current stations have been occupied, and the influence of the bridges upon the tides and currents determined by many experiments. Although our results are of the most direct and practical character, we find at every step some points of scientific value, and of more than local interest. Among these I may mention the curves of density of the water determined for different tidal phases and for different distances from the mouth of Charles river. To these curves very peculiar forms are given by the two variables, *chemical diffusion* and *mechanical mixture*.

The work in Boston harbor has been made the subject of several special reports by the United States commissioners, who have instituted these inquiries at the request and at the expense of the city government.

The same commissioners, under the auspices of the legislature of Massachusetts, having under consideration certain questions involved in the proposed construction of a ship canal across Cape Cod peninsula, current observations have been made for their use at various stations in Cape Cod bay. The objects in these were to develop more fully the character and causes of a coast current discovered last season, and to furnish information relative to the race near Provincetown. In these undertakings Assistant Mitchell was very successful, and the commissioners are furnished with ample data for a special report on these subjects.

Experiments on the temperatures and density of the sea were made incidentally in connexion with the current observations, and have shown some important relations. The cold region off the eastern terminus of the proposed Cape Cod canal proves to be a cropping out of the cold substratum of the sea due to the coast current, which passes up into shallow portions of the bay. The mean temperature of the surface water off the mouth of Scusset river, for the month of July corresponds with the temperature of the sea off Race Point at a depth of about *twenty fathoms*. At this latter point the surface water was found in July to be about fifteen degrees higher in temperature than that of the lowest stratum. This contrast of temperatures is favored by the *increase of density with the depth*, which was distinctly detected by the hydrometer. The variation in specific gravity seems to exceed the greatest possible range due to changes of temperature. If this be so there should be very little alteration in the temperatures of the greatest depths for the different seasons, and the cropping out place near Scusset should in midwinter be warmer than the general surface water of the bay; a practical result of the highest value.

In a report made to a committee of the Massachusetts legislature last year by the United States commissioners we announced the discovery of the *cropping out* referred to above, and suggested that the phenomenon had an important relation to the success of the proposed Cape Cod canal and artificial harbor, especially with regard to the much vexed question of the freezing up in winter. An appropriation for a special study of this subject has been made by the legislature. The observations required to determine the question have not yet been completed.

Assistant Mitchell carried his investigations along the outer coast of Cape Cod, and found another cropping out of sub-currents (cold in midsummer) a mile from the shore of the peninsula, off Nausett.

Under authority of the Treasury Department, and by request of the commanding general of the army, topographical surveys in the vicinity of the capital have been made, as will be more fully described under the appropriate head, with notices of work done in Section III.

TIDES.

The tidal stations occupied, and results obtained from them, are shown in Appendix No. 10, and the office occupation connected with the observations in the report of Assistant L. F. Pourtales, as chief of the tidal division of the office, Appendix No. 12.

The tide tables prepared for the use of navigators were revised in May last, and, under the demand which then existed, were printed in pamphlet form and distributed from the Coast Survey office and from the Naval Observatory, for the use of government vessels. These tables are included with this report, as Appendix No. 9.

INFORMATION FURNISHED.

Appendix No. 4 gives, in the usual form, a synopsis of the general information furnished from the office during the year, in answer to special calls. The regulation of the department

under which data are supplied to applicants, requiring merely that acknowledgment be made in the title of any publication in which it might be embodied, has been adhered to. When tracings or abstracts from the archives requiring time in their preparation are called for, the actual cost, at the working rates, is defrayed by the applicant.

For obvious reasons, the list referred to does not include the mention of a large amount of special information supplied at the call of the various departments of the government, and to officers in every branch of the public service.

STATISTICS.

The table of statistics has been added to, so as to bring it up to the opening of the present surveying year, and is given in Appendix No. 5.

Up to 1860, inclusive, the triangulation had covered an area of nearly sixty-one thousand four hundred square miles; had developed a general extent of coast of over four thousand three hundred, and a shore-line of about twenty-one thousand seven hundred miles, determining nine thousand and fifty geographical positions.

For longitude determinations eighty-three stations had been occupied; for latitude, one hundred and twenty-five; and for azimuth, eighty-two stations.

The topography had extended over an area of sixteen thousand two hundred square miles, having a general coast line of over three thousand seven hundred, and more than forty thousand miles of shore-line, measuring the indentations.

The hydrography extended over an area estimated at forty-five thousand four hundred square miles, in which more than one hundred and ninety-three thousand miles were run in sounding; six million one hundred and seventy-four thousand soundings made, and over eight thousand two hundred specimens of the bottom obtained.

The number of manuscript maps and charts was two thousand and sixty-eight, and of engraved maps, charts, and sketches, four hundred and seventy plates.

DISTRIBUTION OF REPORTS AND MAPS.

The distribution of the report of 1859 has been confined to individuals and institutions in the loyal States of the Union. Of the six thousand two hundred extra copies ordered by the Senate and five thousand by the House of Representatives, eight thousand were to be distributed from the office. It has been judged expedient during the past year to suspend the usual foreign distribution through the Smithsonian Institution.

More than twenty-one thousand copies of maps, charts, and sketches have been sent from the office since the date of my last report—a number exceeding the average yearly distribution by thirteen thousand. This large increase has been due to the demands of the War and Navy Departments, every effort to supply which will continue to be made.

LONGITUDE.

This subject has received two very important additions from the pen of Professor Benjamin Peirce, of Harvard. The first, (Appendix No. 16,) entitled "*Report upon the determination of the longitude of America and Europe from the solar eclipse of July* 28, 1851," embraces a discussion of all the observations published in this country and in Europe, divided into the following five classes: 1. European observations, which record the beginning and the end of the eclipse at the same place; 2. European observations, of which the duration of the eclipse is used, but indpendent observations of the beginning and end rejected for want of a reliable longitude; 3. European observations, of which only one phase of the eclipse is used; 4. European observations; 5. American observations. Hansen's lunar tables were employed in the computation. The conditional equations are divided into two sets, one involving the interval of duration, the

other the mean time of phases. The final equations contain, as quantities to be determined, the correction to the adopted sum of the semi-diameters, that of the tabular longitude, and that of the assumed longitude of America. The longitudes of seven American stations are determined, and the probable error of the final result for the longitude of Washington is only half of a second of time.

The second paper (Appendix No. 17) contains the first fruit of a plan adopted for the determination of our longitudes, by observing occultations of the Pleiades. To render this rather intricate reduction more generally useful, I have thought it expedient to insert the report of Professor Peirce in full, as an example for similar computations. The period between the years 1838 and 1842 is now under discussion, and the example given treats the emersions of September 26, 1839. Observations, taken at six places in Europe and America, have been collected. To the method of reduction which was given in Appendix No. 24 of my annual report for 1856 some auxiliary formulæ have since been added. In the computation Hansen's lunar tables were used. The probable error to be assigned to the final result for longitude from all the occultations is estimated not to exceed one-tenth of a second of time, and the greater part of that estimated error is due to uncertainty in the lunar parallax. The longitude deduced in this example agrees well with the result found by the discussion given in the preceding paper.

In Appendix No. 18 will be found an abstract of the elaborate report made by Dr. B. A. Gould, on the difference of longitude between the cities of Albany and New York. The line of telegraph was used for the observations, connexion being made through it between a station in the grounds of the Dudley Observatory, at Albany, and the private observatory of L. M. Rutherford, esq., in New York city. The method employed is the same that has been applied to the determination of the longitude of all the principal points on the coast of the Atlantic and Gulf of Mexico, and has been repeatedly mentioned in my previous reports.

SOLAR ECLIPSE OF JULY 1860.

In addition to the observations of this eclipse, given in my last annual report, I have inserted in the Appendix of this report (Nos. 19, 20, and 21) abstracts of the observations made at the Coast Survey station on Gunstock mountain, and at Cambridge, Mass., and Washington city. It is expected that the combined observations of this eclipse will yield a valuable result to the determination of our principal longitudes.

OCCULTATIONS OF PLEIADES, ETC.

During the past year the charts of predictions of occultations of the Pleiades have been forwarded, in pursuance of the general plan proposed by Professor Peirce, of Cambridge, Mass., and committed to his execution. The computations have been made, as heretofore, by Mr. Edward Pearce, jr., under the general direction of Professor Peirce.

The list embraced twenty-eight stations in Europe and twenty-four in America.

Charts for the series of December 24, 1860, were forwarded to the foreign and to the American stations, and for the series of February 17, 1861, to the foreign stations only, the occultations of that date not being visible in America.

Returns of forty-nine results have been received from the American stations.

The records of twenty-six moon culminations, observed at Cincinnati, have been furnished by Professor O. M. Mitchel.

MAGNETISM.

In this department of science three contributions have been furnished for this report by Assistant C. A. Schott, and will be found in the Appendix, Nos. 22, 23, and 24. The first one treats of the secular change of the horizontal and total intensity of the magnetic force at a

number of stations along our Atlantic, Gulf, and Pacific coast, to which some adjacent foreign stations have been added. This paper, like the preceding ones on the secular change of the other magnetic elements, gives us the means of referring observed intensities to a common epoch, for the purpose of comparison and combination. The comparatively short period of time since intensity observations were first made, (beginning with the present century,) as well as the difficulty of expressing the older relative values in absolute measure, has necessarily delayed the investigation, at least until approximate results could be expected from the material. The discussion embraces thirty-six stations, with a total of two hundred and seventy observations collected, and now combined for the present investigation. All values have been expressed in the English units of grains and feet. On the Atlantic coast the horizontal force is found decreasing; on the Pacific coast it is increasing; but the total force is very nearly stationary.

The second paper (Appendix No. 23) contains a new discussion of the magnetic declination along the coast of the Gulf of Mexico, a paper of direct practical character and of scientific interest. The epoch to which all the observations were referred is January, 1860, and the discussion is therefore an enlarged edition of my paper on the distribution of terrestrial magnetism, for the epoch 1850, given in the appendix of the annual reports for 1855 and 1856. The earliest observation admitted in the new discussion was made in 1840, and the total number used is thirty-six, or more than twice the number used before. The secular change is fully discussed within the limits of the paper. Some few observations were admitted from other than Coast Survey records. The most approved formula was employed for the analytical expression of the distribution of magnetism, for which purpose six groups were formed. The probable error of a single representation is very small. This, as well as the next paper, concerning the variation of the compass, was prepared for the immediate use of our naval squadrons, and the results of both were printed in pamphlet form and furnished to the proper officers of the government during the summer.

The third paper (Appendix No. 24) shows the distribution of magnetic declination in January, 1860, along the lower part of the Atlantic coast of the United States. The discussion is similar to that in the preceding paper, and comprises twenty-one observations. The results are shown graphically for the Atlantic coast and for the Gulf of Mexico in Sketch No. 30.

SOLAR SPOTS.

In Appendix No. 25 are given the records of these observations to January, 1862, made by Assistant Schott, in continuation of a series published in the appendix of my last annual report. Their probable connexion with terrestrial magnetism has been heretofore discussed.

HEIGHTS.

The collection of data for representation on a map of heights in North America, carried on in conjunction with the Smithsonian Institution, has been continued during the past year. About fifteen hundred points have been obtained since last year's report, making, in all, over fourteen thousand points, derived from explorations for roads and railroads and geological surveys, as well as from the constructed lines of canals and railroads.

The collection of maps of States, counties, and minor details made during the prosecution of this work, by Mr. W. L. Nicholson, has been of service in the present demand for precise knowledge of the topography of the interior; bringing out, at the same time, more and more, the need for thorough trigonometrical surveys to reconcile and avoid the discrepancies in positions and the omissions apparent in so many of the existing maps of the interior.

EXPERIMENTAL INQUIRIES.

Though the interest in regard to improvements in instruments and apparatus has not been lessened, but few occasions during the year have called for the application of implements not already in use. A new form of sounding apparatus, devised by Professor W. P. Trowbridge, to register depths in comparatively shallow water, has been tried with success. The results are given in Appendix No. 11.

In the office, experiments have been made to test the relative accuracy, for critical purposes, with reference to the shrinkage and expansion of manuscript maps on parchment paper, as compared with the same if made on backed drawing paper. The results, given in Appendix No. 15, and also shown graphically in Sketch No. 31, are conclusive in favor of the paper backed with common muslin.

OFFICERS OF THE ARMY.

The names of officers of the army on Coast Survey service at the opening of the present surveying year are given in Appendix No. 2, as also the dates at which some were detached by orders from the War Department, and at which others resigned. Of twelve officers then attached, and qualified not only by natural aptitude, but also by experience in the field or office, only two remain on the list, both actively engaged in their profession, and ready for calls which would necessarily be preceded by orders detaching them formally. Captain (now Major) W. R. Palmer, of the corps of topographical engineers, is still in charge of the Coast Survey office, but is also actively on duty as a member of the staff of the commanding general. Captain T. J. Cram, of the same corps, an officer of great experience in field service in the survey, is at present on military duty at Fortress Monroe, though not withdrawn from the employments of the Coast Survey by formal order. With the loss of his assistance must be counted that of Lieutenants George Bell, O. D. Greene, W. R. Terrill, and W. Craig from the list of field assistants, and Lieutenants J. R. Smead, N. H. McLean, and Thomas Wilson from the Coast Survey office, detached on the 18th of April in consequence of the crisis which was then hastening in the affairs of the nation. Three other officers, viz: Captain M. L. Smith, of the topographical engineers, and Lieutenants R. G. Cole and W. G. Gill, had previously resigned, the first at the beginning of April, the second on the 10th of January, and the last named at the beginning of February. These officers were at those respective dates either engaged or making preparation for continuing field duties, which all of them had discharged acceptably in the preceding season.

Aside from their qualifications for the work of the Coast Survey, on which it would be here in place to remark, I would take the occasion to place on public record, as less than their due, official mention of the inflexible spirit of loyalty manifested by the younger officers previous to the emergency which withdrew them in April last. My regret in parting with them has been tempered not only by the occurrences which returned them to the line of their profession, but also by the cheering conviction that the spirit which has carried them through great personal trials has been committed to men who are not likely to be moved by any but principles of consistency and honor. The fact may be passed that the confusion of social relations only in a slight degree affected several of the officers referred to. The trial of principle in the case of two, at least—Lieutenants Terrill and Bell—was such as few men have met, and fewer resisted. That in the emergency which had arisen such men were found in positions of special usefulness, in which they had engaged when the calls of their profession were not imperative, cannot be regarded as fortuitous. The way being open, they pressed in, accepting toil and hardship cheerfully on the road to usefulness. One was engaged in triangulation on the coast of Florida, and the other on the coast of Texas, when our national affairs became involved. Both were energetic and sagacious in the discharge of duty, and both bid fair to rank with

the ablest, as they do with the most highly esteemed, officers who have been associated with the labors of the Coast Survey.

The charge of the Drawing Division, the operations of which had been directed for several years with marked ability by Lieutenant Thomas Wilson, was, soon after his detachment from the survey, assigned to Captain T. J. Lee, with the sanction of the Treasury Department. The precision in details and method practiced by Lieutenant Wilson in conducting work have added much to the efficiency of the division.

Lieutenant G. H. Elliot, of the corps of engineers, continues the supervision of the tidal observers on the Western coast, under an arrangement which, as it does not interfere with his general duties, has been cordially acceded to by the chief engineer of the army.

OFFICERS OF THE NAVY.

When the surveying year opened, the prospects in regard to the hydrographic work laid out for execution were bright. The number of officers spared by the Navy Department was small, but they were well acquainted with the requirements of the survey, and, under ordinary circumstances, they would have sustained amply the reputation which they had rapidly earned as skilful and energetic hydrographers. Commander James Alden was detached, at his own request, in October, 1860, and had been replaced on the list by the assignment of Commander D. D. Porter to the charge of the hydrographic work on the Western coast. The last-named officer, whose experience on the survey in former years, and well-known energy and intelligence, gave large promise of public benefit, had completed his preparations for proceeding to the Pacific coast just before our national troubles began to take shape. An early occasion requiring, for the immediate honor of the government, the strength of an indomitable will, and loyalty as inflexible, took him necessarily from the list on which his name had stood so high. This was at the end of March. Events which quickly followed in the record of national disaster withdrew the officers then left in the service of the Coast Survey, with a single exception, the immediate necessities of the government requiring that at least one trained hydrographer should remain subject to its call for special duty. The allotment fell on Lieut. Comg. T. S. Phelps, whose labors have not intermitted throughout the year. Lieut. Comg. J. C. Febiger was detached on the 22d of May, and Lieut. Comg. J. P. Bankhead on the 8th of June. The first-named officer had been only recently assigned to a second period of duty in the survey, and the second was under instructions, at the opening of the season, for the prosecution of work in which he had previously shown great zeal and aptitude. Allusion will be made, under another head in this report, to the site of work and duties assigned to this able officer, and to the circumstances which made their execution impracticable.

There being at the critical juncture in public affairs which was passing in May no hydrographic officer on the Western coast, the honorable Secretary of the Navy, at my suggestion, assigned for that important duty Commander B. F. Sands, an officer of large experience, prudence, and ability. As was expected, Commander Sands has since that date co-operated with the military authorities in California in active service, (see Appendix No. 32,) and when the emergency passed which had called for it has advanced the hydrography. His resources, gained by previous duty on the Coast Survey, and natural energy of character, abundantly qualify him for sustaining the interests of the government in either line of service within his profession, as circumstances may require. Appendix No. 3 gives, in the form of a list, the names of all the officers who were attached to the survey last spring, and the dates at which they were either severally detached, or withdrew from the service. The efficiency of the hydrographic office, which had been left vacant by the departure of Commander S. S. Lee and Lieutenant Silas Bent at the end of April, was restored early in May by Captain Carlile P.

Patterson, formerly of the United States navy, and assistant in the Coast Survey, who was assigned to duty in that division of the office under authority of the Treasury Department.

Of the other officers whose names are given in the list in Appendix No. 3, three, viz: Commander W. T. Muse, Lieutenant John Wilkinson, and Lieutenant C. M. Fauntleroy, had been engaged in hydrographic duty during the preceding autumn. The labors of each of them had been marked by zeal and success. Lieutenant R. P. Pegram had been recently assigned to duty in the survey, and was preparing for service afloat when he resigned from naval service.

AIDS TO NAVIGATION.

The result of an examination, made by direction of the Treasury Department, with reference to the expediency of erecting a light-house at the entrance of Gray's harbor, W. T., is given in Appendix No. 34.

The usual progress of the hydrography has brought to the notice of the chiefs of parties in previous seasons the desirableness of minor aids to navigation, as beacons, buoys, and leading marks in the vicinity of channels. These have been communicated from time to time for the information of the Light-house Board. This year, by reason of the fact that along a large part of the coast of the United States the light-houses and day marks have been destroyed, the remarks have been confined to few localities, and chiefly refer to replacing marks that had previously existed.

OBITUARIES.

The opening of the present surveying year was sadly marked by the death of Mr. A. W. Thompson. He entered the survey in March, 1857, and until within a short period before his decease was steadily engaged in field duty, where, by his gentleness and devoted fidelity to the interests intrusted to him, he won the esteem of all with whom he was associated. Mr. Thompson served as a volunteer in the astronomical expedition to Labrador in July, 1860, and after its return rejoined the field party with which he had been previously on duty. While on service with the expedition he contracted a cold which ended in consumption, of which he died, at his home in Philadelphia, on the 19th of December, 1860.

Another of the aids, Mr. M. O. Hering, of excellent attainments in that grade, died of the same wasting disease on the 6th of November, after a lingering illness. He had served with constant fidelity during several years, and his varied talents—having, amongst other qualifications, considerable skill as a draughtsman—were always brought to bear fully in the furtherance of any work with which he had to do. Mr. Hering had also been attached to the Coast Survey office, and was highly esteemed for his kind and manly disposition.

PART II.

In the same general order in which the work of the present year has been mentioned in the preceding pages, detailed statements will now be given of the progress made in each locality of the coast to which parties have been sent. As far as practicable, the field work and hydrography will be arranged in geographical order. The triangulation, as preceding the plane-table work in the field, will be noticed first, generally, but jointly with other operations when the same party has carried on the topography and soundings.

SECTION I.

FROM PASSAMAQUODDY BAY TO POINT JUDITH, INCLUDING THE COAST OF THE STATES OF MAINE, NEW HAMPSHIRE, MASSACHUSETTS, AND RHODE ISLAND.—(SKETCHES NOS. 1, 2, AND 3.)

Separate notice will be taken of work done in the several localities in this section, in the following order:

1. Progress in the triangulation and the taking up of the topographical and hydrographic survey of Passamaquoddy bay in the vicinity of Eastport harbor.

2. The extension of the secondary triangulation of the coast of Maine over the bays and harbors between Moose-a-bec island and Mount Desert, including the mouths of several of the rivers emptying into them.

3. Triangulation of the coast of Maine and islands in the vicinity of Isle au Haut, connecting with the preliminary work done in Penobscot bay and that going eastward from Mount Desert.

4. The triangulation of Penobscot bay continued from the Fox rocks northward, and reaching nearly to the head of the bay.

5. Primary triangulation completed in this section for connecting the primary base on Epping Plains, Me., with the base on Fire island in Section II. Magnetic observations were made in connexion with the geodetic work.

6. Triangulation in the upper part of Narragansett bay, to furnish points for the topographical survey and hydrography.

7. Topography of Rockland harbor, Me., and of the adjacent western shore of Penobscot bay as far south as Fogg hill, below Thomaston.

8. Plane-table survey continued on the shores of Back river, between the Sheepscot and Kennebec, including Hoakomoak and Hanson's bays and parts of Woolwich peninsula.

9. Topography continued at the junction of the Kennebec and Androscoggin rivers, and embracing the immediate vicinity of the banks of both rivers above the junction.

10. Shore line survey of the upper part of Casco bay, between Little Flying Point and Drinkwater's Point, including the shores of Freeport and Yarmouth rivers. This survey embraces also some detailed topography within the limits stated, and a portion of the surface features of Harpswell Neck.

11. Topography of the shore of Cape Cod bay in the vicinity of West Sandwich completed. This work connects the plane-table survey of the mouth of Scusset river with the survey of Barnstable harbor.

12. Topographical survey commenced by tracing the shores of Mount Hope bay and filling in parts of the details, including its rivers, the islands in the vicinity, and the contiguous shores of the upper part of Narragansett bay.

13. Hydrography of the Kennebec river continued from Bath northward through Merrymeeting bay, and in the Androscoggin river to its lower bridges.

14. Hydrography of the upper part of Casco bay nearly completed. This work joins with the survey of Portland harbor and with soundings made at the entrance of the bay and eastward of the harbor. It leaves only a small space requiring soundings in order to complete the chart of Casco bay.

15. Development of the positions of four rocks in Sandy bay, Cape Ann.

16. Current observations in the upper harbor of Boston, for the investigation of commissioners appointed to examine in regard to their effects and causes.

17. Hydrography of Barnstable harbor completed.

18. The currents of Cape Cod bay examined with reference to their bearing upon questions under consideration in the legislature of Massachusetts.

19. Further hydrographic examination off the Nantucket shoals, and development of several small banks, and a prolongation of that found last year, and now known as Phelps's Bank.

20. Hydrography of Mount Hope bay and of the adjacent part of Narragansett bay.

21. Tidal observations at Eastport, Me., and Charlestown navy yard, Mass.

Office-work.—The engraving of coast maps and charts No. 12, Nantucket sound; No. 13, Buzzard's bay and Vineyard sound; and of No. 14, from Point Judith to Block island, has been completed, and additions have been made to the progress sketch of the section. Progress has been made in the drawing and engraving of coast maps and charts No. 8, Atlantic coast, from Seguin island to Kennebunkport; No. 9, from Cape Neddick to Cape Ann; No. 11, from Plymouth harbor to Hyannis harbor; and in the engraving of general coast chart No. II, from Cape Ann to Gay Head; in that of preliminary sea-coast chart No. 3, Cape Small Point to Cape Cod; and on the chart of Portland harbor. The drawing has been continued and the engraving commenced of the chart of the Sheepscot and Kennebec rivers; and the drawing has been commenced of general sea-coast chart No. I, Atlantic coast, from Quoddy Head to Cape Cod; of coast map and chart No. 7, Muscongus bay to Portland; and for a finished chart of Barnstable harbor.

Triangulation, topography, and hydrography of Passamaquoddy bay, Me.—The survey of Passamaquoddy bay was in full progress at the usual period for taking up work in Section I, and, under the stress of circumstances which had withdrawn the usual assistance from the Navy Department, the three classes of work were confided to Assistant C. O. Boutelle. Mr. C. H. Boyd, under his direction, was assigned to carry forward the triangulation. The topography was placed in charge of Sub-Assistant W. H. Dennis. Mr. Robert Platt, the efficient first officer of the Arago, and Mr. E. Willenbucher, an experienced hydrographic draughtsman, were associated with the party, the soundings being made under the immediate direction of Mr. Boutelle.

The stations occupied for the triangulation rest on the shores of the Bay of Fundy, on Campo Bello and Deer islands, and on some of the smaller islands of Passamaquoddy bay, in the vicinity of Eastport. These were selected so as to join with the primary triangulation of the coast of Maine, as well as to furnish points for the thorough survey of the shores and islands belonging to the United States, and to show their positions relative to the shore and islands across the boundary, in the province of New Brunswick. This duty was prosecuted between the 20th of July and the 11th of November. A few of the stations of last year were reoccupied. The field statistics are given below:

Signals erected	19
Stations occupied	25
Objects observed on	76
Number of observations	15,540

Vertical angles were measured at eight stations, and about five hundred readings recorded. The journal in which the observations were noted was kept by Master J. P. Odell, of Eastport, who volunteered to serve as recorder, and acceptably performed the duties assigned.

All the records of the triangulation have been duplicated, and the computations are now in progress in the hands of Mr. Boyd.

Assistant Boutelle was recalled at the close of October by a pressing emergency for his services in Port Royal sound, S. C., his intimate personal knowledge of that locality being deemed of importance as bearing on the success of an expedition destined to restore it to the possession of the government. I had previously visited the working ground of the party near Eastport.

The topography of Passamaquoddy bay, in charge of Sub-Assistant Dennis, was limited to the requirements of the party engaged in sounding with the schooner Arago. Two sheets were projected—one to define the shore-line of the passage between Deer island and Campo Bello, (Sketch No. 2,) the other to contain the entire shore of Moose island and the adjacent shores of Campo Bello, Deer island, and part of the shore of Passamaquoddy bay. While engaged under the direction of Mr. Boutelle, Sub-Assistant Dennis traced about fifty miles of shore-line. He was recalled on the 16th of October, and assigned to duty in the vicinity of Washington city, (Section III.) and later in the season in Port Royal sound, where he is still on duty. The limits of the hydrography correspond nearly with those of the plane-table sheets. The soundings were made during the month of August, and comprise the hydrography of Eastport harbor and anchorage, (Sketch No. 2.) Progress was made in sounding the entrance to Passamaquoddy bay, but the completion of work there was deferred for special duty elsewhere. In the course of the season about four hundred miles were run in soundings, and about eight thousand casts made with the lead. The strong tidal current made it necessary that sextant angles should be taken at each cast. A tide gauge was established at Lubec and another at Eastport, and both were read day and night while the soundings were in progress. The experience of Mr. Platt, who had served acceptably in several of the hydrographic parties of the Coast Survey in former seasons, added to his energy and intelligence, qualified the party in the Arago fully for the difficulties met with in prosecuting the hydrography. The progress of work was suspended by special duty incidentally devolved on the party of Assistant Boutelle, in the absence of any other government vessel at Eastport. Under the authority of the collector of customs at Eastport, Mr. Boutelle in the last of August seized two ships, the *Express* and *Orizimba*, said to be wholly or in part owned by parties in New Orleans, and subject to confiscation under the act of Congress approved August 6, 1861. On the 4th of September the ship *Alice Ball*, of New Orleans, was taken by the Arago in the Bay of Fundy, the schooner being then on a cruise at the request of the collector. The three vessels were left in his custody at Eastport, the circumstances attending their capture being made known at once to the department. When the hydrography was about to be resumed, Mr. Platt and an armed party from the Arago were called on to quell a mutiny on board of the American ship General Norvell, and promptly put the mutineers in the custody of the proper authorities. A laden brig which had run on a ledge of rock in Eastport harbor was relieved from distress and got afloat by the party under Mr. Platt. Aside from the interruptions alluded to, the soundings were continued until near the middle of October, when the Arago sailed for New York, and after refitting joined the blockading squadron then about to sail from Hampton roads for Port Royal sound, under the orders of Commodore DuPont.

Triangulation of Prospect harbor, Goldsborough, Dyer's, Pigeon Hill, and Narraguagus bays, Pleasant bay, and Cape Split harbor, Me.—The secondary triangulation of the coast of Maine, east of Mt. Desert, was resumed early in July by Sub-Assistant F. P. Webber, and has been extended northward and eastward (Sketch No. 2) over the indented coast and harbors between Frenchman's bay and Moose-a-bec island. Mr. Webber took up the work at Schoodic station, and erected signals during the part of the season which was most unfavorable for observing with the theodolite. The secondary triangulation of this year is connected with the primary work in the vicinity of the Epping base, and furnishes points for the plane-table survey of

numerous rivers and small bays in addition to those already mentioned, and the islands which stud the coast of Maine in their neighborhood.

The schooner Hassler was used by the party of Sub-Assistant Webber, and laid up, when the season closed, at Rockland.

The angular measurements at stations embracing the several bays and harbors comprised in the triangulation were made in September and October, the previous months not being so favorable for the purpose. Two theodolites were used, the ten-inch Gambey, C. S. No. 63, and six-inch Brunner, C. S. No. 52. Vertical angles for height were observed at eleven stations. The field-work was continued until the 5th of November. A summary of the statistics is here appended in the usual form:

Signals erected	28
Stations occupied	18
Angles measured	428
Objects observed on	391
Number of observations	5,168

Fifty-four points were determined by this triangulation, and six hundred and seventy-two observations made on fifty-three objects in the measurement of vertical angles.

I visited the party of Mr. Webber early in October, and personally inspected his arrangements for the work.

Triangulation of Great Blue Hill bay, Me.—The secondary triangulation required for the plane-table survey of the shores of Blue Hill bay, between Deer island and Mount Desert, was taken up by the party of Assistant G. A. Fairfield in the middle of August. To the eastward, as will be seen by reference to Sketch No. 2, this work is intended to connect with the secondary triangulation of this and the previous season, executed by Sub-Assistant Webber. Westward it joins with that of Penobscot bay, and, like the portions just referred to, it is connected directly with stations of the primary triangulation which stretches quite across the coast of Maine. The party of Mr. Fairfield used the schooner Bowditch for transportation. At the end of the working season the vessel was laid up at Rockland, on Penobscot bay. In the early part of October I inspected the field operations personally.

Mr. F. S. Eastman took service as aid in the party of Assistant Fairfield and remained until the 30th September, when he resigned.

The following synopsis shows the general progress made in the secondary work between the Penobscot and Frenchman's bay:

Signals erected	8
Stations occupied	7
Angles measured	146
Number of observations	2,774

The horizontal angles were measured with a ten-inch theodolite, No. 91, constructed by E. & G. W. Blunt.

Assistant Fairfield has duplicated the record of his observations, and is now preparing decriptions of the signals and stations of the triangulation.

Triangulation of Penobscot bay, Me.—The determination of points for the topographical survey of Penobscot bay above the Fox islands was resumed on the 2d of August by a party under the charge of Sub-Assistant S. C. McCorkle in the schooner Torrey. This work, as remarked in a previous report, connects with the primary triangulation of the coast of Maine by the line *Ragged Mount—Isle au Haut*, the secondary work of this year being quite north of that line. The positions determined by Mr. McCorkle provide for the topography of the shores of

Penobscot bay, nearly up to Castine, and of Isleboro', including Crow cove, Gilkey's harbor, and Bounty cove. The work was continued until the 25th of October. The triangulation of the upper part of the bay to the mouth of the Penobscot river is provided for by the reconnaissance and signals set up, and will require only part of the next season for its completion.

Mr. T. C. Bowie aided in the field-work of this party. The plan of the triangulation is shown on Sketch No. 2. To the eastward and southward it joins with work done by the party of Assistant Fairfield. The following statistics show the progress made by the party of Sub-Assistant McCorkle:

Signals erected (tripods)	8
Stations occupied	12
Angles measured	105
Number of observations	1,902

The angles were measured with the six-inch Gambey theodolite, C. S. No. 29, and ten-inch, No. 15, and with the ten-inch theodolite, No. 91, by E. & G. W. Blunt.

After closing for the season the schooner Torrey was laid up at Peekskill, N. Y., with other vessels, under the charge of Assistant Blunt.

Primary triangulation for connecting Fire island base with Epping base.—The party under my immediate direction was organized for field service in this section and in Section II in the latter part of June.

Monadnoc mountain, in the township of Jaffrey, Cheshire county, N. H., was occupied by my party for extending the primary triangulation in a straight course towards the Fire island base. The preliminary arrangements were made at the station, as usual, by Mr. Thomas McDonnell, and on their completion, near the middle of July, Assistant George W. Dean took up the geodetic observations and completed them without delay. Urgent official engagements connected with the public service, to which further allusion need not be now made, delayed my departure from Washington, so as to make it impracticable to visit the party before its transfer to a second station in Section II.

Five primary signals were observed on from the station on Monadnoc with the thirty-inch theodolite, C. S. No. 1. The most distant one was about sixty two miles from the instrument. In the measurement of horizontal angles four hundred and forty-four observations were recorded. Vertical angles were measured on the five stations, and in so doing four hundred and twenty observations were made with the eight-inch Gambey circle, C. S. No. 57. The usual meteorological registers were kept during the stay of the party on Mount Monadnoc.

All the records connected with the primary work of the season have been duplicated and deposited in the Coast Survey office.

Sub-Assistant R. E. Halter assisted Mr. Dean in this and in the adjoining lower section, notice of which will be made in the next chapter.

Mr. R. H. Talcott served as aid in the triangulation party until September 5, and then tendered his resignation.

Magnetic observations on Mount Monadnoc, N. H.—Four complete series of observations were made near the geodetic station on Mount Monadnoc by Assistant G. W. Dean and Sub-Assistant R. E. Halter in August, for determining the magnetic dip; and at Troy Village, five miles in a southwesterly direction from the mountain, the magnetic declination, dip, and intensity, were ascertained by the same observers. For that purpose, eighty observations were made on different days for the declination; two complete sets for determining the horizontal intensity, and moment of inertia; and three sets for ascertaining the dip of the needle. The records of these observations are at the office, in duplicate. Declinometer, C. S. No 1, and dip circle, C. S. No. 4, were used in making the observations.

The geodetic and other determinations at Monadnoc were completed by the 15th of

August. Sketch No. 1 shows the position of the station and its connexion in the direct series of triangles.

Triangulation of Narragansett bay, R. I.—In order to furnish points for the plane-table survey of Narraganset bay above the entrance, Assistant Edmund Blunt made a subsidiary triangulation of the shores near Bristol, including those of Mount Hope bay, and supplied the results for the use of the topographical party of Assistant Harrison. Mr. Blunt completed this duty by the end of August, and then took up work in another locality of the section, to which separate reference will be made.

Topography of Penobscot bay, Me.—This work was commenced at Rockland by Sub-Assistant Charles Ferguson on the 24th of June, and continued until the 19th of October. From the town and harbor of Rockland, both of which are included on one of the plane-table sheets, the topographical survey was extended northward to embrace Clam cove and the adjacent shore of Penobscot bay. A second sheet, which joins the one just referred to at Sheep island, continues the survey of the shore of Owl's Head bay, and represents the western side of Penobscot bay, or the shore and islands of Muscle Ridge channel, between Ash Point and Fogg, Hill which is three miles below South Thomaston. All the islands, as well as the buoys and stakes which were within the limits of the sheets, were determined in position by intersections with the plane table, and taken as part of the details of the sheets. Their limits are marked on Sketch No. 2. While the work was in progress I personally inspected the operations of the party.

The two sheets alluded to were projected to connect with a third, which will contain the western shore of Penobscot bay from the entrance and northward as far as Norton's island.

Of the completed details the statistics are as follows :

Shore-line surveyed	62	miles.
Roads	58	"
Creeks	5	"
Area of topography, (square miles)	26	

Sub-Assistant Ferguson has inked and turned in at the office the two plane-table sheets worked on this season. He is now making preparation to take up field-work in Section III.

Topography of the shores of Back river, Me.—The survey of the intricate details between the Sheepscot and Kennebec rivers was resumed at the end of July by a party under the direction of Assistant Hull Adams, but as he was prevented by serious illness from taking the field, the plane-table work was prosecuted by Mr. Oscar Hinrichs. At Westport island the topography of this season joins with the limit reached by Mr. Adams in 1859, and in the vicinity of Montseag bay (Sketch No. 2) with the work done last year by Sub-Assistant Ferguson. Following on westward, Mr. Hinrichs traced the shores of Back river quite through to the Kennebec, which it connects with opposite to Bath. His plane-table sheet of Back river embraces also the two expansions known as Hoakomoak bay and Hanson's bay, and the numerous islands which lie to the southward of the former, between which run the dangerous water passages designated Great and Little Hurl Gate. Upper Hurl Gate, also shown on the topographical sheet, occurs at a contracted part of Back river, about midway between the two bays already mentioned. Early in October I inspected the working methods of this party personally.

Mr. Hinrichs filled in part of the details beyond the traced shore-lines of Back river, leaving for completion hereafter the survey of the river nearest to the Kennebec. The following are statistics of the field-work :

Shore-line surveyed	$36\frac{1}{2}$	miles.
Roads	$8\frac{3}{4}$	"
Area of topography, (square miles)	4	

Mr. Hinrichs is now engaged in inking the sheet worked on this season.

Topography of the Androscoggin and Kennebec rivers, Me.—The plane-table survey of the shores between Bath, on the Kennebec, and Brunswick, on the Androscoggin, has been continued, and the details of the neck of land at the confluence of the two rivers filled in. The party of Assistant R. M. Bache took the field on the 12th of July, encamping within the limits of the ground to be surveyed, and continued work until the 31st of October. Most of the details fall on the south bank of the Androscoggin, and are made up of surface features quite intricate and difficult to represent, as I witnessed in personally inspecting the work in October. The high and low water lines of that river within the range of the plane-table sheet were traced. Its limits are marked on Sketch No. 2.

A summary of the statistics of work done by his party is appended, from the report of Assistant Bache:

Shore-line surveyed	14 miles.
Roads	$11\frac{3}{4}$ "
Area of topography, (square miles)	$3\frac{1}{2}$

Topography of Casco bay, Me.—After tracing the shore of a part of Harpswell Neck, Assistant A. W. Longfellow resumed the connected plane-table survey of the shores of Casco bay at Drinkwater's Point, (Sketch No. 2,) which he had reached in the work of last year, and from thence traced the shore-line of the upper part of the bay and its indentations as far to the northward and eastward as Little Flying Point. The shores of Yarmouth river, Freeport river and its several coves, those of Little river, and the outlines of all the islands in that part of Casco bay, are included on the plane-table sheet. Some of the detailed topography was filled in, but for the most part the attention of Mr. Longfellow was given to the supply of shore-line data for the use of the hydrographic party under Assistant Schott. The shore-line survey was extended to a point on the north shore of the entrance to Maquoit bay. Near the middle of October I personally inspected the operations in the field.

Assistant Longfellow used the schooner Meredith for quarters and transportation. Work was commenced on the 16th of July, and continued until the 9th of November, when the vessel was laid up for the winter at Portland.

The following is a synopsis of the statistics of field-work:

Shore-line surveyed	61 miles.
Roads	$11\frac{1}{2}$ "
Area of topography, (square miles)	9

For surface contour thirty-six linear miles were run exclusive of ten miles of low-water line, and outline of ledges not included in the summary given above.

Topography near West Sandwich, Mass.—The plane-table sheet projected by Assistant A. M. Harrison to contain the survey of the shore of Cape Cod bay, between Barnstable harbor and Plymouth, was well advanced towards completion when his party stopped work in the autumn of last year. Mr. Harrison resumed work on the 12th of June, and by the 1st of July completed the details of the sheet. It now shows a belt a mile and a half in average breadth of topography on the south shore of Cape Cod bay, between Scusset Village (see Sketch No. 3) and West Barnstable. The course of the Cape Cod railroad between those two points is shown, as well as all the prominent local features of that part of the peninsula. The statistics of the supplementary work are as follows:

Creeks and marsh	$10\frac{1}{2}$ miles.
Roads	13 "
Area of topography, (square miles)	$6\frac{1}{2}$

The coast of Massachusetts between Plymouth and Scusset, and supplementary topography in two localities on Cape Cod peninsula, one near the cape and the other near Orleans, yet remain to be surveyed.

Mr. Harrison was assisted in the field-work by Sub-Assistant P. C. F. West and Mr. H. W. Bache.

Topography of the shores of Mount Hope bay, R. I.—For the survey of the shores and islands of Narragansett bay Assistant A. M. Harrison projected five sheets to include the eastern side of the bay and the upper part of Rhode Island with the lower parts of the rivers which flow into the head of Mount Hope bay. His party commenced work on the 15th July, having been previously engaged in this Section. The shore-line was traced from Tiverton along the eastern side of Mount Hope bay, and continuously several miles along the same side of Taunton river. A second sheet includes the opposite western shore of Taunton river and the north shore of Mount Hope bay, formed mostly by the banks of the Lee's, Cole's, and Kikemuit rivers. Bristol bay and the city wharves and topography of the immediate shores, including the islands at its entrance and the western shore of Mount Hope bay, are represented on a third sheet. The fourth contains the detailed topography of the north end of Rhode Island, and the fifth the shore-line of the main body of the island below a point opposite Tiverton. The detailed survey was carried several miles above that town, and the surface features of a portion of the north shore of Mount Hope bay were also filled in on the corresponding sheet, but in other localities the plane-table work of the season was confined to the shore-line contour, which is throughout quite intricate. The location of the sheets is marked on Sketch No. 3.

The course pursued by Assistant Harrison in deferring the surface topography enabled the hydrographic party of Assistant Trowbridge to work to full advantage, the shore-line being furnished as quickly as the soundings could advance.

Until the close of September Mr. Harrison was assisted in the field by Sub-Assistant P. C. F. West. Mr. H. W. Bache served as aid throughout the season. The following are statistics of the plane-table work:

Shore-line surveyed	$75\frac{1}{4}$ miles.
Creeks and ponds	$13\frac{1}{4}$ "
Roads	27 "
Area of topography, (square miles)	7.6

The sheets containing the results of this work are now on file at the Coast Survey office.

I inspected the field operations of this party in the latter part of October.

Hydrography of Merrymeeting bay and of the Androscoggin river, Me.—The hydrography of the Kennebec river, above Bath, has been pushed upwards quite through the expansion known as Merrymeeting bay to Swan island, or within a mile and a half of Richmond, and from Abagadasset Point to the lower bridges in the Androscoggin river. This work was executed, between the 21st of August and the 12th of October, by the party of Assistant F. H. Gerdes, with the schooner James Hall. Sub-Assistants C. Fendall and F. F. Nes were attached to the party, and Mr. A. W. Muldaur served with it as hydrographic draughtsman. The duties devolved on them were performed with energy and intelligence, as I had occasion to witness on my tour of inspection near the middle of October. Forty-seven signals were erected and determined in position by a subsidiary triangulation, the experience of Mr. Gerdes in preliminary work being such as to qualify the party for supplying the shore-line and other data requisite for adjusting the soundings on the chart. The tides were observed at two stations in connexion with the hydrographic work, and at two others for purposes of comparison. A summary of the general statistics is appended:

Miles run in sounding	187
Angles measured	1,743
Number of soundings recorded	12,008

Reference will be made in another chapter of this report to the connexion of Assistant

Gerdes with duty in Section VIII. Since the close of the season in Section I, Sub-Assistant Nes has been assigned to duty in Section VI. The sheet of work done on the Kennebec will be plotted at the office, where arrangements have been made for the completion of the chart. In preliminary form the reduction from it is given as Sketch No. 4, with this report.

Hydrography of Casco bay, Me.—At the limits of the completed survey of Portland harbor and of the hydrography of the approaches to Casco bay, the soundings in the upper part of the bay were commenced by Assistant C. A. Schott on the 1st of August with a party in the schooner Joseph Henry. The work of the season was prosecuted with energy and intelligence, and the result has gone far towards the completion of the hydrography of Casco bay. The hydrographic sheet represents the entire breadth of the bay from Harpswell Neck and Crotch and Jewell's island, westward to the main land. Its southern limit follows the outline of Portland harbor, and the limits of soundings made at the approaches of the bay by Lieutenants Commanding Woodhull, Trenchard, and Wilkinson. Northward, the hydrography was extended by Assistant Schott to a line parallel with the upper end of Cousin's island. These limits are marked on Sketch No. 2. Where the work joined with that of previous years, additional lines were run, particularly in Hussey sound. The season's work includes Luckse's and the greater part of Broad sound. In connexion with the hydrography, regular tidal observations were made, day and night, at Harpswell during four weeks, and for seven weeks and a half at Peak's island. A third station at Man's Point, near Yarmouth, was occupied temporarily for the purpose of tracing the progress of the tide wave, and in connexion with the regular series at Peak's island, high and low water was repeatedly observed and recorded at a fourth station, near the southwest end of Long island, for the same object. In judiciously selected localities, Mr. Schott observed the currents at twelve stations during three or four consecutive tides.

The original records of soundings, angles, and tidal observations, comprising, with the meteorological journals, twelve volumes, have been duplicated, and both sets are now at the office, in Washington.

Assistant Schott was occupied in the hydrography of Casco bay until the 21st of October, soon after which he resumed the charge of the computing division of the office. The following are statistics of the hydrographic work:

Miles run in sounding	574
Angles measured	3,890
Number of soundings	20,954

Mr. E. Cordell efficiently assisted in prosecuting the soundings made by this party. I inspected the working methods used in the party about the middle of October, and found them thorough and practical in every respect.

Development of rocks in Sandy bay, (Cape Ann,) Mass.—Towards the close of the present season, and after the conclusion of work in other parts of this section, Assistant Henry Mitchell visited Sandy bay and determined the position of a rock, the existence of which had been communicated to me by Mr. W. P. G. Bartlett, of Cambridge. Of four points of rock found, Mr. Bartlett, who accompanied the party, recognized one as being the obstacle to which he had directed attention. Mr. Mitchell says, in reference to all of them: "They could scarcely have been found by sounding, on account of their forms. They are sharp projections from the bottom, and are surrounded by three to seven fathoms of water. In order to develop them, we placed ourselves upon the rocky cliffs at a time when a very heavy swell prevailed along the coast, and took angles upon well-defined breakers in the distance. Having plotted the positions of these breakers upon a chart, we visited the spots when the sea became calm, and dropped the lead directly upon the rocks."

The four rocks determined by this examination will be at once marked for insertion on the plate of the chart of Rockport harbor, Cape Ann.

Physical survey of Boston harbor.—In connexion with a close resurvey of parts of the inner harbor of Boston, undertaken by authority of the Treasury Department, as explained in my report of last year, at the request and at the expense of the city of Boston, numerous current stations have been occupied in the upper harbor, and in Charles river. The general scope of the questions which require these and other data for their solution has been referred to already in the introductory part of my report.

The observations were conducted by Assistant Henry Mitchell, and occupied his party during the latter part of summer and autumn of the present year. Messrs. E. P. Heberton, H. W. Longfellow, and L. L. Nicholson served as aids in the party.

Mr. Mitchell has sent to the office the records of observations on the currents last season.

Hydrography of Barnstable harbor, Mass.—The soundings required for the chart of Barnstable harbor and its approaches were executed in the course of the summer by a party in charge of Assistant Henry Mitchell, and the resulting chart accompanies this report as Sketch No. 5. While engaged in the hydrography the positions of ten hidden rocks were determined by Mr. Mitchell. They all lie in or near the channel ways, and the existence of most of them was known in a general way from disasters which have occurred from time to time, yet only the most diligent search finally developed their positions, and secured the means of marking their places on the chart.

Assistant Mitchell was aided in this and other work in the section by Messrs. E. P. Heberton, H. W. Longfellow, and L. L. Nicholson.

Currents of Cape Cod bay.—After completing the hydrography of Barnstable harbor, the party of Assistant Mitchell occupied current stations off the mouth of Scusset river, and around the shore of Cape Cod bay, and also along the outer coast of the cape. These observations were directed to furnish data for the solution of questions connected with a special survey made for the legislature of Massachusetts. The expense attending them has been borne by that State. I have remarked more fully in the introduction of this report on the objects of the investigation.

Hydrographic examination off the Nantucket shoals.—In August of the present year Lieut. Comg. T. S. Phelps, U. S. N., assistant Coast Survey, made a further examination of the bank discovered by him last year while working with the steamer Vixen. The result has developed a prolongation of the shoal to the distance of several miles to the northward and eastward of the limit then reached in soundings. While employed in this work three small banks were found and determined in position and depth. These banks are marked by rips, and lie without the verge of the system of shoals and banks hitherto developed to the southward and eastward of Nantucket. The report of Lieut. Comg. Phelps, stating the latitude and longitude of each, is given in Appendix No. 7.

Hydrography of Narragansett bay.—Following close on the plane-table survey of the upper part of Narragansett bay, the soundings above Newport were commenced in the latter part of August by a party under charge of Professor W. P. Trowbridge, assistant in the Coast Survey, with the schooner Caswell. The sheet projected for the portion of hydrography completed in the course of the season includes Mount Hope bay, Bristol bay, and the entire breadth of Narragansett bay, in the vicinity of Canonicut and Prudence islands. I visited this party in the latter part of October and personally inspected the operations. The limits of the hydrographic sheet are given on Sketch No. 3.

Assistant A. S. Wadsworth was attached to this party, and, after the close of work for the season in this section, engaged in active duties in Section III and Section IV.

The services of Assistant Trowbridge, who had been formerly in the engineer corps of the United States, being urgently called for by the chief engineer, General Totten, in November last he was transferred temporarily for duty in New York harbor, with the understanding that when the emergency has passed he will resume his duties in the Coast Survey.

The new form of sounding apparatus recently invented by Professor Trowbridge was tested with highly-satisfactory results (see Appendix No. 11) while his party in the Caswell was sounding in Narragansett bay. The following summary shows the progress of the hydrography:

Miles run in sounding	450
Angles measured	350
Number of soundings	25,900

Six tidal stations were occupied to furnish data for plotting the soundings.

Tidal observations.—The series of observations, both tidal and magnetic, commenced last year at Eastport, Me., were kept up until the end of September, under the charge of Mr. G. B. Vose. Since that date Mr. Samuel Walker has had the care of the series. A self-registering tape and a pressure tide-gauge were used. The working of the latter, as an experiment, is not yet conclusive, owing to the difficulty in having repairs made to the apparatus in the vicinity of the station. I visited Eastport early in October, and personally inspected the arrangements for continuing the series.

At the Charlestown navy yard Mr. T. E. Ready has continued his series of observations unbroken, as in the several preceding years. The high and low waters are noted by means of a staff-gauge, the position of which has been changed a few paces to avoid obstructions that would otherwise prevent the readings at low water. The city authorities having provided a self-registering gauge, the observations desirable for the special resurvey of Boston harbor have also been attended to by Mr. Ready, and are yet in progress.

SECTION II.

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

The several operations of parties in the section will be noticed as follows:

1. Primary triangulation on the coast of Connecticut, for connecting the base on Epping plains with that on Fire island. Magnetic stations were made in connexion with this work.
2. Triangulation of the lower part of Connecticut river.
3. Revision of secondary triangulation from Sandy Hook southward along the coast of New Jersey to a station near Shark river.
4. Plane-table survey and hydrography of the Hudson river continued, completing the soundings to Tivoli.
5. Development of a sand ridge off Barnegat, and hydrographic examinations in the vicinity of the Five Fathom bank off Cape May.
6. Hydrographic resurvey of the channels of the Delaware river in the vicinity of Pea Patch island, Red Bank, and opposite Philadelphia. Important changes were developed by these examinations.
7. Tidal observations in New York harbor.

Office-work.—The drawing has been completed and the engraving continued for the new edition of coast map and chart, No. 21, New York bay and harbor; and the large manuscript map of that harbor for the commissioners on harbor encroachments has been finished and delivered to the State authorities at Albany. The engraving of the sheet of the Hudson from the river entrance upward to Sing-Sing, and the drawing of the adjoining upper sheet, reaching to Poughkeepsie, have been continued, and a new progress sketch of the section has been drawn and engraved.

Primary triangulation for connecting the Epping base with the Fire Island base.—After occupying a primary station in Section I, notice of which has been already taken, the party under my immediate direction was transferred to Bald Hill, in Union township, Tolland

county, Conn., and in the early part of September commenced the measurement of horizontal angles with the thirty-inch theodolite, C. S. No. 1. Six hundred and eighty-six observations were made on five primary signals, which mark stations in the direct course between the primary base in Maine and that on the south shore of Long Island. The longest line in the triangulation of the season is about sixty-two miles. Assistant G. W. Dean, who measured the horizontal angles, also determined the heights of the five outlying stations by vertical angles, using the eight-inch Gambey theodolite, C. S. No. 57. Three hundred and seventy-eight observations were recorded with that instrument.

In the same county, Box Hill, in Bolton township, was occupied by my party in the month of October, the same instruments being used as at the other two stations. Official duties detained me so late in Washington as to make it quite impracticable to take the field at the opening of the season. Time was found, however, for a rapid tour of inspection of the working parties on the coast of New England, on the return from which I visited my party at Box Hill in the latter part of October. The arrangements and execution of work at all the stations were satisfactory.

The geodetic records have been duplicated and placed in the archives of the Coast Survey office.

Mr. Dean was assisted in the field and office work by Sub-Assistant R. E. Halter. At the two stations in Connecticut Mr. F. A. Lueber served as recorder in the triangulation party. Both stations and their connexion with Monadnoc and relation to the general scheme of primary triangulation are shown on Sketch No. 1. Meteorological journals were kept by the party while the field-work was in progress.

Magnetic observations.—While carrying on the geodetic work at Bald Hill, Assistant Dean made one hundred and twenty-five observations, on three separate days, for determining the magnetic declination, and two sets for intensity and moment of inertia. Four sets of observations were made at that station for ascertaining the dip of the magnetic needles.

At Box Hill about the same number of observations were recorded for the determination of the magnetic elements. Mr. Dean and Sub-Assistant Halter used the declinometer, C. S. No. 1, and dip circle, No. 4, at both stations, and at the close of the season duplicated and sent to the office the notes and records made at each of them.

Triangulation of Connecticut river, Conn.—This work was taken up by Assistant Edmund Blunt on the 1st of September at the mouth of the river, and on closing for the season had been extended seventeen miles northward to Goodspeed's Landing. Points ample in number for the purposes of the plane-table and hydrographic surveys were determined and recorded as the triangulation advanced.

Mr. Blunt was assisted in this duty by Sub-Assistant W. S. Edwards, and aided by Mr. F. M. Wise. The following summary shows the progress made during the season:

Stations occupied	29
Angles observed	399
Signals erected	39
Number of observations	3,899
Area of triangulation (square miles)	62

At the outset of the season and after its close Assistant Blunt took charge of the Coast Survey vessels at Peekskill, N. Y., and rendered important service by having them in readiness for duty afloat as the working parties took the field for the summer and autumn. Sub-Assistant Edwards efficiently aided in the arrangements required at Peekskill and New York. At the end of the working season at the north he was assigned to duty in Port Royal sound, S. C., with the party of Assistant C. O. Boutelle, whose operations will be detailed under the head of Section V.

The original records of horizontal angles in nine volumes, containing the observations of 1859, by Assistant Blunt, and a duplicate of those made by him in 1860, with descriptions of the stations occupied last year on the Hudson river, have been received at the office.

Revision of secondary triangulation on the coast of New Jersey.—Assistant John Farley, after making a reconnaissance in August, in which he was accompanied by Sub-Assistant C. M. Bache, occupied as stations the light-houses at Navesink and Sandy Hook, and laid out a series of triangles to define the coast line of New Jersey as far southward as Great Pond signal, or about fifteen miles from the station on Sandy Hook. Stations have been selected for extending this work southward along the coast of New Jersey. The party of Assistant Farley continued in the field until the beginning of November.

Topography and Hydrography of Hudson river.—The regular survey of the Hudson has been advanced in two localities by a party in charge of Sub-Assistant John Mechan. From a point one mile south of Anthony's Nose, upwards to Sherman's wharf, above Newburg, the shore-line was accurately traced for two hydrographic sheets of last year which contain the soundings executed by Lieutenant Commanding Fauntleroy. After completing this duty the party of Mr. Mechan, in the schooner Gerdes, moved to Rhinebeck, where the shore-line survey and hydrography were jointly resumed and extended to Tivoli. The work of this year connects in that vicinity with a survey made in 1858 by Lieutenant Commanding Murray.

A tide-gauge used in conjunction with the hydrographic operations was read every fifteen minutes, and showed a mean rise and fall of 4.6 feet.

Within the limits of the sheet projected by Mr. Mechan he completely developed the shoals in the Hudson known as "The Flats" and "Hog's Back," and also those immediately opposite to Tivoli. The following general statistics refer to the two localities in which the party worked:

Shore-line surveyed (miles)	65
Angles measured	2,016
Miles run in sounding	155
Number of casts of the lead	12,293

For hydrographic purposes Sub-Assistant Mechan determined two hundred and six points with the plane-table.

Mr. F. R. Hassler aided in the field-work on the Hudson, and accompanied Mr. Mechan after closing work in this section on topographical duty in Fairfax county, Va., mention of which will be made under the head of Section III.

Two plane-table sheets, containing the finished topography of the shores of the Hudson river above and below Yonkers, were inked during the winter by Mr. Cleveland Rockwell and deposited in the office.

In February last Lieutenant Commanding Fauntleroy turned in at the office two hydrographic sheets containing the soundings made by his party in the Hudson river, between Newburg and Poughkeepsie.

Hydrographic examinations off Barnegat and Cape May, N. J.—My attention having been called by G. W. Blunt, esq., of New York, to the supposed existence of banks or ridges off Barnegat, Lieutenant Commanding T. S. Phelps, United States navy, assistant Coast Survey, in command of the steamer Vixen, in July last made an examination of the locality designated. That officer, in reporting the result, remarks: "There is only one ridge or bank in this vicinity, the limits of which are indicated by the following bearings and distances:

"North end of shoal E. $\frac{3}{4}$ N. 15 miles } from Barnegat light.
"South end of shoal E. SE. 16 miles }

"There are from eleven to thirteen fathoms on it, with from fourteen to sixteen fathoms in shore. The length of the shoal is about eight miles, and its general course north and south."

On approaching Barnegat from the southward a line of soundings was carried by the party in the Vixen to show depths between a station fifteen miles distant from Barnegat and the light-boat, which is now moored about a mile southeast from the thirteen feet spot off Cape May. In that vicinity the shoals to the northward of the Five-Fathom bank were carefully examined. The soundings as marked on the Coast Survey chart of 1852 were found unchanged, excepting at one spot, in reference to which Lieutenant Commanding Phelps reports as follows:

"The small shoal with three and a half fathoms on it, given on the chart as being four miles north of the bank, has partially disappeared, the soundings now ranging from four and a half to six fathoms, with seven, eight, and nine fathoms around it."

One hundred and forty-one miles were run while sounding by the party in the Vixen.

Under the head of the next two sections further mention will be made of the occupation of this hydrographic party.

Hydrographic resurvey of the Delaware river, near Philadelphia, Fort Mifflin, and Fort Delaware.—Special instructions were given to Assistant George Davidson on the 26th of August to make a hydrographic resurvey of certain portions of the Delaware river in order to determine what changes had taken place since the first survey. This was directed with reference to purposes of defence. The first portion examined embraced the Delaware opposite Philadelphia, and exhibits marked changes in the eastern channel abreast of the upper part of Camden, the bar from the upper end of Windmill island having formed almost to Cooper's Point. The shoal formerly extending far below Windmill island appears to have been much cut away. Important additions to the wharves are being made along the Philadelphia front by extending them to the port warden's established line; several wharves have been built out from Camden; and a continuous wharf has been constructed around Windmill island. These changes, when completed, will materially affect the condition of the channel and shoals of the Delaware.

The second portion of the resurvey comprised the river between Red Bank and Billingsport, including "the bar" and the approaches to Fort Mifflin. Changes have been developed in this vicinity, and the preliminary reductions indicate a depth of one foot more water on the bar than was found in the original survey. Assistant Davidson suggests that it would be a material aid to navigation if there should be fixed to the light-house pier, and to the wharf at Billingsport, large and distinctly graduated staffs to indicate to outward and inward bound heavily-laden vessels the depth of water on the bar between the buoys.

The third portion of the river resurveyed was between New Castle and Reedy Point, including the Bulkhead shoal and the approaches to Fort Delaware. Part of the shoal between Delaware City and Pea Patch island has been cut away, and important changes appear to have taken place below the island. The preliminary reductions show that the eastern channel along the Bulkhead shoal remains the deeper. The small marshy patches, formerly known as the Goose islands, have disappeared. The positions of all the buoys have been accurately determined.

At the request of the officer commanding Fort Delaware, (Captain A. A. Gibson, 2d artillery, United States army,) Assistant Davidson was instructed to make the resurvey between Reedy Point and Fort Delaware, and also to make a minute survey immediately around the Pea Patch island. A copy of this work will be transmitted to the chief of the corps of engineers, United States army. Assistant Davidson acknowledges the kindness of Captain Gibson in furnishing him with a boat belonging to the fort whilst executing the above survey.

Tidal stations were established at each of the foregoing localities, and marks left for reference. The tide-gauge readings at two of the stations were referred to the tidal staffs at the Philadelphia navy yard and at Fort Delaware.

The following statistics embrace the work which was closed on the 20th of November:

	Philadelphia.	Fort Mifflin.	Fort Delaware.
Signals established	27	23	37
Angles observed	71	149	463
Miles run in sounding	37	49	140
Number of soundings	1,151	1,779	4,460

The six volumes of original records have been duplicated, all the lines are plotted in a preliminary way, and some of the soundings have been reduced and plotted in their final form.

Tidal observations.—The self-registering tide-gauge at Governor's Island (New York harbor) has been kept in operation by Mr. R. T. Bassett, and few interruptions occurred in the record of observations made, even during last winter. The gauge was not taken down, as in former years, on the approach of cold weather, a layer of kerosene oil in the float-box being generally found a sufficient protection against freezing. In a few cases in which the water was, nevertheless, frozen, corresponding observations were read from an ordinary staff-gauge at Brooklyn to complete the record.

SECTION III.

FROM CAPE HENLOPEN TO CAPE HENRY, INCLUDING THE COAST OF PART OF DELAWARE, THE COAST OF MARYLAND, AND PART OF THE COAST OF VIRGINIA.—(SKETCH C, No. 10.)

The field-work in this section will be mentioned in the following order:

1. Extension of the Potomac river triangulation to Swan Point, above Blakistone island.
2. Topography of the sea-coast of Virginia.
3. A minute plane-table survey of the parts of Fairfax county, Va., and of Montgomery county, Md., adjacent to the lines of the District of Columbia.
4. Shore-line survey of the Potomac in the vicinity of Blakistone island.
5. Reconnaissance for determining the topographical features and depth of water in the Potomac river at White House Point, Mathias Point, and at Lower Cedar Point.
6. A general hydrographic reconnaissance of the Potomac from Blakistone island to Georgetown, D. C. The results of this work were plotted at once and lithographed.
7. Tidal observations.

Office-work.—Progress has been made in the drawing of maps and charts, No. 29, Atlantic coast, from Isle of Wight, Del., to Chincoteague inlet, Va.; and No. 30, from Chincoteague inlet to Great Machipongo inlet, Va.; also in the engraving of the following sheets of the Chesapeake series, viz: No. 32, from Magothy river to Hudson river, Md.; No. 34, from the Potomac river to Pocomoke sound; No. 35, from Pocomoke sound to York river; No. 36, from York river to the entrance of Chesapeake bay, and on that of the sheet of Rappahannock river from Punch Bowl to Occupacia creek. The drawing, lithographing, and engraving of the upper sheet of Patuxent river, from Point Judith to Nottingham; the drawing and engraving of the chart of St. Mary's river, Md., and the engraving of the Rappahannock sheet from the river entrance to Punch Bowl, of coast maps and charts; No. 31, Chesapeake bay, from the Susquehanna to Magothy river; No. 33, Chesapeake bay, from the Hudson to the Potomac river, have been completed, as also the photographing and lithographing of the preliminary chart of the Potomac river. Additions have been made to the progress sketch of the section, and the drawing for a finished chart of the Patuxent river has been commenced.

Special notes on the tides and magnetic declination at numerous stations on the eastern

coast of Virginia, and along the shores of Chesapeake bay, have been prepared at the office and distributed for the use of the War and Navy Departments.

Triangulation of the Potomac river.—This work was resumed in the middle of October, 1860, by a party detailed in charge of Assistant John Farley. The signals used by the hydrographic party in the main river as high up as Blakistone island, and in the sounding of Britton's bay and St. Clement's bay, were determined in position, and additional points were furnished for two plane-table parties intended to carry on the finished survey of the Potomac. Mr. Farley reoccupied several of the stations of the previous season, the signals at others nearer to the upper part of the series of triangles having been blown down or destroyed. He then took up the triangulation of the river at Blakistone island, (Sketch No. 10,) and extended it up the course of the Potomac to Swan Point and White Point, reaching those stations at the end of November. The schooner J. Y. Mason was used by his party for transportation.

In the usual course of procedure this work would have been suspended only during the inclement part of the winter and early spring, to be resumed and carried on during the latter part of spring and in the summer. The statistics given below show merely the results for the first half season, the condition of hostilities along the banks of the Potomac making it quite impracticable to continue the work in the spring.

Stations occupied	23
Angles measured	30
Number of observations	1,295

Assistant Farley was engaged in duty in the office until midsummer, and then took up field-work in Section II.

The schooner Mason, used by the triangulation party on the Potomac, was returned to Baltimore in December.

Mr. Farley measured the angles above and below Blakistone island with the six-inch Gambey theodolite, C. S. No. 76.

Topography of the sea-coast of Virginia.—Two parties are now in the field under instructions to continue the plane-table survey from Chincoteague inlet southward towards Cape Charles. One of these is in charge of Assistant A. M. Harrison, who had passed the working season at the north in topographical duty in Section I, as already stated. The other party is under the charge of Mr. Charles Hosmer. Mr. H. W. Bache is attached to the party of Assistant Harrison.

In addition to the regular progress of the survey in this quarter, the parties have been placed at the disposal of Brigadier General H. H. Lockwood for the execution of special surveys required in the military occupation of Accomac and Northampton counties. They are also provided with the means for sounding out the inlets and small bays of that vicinity, which have not been included in the previous hydrographic work of the Coast Survey. Sub-Assistant F. W. Dorr was temporarily engaged in plane-table duty, in this field of work, before the assignment of the parties now employed there.

Topography of part of Fairfax county, Virginia.—At the request of Lieutenant General Winfield Scott, and by authority of the Treasury Department, arrangements were made for this work at the beginning of June by the assignment of the most experienced field assistant, H. L. Whiting, esq., for the general supervision of two working parties. The charge of one of the plane-tables was given to Sub-Assistant F. W. Dorr, and that of the other to Mr. Cleveland Rockwell. Messrs. A. W. Muldaur and W. W. Harding aided from time to time in either of the parties, according to the condition of the survey, with reference to its advance in any desired direction. The working sheets were laid out to include all the detailed features of ground then occupied by the army under Brigadier General Irvin McDowell, and those immediately to the north and west of his line of pickets, as far as practicable, in the direction of

Fairfax Court-house, and as high up the Potomac as the bridge which now occupies the site of a former "chain" bridge.

Mr. Whiting was furnished with the means of transportation from General Tyler's brigade, and on the 11th of June Mr. Dorr occupied two stations, at the Naval Observatory and near the Washington end of the Long bridge. These, with two others on the Virginia side of the Potomac, (Arlington and the Theological Seminary near Alexandria,) are the basis of the plane-table survey. Mr. Dorr projected the sheets and in the course of a few days commenced the field survey in the vicinity of Alexandria. The details in that quarter were completed by the 5th of July. A sheet to contain the surface features below the "chain bridge" was then taken up and the details traced in to a line of junction with an intermediate plane-table sheet of Mr. Rockwell, who had meanwhile extended the topography of the middle section as far west as Fall's Church, then the headquarters of General Tyler, to the immediate vicinity of Vienna, and generally to limits beyond the outposts. Sub-Assistant Dorr completed the work between the "chain bridge" and Georgetown by the 19th of July, and then employed several days in contouring his previous sheet of topography. With unvarying promptness both parties were furnished with armed guards by order of General McDowell, or from the commands of General Tyler or Colonel Heintzelman.

Mr. Rockwell continued his survey until the 26th of June, having met with but one interruption by hostile approach on the 24th. In the early part of July the work was suspended by movements in position of the regiments from which guards could be drawn, but was resumed on the 13th and continued until the 20th without guard. Mr. Rockwell at the last-mentioned date had connected his survey with the topography done by Sub-Assistant Dorr.

Tracings of the work, as the survey advanced, were furnished to General McDowell, General Tyler, and Colonel Heintzelman. The two corps of engineers were also supplied with copies. The resulting map was photographed as soon as practicable and duplicates were placed at the disposal of the officers for whose use the map was ordered.

The statistics of the topography are as follows:

Roads, aggregate length	136 miles.
Railroads	13½ "
Creeks	63 "
Canal	6½ "
Area, in square miles	38 "

In reference to the critical nature of the field duty performed by Messrs. Dorr and Rockwell, at times between two extensive lines of military outposts, Assistant Whiting remarks: "The circumstances and conditions of the service have required the constant exercise of watchfulness and prudence, and that, I am happy to say, has been most judiciously displayed."

Mr. Whiting visited the working parties frequently and gave close and attentive supervision to all the details of the survey. His report on its completion concludes as follows: "In closing, I am gratified to report that the general results of our work have been successful. The detailed survey shows all the important topographical features of the country which it embraces; the main roads, by-roads, and bridle-paths; the woods, open grounds, and streams; houses, out-buildings, and fences; with as close a sketch of contour as the hidden character of the country would allow—producing in all a map by which any practicable military movement might be studied and planned with perfect reliability."

In the middle of August, at the request of Major General McClellan, the topography of the northwestern approaches of the city of Washington was taken up and completed in the course of the following month. This work embraces the turnpikes and main roads from Tennallytown towards Brookville and those passing through Rockville to Great Falls on the Potomac.

In October the same parties, in charge of Messrs. Dorr and Rockwell, aided by Mr. J. W. Donn, extended the survey northward and westward from Fall's Church and the Chain bridge. Sub-Assistant P. C. F. West worked with a third plane-table in the same vicinity.

Early in November Sub-Assistant John Mechan, aided by Mr. F. R. Hassler, took up the general topography below Alexandria, and continued it beyond Mount Vernon, and from the shore of the Potomac to within three miles of Fairfax Court-house, including the line of the Orange and Alexandria railroad as far as Burke station.

To test the detailed surveys which, in the aggregate, had embraced an area of two hundred and twenty-three square miles, and which had been made in detached parts, a triangulation was commenced in October by Sub-Assistant W. H. Dennis. This is still in progress and is now in charge of Sub-Assistant Chas. Ferguson and Mr. C. Hosmer, Mr. Dennis having been assigned to duty in Section V. Mr. L. L. Nicholson is attached to the triangulation party as aid.

Assistant Whiting has had the immediate supervision of the field parties, the labors of which since August have been under the general direction of Lieut. Colonel J. N. Macomb, topographical engineer-in-chief of the army of the Potomac.

The co-operation necessary to meet the requirements of the commanding general has been systematic and effective, the topographers being always in readiness, and the means of transportation and details of men promptly supplied.

Plane-table survey of the Potomac river.—Near the middle of October, 1860, a double party, with the schooner Guthrie, was detailed to execute the topography of the shores of the Potomac between Piney Point and Blakistone island.—(Sketch No. 10.) Assistant I. Hull Adams and Sub-Assistant S. A. Wainwright at once took up the work with separate plane-tables, the object being to complete the detailed survey of the banks of the river as far up as the triangulation had been carried by Assistant Farley. The shore-line of both sides of the Potomac was traced by the parties, and also the mouths of several creeks, Blake's on the north or Maryland side and Jackson's and Machodac creek on the Virginia side.

On account of the unfavorable weather which set in before the close of October it was found impracticable to take up the detailed topography. The two parties traced an aggregate of about thirty-eight miles of shore-line and filled in two square miles of interior. The Potomac is from four to five miles wide where the parties worked. About a fortnight at the outset of the surveying season was employed in replacing the signals left by the triangulation party, most of them having been blown down by storms.

After closing work the vessel was sent to Baltimore and laid up.

Mr. Adams was employed in Section I during the summer.

Sub-Assistant Wainwright resigned his position in the survey on the 25th of June to enter the army.

Special examinations on the Potomac river.—In the first week of June a topographical and hydrographic reconnaissance was made at White House Point and at Mathias Point on the south side of the Potomac, and also of the vicinity of Lower Cedar Point on the Maryland side of the river. This duty was executed by Captain W. R. Palmer, of the topographical engineers, assistant in charge of the Coast Survey office, in the small steamer Resolute, then in command of Acting Master Budd. Commander Rowan, with the sloop of war Pawnee, convoyed the party and placed the boats of that vessel at our disposal for taking soundings. In each instance the shore of the immediate vicinity was traced and mapped, and lines of soundings were run quite across the bed of the Potomac. Copies of the resulting sketches were immediately furnished to the military authorities of the government.

Acting Lieutenant Blue, of the Pawnee, assisted in running the lines of soundings.

Two hydrographic draughtsmen, Mr. Charles Junken and Mr. W. F. Sands, of the Coast Survey office, accompanied Captain Palmer and mapped the results of the observations.

Hydrographic reconnaissance of the Potomac river.—At the end of last season the regular

hydrography of the Potomac river had been advanced from the entrance upwards as far as Blakistone island. In the usual order of work the soundings would have been taken up again in the spring. This, for reasons already stated, being impracticable, a hydrographic reconnaissance of the channel of the Potomac between Blakistone island and Georgetown, D. C., was directed early in May last, and was executed by Lieutenant T. S. Phelps, United States navy, assistant in the Coast Survey. The steamer Mount Vernon, then in command of Lieutenant J. H. Russell, United States navy, was assigned by the honorable Secretary of the Navy for the use of the hydrographic party, and a small detachment sent on board from the 71st regiment of New York militia, then quartered at the navy yard. The Mount Vernon was attended by the steamer Anacostia, Lieutenant T. S. Fillebrown, United States navy, as a convoy. To the party of Lieutenant Phelps were attached Messrs. C. Junken, W. B. McMurtrie, and A. W. Muldaur, of the Coast Survey office. Mr. F. A. Lueber served as aid and recorder while the soundings were in progress.

This duty was prosecuted in the second week of May. Immediately after the return of the party the soundings were plotted, and tracings from the reconnaissance chart furnished to the naval and military authorities of the government.

Previous to his withdrawal from the survey, on the 2d of May, Commander Muse sent to the Coast Survey office all the note books containing the records of soundings, angles, and tidal observations made by his party in the Patuxent and Potomac rivers during the surveying season of 1859–'60.

Tidal observations.—At the Washington navy yard the self-registering tide-gauge was kept in motion under the charge of Mr. J. W. Donn until the 12th of December, 1860, when the instrument was removed to another station.

The results obtained from the observations made at the navy yard at Washington are sufficient for all the purposes intended when the series was undertaken.

The observations at the permanent tidal station at Old Point Comfort, Virginia, have been kept up by Mr. M. C. King with good success.

SECTION IV.

FROM CAPE HENRY TO CAPE FEAR, INCLUDING THE COAST OF PART OF VIRGINIA, AND OF PART OF NORTH CAROLINA.—(Sketch D, No. 11.)

The instructions issued and the work done will be stated under the following heads :

1. Instructions for prosecuting the main triangulation of Pamplico sound, and for determining points to serve for commencing the plane-table survey of the shores. In connexion with this work it was designed to make observations for ascertaining the magnetic variation, dip, and intensity.

2. Additions in topography at several localities for completing the chart of Albemarle sound. A small portion of topography yet remains to be done in order to finish the detailed survey.

3. A hydrographic examination off the coast of Virginia to the southward of Cape Henry, and soundings in the channels and at the approaches of the several inlets into Pamplico sound, N. C.

Office-work.—The drawing and engraving of additions to the two sheets of Albemarle sound (coast maps and charts Nos. 40 and 41) have been executed, and the drawing of a preliminary chart of the coast of North Carolina, from Oregon inlet to Ocracoke inlet, has been lithographed in the office. The engraving of the sketch of North Landing river (Currituck sound) has been completed, and additions have been made to the progress sketch of the section.

Triangulation of Pamplico sound, N. C.—My instructions to Capt. T. J. Cram, United States Topographical Engineers, Assistant Coast Survey, under date of September 24, 1860,

provided for the continuation of the main work north and east of Swan Quarter island, (see Sketch No. 11,) and for taking up the secondary triangulation of the shores of the sound to provide a basis for the topography. Assistant A. S. Wadsworth was assigned to assist in the field-work. Arrangements were also made and instruments selected for determining the magnetic declination, dip, and intensity at stations in the vicinity of those to be occupied in the triangulation. The schooner Bancroft was repaired for transportation, and a flat-boat, for passing through the shallow parts of the sound, was forwarded to the site of work early in December by the Albemarle and Chesapeake canal. The Bancroft was about to proceed to her station, by sea, when I received notice from the general disbursing agent that no funds could be had from the treasury to meet the estimates under the appropriations. The flat-boat was accordingly brought back and laid up with the schooner at Philadelphia. The instruments were returned to the Coast Survey office. One of the theodolites (No. 18) and a reconnoitering telescope, which had been left in the care of Mr. R. N. Taylor, at Newbern, N. C., at the close of the previous season, have not yet been recovered.

Topography of Albemarle sound, N. C.—For the completion of the large chart of Albemarle sound there remained, at the opening of the season, several detached patches of plane-table work, principally at the mouths of the rivers that make in at the western end of the sound and parts of islands lying in and near Roanoke and Croatan sound. For this supplementary work Sub-Assistant John Mechan made preparation at the usual period for taking the field in this section, and executed the topography of the banks of the Chowan river (Sketch No. 11) for three miles of its course above its entrance into the sound. On the same sheet the lower parts of the Roanoke and Cushai and their branches, the easternmost and middle rivers, were mapped, completing the plane-table survey of the western end of Albemarle sound.

In the southeastern part of the sound Mr. Mechan surveyed Durant's island and the shores of East lake and South lake, both of which connect behind the island with the waters of Alligator river.

On the 1st of March the party took up the survey of Roanoke island at Sandy Point and Shallowbag bay, and pushed it southward, and had mapped about fifteen square miles of the area of the island by the 30th of April. At that date the camp fixtures and instruments of the party were seized by an armed body of the citizens of the State of North Carolina. Sub-Assistant Mechan and his aid, Mr. F. R. Hassler, then returned to the office, being thus left without the means of completing the survey of the lower part of the island.

A summary of the work done by the party is given in the following statistics :

Shore-line surveyed	131½ miles.
Roads	23½ "
Area of topography (square miles)	86

After inking and forwarding his plane-table sheets for deposit in the office, Mr. Mechan was assigned to duty in Section II.

Assistant A. S. Wadsworth will be engaged in completing the topography of Roanoke island if that ground shall be occupied in the operations of Brigadier General A. E. Burnside, and in such other plane-table duty as may be called for either by the military movements or by the naval operations under Commodore L. M. Goldsborough.

Hydrographic examination.—Through the superintendent of the National Observatory, Commander J. M. Gilliss, U. S. N., my attention was called about the middle of June to the supposed existence of a shoal or rock off the coast of Virginia. The position of the danger, as reported by Captain Martin Smith, of the American ship Simoom, which struck three times when within sight of Cape Henry, was seventeen to nineteen miles south of the cape, and seven to eight miles off shore. The spot was stated by Captain Smith to be quite small, and to have a depth of twenty-four feet of water on it.

In July Lieut. Comg. T. S. Phelps, U. S. N., assistant Coast Survey, with the steamer Vixen, made a thorough examination off the False cape of the coast of Virginia, and the result shows that no shoal of natural formation exists in the vicinity in which the Simoom touched. Beyond three miles from shore the least depth found was seven fathoms. The party in the Vixen ran eighty miles in sounding out a stretch of twelve miles coastwise with a breadth of six miles seaward.

An intimation given in the log of the Simoom as within the knowledge of the pilot then in charge in regard to the sinking of a vessel some time ago in the vicinity in which the Simoom struck, leads Lieut. Comg. Phelps to the conclusion that a wreck was touched on. His examination was thorough, and though the obstacle was not hit in sounding the non-existence of the supposed shoal may be regarded as clearly made out. An extract from his report is given in Appendix No. 8.

On his way to New York after making this examination, Lieut. Comg. Phelps started a line of soundings from a position eleven miles east of the "False cape" of the Chesapeake, intending to run along the coast in the direction of the light-ship off Sandy Hook. The line was kept across the entrance of the Chesapeake, but a little north of it the Vixen was set to the westward by the effect of a recent gale on the coast of Virginia, and the soundings were, in consequence, interrupted. The vessel was sheltered for the time at the Delaware breakwater, and then resumed hydrographic duty, which has been mentioned in its proper place, under the head of Section II.

Hydrographic resurvey of Hatteras inlet, N. C.—Early in October, Lieutenant Commanding T. S. Phelps, United States navy, with the steamer Vixen, was at Hatteras inlet for the purpose of making a hydrographic examination in regard to the changes which naturally take place there, and also with reference to the present capacity of the channel leading into Pamplico sound by that inlet. The tempestuous weather encountered during that and the following month protracted the work intended, and postponed examinations of other localities in the section included within the programme laid out for the party in the Vixen.

Remarkable changes occurred while Lieutenant Commanding Phelps remained in the vicinity of Hatteras inlet. A short base was laid out and measured on the spit at the south side of the inlet, and a chain of triangles extended across to the northward and eastward to recognized stations on the peninsula above Fort Hatteras and Fort Clarke.—(See Sketch No. 11.) The most important alteration of recent years occurred on the 2d of November, the force of the sea having cut quite through, separating the extremity of the peninsula on the north side of Hatteras inlet from the main body of it above, and leaving a water passage between Fort Clarke and Fort Hatteras.

The new shore-line depending on the triangulation referred to was traced by Lieutenant Commanding Phelps and the soundings commenced when sufficient data had been supplied in that way. The hydrography was carried outside about two miles from the inlet, to include the locality of the bar buoy and inside of the sound rather further. To the northward the hydrography of Pamplico sound was extended as far as the triangulation had been made and shore-line traced, or about two miles northward of Fort Hatteras. The sheet containing this work is now at the Coast Survey office.

After leaving Hatteras inlet Lieutenant Commanding Phelps ran a line of soundings from Cape Hatteras northward to Loggerhead inlet. The line crosses the Wimble shoals.

The steamer Vixen is now refitting for other duty afloat.

At the request of General McClellan, Assistant Henry Mitchell has been sent to examine the physical causes which affect the contour of the shores in the vicinity of the military stations at Hatteras inlet. His report will include the suggestion of expedients for preventing, or at least retarding, the encroachment of the sea at particular points, if the results of his in-

vestigation of the currents and other hydrographic features of that locality should seem to render such designs at all practicable.

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.—(SKETCH E, No. 13.)

The plan laid out and asssigned to the parties which have heretofore been engaged in this section was as described below:

1. Instructions for extending the coast triangulation and topography from Little river along the coast of South Carolina towards Winyah bay. Between that bay and Tybee entrance the detailed triangulation of the coast of South Carolina has been executed.

2. Instructions for completing the primary triangulation between Beaufort and Savannah, so as to connect the surveys of Port Royal sound with that of Savannah river.

3. Completion of the preliminary triangulation of the coast of Georgia. A chain of secondary triangles has now been determined, which joins the two bases measured for the surveys of the Savannah and St. Mary's rivers.

4. Instructions for completing the topographical survey between Port Royal sound and Savannah river, and for its prosecution on the tributaries of the sound.

5. Instructions for the plane-table survey of Wassaw sound, Ga., and for completing that of St. Catharine's sound.

6. Instructions for the hydrography of the two sounds last mentioned, the topography of St. Catharine's being well advanced towards completion.

7. Instructions to complete the off-shore hydrography of South Carolina and Georgia; to test ocean currents within the same limits; and to prosecute the in-shore hydrography of the coast of Georgia in the vicinity of St. Simon's island.

8. Tidal observations.

Office work.—The drawing has been completed, and the engraving in preliminary form of the chart of Ossabaw sound. Additions have been made to the drawing of the preliminary chart of Savannah river, and the engraving of that chart has been continued; the drawing of the hydrography of the rivers comprising the inland passage from St. Helena sound to Beaufort river, and additions to the chart of Port Royal and Broad river have been completed. The engraving of preliminary sea-coast chart No. 14, from Cape Roman, S. C., to Tybee, Ga., has been completed, as far as material allows, and the drawing continued. Additions have been made to the progress sketch of the section and to plates of charts previously engraved. The drawing of general coast charts No. VI, Ocracoke inlet, N. C., to Charleston, S. C.; No. VII, Winyah bay, S. C., to St. John's river, Fla.; of coast maps and charts, No. 53, Rattlesnake shoals to St. Helena sound, S. C.; No. 54, Fripp's inlet, S. C., to Ossabaw sound, Ga.; and the engraving of the preliminary charts of Sapelo sound and St. Simon's sound, Brunswick harbor, and Turtle river have been continued.

Triangulation and topography of the coast of South Carolina.—Instructions were issued, as usual, in the latter part of September, 1860, to Assistant C. P. Bolles and to his aid, Mr. O. Hinrichs, to take up the coast triangulation from its present limit at Little river, (see Sketch No. 13,) and continue the work southward and westward as far as practicable along the coast of South Carolina in the direction of Winyah bay. The topography was to be prosecuted in connexion with the preliminary work, as had been done by the same party in the work between Little river and Cape Fear. Mr. Bolles, residing then at Smithville, N. C., judged, in consequence of the attitude taken by the authorities of the State of South Carolina, when he was ready to proceed, that it would be inexpedient to resume the field-work. Mr. Hinrichs was accordingly detached in January, and on the approach of the working season at the north was

assigned to duty in Section I. On the 20th of April Mr. Bolles resigned his position as Assistant in the Coast Survey. A small vessel, the instruments that had been in the use of his party, and other property belonging to the government, including plane-table sheet No. 725, and the sheets containing the topography executed by Mr. Hinrichs in the working season of 1859–'60, are yet in his custody.

Triangulation between Beaufort, S. C., and Savannah, Ga.—In October, 1860, Assistant C. O. Boutelle was instructed to make arrangements for completing the main triangulation of the coast of South Carolina, between Winyah bay and the Savannah river, by extending the work from Port Royal entrance southward to the city of Savannah. Lieut. Wm. Craig, U. S. A., then on Coast Survey service, was directed to assist Mr. Boutelle in field-work, and Mr. C. H. Boyd was assigned as aid to the party. At the close of the working season of 1859–'60 the schooner Petrel, then unfit for sea, was laid up at Charleston so as to be conveniently near to the site of work for procuring the material and supplies needed by the triangulation party. Arrangements were complete for resuming work in November, 1860, when it was officially stated from the treasury that the usual applications for funds, based on the appropriations, could not be met. What shortly came to pass was not then anticipated.

The schooner Petrel, with her equipments, belonging to the Coast Survey when in charge of Mr. F. M. Jones, of Charleston, was seized by the authorities of South Carolina in December last, and the application which was promptly made for her release was without avail. The steam-tender Fire Fly, a very small vessel, which had proved of great service in the hydrography of the coast of South Carolina and Georgia, was seized at the same time, and is still held by her captors. She had been left in charge of a master's mate by Lieut. Comg. Fauntleroy after closing work in the spring of 1860. The Petrel was in Ashley river, in care of Mr. Jones, who had entered into a formal contract with Assistant Boutelle in May, 1860, in regard to the safe-keeping of the vessel.

The field duty performed by the party of Assistant Boutelle has been stated in the first chapter of this report.

Lieut. Craig was detached from duty in the Coast Survey on the 24th of April.

Early in November, 1861, the party of Mr. Boutelle, with the steamer Vixen and schooner Arago, accompanied the expedition of Commodore DuPont and Brigadier General Sherman to Port Royal sound. The regular work of the survey has been resumed, and additional parties assigned to make special topographical and hydrographic surveys for the use of the military and naval forces which now occupy that part of the coast of South Carolina.

Appendix No. 31 includes Mr. Boutelle's statement in regard to the connexion of his party with the naval operations of Flag-Officer DuPont, and also extracts from official reports, in which references are made to the co-operation of the Coast Survey.

In addition to the two surveying schooners Arago and Caswell the steamer Bibb has been reassigned for service, and sent to Port Royal sound in charge of Mr. Charles French.

Assistant Boutelle has sent to the office the original records of the horizontal angles measured during the last surveying season, and descriptions of the stations occupied by his party in the triangulation between St. Helena and Port Royal sounds.

There are now four parties at work in this section under the general direction of Assistant Boutelle. These will be again referred to under the head of topography, in the present chapter.

Triangulation of the coast of Georgia.—The entire coast of the State of Georgia has been spanned by secondary triangulation. At the opening of the surveying season Sub-Assistant F. P. Webber took up the work behind Cumberland island, and extended his triangulation to a junction with the completed survey of Fernandina harbor, going over a stretch of eight miles coastwise. The triangulation follows the inland passage between Cumberland island and the mainland of Georgia. Stations along the outside beach of the island were determined by

chaining, the measurements being repeated over distances making in the aggregate eleven miles and a half.

The connexion has now been made, through a series of forty-six triangles, between the Sapelo and Tiger island bases, both of which were measured by Lieutenant Evans, U. S. A. The length of the side adopted for connecting the two, (North Base, Point Peter,) as computed by Mr. Webber, is, when referred to the Sapelo base 3577.27 metres, and from the base on Tiger island 3577.83 metres. A very good result for the latitude of station North base (Tiger island) was also found, the position computed from the triangulation between it and Savannah being only 1."5 greater than the latitude determined in the same way from the astronomical station at Fernandina.

Mr. Webber used the ten-inch Gambey theodolite, C. S. No. 63, and the six-inch Brunner instrument, No. 52. He was aided in the field-work by Mr. P. P. Dandridge.

The statistics of the concluding work are as follows:

Signals erected	11
Stations occupied	16
Angles measured	45
Number of observations	588

Observations were made with the theodolite on sixty-one objects, and fourteen points were determined in position. A general scheme of the triangulation done on the coast of Georgia is given on Sketch No. 13. The triangulation party had in use the schooner Hassler. The work was completed early in December. A further extension of the preliminary survey of the coast by Sub-Assistant Webber will be mentioned in the next chapter.

Topography of Port Royal sound, S. C.—To provide for the completion of the plane-table work yet outstanding between the upper part of Port Royal sound and Savannah river, and that of the tributaries to the sound itself, Mr. Cleveland Rockwell was instructed early in October, 1860, to resume the survey with a party in the schooner Bailey. Being at that time, and somewhat later, engaged in topographical duty in Section I, his preparations for taking up duty on the coast of South Carolina were not completed until December. Just before this it had been announced from the treasury that no funds could be had to meet the estimated expenditures under the appropriations. The schooner, in consequence, was turned over to service in the party of Lieutenant Terrill, which had reached Section VI earlier in the season. Under the exigency that arose in April after her return from the Gulf of Mexico the vessel was transferred to the Navy Department.

During May, June, and July Mr. Rockwell was closely engaged on special field duty in Section III, reference to which has been made in the corresponding chapter of this report. The plane-table sheet containing his survey between Port Royal entrance and Savannah river entrance of the working season of 1859–'60 was inked early last spring and is now at the Coast Survey office.

Since the occupation of Port Royal sound by the United States forces, three plane-table parties have been assigned for duty in the field and are now at work under the general direction of Assistant Boutelle. These will be in charge severally of Sub-Assistant W. S. Edwards, Mr. Rockwell, and Mr. C. H. Boyd. The assignment of a fourth party will be referred to under the next head.

Topography of Wassaw sound, Ga.—Sub-Assistant H. S. DuVal was instructed, under date of September 24, 1860, to proceed with his party in the schooner Meredith, and after completing the plane-table survey of St. Catharine's sound, to take up and execute the topography of Wassaw sound, carrying his survey, if practicable, to a junction with that of the Savannah river. Mr. J. D. Bradford was assigned to aid him in field duty.

The repairs required in the vessel and other arrangements of the party having been completed, the Meredith sailed and duly arrived at Savannah, but on learning at the treasury that

for the estimates which had been made in the usual way no funds could be had under the appropriations, the schooner was ordered back to Portland. Mr. DuVal, who had meanwhile been detained at Leesburg, Va., by illness, removed to Tallahassee after his recovery, and sent in his resignation on the 19th of January last. The topography of Wassaw sound in consequence was not resumed this season. It is now about to be taken up by Sub-Assistant W. H. Dennis, whose previous employment has been stated under Sections I and III. Mr. Bradford was transferred to the party of Sub-Assistant Ferguson for service in Section VI.

The schooner Meredith, which had been intended for use in Wassaw sound, was employed by a party working in Section I.

Hydrography of St. Catharine's sound, Ga.—The execution of this work was set aside by the untoward circumstance officially made public from the treasury in November, 1860, that fiscal means could not be had under the appropriations, and upon which estimates had been based. My instructions were issued before the close of September to Lieutenant Commanding C. M. Fauntleroy, U. S. N., Assistant Coast Survey, and contemplated the completion of the hydrography of St. Catharine's sound and the taking up of work in Wassaw sound. The schooner Varina and steam tender Fire Fly were intended for his service. The last-named vessel, however, which was too small to pass to and fro between New York and her working ground, had been left at Charleston by Lieutenant Commanding Fauntleroy when he closed work in the previous spring. The Varina had been laid up at New York.

On the 29th of December the Fire Fly, then in charge of a quartermaster of the hydrographic party, was seized by the State authorities of South Carolina and has not since been delivered. To replace her boiler, which was worn out, a new one had been provided at New York for the service of the present working season, and that on the turn of affairs was retained at that port with the schooner Varina.

Lieutenant Commanding Fauntleroy was detached from duty on the Coast Survey by order of the Navy Department on the 1st of May. All the records connected with the hydrographic survey of Ossabaw sound, including soundings, angles, and tidal observations, were sent to the office by Lieutenant Commanding Fauntleroy in April last. The hydrographic sheet had been completed and sent in during the winter.

Hydrography of Altamaha sound, Ga.—The duty assigned to the party of Lieutenant Commanding J. P. Bankhead, U. S. N., Assistant Coast Survey, by my instructions of September, 1860, included the completion of in-shore soundings abreast of St. Simon's island, and connecting with the work which had been done in Doboy sound. In addition, the party in the schooner Crawford was to run off-shore lines and complete the off-shore hydrography of the coast of South Carolina, developing in its course the curve of one hundred fathoms, and determining the ocean currents by experimental observations. Other duty was assigned in Section VI, and the preliminaries for taking up work were commenced as usual. The usual allowance to this party had been set down from the appropriation, but when the vessel was ready to sail no funds could be had to meet the expenditures. She was accordingly retained at New York, and was in May transferred to the use of the revenue service.

Lieutenant Commanding Bankhead was detached from duty on the Coast Survey by order of the Navy Department on the 8th of June.

Tidal observations.—The record of observations from the self-registering tide-gauge at the Charleston custom-house, S. C., were received up to the 22d of April last from the observer, Mr. W. R. Herron, and the gauge was known to be in operation on the 4th of May. After that time, postal intercourse being suspended, no information has been received in regard to the observations. As far as the returns have come to hand the register of observations has been quite satisfactory.

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 REEFS AND KEYS.—(SKETCHES F, NOS. 14 AND 15.)

The field-work accomplished under my instructions, and portions of work so provided for but not executed, will be referred to as follows:

1. Instructions for continuing the air-line triangulation across the Florida peninsula from its present limit at Gainsville. It was expected that before the close of next season the chain of triangles leading from Fernandina harbor would have been connected with the survey of Cedar Keys.

2. Triangulation embracing the inland passage between Fernandina and St. John's river entrance, and connecting the bases used in those surveys.

3. Instructions for continuing the triangulation of the eastern coast of Florida, from Matanzas inlet southward towards Cape Cañaveral.

4. Triangulation of Indian river, above the inlet, extended from Willis's bay to the "Narrows;" and plane-table survey made within the limits of the triangulation of last year which embraces the vicinity of Indian River inlet and the lower part of the river.

5. Triangulation inside of the Florida reef, reaching from Pie Key westward to Deep Point, and northward to the Main. This work determines in position most of the keys in the lower part of Barnes's sound.

6. Triangulation of the passage between Pine island and the western main shore of the Florida peninsula. This work is supplementary to the preliminary survey of Charlotte harbor, and furnishes points for completing the topography.

7. Topography completed between Diego plains and the head of Guano river, Fla., making the survey continuous between St. John's river entrance and St. Augustine harbor.

8. Plane-table survey of keys in the lower part of Barnes's sound or Chatham bay, and supplementary topography in Charlotte harbor.

9. Instructions for the hydrographic survey of Charlotte harbor, for which ample provision had been made in the triangulation and topography.

10. Tidal observations.

Office-work.—The engraving of coast map and chart No. 68, from Key Biscayne to Carysfort reef, has been completed, and additions have been made to the progress sketch of the section. Progress has been made in the drawing and engraving of general coast chart No. X, Florida reefs, from Key Biscayne to Marquesas key; in the engraving of coast map and chart No. 71, from Newfound Harbor key to Boca Grande key; of St. Augustine harbor; and in the drawing of coast map and chart No. 58, from St. Andrew's sound, Georgia, to St. John's river, Fla.

Air-line triangulation across Florida peninsula.—In the expectation that this work would be nearly completed within the present working season, instructions for its continuance were issued last fall to Captain M. L. Smith, U. S. Topographical Engineers. Lieut. R. G. Cole, U. S. A., who had taken charge of the details in the previous season, was assigned to assist Captain Smith.

Confidence was expressed by the several officers on duty on the eastern side of Florida in regard to the improbability of interference with the operations of the survey up to a date beyond the opening of the working season, and hence arrangements for going on were made as usual. Soon after the beginning of the present year, however, the condition of public affairs was so changed as to render any outlay on the air-line triangulation unadvisable, without a prospect for the return of completed angular measurements. None was therefore incurred in the way of opening and preparing lines of sight, as had been done in extending the work

from Fernandina to Gainsville. The work rests at the last named station, (Sketch No. 14,) but cannot be made available for the purpose intended at the outset until the chain of triangles has been extended to Cedar Keys. The lines are opened a few miles beyond Gainsville, and the distance between the station which would have been occupied next in order and Cedar Keys is about fifty miles.

The camp equipage and implements used by the field party were stored by Capt. Smith in the railroad depot at Waldo previous to his resignation on the 1st of April. Lieut. Cole sent in his resignation from the army on the 10th of January.

Triangulation of the eastern coast of Florida.—Starting from stations which had been used in the completed survey of Cumberland sound, Sub-Assistant F. P. Webber, with a party in the schooner Hassler, extended the coast triangulation southward to a junction with the survey of St. John's river entrance. This work measures coastwise about nineteen miles. Its execution makes the secondary triangulation of the Atlantic coast continuous from Winyah bay, in South Carolina, to Matanzas inlet, on the eastern coast of Florida.

Mr. Webber resumed work for the season on the 13th of December, choosing the line *Martin's island—South base*, (see Sketch No. 14,) and carried his triangulation through the inland passage behind Amelia and Little Talbot islands. The party was employed in this duty and in the determination of stations on the outside beach of Amelia island until the 9th of March. Two theodolites were used, the ten-inch Gambey, No. 63, and the six-inch Brunner theodolite, No. 52. The connexion with the triangulation of St. John's river was made on the side of *Round Pond—Horse Shoe* by a chain of twenty-seven triangles. A difference of only 0.11 metre was found on comparing the two computed lengths of the side, using in one case the determinations of the St. John's river triangulation, and in the other the base at Cumberland sound and the angular measurements leading south from it. Towards the St. John's, the inland passage being there very narrow, triangles of only about a mile on the side could be had, and that length required cutting and clearing for the use of the theodolite. The positions of points on the beach of Amelia island were determined with the chain, and twelve miles were thus run by the party.

The triangulation executed by Sub-Assistant Webber includes points for the plane-table survey and hydrography of Nassau sound.

The general statistics of the triangulation between the St. Mary's and St. John's rivers are thus reported:

Signals erected	27
Stations occupied	31
Angles measured	217
Number of observations	2,546

Two hundred and thirty-one objects were used in observing, and forty points in all determined in position. Mr. P. P. Dandridge, who aided Sub-Assistant Webber, resigned his place in the survey on the 25th of April. On her return passage the schooner Hassler reached New York on the 30th of March. The duplicates of the records of field-work were completed before the return of the party, and are now in the office.

In reference to the inland passage, between Cumberland sound and the St. John's, Mr. Webber says: "Vessels drawing not over seven feet can get through as far as Nassau sound, but south of that part of the passage is left entirely dry at low water, and no more than four feet can be carried through to the St. John's."

Of the entrance to Nassau sound he remarks: "Nassau bar seems to have seven or eight feet on it at low water, but the channel is quite narrow."

During the summer Mr. Webber was actively employed in Section I.

Triangulation south from Matanzas inlet, Fla.—With a view of extending the coast trian-

gulation below St. Augustine, Lieutenant W. G. Gill, U. S. A., Assistant Coast Survey, was detailed to organize a party and take up the work at Matanzas inlet, to which point it had been carried in the previous season by Sub-Assistant Benjamin Huger, jr. The necessary arrangements were made by Lieutenant Gill, and he proceeded south in October, intending to take the field without delay. Lieutenant O. D. Greene was assigned to assist him in the triangulation. Early in November, and when engaged in completing his preparations for work, Lieutenant Gill met with a severe accident at Savannah, and was detained there until the middle of December. The change of circumstances which had meanwhile occurred at the treasury, as already mentioned, induced me to recall the party and defer the prosecution of the work on the eastern coast of Florida.

Lieutenant Gill remained at Savannah, and early in February resigned. Lieutenant Greene was detached from Coast Survey service on the 24th of April by orders from the War Department.

Sub-Assistant Huger sent in his resignation, to take effect on the 31st of March.

The field equipage which had been in use when the party was in charge of Mr. Huger was stored at the close of the previous working season at the barracks at St. Augustine. Early in January the tents were seized by the State authorities of Florida, and are yet held, with the utensils that had been used by the triangulation party.

Triangulation and topography of Indian river, Fla.—As the best means for carrying on the survey of Indian river above Fort Capron, Sub-Assistant Charles Ferguson, having shipped materials in the schooner Peirce, constructed a flat-boat in January last, and near the end of that month took up the triangulation of the river. The work was carried to the Narrows, or about thirteen miles north of the village of Fort Capron. Indian river in that part of its course averages about a mile in width. At all the stations observed on scaffolds of considerable height were required for the theodolite. Two on the outer beach were elevated about twenty-five feet. On the west bank of the river, which has a natural elevation of five to six feet, the height of the scaffolds required was less.

Six signals for topographical purposes were set at suitable points, and their positions determined with the theodolite.

In addition to the work above Fort Capron, Mr. Ferguson occupied a station about half a mile north of the old military post, (Fort Peirce,) and a second at Shoal Point, on the east side of the river. Both of these are in connexion with the preliminary work done last year, and with a third point about three miles south of the inlet, determined in position approximately, completed the basis requisite for the plane-table survey of Indian river in the vicinity of the inlet.

The statistics of the triangulation are thus reported :

Stations occupied	7
Number of observations	610
Area of triangulation, (square miles)	18

The angles were measured with the six-inch Gambey theodolite, C. S. No. 65.

All the records connected with the triangulation have been deposited in the office in Washington.

The plane-table survey of the lower part of Indian river was executed by Mr. J. D. Bradford, under the general direction of Sub-Assistant Ferguson. It joins the survey of Indian River inlet made by Mr. Ferguson last year, and extending northward, embraces both banks of the river as far as the triangulation had then been carried. Mr. Bradford continued the topography about two miles southward of the inlet, and mapped in all seven miles in extent of the beach and peninsula, and the same extent of the western shore of Indian river. Sketch No. 14 shows the position and course of Indian river.

The sheet executed by Mr. Bradford represents twenty-five miles of shore-line and surface details within an area of nineteen square miles.

In many places the shores of the river were very difficult of access, the water being quite shallow. The advance of the survey of the shores, moreover, was retarded by a tangled undergrowth of palmetto and by extensive marshes.

The completed topographical sheet of this season is now at the office.

Advices in regard to the excited state of public feeling made it expedient to withdraw the party in the schooner Peirce, and the vessel accordingly returned to New York at the end of February.

Sub-Assistant Ferguson reports that he found eight feet of water in the south channel at Indian River inlet.

About ten miles north of the inlet Indian river lessens in width very rapidly. At the "Narrows" it is only two to three hundred yards wide, and is blocked up by shoals and islands. The "Narrows" extend eight miles, and then the river widens again.

Mr. Bradford resigned on the 31st of March.

Triangulation of Florida keys and Main.—An advance has been made by the party of Assistant G. A. Fairfield from the completed work in Barnes's sound, and in connexion with it, by triangulation extended westward from Snipe Point, (see Sketch No. 15.) This work includes, also, points which determine the positions of several of the interior keys, and furnishes the means for developing rather more than ten miles of the main coast between Barnes's sound and Cape Sable. The party was employed in this duty during the month of January with the schooner Caswell. Assistant Fairfield was aided by Mr. McLane Tilton in putting up signals, and also in the records of angles and computations.

In the triangulation of this season Mr. Fairfield worked from a camp on Pie key, and had made full preparation for extending the work towards Cape Sable. While the triangulation was in progress the vessel remained at anchor near Rodriguez key, in charge of the sailing-master, her draught not admitting of her use nearer to the site of work. The anchorage being at an exposed position outside of the reef, Mr. Fairfield was authorized to return to New York after consultation with government officers at Key West. He accordingly despatched the schooner on the 11th of February, and laid her up on her arrival at New York.

The following statistics show the progress made in the triangulation:

Signals erected	9
Stations occupied	6
Angles measured	43
Number of observations	1,154

The angles were measured with a ten-inch theodolite, Blunt, No. 91. It will be seen by reference to the progress sketch (No. 15) that a season of ordinary good weather would suffice to complete the triangulation along the main coast of the Florida peninsula, between the inner keys and Cape Sable.

The records of the triangulation of Chatham bay, original and duplicate, with descriptions of the signals, have been turned in at the office. Assistant Fairfield has also completed and furnished his computation of the results for the length of triangle sides.

Triangulation of Charlotte harbor, Florida.—The triangulation of Charlotte harbor has been essentially completed by Lieut. W. R. Terrill, U. S. A., assistant in the Coast Survey. His party, with the schooner Bailey, resumed work on the 13th of December. Lieut. Terrill took up the triangulation at Punta Rasa, and laid out and measured a series of triangles running from that station northward and eastward behind Pine island, (Sketch No. 14,) and forming a junction with points used in the triangulation of the upper part of Charlotte harbor. The length of the series is about fifteen miles. Lieut. Terrill was assisted in this service by

Sub-Assistant W. S. Edwards, whose intelligence and efficiency are warmly commended in the report from the field.

The plan laid out for the season's work of the party in the schooner Bailey was designed to push the triangulation of the coast of Florida northward after completing the angular measurements in Charlotte harbor. With this in view, Lieut. Terrill visited Tampa between the middle and latter part of January for lumber and other requisites, and there first learned the circumstances which, in their course, ended in the withdrawal of the party and the vessel from the western coast of Florida. Returning, however, from Tampa to Charlotte harbor, he continued work, and completed the triangulation of the harbor in the latter part of February. On the 4th of March he was with his vessel and party at Tortugas, and there made preparation for the return voyage to New York. The vessel, with the instruments and equipage of the triangulation party, finally reached port on the 14th of April, after a long and boisterous passage. In the following month she was turned over to the Navy Department.

The statistics of field-work are appended in the usual form:

Signals erected	17
Stations occupied	16
Angles measured	77
Number of observations	2,880
Area of triangulation, (square miles)	30

The angles were measured with the ten-inch theodolite of Gambey, C. S. No. 81.

Lieut. (now Captain) Terrill was detached from Coast Survey service by the honorable Secretary of War on the 24th of April.

Sub-Assistant Edwards was employed throughout the summer in Section II, and is now actively engaged in Section V.

Coast topography north of St. Augustine, Florida.—For continuing the plane-table work on the coast of Florida, north of St. Augustine harbor, Sub-Assistant F. W. Dorr despatched the schooner Dana from New York in the early part of November, and joined the party shortly after at the city of St. Augustine. Taking the first favorable opportunity, the vessel was moved up to Shell bluff, a point on the North river to which the topography had been extended in the work of last season. The plane-table survey of the banks of the North and Guano rivers was then resumed and pushed northward to Diego Plains, where Mr. Dorr's sheet joins a survey made by Sub-Assistant Mechan in 1858. This season's work includes eight miles of coast line, seven miles of the course of Guano river, and over ten miles of the course of the North river, all in a northerly direction (Sketch No. 14) from the limit reached last year, and completes the topography of the coast between St. John's river entrance and St. Augustine harbor. The topography is embraced on two sheets, one of which was worked on last season in the survey of the lower part of the North river. The second contains the plane-table survey between the head of that river and Diego Plains.

A summary of the statistics of this season's work is here given:

Coast line	8	miles.
Shore line of rivers and creeks	154	"
Marsh line	65	"
Roads	37	"
Area of topography, (square miles)	34½	

Above the head of North river the San Pablo road was taken as the inland limit of the survey. It runs nearly parallel with the coast, and at an average distance of a mile and a quarter from it.

Mr. Dorr returned to St. Augustine on the 12th of January, and was about to resume the survey of the Matanzas river, in accordance with my instructions for continuing work, so long

as his party was not molested. The public authorities were favorable and anxious for its continuance, but felt restricted by the policy which was then about to be adopted by the State of Florida. Events followed which rendered it inexpedient to remain, and Mr. Dorr, in consequence, made preparations for returning to New York. The schooner left Matanzas inlet and reached port on the 11th of February. A boat and the camp equipage of a party, intended for extending the triangulation below St. Augustine, was detained by the authorities of the State. When last under the control of an officer of the Coast Survey, this property had been left for safe-keeping with the ordnance sergeant at the barracks.

Mr. E. P. Heberton aided efficiently in the topographical work near St. Augustine. A general description of the coast features embraced in the work of this year is given in extracts from the report of Sub-Assistant Dorr, Appendix No. 26.

The plane-table sheet projected by Mr. Dorr for the survey near Diego Plains has been inked since his return from the coast of Florida and placed in the office with the second sheet referred to, part of the details of which was executed last season.

Topography of Florida keys.—The plane-table survey of keys inside of the Florida reef was resumed in January last by the party of Sub-Assistant C. T. Iardella. The schooner Agassiz, which served for transportation, having too much draught for the shallow passages leading to the site of work in the lower part of Barnes's sound, or Chatham bay, the small tender Sophia was employed. Mr. Iardella, aided by Mr. T. C. Bowie, surveyed most of the keys comprised within the triangulation done in the previous season by Assistant Fairfield, taking up the work in a range parallel to and westward of the inner shore of Key Largo. The plane-table sheet containing this survey was brought away from the section on the return of the party and vessel in March. Mr. Iardella, after reporting in person at the Coast Survey office, retired to his home, at Brentsville, Va., for the purpose of inking the topographical details. He has not yet returned to the office, nor has any communication been received from him.

This topographical party was at work during the month of February on the western side of the Florida peninsula, in a locality which will be referred to presently. Mr. Iardella's report has not yet been received. The statistics of the work done will be stated under the head of Charlotte harbor.

Topography of Charlotte harbor, Fla.—Towards the end of January the party of Sub-Assistant Iardella, which had been employed near the Florida reef, was transferred in the schooner Agassiz, and continued the plane-table survey of Charlotte harbor. The topography was extended along the banks of Peas creek, and a tributary between it and Myakka river was surveyed. The details of the eastern side of the harbor, for which provision had been made in the triangulation of Lieutenant Terrill, were then taken up. Considerable progress had been made towards the final completion of the minor details for a finished chart of Charlotte harbor by the close of February. It became necessary, however, by reason of the excited state of public feeling in the section at that time, to direct precautionary measures for securing the return of the vessels which were then in active service near the Florida peninsula. The schooner Agassiz was employed to visit the several parties and to deliver instructions to provide for their safety. All of the vessels so engaged were returned safely to New York.

After his return to Washington Mr. Iardella proceeded in March to ink his sheet of this season's work in Charlotte harbor at his home, in Brentsville, Va. No intelligence has since been received from him. The aggregate of shore-line run by his party in the two localities of work was one hundred and thirty-four miles.

Hydrography of the Florida reef.—The only interval to be filled in the outside hydrography of the reef is the stretch of about twenty-five miles between Key Rodriguez and Long key, which may be seen by reference to Sketch No. 15. This it was my intention to have sounded out by a party in the steamer Corwin which at the opening of the working season was in charge of Lieut. Comg. John Wilkinson, U. S. N. That officer resigned on the 6th of April, and not

having been replaced on the survey by another officer the vessel remained during the winter at New York. In May the Corwin was transferred for temporary use in the revenue service.

Hydrography of Charlotte harbor, Fla.—The duty of sounding the entrance, approaches, and channel into Charlotte harbor was assigned to an able and energetic officer by instructions issued in the autumn of 1860, full preparation having been previously made in the progress of the triangulation and topography. In addition, Lieut. Comg. Bankhead was directed to run a line of soundings broad off from Cape Romano, and to record the temperatures in the usual way.

The schooner Crawford, with the hydrographic party, sailed from New York on the 21st of November, the purpose being to execute some additional soundings in section V, and then to proceed to the western coast of Florida. Rough weather was encountered off Cape Charles, and with the loss of anchors the vessel reached Norfolk on the 3d of December. Before the necessary repairs could be made public events had so changed in character as to render it unadvisable to proceed to the site of the work. The vessel accordingly returned to New York, and in May was transferred for temporary service to the revenue marine. Lieut. Comg. Bankhead was detached for Coast Survey duty by orders from the Navy Department on the 8th of June.

Magnetic observations at Key West, Fla.—The instruments set up last season at a small observatory in Key West have been kept in operation during the year. Mr. G. D. Allen recorded the observations until the end of March, when the instruments were placed in charge of Mr. Samuel Walker. Sub-Assistant J. G. Oltmanns was assigned to duty at the magnetic station in April, and after passing that and the following month in the joint care of it with him, Mr. Walker was transferred to the magnetic station at Eastport, in Maine, as already stated under the head of Section I.

The records from the instruments at Key West have been regularly received and filed at the office.

Sub-Assistant F. F. Nes has recently been assigned to duty at Key West.

Tidal observations.—These were continued at Fort Clinch, near Fernandina, Fla., by means of a self-registering tide-gauge, under the charge of Mr. J. A. Walker, until September, 1860. The observer then resigned, leaving the instrument in the care of Mr. E. G. Mears, who continued the observations until the 5th of November, when he was replaced by Mr. A. M. Smith, and the record went on during the winter and early part of spring. Mr. Smith resigned on the 1st of April and left the station. Steps were at once taken to have the gauge returned to the Coast Survey office, but without success, owing to interruption in the mail service, and still later to the cessation of commercial intercourse with ports on the coast of Florida.

The tidal observations at Tortugas were continued by Mr. H. Benners, with good results, until the 1st of May, when the observer reported frequent interruptions from the jar produced by the firing of heavy guns at the fort. Under these circumstances the observations were suspended, the other stations on the Gulf coast, and to which the Tortugas results served only as a standard of reference, not being in operation.

SECTION VII.

FROM ST. JOSEPH'S BAY TO MOBILE BAY, INCLUDING PART OF THE WESTERN COAST OF FLORIDA AND THE COAST OF ALABAMA.—(Sketch G, No. 16.)

The work done will be stated in the following order, notice being taken of what was intended by instructions in the usual way, but not accomplished, for reasons which will be given under the several heads:

1. Determination of longitude at Pensacola, by telegraph, with observations for latitude, azimuth, and the magnetic elements. This completes the longitude observations at principal stations along the coast between the northeastern boundary (Calais, Me.) and New Orleans.

2. Triangulation from Bayport southward to Tampa bay, including St. Joseph's bay (south) and Clearwater harbor. The work here referred to makes the triangulation of the western coast of Florida peninsula continuous between Tampa and Cedar Keys.

3. Preliminary reconnaissance and selection of stations for the triangulation of St. Joseph's bay (north) and of the coast of Florida between it and St. Andrew's bay. This work is an extension westward of the triangulation of St. George's and St. Vincent's sounds.

4. Additional triangulation at the head of Blackwater bay, Fla., for carrying the plane-table survey and soundings as far northward as Bagdad.

5. Plane-table survey of the western coast of Florida, in the vicinity of Bayport.

6. Instructions to complete the topography of St. James's island and Crooked river.

7. Instructions to complete the hydrography of St. George's sound, and for soundings between St. Mark's harbor and Southwest Cape.

8. Tidal observations.

Office-work.—Progress has been made in the drawing of coast map and chart No. 81—Gulf coast from Chassahowitzka river, Fla., to Cedar Keys; and in the engraving of important additions to the chart of the western part of St. George's sound. The drawing and engraving of the preliminary chart of Cedar Keys, (new edition;) of Escambia and Santa Maria de Galvaez bays, (in preliminary form;) and the drawing of Apalachicola bay, have been completed, and additions have been made to the progress sketch of the section.

Longitude, by telegraph, at Pensacola, Fla.—The chain of determinations of longitude at the principal ports and cities of the Atlantic and Gulf coast of the United States has been made complete by telegraphic observations at Pensacola, in connexion with Mobile. The longitude of the last-named point was determined in 1858, in connexion with a station at New Orleans.

Assistant Geo. W. Dean having selected the requisite astronomical instruments and apparatus at the office and despatched them in charge of one of the aids of his party, proceeded to Pensacola near the end of November, 1860, and made the arrangements necessary for the use of the telegraph lines between that city and Mobile. An astronomical station was established and instruments set up for determining also the latitude and azimuth at Pensacola.

With the courtesy which has marked the whole progress of this work between Eastport, Me., and New Orleans, the telegraph lines were placed at Mr. Dean's disposal by the general managers, for use after 9 o'clock at night.

Having made preliminary observations to ascertain the personal equation between the members of the party, Assistant Edward Goodfellow and R. H. Talcott, as aid, were assigned to duty at the Mobile end of the line. Mr. Dean, Sub-Assistant J. H. Toomer, and H. W. Bache, aid, remained at Pensacola. After a successful exchange of star and clock signals, the observers changed stations, making similar exchanges of signals. Forty-seven stars at Pensacola, and forty at Mobile were observed on and during three nights when clock signals were exchanged—one hundred and seventy stars were observed at each station to ascertain the local time and instrumental corrections, exclusive of two hundred and sixteen observations recorded at Pensacola, and fifty-six observations on twenty circumpolar stars for determining the thread intervals of Transit C. S. No. 4.

At Mobile one hundred and twenty observations were made on twenty-eight zenith and circumpolar stars for local time and thread values.

On six of the nights employed in the longitude work, in January and February, one hundred and ninety-six observations were made for personal equation.

The usual meteorological journals were kept by the party at the two stations, and have been turned in with the original astronomical and other records.

Latitude observations at Pensacola, Fla.—For establishing the latitude of the astronomical station at Pensacola, Assistant Goodfellow made one hundred and thirty-seven observations

in February, on thirty-one sets of stars, with the zenith telescope, C.S. No. 5. The arc value of the micrometer divisions was determined by two complete series upon Polaris, near western elongation, and the divisions of the level scale were measured with the micrometer in the usual manner.

The record of observations has been duplicated and turned in at the office, with the computation for latitude.

Azimuth at Pensacola.—The azimuth was determined by Assistant Dean at the geodetic station designated in the record as Barkley No. 2, on the north side of Pensacola bay. For that purpose one hundred and thirty-four observations in all were made in December and January upon Polaris, near its lower culmination and western elongation; on *delta* Ursæ Minoris near the lower culmination; and on *lambda* Ursæ Minoris near western elongation, in connexion with one hundred and twenty observations on the elongation mark. The mark was referred to two of the geodetic stations by the measurement of eight series of angles in five positions of the instrument, with the 24-inch theodolite, C. S. No. 2, embracing in all two hundred and forty observations.

In June, Assistant Dean deposited in the archives the records of the work, original and duplicate, containing observations for longitude, azimuth, the measurements for horizontal angles in connecting the longitude station, "Barkley 2," with the triangulation of Pensacola harbor, and the register of the observations for time and magnetic elements.

Magnetic observations.—At the astronomical station near Pensacola, Assistant Dean made two sets of experiments in January last, for ascertaining the moment of inertia, using the declinometer C. S. No. 1.

The magnetic declination was found from eighty observations, made on two days.

The dip of the needle was determined from two series of observations with the dip circle C. S. No. 4.

Assistant Dean has deposited in the office reductions of the results for the magnetic elements, and the records kept at the station.

The party returned to Washington in February, bringing the instruments which had been used in the several operations at Pensacola and Mobile.

During the summer Mr. Dean was employed in Section I.

Triangulation of St. Joseph's bay, (south,) Fla.—In continuation of the preliminary work which has been extended along the western coast of the Florida peninsula, from Cedar Keys southward, Sub-Assistant G. H. Bagwell again took up the triangulation on the 5th of December, 1860, at North Anclote key. As intimated in an extract from his report of last season, the coast south of that key and so on to Tampa entrance was found easy of access, affording natural facilities for pushing the work rapidly. The triangulation was extended (Sketch No. 16) quite through St. Joseph's bay (south) and through Clearwater harbor to McKay's Point. In the terminating quadrilateral, as will be seen by the sketch, the triangulation is made to connect with the site selected on Chaldee's key by Mr. Bagwell, in 1859, for a base of verification. Arrangements were made by Mr. Bagwell to meet the intended measurement of the line early in February, Assistant F. H. Gerdes having been provided with the means and instructed for that duty. The circumstances, however, then existing in his section of the work made it inexpedient to keep the appointment which had been settled between him and Sub-Assistant Bagwell, and in consequence the line has not yet been measured.

At Cedar Keys, where he was to meet Mr. Gerdes, Sub-Assistant Bagwell, learning that public property had been put in jeopardy of seizure in the neighboring section, reported to me accordingly, and having well-founded fears for the safety of the schooner Joseph Henry, then in his charge, he hastened her departure from that port. The vessel left Cedar Keys on the 12th of February, and duly arrived at New York.

The progress made during the season, which was cut short by the circumstances alluded to, is shown in the following abstract of statistics:

Stations occupied	15
Signals observed on	27
Angles measured	66
Number of observations	2,550

The eight-inch Würdemann theodolite, No. 86, was used in measuring the horizontal angles.

Mr. M. O. Hering served as aid in the triangulation party.

Appendix No. 27 contains remarks taken from the official report of Mr. Bagwell, descriptive of the character of the coast of Florida in the vicinity of St. Joseph's bay, (south).

Sub-Assistant Bagwell resigned his position on the survey on the 30th of April. All the records and field-notes pertaining to his triangulation between Cedar Keys and Tampa have been received from him. These include his field computation of results.

Triangulation of St. Joseph's bay, (north,) Fla.—The party of Sub-Assistant S. C. McCorkle was detailed at the outset of the surveying year for the purpose of extending the triangulation of the coast of Florida around Cape San Blas, (see Sketch No. 16,) and through St. Joseph's bay. The schooner Torrey, with the equipments of the party, reached her working ground on the 16th of December. Mr. McCorkle commenced work immediately, and occupied in succession three stations to the eastward of the cape, completing at them the measurement of angles as the basis of the work, which was to be prolonged westward across the sudden turn of the coast and into St. Joseph's bay. After a general reconnaissance to determine the direction of the lines required, the termini of which on the shores of the bay could not be seen, the schooner was moved into that body of water, and the party set to work in tracing and opening lines of sight through the woods. Three of these, as may be seen by the sketch, converge at Inch Keith, a small island in the lower part of St. Joseph's bay. A fourth, from a station east of Cape San Blas, opens on a signal which Mr. McCorkle set up on the western shore of the bay. Six lines in all were laid out, and four of them opened for observing. In this duty the party was occupied during the month of February. There being no disposition shown towards interference with his progress, Sub-Assistant McCorkle proceeded with the field-work and erected six tripod signals for observing with the theodolite. Before taking up the angular measurements, however, it was found necessary to return to Apalachicola for provisions and water, in the early part of March, and he there found the public excitement such as to render it imprudent to detain the vessel longer in the section. The instruments and other public property in charge of Mr. McCorkle were accordingly sent on board, and reached New York with the schooner on the 27th of March.

The reconnaissance made by Sub-Assistant McCorkle furnishes a scheme for connecting the completed triangulations of St. George's sound and St. Andrew's bay. Two of the lines leading into St. Joseph's bay yet require to be opened for sight. One, leading from station Dead Oak to station Inch Keith, will need but little cutting; the other, between Ragged Point and the same station, will be difficult, but the opening is stated to be quite practicable.

Mr. H. W. Longfellow aided in the field-work of this party.

During the surveying season at the north Sub-Assistant McCorkle was employed in Section I.

Triangulation in Pensacola bay and its dependencies, Fla.—At the usual period for resuming work in this section Assistant F. H. Gerdes proceeded to Pensacola, with a view of completing the preliminary survey and topography of the bay and its dependencies. His first duty was, in co-operating with the longitude party, to connect the new astronomical station with the triangulation. For this purpose he occupied four stations and measured seven horizontal angles by two hundred and fifty-two observations. The station points were carefully marked.

In Santa Maria de Galvez bay three stations of the triangulation of last year were reoccupied, and the angular measurements at them completed.

The triangulation of Blackwater bay was then resumed at Escribano Point, (Sketch No. 16,) and was extended northward to the town of Bagdad, completing the preliminary work on the eastern arm of Pensacola bay. On its western arm (Escambia bay) a reconnaissance was made and signals erected for furnishing the data required to complete the plane-table survey.

This work was prosecuted in December.

Sub-Assistants J. G. Oltmanns and C. Fendall were attached to the party of Mr. Gerdes. The schooners James Hall and Gerdes were used for transportation, and at the close of the year full preparation had been made for completing the plane-table survey for the finished chart of Pensacola harbor and its dependencies.

Early in January Mr. Gerdes reported from Pensacola that the public excitement was such as to endanger the possession of the two vessels under his charge. They were accordingly removed to Passe à Loutre, but the assurance being no greater in regard to their safety there, both were despatched in the middle of that month for New York, and reached their destination in safety on the 3d of February, with the instruments and camp equipage of the party.

The following statistics refer to the work done in completing the triangulation of Blackwater bay:

Stations occupied	10
Angles measured	45
Number of observations	350

Topography north and south of Bayport, Fla.—The plane-table survey of the western coast of the Florida peninsula was resumed on the 1st of December at Raccoon Point by Sub-Assistant N. S. Finney, and was continued southward to Round island signal, two miles below Bayport. Two sheets were worked on; one embracing seven miles of the coast north and south, and the other, on a larger scale, the town of Bayport and its vicinity, and the Wekawatchee and Mud rivers. The positions of both are shown on Sketch No. 16.

Transportation for the party and implements used in the topography was furnished by Sub-Assistant Bagwell with the schooner Joseph Henry.

In the early part of February, while Mr. Finney was engaged in topographical duty with the prospect of a large return of work, as will be seen by the statistics, the public property in his charge necessary for its continuance was demanded by a committee of armed inhabitants of Bayport, in number about twenty. The tents and camp fixtures being under the protection of only Sub-Assistant Finney and his aid, Mr. L. L. Nicholson, were necessarily relinquished to the chairman of the committee, Mr. C. T. Jenkins, whose receipt for the property is now on file in the Coast Survey office. Mr. Finney had just previously sent off his boats to the schooner Joseph Henry, thereby securing the instruments and a large part of the outfit intended for the remainder of the working season. A boat which could not be removed by the plane-table party was left at Homasassa on the 15th of February, in the care of Hon. D. L. Yulee, a receipt for it being taken in the usual form.

The following are statistics of the part of the season employed near Bayport:

Shore-line surveyed	101½	miles.
Low water shore-line	16	"
Roads	4	"
Area of topography (square miles)	16	

The work was stopped on the 11th of February. On leaving Bayport Mr. Finney proceeded to his residence at Brunswick, Georgia, and forwarded his official report to the office on

the 3d of April. The two plane-table sheets in his charge at that date, not having been inked, are yet at Brunswick.

Some incidental remarks in the report of Sub-Assistant Finney, relating to the coast and waters of the Florida peninsula in the neighborhood of Bayport, are given in Appendix No. 28.

Topography of St. George's and St. Vincent's sounds, Fla.—The only work required to complete the plane-table survey of St. George's sound is a portion of the course of Crooked river and the neighboring part of St. James's island inside of the shore of the sound. This duty would have been taken in hand at the approach of winter by Assistant G. D. Wise, with a party in the schooner Howell Cobb, if funds had been available at the treasury. My instructions for the service were issued in September, 1860. It was intended also to push the plane-table work westward from Indian Pass within the triangulation of this year by Sub-Assistant McCorkle.

In May last the vessel was transferred to the Navy Department. During the spring and summer Mr. Wise was actively engaged in the charge, transfer, and repairs of vessels at Baltimore and Philadelphia, and subsequently has been on special service by permission from the Treasury Department.

In the course of the winter of 1860–'61 Mr. Wise inked and sent to the office two plane-table sheets, containing his survey of the coast of Florida between Ocilla river and Ocklokonee bay.

Hydrography of St. George's sound, Fla.—The work intended to be assigned to the party of Lieut. Comg. T. S. Phelps, U. S. N., with the steamer Vixen, by my instructions of the autumn of 1860, was the completion of the hydrography of St. George's sound, by extending the inside work from Cat Point to Royal Bluff. The outside hydrography was to be executed between St. Mark's harbor and Southwest cape, and a screw-pile signal set on the Ocklokonee shoal.

The execution of this plan of work in the present surveying year was prevented by the disturbed fiscal relations of the government, to which allusion has been made in several instances in connexion with notices of work in other localities on the Atlantic and Gulf coast.

Lieut. Comg. Phelps was actively employed during the entire season, which, if circumstances had permitted, would have been spent in completing the hydrography between St. Mark's and Apalachicola. The labors of the party in the steamer Vixen, and subsequently in the steamer Corwin, have been noticed under Sections I, II, III, and IV, in this report.

The sheet containing the soundings made last year in the eastern part of St. George's sound has been plotted and filed in the office.

The hydrographic survey made by Lieut. Comg. Phelps in the dependencies of Pensacola bay during the working season of 1859–'60 is represented by two sheets, which were plotted in the course of last winter. One of these contains the soundings made in Escambia bay, the other those made in Maria de Galvez bay and its dependencies.

Tidal observations.—The self-registering tide-gauges, mentioned in my report of last year as having been in operation at St. Mark's and on St. Vincent's island, were taken up in the beginning of February last by Mr. A. C. Mitchell, after the completion of a year's series at each of the stations. My purpose was to have them set up at stations to the westward of Mobile, and for that purpose the schooner Twilight, then in charge of Sub-Assistant Halter, was transferred to Mr. Mitchell. Though threatened with seizure at Apalachicola, the Twilight was repaired there in February, having met with an accident in the bay, and was finally permitted to sail with the tidal party. Mr. Maslin, who had made the observations at St. Vincent's island, and previously at Charlotte harbor, declined to serve at either of the new stations, and was discharged. Mr. P. H. Donegan, who had registered the observations at St. Mark's, accompanied Mr. Mitchell to Section VIII. Mention will be made in its place under the next head of the means taken to procure results at new stations in the Gulf.

The tide-gauge at the Warrington navy yard was taken down on the 16th of November, 1860, for repairs, and owing to the absence of S. Thayer Abert, esq., who had taken unwearied interest in the observations, it had not been set up at the time of the seizure of the navy yard by the State authorities of Florida. The instruments probably yet remain boxed up at Warrington.

SECTION VIII.

FROM MOBILE BAY TO VERMILION BAY, INCLUDING THE COAST OF MISSISSIPPI AND PART OF THE COAST OF LOUISIANA.—(SKETCH H, No. 18.)

The plan laid out for continuing the work in this section will be stated in general terms under the following heads :

1. Instructions to complete the triangulation of Isle au Breton sound, and for the plane-table survey of the keys and islands of the sound. This work was intended to connect the triangulation of the Chandeleur islands with that of the Mississippi delta, at points near the head of the passes.

2. Triangulation commenced to determine points for the topographical survey of the Southwest Pass, (Mississippi delta.) Instructions were issued to the same party for the triangulation of Atchafalaya river.

3. Tidal observations.

Office-work.—The drawing and engraving of the preliminary chart of Passe à Loutre, (Mississippi delta,) and the engraving of coast map and chart No. 92, Gulf coast from Round island to Grande island, have been completed. The drawing has been continued on coast map and chart No. 93, Lake Borgne to Lake Pontchartrain ; and additions have been made to the plate of lines of deep-sea soundings in the Gulf of Mexico, and progress sketch of the section.

Triangulation and topography of Isle au Breton sound, La.—In the expectation of completing within the present season the preliminary work between Mobile entrance and the Mississippi delta, Sub-Assistant R. E. Halter was instructed at the outset of the year to carry a series of triangles southward and westward from the Chandeleur islands to the delta, occupying as stations the range of islands lying on the south side of Isle au Breton sound. The object alluded to will be understood by reference to Sketch No. 18. To meet the requirements of the party for transportation, the schooner Twilight was repaired and assigned to the charge of Mr. Halter. Under his general direction the plane-table survey was to be carried on by Mr. J. L. Tilghman, in conjunction with the preliminary work. The vessel was repaired at Mobile, and early in January was ready to proceed to the intended site of work. An estimate had been made as usual, based on the appropriation, but no funds could be had to meet the expenditures. The schooner was therefore transferred to Mr. A. C. Mitchell in the latter part of January, and was used in visiting the tidal stations of the Gulf, as will be further explained under another head.

Sub-Assistant Halter, on being recalled from Section VIII, was assigned to duty in Section I.

Mr. Tilghman sent in his resignation on the 30th of April.

Triangulation of Southwest Pass, Mississippi delta.—The excitement of the public mind at Pensacola having induced Mr. Gerdes to remove his party as a measure of precaution, the schooners James Hall and Gerdes, then under his charge, were transferred to the anchorage at Passe à Loutre. On the 8th of January the preliminary survey was resumed at the Southwest Pass, but the unsettled condition of affairs made its continuance inexpedient. By the advice of parties favorably disposed to the work in both localities, Assistant Gerdes reshipped the instruments, and on the 14th of January despatched the two vessels to New York, as already stated.

The present condition of the survey at the delta may be seen by reference to Sketch No. 18.

Triangulation of Atchafalaya river, La.—For this work a party was organized under the charge of Assistant F. H. Gerdes. Sub-Assistant J. G. Oltmanns and Mr. G. U. Mayo were assigned to assist in the field-work.

Full preparations were made by Mr. Gerdes for work in this and in the adjoining eastern section at several localities, to which I have already referred. One of the two vessels assigned was intended for service in the Atchafalaya, the object being to carry a triangulation from Berwyck over the bay of that name and down the Atchafalaya river to a junction with the completed survey of Atchafalaya bay.

The return of the parties before reaching the site of work west of the Mississippi delta has been stated under another head.

Assistant Gerdes passed the working season at the north in active duty in Section I. Sub-Assistant Oltmanns was, on the return of the party, placed in charge of the magnetic station at Key West.

Mr. Mayo was dropped from the Coast Survey on the 6th of July.

Triangulation, topography, and hydrography.—A party provided with means for extending work in either branch of the survey has been assigned to duty in charge of Sub-Assistant R. E. Halter, who is now attached to the expedition of Commodore D. G. Farragut, for service in the Gulf of Mexico. Mr. Halter's general acquaintance with localities in the Gulf sections fits him well for the duty of pointing out where facilities exist to warrant naval and military operations, and where they are wanting. He is instructed to push the regular work of the survey as opportunity offers, connecting, when practicable, with the work already done, and to make such special surveys as may be deemed essential for the public service by the military and naval commanders in the Gulf. It is intended at an early day to assign Assistant F. H. Gerdes with additional force to duty in this section.

Tidal observations.—In accordance with the request and at the expense of the Mobile Harbor Commission, a self-registering tide-gauge was put in operation on the 20th of November, 1860, at Great Point Clear, in Mobile bay. The records from it were received monthly at the Coast Survey office until the 1st of April, but not later, by reason of the suspension of postal intercourse with the Gulf States.

At the Southwest Pass (Mississippi delta) tidal observations were discontinued on the 11th of February, advice having been received of the completion, a short time before, of a full year's series under the direction of Captain A. A. Humphreys, United States Topographical Engineers, who has kindly offered to put his entire record of that station at the disposal of the Coast Survey. My intention was to have the gauge transferred to a station on the coast of Texas, and with that view Mr. A. C. Mitchell was directed to call at the delta and take the instrument on board the schooner Twilight. This was done on the 4th of March. Mr. Keyser, who had attended to the gauge while it was in operation, resigned his position as observer.

The tide-gauge at Isle Dernière, set up last season, was intended to furnish a full year's observations, and was in good order in the beginning of March, when Mr. Mitchell visited the station. He left a supply of paper for the observer, Mr. H. Peter Wilson, from whom the records, up to the 1st of April, have been received. The station being on an almost uninhabited island, and the neighboring mainland being also very sparsely settled, it was thought improbable in May, when the record for March was received, that the observations would be interrupted, but as the mail communications had become deranged, the observer was directed to pack up and store the tide-gauge at the most convenient place in the vicinty of the station. No intelligence in regard to his action has reached the office since the 7th of May, the schooner Twilight which had passed on westward in March, and which would have called at the close of the season on her return, having been seized at Aransas.

SECTION IX.

FROM VERMILION BAY TO THE RIO GRANDE BOUNDARY, INCLUDING PART OF THE COAST OF LOUISIANA AND THE COAST OF TEXAS.—(SKETCH I, No. 19.)

The progress made by the parties sent to this section, and the purpose intended by instructions which have not yet been carried out, will be referred to as follows:

1. Triangulation extended from the completed survey of Galveston bay northward and eastward along the coast of Texas to the High islands.

2. Instructions to extend the triangulation of the coast of Texas from Corpus Christi southward through Laguna Madre. The triangulation is continuous between the limits mentioned in this and the preceding paragraph.

3. Plane-table work completing the topography of St. Charles's, Copano, and Aransas bays, and extending the survey of the coast of Texas to the upper part of Corpus Christi bay.

4. Tidal observations.

Office-work.—The drawing and engraving of coast map and chart No. 107, Gulf coast from Oyster bay to Matagorda bay; the engraving of coast map and chart No. 106, Galveston bay to Oyster bay; and the drawing of coast map and chart No. 108, Matagorda and Lavaca bays, and of general coast chart No. XVI, Galveston bay to the Rio Grande, have been continued. Additions to the progress sketch of the section have been made.

Coast triangulation north and east of Galveston, Texas.—The triangulation which was commenced at Galveston entrance in 1849 proceeded southward and westward along the coast, and at the date of my last annual report it had been pushed to the northern end of the Laguna Madre. Between the limits just given it has included Galveston and Matagorda bays, Espiritu Santo, San Antonio, Aransas, and Corpus Christi bays, and the dependencies of each.

Lieutenant George Bell, U. S. A., Assistant in the Coast Survey, was detailed to resume the coast triangulation above Bolivar Point, and took up that duty in the latter part of November, 1860. He visited the stations necessary as points in a chain of triangles to extend towards the Sabine, and found the marks which had been set in the ground at Stevenson's Point and at four other stations on the shores of East bay. Three of these positions he reoccupied, and also measured angles at four others with the ten-inch Blunt theodolite, No 92. Signals were set up at all of them, and going northward and eastward, at points intermediate between them and the High islands, or within thirty-five miles of the mouth of the Sabine.

This triangulation extends along the low, wet prairie that skirts the coast (Sketch No. 19) above the head of East bay. The High islands, fifteen miles from the head of the bay, present elevations of from eighty to one hundred and fifty feet, and are probably the highest parts of the coast of Texas. With the exception thus made, the coast retains its marshy character all the way to the Sabine.

Lieutenant Bell makes the following return of statistics:

Signals erected	10
Stations occupied	7
Angles measured	20
Number of observations	597

The work was suspended on the 21st of March. In explanation of the short period employed Lieutenant Bell makes the following remark in his report: "I regret exceedingly that the unfortunate and excited state of the country prevented me from extending the coast triangulation to the Sabine, as otherwise might have been done with a month of favorable weather."

Strong posts of cast iron were inserted in the ground at all the stations occupied within

the present surveying season. The instruments and public property used by the party reached New York safely.

Before the seizure of the United States revenue cutter Henry Dodge by citizens of Texas, that vessel had been placed at the disposal of Lieutenant Bell, and her boats assisted materially in passing through the shallow bayous above the head of East bay. Earlier in the season a sloop of light draught furnished by Lieutenant W. H. Stevens, late of the United States Engineers, proved of great service in examining the shores of East bay.

Lieutenant (now Captain) Bell reported in person at the Coast Survey office early in April, and on the 24th of that month was detached from duty in the survey. His report, extracts from which are given in Appendix No. 29, contains remarks on the character of the coast of Texas between the Sabine and Galveston entrance. The usual field record of angles and descriptions of the stations and signals have been furnished by Lieutenant Bell and filed with the field notes of the section.

Triangulation of Laguna della Madre, Texas.—The course intended by my instructions near the beginning of October, 1860, to Assistant S. A. Gilbert would, in all probability, have carried the triangulation of the coast of Texas nearly or quite to the Rio Grande boundary, but for circumstances that arose to disturb the public mind during the winter. Assistant Gilbert remained at Zanesville, Ohio, while the topography went forward, it being deemed best to wait the issue of events before pushing the triangulation, as that work was already a full season in advance of the plane-table survey. The progress made in topography will be stated further on.

Mr. Gilbert's camp fixtures and means used in transportation while employed in Corpus Christi bay in the previous surveying season had been stored at Corpus Christi. At his instance the former aid, Mr. Charles Hosmer, who served this season in the plane-table party, procured a receipt from Mr. J. Benton Johnson, with whom the property was stored on the 24th of April, 1860. It is supposed, for reasons which will be given presently, that the articles heretofore used by the party of Assistant Gilbert were seized in the early part of May, 1861, by a committee of the citizens of Corpus Christi. No information respecting them has been received since that time.

On the breaking out of hostilities in April last, Assistant Gilbert accepted a military commission and took the field, under the terms of leave of absence, without pay from the Coast Survey, which have been approved by the honorable Secretary of the Treasury. In addition to his duties as lieutenant colonel of the 24th Ohio regiment, as I am informed in a communication from Brigadier General J. J. Reynolds, (Appendix No. 33,) to whose division that regiment was attached, Mr. Gilbert superintended the erection of the defensive works at Cheat mountain, in Western Virginia, and planned and constructed others, exhibiting in all the skill of an accomplished engineer. He is now colonel of the 44th regiment of Ohio.

Topography of Aransas and Copano bays, Texas.—The plane-table survey of the coast of Texas was resumed on the first of December by Sub-Assistant W. S. Gilbert, and was continued until the end of April. Mr. Charles Hosmer, heretofore attached to the triangulation party, assisted in the field-work. Three sheets, showing the topography done by his party, have been forwarded to the office by Mr. Gilbert. One of them contains the shore-line and details of the west side of San Antonio bay below Webb's Point, and also the shores of the upper part of St. Charles's bay. The second sheet comprises the lower part of Aransas bay, including part of St. Joseph's island, and also the shores of the upper part of Corpus Christi bay. These two sheets fill up the only intervals which remained unsurveyed at the beginning of the present year between the north end of Galveston bay and Aransas Pass. On his third plane-table sheet Mr. Gilbert traced the shore-line and topography of Copano bay and of Mission bay, with the mouth of Aransas river.

The work done by this party brings the topographical survey of the coast of Texas within one season of the triangulation. Sketch No. 19 shows the advance made in both kinds of work.

The following is an abstract of the plane-table statistics:

Shore-line surveyed	82 miles.
Roads	18 "
Area of topography, (square miles)	$37\frac{1}{2}$

Sub-Assistant Gilbert returned to Zanesville, Ohio, early in May.

Before leaving Corpus Christi Mr. Gilbert packed the camp equipage which had been in his charge in this section, and placed the property in the care of Mr. James W. Byrne, at Lamar, to be held, as expressed in the receipt, subject to the order of Mr. Gilbert or other authorized receiver, and with the understanding that the packages would be forwarded to Zanesville, Ohio. The camp fixtures, and also the instruments which had been used in the field-work, and which Mr. Gilbert expected to receive at the same time, are supposed to have been stopped at Corpus Christi, as mention to that effect was made in one of the newspapers of Texas in the month of May.* A sloop-boat, with spars, sails, and rigging, etc., complete, stored, under the same conditions, on the 19th of April, with Mr. James M. Coffin, for safe-keeping, at La Salle, was, according to the newspaper account just referred to, seized by the same "committee of safety" which took possession of the camp fixtures.

Since the opening of the present year the volumes containing the original entries of soundings made by the party of Lieutenant Ronckendorff, U. S. N., inside of Matagorda bay in the working season of 1859–'60, and the register of tidal observations made at the same time, have been received at the office.

Tidal observations.—A self-registering tide-gauge which had been in use at St. Mark's was removed in the spring, and on the 14th of March was set up at Calcasieu entrance, La., and left in charge of Mr. P. H. Donegan. The last letter received from him at the Coast Survey office was dated May 1, transmitting the observations for April, and reporting the particulars of an interview with a committee appointed by residents of the vicinity to inquire into his doings at the entrance of the river. After he had explained to them the nature of his work he was allowed to continue; but as correspondence with the office in Washington, and the sending of his pay, became impracticable, he was officially directed to pack and store his gauge, and to return to the office as he best could. As he did not report in person, it was concluded that he found himself unable to leave the station. In August, however, Mr. A. C. Mitchell, who had stationed all the tidal observers on the Gulf coast, ascertained that in the previous month Mr. Donegan was held as a prisoner of war at Lake Charles City, La. As a station observer, he was entirely alone, and without implements offensive or defensive.

After the gauge had been fairly started at Calcasieu, Mr. Mitchell sailed in the schooner Twilight, and set a similar one up at Aransas Pass. This was done by the 16th of April. A few days after it became necessary to go to Corpus Christi, a draft sent to him from the office not being negotiable at Aransas. While he was absent the schooner, with all the property on board of her, was seized (on the 20th of April) by the deputy collector of the port of Aransas, Mr. W. H. Jones, and a body of nine armed men.

Mr. Mitchell reached Washington in May, after considerable trouble, and was then assigned to duty in Section I.

Mr. Donegan regained his liberty in the middle of November, and as soon as possible reported in person at the office in Washington. He had been employed continuously for fifteen months at tidal stations on the Gulf coast, when he was interrogated in the beginning of April at Calcasieu. The nature of his occupation being easily made clear to the inquirers, his tide-gauge was kept in operation until the 11th of July, with the general consent of the responsible residents. Mr. Donegan states that his arrest at the last-mentioned date, by orders from New

*Corpus Christi Ranchero, May 11, 1861.

Orleans, was to be followed by his trial as a spy, at Lake Charles City, in the interior of Calcasieu parish, about sixty miles from the tidal station, and that he was there in custody until the 15th of August, when his captors were found by a second armed detachment sent from New Orleans to take him to that city as a prisoner of war. The first detachment reached the mouth of the Calcasieu after his removal to the interior. He further states that on explaining the nature of his employment to the governor of Louisiana, at New Orleans, his parole was accepted, but with a reservation which brought him before the insurgent military commander, D. E. Twiggs, who met his explanations with personal abuse, and ordered his trial by court-martial as a spy; that he was thereupon handcuffed, marched to the common "lock up," and, after being twenty-four hours without any food, was examined before the recorder of the first district of New Orleans, who remanded him to the parish prison, where he was kept for a like period without food, to await the orders of the military commander; that he was there incarcerated, on the 23d of August, with seven acknowledged criminals, in a space so small and close that all had to sustain life by taking turns at a little hole in the door for air. There he remained nearly three months, and was at last liberated through the interposition of the British consul on the 15th of November.

SECTION X.

FROM SAN DIEGO, OR THE SOUTHERN BOUNDARY ON THE PACIFIC OCEAN, TO THE FORTY-SECOND PARALLEL, INCLUDING THE COAST OF CALIFORNIA.—(SKETCHES J, Nos. 20 and 21.)

The work done in the field and afloat will be stated as follows:

1. The continued triangulation to connect the Santa Barbara islands with the main coast of California.

2. Extension of the main and secondary triangulation which passes north of San Francisco bay, along the coast of California in the vicinity of Bodega bay.

3. Plane-table survey of the shores of Half Moon bay, California, filling an interval in the survey between Monterey and San Francisco entrance.

4. The topography of Tomales bay, and connexion of that survey with plane-table work in the vicinity of Point Reyes.

5. The hydrography of Tomales bay.

6. Tidal observations at San Diego and near San Francisco.

Office-work.—The drawing has been completed, and the engraving in preliminary form, of the chart of Drake's bay; the drawing of the map of Napa creek and that of the chart of the approaches to San Francisco bay has been completed, and the engraving has been continued on the chart of San Pablo bay. Additions have been made to the progress sketches of the section, and to plates of charts previously engraved.

Triangulation of the Santa Barbara channel, Cal.—Assistant W. E. Greenwell, after revisiting the Atlantic coast, returned to San Francisco in June, and at once reorganized his party for service in the schooner Humboldt. The vessel proceeded to the western end of Santa Cruz island, where a signal was put up to be observed on from stations on the main shore of Santa Barbara channel. Others were adjusted which had been previously erected on that island and on Anacapa. These preliminaries were attended to under the disadvantage of prevailing fogs and gales of wind. At present Mr. Greenwell is engaged in measuring the horizontal angles formed by the island stations with those on the main.—(Sketch No. 20.)

In September Assistant Greenwell made an exploration of the estuary or lagoon to the northward and eastward of San Pedro. The lagoon was found to be some five miles long, and separated from the ocean by a narrow strip of sand-beach, over which the heavy southeast and northwest swells wash in every gale. The estuary has a breadth of only a few hundred yards, and receives the river Santa Anna. Of the entrance to the lagoon Mr. Greenwell

reports as follows: "The outlet or mouth is fifty yards in width, with a narrow bar outside, upon which I should judge that twelve feet of water at full tide might be found. Over this bar there is a frightful swell rolling and tumbling at all stages of the tide, making it dangerous to cross in boats of any kind."

With reference to the capacity of the lagoon as a port or harbor, the following remarks are made in the same report: "It may be that the winter rains accumulating in the river and lagoon may deepen the bar so as to admit vessels of thirty or forty tons during winter and spring, and with this in view it will be again examined when the spring opens. At the present time it would be quite impossible to take the schooner Humboldt over the bar, or to cross it in a boat with tents and provisions for a surveying party. There is no anchorage off the entrance, and neither point nor headland to give a lee. The smooth, straight beach, with a trend to the southeast and northwest, gives no protection whatever to vessels from the heavy northwest swell that rolls in with tremendous force."

The first work of this party in the coming spring will be to examine the lagoon referred to, and to make a survey of it, if practicable.

Assistant Greenwell is now going forward with the work of triangulation required to connect the Santa Barbara islands with the coast line of the Pacific.

Triangulation north of San Francisco, Cal.—At the date of his last report, September 4, 1860, Assistant George Davidson was transferring his party to station "Redwood." This station, (Sketch No. 21,) as well as Bodega Hill, was occupied to determine all the secondary and tertiary points south of Ross mountain. At Redwood the transit instrument (C. S. No. 7) was placed in the meridian, and observations made in anticipation of the occultations of the Pleiades, but the cloudy night prevented him seeing the latter.

The following are the statistics of the triangulation at the two stations occupied:

Signals erected	5
Objects observed upon	23
Angles measured	31
Number of measurements	1,539

The horizontal angles were measured with the Coast Survey theodolite No. 37.

At station Redwood seventy-two measurements of vertical angles were made upon three objects.

The records were all duplicated, as were also the abstracts of the results. The field computation of the triangulation and the L, M, Z of the whole work were made and reviewed, and also furnished in duplicate. Twenty volumes of original and duplicate records of the above and of previous stations have been received.

In October Assistant Davidson received orders from me to report upon the Atlantic coast. Leaving California November 5, he reported in person early in December. Before leaving the Pacific coast he obtained for the Coast Survey the free use of the California State Telegraph line for the determination of the differences of longitudes. He acknowledges indebtedness for this privilege to H. W. Carpentier, esq., the president of the company.

Since Mr. Davidson's return to the Atlantic coast he has been engaged in recomputing all the observations of vertical angles made by him during the years 1859 and 1860. Before a fair copy of this work was finished, special instructions were sent him to make a hydrographic resurvey of specified portions of the Delaware river, a notice of which has been made under Section II.

Topography of Half Moon bay, Cal.—The coast topography below San Francisco entrance, outstanding near the close of last season, was then taken up by the party of Sub-Assistant W. M. Johnson. The plane-table sheet will include the shores of Half Moon bay and the Pacific

coast immediately adjacent to its approaches. The statistics in regard to the work have not yet reached the office.

Topography of Tomales bay, Cal.—This survey was commenced at the opening of the present year by Assistant A. F. Rodgers, and is still in active progress. It is connected with work previously completed to the southward, and brings up the detailed topography of the coast of California continuously from San Francisco entrance northward. The shore-line and other data required for the hydrography of Tomales bay were furnished by this party.

Mr. Rodgers was assisted in the field by Sub-Assistant Julius Kincheloe and Mr. David Kerr. The statistics of the plane-table work have not yet been received at the office.

Assistant Rodgers has sent to the office the original plane-table sheets of his survey of Petaluma creek. Engraved reductions from them and from those of Napa creek accompany this report.—(See Sketch No. 22.)

Hydrography of Tomales bay, Cal.—At the opening of the present surveying year the officer whose name is largely identified with the hydrography of the Western Coast had been recalled, leaving at San Francisco no officer qualified for meeting the calls likely at any time to arise, and which were more likely to become pressing under the force of public events that transpired in the course of the spring and early part of last summer.

Commander B. F. Sands, U. S. N., on being reassigned to duty in the Coast Survey, personally completed arrangements at the office, and on the 11th of June took passage for the Western Coast to replace Commander Alden. The steamer Active was as soon as possible repaired and fitted for duty afloat. With this a period was reached so critical to public interests as to call for the services of the Active in transporting troops to San Pedro at the request of Brigadier General Sumner, who, under the orders of the general-in-chief, was then co-operating with Captain Gardiner, the commandant of the navy yard at Mare island. Three trips were made to and fro with the steamer, and the emergency having been met, preparations were completed, and the vessel sailed for Tomales bay.

Following close on the topographical survey made by Assistant Rodgers, the hydrography of Tomales bay was taken up and prosecuted by the party in the Active until its completion on the 19th of October. In reference to the capacity and character of this harbor Commander Sands observes: "Over the bar, previously surveyed by Commander Alden, a depth of ten feet can be carried between sand lumps of seven feet at mean low water, and inside of the bay depths of from four to nine fathoms are found through the greater part of its extent. Its shores are becoming thickly settled, and a considerable trade has sprung up in grain and other agricultural products. These have been carried by small craft, but have so increased as to call into requisition a steamer, which is soon to commence regular trips. The following are the statistics of the hydrographic work:"

Miles run in sounding	176
Points determined on sounding lines	415
Angles measured	1,245
Number of soundings	11,705

The original chart has been received at the office. A reduction from it is given with the charts which accompany this report, as Sketch No. 23.

The steamer Active, though in need of much more extensive repairs, had been fitted out in the summer, and furnished with such an armament as the vessel would bear, in order to meet emergencies growing out of the involved state of the country. The first special duty discharged by Commander Sands was at the request of the commandant of the Mare island navy yard. The steamer was moored off the magazine, to protect it against a rumored attack by parties concerned in the present rebellion against the general government. This was in the latter part of August. Having towed the sloop-of-war St. Mary's to anchorage off San

Francisco, the Active returned to her station off the magazine, and remained there until relieved by the order to pass troops to San Pedro for San Bernardino, which employed the vessel until the 14th of September. The hydrography of Tomales bay was done subsequently.

Appendix No. 32 contains copies of the orders under which the special service was rendered with the steamer Active.

Tidal observations.—Under the general supervision of Lieut. G. H. Elliot, of the Corps of Engineers, U. S. A., the tide-gauges at San Diego and San Francisco have been kept in operation throughout the year. The instruments are in the intelligent care of Messrs. A. Cassidy and H. E. Uhrlandt.

The observations at the temporary station on Cape San Lucas were continued during the early part of the year in order to complete the desirable twelve months' series, the records for which are now full.

SECTION XI.

FROM THE FORTY-SECOND PARALLEL TO THE NORTHWESTERN BOUNDARY OF THE UNITED STATES, INCLUDING THE COAST OF THE STATE OF OREGON AND THE COAST OF WASHINGTON TERRITORY.—(SKETCH K, No. 24.)

The progress made in the survey of this section will be described under the following heads:

1. Triangulation and plane-table survey of the shores of Koos bay, Oregon. The soundings were taken up by the same party, and will, if practicable, be completed within the season.

2. Determinations of latitude and azimuth at Gray's harbor, W. T., and observations for determining the difference of longitude between the astronomical station there and the one at Port Townshend.

3. Remeasurement of the preliminary base at Gray's harbor.

4. The topographical survey of the shores of Gray's harbor completed.

5. Tidal observations at Astoria, Oregon.

Office-work.—The drawing has been completed, and the engraving commenced, of the chart of Coquille river, Oregon; and additions have been made to the progress sketch of the section.

Triangulation, topography, and hydrography of Koos bay, Oregon.—The party of Sub-Assistant J. S. Lawson arrived off the bar of Koos bay, in the brig Fauntleroy, on the 16th of June. The sea being too smooth at the time to mark the channel by breaking water on the spits at the entrance, the sailing-master was sent in advance with a boat, and, on a signal agreed upon, stood in with the vessel and anchored inside of the bay. A reconnaissance was made as soon as possible, and the site for a base line selected at a distance of several miles from the mouth of the bay. Its location and the scheme of triangulation, made by Mr. Lawson to depend upon it, are shown on Sketch No. 24. The operations of the party included the determination of local time by astronomical observations, as well as observations for latitude and azimuth. The time was ascertained by three hundred and forty-six measures of zenith distances on five stars with the vertical circle No. 80, near the prime vertical, on nine nights favorable for the purpose. With the same instrument four hundred and twenty-six measures of zenith distances were made on six stars for latitude. The azimuth was determined by seventy-two observations on Polaris at its eastern elongation on two nights with the ten-inch Gambey theodolite, C. S. No. 20. The instruments were securely mounted on blocks of wood as the best means at hand for keeping them steady. All the astronomical observations were made at station Pigeon, (see sketch,) on the eastern shore of the bay.

The alignment of the base line was made by Mr. A. T. Mosman; Mr. H. Anderson recorded the observations of all kinds as they were made, and both assisted Mr. Lawson in the various

operations of the season. The general statistics of the triangulation are shown in the following summary:

Signals erected	28
Stations occupied	11
Angles measured	112
Number of observations	5,052

Ninety-seven objects were observed on, exclusive of over two hundred readings on subsidiary ones intended as points to facilitate progress in tracing the shore-line. The angles were measured with the ten-inch theodolite, No. 20.

At two stations the altitudes of five others were determined by zenith distances measured with the vertical circle No. 80, three hundred and ninety-six observations being recorded for the purpose. The computations and duplication of records kept pace with the field-work, and the volumes containing them are now in the archives of the office in Washington.

In the early part of September, when Mr. Lawson reported in detail, the triangulation had been completed and the topography was in progress. Fourteen miles of shore-line had been traced, and the party was making arrangements for sounding out the bay within the limits of the triangulation.—(See Sketch No. 26.)

The general character of Koos bay is described in the extracts taken from the report of Sub-Assistant Lawson, which will be found in Appendix No. 30.

Meteorological observations were carefully registered while the party remained at Koos bay.

Astronomical observations at Gray's harbor, W. T.—After completing the angular measurements at Gray's harbor, the triangulation of which was reported last year, Sub-Assistant J. S. Lawson occupied the astronomical station near Point Hanson, (Sketch No. 24,) and determined the azimuth. He used for the purpose theodolite No. 20, mounted on a block of wood instead of the tripod. The signal-pole at station Point Hanson, distant 849.5 metres, was observed on as an elongation mark, and ninety-five observations were made on the star δ Ursæ Minoris, near its western elongation.

The latitude of the astronomical station was determined in the latter part of September, 1860, from two hundred and seventy-two measures of the zenith distances of five stars when near the meridian. These observations were made on five nights, with the vertical circle C. S. No. 80. For local time twenty-nine observations were made on the sun with the sextant and artificial horizon on four days and one hundred and eighty measures of zenith distance on seven stars near the prime vertical on five nights.

All the records and notes connected with the astronomical work, and the register containing the meteorological observations made at the same time, have been forwarded to the office.

Sub-Assistant Lawson was efficiently aided in duty at Gray's harbor by Mr. A. T. Mosman.

For the purpose of determining the difference of longitude between Gray's harbor entrance and one of the points in the general scheme of triangulation in Washington Territory, Mr. Lawson transferred his party in the brig Fauntleroy, in the early part of October, to Port Townshend, and there found the local time by one hundred and ninety-two measures of zenith distance with eight stars, using, as before, the vertical circle No. 80. The station occupied had been used by Assistant Davidson for astronomical purposes in 1852.

After completing the observations at Port Townshend, Sub-Assistant Lawson set sail with the Fauntleroy for San Francisco, and reached that port on the 20th of November.

Measurement of the preliminary base at Gray's harbor, W. T.—The approximate length of the line selected on Eld island had been determined by Sub-Assistant Lawson before taking up the triangulation of Gray's harbor. On concluding that work the base was remeasured with the Saxton and Hilgard apparatus, with the bars No. 1 and No. 2. The length found was

1,744.31 metres. Mr. Lawson states that fresh southerly winds interfered with progress in the work, the line running only a little north of west, (see Sketch No. 24.) and the site being consequently exposed to all the atmospheric changes peculiar to the ocean margin. The measurement was commenced on the 6th and completed on the 17th of September. Mr. A. T. Mosman made the alignment with the theodolite. Stone blocks not being procurable, the ends of the base were marked by sections of large trees, cut off with a diameter of about three feet and to a length of rather more than five feet. These were sunk to their entire length and secured firmly in the ground, the exact termination of the line being carefully marked on each. The record sent by Mr. Lawson to the office contains a full description of the measurement and of the marks set for identifying the ends of the line on Eld island.

Topography of Gray's harbor, W. T.—From points determined in his triangulation. Sub-Assistant Lawson, towards the close of last surveying season, took up and executed a close topographical reconnaissance of the entire shores of Gray's harbor. The entrance and approaches north and south for several miles, and the shores to a distance of five miles eastward from the entrance, were surveyed with the plane table. On a second sheet the whole range of the shores of the harbor to the mouth of the Chehalis river is represented.

This survey, though not minute, is in sufficient detail as a preliminary work. The sheet of the entrance represents all the objects that could be used by mariners as ranges or marks for approaching or entering the harbor.

On the second sheet, the scale of which is less than that just referred to, Mr. Lawson sketched in the outline of the extensive banks or flats that make up a large part of the surface of Gray's harbor. In correspondence with his report, after completing the triangulation, this sheet shows but one practicable channel, (the north channel.) The south channel, he states, is obstructed by a bar caused by the deposits from John's river, and on which small boats will sometimes ground.

The sheet of the entrance contains over forty miles of shore-line and ten square miles of topography executed with the plane-table.

Mr. Mosman assisted in the topography and other field-work of the party.

The remarks made by Sub-Assistant Lawson on the capacity of Gray's harbor for commercial development, after having passed an extended season there, are in tenor like those extracted from his report of last year.* He states in conclusion that "the entrance is tolerably good and will compare very favorably with the other bar harbors north of San Francisco. But the navigable portion of the harbor is so contracted, and the approach to the shores, except at high water, rendered so difficult by the immense flats, as most effectually to retard its prospect of early development."

Mr. Lawson furnished tracings from the sheets of his survey of Gray's harbor for the use of the hydrographic party. The original sheets are now at the Coast Survey office.

Tidal observations.—As in former years, the self-registering tide-gauge in charge of Mr. Louis Wilson, at Astoria, has continued to give excellent results. Lieutenant G. H. Elliot, United States Engineers, has the general supervision over the work at this station, as well as at several others on the Western coast. The meteorological observations made by Mr. Wilson deserve special notice for their completeness.

OFFICE-WORK.

The Coast Survey office in Washington has remained under the charge of Major W. R. Palmer, United States Topographical Engineers, who, as heretofore, directed the operations of the several divisions efficiently and acceptably. A. P. Hill, esq., continued in the office as general assistant until the 30th of April, when he resigned, and was succeeded by Assistant Edward Goodfellow, who now discharges the active duties of that position.

* C. S. Report for 1860, page 100.

The report of Major Palmer (Appendix No. 12) is accompanied by sub-reports from the chiefs of the office divisions, showing the details of occupation in each branch of the office. I will here refer to them in brief, using the reports which will be found at length in the Appendix.

Hydrographic division.—This important branch of the office remained in charge of *Commander S. S. Lee* and *Lieutenant Silas Bent, U. S. N.*, until the outbreak of our national troubles in the month of April, when both resigned, the first-named officer on the 23d and the latter on the 30th of that month.

Captain C. P. Patterson, some years ago an officer of the United States navy, and well known by his intelligence and sagacity as chief of one of the hydrographic parties of the Coast Survey, was assigned to duty at the head of the division on the 6th of May. The principal occupation under the direction of its chief has been the examination and verification of original hydrographic work, including the charts resulting from it; furnishing sailing directions; compilation of hydrographic sketches, and making projections for hydrographic parties.

Mr. Arthur Balbach executed the details of the work under the direction of Lieutenant Bent until the middle of April, when he joined the military service as a volunteer. Some time after the expiration of his term of service, which was followed by severe sickness, he rejoined the division, and his intelligent services have since been given to hydrographic details, under the direction of Captain Patterson.

Mr. L. Karcher has been engaged in making projections for hydrographic parties. He also replotted some preliminary hydrographic work, and has assisted in the compilation of hydrographic sketches, verifications, and examinations of original sheets. Under the emergency which arose in April last the zeal and activity shown by Mr. Karcher aided much in procuring data of great importance for the public service.

Mr. W. B. McMurtrie was employed in making projections and drawing views for hydrographic charts until the middle of May, when he was assigned to duty connected with the preparation of special hydrographic notes in another division of the office.

Tidal division.—This division has been, as heretofore, under the charge of *Assistant L. F. Pourtales*, whose reports in reference to coast stations and office-work will be found in the Appendix Nos. 10 and 12. In the course of the season the tidal data on record proved available in several emergencies for the public service, the calls for information being met without delay.

The force of the division has been employed as follows: *Mr. R. S. Avery* has revised and consolidated the reductions of the observations at the permanent stations, and has deduced the daily inequality from the reduction of those in the Gulf of Mexico. *Mr. J. Downes* has read off the sheets of the self-registering tide-gauges preparatory to plotting and decomposing the curves, and has also made various reductions. *Messrs. J. R. Gilliss, C. Balmain, L. M. Johnson,* and *L. L. Nicholson* were temporarily attached to this division, and engaged in plotting, decompositions, and reductions. *Mr. J. W. Donn* has had charge of the office, reading of the self-registering observations, of the correspondence with the observers, &c. *M. Thomas* and *S. D. Pendleton* have made the ordinary reductions of most of the permanent stations.

Mr. Gilliss resigned on the 4th of June, and *Mr. Johnson* on the 19th of September. At the opening of summer *Mr. Balmain* was put in charge of the map room, and *Mr. Nicholson* assigned to field duty.

Computing division.—This division of the office has been in charge of its efficient chief, *Assistant Charles A. Schott.* During three months and a half, when he was engaged on a hydrographic survey of the upper part of Casco bay, *Mr. J. Main* was left in charge. Of some interesting and valuable contributions to science by Mr. Schott accounts will be found in the Appendix (Nos. 22, 23, 24, 25.) The number of computers in the division is less than it was last year, but the current work required for office use has been kept up. A detailed statement of the work of each is given in Appendix No. 12.

Assistant T. W. Werner has generally been engaged on the calculations of triangulations.

Mr. E. Nulty has attended to the reduction of the astronomical observations for time, azimuth, and latitude.

Mr. J. Main to the revision of the astronomical computations and to the reduction of magnetic observations.

Mr. J. Wiessner has computed triangulations and assisted in the magnetic reductions.

Mr. J. E. Dow has been engaged in copying, and other clerical duties, and R. Freeman in copying.

The following members of the division resigned during the year: *Mr. W. D. Storke*, in February; *Messrs. B. H. Todd* and *J. H. Patton*, in May last.

Sub-Assistant C. Fendall and *Assistant A. S. Wadsworth* were temporarily engaged on the computation of solar spot observations made by Assistant Schott in connexion with magnetic observations. They have since been on field duty.

Drawing division.—Until April 24 this division remained in charge of *Lieut. Thomas Wilson, U. S. A.*, and from that date to July 18 in charge of *Assistant Henry L. Whiting*, and since July 18 in charge of *Capt. Thomas J. Lee.* The distribution of work to the draughtsmen (Appendix No. 12) has differed but little from that of the previous year. *Assistant M. J. McClery* has been engaged in filling in topography upon photographed outline, and hachuring duplicate photographs on a scale of $\frac{1}{40000}$, as a guide for engraving the $\frac{1}{80000}$ reductions of the same. *Mr. E. Hergesheimer* has had charge of the preparation and generalization of sheets intended for the photograph, and has been engaged upon reductions of topography and hydrography. *Mr. A. Lindenkohl* on topographical and hydrographic reductions of various scales, projects, projections, verifications, progress sketches, and special maps for different departments of the government. *Mr. L. D. Williams* on fine reductions of topography and hydrography, verifications and projections. *Mr. A. Strausz* was employed upon hydrographic reductions and projections for field parties. *Mr. W. T. Martin* was employed upon topographical drawings and filling in topography on photographed outline until his resignation, on the 23d of April. *Mr. S. B. Linton* has made reductions of various kinds, progress sketches, projections, diagrams, and executed lettering until his resignation, on the 23d of April. *Mr. T. Jekyll*, during the short time he was employed in the office, worked upon topography, upon outline reduced by photography, and on lithographic sketches. *Mr. F. Fairfax* has been employed on general topography and tracings. *Mr. H. Lindenkohl*, since his employment in the office, has worked upon topographical and hydrographical reductions, lithographic sketches, and tracings. *Messrs. J. W. Maedel* and *W. H. Gardner* have made tracings of original sheets to be used in photography, and *Mr. B. Hooe* and *Mr. W. Fairfax* tracings generally.

Mr. Jekyll resigned on the 1st of October, and Mr. Gardner on the 4th of that month.

Engraving division.—The duties of this division were conducted by *Lieut. J. R. Smead, U. S. A.*, until the 24th of April. Since that date the division has been temporarily under the charge of *Mr. Edward Wharton.*

The allotment of work to the various engravers has differed but little from that of previous years.—(See Appendix No. 12.) *Messrs. McCoy, Rollé*, and *Enthoffer* have been engaged upon topography from photographic reductions, and *Mr. John Knight* upon first class lettering. *Messrs. Sengteller, Phillips, Metzeroth*, and *Evans* have engraved topography and sanding.

Messrs. Blondeau and *Maedel* have been employed in topographic engraving; *Mr. Barnard* upon sanding; *Mr. Kondrup* upon lettering and first class outlines; *Messrs. E. A. Maedel, Petersen*, and *Langran*, upon lettering and figures; *Mr. Ogilvie* upon lettering and sand; *Messrs. Bartle, W. A. Thomson*, and *Benner*, upon topography, sand, and miscellaneous work; *Mr. Klakring* in miscellaneous lettering and additions; *Mr. Sipe* upon outlines and letters; *Mr. J. G. Thompson* upon topography and letters; and *Mr. Buckle*, since entering the office, in practice with punches as substitutes for figures cut by hand for soundings.

Photograph and Electrotype division.—The details of the work done in this division of the

office will be found in the report of Mr. George Mathiot, (Appendix No. 12,) who is in charge of the division. Mr. Mathiot has continued to improve the photographic process, and is now producing glass "negatives" twenty-four inches square. The application of the photograph, at first limited to the coast charts, scale $\frac{1}{80000}$, has been extended to embrace reductions for the larger scales, the draughtsman using the photograph as he would the hand-reduced outline. Thus the mechanical process of "hand reducing" has been almost entirely superseded. The photograph has also been made useful in miscellaneous copying, and in facilitating the publication of preliminary charts called for by sudden emergencies.

The engraving of the outlines of two coast charts from the photographs has been completed, leaving nothing in doubt as to the practicability of reducing and engraving a chart in detached sections.

The photographic reductions now embrace charts on the scales $\frac{1}{20000}$, $\frac{1}{30000}$, $\frac{1}{40000}$, and $\frac{1}{60000}$, besides those of the scale of $\frac{1}{80000}$, to which the process was at first confined.

Mr. David Hinkle has assisted Mr. Mathiot in the division, and by promptness and intelligence has met without delay the numerous special calls that have arisen through the necessity for copies of maps and charts in advance of the time that would have been required for either engraving or lithographing.

Lithographing division.—This division was organized during the past year, principally to assist in meeting the great demand for charts required for the public service, as also to afford the means of bringing out, under my immediate supervision, copies of a set of memoirs of the coast of the United States south of Delaware bay.

The division commenced operations under the charge of Professor W. P. Trowbridge, Assistant in the Coast Survey, and, since his assignment in August last to other duty, has been continued under charge of Mr. W. L. Nicholson.

Upwards of sixteen hundred impressions of charts and diagrams had been printed up to October 1, and seventy copies of each of ten memoirs of different parts of the coast had been struck off at that date.

Since then two other memoirs have been prepared.

At the date of the present report three hundred copies of these memoirs have been distributed to the naval and military commanders at the seat of government and along the coast.

Miscellaneous division.—The officer in charge of this division, *Lieut. N. H. McLean, U. S. A.*, was relieved from duty on the survey in April last. *Assistant R. D. Cutts* succeeded him in its direction until July, acceding with much promptness and zeal to my request to that effect in the interval of other important government service, since which time it has been continued in charge of *Assistant Edward Goodfellow.*

More than twenty-one thousand copies of maps and charts of the Coast Survey have been distributed during the year ending November 1, over eight thousand of which have been sent to the naval observatory for the use of national vessels. Of the annual report of the superintendent, of 1859, four thousand copies have been distributed.

Mr. C. Balmain has acted as clerk to the division since the resignation of *Mr. Maynadier* in May. *Mr. J. Rutherdale*, aided by *Mr. J. Barrett*, has rendered efficient service as printer. *Mr. W. Mertz*, assisted by *Mr. F. Hanson*, has had charge of the folding room, and has prepared the paper required for field parties.

Mr. J. Vierbuchen, master machinist, and *Mr. A. Yeatman*, master carpenter, have promptly met the numerous calls made upon them by the office.

The details of work done in the several branches of this division are stated in Appendix No. 12.

On Captain C. P. Patterson, the hydrographic inspector, has devolved the duty of making arrangements in regard to vessels for the hydrographic work of the survey. This service,

under a stress which has called for vessels of every class for special uses of the government, has been successfully performed.

Professor W. P. Trowbridge has rendered valuable assistance in preparing special information needed by the Navy Department, and Assistants H. L. Whiting and Thomas J. Lee in supervising the issue of special maps for military purposes. Assistant L. F. Pourtales has promptly met the numerous calls for tidal data, and Assistant C. A. Schott questions relative to magnetic variation, in both of which branches of inquiry no previous season has made so constant a demand as the present.

In difficult circumstances, arising out of the monetary derangement of the country, the duties of the general disbursing agent, Samuel Hein, esq., have been discharged with the judgment due to close attention and regard for economy.

The routine of clerical duties in the Superintendent's office has been efficiently maintained by the principal clerk, and the clerical services connected with my duties in the field have been acceptably performed by Mr. J. T. Hoover.

Respectfully submitted.

A. D. BACHE,
Superintendent United States Coast Survey.

Hon. S. P. CHASE,
Secretary of the Treasury.

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APPENDIX.

APPENDIX No. 1.

Distribution of the parties of the Coast Survey upon the coasts of the United States during the surveying season of 1860–'61.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION I.				
From Passamaquoddy bay to Point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.	No. 1	Triangulation, topography, and hydrography.	C. O. Boutelle, assistant; W. H. Dennis, sub-assistant; C. H. Boyd, aid; R. H. Platt, sailing-master.	Preliminary survey made, shore-line traced, and hydrography executed at Eastport harbor, Me., and soundings extended towards the approaches of Passamaquoddy bay. (See also Section V.)
	2	Secondary triangulation.	F. P. Webber, sub-assistant.	Triangulation of the coast of Maine, extended for plane-table purposes over Narraguagus bay, Prospect harbor, and the neighboring river entrances between Moose-a-bec and Mt. Desert island. (See also Sections V and VI.)
	3	Secondary triangulation.	G. A. Fairfield, assistant; F. S. Eastman, aid, (part of season.)	Triangulation of Great Blue Hill bay and adjacent coast of Maine, between Mt. Desert and Isle au Haut. (See also Section VI.)
	4	Secondary triangulation.	S. C. McCorkle, sub-assistant.	Triangulation of the upper part of Penobscot bay continued from the vicinity of Camden, northward, and completed nearly to the mouth of Penobscot river.
	5	Primary triangulation and magnetic observations.	A. D. Bache, superintendent; G. W. Dean, assistant; R. E. Halter, sub-assistant; R. H. Talcott, aid, (part of season;) F. A. Lueber, aid, (part of season.)	Mt. Monadnoc, N. H., occupied as a station in the primary series of triangles for connecting the Epping base by direct course with the base line on Fire island, and magnetic elements determined at Mt. Monadnoc. (See also Section II.)
	6	Triangulation.....	Edmund Blunt, assistant.....	Determination of points on the shores of Narragansett and Mt. Hope bays for the topographical and hydrographic surveys. (See also Section II.)
	7	Topography.....	Charles Ferguson, sub-assistant.	Detailed plane-table survey of the shores of Rockland harbor, Me., and adjoining shores of Owl's Head bay and Muscle Ridge channel, including the western shore of Penobscot bay to Fogg Hill, south of Thomaston. (See also Section VI.)
	8	Topography.....	I. Hull Adams, assistant; O. Hinrichs, aid.	Topography of the shores of Back river, Me., continued between Westport island and Kennebec river, including the islands in Back river.
	9	Topography.....	R. M. Bache, assistant.....	Plane-table survey continued on the neck of land between the Kennebec and Androscoggin rivers.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION I—(Continued.)	No. 10	Topography	A. W. Longfellow, assistant.	Shore-line survey of the upper part of Casco bay extended from Drinkwater's Point eastward to Little Flying Point, including the shores of the neighboring islands; and detailed topography continued on the eastern side of Harpswell Neck.
	11	Topography	A. M. Harrison, assistant; P. C. F. West, sub-assistant; H. W. Bache, aid.	Detailed topography of the southern shore of Cape Cod bay completed between Barnstable harbor and West Sandwich, including the mouth of Scusset river.
	12	Topography	A. M. Harrison, assistant; P. C. F. West, sub-assistant, (part of season;) H. W. Bache, aid.	Shore-line survey of the shores of Mt. Hope and Bristol bays, including part of the shores of Narragansett bay, and detailed topography commenced in the vicinity of Swansea and Tiverton.
	13	Hydrography	F. H. Gerdes, assistant; C. Fendall, sub-assistant; F. F. Nes, sub-assistant.	Soundings in the Kennebec river continued from Bath, northward, through Merrymeeting bay; and in the Androscoggin from Merrymeeting bay to the lower bridges. (See also Section VIII.)
	14	Hydrography	C. A. Schott, assistant	Hydrography of Casco bay nearly completed by soundings northward and eastward of Portland harbor, extending to Harpswell Neck, and northward from the limit of previous work to the vicinity of Yarmouth river.
	15	Hydrography	H. Mitchell, assistant; E. P. Heberton, H. W. Longfellow, and L. L. Nicholson, aids.	Determination of the positions and depth of water on rocks near the entrance to Sandy bay, (Cape Ann,) Mass. The currents of Boston harbor and Cape Cod bay observed with reference to their causes and effects. Hydrography of Barnstable harbor completed.
	16	Hydrography	Lieut. Comg. T. S. Phelps, U. S. N., assistant.	Further examination and development of Phelps's Bank, and discovery of three small banks made in sounding in its vicinity. (See also Sections II, III and IV.)
	17	Hydrography	W. P. Trowbridge, assistant; A. S. Wadsworth, assistant.	Hydrography of Narragansett bay executed and completed on the eastern side, between Prudence island and Rhode Island, including Mt. Hope bay and Bristol bay, with the mouths of their rivers.
	18	Tidal observations	Samuel Walker, T. E. Ready.	Tidal observations continued at Eastport, Me., and at Charlestown navy yard, Mass.
	-------	Inspection	A. D. Bache, superintendent.	Inspection of parties working in this section, generally, in the month of October.
SECTION II.				
From Point Judith to Cape Henlopen, including the coast of the States of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.	1	Primary triangulations and magnetic observations.	A. D. Bache, superintendent; G. W. Dean, assistant; R. E. Halter, sub-assistant, F. A. Lueber, aid.	Blue Hill and Box Hill, Conn, occupied for connecting by direct course the primary base on Epping Plains, Me., with that on Fire island. Magnetic elements determined at both stations. (See also Section I.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION II—Continued.	No. 2	Triangulation	Edmund Blunt, assistant; W. S Edwards, sub-assistant; F. M. Wise, aid.	Triangulation to determine the position of points for the plane-table survey of the shores of Connecticut river, between the entrance and Goodspeed's Landing. (See also Section I.)
	3	Secondary triangulation.	John Farley, assistant; C. M. Bache, sub-assistant.	Triangulation of the coast of New Jersey revised by occupying stations between Sandy Hook and Shark river. (See also Section III.)
	4	Topography and hydrography.	John Mechan, sub-assistant; F. R. Hassler, aid.	Shore-line survey of Hudson river executed between Anthony's Nose and Tivoli, and soundings completed from Rhinebeck and Tivoli. (See also Sections III and IV.)
	5	Hydrography	Lieut. Comg. T. S. Phelps, U. S. N., assistant.	Development by soundings of the sand ridge off Barnegat Light, N. J.; and hydrographic examination of the vicinity of the Five Fathom bank off Cape May. (See also Sections I, III, and IV.)
	6	Hydrography	George Davidson, assistant	Hydrographic resurvey of the channels of the Delaware river, in the vicinity of Pea Patch island; near Red Bank; and opposite Philadelphia. (See also Section X.)
	7	Tidal observations.	R. T. Bassett	Observations continued at Governor's island, (New York harbor.)
SECTION III.				
From Cape Henlopen to Cape Henry, including the coast of part of Delaware, and the coast of Maryland and part of Virginia.	1	Triangulation	John Farley, assistant	Triangulation of the Potomac river in the vicinity of Blakistone island, and stations established and partly occupied for extending work upward to Swan Point. (See also Section II.)
	2	Triangulation	W. H. Dennis, sub-assistant; C. Ferguson, sub assistant; Charles Hosmer, aid.	Points determined for the survey of the Potomac between Georgetown and Alexandria, and for completing the topography of the District of Columbia. (See also Sections I and V.)
	3	Topography	H. L. Whiting, assistant; F. W. Door, sub-assistant; J. Mechan, sub-assistant; P. C. F. West, sub-assistant, (part of the season;) Cleveland Rockwell, aid; F. R. Hassler, W. W. Harding, and A. W. Muldaur, aids, (part of season.)	Minute topographical survey of the parts of Fairfax county, Va., adjacent to the Potomac river, between Little Falls and Mount Vernon; and survey of Montgomery county, Md., and banks of the Potomac north of the District of Columbia.
	4	Topography	I. Hull Adams, assistant; S. A. Wainwright, sub-assistant.	Shore-line of the Potomac traced from Piney Point upward to Blakistone island for the regular detailed survey of the river.
	5	Reconnaissance	Captain W. R. Palmer, U. S. Topographical Engineers, assistant; Charles Junken and W. F. Sands, aids.	Topographical reconnaissance of White House Point, Mathias Point, and Lower Cedar Point, and lines of soundings in the vicinity of each run across the Potomac river.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION III—(Continued)	No. 6	Hydrography	Lieut. Comg. T. S. Phelps, U. S. N., assistant; W. B. McMurtrie, A. W. Muldaur, F. A. Lueber, aids.	General reconnaissance and soundings in the channel of the Potomac from Blakistone island upwards to Georgetown. (See also Sections I, II, and IV.)
	7	Tidal observations	J. W. Donn, M. C. King	Series completed with the self-registering gauge at the Washington navy yard, D. C., and observations continued at the permanent station, Old Point Comfort, Va.
SECTION IV.				
From Cape Henry to Cape Fear, including part of the coast of Virginia and N. Carolina.	1	Triangulation	Captain T. J. Cram, U. S. topographical engineers, assistant; A. S. Wadsworth, assistant.	Instructions for continuing the triangulation of Pamplico sound, and for making magnetic observations.
	2	Topography	John Mechan, sub-assistant; F. R. Hassler, aid.	Supplementary plane-table work on part of Roanoke island; on Durant's island and adjacent shore; and at the mouths of the Chowan, Cushai, and Roanoke rivers. (See also Sections II and III.)
	3	Hydrography	Lieut. Comg. T. S. Phelps, U. S. N., assistant.	Examination and soundings in the vicinity of an alleged shoal off the "False Cape," coast of Virginia, below Cape Henry.
SECTION V.				
From Cape Fear to St. Mary's river, including the coast of South Carolina and Georgia.	1	Triangulation and topography.	C. P. Bolles, assistant; O. Hinrichs, aid.	Instructions for continuing triangulation and topography from Little river, southward, along the coast of South Carolina.
	2	Triangulation	C. O. Boutelle, assistant; Lieut. Wm. Craig, U. S. A., assistant; C. H. Boyd, aid.	Instructions for completing the primary triangulation between Beaufort entrance, S. C., and Savannah. (See also Section I.)
	3	Triangulation	F. P. Webber, sub-assistant, P. P. Dandridge, aid.	Secondary triangulation of the coast of Georgia completed, including the Inland Passage, between Cumberland island and the main, and connecting with the survey of Fernandina harbor. (See also Sections I and VI.)
	4	Topography	Cleveland Rockwell	Instructions for completing the topography of tributaries of Port Royal sound, S. C. (See also Section III.)
	5	Topography	H. S. DuVal, sub-assistant; J. D. Bradford, aid.	Instructions for the plane-table survey of Wassaw sound, and for completing the topography of St. Catharine's sound, Ga.
	6	Hydrography	Lieut. Comg. C. M. Fauntleroy, U. S. N., assistant.	Instructions for the hydrographic survey of St. Catharine's sound, Ga., and for commencing work in Wassaw sound.
	7	Hydrography	Lieut. Comg. J. P. Bankhead, U. S. N., assistant.	Instructions for completing in-shore hydrography in the vicinity of St. Simon's island; and for running supplementary off-shore lines, and making observations on currents off the coast of South Carolina and Georgia.
	8	Tidal observations	W. R. Herron	Series at the Charleston custom-house, S. C., continued, and record received for three weeks of April and for previous months.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION VI.				
From St. Mary's river to St. Joseph's bay, including the eastern and part of the western coast of the Florida peninsula, with the Florida reefs and keys.	No. 1	Triangulation	Captain M. L. Smith, U. S. topographical engineers, assistant; Lieut. R. G. Cole, U. S. A., assistant; J. B. Grant, aid.	Instructions for extending the air-line triangulation from Gainsville, southward and westward, across the head of the Florida peninsula, in the direction to Cedar Keys.
	2	Triangulation	F. P. Webber, sub-assistant; P. P. Dandridge, aid.	Connexion made through the Inland Passage, by triangulation, between the completed surveys of Fernandina harbor and St. John's river entrance. (See also Sections I and V.)
	3	Triangulation	Lieut. W. G. Gill, U. S. A., assistant; Lieut. O. D. Greene, U. S. A., assistant.	Instructions for extending the triangulation of the eastern coast of Florida, from Matanzas inlet, southward.
	4	Triangulation and topography.	Charles Ferguson, sub-assistant; J. D. Bradford, aid.	Triangulation of Indian river, Fla., completed from Willis's bay, northward, to the "Narrows;" and plane-table survey of the shores in the vicinity of Fort Capron, within the limits of previous triangulation. (See also Section I.)
	5	Triangulation	G. A. Fairfield, assistant; McLane Tilton, aid.	Inside triangulation of the Florida reef extended across Chatham bay, from Pie key, westward, to Deep Point, and northward to the shore of Florida peninsula. (See also Section I.)
	6	Triangulation	Lieut. W. R. Terrill, U. S. A., assistant; W. S. Edwards, sub-assistant.	Triangulation from Punta Rasa, northward and westward, between Pine island and the main land of Florida, nearly completing the preliminary survey of Charlotte harbor.
	7	Topography	F. W. Dorr, sub-assistant; E. P. Heberton, aid.	Plane-table survey of the eastern coast of the Florida peninsula, from the head of Guano river, northward, to Diego Plains, and of the adjacent shores of North river; completing the topography between St. John's river and St. Augustine harbor. (See also Section III.)
	8	Topography	C. T. Iardella, sub-assistant; T. C. Bowie, aid.	Survey of keys in the lower part of Barnes's sound, or Chatham bay; and topographical details nearly completing the survey of Charlotte harbor.
	9	Hydrography	Lieut. Comg. J. P. Bankhead, U. S. N., assistant.	Instructions to sound at the entrance and in the approaches and channels of Charlotte harbor.
	10	Tidal observations	J. A. Walker, E. G. Meares, A. M. Smith, H. Benners.	Series continued until April with self-registering gauge at Fort Clinch, and until May at Tortugas.
SECTION VII.				
From St. Joseph's bay to Mobile bay, including part of the western coast of Florida and the coast of Alabama.	1	Astronomical, telegraphic, and magnetic observations.	G. W. Dean, assistant; Edw'd Goodfellow, assistant; J. H. Toomer, sub-assistant; H. W. Bache, aid; R. H. Talcott, aid.	Longitude of Pensacola determined by telegraph in connexion with Mobile. Azimuth observed, and latitude and magnetic elements determined at Pensacola. (See also Section I.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION VII—Continued.	No. 2	Triangulation	G. H. Bagwell, sub-assistant; M. O. Hering, aid.	Triangulation of the western coast of Florida peninsula extended from the vicinity of Bayport southward to Tampa bay, including the waters of St. Joseph's bay (south) and Clear Water harbor.
	3	Triangulation	S. C. McCorkle, sub-assistant; H. W. Longfellow, aid.	Stations selected on the shores of St. Joseph's bay, (north,) and lines opened for the triangulation and for connecting that work with the survey of St. George's sound. (See also Section I.)
	4	Triangulation	F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant; C. Fendall, sub-assistant.	Supplementary triangulation of Blackwater bay to furnish points for its survey between Escribano Point and Bagdad. (See also Section I.)
	5	Topography	N. S. Finney, sub-assistant; L. L. Nicholson, aid.	Coast topography completed in the vicinity of Bayport, Fla, and survey made of the town.
	6	Topography	G. D. Wise, assistant.	Instructions to complete the plane-table survey of St James's island and Crooked river, and for extending the topography of St. Vincent's sound westward of Indian Pass.
	7	Hydrography	Lieut. Comg. T. S. Phelps, U. S. N., assistant.	Instructions to complete the hydrography of St. George's sound by additional lines between Cat Point and Royal Bluff, and for soundings between St. Mark's harbor and Southwest cape. (See also Sections I, II, III, and IV.)
	8	Tidal observations	----------	Series continued until the middle of November, 1860, with self-registering gauge, at Warrington navy yard.
SECTION VIII.				
From Mobile bay to Vermilion bay, including the coast of Alabama and Mississippi, and part of the coast of Louisiana.	1	Triangulation and topography.	R. E. Halter, sub-assistant; J. L. Tilghman, aid.	Instructions to connect the survey of the Chandeleur islands with that of Mississippi delta by triangulation across the waters of Isle au Breton sound, and for the plane-table survey of the included shore and keys. (See also Section I.)
	2	Triangulation	F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant; G. U. Mayo, aid.	Triangulation commenced to provide points for the survey of the Southwest Pass, (Mississippi delta.) Instructions to connect Berwyck bay, La., with Atchafalaya bay, by a chain of triangles, including Atchafalaya river. (See also Section I.)
	3	Tidal observations	A. C. Mitchell ----------	Observations continued until April at Great Point Clear, (Mobile bay;) at Southwest Pass, (Mississippi delta,) until February; and at Isle Dernière until April.
SECTION IX.				
From Vermilion bay to the Rio Grande boundary, including part of the coast of Louisiana and the coast of Texas.	1	Triangulation	Lieut. Geo. Bell, U. S. A., assistant.	Triangulation of the coast of Texas extended from Stevenson's Point, northward and eastward, to the High islands, including Robinson's, East bay, and other intervening bayous.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION IX—Continued.	No. 2	Triangulation	S. A. Gilbert, assistant	Instructions to extend the coast triangulation from Corpus Christi, southward, through the Laguna Madre.
	3	Topography	W. S. Gilbert, sub-assistant; Charles Hosmer, aid.	Supplementary topography completing the survey of St. Charles's, Copano, and Aransas bays, Tex.
	4	Tidal observations	A. C. Mitchell	Series continued with self-registering gauge at Calcasieu, La., until May.
SECTION X.				
From San Diego, the southern boundary of the United States on the Pacific, to the forty-second parallel, including the coast of California.	1	Triangulation	W. E. Greenwell, assistant; Julius Kincheloe, sub-assistant.	Signals erected for continuing the triangulation required to connect the Santa Barbara islands with the main coast of California.
	2	Primary and secondary triangulation.	George Davidson, assistant	Observations completed at stations near Bodega bay, extending the main and secondary triangulation of the coast of California to that bay from the southward. (See also Section II.)
	3	Topography	W. M. Johnson, sub-assistant	Plane-table survey of the shores of Half Moon bay, Cal., to complete the coast topography of California between San Francisco entrance and Monterey.
	4	Topography	A. F. Rodgers, assistant; David Kerr, aid.	Detailed survey of the shores of Tomales bay nearly completed, connecting with the topography of Point Reyes and Drake's bay.
	5	Hydrography	Commander B. F. Sands, U. S. N., assistant.	Hydrography of Tomales bay, Cal., completed.
	6	Tidal observations	A. Cassidy, H. E. Uhrlandt	Observations continued with self-registering gauges at San Diego and San Francisco, Cal.
SECTION XI.				
From the 42d parallel of latitude to the northwestern boundary of the United States, including the coast of the State of Oregon and the coast of Washington Territory.	1	Triangulation, topography, and hydrography.	J. S. Lawson, sub-assistant; A. T. Mosman, aid; H. Anderson, aid.	Preliminary base measured; triangulation executed, and the topographical survey made of the shores of Koos bay, Oregon. Hydrography of the bay commenced.
	2	Astronomical observations and topography.	J. S. Lawson, sub-assistant; A. T. Mosman, aid; H. Anderson, aid.	Latitude and azimuth determined at Gray's harbor, W. T. Preliminary base remeasured and topographical survey completed.
	3	Tidal observations	Louis Wilson	Observations continued with the self-registering tide-gauge at Astoria.

APPENDIX No. 2.

List of Army Officers on Coast Survey duty at the opening of the surveying year 1860–'61.

Officers.	Rank.	Date of attachment.	Remarks.
T. J. Cram	Captain topographical engineers	March 26, 1858	
W. R. Palmer	do	November 17, 1857	
M. L. Smith	do	December 9, 1856	Resigned April 1, 1861
N. H. McLean	First lieutenant 2d infantry	March 21, 1860	Detached April 18, 1861
G. Bell	First lieutenant 1st artillery	November 15, 1859	do
W. G. Gill	First lieutenant 4th artillery	June 16, 1860	Resigned February, 1861
W. R. Terrill	do	March 19, 1858	Detached April 18, 1861
J. R. Smead	First lieutenant 2d artillery	May 21, 1859	do
T. Wilson	First lieutenant 5th infantry	May 26, 1857	do
R. G. Cole	First lieutenant 8th infantry	June 11, 1859	Resigned January 10, 1861
W. Craig	do	March 9, 1860	Detached April 18, 1861
O. D. Greene	Second lieutenant 2d artillery	November 23, 1859	do

APPENDIX No. 3.

List of Navy Officers on Coast Survey duty at the opening of the working season of 1861.

Vessel.	Locality of service.	Officers.	Rank.	Date of attachment.	Remarks.
	Office-work	S. S. Lee	Commander	Aug. 8, 1859.	Resigned April 23, 1861
Steamer Active	Sections X and XI	B. F. Sands	do	May 24, 1861.	On service afloat during the year.
	Office-work	W. T. Muse	do	Feb. 27, 1857.	Resigned May 2, 1861
	Do	S. Bent	Lieutenant	March 1, 1860.	Resigned April 30, 1861
Steamer Bibb	Waiting instructions	R. B. Pegram	Lieut. commanding	Oct. 1, 1860.	Resigned April 17, 1861
Sch'r Varina	Under instructions for Section V.	C. M. Fauntleroy	do	Nov. 13, 1858.	Detached May 1, 1861
Sch'r Crawford	Under instructions for Section V.	J. P. Bankhead	do	Oct. 16, 1858.	Detached June 8, 1861
Steamer Corwin	Under instructions for Section VI.	J. Wilkinson	do	June 25, 1859.	Resigned April 6, 1861
Steamer Vixen	Sections I, II, III, and IV.	T. S. Phelps	do	Aug. 24, 1859.	On service afloat during the year.
Schooner Arago	Waiting instructions	J. C. Febiger	do	Oct. 29, 1860.	Detached May 22, 1861
Steamer Active	Under instructions for Sections X and XI.	D. D. Porter	do	Sept. 28, 1860.	Detached April 5, 1861

APPENDIX No. 4.

Information furnished from the Coast Survey office by authority of the Treasury Department in reply to special calls during the year 1860–'61.

Date.	Names.	Data furnished.
1860.		
Oct. 9	G. W. Blunt, esq., New York	Tracings showing lines of deep-sea soundings across Jeffrey's Ledge, and hydrography from Cape Ann to Seal island, Mass.
22	Hon. Secretary of State	Tracing of resurvey of Maffitt's channel, S. C.
23	James Howard, esq., Portland, Me	Hydrography of Portland harbor, Me.
31	G. W. Blunt, esq., New York	Tracing from hydrographic survey of East river from Hell Gate to Throg's Neck, N. Y.
Nov. 13	ditto	Tracing of Asia Rip, southeast of Nantucket, Mass.
28	Hon. H. Fish, New York	Tracing of Irvington and vicinity, Hudson river, N. Y.
Dec. 16	P. Witzel, esq., New York	Tracing of topography of Newark Neck, N. J.
17	E. F. Northam, esq., San Francisco, Cal	Tracing of topography of west shore of San Francisco bay, from Point San Bruno to Point San Francisquito.
24	Captain G. W. Cullum, corps of engineers	Tracing of comparative sketch of Maffitt's channel from surveys of 1855, 1859, and 1860.
1861.		
Jan. 8	Lieutenant J. C. Clark, U. S. A	Tracing of triangulation of Charlotte harbor, Fla., (upper sheet.)
March 2	Croton Aqueduct Engineers, New York city	Tracing of hydrography of Harlem river and Spuyten Duyvel creek, N. Y.
May 7	Major General B. F. Butler, U. S. A	Tracing of topography in vicinity of Ft. Monroe and Cape Henry.
24	ditto	Tracing coast of North Carolina from North river to Kill Devil Hills.
25	Commander H. S. Stellwagen, U. S. N	Tracing coast of North Carolina from Bay Signal to Wreck Stafford.
25	Major General B. F. Butler, U. S. A	Tracing of Currituck sound, N. C.
25	ditto	Tracing of Head of Currituck sound, N. C.
June 11	ditto	Tracing of reconnaissance between Cape Henry and Elizabeth river.
12	War Department	Map of the country between York and Rappahannock rivers, Virginia.
18	Major Hartman Bache, topographical engineers	Tracings of Lower Cedar, Mathias, and White House Points, Potomac river.
18	General Joseph G. Totten, corps of engineers	Tracings of Lower Cedar, Mathias, and White House Points, Potomac river.
20	Commander J. H. Rowan, U. S. N	Tracings of Lower Cedar, Mathias, and White House Points, Potomac river.
20	Hon. Secretary of the Navy	Tracings of Lower Cedar, Mathias, and White House Points, Potomac river.
20	Major General B. F. Butler, U. S. A	Tracing of topography of Old Point Comfort, Sewell's Point, Newport News Point, &c.
27	P. Stine Sanderson, esq	Tracing of hydrography between Ft Monroe and Newport News Point, for laying down submarine telegragh cable.
27	Navy Department	Tracings of Lower Cedar, Mathias, and White House Points, Potomac river.
July 20	Capt. W. F. Reynolds, topographical engineers	Tracing of topography of Old Point Comfort, Sewell's Point, Newport News Point, &c.
Aug. 2	Major J. G. Barnard, engineers	Photograph copy of ground of occupation and defence, west side Potomac river.
6	Commander H. S. Stellwagen, U. S. N	Tracing of Coast of North Carolina, from Bodies island to Nag's Head.
8	Capt. A. W. Whipple, topographical engineers	Photograph copy of ground of occupation and defence, west side Potomac river.
9	Brig. Gen. George A. McCall, U. S. A	Tracing of topography of Old Point Comfort, Sewell's Point, Newport News Point, &c.
10	Captain H. G. Wright, engineers	Photograph copy of ground of occupation and defence west side Potomac river.

APPENDIX No. 4—Continued.

Date.		Names.	Data furnished.
1861.			
Aug.	10	Major J. G. Barnard, engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	10	Brig. Gen. W. B. Franklin, U. S. A	Photograph copy of ground of occupation and defence west side Potomac river.
	10	Brig. Gen. H. G. Wright, U. S. A	Tracing of upper part of Edisto and Jehossee islands, S. C.
	12	ditto	Tracing of sea-coast of South Carolina from Port Royal to mouth of May river.
	13	ditto	Tracing of sea-coast of South Carolina from mouth of Savannah river to mouth of May river.
	13	Major Gen. George B. McClellan, U. S. A	Photograph copy of ground of occupation and defence west side Potomac river.
	15	Brig. Gen. H. G. Wright, U. S. A	Tracing of St. Helena Sound, S. C.
	19	ditto	Tracing of South Edisto river, S. C.
	22	ditto	Tracing of Daw island in Port Royal sound, S. C.
	23	ditto	Tracing of coast of South Carolina from Fripp's inlet to Port Royal sound, S. C.
	23	Brig. Gen. S. P. Heintzleman, U. S. A	Photograph copy of ground of occupation and defence west side Potomac river.
	23	Major Gen. George B. McClellan, U. S. A	Tracings from original plane-table sheets of work in Virginia.
	27	Major J. G. Barnard, engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	28	ditto	Photograph copy of ground of occupation and defence west ssde Potomac river.
	31	Lieutenant Henry M. Robert, engineers	Photograph copy of ground of occupation and defence west side Potomac river.
Sept.	3	Treasury Department	Tracing of topography of Hatteras inlet, N. C.
	3	Light-house board	Tracing of hydrography of Ocracoke inlet, N. C.
	3	Major J. N. Macomb, topographical engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	4	Light-house board	Tracing of hydrography of Hatteras inlet, N. C.
	9	Major J. G. Barnard, engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	9	Major J. N. Macomb, topographical engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	10	Major J. G. Barnard, engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	10	Major J. N. Macomb, topographical engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	10	Major J. G. Barnard, engineers	Tracing of reconnaissance of Mathias Point, Potomac river.
	12	Lieut. H. L. Abbott, topographical engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	14	Major J. N. Macomb, topograhpical engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	17	Brig. Gen. W. B. Franklin, U. S. A	Photograph copy of ground of occupation and defence west side Potomac river.
	17	Commander J. A. Dahlgren, U. S. N	Tracing of reconnaissance of Mathias Point, Potomac river.
	18	Brig. Gen. H. G. Wright, U. S. A	Tracing of St. Mary's river and Fernandina harbor, Fla.
	18	Commander C. H. Davis, U. S. N	Photograph copy of ground of occupation and defence west side Potomac river.
	21	Commander R. Wainwright, U. S. N	Photograph copy of ground of occupation and defence west side Potomac river.
	27	Captain B. S. Alexander, corps of engineers	Photograph copy of ground of occupation and defence west side Potomac river.
	28	Major W. R. Palmer, topographical engineers	Photograph copy of ground of occupation and defence west side Potomac river.
Oct.	4	Major Gen. George B. McClellan, U. S. A	Tracing of plane-table work above Chain bridge on Virginia side of Potomac.
	12	Lieut. Colonel J. N. Macomb, A. D. C	Photograph copy of ground of occupation and defence west side Potomac river.
	13	ditto	Photograph copy of ground of occupation and defence west side Potomac river.
	16	Brig. Gen. Fitz John Porter, U. S. A	Photograph copy of ground of occupation and defence west side Potomac river.

APPENDIX No. 5.

Statistics of field and office-work of the United States Coast Survey during the years—

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	Total.
Reconnaissance—																			
Area, in square miles	9,642	1,140	3,739	1,830	2,950	3,940	10,159	3,980	3,510	1,706	1,708	795	1,487	4,072	2,855	709	1,782	6,050	61,354
Parties, number of, in each year	4	2			5	7		4	6	6	5	13	7	5	8	4	3	1	.....
Base lines—																			
Primary, number of	1	2	.....	.....	1	1	.....		.....	.....	1	.....	2	.....	1	.....	.....	.....	10
Secondary, number of	2	.....	.....	.....	2	1	4	3	3	4	5	2	8	8	1	4	5	2	54
Length of, in miles	19½	16	.....	.....	9¼	13	6¼	17¼	2	4⅛	18⅛	3⅞	24⅛	9½	9	3⅛	6¼	1⅛	164⅛
Triangulation—																			
Area, in square miles	9,076	795	2,166	1,185	1,903	2,592	4,091	2,097	2,465	1,703	3,089	2,701	2,729	2,793	1,640	3,033	3,724	4,773	52,555
Extent of general coast, in miles	570	179	162	123	159	115	285	216	243	220	94	246	188	320	357	278	358	232	4,345
Extent of shore-line, in miles, including bays, sounds, islands, and rivers	1,588	589	554	1,018	541	796	1,398	730	1,097	1,104	884	1,269	1,401	1,895	1,481	1,715	2,092	1,617	21,699
Horizontal angle stations occupied	750	120	80	197	120	98	204	157	184	223	224	204	410	541	385	384	344	322	4,950
Geographical positions determined	1,183	147	148	372	194	227	310	294	307	446	346	388	584	1,240	777	603	794	681	9,050
Vertical angle stations occupied	15	2	5	7	3	1	18	13	22	14	7	89	6	1	4	11	17	17	252
Elevations determined, number of	44	12	7	46	44	1	59	22	53	66	9	127	6	12	15	14	31	44	612
Parties, number of, in each year	4	5	8	7	8	10	13	14	14	13	18	17	17	20	20	19	21	21	.....
Astronomical operations—																			
Stations occupied for azimuth	9	8	2	2	3	3	4	4	6	6			4	2	1	2	7	5	82
Stations occupied for latitude	9	8	5	3	8	2	4	6	8	17	20	6	4	6	3	5	5	6	125
Stations occupied for longitude	1	1	.....	2	3	3	7	3	7	18	21	4	1	1	2	2	.....	7	83
Permanent longitude stations	.....	1	1	2	1	1	2	3	5	5	5	4	3	1	1	1	1	1	.....
Special longitude stations for occultations, &c	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23	30	24	21	.....
Parties, number of, in each year	1	3	2	2	3	3	5	5	6	4	7	7	6	4	3	4	5	6	.....
Magnetic stations occupied, number of	.....	14	21	28	19	4	11	9	10	8	13	9	8	23	4	5	18	25	229
Parties, number of, in each year	.....	2	3	3	3	3	5	4	3	2	3	6	3	4	3	3	4	7	.....
Topography—																			
Area surveyed, square miles	6,131	195	503	750	595	471	532	652	681	653	554	513	656	536	1,003	706	476	592	16,199
Length of general coast, in miles	414	110	168	119	117	185	95	133	260	236	251	174	176	165	309	292	224	320	3,748
Length of shore-line, in miles, including rivers, creeks, and ponds	7,667	424	879	1,120	1,460	1,703	1,709	1,557	1,760	1,737	2,160	1,796	2,138	2,398	3,913	3,408	2,334	2,052	40,155
Length of roads, in miles	11,734	395	997	1,402	1,354	640	504	511	500	732	502	618	733	750	1,404	870	434	260	24,337
Parties, number of, in each year	6	5	6	8	9	9	11	11	13	13	17	12	17	17	23	23	22	23	.....
Hydrography—																			
Parties, number of, in each year	2	5	5	6	6	8	11	11	12	9	9	10	11	12	12	10	9	9	.....
Number of miles run while sounding	29,214	1,857	3,493	3,559	5,138	8,047	4,299	5,995	10,570	9,534	9,050	9,141	13,115	15,305	12,377	8,884	9,175	6,565	163,378
Area sounded out, square miles	9,601	663	677	574	979	2,185	1,335	2,012	3,200	2,823	2,061	1,937	3,433	3,743	2,705	1,799	4,314	1,392	45,433
Miles run additional, of outside or deep-sea soundings	1,800	1,020	.....	.....	210	2,240	.....	1,198	2,037	360	1,902	2,793	5,919	1,202	3,218	2,092	2,353	2,375	30,019
Soundings, number of	808,147	120,8.7	125,173	220,402	228,402	255,003	265,824	264,718	371,660	288,375	305,377	162,454	526,875	439,614	506,034	513,607	398,053	373,251	6,173,796

APPENDIX No. 5—Continued.

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	Total.
Hydrography—																			
Soundings in Gulf Stream for temperature	.....	.....	118	581	207	425	.....	.....	.....	.....	1,053	257	310	.....	478	172	235	236	4,072
Tidal stations, permanent	.....	2	2	2	3	3	3	3	4	4	7	7	7	8	8	10	10	11	.....
Tidal stations occupied temporarily	127	14	33	39	33	29	35	41	51	76	78	89	80	77	74	53	32	25	986
Tidal parties, number of, in each year	2	5	5	5	5	8	11	11	12	9	11	12	13	14	14	13	10	6	.....
Current stations occupied	.....	27	42	41	59	54	28	44	41	24	89	10	84	84	156	47	38	84	952
Current parties, number of, in each year	.....	3	5	3	3	4	6	4	7	7	5	3	5	6	6	2	2	1	.....
Specimens of bottom, number of	1,029	2,776	89	129	371	769	287	381	278	215	141	135	255	146	422	668	161	13	8,268
Records—																			
Triangulation, originals, number of volumes	97	12	17	23	17	32	38	40	33	33	64	46	79	96	76	96	94	120	1,013
Astronomical observations, originals, number of volumes	17	10	11	10	16	22	72	30	41	48	29	88	35	12	35	63	27	35	601
Magnetical observations, originals, number of volumes	4	2	1	6	7	4	3	5	5	7	6	4	33	13	4	10	9	13	136
Duplicates of the above, number of volumes	27	26	32	32	44	49	19	23	45	73	76	84	139	101	140	168	77	111	1,266
Computations, number of volumes	78	25	17	21	26	23	57	24	40	72	101	91	109	99	83	101	88	115	1,170
Hydrographic soundings and angles, originals, volumes	188	22	26	152	54	154	134	170	213	206	183	66	332	197	319	322	306	194	3,238
Hydrographic soundings and angles, duplicates, volumes	28	2	5	4	11	11	12	12	16	27	15	7	26	27	21	20	19	10	273
Tidal and current observations, originals, volumes	127	23	47	51	44	40	67	88	114	139	123	70	196	110	213	104	75	64	1,695
Tidal and current observations, duplicates, volumes	.....	23	47	51	44	41	63	79	385	132	114	79	87	100	67	74	57	53	1,496
Sheets from self-registering tide-gauges, number of	.....	.....	.....	.....	.....	.....	.....	.....	.....	26	72	106	80	103	119	141	149	180	976
Tidal reductions, number of volumes	.....	46	94	102	88	80	16	58	22	28	17	99	79	73	63	64	52	60	1,039
Total number of volumes of records	566	191	297	452	351	456	481	529	914	763	728	634	1,115	828	1,021	1,022	804	775	11,927
Maps and charts—																			
Topographical maps, originals	168	14	16	25	29	20	22	30	41	47	54	45	55	51	74	44	36	37	808
Hydrographic charts, originals	142	9	8	18	18	21	16	20	47	56	56	52	65	62	51	33	40	31	745
Reductions from original sheets, number of	15	9	15	16	17	13	18	22	26	48	35	27	36	39	40	35	92	24	526
Total number of manuscript maps and charts	325	32	39	59	64	54	56	72	114	151	145	124	156	152	165	112	165	83	2,068
Number of sketches made in field and office	311	24	33	32	29	48	82	85	126	137	103	101	132	125	132	127	353	108	2,088
Engraving and printing—																			
Engraved plates of finished charts, number of	5	2	3	5	3	6	3	5	6	5	4	2	7	3	7	6	8	8	88
Engraved plates of preliminary charts, sketches, and diagrams, for the Coast Survey reports, number of	.....	.....	.....	4	5	7	6	10	38	20	39	42	46	51	51	25	21	17	382
Electrotype plates made in each year	.....	.....	.....	.....	1	7	6	25	16	23	47	77	50	69	79	95	87	58	640
Finished charts published in each year	.....	4	3	4	3	10	3	4	6	6	3	2	8	3	5	6	6	7	83

APPENDIX No. 5—Continued.

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	Total.
Engraving and printing—																			
Preliminary charts and hydrographic sketches published	.....	.....	.....	2	4	2	4	10	36	19	34	34	34	38	41	22	15	15	310
Printed sheets of maps and charts distributed	.....	169	416	1,708	1,104	2,923	1,848	326	5,649	5,799	8,042	5,195	5,392	8,858	19,147	4,209	10,486	6,425	87,696
Printed sheets of ditto deposited with sale agents	.....	.....	880	1,686	4,981	5,016	1,506	3,115	5,168	6,866	4,375	3,232	2,577	2,895	648	1,717	3,584	1,633	49,882
Library—																			
Number of volumes	.....	.....	.....	.....	.....	655	95	590	333	171	273	155	250	389	106	116	174	159	3,466
Instruments—																			
Cost of	.....	.....	.....	.....	.....	.....	$8,326	$4,652	$4,603	$3,835	$5,296	$5,402	$3,958	$5,369	$3,185	$1,224	$1,852	$1,729	.....

GENERAL NOTE.

Parties.—An average number is given for the years previous to 1844. A party operating in 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 general coast is measured similarly to that under triangulation; but shore-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 655.

It is to be remarked that the numbers appearing in the column 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. 6.

GENERAL LIST OF COAST SURVEY DISCOVERIES AND DEVELOPMENTS TO 1860, INCLUSIVE.

1. A ledge with four fathoms water on it, discovered S.SW. $\frac{1}{4}$ W. (true) and a mile and a quarter from Pemaquid light-house, coast of Maine, 1860.

2. Numerous dangerous reefs and ledges developed at the entrance and in the approaches of Damariscotta river, Maine, 1860.

3. Two rocks, one with three and a quarter fathoms, the other with only ten feet of water, and a ledge with three and a half fathoms, found in the channel of Booth bay, Maine, 1860.

4. Jeffrey's bank and Jeffrey's ledge, off the coast of Maine, thoroughly sounded out, 1860.

5. Only eighteen feet at mean low water found on the rock one mile to the southward of Seguin island, coast of Maine, 1859.

6. Temple's ledge, near Cape Small Point, Maine, 1857.

7. True position of the Hussey rock, in Casco bay, determined, correcting the erroneous one assigned on previous charts, 1859.

8. 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.

9. Determination of the dimensions of Alden's rock, near Cape Elizabeth, Maine, 1854.

10. Determination of the position of the "Hue and Cry," the "Old Proprietor," and other dangers off Cape Elizabeth, Maine, 1859.

11. Huzzey's rock, south of Fletcher's Neck, Maine, determined in position, 1859.

12. Development of a four-fathom bank off Cape Porpoise, Maine, 1859.

13. Fishing ledge, off Kennebunk, Maine, thoroughly sounded, 1859.

14. 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.

15. Development of a rock off Ogunquit, bare at low tides, and very little known, 1859.

16. Development of Boon Island ledge, coast of Maine, 1858.

17. A rock off Cape Neddick, Maine, determined in position, 1858.

18. A detached rock, two-thirds of a mile northward and eastward of York ledge, Maine, 1858.

19. Determination of the position of a rock more than a mile off the mouth of York river, Maine, bare at low tides and dangerous to coasters, 1858.

20. Development of Duck Island ledge, 1858.

21. A fishing bank sounded out off Wood island, coast of Maine, 1859.

22. A very dangerous rock, with only six and a half feet water, off the entrance to Portsmouth harbor, New Hampshire, about four nautical miles eastward from the Whale's Back light, 1858.

23. A rock with twelve feet at mean low water, about four miles and a third eastward of the Whale's Back, 1858.

24. A rock (not on any chart) in the inner harbor of Gloucester, Massachusetts, discovered in 1853.

25. Determination of rocks off Marblehead and Nahant, 1855.

26. Determination of the position of White Rock ledge, at the entrance of Saugus river, Massachusetts, 1860.

27. A bank ninety miles eastward of Boston, with about thirty-six fathoms of water, probably a knoll connected with Cashe's ledge, but with deep water between it and the ledge, 1853.

28. Boston harbor; Broad Sound channel thoroughly surveyed and marks recommended, 1848.

29. Several rocks in the fair channel-way in Boston harbor entrance, 1854.

30. An extension of the sand-spit to the southward of Sunken ledge, Boston harbor, since the survey of 1847, 1858.

31. Discovery of a rock with only seventeen feet of water at mean low tide in the Narrows of Boston harbor, 1860.

32. Special investigation of the currents of Boston harbor, 1860.

33. 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.

34. Extension of Stellwagen's bank to the southward and eastward some sixteen or seventeen square miles, enclosed by the twenty-fathom curve, 1855.

35. Changes in the vicinity of East harbor, (Cape Cod,) 1857.

36. Special tidal and current observations at the mouth of Scusset river, (Cape Cod bay,) 1860.

37. A dangerous sunken ledge (Davis's ledge) to the eastward and in the neighborhood of Minot's ledge, 1854.

38. Development of a reef extending between Minot's and Scituate light, 1856.

39. A sunken rock, with only six feet on it at low water, off Webster's Flag-staff, Massachusetts bay, 1856.

40. A dangerous rock near Saquish Head, entrance to Plymouth harbor, 1856.

41. Three rocks determined in position, partly bare at low water, off Manomet Point, Massachusetts bay, 1856.

42. 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.

43. 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, 1859.

44. Probable connexion of George's bank and the deep sea banks north and east of Nantucket, 1855.

45. The decrease of depth, with general permanence of form of George's bank, off the coast of Massachusetts, 1857.

46. A shoal spot near Little George's bank, 1857.

47. 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.

48. Nantucket shoals; Davis's 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.

49. Two new shoals north and east of Nantucket; discovered in 1847.

50. Six new shoals near Nantucket, the outermost fourteen and a half miles from land, and with only ten feet water; discovered in 1848.

51. McBlair's shoals off Nantucket; discovered in 1849.

52. The tidal currents of Nantucket shoals and the approaches, 1854.

53. Davis's bank, Nantucket shoals; discovered in 1848, and survey finished in 1851.

54. Fishing Rip, a large shoal extending north and south, about ten miles to the eastward of Davis's bank, and thirty miles from Nantucket, with four and a half fathoms; surveyed in 1852.

55. A ridge connecting Davis's New South shoal and Davis's bank; found in 1853.

56. 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's 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.

57. Discovery of a shoal lying N.NE., over six miles long, and twenty-four miles southeast of Davis's south shoal, with ten to ten and a half fathoms of water, 1860.

58. Discovery of Edward's shoal, one mile and seven-eighths southward of Nantucket light-boat, 1855.

59. Examination of the interference tides of Nantucket and Martha's Vineyard sounds, 1855.

60. The study of the tidal currents of the Vineyard and Nantucket sounds, 1857.

61. Contraction of the inlet at the north end of Monomoy island, and opening of a new entrance to Chatham harbor, 1853.

62. Muskeget channel, surveyed by Lieutenant C. H. Davis in 1848, and Lieutenant C. H. McBlair in 1850.

63. Discovery of two shoal spots, with twelve and thirteen feet water, eastward from Great and Little Round shoals, Nantucket sound, 1856.

64. Determination of two shoal spots near the northern extremity of Davis's bank, with fourteen and eighteen feet water, 1856.

65. Further development of Edward's shoal, three-fourths of a mile from the southern Cross Rip, Nantucket sound, 1856.

66. Shoal sand ridges discovered northward of Great Point light, Nantucket sound, 1856.

67. Important changes in geographical feature at the southeastern end of Martha's Vineyard, Muskeget channel, 1856.

68. Numerous rocks in Martha's Vineyard sound, Long Island sound, and the various bays and harbors connected with them.

69. Luddington rocks determined in position, about ten yards apart, a mile and a half (nautical) southwest by compass from New Haven light, 1858.

70. The tidal currents of Long Island sound, 1854.

71. The tidal currents of Hell Gate, 1857.

72. Least water on the Hell Gate rocks determined by dragging, 1857.

73. Tidal currents in East river, New York, and surface and sub-currents investigated in New York harbor, the lower bay, and on the bar, 1858.

74. The currents of the great bay between Massachusetts, Rhode Island, Connecticut, New York, and New Jersey, 1855.

75. 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.

76. The changes in New York harbor, near New York city, between 1845 and 1858.

77. Increase of depth in Buttermilk channel, ascertained and made known in 1848 by survey of Lieutenant D. D. Porter, United States navy.

78. 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, 1859.

79. Shoal in the main ship channel of New York harbor, 1855.

80. The existence and character of sub-currents ascertained as bearing on the physical conditions of New York harbor, 1859.

81. The tides of Hudson river, 1856.

82. 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.

83. 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.

84. Blunt's channel in Delaware bay.

85. Changes in the Delaware near the Pea Patch, 1847.

86. The true extent and position of the dangerous shoals near the Chincoteague inlet, Virginia, 1852.

87. Metomkin inlet, Virginia, shoaling from eleven to eight feet in the channel during 1852.

88. Two channels into Wachapreague inlet, Virginia—one from the northward and the other from the eastward; both with seven feet water at low tide, 1852.

89. 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, Virginia. It has but four fathoms water on it, and nine fathoms around it, 1852.

90. Great Machipongo inlet, Virginia. Found to have a fine wide channel, with eleven feet water on the bar at low ebb and fourteen at high tide. Good anchorage inside from two to eight fathoms. The best harbor between the Chesapeake and Delaware entrances, 1852.

91. Two shoals near the entrance to the Chesapeake—one, four and three-quarters 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-quarters miles from the same light, with nineteen and a half feet upon it, 1853.

92. 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.

93. 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.

94. A shoal at the mouth of the Great and Little Choptank, in Chesapeake bay, 1848.

95. The sounding and measurement of the bars in Rappahannock river, 1855.

96. The general permanence of the Bodkin channel and shoals in its vicinity, at the entrance of the Patapsco river, between 1844 and 1854.

97. Changes developed in the shore-lines at the entrance of Little Annemessex river, Chesapeake bay, 1859.

98. 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.

99. Re-examination of York spit, Chesapeake bay, and least water determined, (nine feet,) 1855.

100. York river, Va., as a harbor, 1857.

101. A reconnaissance of the Wimble shoals, near Nag's Head, coast of North Carolina, 1854.

102. Submarine range of hills beyond the Gulf Stream tracked from Cape Florida to Cape Lookout, 1855.

103. Deep water found on Diamond shoal, and a dangerous nine-feet shoal off Cape Hatteras, 1850.

104. A new channel, with fourteen feet water, into Hatteras inlet, formed during the year 1852, which is better and straighter than the old channel.

105. Changes at Hatteras and Ocracoke inlets, 1857.

106. Extent of the sea encroachment at Cape Hatteras, and changes found near Hatteras inlet, N. C., 1860.

107. The general permanence in depth on the bar of Beaufort, N. C., with the changes of position of the channel, 1854.

108. Changes on the bar of Beaufort, N. C., 1857.

109. 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.

110. Changes in the main Western and New Inlet channels in Cape Fear, 1855.

111. 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.

112. Shoaling of Cape Fear river bar thoroughly examined for purposes of improvement, 1852.

113. Changes of shore-line and hydrography determined at the Cape Fear entrances, N. C., 1858.

114. Changes of the Cape Fear bars and channels, 1857.

115. Changes at the entrance of Winyah bay and Georgetown harbor, and the washing away of Light-house Point at the same entrance, 1853.

116. Less water found off Cape Romain by preliminary examination than has been heretofore assigned, 1859.

117. Maffitt's new channel, Charleston harbor, with the same depth of water as the ship channel, 1850.

118. The changes in Maffitt's channel, Charleston harbor, S. C., from 1852 to 1857.

119. Increase of depth developed in Maffitt's channel, Charleston harbor, S. C., 1858.

120. Changes in the main ship channel, Charleston harbor, 1851.

121. Changes in the channels at the entrance of Charleston harbor, 1852.

122. 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.

123. Development of the changes affecting the entrance to North Edisto river, S. C., 1856.

124. Greater depth found through the channel of Coosaw river, S. C., (inland passage,) than has been hitherto supposed to exist, 1860.

125. Discovery of a new channel between Martin's Industry (shoal) and the southeast breakers, Port Royal entrance, S. C., 1856.

126. Discovery of cold water at the bottom of the ocean below the Gulf Stream, along the coast of North and South Carolina, Georgia, and Florida, 1853.

127. 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.

128. Various facts relative to the distribution of minute shells on the ocean bottom, of probable use to navigators for recognizing their positions.

129. Changes in shore-line and in depth observed in Ossabaw sound, Ga., 1860.

130. A new channel developed leading into Sapelo sound, Ga., three-quarters of a mile southward, and better than the one in use, 1860.

131. Examination of Doboy, St. Simon's, and Cumberland entrances, 1855.

132. A shoal inside of the entrance to Amelia river, Fla., 1857.

133. Hetzel shoal, off Cape Cañaveral, Fla., 1850.

134. A shoal spot found off the coast of Florida, ten miles from land and fifteen miles NE. of Indian River inlet, 1860.

135. Temperature of 34° beneath the Gulf Stream, thirty-five miles east of Cape Florida, at a depth of three hundred and seventy fathoms, 1855.

136. Further explorations and investigations in developing the character of the Gulf Stream in the Florida channel, 1859 and 1860.

137. 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.

138. A new passage, with three fathoms water, across the Florida reef, to Legaré harbor, under Triumph reef, (latitude 25° 30′ N., longitude 80° 03′ W.,) which, if properly buoyed, will be valuable as a harbor of refuge, 1852.

139. A safe rule for crossing the Florida reef near Indian key, 1854.

140. Tennessee shoal, Florida reef, developed, giving only twelve feet of water on its outer patch, 1860.

141. The position of a sunken wreck determined and marked, lying off Grassy key, Florida reef, and near the track of vessels, 1860.

142. A new channel into Key West harbor, 1850.

143. Co-tidal lines for the Atlantic coast of the United States, 1854.

144. Rules for navigators in regard to the tidal currents of the coast, 1857.

145. Isaac shoal, near Rebecca shoal, Florida reef; not laid down on any chart, 1852.

146. Channel No. 4, a northeast entrance into Cedar Keys bay, 1852.

147. Directions for entering the harbor from Crystal River offing, west coast of Florida peninsula, 1856.

148. 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.

149. 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.

150. Indications noticed of a deeper and better channel forming to lead to the East Pass anchorage, St. George's sound, Fla., 1860.

151. Changes in the depth of water observed by comparison of soundings at Perdido entrance, 1860.

152. 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.

153. The diminution, almost closing, of the passage between Dauphine and Pelican islands, at the entrance of Mobile bay, 1853.

154. The currents of Mobile bay specially investigated, 1860.

155. Horn Island channel, Mississippi sound, 1852.

156. 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.

157. The accurate determination of Ship shoal, off the coast of Louisiana, in connexion with the site for a light-house, 1853.

158. An increase of depth of water on the bar of Pass Fourchon, La., 1854.

159. Deep-sea soundings in the Gulf of Mexico, 1855–'56.

160. Tidal phenomena of the Gulf, 1855.

161. The changes at Aransas Pass, Texas, as bearing on the question of a light-house site, 1853.

162. Co-tidal lines of the Gulf of Mexico, 1856.

163. On the effect of wind in disturbing the tides of the Gulf of Mexico, 1856.

164. Development of a bar at the entrance of San Diego bay, Cal., 1856.

165. A shoal inside of Ballast Point, San Diego bay, with only twelve and a half feet water, not laid down on any chart, 1852.

166. The determination of the position and soundings on Cortez bank, off the coast of California, 1853.

167. Complete hydrographic survey and determination of a point of rock on Cortez shoal, 1856.

168. Tides of San Diego, San Francisco, and Astoria, 1854.

169. The non-existence of San Juan island, usually laid among the Santa Barbara group, 1852.

170. Co-tidal lines of the Pacific coast, 1855.

171. Determination of Uncle Sam rock, 1855.

172. Investigation of the currents of Santa Barbara channel, 1856.

173. Red sand marking the entrance to the Golden Gate, 1855.

174. Channel sounded out between Yerba Buena and the Contra Costa, San Francisco bay, 1855.

175. A reef developed off the Contra Costa flats, San Francisco bay, Cal., 1858.

176. Whiting's rock determined in position, near the "Brothers," at the entrance of San Pablo bay, Cal., 1858.

177. Further development of the extent of Commission rock, San Pablo bay, 1856.

178. Changes in the channel entrance of Humboldt bay or harbor, Cal., 1852 and 1853.

179. 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.

180. The depth of water on the bars at the entrance of Rogue river and Umpquah river, Oregon, 1853.

181. A shoal at the northern entrance to the strait of Rosario, W. T., giving good holding ground in thirty-three feet, 1854.

182. Boulder reef, northwest of Sinclair island, Rosario strait, partly bare at unusually low tides, and surrounded by kelp, 1854.

183. 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.

184. Belle rock, in the middle of Rosario strait, visible only at extreme low tides, 1854.

185. Entrance rock, at the entrance of Rosario strait, 1854.

186. Unit rock, in the Canal de Haro, W. T., visible only at extreme low tides, 1854.

187. A three-fathom shoal in the strait of Juan de Fuca, off the southeast part of Bellevue, or San Juan island, 1854.

188. Allen's bank, Admiralty inlet, W. T., 1857.

189. A five-fathom shoal in the strait of Juan de Fuca, between Canal de Haro and Rosario strait, 1854.

190. A bank in eleven fathoms off the southern entrance to Canal de Haro, 1854.

191. The non-existence of two islands at the northern entrance of Canal de Haro, laid down on charts, 1853.

192. Various surveys and charts of small harbors on the Pacific coast of the United States, and a continuous reconnaissance of the entire Western Coast and islands adjacent, a great part of which was imperfectly known.

193. Winds of the Western Coast of the United States, 1857.

ADDITIONAL LIST FOR 1861.

1. Determination of the positions of four points of rock in Sandy bay, (Cape Ann,) Mass.

2. Special investigation of the currents of Boston harbor.

3. The currents of Cape Cod bay observed with reference to their physical effects on the shores.

4. Discovery of three small banks off the Nantucket shoals in the vicinity of Phelps's bank, and further development of the extent of that shoal ground.

5. Development, by soundings, of a ridge lying sixteen miles off Barnegat, N. J., with eleven to thirteen fathoms of water, and sixteen fathoms between it and the coast.

6. Special examination made and changes noted in the vicinity of the Five-fathom bank off Cape May.

7. Hydrographic changes developed in the Delaware river, at the Bulk Head shoal, near Fort Delaware, at the bar off Fort Mifflin, and opposite to Philadelphia.

8. Development of important changes in the hydrography of the bar and channels of Hatteras inlet, N. C.

APPENDIX No. 7.

LETTER TO THE SECRETARY OF THE TREASURY, COMMUNICATING THE POSITION OF SEVERAL SMALL BANKS LYING OUTSIDE OF THE NANTUCKET SHOALS, IN EXTRACTS FROM A REPORT BY LIEUT COMG. T. S. PHELPS, U. S. N., ASSISTANT COAST SURVEY.

COAST SURVEY OFFICE, *August* 27, 1861.

SIR: Lieut. Comg. T. S. Phelps, U. S. N., Assistant Coast Survey, reports, "that in executing work in the vicinity of Nantucket shoals three small banks were found, with these positions and depths of water on them, as follows, viz:

"Latitude 40° 55′ 15″ N., longitude 69° 36′ 45″ E., 11 fathoms.

"Latitude 40° 54′ 20″ N., longitude 69° 28′ 45″ E., 10 fathoms.

"Latitude 40° 55′ 12″ N., longitude 69° 19′ 30″ E., 16 fathoms.

"These banks were marked by rips.

"Phelps's bank appears to extend between three and four miles to the northward and eastward of the northern limits given in my work of last October, with fifteen and seventeen fathoms on it, and with much deeper water on either side. This northern extremity was not marked by a rip."

I would respectfully request authority to publish this letter for the benefit of mariners.

Respectfully yours,

A. D. BACHE, *Superintendent.*

Hon. S. P. CHASE, *Secretary of the Treasury.*

APPENDIX No. 8.

LETTER TO THE SECRETARY OF THE TREASURY, COMMUNICATING THE RESULT OF EXAMINATION MADE BY LIEUT. COMG. T. S. PHELPS, U. S. N., FOR A SHOAL REPORTED AS EXISTING IN THE TRACK OF VESSELS OFF THE COAST OF VIRGINIA.

COAST SURVEY OFFICE, *August* 6, 1861.

SIR: I have the honor to report that on the 15th of June I received, through the courtesy of Lieut. J. M. Gilliss, U. S. N., Superintendent of the National Observatory, a notice, communicated by the first officer of the American ship "Simoom," relative to the supposed discovery of a rock or shoal off the coast of Virginia. The position given by the log of the Simoom, which struck three times when within sight of Cape Henry, is seventeen to nineteen miles south of Cape Henry, and seven to eight miles off shore. The particulars are stated as follows: "The shoal or lump has 24 feet on it, as she struck aft between the seas, it being nearly high water, the sea moderate. Threw the lead as soon as possible; no bottom at 12 fathoms. It cannot be more than 150 feet across, as we cleared it in three seas. We named it the 'Simoom' shoal. Our pilot said that some years since a ship loaded with guano struck somewhere near

the place and sunk, but as no shoal could be found, concluded it was false. Captain Smith says he has since learned that it occurred within the last six months."

Lieut. Comg. Phelps, in the Coast Survey steamer Vixen, was requested to examine the ground in question, and reported the result on the 27th of July. The following are extracts from his report: "I have thoroughly explored the vicinity of the supposed Simoom shoal, on the coast of Virginia, and am perfectly satisfied that no such shoal exists in that locality." * * * * * * * *

"An area of twelve miles north and south by six miles east and west was carefully examined, and the least water found beyond three miles from the shore was seven fathoms. If the Simoom was over three miles from shore when she struck, my belief is that she touched on a sunken vessel."

I would respectfully request authority to publish the substance of this communication as a notice to mariners.

Very respectfully yours,

A. D. BACHE, *Superintendent.*

Hon. S. P. CHASE, *Secretary of the Treasury.*

APPENDIX No. 9.

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. and G. W. Blunt, New York, and revised May, 1861.]

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 tides, it is a less convenient and less accurate quantity for the use of the navigation 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 connexion.

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 $\frac{69}{100}$ (or 14.69 feet) above mean low water.†

New York.—The lower edge of a straight line cut in a stone wall, at the head of a wooden wharf on Governor's island, is thirteen feet $\frac{97}{100}$ (or 13.97 feet) above mean low water. The letters U. S. C. S. are cut in the same stone.

Old Point Comfort, Va.—A line cut in the wall of the light-house, one foot from the ground, on the southwest side, is eleven feet (11 feet) above mean low water.

Charleston, S. C.—The outer and lower edge of embrasure of gun No. 3, at Castle Pinckney, is ten feet $\frac{13}{100}$ (10.13 feet) above mean low water.

* This term was introduced by the Rev. Dr. Whewell, who has done so much for the investigation of the laws of the tides.

† In consequence of alterations made to the wall during the year 1860, the coping is seven hundredths of a foot lower than formerly.

TABLE I.

Tide table for the coast of the United States.

PORT.	STATE.	INTERVAL BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION OF—		
		Mean interval.	Diff. between greatest and least interval.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
COAST FROM PORTLAND TO NEW YORK.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*h. m.*
Hanniwell's Point, Kennebec river	Maine	11 15	1 14	8.1	9.3	7.0	6 16	6 11	0 22
Portland	do	11 25	0 44	8.9	9.9	7.6	6 14	6 12	20
Portsmouth	New Hampshire	11 23	53	8.6	9.9	7.2	6 22	6 7	21
Newburyport	Massachusetts	11 22	50	7.8	9.1	6 6	5 16	7 9	24
Rockport	do	10 57	42	8.6	10.2	7.1	6 17	6 9	30
Salem	do	11 13	50	9.2	10.6	7.6	6 19	6 6	6
Boston Light	do	11 12	35	9.3	10.9	8.1	6 20	6 6	15
Boston	do	11 27	43	10.0	11.3	8.5	6 13	6 13	9
Plymouth	do	11 19	51	10.2	11.4	9.0	6 13	6 17	29
Wellfleet	do	11 5	1 13	11.2	13.2	9.2	6 6	6 17	15
Provincetown*	do	11 22	40	9.2	10.8	7.7	6 16	6 10	21
Monomoy	do	11 58	37	3.8	5.3	2.6	6 25	5 59	36
Nantucket	do	12 24	37	3.1	3.6	2.6	6 23	5 44	9
Hyannis	do	12 22	30	3.2	3.9	1.8	6 44	5 41	9
Edgartown	do	12 16	34	2.0	2.5	1.6	6 51	5 29	24
Holmes's Hole	do	11 43	31	1.7	1.8	1.3	6 41	5 21	12
Tarpaulin Cove	do	8 4	49	2.3	2.8	1.8	6 9	6 17	34
Wood's Hole, north side	do	7 59	53	4.0	4.7	3.1	6 51	5 31	38
Wood's Hole, south side	do	8 34	45	1.6	2.0	1.2	5 17	7 10	59
Menemsha Bight	do	7 45	1 0	2.7	3.9	1.8	6 14	6 14	4
Quick's Hole, north side	do	7 31	1 15	3.7	4.3	2.9	6 31	5 54	39
Quick's Hole, south side	do	7 36	1 10	3.1	3.8	2.3	6 29	5 55	40
Cuttyhunk	do	7 40	49	3.5	4.2	2.9	6 31	5 54	39
Kettle Cove	do	7 48	1 0	4.3	5.0	3.7	6 17	6 4	29
Bird Island light	do	7 59	45	4.4	5.3	3.5	6 51	5 58	.....
New Bedford entrance, (Dumpling Rock)	do	7 57	41	3.8	4 6	2.8	6 50	5 33	42
Newport	Rhode Island	7 45	24	3.9	4.6	3.1	6 21	6 3	23
Point Judith	do	7 32	46	3.1	3.7	2.6	6 12	6 10	1 0
Block Island	do	7 36	41	2.8	3.5	2.0	6 23	6 2	5
Montauk Point, L. I.	New York	8 20	1 11	1.9	2.4	1.8	6 17	6 7	31
Sandy Hook	do	7 29	47	4.8	5.6	4.0	6 10	6 15	21
New York	do	8 13	43	4.3	5.4	3.4	6 0	6 25	28
HUDSON RIVER.									
Dobb's Ferry	New York	9 19	44	3.6	4.4	2.7	6 5	6 18	17
Tarrytown	do	9 57	58	3.5	4.0	2.7	6 6	6 20	43
Verplanck's Point	do	10 8	34	3.1	3 8	2.5	5 25	7 12	16
West Point	do	11 2	37	2.7	3.2	2.0	5 28	7 10	20
Poughkeepsie	do	12 34	54	3.2	3.9	2.4	5 41	6 44	22
Tivoli	do	1 24	51	4.0	4.6	3.2	5 40	6 54	25
Stuyvesant	do	3 23	48	3.8	4.4	3.0	5 18	7 2	31
Castleton	do	4 29	55	2.7	3.0	2.3	5 1	7 23	20
Greenbush	do	5 22	40	2.3	2.5	1.9	4 26	7 59	.....
LONG ISLAND SOUND.									
Watch Hill	Rhode Island	9 0	23	2.7	3.1	2.4	6 35	5 56	14
Stonington	Connecticut	9 7	30	2.7	3.2	2.2	6 15	6 10	25
Little Gull island	New York	9 38	1 7	2.5	2.9	2.3	6 1	6 21	37
New London	Connecticut	9 28	52	2.6	3.1	2.1	5 56	6 26	22
New Haven	do	11 16	1 8	5.9	6.2	5.2	6 24	6 5	33
Bridgeport	do	11 11	1 3	6.5	8.0	4.7	6 1	6 7	30

* From Major J. D. Graham's observations.

TABLE I—Continued.

PORT.	STATE.	INTERVAL BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION OF—		
		Mean interval.	Diff. between greatest and least interval.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
LONG ISLAND SOUND—Continued.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*h. m.*
Oyster Bay, L. I.	New York	11 7	0 51	7.3	9.2	5.4	6 8	6 24	0 25
Sand's Point, L. I.	do	11 13	31	7.7	8.9	6.4	5 55	6 30	14
New Rochelle	do	11 22	32	7.6	8.6	6.6	5 51	6 35	12
Throg's Neck	do	11 20	39	7.3	9.2	6.1	5 50	6 33	43
COAST OF NEW JERSEY.									
Cold Spring inlet	New Jersey	7 32	51	4.4	5.4	3.6	6 8	6 18	19
Cape May Landing	do	8 19	47	4.8	6.0	4.3	6 11	6 15	20
DELAWARE BAY AND RIVER.									
Delaware breakwater	Delaware	8 0	50	3.5	4.5	3.0	6 15	6 6	26
Higbee's, Cape May	New Jersey	8 33	43	4.9	6.2	3.9	6 26	6 0	19
Egg Island light	do	9 4	51	6.0	7.0	5.1	5 52	6 27	36
Mahon's river	Delaware	9 52	48	5.9	6.9	5.0	6 11	6 11	26
Newcastle	do	11 53	24	6.5	6.9	6.0	5 6	6 43	47
Philadelphia	Pennsylvania	13 44	44	6.0	6.8	5.1	4 52	7 6	15
CHESAPEAKE BAY AND RIVERS.									
Old Point Comfort	Virginia	8 17	60	2.5	3.0	2.0	6 1	6 25	14
Point Lookout	Maryland	12 58	45	1.4	1.9	0.7	5 59	6 19	35
Annapolis	do	17 4	40	0.9	1.0	0.8	6 11	6 15	32
Bodkin light	do	18 8	48	1.0	1.3	0.8	5 23	7 8	15
Baltimore	do	18 59	44	1.3	1.5	0.9	5 54	6 33	44
Washington	Dist. of Columbia	20 10	52	3.0	3.4	2 6	5 37	6 49	.....
James river, (City Point)	Virginia	14 37	1 0	2.8	3.0	2.5	5 14	6 58	32
Richmond	do	16 54	1 6	2.9	3.4	2.3	4 53	7 31	35
Tappahannock	do	13 8	46	1.6	1.9	1.3	5 21	7 6	.....
COAST OF NORTH AND SOUTH CAROLINA, GEORGIA, AND FLORIDA.									
Hatteras inlet	North Carolina	7 4	57	2.0	2.2	1.8	6 7	6 7	50
Beaufort	do	7 26	50	2.8	3.3	2.2	6 11	6 10	42
Bald Head	do	7 26	34	4.3	5.0	3.4	6 18	6 17	31
Smithville	do	7 19	38	4.5	5.5	3.8	6 1	6 26	26
Wilmington	do	9 6	1 0	2.7	3.1	2.2	4 45	7 40	30
Georgetown entrance	South Carolina	7 56	42	3.8	4.7	2.7	6 4	6 19	35
Bull's Island bay	do	7 16	57	4.8	5.7	3.7	6 20	6 6	30
Charleston, (custom-house wharf)	do	7 26	48	5.1	6.0	4.1	6 19	6 7	33
St. Helena sound	do	7 8	1 0	5.9	7.4	4.4	6 13	6 12	23
Fort Pulaski, (Savannah entrance)	Georgia	7 20	40	7.0	8.0	5.9	5 49	6 35	26
Savannah, (dry-dock wharf)	do	8 13	51	6.5	7.6	5.5	5 4	7 22	14
Doboy Light-house	do	7 33	55	6.6	7.8	5.4	6 2	6 20	.....
St. Simons	do	7 43	46	6.8	8.2	5.4	6 10	6 16	20
Fort Clinch	Florida	7 53	1 6	5.9	6.7	5.3	6 9	6 17	.....
St. John's river	do	7 28	48	4.5	5.5	3.7	5 58	6 28	16
St. Augustine	do	8 21	43	4.2	4.9	3.6	6 5	6 11	32
Cape Florida	do	8 34	51	1.5	1.8	1.2	6 0	6 26	45
Indian key	do	8 23	49	1.8	2.2	1.3	6 25	5 59	19
Sand key	do	8 40	.....	1.2	2.0	0.6	6 31	5 55	13
Key West	do	9 30	1 15	1.3	1.5	0.9	6 55	5 39	12
Tortugas	do	9 56	1 32	1.2	1.5	0.6	6 43	5 40	.....
Charlotte Harbor	do	13 9	1 38	1.1	1.3	0.8	6 51	5 35	.....
Tampa Bay, (Egmont key)	do	11 21	1 33	1.4	1.8	1.0	6 36	6 11	43
Cedar Keys, (Depot key)	do	13 15	1 55	2.6	3.2	1.6	6 12	6 13	.....
St. Mark's	do	13 38	2 0	2.2	2.9	1 4	6 12	6 11	.....

TABLE I—Continued.

PORT.	STATE.	INTERVAL BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION OF—		
		Mean interval.	Diff. between greatest and least interval.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
WESTERN COAST.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*h. m.*
San Diego	California	9 38	1 35	3.7	5.0	2.3	6 22	6 0	0 30
San Pedro	do	9 39	1 48	3.7	4.7	2.2	6 18	6 5	30
Cuyler's harbor	do	9 25	1 2	3.7	5.1	2.8	6 13	6 5	.....
San Luis Obispo	do	10 8	1 52	3.6	4.8	2.4	6 25	5 58	.....
Monterey	do	10 22	49	3.4	4.3	2.5	6 31	6 2	35
South Farallone	do	10 37	1 16	3.6	4.4	2.8	6 18	6 9	.....
San Francisco, (north beach)	do	12 6	1 4	3.6	4.3	2.8	6 39	5 51	34
Mare Island, (San Francisco bay)	do	13 40	1 15	4.8	5.2	4.1	6 13	6 7	.....
Benicia	do	14 10	1 0	4.5	5.1	3.7	6 26	5 59	.....
Ravenswood	do	12 36	57	6.3	7.3	4.9	6 15	6 11	.....
Bodega	do	11 17	1 54	3.6	4.7	2 7	6 19	5 59	.....
Humboldt bay	do	12 2	1 11	4.4	5.5	3.5	6 19	6 0	.....
Port Orford	Oregon Territory	11 26	1 6	5.1	6.8	3.7	6 19	6 7	39
Astoria	do	12 42	1 13	6.1	7.4	4 6	6 3	6 28	33
Nee-ah harbor	Washington Ter'y	12 33	1 28	5.6	7.4	4.8	6 20	6 6	.....
Port Townshend*	do	3 49	1 3	4.6	5.5	4.0	6 34	5 52	.....
Steilacoom*	do	4 46	1 6	9.2	11.1	7.2	6 3	6 25	28
Semi-ah-moo bay*	do	4 50	1 2	5.7	6.6	4.8	6 11	6 19	26

* See remarks on page 22 and following.

Note.—The mean interval in column 3 has been increased by 12*h.* 26*m.*, (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 12*h.* 26*m.* 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. Thus :

Example I.—It is required to find the time of high water at New York on November 5, 1854. The American Almanac gives 0*h.* 0*m.* as the time of transit of the moon on that day. The mean interval for New York, from Table I, column 3, is 8*h.* 13*m.*, which, as the transit was at 0*h.*, is, roughly, the time of high water. The moon being full, the height is that of spring tides of column 6, 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 5*h.* 18*m.* a. m., and from Table I the mean interval at Boston dry dock is 11*h.* 27*m.*

We have then 5*h*. 18*m*. time of transit.
To which add 11 27 mean interval from Table I.

16 45 time of high water, or 4*h*. 45*m*. p. m.

If the Greenwich Nautical Almanac is used, add 2*m*. to the time of transit of Greenwich for every hour of west longitude and its proportional part for less than an hour. It will suffice to take the half hour which may be over any number of hours, as the correction for less than this would be less than one minute, and need not be taken into account. Thus, Boston is 4*h*. 44*m*. west of Greenwich. The correction to be applied to the time of transit of the moon is, for the four hours, eight minutes, and for the forty-four minutes, one minute. The time of transit on the date assumed in the preceding example is 17*h*. 9*m*. of the 22d, or 5*h*. 9*m*. a. m. of the 23d, to which add nine minutes; the correction just found gives 5*h*. 18*m*., as before ascertained from the American Almanac.

In using the United States Nautical Almanac, in the astronomical part of which the transits of the moon are given for the meridian of Washington, the corrections required may, in this first approximation for the Atlantic coast, be neglected. To find the time of the next following low water add, from Table I, the duration of ebb tide.

This gives 4*h*. 45*m*. p. m. time of high water.
6 13 duration of ebb tide from Table I.

10 58 p. m.

By subtracting the duration of flood tide we obtain the time of the preceding low water, 10*h*. 32*m*. a. m., recollecting that 4*h*. 45*m*. p. m. is the same as 16*h*. 45*m*. reckoned from midnight.

The height of this tide, corresponding to the transit of 5*h*., will bring it nearly to a neap tide, and the rise and fall obtained from column 7, Table I, is 8.5 feet. The next following high water may be had by adding to the time of low water the duration of flood from Table I. Thus:

10*h*. 58*m*. p. m. time of low water January 23.
6 13 duration of flood from Table I.

Sum 17 11 or 5*h*. 11*m*. on January 24.

Or, having found the time of high water, the time of the next following high water may be found by adding the duration of flood and ebb together, and their sum to the time of high water found, thus:

6*h*. 13*m*. duration of ebb tide, from Table I.
6 13 duration of flood.

Sum 12 26 duration of whole tide.
4 45 p. m., January 23, time of high water.

Sum 17 11 or 5*h*. 11*m*. a. m., January 24, time of the next succeeding high water.

Subtracting the same quantity will give the time of the preceding high water, thus:

4*h*. 45*m*. p. m., or 16*h*. 45*m*. from midnight, is the time of high water.
12 26 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 of ebb or flood will be found by subtracting half the duration of stand or slack water given by column 10, Table I, from the time of high or low water, and the time of the end of the stand of ebb or flood by adding the same. A nearer approximation to the times and heights of high water may be obtained by the use of Tables II and III.

TABLE II.

Interval between the time of moon's transit and the time of high water for different hours of transit, and for several different ports.

Time of moon's transit.	Boston, Mass.	New York, N. Y.	Philadelphia, Pa.	Old Pt. Comfort, Va.	Baltimore, Md.	Smithville, N. C.	Charleston, S. C.	Ft. Pulaski, Savannah, Ga.	Key West, Fla.	San Francisco, Cal.
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
0 0	11 38	8 20	1 31	8 33	6 47	7 26	7 38	7 30	9 33	12 5
0 30	11 33	8 18	1 28	8 27	6 42	7 21	7 33	7 25	9 26	11 59
1 0	11 28	8 15	1 25	8 21	6 37	7 16	7 27	7 19	9 19	11 53
1 30	11 24	8 10	1 21	8 15	6 31	7 13	7 21	7 15	9 13	11 47
2 0	11 20	8 6	1 18	8 9	6 26	7 9	7 16	7 11	9 6	11 41
2 30	11 16	8 0	1 14	8 4	6 21	7 6	7 12	7 8	9 1	11 36
3 0	11 13	7 55	1 11	8 0	6 17	7 4	7 8	7 6	8 57	11 33
3 30	11 10	7 52	1 8	7 56	6 13	7 3	7 5	7 5	8 53	11 33
4 0	11 7	7 52	1 6	7 52	6 11	7 2	7 2	7 4	8 53	11 38
4 30	11 6	7 52	1 3	7 49	6 10	7 3	7 2	7 3	8 56	11 46
5 0	11 6	7 53	1 0	7 48	6 10	7 4	7 3	7 4	9 2	11 55
5 30	11 9	7 56	0 59	7 50	6 13	7 6	7 7	7 6	9 10	12 3
6 0	11 13	7 59	0 59	7 53	6 19	7 9	7 12	7 8	9 22	12 11
6 30	11 19	8 5	1 1	8 0	6 25	7 13	7 19	7 12	9 33	12 16
7 0	11 25	8 11	1 7	8 7	6 32	7 17	7 24	7 16	9 49	12 23
7 30	11 32	8 17	1 15	8 15	6 39	7 23	7 32	7 22	10 0	12 29
8 0	11 38	8 23	1 23	8 24	6 44	7 28	7 38	7 28	10 6	12 34
8 30	11 43	8 27	1 29	8 33	6 49	7 33	7 45	7 34	10 7	12 37
9 0	11 47	8 32	1 34	8 40	6 52	7 37	7 48	7 39	10 6	12 36
9 30	11 48	8 34	1 39	8 45	6 54	7 39	7 50	7 42	10 3	12 34
10 0	11 49	8 35	1 42	8 48	6 53	7 40	7 50	7 43	9 59	12 30
10 30	11 48	8 34	1 43	8 48	6 52	7 40	7 47	7 41	9 56	12 24
11 0	11 47	8 31	1 41	8 46	6 50	7 36	7 44	7 37	9 48	12 17
11 30	11 43	8 25	1 37	8 40	6 48	7 30	7 41	7 34	9 40	12 9

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.

Time of moon's transit.	Boston, Mass.			New York, N. Y.			Philadelphia, Pa.			Old Point Comfort.			Baltimore, Md.			Time of moon's transit.
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	11.2	10.6	11.3	4.9	4.5	4.9	6.3	6.2	6.3	2.9	2.6	2.9	1.5	1.4	1.6	0
1	11.3	10.6	11.3	4.9	4 5	4.9	6.4	6 4	6.5	3.0	2.7	3.0	1.5	1.4	1.6	1
2	11.2	10.5	11.2	4.7	4.4	4.8	6.6	6.5	6.6	2.9	2.7	2.9	1.5	1.3	1.5	2
3	10 6	10.3	10.0	4.3	4.2	4.6	6.6	6 5	6.6	2.6	2.6	2.8	1.4	1.3	1.5	3
4	10.0	10.0	10.7	3.8	4.0	4.4	6.4	6.4	6.5	2.3	2.4	2.7	1.3	1.2	1.4	4
5	9.2	9.7	10.4	3.5	3.8	4.2	6.1	6.2	6.3	2.1	2.3	2.6	1.1	1.1	1.3	5
6	8.8	9.4	10.1	3.3	3.7	4.1	5.7	5.9	6.0	2.0	2.2	2.5	0.9	1.1	1.3	6
7	8.6	9.3	10.0	3 3	3.7	4.1	5.4	5.6	5.7	2.0	2.3	2.5	0.9	1.1	1.3	7
8	8.9	9.5	10.2	3.6	3.8	4.2	5.2	5.3	5.4	2.2	2.4	2.6	1.0	1.2	1.4	8
9	9.4	9.7	10.4	4.0	4.0	4.4	5 4	5.4	5.5	2 5	2.5	2.8	1.1	1.3	1.5	9
10	10.1	10.0	10.7	4.5	4.3	4.7	5.7	5.7	5.8	2.8	2.7	2.9	1.3	1.4	1.6	10
11	10 7	10.3	11.0	4.8	4.5	4.9	6.0	6.0	6.1	3.0	2.8	3.0	1.4	1.4	1.6	11

TABLE III—Continued.

Time of moon's transit.	Smithville, N. C.			Charleston, S. C.			Fort Pulaski, Savannah entrance.			Key West, Fla.			San Francisco, Cal.			Time of moon's transit.
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	5.2	4.8	5.1	6.0	5.5	6.0	7.8	7.4	7.8	1.5	1.4	1.5	4.5	4.0	4.4	0
1	5.1	4.8	5.1	5.9	5.5	5.9	7.9	7.4	7.9	1.5	1.4	1.5	3.9	3.7	4.1	1
2	5.0	4.7	5.0	5.7	5.4	5.8	7.6	7.3	7.7	1.5	1.4	1.5	3.7	3.6	4.1	2
3	4.6	4.5	4.8	5.3	5.2	5.6	7.1	7.0	7.5	1.4	1.3	1.4	3.5	3.5	4.0	3
4	4.3	4.4	4.7	4.7	4.9	5.4	6.5	6.7	7.2	1.2	1.2	1.3	3.1	3.3	3.8	4
5	4.0	4.3	4.6	4.4	4 8	5.2	6.1	6.5	7.0	1.0	1.1	1.2	2.8	3.1	3.6	5
6	3.8	4.2	4.5	4.2	4.6	5.1	5.8	6.4	6.8	0.9	1.0	1.1	2 7	3.1	3.6	6
7	3.8	4.1	4.4	4.3	4.7	5.1	6.0	6.5	6.9	0.9	1.1	1.2	3.0	3.3	3.7	7
8	4.0	4.2	4.5	4.5	4.8	5.3	6.4	6.7	7.1	1.0	1.2	1.3	3.4	3.5	3.9	8
9	4.3	4.3	4.6	5.0	5.0	5.5	6.9	6.9	7.4	1.2	1.3	1.4	3.8	3.6	4.1	9
10	4.7	4.6	4.9	5.5	5.3	5.8	7.4	7.0	7.6	1.4	1.4	1.5	4.0	3.8	4.2	10
11	5.0	4.7	5.0	5.9	5.5	5.9	7.8	7.2	7.8	1.5	1.4	1.5	4.2	3.8	4.3	11

In these the variations in the interval between the moon's transit and high water are shown for some of the principal ports contained in Table I. These variations of 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 $0h.$ of transit, midnight of the calendar day, or full of the moon, to $11\frac{1}{2}$ hours. The numbers for change of the moon correspond to those of $0h.$, and for 13 hours (or $1h.$ 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 $1h.\ 24m.$ astronomical reckoning, or $1h.\ 24m.$ p. m. calendar time. From Table II we have, under the heading of New York, for $1h.\ 30m.$ (the nearest number to $1h.\ 24m.$ in the table) $8h.\ 10m.$

Thus, to $1h.\ 24m.$, time of moon's transit,

Add 8 10 interval found in 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 1 and 2 hours, we find from Table III the rise and fall of tides on the 1st of October, 1856, between 4.9 and 4.7; the number to be added to soundings given for mean low water 4.5 feet, (column B,) and for low water spring tides (column C) 4.9 feet.

Having found the time of high water, that of low water may be obtained, nearly, by adding the duration of ebb from column 9, Table I. The time of the next preceding low water may be found by subtracting the duration of flood from column 8, Table I. The time of the next following high water may be found by adding the duration of both flood and ebb; and of the next preceding high water by subtracting the same duration of the whole tide.

Example IV.—To find the next high water following that of Example III.

The duration of flood, column 8, Table I, for New York, is $6h.\ 0m.$, 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 AND OF PART OF THE COAST OF FLORIDA.

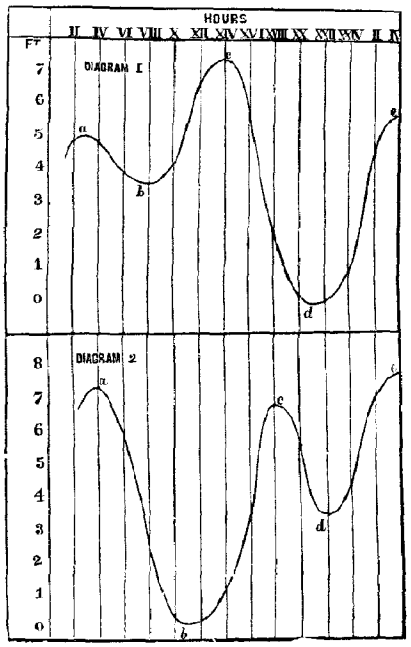
On the Pacific coast there are, as a general rule, one large and one small tide during the day, the height of the two successive high waters occurring one a. m. the other p. m. of the same twenty-four hours, and the intervals from the next preceding transit of the moon are very different. The inequalities 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. The tides of the southern part of Florida and of the western coast of that peninsula, as far as St. Mark's, are of the same character.

In Puget's 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 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 6.7 feet. Joining all the heights observed in the twenty-four hours, we have a curve like that marked in the figure. The two high waters are *a* and *c*, the two low waters *b* and *d*. If *a* is the high water which occurs about twelve hours after the transit of the moon, when the declination is south, the ebb *a b* is quite small, and the high water, *a*, is much lower than the next high water, *c*. If the moon's declination is north, it is the large high water, *a*, of the second diagram which occurs next after the transit, and about twelve hours from it. At Key West the contrary obtains, diagram 1 applying when the moon's declination is north, and diagram 2 when south. 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 the 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, Port Townshend, and Key West, Fla. 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 Tables 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 Farallone, 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 Farallone, and 49*m.* for Bodega; and add 34*m.* for Mare Island, 1*h.* 4*m.* for Benicia, and 30*m.* for Ravenswood. For Humboldt bay, Port Orford, and Neeah 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 Neeah harbor.

For Steilacoom and Semiahmoo bay, compute first the time for Port Townshend, and add to it 57*m.* for Steilacoom and 1*h.* for Semiahmoo. 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 Farallone, 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 Neeah harbor, the tables for Astoria may be used, subtracting 1.7 foot for Humboldt bay, and 1.0 foot for Port Orford. For Neeah harbor the tables will give approximate results without change.

For Semiahmoo bay, add one foot to the quantities in the tables for Port Townshend. For Steilacoom, a rough approximation may be obtained by adding 4.6 feet to them.

For the coast of Florida, compute the times of high or low water for Key West, and subtract 1*h.* 7*m.* for Indian key, and add 26*m.* for Tortugas and 1*h.* 51*m.* for Egmont key, 3*h.* 45*m.* for Cedar Keys, and 4*h.* 8*m.* for St. Mark's. For the heights, add half a foot for Indian key, and use the tables without change for Tortugas and Egmont key. For Cedar Keys and St. Mark's the results could not be obtained with much accuracy in this way; special tables will be prepared for those places.

TABLE IV.—KEY WEST.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m	h. m.	h. m.	h. m.	h. m.
0 00	9 40	9 30	9 18	9 07	9 01	8 49	8 44	8 40	8 40	8 46	8 54	9 06	9 16	9 27	9 37
0 30	9 33	9 23	9 11	9 00	8 54	8 42	8 37	8 33	8 33	8 39	8 47	8 59	9 09	9 20	9 30
1 00	9 26	9 16	9 04	8 53	8 47	8 35	8 30	8 26	8 26	8 32	8 40	8 52	9 02	8 13	9 23
1 30	9 20	9 10	8 58	8 47	8 41	8 29	8 24	8 20	8 20	8 26	8 34	8 46	8 56	9 07	9 17
2 00	9 13	9 03	8 51	8 40	8 34	8 22	8 17	8 13	8 13	8 19	8 27	8 39	8 49	9 00	9 10
2 30	9 08	8 58	8 46	8 35	8 29	8 17	8 12	8 08	8 08	8 14	8 22	8 34	8 44	8 55	9 05
3 00	9 04	8 54	8 42	8 31	8 25	8 13	8 08	8 04	8 04	8 10	8 18	8 30	8 40	8 51	9 01
3 30	9 00	8 50	8 38	8 27	8 21	8 09	8 04	8 00	8 00	8 06	8 14	8 26	8 36	8 47	8 57
4 00	9 00	8 50	8 38	8 27	8 21	8 09	8 04	8 00	8 00	8 06	8 14	8 26	8 36	8 47	8 57
4 30	9 03	8 53	8 41	8 30	8 24	8 12	8 07	8 03	8 03	8 09	8 17	8 29	8 39	8 50	9 00
5 00	9 09	8 59	8 47	8 36	8 30	8 18	8 13	8 09	8 09	9 15	8 23	8 35	8 45	8 56	9 06
5 30	9 17	9 07	8 55	8 44	8 38	8 26	8 21	8 17	8 17	8 23	8 31	8 43	8 53	9 04	9 14
6 00	9 29	9 19	9 07	8 56	8 50	8 38	8 33	8 29	8 29	8 35	8 43	8 55	9 05	9 16	9 26
6 30	9 40	9 30	9 18	9 07	9 01	8 49	8 44	8 40	8 40	8 46	8 54	9 06	9 16	9 27	9 37
7 00	9 56	9 46	9 34	9 23	9 17	9 05	9 00	8 56	8 56	9 02	9 10	9 22	9 32	9 43	9 53
7 30	10 07	9 57	9 45	9 34	9 28	9 16	9 11	9 07	9 07	9 13	9 21	9 33	9 43	9 54	10 04
8 00	10 13	10 03	9 51	9 40	9 34	9 22	9 17	9 13	9 13	9 19	9 27	9 39	9 49	10 00	10 00
8 30	10 14	10 04	9 52	9 41	9 35	9 23	9 18	9 14	9 14	9 20	9 28	9 40	9 50	10 01	10 11
9 00	10 13	10 03	9 51	9 40	9 34	9 22	9 17	9 13	9 13	9 19	9 27	9 39	9 49	10 00	10 10
9 30	10 10	10 00	9 48	9 37	9 31	9 19	9 14	9 10	9 10	9 16	9 24	9 36	9 46	9 57	10 07
10 00	10 06	9 56	9 44	9 33	9 27	9 15	9 10	9 06	9 06	9 12	9 20	9 32	9 42	9 53	10 03
10 30	10 03	9 53	9 41	9 30	9 24	9 12	9 07	9 03	9 03	9 09	9 17	9 29	9 39	9 50	10 00
11 00	9 55	9 45	9 33	9 22	9 16	9 04	8 59	8 55	8 55	9 01	9 09	9 21	9 31	9 42	9 52
11 30	9 47	9 37	9 25	9 14	9 08	8 56	8 51	8 47	8 47	8 53	9 01	9 13	9 23	9 34	9 44

TABLE V.—KEY WEST.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	9 29	9 36	9 43	9 53	10 06	10 16	10 22	10 22	10 22	10 18	10 06	9 56	9 43	9 34	9 27
0 30	9 22	9 29	9 36	9 46	9 59	10 09	10 15	10 15	10 15	10 11	9 59	9 49	9 36	9 27	9 20
1 0	9 15	9 22	9 29	9 39	9 52	10 02	10 08	10 08	10 08	10 04	9 52	9 42	9 29	9 20	9 13
1 30	9 09	9 16	9 23	9 33	9 46	9 56	10 02	10 02	10 02	9 58	9 46	9 36	9 23	9 14	9 07
2 0	9 02	9 09	9 16	9 26	9 39	9 49	9 55	9 55	9 55	9 51	9 39	9 29	9 16	9 07	9 00
2 30	8 57	9 04	9 11	9 21	9 34	9 44	9 50	9 50	9 50	9 46	9 34	9 24	9 11	9 02	8 55
3 0	8 53	9 00	9 07	9 17	9 30	9 40	9 46	9 46	9 46	9 42	9 30	9 20	9 07	8 58	8 51
3 30	8 49	8 56	9 03	9 13	9 26	9 36	9 42	9 42	9 42	9 38	9 26	9 16	9 03	8 54	8 47
4 0	8 49	8 56	9 03	9 13	9 26	9 36	9 42	9 42	9 42	9 38	9 26	9 16	9 03	8 54	8 47
4 30	8 52	8 59	9 06	9 16	9 29	9 39	9 45	9 45	9 45	9 41	9 39	9 29	9 06	8 57	8 50
5 0	8 58	9 05	9 12	9 22	9 35	9 45	9 51	9 51	9 51	9 47	9 35	9 25	9 12	9 03	8 56
5 30	9 06	9 13	9 20	9 30	9 43	9 53	9 59	9 59	9 59	9 55	9 43	9 33	9 20	9 11	9 04
6 0	9 18	9 25	9 32	9 42	9 55	10 05	10 11	10 11	10 11	10 07	9 55	9 45	9 32	9 23	9 16
6 30	9 29	9 36	9 43	9 53	10 06	10 16	10 22	10 22	10 22	10 18	10 06	9 56	9 43	9 34	9 27
7 0	9 45	9 52	9 59	10 09	10 22	10 32	10 38	10 38	10 38	10 34	10 22	10 12	9 59	9 50	9 43
7 30	9 56	10 03	10 10	10 20	10 33	10 43	10 49	10 49	10 49	10 45	10 33	10 23	10 10	10 01	9 54
8 0	10 02	10 09	10 16	10 26	10 39	10 49	10 55	10 55	10 55	10 51	10 39	10 29	10 16	10 07	10 00
8 30	10 03	10 10	10 17	10 27	10 40	10 50	10 56	10 56	10 56	10 52	10 40	10 30	10 17	10 08	10 01
9 0	10 02	10 09	10 16	10 26	10 39	10 49	10 55	10 55	10 55	10 51	10 39	10 29	10 16	10 07	10 00
9 30	9 59	10 06	10 13	10 23	10 36	10 46	10 52	10 52	10 52	10 48	10 36	10 26	10 13	10 04	9 5
10 0	9 55	10 02	10 09	10 19	10 32	10 42	10 48	10 48	10 48	10 44	10 32	10 22	10 09	10 00	9 53
10 30	9 52	9 59	10 06	10 16	10 29	10 39	10 45	10 45	10 45	10 41	10 29	10 19	10 06	9 57	9 50
11 0	9 44	9 51	9 58	10 08	10 21	10 31	10 37	10 37	10 37	10 33	10 21	10 11	9 58	9 49	9 42
11 30	9 36	9 43	9 50	10 00	10 13	10 23	10 29	10 29	10 29	10 25	10 13	10 03	9 50	9 41	9 34

TABLE IV.—SAN DIEGO.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
0 0	9 25	9 40	9 52	10 3	10 12	10 20	10 25	10 29	10 29	10 25	10 19	10 10	10 0	9 47	9 30
0 30	9 15	9 30	9 42	9 53	10 2	10 10	10 15	10 19	10 19	10 15	10 9	10 0	9 50	9 27	9 20
1 0	9 8	9 23	9 35	9 46	9 55	10 3	10 8	10 12	10 12	10 8	10 2	9 53	9 43	9 30	9 13
1 30	9 1	9 16	9 28	9 39	9 48	9 56	10 1	10 5	10 5	10 1	9 55	9 46	9 36	9 23	9 6
2 0	8 54	9 9	9 21	9 32	9 41	9 49	9 54	9 58	9 58	9 54	9 48	9 39	9 29	9 16	8 59
2 30	8 49	9 4	9 16	9 27	9 36	9 44	9 49	9 53	9 53	9 49	9 43	9 34	9 24	9 11	8 54
3 0	8 48	9 3	9 15	9 26	9 35	9 43	9 48	9 52	9 52	9 48	9 42	9 33	9 23	9 10	8 53
3 30	8 48	9 3	9 15	9 26	9 35	9 43	9 48	9 52	9 52	9 48	9 42	9 33	9 23	9 10	8 53
4 0	8 52	9 7	9 19	9 30	9 39	9 47	9 52	9 56	9 56	9 52	9 46	9 37	9 27	9 14	8 57
4 30	8 56	9 11	9 23	9 34	9 43	9 51	9 56	10 0	10 0	9 56	9 50	9 41	9 31	9 18	9 1
5 0	9 15	9 30	9 42	9 53	10 2	10 10	10 15	10 19	10 19	10 15	10 9	10 0	9 50	9 37	9 20
5 30	9 37	9 52	10 4	10 15	10 24	10 32	10 37	10 41	10 41	10 37	10 31	10 22	10 12	9 59	9 42
6 0	9 55	10 10	10 22	10 33	10 42	10 50	10 55	10 59	10 59	10 55	10 49	10 40	10 30	10 17	10 0
6 30	10 12	10 27	10 39	10 50	10 59	11 7	11 12	10 16	10 16	11 12	11 6	10 57	10 47	10 34	10 17
7 0	10 18	10 33	10 45	10 56	11 5	11 13	11 18	11 22	11 22	11 18	11 12	11 3	10 53	10 40	10 23
7 30	10 20	10 35	10 47	10 58	11 7	11 15	11 20	11 24	11 24	11 20	11 14	11 5	10 55	10 42	10 25
8 0	10 22	10 37	10 49	11 0	11 9	11 17	11 22	11 26	11 26	11 22	11 16	11 7	10 57	10 44	10 27
8 30	10 24	10 39	10 51	11 2	11 11	11 19	11 24	11 28	11 28	11 24	11 18	11 9	10 59	10 46	10 29
9 0	10 18	10 33	10 45	10 56	11 5	11 13	11 18	11 22	11 22	11 18	11 12	11 3	10 53	10 40	10 23
9 30	10 10	10 25	10 37	10 48	10 57	11 5	11 10	11 14	11 14	11 10	11 4	10 55	10 45	10 32	10 15
10 0	10 0	10 15	10 27	10 38	10 47	10 55	11 0	11 4	11 4	11 0	10 54	10 45	10 35	10 22	10 5
10 30	9 53	10 8	10 20	10 31	10 40	10 48	10 53	10 57	10 57	10 53	10 47	10 38	10 28	10 15	9 58
11 0	9 45	10 0	10 12	10 23	10 32	10 40	10 45	10 49	10 49	10 45	10 39	10 30	10 20	10 7	9 50
11 30	9 36	9 51	10 3	10 14	10 23	10 31	10 36	10 40	10 40	10 36	10 30	10 21	10 11	9 58	9 41

TABLE V.—SAN DIEGO.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m*	*h. m.*
0 0	9 30	9 16	9 4	8 53	8 44	8 36	8 31	8 27	8 27	8 31	8 37	8 46	8 56	9 9	9 26
0 30	9 21	9 6	8 54	8 43	8 34	8 26	8 21	8 17	8 17	8 21	8 27	8 36	8 46	8 59	9 16
1 0	9 14	8 59	8 47	8 36	8 27	8 19	8 14	8 10	8 10	8 14	8 20	8 29	8 39	8 52	9 9
1 30	9 7	8 52	8 40	8 29	8 20	8 12	8 7	8 3	8 3	8 7	8 13	8 22	8 32	8 45	9 2
2 0	9 0	8 45	8 33	8 22	8 13	8 5	8 0	7 56	7 56	8 0	8 6	8 15	8 25	8 38	8 55
2 30	8 55	8 40	8 28	8 17	8 8	8 0	7 55	7 51	7 51	7 55	8 1	8 10	8 20	8 33	8 50
3 0	8 54	8 39	8 27	8 16	8 7	7 59	7 54	7 50	7 59	7 54	8 0	8 9	8 19	8 32	8 49
3 30	8 54	8 39	8 27	8 16	8 7	7 59	7 54	7 50	7 50	7 54	8 0	8 9	8 19	8 32	8 49
4 0	8 58	8 43	8 31	8 20	8 11	8 3	7 58	7 54	7 54	7 58	8 4	8 13	8 23	8 36	8 53
4 30	9 2	8 47	8 35	8 24	8 15	8 7	8 2	7 58	7 58	8 2	8 8	8 17	8 27	8 40	8 57
5 0	9 21	9 6	8 54	8 43	8 34	8 26	8 21	8 17	8 17	8 21	8 27	8 36	8 46	8 59	9 16
5 30	9 43	9 28	9 16	9 5	8 56	8 48	8 43	8 39	8 39	8 43	8 49	8 58	9 8	9 21	9 38
6 0	10 1	9 46	9 34	9 23	9 14	9 6	9 1	8 57	8 57	9 1	9 7	9 16	9 26	9 39	9 56
6 30	10 18	10 3	9 51	9 40	9 31	9 23	9 18	9 14	9 14	9 18	9 24	9 33	9 43	9 56	10 13
7 0	10 24	10 9	9 57	9 46	9 37	9 29	9 24	9 20	9 20	9 24	9 30	9 39	9 49	10 2	10 19
7 30	10 26	10 11	9 59	9 48	9 39	9 31	9 26	9 22	9 22	9 26	9 32	9 41	9 51	10 4	10 21
8 0	10 28	10 13	10 1	9 50	9 41	9 33	9 28	9 24	9 24	9 28	9 34	9 43	9 53	10 6	10 23
8 30	10 30	10 15	10 3	9 52	9 43	9 35	9 30	9 26	9 26	9 30	9 36	9 45	9 55	10 8	10 25
9 0	10 24	10 9	9 57	9 46	9 37	9 29	9 24	9 20	9 20	9 24	9 30	9 39	9 49	10 2	10 19
9 30	10 16	10 1	9 49	9 38	9 29	9 21	9 16	9 12	9 12	9 16	9 22	9 31	9 41	9 54	10 11
10 0	10 6	9 51	9 39	9 28	9 19	9 11	9 6	9 2	9 2	9 6	9 12	9 21	9 31	9 44	10 1
10 30	9 59	9 44	9 32	9 21	9 12	9 4	8 59	8 55	8 55	8 59	9 5	9 14	9 24	9 37	9 54
11 0	9 51	9 36	9 24	9 13	9 4	8 56	8 51	8 47	8 47	8 51	8 57	9 6	9 16	9 29	9 46
11 30	9 42	9 27	9 15	9 4	8 55	8 47	8 42	8 38	8 38	8 42	8 48	8 57	9 7	9 20	9 37

TABLE IV.—SAN FRANCISCO.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	11 43	11 59	12 15	12 33	12 50	13 03	13 17	13 20	13 19	13 14	13 07	12 57	12 45	12 32	12 18
0 30	11 37	11 53	12 09	12 27	12 44	12 57	13 11	13 14	13 13	13 08	13 01	12 51	12 39	12 26	12 12
1 0	11 31	11 47	12 03	12 21	12 38	12 51	13 05	13 08	13 07	13 02	12 55	12 45	12 33	12 20	12 06
1 30	11 25	11 41	11 57	12 15	12 32	12 45	12 59	13 02	13 01	12 56	12 49	12 39	12 27	12 14	12 00
2 0	11 19	11 35	11 51	12 09	12 26	12 39	12 53	12 56	12 55	12 50	12 43	12 33	12 21	12 08	11 54
2 30	11 14	11 30	11 46	12 04	12 21	12 34	12 48	12 51	12 50	12 45	12 38	12 28	12 16	12 03	11 49
3 0	11 11	11 27	11 43	12 01	12 18	12 31	12 45	12 48	12 47	12 42	12 35	12 25	12 13	12 00	11 46
3 30	11 11	11 27	11 43	12 01	12 18	12 31	12 45	12 48	12 47	12 42	12 35	12 25	12 13	12 00	11 46
4 0	11 16	11 32	11 48	12 06	12 23	12 36	12 50	12 53	12 52	12 47	12 40	12 30	12 18	12 05	11 51
4 30	11 24	11 40	11 56	12 14	12 31	12 44	12 58	13 01	13 00	12 55	12 48	12 38	12 26	12 13	11 59
5 0	11 33	11 49	12 05	12 23	12 40	12 53	13 07	13 10	13 09	13 04	12 57	12 47	12 35	12 22	12 08
5 30	11 41	11 57	12 13	12 31	12 48	13 01	13 15	13 18	13 17	13 12	13 05	12 55	12 43	12 30	12 16
6 0	11 49	12 05	12 21	12 39	12 56	13 09	13 23	13 26	13 25	13 20	13 13	13 03	12 51	12 38	12 24
6 30	11 54	12 10	12 26	12 44	13 01	13 14	13 28	13 31	13 30	13 25	13 18	13 08	12 56	12 43	12 29
7 0	12 01	12 17	12 33	12 51	13 08	13 21	13 35	13 38	13 37	13 32	13 25	13 15	13 03	12 50	12 36
7 30	12 07	12 23	12 39	12 57	13 14	13 27	13 41	13 44	13 43	13 38	13 31	13 21	13 09	12 56	12 42
8 0	12 12	12 28	12 44	13 02	13 19	13 32	13 46	13 49	13 48	13 43	13 36	13 26	13 14	13 01	12 47
8 30	12 15	12 31	12 47	13 05	13 22	13 35	13 49	13 52	13 51	13 46	13 39	13 29	13 17	13 04	12 50
9 0	12 14	12 30	12 46	13 04	13 21	13 34	13 48	13 57	13 50	13 45	13 38	13 28	13 16	13 03	12 49
9 30	12 12	12 28	12 44	13 02	13 19	13 32	13 46	13 49	13 48	13 43	13 36	13 26	13 14	13 01	12 47
10 0	12 08	12 24	12 40	12 58	13 15	13 28	13 42	13 45	13 44	13 39	13 32	13 22	13 10	12 57	12 43
10 30	12 02	12 18	12 34	12 52	13 09	13 22	13 36	13 39	13 38	13 33	13 26	13 16	13 04	12 51	12 37
11 0	11 55	12 11	12 27	12 45	13 02	13 15	13 29	13 32	13 31	13 26	13 19	13 09	12 57	12 44	12 30
11 30	11 47	12 03	12 19	12 37	12 54	13 07	13 21	13 24	13 23	13 18	13 11	13 01	12 49	12 36	12 22

TABLE V.—SAN FRANCISCO.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	12 27	12 11	11 55	11 37	11 20	11 07	10 53	10 50	10 51	10 56	11 03	11 13	11 25	11 38	11 52
0 30	12 21	12 05	11 49	11 31	11 14	11 01	10 47	10 44	10 45	10 50	10 57	11 07	11 19	11 32	11 46
1 0	12 15	11 59	11 43	11 25	11 08	10 55	10 41	10 38	10 39	10 44	10 51	11 01	11 13	11 26	11 40
1 30	12 09	11 53	11 37	11 19	11 02	10 49	10 35	10 32	10 33	10 38	10 45	10 55	11 07	11 20	11 34
2 0	12 03	11 47	11 31	11 13	10 56	10 43	10 29	10 26	10 27	10 32	10 39	10 49	11 01	11 14	11 28
2 30	11 58	11 42	11 26	11 08	10 51	10 38	10 24	10 21	10 22	10 27	10 34	10 44	10 56	11 09	11 23
3 0	11 55	11 39	11 23	11 05	10 48	10 35	10 21	10 18	10 19	10 24	10 31	10 41	10 53	11 06	11 20
3 30	11 55	11 39	11 23	11 05	10 48	10 35	10 21	10 18	10 19	10 24	10 31	10 41	10 53	11 06	11 20
4 0	12 00	11 44	11 28	11 10	10 53	10 40	10 26	10 23	10 24	10 29	10 36	10 46	10 58	11 11	11 25
4 30	12 08	11 52	11 36	11 18	11 01	10 48	10 34	10 31	10 32	10 37	10 44	10 54	11 06	11 19	11 33
5 0	12 17	12 01	11 45	11 27	11 10	10 57	10 43	10 40	10 41	10 46	10 53	11 03	11 15	11 28	11 42
5 30	12 25	12 09	11 53	11 35	11 18	11 05	10 51	10 48	10 49	10 54	11 01	11 11	11 23	11 36	11 50
6 0	12 33	12 17	12 01	11 43	11 26	11 13	10 59	10 56	10 57	11 02	11 09	11 19	11 31	11 44	11 58
6 30	12 38	12 22	12 06	11 48	11 31	11 18	11 04	11 01	11 02	11 07	11 14	11 24	11 36	11 49	12 03
7 0	12 45	12 29	12 13	11 55	11 38	11 25	11 11	11 08	11 09	11 14	11 21	11 31	11 43	11 56	12 10
7 30	12 51	12 35	12 19	12 01	11 44	11 31	11 17	11 14	11 15	11 20	11 27	11 37	11 49	12 02	12 16
8 0	12 56	12 40	12 24	12 06	11 49	11 36	11 22	11 19	11 20	11 25	11 32	11 42	11 54	12 07	12 21
8 30	12 59	12 43	12 27	12 09	11 52	11 39	11 25	11 22	11 23	11 28	11 35	11 45	11 57	12 10	12 24
9 0	12 58	12 42	12 26	12 08	11 51	11 38	11 24	11 21	11 22	11 27	11 34	11 44	11 56	12 09	12 23
9 30	12 56	12 40	12 24	12 06	11 49	11 36	11 22	11 19	11 20	11 25	11 32	11 42	11 54	12 07	12 21
10 0	12 52	12 36	12 20	12 02	11 45	11 32	11 18	11 15	11 16	11 21	11 28	11 38	11 50	12 03	12 17
10 30	12 46	12 30	12 14	11 56	11 39	11 26	11 12	11 09	11 10	11 15	11 22	11 32	11 44	11 57	12 11
11 0	12 39	12 23	12 07	11 49	11 32	11 19	11 05	11 02	11 03	11 08	11 15	11 25	11 37	11 50	12 04
11 30	12 31	12 15	11 59	11 41	11 24	11 11	10 57	10 54	10 55	11 00	11 07	11 17	11 29	11 42	11 56

TABLE IV.—ASTORIA.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	12 42	12 55	13 5	13 18	13 28	13 38	13 41	13 45	13 46	13 44	13 40	13 34	13 24	13 14	13 2
0 30	12 36	12 49	12 59	13 12	13 22	13 32	13 35	13 39	13 40	13 38	13 34	13 28	13 18	13 8	12 56
1 0	12 29	12 42	12 52	13 5	13 15	13 25	13 28	13 32	13 33	13 31	13 27	13 21	13 11	13 1	12 49
1 30	12 23	12 36	12 46	12 59	13 9	13 19	13 22	13 26	13 27	13 25	13 21	13 15	13 5	12 55	12 43
2 0	12 15	12 28	12 38	12 51	13 1	13 11	13 14	13 18	13 19	13 17	13 13	13 7	12 57	12 47	12 35
2 30	12 9	12 22	12 32	12 45	12 55	13 5	13 8	13 12	13 13	13 11	13 7	13 1	12 51	12 41	12 29
3 0	12 3	12 16	12 26	12 39	12 49	12 59	13 2	13 6	13 7	13 5	13 1	12 55	12 45	12 35	12 23
3 30	11 58	12 11	12 21	12 34	12 44	12 54	12 57	13 1	13 2	13 0	12 56	12 50	12 40	12 30	12 18
4 0	11 57	12 10	12 20	12 33	12 43	12 53	12 56	13 0	13 1	12 59	12 55	12 49	12 39	12 29	12 17
4 30	12 0	12 13	12 23	12 36	12 46	12 56	12 59	13 3	13 4	13 2	12 58	12 52	12 42	12 32	12 20
5 0	12 8	12 21	12 31	12 44	12 54	13 4	13 7	13 11	13 12	13 10	13 6	13 0	12 50	12 40	12 28
5 30	12 15	12 28	12 38	12 51	13 1	13 11	13 14	13 18	13 19	13 17	13 13	13 7	12 57	12 47	12 35
6 0	12 25	12 38	12 48	13 1	13 11	13 21	13 24	13 28	13 29	13 27	13 23	13 17	13 7	12 57	12 45
6 30	12 36	12 49	12 59	13 12	13 22	13 32	13 35	13 39	13 40	13 38	13 34	13 28	13 18	13 8	12 56
7 0	12 45	12 58	13 8	13 21	13 31	13 41	13 44	13 48	13 49	13 47	13 43	13 37	13 27	13 17	13 5
7 30	12 55	13 8	13 18	13 31	13 41	13 51	13 54	13 58	13 59	13 57	13 53	13 47	13 37	13 27	13 15
8 0	13 3	13 16	13 26	13 39	13 49	13 59	14 2	14 6	14 7	14 5	14 1	13 55	13 45	13 35	13 23
8 30	13 8	13 21	13 31	13 44	13 54	14 4	14 7	14 11	14 12	14 10	14 6	14 0	13 50	13 40	13 28
9 0	13 10	13 23	13 33	13 46	13 56	14 6	14 9	14 13	14 14	14 12	14 8	14 2	13 52	13 42	13 30
9 30	13 9	13 22	13 32	13 45	13 55	14 5	14 8	14 12	14 13	14 11	14 7	14 1	13 51	13 41	13 29
10 0	13 5	13 18	13 28	13 41	13 51	14 1	14 4	14 8	14 9	14 7	14 3	13 57	13 47	13 37	13 25
10 30	12 59	13 12	13 22	13 35	13 45	13 55	13 58	14 2	14 3	14 1	13 57	13 51	13 41	13 31	13 19
11 0	12 53	13 6	13 16	13 29	13 39	13 49	13 52	13 56	13 57	13 55	13 51	13 45	13 35	13 25	13 13
11 30	12 46	12 59	13 9	13 22	13 32	13 42	13 45	13 49	13 50	13 48	13 44	13 38	13 28	13 18	13 6

TABLE V.—ASTORIA.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	h. m.	h. m	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	13 10	12 57	12 47	12 34	12 24	12 14	12 11	12 7	12 6	12 8	12 12	12 18	12 28	12 38	12 50
0 30	13 4	12 51	12 41	12 28	12 18	12 8	12 5	12 1	12 0	12 2	12 6	12 12	12 22	12 32	12 44
1 0	12 57	12 44	12 34	12 21	12 11	12 1	11 58	11 54	11 53	11 55	11 59	12 5	12 15	12 25	12 37
1 30	12 51	12 38	12 28	12 15	12 5	11 55	11 52	11 48	11 47	11 49	11 53	11 59	12 9	12 19	12 31
2 0	12 43	12 30	12 20	12 7	11 57	11 47	11 44	11 40	11 39	11 41	11 45	11 51	12 1	12 11	12 23
2 30	12 37	12 24	12 14	12 1	11 51	11 41	11 38	11 34	11 33	11 35	11 39	11 45	11 55	12 5	12 17
3 0	12 31	12 18	12 8	11 55	11 45	11 35	11 32	11 28	11 27	11 29	11 33	11 39	11 49	11 59	12 11
3 30	12 26	12 13	12 3	11 50	11 40	11 30	11 27	11 23	11 22	11 24	11 28	11 34	11 44	11 54	12 6
4 0	12 25	12 12	12 2	11 49	11 39	11 29	11 26	11 22	11 21	11 23	11 27	11 33	11 43	11 53	12 5
4 30	12 28	12 15	12 5	11 52	11 42	11 32	11 29	11 25	11 24	11 26	11 30	11 36	11 46	11 56	12 8
5 0	12 36	12 23	12 13	12 0	11 50	11 40	11 37	11 33	11 32	11 34	11 38	11 44	11 54	12 4	12 16
5 30	12 43	12 30	12 20	12 7	11 57	11 47	11 44	11 40	11 39	11 41	11 45	11 51	12 1	12 11	12 23
6 0	12 53	12 40	12 30	12 17	12 7	11 57	11 54	11 50	11 49	11 51	11 55	12 1	12 11	12 21	12 33
6 30	13 4	12 51	12 41	12 28	12 18	12 8	12 5	12 1	12 0	12 2	12 6	12 12	12 22	12 32	12 44
7 0	13 13	13 0	12 50	12 37	12 27	12 17	12 14	12 10	12 9	12 11	12 15	12 21	12 31	12 41	12 53
7 30	13 23	13 10	13 0	12 47	12 37	12 27	12 24	12 20	12 19	12 21	12 25	12 31	12 41	12 51	13 3
8 0	13 31	13 18	13 8	12 55	12 45	12 35	12 32	12 28	12 27	12 29	12 33	12 39	12 49	12 59	13 11
8 30	13 36	13 23	13 13	13 0	12 50	12 40	12 37	12 33	12 32	12 34	12 38	12 44	12 54	13 4	13 16
9 0	13 38	13 25	13 15	13 2	12 52	12 42	12 39	12 35	12 34	12 36	12 40	12 46	12 56	13 6	13 18
9 30	13 37	13 24	13 14	13 1	12 51	12 41	12 38	12 34	12 33	12 35	12 39	12 45	12 55	13 5	13 17
10 0	13 33	13 20	13 10	12 57	12 47	12 37	12 34	12 30	12 29	12 31	12 35	12 41	12 51	13 1	13 13
10 30	13 27	13 14	13 4	12 51	12 41	12 31	12 28	12 24	12 23	12 25	12 29	12 35	12 45	12 55	13 7
11 0	13 21	13 8	12 58	12 45	12 35	12 25	12 22	12 18	12 17	12 19	12 23	12 29	12 39	12 49	13 1
11 30	13 14	13 1	12 51	12 38	12 28	12 18	12 15	12 11	12 10	12 12	12 16	12 22	12 32	12 42	12 54

TABLE IV.—PORT TOWNSHEND.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	3 45	3 21	2 51	2 2	1 32	1 13	1 26	1 44	2 2	2 21	2 42	2 57	3 15	3 33	3 45
0 30	3 38	3 14	2 44	1 55	1 25	1 6	1 19	1 37	1 55	2 14	2 35	2 50	3 8	3 26	3 36
1 0	3 32	3 8	2 38	1 49	1 19	1 0	1 13	1 31	1 49	2 8	2 29	2 44	3 2	3 20	3 32
1 30	3 26	3 2	2 32	1 43	1 13	0 54	1 7	1 25	1 43	2 2	2 23	2 38	2 56	3 14	3 26
2 0	3 21	2 57	2 27	1 38	1 8	0 49	1 2	1 20	1 38	1 57	2 18	2 33	2 51	3 9	3 21
2 30	3 18	2 54	2 24	1 35	1 5	0 46	0 59	1 17	1 35	1 54	2 15	2 30	2 48	3 6	3 18
3 0	3 16	2 52	2 22	1 33	1 3	0 44	0 57	1 15	1 33	1 52	2 13	2 28	2 46	3 4	3 16
3 30	3 17	2 53	2 23	1 34	1 4	0 45	0 58	1 16	1 34	1 53	2 14	2 29	2 47	3 5	3 17
4 0	3 21	2 57	2 27	1 38	1 8	0 49	1 2	1 20	1 38	1 57	2 18	2 33	2 51	3 9	3 21
4 30	3 26	3 2	2 32	1 43	1 13	0 54	1 7	1 25	1 43	2 2	2 23	2 38	2 56	3 14	3 26
5 0	3 32	3 8	2 38	1 49	1 19	1 0	1 13	1 31	1 49	2 8	2 29	2 44	3 2	3 20	3 32
5 30	3 41	3 17	2 47	1 58	1 28	1 9	1 22	1 40	1 58	2 17	2 38	2 53	3 11	3 29	3 41
6 0	3 52	3 28	2 58	2 9	1 39	1 20	1 33	1 51	2 9	2 28	2 49	3 4	3 22	3 40	3 52
6 30	4 1	3 37	3 7	2 18	1 48	1 29	1 42	2 0	2 18	2 37	2 58	3 13	3 31	3 49	4 1
7 0	4 8	3 44	3 14	2 25	1 55	1 36	1 49	2 7	2 25	2 44	3 5	3 20	3 38	3 56	4 8
7 30	4 15	3 51	3 21	2 32	2 2	1 43	1 56	2 14	2 32	2 51	3 12	3 27	3 45	4 3	4 15
8 0	4 18	3 54	3 24	2 35	2 5	1 46	1 59	2 17	2 35	2 54	3 15	3 30	3 48	4 6	4 18
8 30	4 19	3 55	3 25	2 36	2 6	1 47	2 0	2 18	2 36	2 55	3 16	3 31	3 49	4 7	4 19
9 0	4 18	3 54	3 24	2 35	2 5	1 46	1 59	2 17	2 35	2 54	3 15	3 30	3 48	4 6	4 18
9 30	4 15	3 51	3 21	2 32	2 2	1 43	1 56	2 14	2 32	2 51	3 12	3 27	3 45	4 3	4 15
10 0	4 10	3 46	3 16	2 27	1 57	1 38	1 51	2 9	2 27	2 46	3 7	3 22	3 40	3 58	4 10
10 30	4 6	3 42	3 12	2 23	1 53	1 34	1 47	2 5	2 23	2 42	3 3	3 18	3 36	3 54	4 6
11 0	4 0	3 36	3 6	2 17	1 47	1 28	1 41	1 59	2 17	2 36	2 57	3 12	3 30	3 48	4 0
11 30	3 54	3 30	3 0	2 11	1 41	1 22	1 35	1 53	2 11	2 30	2 51	3 6	3 24	3 42	3 54

TABLE V.—PORT TOWNSHEND.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	3 45	4 9	4 39	5 28	5 58	6 17	6 4	5 46	5 28	5 9	4 48	4 33	4 15	3 57	3 45
0 30	3 38	4 2	4 32	5 21	5 51	6 10	5 57	5 39	5 21	5 2	4 41	4 26	4 8	3 50	3 38
1 0	3 32	3 56	4 26	5 15	5 45	6 4	5 51	5 33	5 15	4 56	4 35	4 20	4 2	3 44	3 32
1 30	3 26	3 50	4 20	5 9	5 39	5 58	5 45	5 27	5 9	4 50	4 29	4 14	3 56	3 38	3 26
2 0	3 21	3 45	4 15	5 4	5 34	5 53	5 40	5 22	5 4	4 45	4 24	4 9	3 51	3 33	3 21
2 30	3 18	3 42	4 12	5 1	5 31	5 50	5 37	5 19	5 1	4 42	4 21	4 6	3 48	3 30	3 18
3 0	3 16	3 40	4 10	4 59	5 29	5 48	5 35	5 17	4 59	4 40	4 19	4 4	3 46	3 28	3 16
3 30	3 17	3 41	4 11	5 0	5 30	5 49	5 36	5 18	5 0	4 41	4 20	4 5	3 47	3 29	3 17
4 0	3 21	3 45	4 15	5 4	5 34	5 53	5 40	5 22	5 4	4 45	4 24	4 9	3 51	3 33	3 21
4 30	3 26	3 50	4 20	5 9	5 39	6 58	5 45	5 27	5 9	4 50	4 29	4 14	3 56	3 38	3 26
5 0	3 32	3 56	4 26	5 15	5 45	6 4	5 51	5 33	5 15	4 56	4 35	4 20	4 2	3 44	3 32
5 30	3 41	4 5	4 35	5 24	5 54	6 13	6 0	5 42	5 24	5 5	4 44	4 29	4 11	3 53	3 41
6 0	3 52	4 16	4 46	5 35	6 5	6 24	6 11	5 53	5 35	5 16	4 55	4 40	4 22	4 4	3 52
6 30	4 1	4 25	4 55	5 44	6 14	6 33	6 20	6 2	5 44	5 25	5 4	4 49	4 31	4 13	4 1
7 0	4 8	4 32	5 2	5 51	6 21	6 40	6 27	6 9	5 51	5 32	5 11	4 56	4 38	4 20	4 8
7 30	4 15	4 39	5 9	5 58	6 28	6 47	6 34	6 16	5 58	5 39	5 18	5 3	4 45	4 27	4 15
8 0	4 18	4 42	5 12	6 1	6 31	6 50	6 37	6 19	6 1	5 42	5 21	5 6	4 48	4 30	4 18
8 30	4 19	4 43	5 13	6 2	6 32	6 51	6 38	6 20	6 2	5 43	5 22	5 7	4 49	4 31	4 19
9 0	4 18	4 42	5 12	6 1	6 31	6 50	6 37	6 19	6 1	5 42	5 21	5 6	4 48	4 30	4 18
9 30	4 15	4 39	5 9	5 58	6 28	6 47	6 34	6 16	5 58	5 39	5 18	5 3	4 45	4 27	4 15
10 0	4 10	4 34	5 4	5 53	6 23	6 42	6 29	6 11	5 53	5 34	5 13	4 58	4 40	4 22	4 10
10 30	4 6	4 30	5 0	5 49	6 19	6 38	6 25	6 7	5 49	5 30	5 9	4 54	4 36	4 18	4 6
11 0	4 0	4 24	4 54	5 43	6 13	6 32	6 19	6 1	5 43	5 24	5 3	4 48	4 30	4 12	4 0
11 30	3 54	4 18	4 48	5 37	6 7	6 26	6 13	5 55	5 37	5 18	4 57	4 42	4 24	4 6	3 54

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 of February, 1853.

1st. The time of the moon's transit at Greenwich, from the Nautical Almanac, is 11*h.* 41*m.*; the longitude of San Francisco 8*h.* 10*m.*, requiring a correction of 16*m.* to the time of transit for San Francisco, which is thus found to be 11*h.* 57*m.*

2d. The moon's declination is south, and at the time of transit about two days after the greatest. Entering Table IV, we find 12*h.* (or 0*h.*) of transit, the nearest number to 11*h.* 57*m.* which the table gives; and following the line horizontally, until we come to two days after the greatest declination, we find 13*h.* 14*m.*

To 11*h.* 57*m.*, time of transit of the moon, February 7, San Francisco, add 13*h.* 14*m.*, from column 0*h.*, transit, and two days after greatest declination; the sum, 25*h.* 11*m.*, or 1*h.* 11*m.*, February 8, is the time of high water, corresponding to the transit which we took of February 7. If we desire the tide of February 7 we must go back to the moon's transit of the 6th. The example was purposely assumed to show this case.

11*h.*	01*m.*,	time of transit February 6, 1853.
13	31	number for 11*h.* transit, and one day from greatest declination.
Sum 24	32	time of high water 0*h.* 32*m.* a. m. February 7.

The height of high water.—The height of high water is obtained in a similar manner by the use of 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.

TABLE VI.—KEY WEST.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After--						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	1.5	1.6	1.8	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.8	1.7	1.5
1	1.5	1.6	1.8	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.8	1.7	1.5
2	1.5	1.6	1.8	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.8	1.7	1.5
3	1 4	1.5	1.7	1 8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.7	1.6	1.4
4	1.3	1.4	1.6	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1 6	1.5	1.3
5	1.2	1.3	1.5	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.5	1.4	1.2
6	1.1	1.2	1.4	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1 3	1.1
7	1.1	1.2	1 4	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.3	1.1
8	1.2	1.3	1.5	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.5	1.4	1.2
9	1.3	1.4	1.6	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6	1.5	1.3
10	1.4	1 5	1.7	1.8	1.9	1.9	1 9	1.9	1.9	1.9	1.9	1.8	1.7	1.6	1.4
11	1.5	1.6	1.8	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.8	1.7	1.5

TABLE VII.—KEY WEST.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	1.7	1.6	1.4	1.3	1.2	1.1	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.6	1.8
1	1.7	1.6	1.4	1.3	1.2	1.1	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.6	1.8
2	1.7	1.6	1.4	1.3	1.2	1.1	1.0	1 0	1.1	1.1	1.2	1.3	1.4	1.6	1.8
3	1.6	1.5	1.3	1.2	1 1	1.0	0.9	0.9	1.0	1.0	1.1	1.2	1.3	1.5	1.7
4	1.5	1.4	1.2	1.1	1.0	0.9	0.8	0.8	0.9	0.9	1.0	1.1	1.2	1.4	1.6
5	1.4	1.3	1.1	1.0	0.9	0.8	0.7	0.7	0.8	0.8	0.9	1.0	1.1	1.3	1.5
6	1.3	1 2	1.0	0.9	0.8	0.7	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.2	1.4
7	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.2	1.4
8	1.4	1.3	1.1	1.0	0.9	0.8	0.7	0.7	0.8	0.8	0.9	1.0	1.1	1.3	1.5
9	1.5	1.4	1.2	1.1	1.0	0.9	0.8	0.8	0.9	0.9	1.0	1.1	1.2	1.4	1.6
10	1.6	1.5	1.3	1.2	1.1	1.0	0.9	0.9	1.0	1.0	1.1	1.2	1 3	1.5	1.7
11	1.7	1.6	1.4	1.3	1.2	1.1	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.6	1.8

TABLE VI.—SAN DIEGO.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	4.7	4.5	4.3	4.2	4.1	4.1	4.1	4.1	4.2	4.3	4.5	4.8	5.1	5.5	5.8
1	4.6	4.4	4.2	4.1	4.0	4.0	4 0	4.0	4.1	4.2	4.4	4.7	5.0	5.4	5.7
2	4.4	4 2	4.0	3.9	3.8	3.8	3.8	3.8	3.9	4.0	4.2	4.5	4.8	5.2	5.5
3	4.1	3.9	3.7	3.6	3.5	3.5	3.5	3.5	3.6	3.7	3.9	4.2	4.5	4.9	5.2
4	3.8	3.6	3.4	3.3	3 2	3.2	3.2	3.2	3.3	3.4	3.6	3.9	4.2	4.6	4.9
5	3.6	3.4	3.2	3.1	3.0	3.0	3.0	3.0	3.1	3.2	3.4	3.7	4.0	4.4	4.7
6	3.6	3.4	3.2	3.1	3.0	3.0	3.0	3 0	3.1	3.2	3.4	3.7	4.0	4.4	4.7
7	3.7	3.5	3.3	3.2	3.1	3.1	3.1	3.1	3.2	3.3	3.5	3.8	4.1	4.5	4.8
8	3 8	3.6	3 4	3.3	3.2	3.2	3.2	3.2	3.3	3.4	3.6	3.9	4.2	4.6	4.9
9	4.4	4.2	4.0	3.9	3.8	3.8	3.8	3.8	3.9	4.0	4.2	4.5	4.8	5.2	5.5
10	4.7	4.5	4.3	4.2	4.1	4.1	4.1	4.1	4.2	4.3	4.5	4.8	5.1	5.5	5.8
11	4.8	4.6	4.4	4.3	4.2	4.2	4.2	4.2	4.3	4.4	4.6	4.9	5.2	5.6	5.9

TABLE VII.—SAN DIEGO.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	5.7	5.9	6.1	6.2	6.3	6.3	6.3	6.3	6.2	6.1	5.9	5.6	5.3	4.9	4.6
1	5.6	5.8	6.0	6.1	6 2	6.2	6.2	6.2	6.1	6.0	5.8	5.5	5.2	4.8	4.5
2	5.4	5.6	5.8	5.9	6.0	6.0	6.0	6.0	5.9	5.8	5.6	5.3	5.0	4.6	4.3
3	5.1	5.3	5.5	5.6	5.7	5.7	5.7	5.7	5.6	5.5	5.3	5.0	4.7	4.3	4.0
4	4.8	5.0	5.2	5.3	5.4	5.4	5.4	5.4	5.3	5.2	5 0	4.7	4.4	4.0	3.7
5	4 6	4.8	5.0	5.1	5.2	5.2	5.2	5.2	5.1	5.0	4.8	4.5	4.2	3.8	3.5
6	4.6	4.8	5.0	5.1	5.2	5.2	5.2	5.2	5.1	5.0	4.8	4.5	4.2	3.8	3.5
7	4.7	4.9	5.1	5.2	5.3	5.3	5.3	5.3	5.2	5.1	4.9	4.6	4.3	3.9	3.6
8	4.8	5.0	5.2	5.3	5 4	5.4	5.4	5.4	5.3	5.2	5.0	4.7	4.4	4.0	3.7
9	5.4	5.6	5.8	5.9	6.0	6.0	6.0	6.0	5.9	5.8	5.6	5.3	5.0	4.6	4.3
10	5.7	5.9	6.1	6.2	6.3	6.3	6.3	6.3	6.2	6.1	5.9	5.6	5.3	4.9	4.6
11	5.8	6.0	6.2	6.3	6.4	6.4	6.4	6.4	6.3	6.2	6.0	5.7	5.4	5.0	4.7

TABLE VI.—SAN FRANCISCO.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet*	*Feet.*	*Feet.*	*Feet.*
0	4.8	4.7	4.5	4.3	4.3	4.2	4.3	4.3	4.4	4.5	4.7	4.8	5.0	5.3	5.5
1	4.7	4 6	4.4	4.2	4.2	4.1	4.2	4.2	4.3	4.4	4.6	4 7	4.9	5.2	5.4
2	4.6	4.5	4.3	4.1	4.1	4.0	4.1	4.1	4 2	4.3	4.5	4.6	4.8	5.1	5.3
3	4.5	4.4	4.2	4.0	4.0	3.9	4.0	4.0	4.1	4.2	4.4	4.5	4.7	5.0	5.2
4	4.3	4.2	4.0	3.8	3.8	3.7	3.8	3.8	3.9	4.0	4 2	4.3	4.5	4.8	5.0
5	4.1	4.0	3.8	3.6	3.6	3.5	3.6	3.6	3.7	3.8	4.0	4.1	4.3	4.6	4.8
6	4.1	4.0	3.8	3.6	3.6	3.5	3.6	3.6	3 7	3.8	4.0	4.1	4.3	4.6	4.8
7	4.2	4.1	3.9	3.7	3.7	3.6	3.7	3.7	3.8	3.9	4.1	4.2	4 4	4.7	4.9
8	4.4	4.3	4.1	3.9	3.9	3.8	3.9	3.9	4.0	4.1	4.3	4.4	4.6	4.9	5.1
9	4.5	4.4	4.2	4.0	4.0	3.9	4.0	4.0	4.1	4.2	4.4	4.5	4.7	5.0	5.2
10	4.7	4.6	4.4	4.2	4.2	4.1	4.2	4.2	4.3	4.4	4.6	4.7	4.9	5.2	5.4
11	4.8	4.7	4.5	4.3	4.3	4.2	4.3	4.3	4.4	4.5	4.7	4.8	5.0	5.3	5.5

TABLE VII.—SAN FRANCISCO.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	5.4	5.5	5.7	5.9	5.9	6.0	5.9	5.9	5.8	5.7	5.5	5.4	5.2	4.9	4.7
1	5.3	5.4	5.6	5.8	5.8	5.9	5.8	5.8	5.7	5.6	5.4	5.3	5.1	4.8	4.6
2	5.2	5.3	5.5	5.7	5.7	5.8	5.7	5.7	5.6	5.5	5.3	5.2	5.0	4.7	4.5
3	5.1	5.2	5.4	5.6	5.6	5.7	5.6	5.6	5.5	5.4	5.2	5.1	4.9	4.6	4.4
4	4.9	5.0	5.2	5.4	5.4	5.5	5.4	5.4	5 3	5.2	5.0	4.9	4.7	4.4	4.2
5	4.7	4.8	5.0	5.2	5.2	5.3	5.2	5.2	5.1	5.0	4.8	4.7	4.5	4.2	4.0
6	4.7	4.8	5.0	5.2	5.2	5.3	5.2	5.2	5.1	5.0	4.8	4.7	4.5	4.2	4.0
7	4.8	4.9	5.1	5.3	5.3	5.4	5.3	5 3	5.2	5.1	4.9	4.8	4.6	4.3	4.1
8	5.0	5.1	5.3	5.5	5.5	5.6	5.5	5.5	5.4	5.3	5.1	5.0	4.8	4.5	4.3
9	5.1	5.2	5.4	5.6	5.6	5.7	5.6	5.6	5.5	5.4	5.2	5.1	4.9	4.6	4.4
10	5.3	5.4	5.6	5.8	5.8	5 9	5.8	5.8	5.7	5.6	5.4	5.3	5.1	4.8	4.6
11	5.4	5.5	5.7	5.9	5.9	6.0	5.9	5.9	5.8	5.7	5.5	5.4	5.2	4.9	4.7

TABLE VI.—ASTORIA.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	8.0	8.3	8.4	8.5	8.6	8.6	8.6	8.6	8.5	8.4	8.3	8.1	7.7	7.4	7.0
1	8.0	8.2	8.4	8.5	8.6	8.6	8.6	8.6	8.5	8.4	8.2	8.1	7.7	7.4	7.0
2	7.8	8.1	8.2	8.4	8.4	8.4	8.4	8.4	8.3	8.2	8.1	7.9	7.5	7.2	6.8
3	7.5	7.8	7.9	8.1	8.1	8.1	8.1	8.1	8.0	7.9	7.8	7.6	7.2	6.9	6.5
4	7.1	7.4	7.5	7.7	7.7	7.7	7.7	7.7	7.6	7.5	7.4	7 2	6.8	6.5	6.1
5	6 7	7.0	7.2	7.3	7.3	7.3	7.3	7.3	7.2	7.1	7.0	6.8	6.5	6.1	5.7
6	6 5	6 8	7.0	7.1	7.1	7.1	7.1	7.1	7.0	6.9	6.8	6.6	6.3	5.9	5.5
7	6.7	7.0	7.1	7.2	7.3	7.3	7.3	7.3	7.2	7.1	7.0	6.8	6.4	6.1	5.7
8	7.0	7.3	7.5	7.6	7.6	7.6	7.6	7.6	7.5	7.4	7.3	7.1	6.8	6.4	6.0
9	7.5	7.8	8.0	8.1	8.1	8.1	8.1	8.1	8.0	7.9	7.8	7.8	7.3	6.9	6.5
10	7.9	8.2	8.4	8.5	8.5	8.5	8.5	8.5	8.4	8.3	8.2	8.0	7.7	7.3	6.9
11	8.1	8.4	8.6	8.7	8.7	8.7	8.7	8.7	8.6	8.5	8.4	8.2	7.9	7.5	7.1

TABLE VII.—ASTORIA.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	7.4	7.1	6.9	6.8	6.8	6.8	6.8	6.8	6.9	7.0	7.1	7.3	7.6	8.0	8.4
1	7.4	7.1	6.9	6.8	6.8	6.8	6.8	6.8	6.9	7.0	7.1	7.3	7.6	8.0	8.4
2	7.2	6.9	6.8	6 6	6 6	6.6	6.6	6.6	6.7	6.8	6.9	7.1	7 5	7.8	8.2
3	6.9	6.6	6.5	6.3	6.3	6.3	6 3	6.3	6.4	6.5	6.6	6.8	7.2	7.5	7.9
4	6.5	6.2	6 1	5.9	5.9	5 9	5.9	5.9	6.0	6.1	6.2	6.4	6.7	7.1	7.5
5	6.1	5.9	5.7	5.6	5.5	5.5	5.6	5.6	5.7	5.7	5.9	6.0	6.4	6.7	7.1
6	5.9	5.7	5.5	5.4	5.3	5.3	5.3	5.4	5.5	5.5	5.7	5.9	6.2	6.5	6.9
7	6.1	5.8	5.6	5.5	5.5	5.5	5 5	5.5	5.6	5.7	5.8	6.0	6.3	6.7	7.1
8	6.4	6.2	6.0	5.9	5.8	5.8	5.8	5.8	5.9	6.0	6.2	6.3	6.7	7.0	7.4
9	6.9	6.7	6.5	6.4	6.3	6.3	6 3	6.4	6.4	6.5	6.7	6.8	7.2	7.5	7.9
10	7.3	7.1	6.9	6 8	6.7	6.7	6.7	6.8	6.9	6.9	7.0	7.2	7.6	7.9	8.3
11	7.5	7.2	7.1	7.0	6.9	6.9	6.9	6.9	7.0	7.1	7.2	7.4	7.8	8.1	8.5

TABLE VI.—PORT TOWNSHEND.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	6.6	6.3	5.9	6.1	6.4	6.9	7.2	7.4	7.5	7.5	7.5	7.5	7.6	7.7	7.9
1	6.7	6 4	6.0	6.2	6.5	7.0	7.3	7.5	7.6	7.6	7.6	7.6	7.7	7 8	8.0
2	6.6	6 3	5.9	6.1	6.4	6.9	7.2	7.4	7.5	7.5	7.5	7.5	7.6	7.7	7.9
3	6.3	6.0	5.6	5.8	6.1	6.6	6.9	7.1	7.2	7.2	7.2	7.2	7.3	7.4	7 6
4	6 0	5.7	5.3	5 5	5.8	6.3	6.6	6.8	6.9	6 9	6.9	6.9	7.0	7.1	7.3
5	5.9	5.6	5.2	5.4	5.7	6.2	6.5	6.7	6.8	6.8	6.8	6.8	6.9	7.0	7.2
6	6.1	5.8	5.4	5.6	5.9	6.4	6.7	6.9	7.0	7.0	7.0	7.0	7.1	7.2	7.4
7	6.4	6.1	5.7	5.9	6.2	6.7	7.0	7.2	7.3	7.3	7.3	7.3	7.4	7.5	7.7
8	6.5	6 2	5.8	6.0	6.3	6.8	7 1	7.3	7.4	7.4	7.4	7.4	7.5	7.6	7.8
9	6.5	6.2	5.8	6.0	6.3	6 8	7.1	7.3	7.4	7.4	7.4	7.4	7.5	7.6	7.8
10	6.6	6.3	5.9	6.1	6.4	6 9	7.2	7.4	7.5	7 5	7.5	7.5	7.6	7 7	7.9
11	6.6	6.3	5.9	6.1	6.4	6.9	7.2	7.4	7.5	7.5	7.5	7.5	7.6	7.7	7.9

TABLE VII.—PORT TOWNSHEND.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	7.6	7.9	8 3	8.1	7.8	7.3	7.0	6 8	6.7	6.7	6.7	6.7	6.6	6.5	6.3
1	7 7	8.0	8.4	8.2	7.9	7.4	7.1	6.9	6.8	6.8	6.8	6.8	6.7	6.6	6.4
2	7.6	7.9	8.3	8.1	7.8	7.3	7.0	6.8	6.7	6.7	6 7	6.7	6.6	6.5	6.3
3	7.3	7 6	8.0	7.8	7.5	7.0	6.7	6.5	6 4	6.4	6 4	6.4	6.3	6.2	6.0
4	7.0	7.3	7.7	7.5	7.2	6.7	6 4	6.2	6.1	6.1	6.1	6.1	6.0	5.9	5.7
5	6.9	7.2	7.6	7.4	7.1	6.6	6.3	6.1	6.0	6.0	6.0	6.0	5.9	5.8	5.6
6	7.1	7.4	7.8	7.6	7.3	6.8	6.5	6.3	6 2	6.2	6.2	6.2	6.1	6.0	5.8
7	7.4	7.7	8.1	7.9	7.6	7.1	6 8	6.6	6.5	6.5	6.5	6 5	6.4	6 3	6.1
8	7.5	7.8	8 2	8.0	7.7	7.2	6.9	6.7	6.6	6.6	6.6	6.6	6.5	6.4	6.2
9	7.5	7.8	8.2	8.0	7.7	7 2	6.9	6.7	6.6	6.6	6.6	6.6	6.5	6.4	6.2
10	7.6	7.9	8.3	8.1	7.8	7.3	7.0	6.8	6.7	6.7	6.7	6.7	6.6	6.5	6.3
11	7.6	7.9	8.3	8.1	7.8	7.3	7.0	6.8	6.7	6.7	6.7	6.7	6.6	6.5	6.3

NOTE.—To use these tables with a chart on which the soundings are referred to mean low water, subtract 1 2 foot from the numbers in the tables from San Diego to Astoria, 1.7 foot for Nee-ah harbor, 2.3 for Port Townshend, and 2.7 for Semiahmoo and Steilacoom.

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*h.* 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 waters, or that 4.5 feet are to be added to the soundings of a chart reduced to the mean of the lowest low waters of each day. If the soundings of the chart are 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 high and low waters.

TABLE VIII.—KEY WEST.

Days from moon's greatest declination.		SOUTH DECLINATION.			NORTH DECLINATION.			Days from moon's greatest declination.	
		Low water. (Large.)	High water. (Small.)	Low water. (Small.)	Low water. (Small.)	High water. (Large.)	Low water. (Large.)		
		h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*		
Before.	7	5 22	12 10	17 38	5 36	12 33	17 46	7	Before.
	6	5 42	12 31	17 40	5 18	12 18	17 50	6	
	5	6 05	12 55	17 41	4 58	12 03	17 56	5	
	4	6 24	13 17	17 44	4 35	11 44	17 59	4	
	3	6 39	13 28	17 39	4 11	11 18	17 58	3	
	2	7 02	13 52	17 40	3 50	10 58	17 58	2	
	1	7 13	14 01	17 39	3 39	10 46	17 56	1	
	0	7 18	14 10	17 42	3 37	10 46	17 59	0	
After.	1	7 12	14 10	17 48	3 44	10 46	17 52	1	After.
	2	6 57	13 58	17 51	3 57	10 54	17 47	2	
	3	6 39	13 41	17 53	4 21	11 19	17 48	3	
	4	6 15	13 18	17 53	4 43	11 38	17 45	4	
	5	5 57	12 59	17 53	5 09	12 03	17 44	5	
	6	5 32	12 36	17 54	5 26	12 22	17 46	6	
	7	5 13	12 16	17 53	5 40	12 36	17 46	7	

TABLE VIII.—SAN DIEGO.

Days from moon's greatest declination.		SOUTH DECLINATION.			NORTH DECLINATION.			Days from moon's greatest declination.	
		Low water. (Small.)	High water. (Large.)	Low water. (Large.)	Low water. (Large.)	High water. (Small.)	Low water. (Small.)		
		h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*		
Before.	7	5 44	12 28	18 44	6 16	12 16	18 00	7	Before.
	6	5 18	11 58	18 40	6 42	12 46	18 04	6	
	5	5 00	11 34	18 34	7 00	13 10	18 10	5	
	4	4 47	11 12	18 25	7 13	13 32	18 19	4	
	3	4 34	10 54	18 20	7 26	13 50	18 24	3	
	2	4 24	10 38	18 14	7 36	14 06	18 30	2	
	1	4 17	10 28	18 11	7 43	14 16	18 33	1	
	0	4 12	10 20	18 08	7 48	14 24	18 36	0	
After.	1	4 14	10 20	18 06	7 46	14 24	18 38	1	After.
	2	4 24	10 28	18 04	7 36	14 16	18 40	2	
	3	4 38	10 40	18 02	7 22	14 04	18 42	3	
	4	5 01	10 58	17 57	6 59	13 46	18 47	4	
	5	5 25	11 18	17 53	6 35	13 26	18 51	5	
	6	5 49	11 44	17 55	6 11	13 00	18 49	6	
	7	6 18	12 18	18 00	5 42	12 26	18 44	7	

TABLE VIII.—SAN FRANCISCO.

Days from moon's greatest declination.		SOUTH DECLINATION.			NORTH DECLINATION.			Days from moon's greatest declination.	
		Low water. (Small.)	High water. (Large.)	Low water. (Large.)	Low water. (Large.)	High water. (Small.)	Low water. (Small.)		
		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		
Before.	7	5 58	13 14	18 58	5 44	11 46	17 44	7	Before.
	6	5 36	12 42	18 48	6 06	12 18	17 54	6	
	5	5 14	12 10	18 38	6 28	12 50	18 04	5	
	4	4 55	11 34	18 21	6 47	13 26	18 21	4	
	3	4 37	11 00	18 05	7 05	14 00	18 37	3	
	2	4 24	10 34	17 52	7 18	14 26	18 50	2	
	1	4 12	10 06	17 36	7 30	14 54	19 06	1	
	0	4 12	10 00	17 30	7 30	15 00	19 12	0	
After.	1	4 17	10 02	17 27	7 25	14 58	19 15	1	After.
	2	4 27	10 12	17 27	7 15	14 48	19 15	2	
	3	4 41	10 26	17 27	7 01	14 34	19 15	3	
	4	4 56	10 46	17 32	6 46	14 14	19 10	4	
	5	5 14	11 10	17 38	6 28	13 50	19 04	5	
	6	5 36	11 36	17 42	6 06	13 24	19 00	6	
	7	5 57	12 04	17 49	5 45	12 56	18 53	7	

TABLE VIII.—ASTORIA.

Days from moon's greatest declination.		SOUTH DECLINATION.			NORTH DECLINATION.			Days from moon's greatest declination.	
		Low water. (Small.)	High water. (Large.)	Low water. (Large.)	Low water. (Large.)	High water. (Small.)	Low water. (Small.)		
		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		
Before.	7	6 38	12 59	19 17	6 18	12 03	18 41	7	Before.
	6	6 14	12 33	19 15	6 42	12 29	18 43	6	
	5	5 55	12 13	19 14	7 01	12 49	18 44	5	
	4	5 34	11 47	19 09	7 22	13 15	18 49	4	
	3	5 20	11 27	19 03	7 36	13 35	18 55	3	
	2	5 09	11 07	18 54	7 47	13 55	19 04	2	
	1	5 05	11 01	18 52	7 51	14 01	19 06	1	
	0	5 03	10 53	18 46	7 53	14 09	19 12	0	
After.	1	5 05	10 51	18 42	7 51	14 11	19 16	1	After.
	2	5 11	10 55	18 40	7 45	14 07	19 18	2	
	3	5 18	11 03	18 41	7 38	13 59	19 17	3	
	4	5 32	11 15	18 39	7 24	13 47	19 19	4	
	5	5 50	11 35	18 41	7 06	13 27	19 17	5	
	6	6 11	11 55	18 40	6 45	13 07	19 18	6	
	7	6 35	12 19	18 40	6 21	12 43	19 18	7	

TABLE VIII.—PORT TOWNSHEND.

Days from moon's greatest declination.	SOUTH DECLINATION.			NORTH DECLINATION.			Days from moon's greatest declination.
	Low water.	High water.	Low water.	Low water.	High water.	Low water.	
	h. *m.*	*h.* *m.*	*h.* *m.*	*h.* *m.*	*h.* *m.*	*h.* *m.*	
Before. 7	6 05	12 26	18 05	5 39	12 26	18 31	7 After.
6	6 38	13 14	18 20	5 06	11 38	18 16	6
5	7 18	14 14	18 40	4 26	10 38	17 56	5
4	8 13	15 52	19 23	3 31	9 00	17 13	4
3	8 36	16 52	20 00	3 08	8 00	16 36	3
2	8 43	17 30	20 31	3 01	7 22	16 05	2
1	8 12	17 04	20 36	3 32	7 48	16 00	1
0	7 40	16 28	20 32	4 04	8 24	16 04	0
After. 1	7 18	15 52	20 18	4 26	9 00	16 18	1 Before.
2	6 59	15 14	19 59	4 45	9 38	16 37	2
3	6 38	14 32	19 38	5 06	10 20	16 58	3
4	6 24	14 02	19 22	5 20	10 50	17 14	4
5	6 10	13 26	19 00	5 34	11 26	17 36	5
6	5 59	12 50	18 35	5 45	12 02	18 01	6
7	5 42	12 26	18 28	6 02	12 26	18 08	7

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 fifth, sixth, and seventh to north, and the reverse for Key West. The second column gives the number which is to be added, according to the declination, to the time of high water, obtained by means of Tables IV and V, to give the next low water, which is the small low water, *b*, of diagram I. The third contains the numbers to be added to the same to give the second or large high water, *c*, of diagram I. The fourth, the numbers to be added to the same to give the second or large low water, *d*, of diagram I. The succeeding columns give the numbers to be used in the same way for north declination to obtain the low water, *b*, (large,) of diagram II; the high water, *c*, (small,) and the low water, *d*, (small,) of the same diagram. The rise and fall of the same successive tides may be obtained by inspection from Table IX, in which the first column at the side contains the time of transit, and the successive columns the numbers corresponding to that time and to the number of days from greatest declination. The arrangement of this table is like that already given.

The numbers for the small ebb tide, *a b*, of diagram I, or *c d*, of diagram II, are first given; then those for small low and large high 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.—KEY WEST.

Time of moon's transit.	SMALL EBB TIDE. Days from moon's greatest declination. Before—								After—							SMALL LOW TO LARGE HIGH WATER. Days from moon's greatest declination. Before—								After—							Time of moon's transit.
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
H.	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft*	*H.*
0	1.6	1.4	1.1	1.0	0.8	0.7	0.7	0.7	0.7	0.8	0.9	1.1	1.2	1.5	1.8	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1 7	1.7	1.6	1.7	1.7	1.6	1.5	1.4	0
1	1.6	1.4	1.1	1.0	0.8	0.7	0.7	0.7	0.7	0.8	0.9	1.1	1.2	1.5	1.8	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1.7	1.7	1.6	1.7	1.7	1.6	1.5	1.4	1
2	1.6	1.4	1.1	1.0	0.8	0.7	0.7	0.7	0.7	0.8	0.9	1.1	1.2	1.5	1.8	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1.7	1.7	1.6	1.7	1.7	1.6	1.5	1.4	2
3	1.5	1.3	1.0	0.9	0.7	0.6	0.6	0.6	0.6	0.7	0.8	1.0	1.1	1.4	1.7	1.3	1.3	1.4	1.5	1.5	1 6	1.6	1.6	1.6	1.5	1.6	1.6	1.5	1.4	1.3	3
4	1.3	1.1	0.8	0.7	0.5	0.4	0.4	0.4	0.4	0.5	0 6	0.8	0.9	1.2	1.5	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.4	1.4	1.3	1.4	1.4	1.3	1.2	1.1	4
5	1.1	0.9	0.6	0.5	0.3	0.2	0 2	0.2	0.2	0.3	0.4	0.6	0.7	1.0	1.3	0.9	0.9	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.2	1.2	1.1	1.0	1.9	5
6	1.0	0.8	0.5	0 4	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.2	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.0	0.9	0.8	6
7	1.0	0.8	0 5	0.4	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.2	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.0	0.9	0.8	7
8	1.1	0.9	0 6	0.5	0.3	0.2	0.2	0.2	0.2	0 3	0.4	0.6	0.7	1.0	1.3	0.9	0.9	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1 2	1.2	1.1	1.0	0.9	8
9	1.3	1.1	0.8	0.7	0.5	0.4	0.4	0.4	0.4	0.5	0.6	0.8	0.9	1.2	1.5	1.1	1.1	1.2	1 3	1.3	1.4	1.4	1.4	1.4	1.3	1.4	1.4	1.3	1.2	1.1	9
10	1.5	1.3	1.0	0.9	0.7	0.6	0.6	0.6	0.6	0.7	0.8	1.0	1.1	1.4	1.7	1.3	1.3	1.4	1.5	1.5	1 6	1 6	1.6	1.6	1.5	1.6	1.6	1.5	1.4	1.3	10
11	1.6	1.4	1.1	1.0	0.8	0.7	0.7	0.7	0·7	0.8	0.9	1.1	1.2	1.5	1.8	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1.7	1.7	1.6	1.7	1.7	1.6	1.5	1.4	11

TABLE IX.—KEY WEST—Continued.

Time of moon's transit.	LARGE EBB TIDE. Days from moon's greatest declination. Before.—								After.—							LARGE LOW TO SMALL HIGH WATER. Days from moon's greatest declination. Before—								After—							Time of moon's transit.
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
H.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*H.*
0	1.4	1.6	1.9	2.0	2.2	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.5	1.2	1 6	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.5	1.6	0
1	1.4	1.6	1.9	2 0	2.2	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.5	1.2	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.5	1.6	1
2	1.4	1.6	1.9	2.0	2.2	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.5	1.2	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.5	1.6	2
3	1.3	1.5	1.8	1.9	2.1	2.2	2.2	2.2	2.2	2.1	2.0	1.8	1.7	1.4	1.1	1.5	1.4	1 4	1.3	1.3	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.3	1.4	1.5	3
4	1.1	1.3	1.6	1.7	1 9	2.0	2.0	2.0	2.0	1.9	1.8	1.6	1.5	1.2	0.9	1.3	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.1	1.2	1.3	4
5	0.9	1.1	1.4	1.5	1.7	1.8	1.8	1.8	1 8	1.7	1.6	1.4	1.3	1.0	0.7	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.9	1.0	1.1	5
6	0.8	1.0	1.3	1.4	1.6	1.7	1.7	1.7	1.7	1.6	1.5	1.3	1.2	0.9	0.6	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.9	1.0	6
7	0.8	1.0	1.3	1.4	1.6	1.7	1.7	1 7	1.7	1.6	1.5	1.3	1.2	0.9	0.6	1.0	0.9	0.9	0.8	0.8	0 7	0.7	0.7	0 7	0.8	0.7	0.7	0.8	0.9	1.0	7
8	0.9	1.1	1.4	1.5	1.7	1.8	1.8	1.8	1.8	1.7	1.6	1.4	1.3	1.0	0.7	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.9	1.0	1.1	8
9	1.1	1.3	1.6	1.7	1.9	2.0	2.0	2.0	2.0	1.9	1.8	1.6	1.5	1 2	0 9	1.3	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1 0	1.1	1.2	1.3	9
10	1.3	1.5	1.8	1.9	2.1	2.2	2.2	2.2	2.2	2.1	2.0	1.8	1.7	1.4	1.1	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.3	1.4	1.5	10
11	1.4	1.6	1.9	2.0	2.2	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.5	1.2	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.5	1.6	11

TABLE IX.—SAN DIEGO.

Time of moon's transit.	SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER. Days from moon's greatest declination.															FROM SMALL LOW WATER TO LARGE HIGH WATER. Days from moon's greatest declination.														Time of moon's transit.
	Before—							After—								Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
H.	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*H.*
0	4.0	3.4	3.0	2.6	2.3	2.1	2.0	2.0	2.1	2.3	2.7	3.2	3.8	4.6	5.2	5.1	4.9	4.7	4.5	4.4	4.3	4.2	4.2	4.1	4.1	4.0	4.0	3.9	3.9	4.0	0
1	3.8	3.2	2.8	2.4	2.1	1.9	1.8	1.8	1.9	2.1	2.5	3.0	3.6	4.4	5.0	4.9	4.7	4.5	4.3	4.2	4.1	4.0	4.0	3.9	3.9	3.8	3.8	3.7	3.7	3.8	1
2	3.5	2.9	2.5	2.1	1.8	1.6	1.5	1.5	1.6	1.8	2.2	2.7	3.3	4.1	4.7	4.6	4.4	4.2	4.0	3.9	3.8	3.7	3.7	3.6	3.6	3.5	3.5	3.4	3.4	3.5	2
3	3.0	2.4	2.0	1.6	1.3	1.1	1.0	1.0	1.1	1.3	1.7	2.2	2.8	3.6	4.2	4.1	3.9	3.7	3.5	3.4	3.3	3.2	3.2	3.1	3.1	3.0	3.0	2.9	2.9	3.0	3
4	2.2	1.6	1.2	0.8	0.5	0.3	0.2	0.2	0.3	0.5	0.9	1.4	2.0	2.8	3.4	3.3	3.1	2.9	2.7	2.6	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.2	4
5	1.7	1.1	0.7	0.3	0.0	−.2	−.3	−.3	−.2	0.0	0.4	0.9	1.0	2.3	2.9	2.8	2.6	2.4	2.2	2.1	2.0	1.9	1.9	1.8	1.8	1.7	1.7	1.6	1.6	1.7	5
6	1.8	1.2	0.8	0.4	0.1	−.1	−.2	−.2	−.1	0.1	0.5	1.0	1.6	2.4	3.0	2.9	2.7	2.5	2.3	2.2	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.7	1.7	1.8	6
7	2.3	1.7	1.3	0.9	0.6	0.4	0.3	0.3	0.4	0.6	1.0	1.5	2.1	2.9	3.5	3.4	3.2	3.0	2.8	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.3	7
8	2.9	2.3	1.9	1.5	1.2	1.0	0.9	0.9	1.0	1.2	1.6	2.1	2.7	3.5	4.1	4.0	3.8	3.6	3.4	3.3	3.2	3.1	3.1	3.0	3.0	2.9	2.9	2.8	2.8	2.9	8
9	3.7	3.1	2.7	2.5	2.0	1.8	1.7	1.7	1.8	2.0	2.4	2.9	3.5	4.3	4.9	4.8	4.6	4.4	4.2	4.1	4.0	3.9	3.9	3.8	3.8	3.7	3.7	3.6	3.6	3.7	9
10	4.2	3.6	3.2	2.8	2.5	2.3	2.2	2.2	2.3	2.5	2.9	3.4	4.0	4.8	5.4	5.3	5.1	4.9	4.7	4.6	4.5	4.4	4.4	4.3	4.3	4.2	4.2	4.1	4.1	4.2	10
11	4.3	3.7	3.3	2.9	2.6	2.4	2.3	2.3	2.4	2.6	3.0	3.5	4.1	4.9	5.5	5.4	5.2	5.0	4.8	4.7	4.6	4.5	4.5	4.4	4.4	4.3	4.3	4.2	4.2	4.3	11

From *a* to *b*.....Diagram I. From *b* to *c*.....Diagram I.
From *c* to *d*.....Diagram II. From *d* to *e*.....Diagram II.

TABLE IX.—SAN DIEGO—Continued.

Time of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER. Days from moon's greatest declination.															FROM LARGE LOW WATER TO SMALL HIGH WATER. Days from moon's greatest declination.														Time of moon's transit.
	Before—							After—								Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
H.	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft*	*Ft*	*Ft*	*Ft*	*Ft*	*Ft*	*H.*
0	5.2	5.8	6.2	6.6	6.9	7.1	7.2	7.2	7.1	6.9	6.5	6.0	5.4	4.6	4.0	4.1	4.3	4.5	4.7	4.8	4.9	5.0	5.0	5.1	5.1	5.2	5.2	5.3	5.3	5.2	0
1	5.0	5.6	6.0	6.4	6.7	6.9	7.0	7.0	6.9	6.7	6.3	5.8	5.2	4.4	3.8	3.9	4.1	4.3	4.5	4.6	4.7	4.8	4.8	4.9	4.9	5.0	5.0	5.1	5.1	5.0	1
2	4.7	5.3	5.7	6.1	6.4	6.6	6.7	6.7	6.6	6.4	6.0	5.5	4.9	4.1	3.5	3.6	3.8	4.0	4.2	4.3	4.4	4.5	4.5	4.6	4.6	4.7	4.7	4.8	4.8	4.7	2
3	4.2	4.8	5.2	5.6	5.9	6.1	6.2	6.2	6.1	5.9	5.5	5.0	4.4	3.6	3.0	3.1	3.3	3.5	3.7	3.8	3.9	4.0	4.0	4.1	4.1	4.2	4.2	4.3	4.3	4.2	3
4	3.4	4.0	4.4	4.8	5.1	5.3	5.4	5.4	5.3	5.1	4.7	4.2	3.6	2.8	2.2	2.3	2.5	2.7	2.9	3.0	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.5	3.4	4
5	2.9	3.5	3.9	4.3	4.6	4.8	4.9	4.9	4.8	4.6	4.2	3.7	3.1	2.3	1.7	1.8	2.0	2.2	2.4	2.5	2.6	2.7	2.7	2.8	2.8	2.9	2.9	3.0	3.0	2.9	5
6	3.0	3.6	4.0	4.4	4.7	4.9	5.0	5.0	4.9	4.7	4.3	3.8	3.2	2.4	1.8	1.9	2.1	2.3	2.5	2.6	2.7	2.8	2.8	2.9	2.9	3.0	3.0	3.1	3.1	3.0	6
7	3.5	4.1	4.5	4.9	5.2	5.4	5.5	5.5	5.4	5.2	4.8	4.3	3.7	2.9	2.3	2.4	2.6	2.8	3.0	3.1	3.2	3.3	3.3	3.4	3.4	3.5	3.5	3.6	3.6	3.5	7
8	4.1	4.7	5.1	5.5	5.8	6.0	6.1	6.1	6.0	5.8	5.4	4.9	4.3	3.5	2.9	3.0	3.2	3.4	3.6	3.7	3.8	3.9	3.9	4.0	4.0	4.1	4.1	4.2	4.2	4.1	8
9	4.9	5.5	5.9	6.3	6.6	6.8	6.9	6.9	6.8	6.6	6.2	5.7	5.1	4.3	3.7	3.8	4.0	4.2	4.4	4.5	4.6	4.7	4.7	4.8	4.8	4.9	4.9	5.0	5.0	4.9	9
10	5.4	6.0	6.4	6.8	7.1	7.3	7.4	7.4	7.3	7.1	6.7	6.2	5.6	4.8	4.2	4.3	4.5	4.7	4.9	5.0	5.1	5.2	5.2	5.3	5.3	5.4	5.4	5.5	5.4	5.4	10
11	5.5	6.1	6.5	6.9	7.2	7.4	7.5	7.5	7.4	7.2	6.8	6.3	5.7	4.9	4.3	4.4	4.6	4.8	5.0	5.1	5.2	5.3	5.3	5.4	5.4	5.5	5.5	5.6	5.6	5.5	11

From *c* to *d*.....Diagram I. From *d* to *e*.....Diagram I.
From *a* to *b*.....Diagram II. From *b* to *c*.....Diagram II.

TABLE IX.—SAN FRANCISCO.

Hours of moon's transit.	SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER. Days from moon's greatest declination. Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	FROM SMALL LOW WATER TO LARGE HIGH WATER. Days from moon's greatest declination. Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	Hours of moon's transit.
H.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*H.*
0	4.7	4.0	3.4	2.9	2.4	2.0	1.8	1.7	1.7	1.9	2.2	2.6	3.1	3.7	4.4	5.2	4.9	4.6	4.5	4.0	3.7	3.4	3.2	3.1	3.0	3.1	3.1	3.3	3.4	3.5	0
1	4.5	3.8	3.2	2.7	2.2	1.8	1.6	1.5	1.5	1.7	2.0	2.4	2.9	3.5	4.2	5 0	4.7	4.4	4.3	3.8	3 5	3.2	3.0	2.9	2.8	2.9	2.9	3.1	3.2	3 3	1
2	4.3	3.6	3.0	2.5	2.0	1.6	1.4	1.3	1.3	1.5	1.8	2.2	2 7	3.3	4.0	4.8	4.5	4 2	4.1	3.6	3.3	3.0	2.8	2.7	2.6	2.7	2.7	2.9	3.0	3.1	2
3	4.0	3.3	2.7	2.2	1.7	1.3	1.1	1.0	1.0	1 2	1.5	1.8	2.4	3.0	3.7	4.5	4.2	3.9	3.8	3.3	3.0	2.7	2.5	2.4	2.3	2 4	2 4	2.6	2.7	2.8	3
4	3.6	2.9	2.3	1.8	1.3	0 9	0.7	0.6	0.6	0.8	1.1	1.5	2.0	2.6	3.3	4.1	3.8	3.5	3.4	2.9	2.6	2.3	2.1	2.0	1.9	2 0	2.0	2.2	2.3	2.4	4
5	3.2	2.5	1.9	1.4	0.9	0.5	0.3	0.2	0.2	0.4	0.7	1.1	1.6	2.2	2.9	3.7	3.4	3.1	3 0	2.5	2.2	1.9	1.7	1.6	1.5	1.6	1.6	1.8	1.9	2.0	5
6	3.2	2.5	1.9	1.4	0.9	0.5	0.3	0.2	0.2	0.4	0.7	1.1	1.6	2 2	2.9	3.7	3.4	3.1	3.0	2.5	2.2	1.9	1.7	1.6	1 5	1.6	1.6	1.8	1.9	2.0	6
7	3.4	2.7	2.1	1.6	1.1	0.7	0.5	0.4	0.4	0.6	0.9	1.3	1 8	2.4	3.1	3.9	3.6	3 3	3.2	2.7	2.4	2.1	1.9	1.8	1.7	1.8	1.8	2.0	2.1	2.2	7
8	3.8	3.1	2.5	2.0	1.5	1.1	0.9	0.8	0.8	1.0	1.3	1.7	2.2	2.8	3 5	4.3	4.0	3.7	3.6	3.1	2.8	2 5	2.3	2.2	2.1	2.2	2.2	2.4	2.5	2.6	8
9	4.1	3.4	2.8	2.3	1.8	1.4	1.2	1.1	1.1	1.3	1.6	2.0	2.5	3.1	3.8	4.6	4.3	4.0	3.9	3.4	3.1	2.8	2.6	2.5	2.4	2.5	2 5	2.7	2.8	2.9	9
10	4.5	3.8	3.2	2.7	2.2	1.8	1.6	1.5	1.5	1.7	2.0	2.4	2.9	3.5	4.2	5.0	4.7	4.4	4.3	3.8	3.5	3.2	3.0	2 9	2.8	2.9	2.9	3.1	3.2	3.3	10
11	4.7	4.0	3.4	2.9	2.4	2.0	1.8	1.7	1.7	1.9	2.2	2.6	3.1	3.7	4.4	5.2	4.9	4.6	4.5	4.0	3.7	3.4	3.2	3.1	3.0	3.1	3.1	3.3	3.4	3.5	11

From *a* to *b*..... Diagram I.
From *c* to *d*..... Diagram II.

From *b* to *c*..... Diagram I.
From *d* to *e*..... Diagram II.

TABLE IX.—SAN FRANCISCO—Continued.

Hours of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER. Days from moon's greatest declination. Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	FROM LARGE LOW WATER TO SMALL HIGH WATER. Days from moon's greatest declination. Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	Hours of moon's transit.
H.	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*H.*
0	3.9	4.6	5.2	5.7	6.2	6.6	6.8	6.9	6.9	6.7	6.4	6.0	5.5	4.9	4.2	3.4	3.7	4.0	4.1	4.6	4.9	5.2	5.4	5.5	5.6	5.6	5.5	5.3	5.2	5.2	0
1	3.7	4.4	5.0	5 5	6.0	6.4	6 6	6 7	6.7	6.5	6.2	5 8	5.3	4.7	4.0	3.2	3.5	3.8	3.9	4.4	4.7	5.0	5.2	5 3	5.4	5.3	5.3	5.1	5 0	5.0	1
2	3.5	4.2	4.8	5.3	5.8	6.2	6.4	6.5	6.5	6.3	6.0	5.6	5 1	4.5	3.8	3.0	3.3	3.6	3.7	4.2	4.5	4.8	5.0	5.1	5.2	5.1	5.1	4.9	4 8	4.8	2
3	3.2	3.9	4.5	5.0	5.5	5.9	6.1	6.2	6.2	6.0	5.7	5.	4.8	4.2	3.5	2.7	3.0	3.3	3.4	3.9	4.2	4.5	4.7	4.8	4.9	4.8	4.8	4.6	4.5	4.5	3
4	2 8	3.5	4.1	4.6	5.1	5.5	5.7	5.8	5.8	5.6	5 3	4.9	4.4	3.8	3.1	2.3	2.6	2.9	3 0	3.5	3.8	4.1	4.3	4.4	4.5	4.4	4.4	4.2	4.1	4.1	4
5	2.4	3.1	3.7	4.2	4.7	5.1	5.3	5.4	5.4	5.2	4.9	4.5	4.0	3 4	2.7	1.9	2.2	2.5	2.6	3.1	3.4	3.7	3.9	4.0	4.1	4.0	4.0	3.8	3.7	3.7	5
6	2.4	3.1	3.7	4.2	4.7	5.1	5.3	5.4	5.4	5.2	4.9	4.5	4.0	3.4	2.7	1.9	2 2	2.5	2.6	3.1	3.4	3.7	3.9	4.0	4.1	4.0	4.0	3.8	3.7	3.7	6
7	2.6	3.3	3.9	4.4	4.9	5.3	5.5	5.6	5.6	5.4	5 1	4.7	4.2	3.6	2.9	2.1	2.4	2.7	2.8	3.3	3.6	3.9	4.1	4.2	4.3	4.2	4.2	4.0	3 9	3.9	7
8	3.0	3.7	4.3	4.8	5.3	5.7	5.9	6.0	6.0	5.8	5.5	5.1	4.6	4.0	3 3	2.5	2.8	3.1	3.2	3.7	4.0	4.3	4.5	4.6	4.7	4.6	4.6	4 4	4.3	4 3	8
9	3.3	4.0	4.6	5.1	5.6	6 0	6.2	6.3	6.3	6.1	5.8	5.4	4.9	4.3	3.6	2.8	3.1	3.4	3.5	4.0	4 3	4.6	4.8	4.9	5.0	4.9	4.9	4.7	4 6	4.6	9
10	3.7	4.4	5.0	5.5	6.0	6.4	6.6	6.7	6.7	6.5	6.2	5.8	5.3	4.7	4.0	3.2	3.5	3.8	3.9	4.4	4.7	5.0	5.2	5.3	5.4	5.3	5.3	5.1	5 0	5 0	10
11	3.9	4.6	5.2	5.7	6.2	6.6	6.8	6.9	6.9	6.7	6.4	6.0	5.5	4.9	4.2	3.4	3.7	4.0	4 1	4.6	4.9	5.2	5.4	5.5	5.6	5.5	5.5	5.3	5.2	5.2	11

From *c* to *d*..... Diagram I.
From *a* to *b*..... Diagram II.

From *d* to *e*..... Diagram I.
From *b* to *c*..... Diagram II.

TABLE IX.—ASTORIA.

Hours of moon's transit.	SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER. Days from moon's greatest declination. Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7
H.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*
0	7.4	6.7	6.0	5.4	5.0	4.6	4.5	4.5	4.6	4.7	5.1	5.5	6.2	6.8	7.8
1	7.5	6.8	6 1	5.5	5.1	4.7	4.6	4 6	4.7	4.8	5.2	5.6	6.3	7.0	7.9
2	7.2	6.5	5.8	5.2	4.8	4.4	4.3	4.3	4.4	4.5	4.9	5.3	6.0	6.7	7.6
3	6.6	5.9	5.2	4.6	4.2	3.8	3.7	3.7	3.8	3.9	4.3	4.7	5.4	6.1	7.0
4	5.9	5.2	4.5	3.9	3.5	3.1	3.0	3.0	3.1	3.2	3.6	4.0	4.7	5.4	6.3
5	5.2	4.5	3.8	3 2	2.8	2.4	2.3	2.3	2.4	2.5	2.9	3.3	4.0	4.7	5.6
6	4.8	4.1	3.4	2.8	2.4	2.0	1.9	1.9	2.0	2.1	2 5	2.9	3.6	4.3	5.2
7	5.0	4.3	3.6	3.0	2.6	2.2	2.1	2.1	2.2	2.3	2.7	2.1	3.8	4.5	5.4
8	5 5	4.8	4.1	3.5	3.1	2.7	2.6	2.6	2.7	2.8	3.2	3.6	4.3	5.0	5.9
9	6.3	5.6	4.9	4.3	3.9	3.5	3.4	3.4	3.5	3.6	4.0	4 4	5.1	5.8	6.7
10	7.0	6.3	5.6	5.0	4.6	4.2	4.1	4.1	4.2	4 3	4.7	5 1	5.8	6.5	7.4
11	7.3	6.6	6.9	5.3	4.9	4.5	4.4	4.4	4.5	4 6	5.0	5.4	6.1	6.8	7.7

From *a* to *b*.....Diagram I.
From *c* to *d*.....Diagram II.

Hours of moon's transit.	FROM SMALL LOW WATER TO LARGE HIGH WATER. Days from moon's greatest declination. Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	Hours of moon's transit.
H.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*H.*
0	8.0	7.8	7.5	7.2	6.8	6.4	6.3	6.2	6.1	6.2	6.2	6 3	6 3	6.3	6.4	0
1	8.1	7.9	7.6	7.3	6.9	6.5	6.4	6.3	6 2	6.3	6.3	6.4	6.4	6.4	6 5	1
2	7.8	7 6	7.3	7.0	6 6	6 2	6.1	6.0	5.9	6.0	6.0	6.1	6.1	6.1	6.2	2
3	7.2	7.0	6.7	6.4	6.0	5.6	5.5	5.4	5.3	5.4	5.4	5.5	5.5	5.5	5.6	3
4	6.5	6.3	6.0	5.7	5.3	4.9	4.8	4.7	4.6	4.7	4.7	4.8	4.8	4.8	4.9	4
5	5.8	5.6	5.3	5 0	4.6	4.2	4.1	4 0	3.9	4.0	4.0	4.1	4.1	4.1	4.2	5
6	5.4	5.2	4.9	4.6	4.2	3.8	3.7	3.6	3.5	3.6	3.6	3.7	3.7	3 7	3.8	6
7	5.6	5.4	5.1	4.8	4.4	4.0	3 9	3.8	3.7	3.8	3 8	3.9	3.9	3.9	4.0	7
8	6.1	5.9	5.6	5.3	4.9	4.5	4 4	4 3	4.2	4.3	4.3	4.4	4.4	4.4	4.5	8
9	6.9	6.7	6.4	6.1	5.7	5.3	5.2	5.1	5.0	5.1	5.1	5.2	5.2	5.2	5 3	9
10	7.6	7.4	7.1	6.8	6.4	6 0	5.9	5.8	5.7	5.8	5.8	5.9	5.9	5.9	6.0	10
11	7.9	7.7	7.4	7.1	6.7	6.3	6.2	6.1	6.0	6.1	6.1	6.2	6.2	6 2	6.3	11

From *b* to *c*.....Diagram I.
From *d* to *e*.....Diagram II.

TABLE IX.—ASTORIA—Continued.

Hours of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER. Days from moon's greatest declination. Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7
H.	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft*
0	7.0	7.7	8 4	9.0	9.4	9.8	9.9	9.9	9.8	9.7	9.3	8.9	8.2	7.5	6.6
1	7.1	7.8	8.5	9.1	9.5	9.9	10.0	10 0	9.9	9.8	9.4	9.0	8.3	7.6	6.7
2	6.8	7.5	8.2	8.8	9.2	9.6	9.7	9.7	9.6	9.5	9.1	8.7	8.0	7.3	6.4
3	6.2	6.9	7.6	8.2	8.6	9.0	9.1	9.1	9.0	8.9	8.5	8.1	7.4	6.7	5.8
4	5 5	6 2	6.9	7.5	7.9	8.3	8.4	8.4	8.3	8.2	7.8	7 4	6.7	6.0	5.1
5	4.8	5.5	6.2	6.8	7.2	7.6	7.7	7.7	7.6	7.5	7.1	6.7	6.0	5.3	4.4
6	4.4	5.1	5.8	6.4	6.8	7.2	7.3	7.3	7.2	7.1	6 7	6.3	5.6	4.9	4.0
7	4.6	5.3	6.0	6.6	7.0	7.4	7.5	7.5	7.4	7.3	6.9	6.5	5.8	5.1	4.2
8	5.1	5.8	6.5	7.1	7.5	7.9	8.0	8.0	7.9	7.8	7.4	7.0	6.3	5.6	4.7
9	5.9	6.6	7.3	7.9	8.3	8.7	8 8	8.8	8.7	8.6	8.2	7.8	7.1	6.4	5.5
10	6.6	7.3	8.0	8 6	9.0	9.4	9.5	9.5	9.4	9.3	8.9	8.5	7.8	7.1	6.2
11	6.9	7.6	8.3	8.9	9.3	9.7	9 8	9.8	9.7	9.6	9.2	8.8	8.1	7.4	7.5

From *c* to *d*.....Diagram I.
From *a* to *b*.....Diagram II.

Hours of moon's transit.	FROM LARGE LOW WATER TO SMALL HIGH WATER. Days from moon's greatest declination. Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	Hours of moon's transit.
H.	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*H.*
0	6.4	6.6	6 9	7 2	7.6	8.0	8.1	8.2	8.3	8.2	8.2	8.1	8.1	8.1	8.0	0
1	6.5	6.7	7.0	7 3	7.7	8.1	8.2	8.3	8.4	8 3	8 3	8 2	8.2	8.2	8.1	1
2	6.2	6.4	6.7	7 0	7.4	7.8	7.9	8.0	8.1	8.0	8.0	7.9	7.9	7.9	7 8	2
3	5.6	5.8	6.1	6.4	6.8	7.2	7.3	7.4	7 5	7.4	7.4	7.3	7 3	7.3	7.2	3
4	4.9	5.1	5.4	5.7	6 1	6.5	6.6	6.7	6.8	6 7	6.7	6 6	6.6	6.6	6.5	4
5	4.2	4.4	4.7	5 0	5.4	5 8	5.9	6.0	6.1	6.0	6 0	5.9	5.9	5.9	5.8	5
6	3.8	4.0	4.3	4.6	5.0	5.4	5.5	5.6	5.7	5.6	5.6	5.5	5.5	5.5	5.4	6
7	4.0	4.2	4.5	4.8	5.2	5.6	5.7	5.8	5 9	5.8	5.8	5.7	5.7	5 7	5.6	7
8	4.5	4.7	5.0	5.3	5.7	6.1	6.2	6.3	6.4	6.3	6.3	6.2	6.2	6.2	6.1	8
9	5.3	5.5	5.8	6.1	6.5	6.9	7.0	7 1	7.2	7 1	7.1	7.0	7.0	7.0	6.9	9
10	6.0	6.2	6.5	6.8	7.2	7.6	7.7	7.8	7.9	7.8	7.8	7.7	7.7	7.7	7.6	10
11	6.3	6.5	6.8	7.1	7.5	7.9	8 0	8.1	8.2	8.1	8.1	8.0	8.0	8.0	7.9	11

From *d* to *e*.....Diagram I.
From *b* to *c*.....Diagram II.

TABLE IX.—PORT TOWNSHEND.

Hours of moon's transit.	SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER.															FROM SMALL LOW WATER TO LARGE HIGH WATER.														Hours of moon's transit.
	Days from moon's greatest declination.															Days from moon's greatest declination.														
	Before—							After—								Before—							After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
H.	*Feet.*	*Ft.*	*Ft.*	*Ft*	*Ft*	*Ft*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft*	*Ft*	*Ft.*	*Ft*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*H.*
0	4 5	5.6	6.9	8.0	8 6	8.9	8.8	8.6	8.7	8.7	8.5	8.0	7.3	6.6	5.5	3.5	3.9	4 6	6.0	7.2	8.4	9.0	9.5	9.6	9 4	9.2	8.7	8.2	7.9	7.1	0
1	4.5	5.6	6.9	8.0	8.6	8 9	8.8	8.8	8.7	8.7	8.5	8.0	7.3	6.6	5.5	3.5	3.9	4.6	6.0	7.2	8.4	9 0	9.5	9.6	9.4	9.2	8.7	8.2	7.9	7.1	1
2	4.4	5.5	6.8	7.9	8.5	8.8	8.7	8.7	8.6	8.6	8.4	7.9	7.2	6.5	5.4	3.4	3.8	4.5	5.9	7.1	8 3	8.9	9.4	9.5	9 3	9.1	8.6	8.1	7.8	7.0	2
3	4.1	5 2	6.5	7.6	8 2	8.5	8.4	8.4	8.3	8.3	8.1	7.6	6.9	6.2	5.1	3.1	3.5	4.2	5.6	6.8	8.0	8 6	9.1	9.2	9.0	8.8	8.3	7.8	7.5	6.7	3
4	3 5	4.6	5.9	7.0	7.6	7.9	7.8	7 8	7.7	7.7	7.5	7.0	6.3	5.6	4.5	2.5	2.9	3.6	5.0	6.2	7.4	8.0	8.5	8.6	8.4	8.2	7.7	7.2	6 9	6.1	4
5	3.1	4.2	5.5	6.6	7.2	7.5	7.4	7.4	7.3	7.3	7.1	6.6	5.9	5.2	4.1	2.1	2.5	3.2	4.6	5.8	7.0	7.6	8.1	8.2	8.0	7.8	7.3	6.8	6.5	5.7	5
6	3.1	4.2	5.5	6 6	7.2	7.5	7.4	7.4	7.3	7.3	7.1	6.6	5.9	5.2	4 1	2 1	2.5	3.2	4.6	5.8	7.0	7.6	8.1	8.2	8.0	7.8	7.3	6.8	6.5	5.7	6
7	3.3	4.4	5.7	6.8	7.4	7.7	7.6	7.6	7.5	7.5	7.3	6.8	6.1	5.4	4.3	2.3	2.7	3.4	4.8	6 0	7.2	7.8	8.3	8.4	8.2	8.0	7 5	7.0	6.7	5 9	7
8	3 5	4.6	5.9	7.0	7.6	7.9	7.8	7.8	7.7	7.7	7.5	7.0	6.3	5.6	4.5	2.5	2.9	3.6	5.0	6.2	7.4	8.0	8.5	8.6	8.4	8.2	7.7	7.2	6.9	6.1	8
9	3.7	4.8	6.1	7.2	7.8	8.1	8.0	8.0	7.9	7.9	7.7	7.2	6.5	5.8	4.7	2.7	3.1	3.8	5.2	6.4	7.6	8.2	8.7	8.8	8.6	8.4	7.9	7.4	7.1	6.3	9
10	4.1	5.2	6.5	7.6	8.2	8.5	8.4	8.4	8.3	8.3	8.1	7.6	6.9	6.2	5.1	3.1	3.5	4.2	5.6	6.8	8.0	8.6	9.1	9.2	9.0	8.8	8.3	7.8	7 5	6.7	10
11	4.4	5 5	6.8	7.9	8.5	8.8	8.7	8.7	8.6	8.6	8.4	7.9	7.2	6.5	5.4	3.4	3.8	4.5	5.9	7.1	8.3	8.9	9.4	9.5	9.3	9.1	8.6	8.1	7 8	7 0	11

TABLE IX.—PORT TOWNSHEND—Continued

Hours of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.															FROM SMALL LOW WATER TO LARGE HIGH WATER.														Hours of moon's transit.
	Days from moon's greatest declination.															Days from moon's greatest declination.														
	Before.							After—								Before—							After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
H.	*Feet.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*H.*
0	6.5	5.4	4.1	3.0	2.4	2.1	2.2	2 2	2.3	2.5	2.5	3.0	3.7	4 4	5.5	7.5	7.1	6.4	5.0	3.8	2.6	2.0	1.5	1.4	1.6	1.8	2.3	2.8	3.1	3.9	0
1	6 5	5.4	4.1	3.0	2.4	2.1	2.2	2.2	2.3	2.3	2.5	3.0	3 7	4.4	5.5	7.5	7.1	6.4	5.0	3.8	2.6	2.0	1.5	1.4	1.6	1.8	2.3	2.8	3 1	3.9	1
2	6 4	5.3	4.0	2.9	2.3	2 0	2.1	2.1	2.2	2.2	2.4	2.9	3.6	4 3	5.4	7.4	7.0	6 3	4.9	3.7	2.5	1.9	1.4	1.3	1.5	1.7	2.2	2.7	3.0	3 8	2
3	6.1	5.0	3 7	2.6	2.0	1.7	1.8	1 8	1.9	1.9	2.1	2.6	3.3	4.0	5.1	7.1	6.7	6.0	4 6	3.4	2.2	1.6	1.1	1.0	1.2	1.4	1.9	2.4	2.7	3.5	3
4	5.5	4.4	3.1	2.0	1.4	1.1	1.2	1 2	1.3	1.3	1.5	2 0	2.7	3.4	4.5	6.5	6 1	5.4	4.0	2.8	1.6	1.0	0.5	0.4	0.6	0.8	1.3	1.8	2.1	2.9	4
5	5.1	4.0	2.7	1.6	1.0	0.7	0.8	0.8	0.9	0.9	1.1	1.6	2.3	3 0	4.1	6.1	5.7	5.0	3.6	2.4	1.2	0.6	0.1	0.0	0.2	0.4	0.9	1.4	1.7	2.5	5
6	5.1	4.0	2.7	1.6	1.0	0.7	0.8	0.8	0 9	0.9	1.1	1.6	2.3	3.0	4.1	6.1	5.7	5.0	3 6	2.4	1.2	0.6	0.1	0.0	0.2	0.4	0.9	1.4	1.7	2 5	6
7	5.3	4.2	2 9	1.8	1.2	0.9	1.0	1.0	1.1	1.1	1.3	1.8	2.5	3.2	4.3	6.3	5.9	5.2	3.8	2.6	1.4	0.8	0.3	0.2	0.4	0.6	1.1	1.6	1.9	2.7	7
8	5.5	4.4	3.1	2.0	1.4	1.1	1.2	1.2	1.3	1.3	1.5	2.0	2.7	3.4	4.5	6.5	6.1	5.4	4.0	2.8	1.6	1.0	0.5	0.4	0.6	0.8	1.3	1.8	2.1	2.9	8
9	5.7	4.6	3.3	2.2	1.6	1.3	1.4	1.4	1.5	1.5	1 7	2.2	2 9	3.6	4.7	6.7	6 3	5.6	4.2	3.0	1.8	1.2	0.7	0.6	0.8	1.0	1.5	2.0	2.3	3.1	9
10	6.1	5.0	3.7	2.6	2.0	1.7	1.8	1.8	1.9	1.9	2.1	2.6	3.3	4.0	5.1	7.1	6.7	6.0	4 6	3.4	2.2	1.6	1.1	1.0	1.2	1.4	1.9	2.4	2.7	3 5	10
11	6.4	5.3	4.0	2.9	2.3	2.0	2.1	2.1	2.2	2.2	2.4	2.9	3 6	4.3	5.4	7 4	7.0	6.3	4.9	3.7	2 5	1.9	1.4	1 3	1.5	1.7	2.2	2.7	3.0	3.8	11

Example VII.—Thus, in Example VI, the high water of February 7th 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 0*h.* 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 the 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.

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 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 six to nine 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 six to ten 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 the 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 requires 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 six to nine hours, during which there are often small, irregular fluctuations or a very slow fall. In the following table the mean rise and fall of tides at the above stations are given.

The highest high and the lowest low waters occur when the greatest declination of the moon happens at full or change; the least tide when the moon's declination is nothing at the first or last quarter. The rise and fall being so small, the times and heights are both much influenced by the winds, and are thus 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 greatest declination.	At moon's least declination.
	Feet.	*Feet.*	*Feet.*
St George's island, Florida	1.1	1.8	0.6
Pensacola, Florida	1.0	1.5	0.4
Fort Morgan, Mobile bay, Alabama	1.0	1.5	0.4
Cat island, Mississippi	1.3	1.9	0.6
Southwest Pass, Louisiana	1.1	1.4	0.5
Isle Dernière, Louisiana	1.4	2.2	0.7
Entrance to Lake Calcasieu, Louisiana	1.9	2.4	1.7
Galveston, Texas	1.1	1.6	0.8
Aransas Pass, Texas	1.1	1.8	0.6
Brazos Santiago, Texas	0.9	1.2	0.5

TO DETERMINE THE RISE AND FALL OF THE 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 and 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 devote the proportional fall of the tide from high water onward to low water. For example at New York, three hours after high water, a spring tide has fallen six-tenths (sixty hundredths) of the whole fall. Suppose the whole rise and fall of that day to be 5.4 feet, (Table I;) then, three hours after high water, the tide will have fallen 3.24 feet, or three feet three inches, nearly. Conversely, if we have observed that a spring tide has fallen three feet three inches, we may know that high water has passed about three hours.

TABLE XI.

Giving the height of the tide above low water for every half hour before or after high water, the total range being taken as equal to 1.

Time before or after high water.	New York.		Old Point Comfort.	
	Spring tide.	Neap tide.	Spring tide.	Neap tide.
h. m.				
0 0	1.00	1 00	1.00	1.00
0 30	0.98	0.93	0.98	0.98
1 0	0.94	0.93	0.95	0.94
1 30	0.89	0.86	0.88	0.87
2 0	0.80	0.72	0.80	0.78
2 30	0.72	0.59	0.70	0.68
3 0	0.60	0.45	0.59	0.57
3 30	0.49	0.31	0.49	0.44
4 0	0.39	0.19	0.37	0.34
4 30	0.28	0.10	0.26	0.22
5 0	0.18	0.02	0.17	0.13
5 30	0.09	0.00	0.08	0.05
6 0	0.05	----------	0.03	0.01
6 30	0.00	----------	0.00	0.00

TIDES IN COASTING.

By observing the 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 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 twelve 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 XI$\frac{3}{4}$ nowhere more than 35 miles; that of XI$\frac{1}{2}$ 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,) for 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, XI$\frac{3}{4}$, XI$\frac{1}{2}$, 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 XI$\frac{3}{4}$ and XI$\frac{1}{2}$ hours.

A.

Names of locations.	Distance from coast, measured on perpendicular to co-tidal lines.			
	At XII hours.	At XI$\frac{3}{4}$ hours.	At XI$\frac{1}{2}$ hours.	At XI hours.
	Nautical miles.	*Nautical miles.*	*Nautical miles.*	*Nautical miles.*
Sandy Hook	12	32	53	100
Barnegat	2	29	39	78
Cape May	15	30	46	92
Cape Henlopen	18	33	47	92
Assateague	7	22	36	82
Cape Henry	12	28	43	100
Cape Hatteras	----------	8	20	63
Ocracoke inlet	----------	11	26	71
Cape Lookout	----------	7	18	56
Beaufort entrance, North Carolina	6	15	24	63
Cape Fear	----------	6	16	55
Cape Roman	----------	10	21	67
Charleston light	3	15	27	70
Port Royal entrance	5	17	29	78
Tybee entrance	6	17	31	82
St. Mary's entrance	12	25	40	110
St. John's entrance	17	35	48	----------
Cape Cañaveral	16	----------	----------	----------
Cape Florida	----------	----------	----------	----------

The co-tidal lines are in such directions that at 10, 20, and 30 miles from the coast, between Sandy Hook and the St. John's, there is but a variation of seven minutes, and even to Cape Cañaveral only of eight minutes.

Keeping ten miles from the shore the coaster would pass from 12 hours at Sandy Hook to 11 hours 45 minutes at Hatteras, and increase again irregularly to 12 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 Cañaveral.

B.

Names of stations.	Co-tidal hour at 10, 20, and 30 nautical miles from the coast, perpendicular to the coast.		
	Ten miles off	Twenty miles off.	Thirty miles off.
	h. *m.*	*h* *m.*	*h.* *m.*
Sandy Hook	12 0	11 52	11 45
Barnegat	11 52	11 44	11 35
Cape May	12 5	11 53	11 45
Cape Henlopen	12 7	11 57	11 48
Assateague	12 0	11 48	11 37
Cape Henry	12 5	11 48	11 42
Cape Hatteras	11 45	11 30	11 22
Ocracoke inlet	11 47	11 36	11 25
Cape Lookout	11 45	11 30	11 20
Beaufort entrance, N. C.	11 55	11 38	11 25
Cape Fear	11 38	11 25	11 18
Cape Roman	11 45	11 33	11 24
Charleston light	11 52	11 38	11 25
Port Royal entrance	11 57	11 45	11 32
Tybee entrance	11 55	11 43	11 30
St. Mary's entrance	12 8	11 57	11 47
St. John's entrance	12 7	11 57	11 50
Cape Cañaveral	12 8	----------	----------
Cape Florida	13 10	----------	----------

It follows, then, as a general thing, from these two tables, that the coaster, in passing from Sandy Hook to the St. John's would have the tides the same, within some fifteen minutes, as if he remained at Sandy Hook; so that leaving, for example, at high water, he would, according to the elapsed time, have the ebb and flood alternating every six hours and a quarter, nearly, as if he had remained near Sandy Hook. As the flood tide sets in generally to the northward and on shore, and the ebb to the southward and off shore, he would know by the time that elapsed from his departure and the period of the tide at which he started what tidal currents he might expect to meet as he passed along the coast. This, of course, is not peculiar to Sandy Hook as a point of departure, but would be true for any of the entrances given in the table, taking care not to mistake the 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.

C.

Off—	Co-tidal hours on sailing lines measured on parallels of latitude of places named in the first column, between New York and—							
	Delaware bay.	Chesapeake bay.	Ocracoke inlet.	Cape Fear.	Charleston.	Savannah.	St. John's.	Cape Florida.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Sandy Hook	12 5	12 5	12 5	12 5	12 5	12 5	12 5	12 5
Barnegat	11 57	11 57	11 57	11 57	11 57	11 57	11 57	11 57
Cape May	12 10	11 52	11 45	11 45	11 45	11 45	11 45	11 45
Cape Henlopen	.....	11 51	11 43	11 43	11 43	11 43	11 43	11 43
Assateague	.....	11 55	11 33	11 33	11 33	11 33	11 33	11 33
Cape Henry	.....	12 13	11 24	11 24	11 24	11 24	11 24	11 24
Cape Hatteras	.....	.....	11 48	11 48	11 48	11 48	11 48	11 48
Ocracoke inlet	.....	.....	.....	11 42	11 42	11 42	11 42	11 42
Cape Lookout	.....	.....	.....	11 39	11 39	11 39	11 32	11 24
Beaufort entrance	.....	.....	.....	11 39	11 39	11 39	11 32	11 24
Cape Fear	.....	.....	.....	.....	11 36	11 36	11 24	11 0
Cape Roman	.....	.....	.....	.....	11 46	11 46	11 19	.....
Charleston light	.....	.....	.....	.....	.....	11 52	11 18	.....
Port Royal entrance	.....	.....	.....	.....	.....	12 3	11 18	.....
Tybee entrance	.....	.....	.....	.....	.....	.....	11 16	.....
St. Mary's entrance	.....	.....	.....	.....	.....	.....	11 55	.....
St. John's entrance	.....	.....	.....	.....	.....	.....	12 10	.....
Cape Cañaveral	.....	.....	.....	.....	.....	.....	.....	.....
Cape Florida	.....	.....	.....	.....	.....	.....	.....	.....

Thus, from Sandy Hook to Delaware bay, starting with 12 hours 5 minutes, off Barnegat there would be, at the same instant, 11 hours 57 minutes, and off Cape May 12 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, 12 hours 5 minutes, at Sandy Hook, 11 hours 57 minutes off Barnegat, 11 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 in-shore 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 Cañaveral, measured, from the several points named in the table, at right angles to the direction of the course, or measured along the parallels of latitude of the points, at distances from 195 to 28 miles, between Assateague and Cape Cañaveral, (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.

D.

Distance from coast to "cold wall" of Gulf Stream, off—	Measured at right angles to coast.	Measured on parallel of latitude.
	Naut. miles.	*Naut. miles.*
Sandy Hook	170	----------
Barnegat	135	----------
Cape May	137	----------
Cape Henlopen	137	----------
Assateague	95	195
Cape Henry	92	107
Cape Hatteras	30	31
Ocracoke inlet	53	52
Cape Lookout	53	65
Beaufort entrance	62	----------
Cape Fear	54	97
Cape Roman	57	103
Charleston light	61	95
Port Royal entrance	79	97
Tybee entrance	79	95
St. Mary's	90	87
St. John's	85	82
Cape Cañaveral	29	28
Cape Florida	----------	----------

The coasting line of thirty miles keeps inside of the cold wall all the way to Cañaveral, and all the routes traced on the chart from Sandy Hook to southern ports are on the inside of it. The Gulf Stream lines, as 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.

E.

Off—	Co-tidal hours on sailing lines between New York and—						
	Newport.	New Bedford.	Nantucket.	Boston.	Portsmouth.	Portland.	Halifax.
	h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
Sandy Hook	----------	----------	----------	----------	----------	----------	12 5
Throg's Point	16 16	16 16	16 16	16 16	16 16	16 16	----------
Fisher's island	13 48	13 48	13 48	13 48	13 48	13 48	----------
Block island	12 16	12 16	12 16	12 16	12 16	12 16	11 30
Monomoy	----------	----------	----------	16 10	16 10	16 10	----------
Cape Cod	----------	----------	----------	14 35	14 35	14 35	12 15
Cape Ann	----------	----------	----------	----------	15 00	14 40	----------
Portland	----------	----------	----------	----------	----------	15 30	----------

In passing from New York to an eastern port the first great change in the tides and tidal currents is between the East river and Long Island sound ; the difference between Governor's island and Negro Point, on Ward's island, at the eastern entrance to Hell Gate, is 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 practicable 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 12 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's 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 take 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 12 hours of Greenwich time ; that of our eastern coast, from Nantucket to Passamaquoddy, is, in general, 15 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 tract on the chart, vary their co-tidal hour but little, keeping between the lines of 12 and 11½ 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. 10.

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, 1861.

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 it is proposed to observe the tides for a long period of years, so as to have full data for the study of all their inequalities, were, at the beginning of the year: Eastport, Boston, New York, Old Point Comfort, Charleston, Fort Clinch, on the Atlantic coast; and San Diego, San Francisco, and Astoria, on the Pacific coast; Tortugas and Pensacola, on the Gulf of Mexico, were considered as partaking nearly of the character of permanent stations.

The station at Eastport was kept up by Mr. G. B. Vose, who had at the same time charge of the magnetic station at that place. In August last Mr. S. Walker was ordered to take charge of the station in place of Mr. Vose.

At the Charleston dry dock the location of the tide-gauge has become inconvenient on account of its becoming silted up so much that the low water could not always be observed, and a new tide-gauge was therefore erected under the supervision of Assistant H. Mitchell in the building used for a self-registering tide-gauge by the Harbor Improvement Commission.

At Governor's island the self-registering tide-gauge was kept in operation during the whole winter by using kerosene oil in the float tube to prevent freezing. The experiment was not perfectly successful, owing, probably, to some leakage in the tube. The corresponding observations at Brooklyn were made as usual. During part of the summer a temporary staff was used, the observer's house having been taken down by the ferry company for repairs to their wharf. They have lately finished that work and put up on it a neat house for the tide-gauge.

At the Washington navy yard the tide-gauge was kept in operation until December 12, 1860, under the care of Mr. J. W. Donn, of this division. The gauge was then removed, being needed elsewhere.

At Old Point Comfort the series was continued during the year, with the exception of some slight accidental interruptions.

The observations at Charleston were received up to April 22. The gauge was still in operation on May 4, when the last letter was received from the observer. Postal intercourse with the southern States having then become interrupted, it became impossible to communicate with him.

The tide-gauge at Fort Clinch remained under the charge of Mr. J. A. Walker until September, 1860, when he resigned, leaving the station in charge of Mr. Meares, who, being inexperienced in the use of the instruments, was replaced on November 5 by Mr. A. M. Smith; the latter resigned and left the station on the first of April. A letter was then written to Mr. Walker to pack up the gauge and send it to New York, if possible, but no answer was received, postal intercourse having in the mean time become interrupted.

From Tortugas good observations were received until May 1. The observer then advised the discontinuance of the observations on account of frequent interruptions caused by the concussions of the heavy ordnance fired for practice at the fort. There being no particular reasons for keeping up the observations, which were instituted chiefly for comparison with the other tidal stations in the Gulf of Mexico, which had all been interrupted, the observer was instructed to pack up and store away the instruments.

A full year's observations having been obtained at St. Mark's and St. Vincent's islands,

(western entrance to Apalachicola,) Mr. A. C. Mitchell was directed to take up the gauges and remove them to stations on the coast of Louisiana and Texas, where it was hoped they would scarcely be molested by the sparse population inhabiting those parts. Mr. Mitchell performed that duty with the use of the schooner Twilight, turned over to him by Sub-Assistant R. E. Halter, in Mobile. No opposition was made to the removal by the inhabitants, although the schooner had to go into the harbor of Apalachicola for repairs, owing to an accident to one of her masts. Mr. Donegan, the observer at St. Mark's, accompanied Mr. Mitchell. Mr. Maslin, from St. Vincent's island, resigned and remained at Apalachicola. The schooner then proceeded to the Southwest Pass of the Mississippi, where she arrived on the 4th of March to remove the gauge located there, it having been found superfluous to keep it up any longer, on account of a full year's self-registering observations, kindly placed at the disposal of the Coast Survey by Captain A. A. Humphreys, United States Topographical Engineers. The observer, Mr. C. Keyser, had previously resigned, having engaged in other occupation. He had been for a number of years a faithful tidal observer at numerous southern stations, under the direction of the late G. Würdemann. Mr. Mitchell then visited the tide-gauge at Last island, established in 1860, and supplied the observer with paper; and, after stationing Mr. Donegan at Calcasieu entrance, proceeded to Aransas Pass, Texas, where he established a tide-gauge on the 16th of April. Having received a draft from the office, which he was unable to negotiate at Aransas, he was obliged to go to Corpus Christi, leaving the schooner for a day or two. On April 21 she was boarded by W. H. Jones, deputy collector, and a body of nine armed rebels, several of whom still held federal commissions in the custom-house, post office, or light-house establishment, who seized her and all the public property on board. Mr. Mitchell returned to Washington in May, after a very troublesome journey through the seceded States, and was assigned to duty in Section I.

Mr. Donegan wrote to the office on May 1, transmitting his observations for April, and reporting that a committee of citizens had visited him and insisted upon reading his future correspondence. He was notified by the Superintendent, in consequence, to pack up and store his instruments in the safest place he could find, and to make his way north in the best way he could, as no money could be safely transmitted to him. A letter from him was received in August, stating that he was detained as a prisoner.

The observer at Last island was also notified to pack up his instruments, but nothing more has been heard from him. He is a resident of the neighborhood of his station. He had transmitted his observations up to April 1.

At Great Point Clear, Mobile bay, a self-registering tide-gauge had been established by Mr. Mitchell on the 20th of November, 1860, at the request of the Mobile harbor commissioners. The records were received until April 1. Since that we have had no information about it.

The tide-gauge at the Warrington navy yard had been taken down for repairs in the middle of November, and not set up again on account of Mr. Abert's absence. It was still there at the time of the seizure of the yard by the rebels.

The tide-gauge at Cape San Lucas, Lower California, gave satisfactory results after the change mentioned in last year's report. The station was discontinued July 28.

The three stations at San Diego, San Francisco, and Astoria, under the general supervision of Lieutenant G. H. Elliot, United States Engineers, have continued to give the most satisfactory results, as heretofore. Every tidal station is provided with a set of meteorological instruments, which are recorded three times a day.

The following table exhibits the tidal observations received during the year, with the exclusion of those taken by the hydrographical parties for the reduction of their soundings:

List of observations received during the year ending September 30, 1861.

Section.	Name of stations.	Name of observer.	Kind of gauge.	Stations, permanent or temporary.	Time of occupation. From—	Time of occupation. To—	Total days.	Remarks.
I	Eastport, Me	G. R. Vose. S. Walker	S. R.	Permanent	Oct. 1, 1860	Sept. 30, 1861	365	
	Boston Dry Dock	T. E. Ready	Staff box	do	Oct. 1, 1860	Sept. 30, 1861	365	
II	Governor's Island, N. Y	R. T. Bassett	S. R.	do	Oct. 1, 1860	Sept. 30, 1861	365	
	Brooklyn, N. Y	do	Box.	do	Oct. 1, 1860	Sept. 30, 1861	365	Day tides for comparison with Governor's island.
III	Old Point Comfort, Va	M. C. King	S. R.	do	Oct. 1, 1860	Sept. 30, 1861	365	
	Washington Navy Yard	J. W. Donn	S. R.	Temporary	Oct. 1, 1860	Dec. 12, 1860	73	
V	Charleston, S. C	W. R. Herron	S. R.	Permanent	Oct. 1, 1860	April 22, 1861	204	
VI	Fort Clinch, Fla	A. M. Smith	S. R.	do	Sept. 1, 1860	Mar. 25 1861	206	
	Tortugas, Fla	H. Benners	S. R.	Temporary	Sept. 1, 1860	Aug. 1, 1861	273	
VII	St. Mark's, Fla	P. H. Donegan	S. R.	do	Sept. 1, 1860	Feb. 7, 1861	160	
	St. Vincent's Island, Fla	G. W. Maslin	S. R.	do	Sept. 1, 1860	Feb. 8, 1861	161	
	Warrington Navy Yard, Fla	S. T. Abert	S. R.	Permanent	Sept. 8, 1860	Nov. 16, 1860	69	
VIII	Great Point Clear, Ala	N. E. Stewart. T. Spelman	S. R.	Temporary	Nov. 20, 1860	April 1, 1861	132	
	Southwest Pass, La	C. Keyser	S. R.	do	Aug. 23, 1860	Feb. 11, 1861	172	
	Last Island, La	Peter Wilson	S. R.	do	Sept. 1, 1860	April 1, 1861	213	
	Calcasieu, La	P. H. Donegan	S. R.	do	April 1, 1861	May 1, 1861	31	
X	Cape San Lucas, L. Cal	J. Xantus	S. R.	do	June 17, 1860	July 23, 1861	406	
	San Diego, Cal	A. Cassidy	S. R.	Permanent	July 1, 1861	Aug. 1, 1861	396	
	Fort Point, Cal	H. E Uhrlandt	S. R.	do	July 1, 1861	Aug. 26, 1861	422	
XI	Astoria, Oregon	L. Wilson	S. R.	do	July 1, 1861	Aug. 1, 1861	396	

Office-work.—The following persons are now attached to this division: R. S. Avery, J. Downes, J. W. Donn, M. Thomas, and S. D. Pendleton. The following were temporarily attached to it during the year: J. R. Gilliss, Charles Balmain, L. M. Johnson, L. L. Nicholson, and P. P. Dandridge. The detail of dates of their reporting and detachment are already comprised in my report to the assistant in charge and need not be repeated here.

Mr. Avery has been chiefly engaged in a thorough revision and consolidation of the reductions of the different permanent stations, and in completing the tide tables of some of the temporary ones; also in making reductions of some of the stations in the Gulf of Mexico, and deducing the daily inequalities from them. He has besides performed miscellaneous other duties.

The work of decomposing graphically the tidal curves of the stations in the Gulf of Mexico has been distributed among Messrs. Downes, Gilliss, Balmain, Johnson, and Nicholson, Mr. Downes reading off the original sheets, and the others plotting and decomposing them. Mr. Gilliss has introduced several ingenious and time-saving improvements in the mode of executing this work. Messrs. Johnson and Nicholson were detailed to make tidal observations at the Washington navy yard during the time employed by Lieutenant Phelps in making a hydrographical survey of the Potomac river.

Mr. Donn has had, as heretofore, the duty assigned to him of examining the sheets of the self-registering tide-gauges, when received; of registering and reading them off; of acknowledging their receipt, and pointing out defects to the observers; he has besides attended to other miscellaneous duties.

M. Thomas and S. D. Pendleton have made the ordinary reductions of some of the permanent stations.

Very respectfully, your obedient servant,

L. F. POURTALES,

Assistant United States Coast Survey, in charge of Tidal Division.

Professor A. D. BACHE, LL.D.,

Superintendent United States Coast Survey.

APPENDIX No. 11.

REPORT OF PROFESSOR W. P. TROWBRIDGE, ASSISTANT COAST SURVEY, WITH RESULTS OF EXPERIMENTS MADE WITH AN INSTRUMENT DEVISED BY HIM TO REGISTER DEPTHS IN SOUNDING, AND DISTANCE AS A LOG AT SEA.

NEW YORK, *January* 25, 1862.

DEAR SIR: I respectfully beg leave to present, as a supplement to the report on my season's work in Narragansett bay, the enclosed results of experiments with the sounding apparatus and log which I have devised. These experiments were made from time to time during the season, and on referring to my note books they appear to give such satisfactory evidence of the accuracy and reliability of the instrument that I have thought it worth while to make a formal report upon the subject.

The use of the revolving helix in sounding has never before given the very nice and accurate results which were expected, and as the errors of the instrument were large, Massey's indicator, in which this principle is applied, has heretofore been chiefly employed in deep-sea soundings, where errors in determining depth might be tolerated. Having become satisfied that the faults of Massey's indicator were owing to the construction of that instrument not being adapted to the nice work which it was expected to perform, I endeavored to combine the revolving helix with the registering wheels in such a manner as to allow the blades the fullest freedom of revolution, approaching as near as possible to absolute freedom of motion in the water, and at the same time making the work which the blades have to perform in giving motion to the self-registering wheels the least possible. The form of the blades was also modified so as to present a greater surface to the water and to throw the points of action of the water as far from the axis of motion as possible, in order to give the blades the greater power to overcome the friction of the wheel work. The result of these considerations was the instrument which was used in these experiments. I believe it possesses great superiority in the following points:

1. Its delicacy or accuracy combined with strength.

2. The great range in the magnitude of the distances which may be accurately measured by it. It is quite as useful in sounding in three fathoms as in depths of three hundred or even a thousand fathoms.

3. It may, without alteration, be used as a log or a current metre. As a log a distance of one hundred and fifty miles may be run before a complete cycle in the revolution of the wheels is accomplished.

To use the instrument as a log it is only necessary to take off the lead and tow the register astern of the vessel.

Thus it will be seen, by inspecting the appended results, that the apparatus records feet in small measurements (for depth,) and miles and fractions of miles in large measurements if used as a log.

I am, very respectfully, your obedient servant,

W. P. TROWBRIDGE,
Assistant U. S. Coast Survey.

Professor A. D. BACHE,
Sup't U. S. Coast Survey.

Experiments in sounding with "sounding apparatus and log."

Mount Hope bay.—Line made fast to rail. In each series the depth is constant.

One revolution of blades = 1½ foot.

First series, September 8.					Second series, September 8.				
Number of cast.	Number of revolutions of blades.	Depth in feet and tenths.	Depth in fathoms and tenths.	Difference from mean.	Number of cast.	Number of revolutions of blades.	Depth in feet and tenths.	Depth in fathoms and tenths.	Difference from mean.
1	6.75	10.1	1.7	.0	1	7.3	11.0	1.8	.0
2	7.0	10.5	1.7	.0	2	7.3	11.0	1.8	.0
3	7.0	10.5	1.7	.0	3	7.0	10.5	1.7	.1
4	7 3	11.0	1.8	.1	4	7.5	11.3	1.9	.1
5	7.0	10.5	1.7	.0	5	7.3	11.0	1.8	.0
6	7.5	11.3	1.9	.2	6	7.3	11.0	1.8	.0
7	7.0	10.5	1.7	.0	7	7.8	11.7	1.9	.1
8	7.0	10.5	1.7	.0	8	7.5	11.0	1.8	.0
9	7.5	11.3	1.9		9	7.3	11.3	1.9	.1
					10	7.3	11.0	1.8	.0
					11	7.3	11.0	1 8	.0
					12	7.3	11.0	1.8	.0
					13	7.0	11.0	1.8	.0
					14	7.3	11.3	1.9	.1
					15	7.3	10.5	1.7	.1
					16	7.3	11.0	1.8	.0
					17	7·3	11.0	1.8	.0
Mean.....			1.7	.....	Mean.....			1.8	.....
Register No. 1.					Register No. 2.				

Experiments with sounding apparatus No. 1.

Bristol Ferry, September 20, 1861.—Boat anchored in about thirteen fathoms, and lead sent to the bottom at each cast, and all the casts in the same place. Strong tide running.

One revolution = 1½ foot.

Number of cast.	Number of revolutions of blades.	Depth of feet and tenths.	Depth in fathoms.	Difference from mean.	Remarks.
1	53.8	80.7	13.5	.1	The foregoing soundings are average results taken from a large number of experiments.
2	53.7	80.6	13.4	.0	Experiments in 22 fathoms show that the errors do not increase with the depth. Five casts in the same place gave a depth in revolution between 90 and 90.7, or a range of 1 foot only.
3	53.5	80.3	13.4	.0	
4	53.5	80.3	13.4	.0	
5	52.8	79.2	13.2	.2	
6	53.2	79.8	13 3	.1	Experiments with different weights at same depth gave nearly identical results, showing that the number of revolutions is proportional to depth and not to velocity.
7	53.3	80.0	13.3	.1	
8	53.7	80.6	13.4	.0	
9	53.5	80.3	13.4	.0	
10	52.8	79.2	13.2	.2	
11	53.7	80.6	13.4	.0	
12	53.8	80.7	13.5	.1	
13	53.2	79.8	13.3	.1	
14	53.0	79.5	13.3	.1	
15	53.8	80.7	13.3	.1	
Mean.....			13.4	.....	

Experiments in sounding with register No. 3.

Between Hog island and Prudence island, October 17, 1861.—*Slackwater lead went to soft bottom each cast.*

One revolution = 1.5 foot.

Number of cast.	Number of revolutions of blades.	Depth in feet and tenths.	Depth in fathoms and tenths.	Difference in tenths.	Number of cast.	Number of revolutions of blades.	Depth in feet and tenths.	Depth in fathoms and tenths.	Difference in tenths.
1	58.0	87.0	14.5	.1	1	57.0	85.5	14.3	.0
2	58.0	87.0	14.5	.1	2	57.8	86.7	14.5	.2
3	58.0	87.0	14.5	.1	3	57.5	86 3	14.4	.1
4	58.0	87.0	14.5	.1	4	57.2	85.8	14.3	.0
5	58.0	87.0	14.5	.1	5	55 5?	83.3	13.9?	
6	58.0	87.0	14.5	.1	6	57.1	85.7	14.3	.0
7	57.5	86.3	14.4	.0	7	57.7	86.6	14.4	.1
8	57.7	86.6	14 4	.0	8	57 0	85.5	14.3	.0
9	57.2	85.8	14.3	.1	9	56.7	85.1	14.2	.1
10	57.6	86.4	14.4	.0	10	57.3	86.0	14.3	.0
11	57.5	86.3	14.4	.0	11	57.6	86.4	14.4	.1
12	57.3	86.0	14.3	.1	12	57.4	86.1	14.3	.0
					13	57.2	85.8	14.3	.0
					14	57.0	85.5	14.3	.0
Mean.....			14.4	.....	Mean.....			14.3	.....

Experiments in sounding with register No. 1.

Off the south end of Prudence island, October 4, 1861.—*Boat anchored in about* 22 *fathoms. Strong tide running. Lead went to hard bottom each cast.*

One revolution of blades = 1.5 foot.

Number of cast.	Number of revolutions of blades.	Depth in feet.	Depth in fathoms.	Difference from mean in tenths.	Number of cast.	Number of revolutions of blades.	Depth in feet and tenths.	Depth in fathoms and tenths.	Difference from mean in tenths.
1	85.2	127.8	21.3	.0	1	90.7	136.1	22 7	.1
2	85.1	127.7	21.3	.0	2	90.3	135.5	22.6	.0
3	84.5	126.8	21.1	.2	3	90.7	136.1	22 7	.1
4	83.7	125.6	21.0	.3	4	90.5	135.8	22.6	.0
5	85.0	127.5	21.3	.0	5	90.5	135.8	22.6	.0
6	85.5	128.3	21.4	.1	6	90.0	135.0	22.5	.1
7	85.3	128.1	21.3	.0	7	90.5	135.8	22.6	.0
8	86.2	129 3	21.5	.2	8	90.5	135.8	22.6	.0
9	85.0	127.5	21.3	.0					
10	85.4	128.1	21.3	.0					
11	85.4	128.1	21 3	.0					
12	85.6	128.4	21.4	.1					
Mean.....			21.3	.....	Mean.....			22.6	.....

NOTE.—In each of the foregoing series the casts are repetitions at the same depth and in the same place. In some cases the bottom was hard and in others soft.

Experiment with sounding register No. 3.

Bristol harbor, October 19, 1861.—*With different weights attached, 7 pounds and* 28 *pounds, at same depth. Line made fast to rail.*

One revolution = 1.5 feet.

Twenty-eight pounds of lead attached.					Seven pounds of lead attached.				
Number of cast.	Number of revolutions.	Depth in feet and tenths.	Depth in fathoms and tenths.	Difference from mean.	Number of cast.	Number of revolutions of blades.	Depth in feet and tenths.	Depth in fathoms and tenths.	Difference from mean.
1	12.5	18.8	3.1	.0	1	12.7	19.1	3.2	.1
2	11.5	17.3	2.9	.2	2	12.5	18.8	3.1	.0
3	11.3	17.0	2.8	.3	3	12.0	18.0	3.0	.1
4	12.2	18.3	3.1	.0	4	12.4	18.6	3.1	.0
5	12.5	18.8	3.1	.0	5	12.5	18.8	3.1	.0
6	11.5	17.3	2.9	.2	6	13.1	19.7	3.3	.2
7	11.3	17.0	2.8	.3	7	12.5	18.8	3.1	.0
8	11.5	17.3	2.9	.2	8	12.9	19.4	3.2	.1
9	12.4	18.6	3.1	.0	9	12.1	18.2	3.0	.1
10	13.1	19.7	3.3	.2	10	12.2	18.3	3.0	.1
11	11.3	17.0	2.8	.3	11	11.8	17.7	3.0	.1
12	13.0	19.5	3.3	.2	12	12.5	18.8	3.1	.0
13	11.8	17.7	2.9	.2	13	12.0	18.0	3.0	.1
14	12.7	19.1	3.2	.1	14	12.3	18.5	3.1	.0
15	12.0	18.0	3.0	.1	15	12.7	19 0	3.2	.1
16	12.7	19.1	3.2	.1	16	12.2	18.3	3.0	.1
17	12.6	18.9	3.2	.1	17	12.7	19.0	3.2	.1
18	12.6	18 9	3.2	.1	18	12.1	18.2	3.0	.1
19	12.5	18 8	3.1	.0	19	12.3	18.5	3.1	.0
20	13.0	19.5	3.2	.1	20	11.2	16.8	2.8	.3
Means.....		18.3	3.1	.....	Means.....		18.5	3.1	.....

NOTE.—These experiments were not made under satisfactory circumstances entirely. The means, however, differ only in 0.2 feet.

Experiments with Trowbridge's "sounding apparatus and log," used as a log. Apparatus drawn after a boat with floats attached.

Register No. 1, drawn after a four-oared boat from Bowen's wharf to Church's wharf, Bristol harbor.	Feet.	Register No. 2, drawn after a two-oared boat from Derrick to Southwest wharf, Fall river.	Feet.
Number of revolutions of blades, 5,376	8,064	Number of revolutions of blades, 7,014.....	10,521
Double the distance $\frac{8,064}{2}$ = distance	4,032	Double the distance, $\frac{10,521}{2}$ = distance.....	5,260
Distance by chart.....	4,000	Distance by plane-table sheet.....	5,380
By log.....	4,032	By log.....	5,260
Difference.....	32	Difference.....	120

NOTE.—In these experiments the lines were run over and back so as to compensate for the effect of the tidal currents, thus measuring double the distance each time.

Experiments with Trowbridge's sounding apparatus and log, used as a log.

Registers No. 1 and No. 2, floated behind a two-oared boat, (dingy of schooner Caswell,) at Fall river, Massachusetts, from Derrick wharf to breakwater and back.

One revolution of blades = $1\frac{1}{2}$ foot.

Register No. 1.	Feet.	Register No. 2.	Feet.
First trial.		*First trial.*	
Number of revolutions of blades, 2,599	3,898	Number of revolutions of blades, 2,759	4,138
Double the distance, $\frac{3,898}{2}$ = distance	1,949	Double the distance, $\frac{4,138}{2}$ = distance	2,069
Second trial.		*Second trial.*	
Number of revolutions of blades, 2,795	4,192	Number of revolutions of blades, 2,926	4,389
Double the distance, $\frac{4,192}{2}$ = distance	2,096	Double the distance, $\frac{4,389}{2}$ = distance	2,195

RECAPITULATION.

Distance by—	Feet.	
Register 1—First trial	1,949	Distance by plane-table sheet = 2,136 feet.
Second trial	2,096	
Register 2—First trial	2,069	
Second trial	2,195	
	2,077	
Distance by plane-table	2,136	
Difference	59	

Experiments with Trowbridge's "sounding apparatus and log" used as a current metre, boat anchored and instruments floated astern, &c.

Experiments in the water-way of drowbridge at Stonebridge, September 14, 1861.

Very high velocity—Apparatus floated on surface.

FIRST TRIAL.

Number of revolutions of blades, 902 = 1,353 feet.
Time = 225 seconds.

$\frac{1,353}{225}$ = 6 feet a second = 21,600 = 4.1 miles per hour.

Apparatus sunk below surface by weight.

SECOND TRIAL.

Number of revolutions of blades, 3,557 = 5,320 feet.
Time = 765 seconds.

$\frac{5,320}{765}$ = 6.9 feet a second = 24,840 = 4.7 miles an hour.

Experiments off Hog Island wharf, September 20, 1861.

Boat anchored and apparatus floated astern.

FIRST TRIAL.

Number of revolutions of blades = 163 = 243 feet.
Time = 300 seconds.

$\frac{243}{300}$ = 0.8 feet a second = 2,880 feet an hour.

NOTE.—These experiments show the different uses to which the apparatus may be applied without change or modification.

APPENDIX No. 12.

REPORT OF MAJOR W. R. PALMER, U. S. TOPOGRAPHICAL ENGINEERS, ASSISTANT COAST SURVEY, IN CHARGE OF THE OFFICE, AND SUB-REPORTS OF THE CHIEFS OF OFFICE DIVISIONS.

U. S. COAST SURVEY OFFICE, *Washington, Nov.* 1, 1861.

DEAR SIR: I have the honor to submit herewith, in conformity with your instructions, the annual reports of the chiefs of the divisions of this office, in which are given a minute detail of the amount of work accomplished during the year. It will be seen, from these reports, that the past year has not fallen behind those preceding in efficiency and economy.

The diffusion of such knowledge as results from our various hydrographic, geodetic, astronomical, and magnetic operations, which in former years was freely accorded to all applicants has, by the exigencies of the times, been necessarily restricted, and in a great degree confined to the use of the general government. Much valuable and important information of various kinds has been communicated to both the War and the Navy Departments.

In connexion with this, the photographic art has lent its aid and produced numerous reductions for facilitating the demands of the office. So great, in fact, were and still are the requisitions for charts and maps of the survey for both the War and Navy Departments, that it became necessary to establish an additional division—the lithographic division—which was done early in the spring, and was placed under the charge of Prof. W. P. Trowbridge. For a more general view of this division, I would respectfully refer you to another portion of this report, where a more detailed account of its working is given. At the same time, some of the most highly finished and important charts of the survey have been completed, and were added to our former results. The final completion of these charts was much facilitated by means of photographic reductions. The printing establishment has been taxed to its utmost capacity to supply the ordinary as well as the extraordinary demands alluded to above.

I shall now refer to the different divisions of this office, in their order of precedence:

Computing division.—This division, as heretofore, under the charge of Assistant C. A. Schott, has kept up the excellent organization for which it has been distinguished in former years. I would desire to call the especial attention of the Superintendent to the laborious industry of the chief of this division, as shown in the preparation of many important papers while still efficiently directing the labors of the other members of the division, and answering, as has been done, satisfactorily, all calls for information from the field parties on the survey, as well as from many other quarters.

Tidal division.—The charge of this division has continued with Assistant L. F. Pourtales, who also reports directly to the Superintendent on the progress of the tidal reductions and discussions. Messrs. R. S. Avery, John Downes, and J. W. Donn have been employed as regular computers. Mr. C. Balmain was also so employed until May 4, when he was transferred to the miscellaneous division, as clerk to the map room. Other employés on the survey have rendered aid to Mr. Pourtales during the intervals of their field duties, as will be seen from his report, hereto appended.

Drawing division.—At the date of my last report this division was under the charge of First Lieut. Thomas Wilson, 5th infantry, U. S. A., who continued in that position until April 24, when he was relieved by Assistant H. L. Whiting, who occupied the position until July 18, when Assistant Thomas J. Lee was placed in charge.

In this division the force is two less than at the date of my last report; and the unusual number of calls for military information, and the preparation of drawings for the lithographers, have caused a very great interruption in the finished work of the division. Yet with the assistance afforded by photographic reductions the work continues in advance of the engraving.

The system adopted for the reduction of original field sheets remains unchanged, and the reductions by photography, for the finished maps, have been successfully continued.

The clerical duties of the division have been performed by Mr. W. T. Bright, who is reported by his chief as being very attentive and efficient.

Engraving division.—First Lieutenant J. R. Smead, second artillery, U. S. A., continued in charge of this division until April 24, when he was detached by orders from the War Department, and the charge has temporarily continued with Mr. Edward Wharton, assisted by Mr. C. C. Callan as clerk.

It will be seen from this report that complete success has attended the engraving of reductions made by photography, and four of our most important charts on the $\frac{1}{600}$ scale are now in hand, the material having been furnished by this process.

Electrotype and Photographic division.—This division has continued under the charge f Mr. George Mathiot, assisted by Mr. D. Hinkle, who is again highly spoken of by Mr. Mathiot for his zeal and industry in prosecuting the work of photographic reductions of maps.

Sixty plates have been electrotyped during the year—thirty-six in alto, and twenty-four in basso. Thirty-one glass "positives," one hundred and twenty-four glass "negatives," and two hundred and seventy-two "paper prints" of original charts have been produced during the year.

Archives and Library.—Six hundred volumes of original and duplicate records, one hundred and seventy-five volumes and copies of computations and reductions, and fifty-two original topographical and hydrographical sheets have been added to the archives of the survey during the past year. Eighty-one volumes have been purchased for the library, and seventy-eight added by presentation during the same period.

The attention of the Superintendent is again called to the limited space available for the preservation of the archives. A large amount of the deposits of the fire-proof building have been removed to another place of deposit in consequence of the want of room, and are now placed in a building some distance from that occupied by the librarian, and not fire-proof in its construction.

Miscellaneous division.—This division consists of the printing office and map room, and is also intrusted with the distribution of the annual report of the Superintendent. It was under the charge of First Lieutenant N. H. McLean, second infantry, U. S. A., at the date of my last report, who was detached by order of the Secretary of War, April 24, 1861. It is now in charge of Assistant Edward Goodfellow, who succeeded Assistant R. D. Cutts, July 1, 1861.

From the subjoined report of that division it will be seen that seventeen thousand five hundred and ninety-one impressions from plates of charts and sketches have been printed; thirteen thousand eight hundred and twenty-seven copies of maps, charts, and sketches, and four thousand nine hundred and forty three copies of the report of the Superintendent for the years 1851 to 1859, have been distributed since the date of my last report.

Lithographic division.—This division was organized in the month of May last, in order to aid the regular copper-plate printing department in supplying, speedily, charts for the great demand made upon the office by the existing exigencies of the naval service, and also to afford the means of printing (under due supervision) a set of descriptive memoirs and sailing directions for the coast for the use of the naval and military commanders.

The division was under the charge of Professor W. P. Trowbridge, assistant in the Coast Survey, until his assignment to duty in the field in August last; since which time the division has been in charge of Mr. W. L. Nicholson, from whose report, subjoined, it will be seen that twenty-two charts and diagrams have been transferred to stone, and also the sheets of ten memoirs of the coast; and that eleven hundred and sixty-eight impressions of charts, four hundred and sixty-four impressions of diagrams, and seven hundred copies of memoirs have been printed.

Carpentry.—The charge of the carpenter's shop remains with Mr. A. Yeatman, who is assisted by two workmen. The usual satisfaction has been given in the performance of the work of this shop. There have been made during the year various stands and cases for instruments, books, maps, and copper plates, drawing and plane-table boards, implements for the photographic purposes, packing boxes for instruments, patterns for castings, wood work for a new self-registering tide-gauge, the necessary repairs to instruments and Coast Survey buildings, and, in addition, a large amount of miscellaneous work.

Instrument shop.—The force of this shop continues the same as last year, consisting of Mr. J. Vierbuchen, master instrument maker, five workmen, and one apprentice. During the year 5 geodetic, 5 astronomical, 1 magnetic, 62 hydrographic, 23 drawing, 57 engraving, and 31 topographical instruments have been made, and 47 geodetic, 5 astronomical, 4 magnetic, 58 hydrographic, 21 drawing, 2 engraving, and 78 topographical instruments have been repaired, in addition to a variety of miscellaneous work for the use of the office and parties in the field.

I would express my acknowledgments to Captain C. P. Patterson, who succeeded Commander S. S. Lee in charge of the hydrographic division; to Professor W. P. Trowbridge, Assistant in the Coast Survey, and in charge of the lithographic division; to Joseph Saxton, assistant in weights and measures; and Samuel Hein, esq., general disbursing agent, for their cheerful co-operation in every duty in which I have been associated with them in this office.

Very respectfully, your obedient servant,

W. R. PALMER,

Major Topographical Engineers, Asst. C. S., in charge of office.

Prof. A. D. BACHE,

Superintendent United States Coast Survey.

Report of Assistant Charles A. Schott, in charge of the Computing Division.

COAST SURVEY OFFICE, *October* 31, 1861.

The usual annual report on the work done by the several computers for the year ending October 1, 1861, is herewith respectfully submitted. With the exception of a reduction in the *personnel* of the division, no change has been made in the general organization as compared with previous years. Under the present circumstances the reduced force of the computers is yet sufficient to keep up with the current field-work. Mr. W. D. Storke was sick during October, and resigned, at the expiration of his leave of absence, on February 1, 1861. Mr. B. H. Todd resigned on the 11th of May, 1861, and Mr. J. H. Patton on the 22d of the same month. Mr. J. E. Dow was appointed copyist October 30, 1860, and on the resignation of Mr. Patton attended to the clerical duty of the division. Sub-Assistant C. Fendall was temporarily attached to the division for special reduction of my solar-spot observations, from October 1, 1860, to November 16, and again from February 11 to March 11, 1861. Assistant A. S. Wadsworth was also engaged during last winter for a time in these computations.

Owing to the exigencies of the times the duty of a hydrographic survey of Casco bay, Me., was assigned to me by the Superintendent, on which operation I was engaged for three months and a half, during which interval (from July 8 to October 30) Mr. Main was acting in charge of the division, as he had done in preceding years on similar occasions.

During the fiscal year one hundred and twenty reports have been submitted, principally on the results reached by the computers and on the examination of field records.

Among other papers, I have discussed the secular change of the magnetic intensity, horizontal and total, for the coast of the United States; made a new discussion of the magnetic declinations for the epoch 1860.0 in Sections III, IV, V, VI, VII, VIII, and IX, for which isogonic lines were constructed; discussed and constructed the co-tidal lines and currents of Chesapeake bay and rivers. With the assistance of Messrs. Patton and Dow the duplicate

records of the survey were rearranged and deposited in the Treasury building. The solar-spot observations have been continued. On two hundred and eight days the sun's surface was examined. During my temporary absence these observations were made by Assistant L. F. Pourtales. The following detail statement will show the work done by each computer.

Assistant Theodore W. Werner computed the triangulation of Altemaha river to Cumberland sound; the triangulation of Indian river; of Isle au Breton sound, 1860; the observations for latitude at Assistant Davidson's secondary latitude stations, 1852, Sections X and XI; the horizontal angles at Gunstock, Wachusett, and Unkonoonuc, 1860, by the method of least squares; the observations for latitude at Point Conception; the triangulation of the Upper Patuxent, of Corpus Christi and Nueces bays; the triangulation near Anclote key, 1860–'61; the triangulation of the Hudson river near Albany, 1860; and Webber's triangulation, joining Sections V and VI.

Mr. Eugene Nulty reduced the observations for latitude at Eufala; the observations for time, azimuth, and latitude at Western ridge; the observations for time, azimuth, and latitude at Gunstock; the observations for time, azimuth, and latitude at Gray's harbor, and the observations for azimuth and latitude at Barkley No. 2, Pensacola.

Mr. James Main computed Mr. Schott's magnetic observations in Sections I, II, and III; those of Assistant Gerdes's party in Section VIII; those of the Superintendent's party in Section I; those made by Assistant Davidson in Section X, and those made in Labrador by the solar-eclipse party; prepared an abstract of magnetic results from Mr. Vose's reduction of his observations at Eastport; revised the reduction of observations for azimuth and latitude at yard; the reduction of the observations for latitude at Sulphur Peak; the reduction of observations for latitude and azimuth at Ross mountain; the reduction of observations for latitude at Presidio and Point Conception; the micrometer values of zenith telescope No. 3; and made progress with the revision of the longitude computations from the eclipse of 1851.

Dr. Gottlieb Rumpf adjusted the triangulation of St. George's sound; made an additional reduction of the primary triangles north of San Francisco; assisted in the preparation of the annual statistics; adjusted the St. Mark's and St. George's triangulation; reduced the triangulation of Boston harbor, 1860; Webber's triangulation in Section I, 1860; the triangulation of Penobscot bay and Rockland harbor, 1858–'59–'60; prepared a list of new geographical positions for the report of 1861; assisted in the reduction of tidal currents in Chesapeake bay; computed the length of Gray's Harbor base. He also attended to the insertion of geographical positions in the registers, and to furnishing information for field parties.

Mr. John Wiessner assisted in the reduction of Mr. Schott's magnetic observations of 1860; made some astronomical computations for Lieutenant Gilliss in connexion with the solar eclipse of July, 1860; reduced Assistant Boutelle's latest triangulation between St. Helena sound and Broad river; adjusted the secondary points of the Washington Branch triangulation; reduced Assistant Davidson's triangulation north of San Francisco; revised the primary and secondary triangulation between Monterey and Sanel Mount; assisted Mr. Schott in special geodetic investigations; reduced the observations for height near San Francisco bay, 1851–'60; assisted in the discussion of magnetic declinations in Section III, and also from Section IV to to IX; reduced Assistant Farley's triangulation of the Potomac and the triangulation of Santa Barbara and Indian river. He was also engaged on some statistical computations.

Mr. B. H. Todd computed the triangulation of Charlotte harbor; of San Miguel island, 1858; of St. Augustine, 1860; of Côte Blanch bay, 1859–'60; of San Pedro harbor, 1859; made a second reduction of Charlotte harbor triangulation, 1860; computed the rectangular co-ordinates for the Indian river triangulation. He was also engaged in some miscellaneous computations and in copying. He tendered his resignation on May 11.

Mr. J. H. Patton attended to the clerical duties of the division, and assisted in observing solar spots. He tendered his resignation on May 22.

Mr. J. E. Dow reported for duty October 30. He has been engaged in copying description of stations for field parties, copying for permanent record, and has assisted occasionally in the office of the assistant in charge and in the archives.

Mrs. Freeman has supplied the extra copying.

Report of Assistant L. F. Pourtales, in charge of the Tidal Division.

COAST SURVEY OFFICE, *October* 1, 1861.

The following report on the occupation of the computers in this division is respectfully submitted:

Mr. R. S. Avery has been chiefly engaged in a thorough revision of the reductions of the different permanent stations, and in completing tide-tables from them. Also in making reductions of some of the observations in the Gulf of Mexico and deducing the daily inequality from them. He has also attended to miscellaneous other duties.

Mr. John Downes has furnished the hourly readings of the tides in the Gulf of Mexico for the decompositions, and has also made ordinary reductions of the observations of some of the permanent stations.

Mr. J. W. Donn has read off the observations from the sheets of the self-registering tide-gauges; kept a register of the observations received; noted their defects and corresponded with the observers. He has besides done miscellaneous copying and other work.

Mr. J. R. Gilliss was employed on plotting and decomposing graphically the tides of the Gulf of Mexico until December 17, when he was detached from this division.

Mr. Chas. Balmain was engaged in work similar to Mr. Gilliss, and also in reducing some of the results obtained, until May 4, when he was detached from this division for duty in the map room.

Mr. L. M. Johnson reported for duty on April 1, and has been engaged since in ordinary reductions, plottings, and decompositions.

Mr. L. L. Nicholson was temporarily attached to this division from March 26 to July 26, and was engaged in plotting tides of the Gulf of Mexico preparatory to decomposition.

Mr. P. P. Dandridge was temporarily attached to the tidal division from April 2 to 19, during which time he made reductions of the Governor's island tides.

M. Thomas and *S. D. Pendleton* have made ordinary reductions of some of the permanent stations.

Report of Assistant T. J. Lee, in charge of the Drawing Division.

COAST SURVEY OFFICE, *October* 1, 1861.

In accordance with the regulations of the office, I beg leave to submit the following report of the operations of this division for the year ending October 1, 1861:

The division was in charge of Lieut. Thos. Wilson, U. S. A., from the date of last report to April 24, and in charge of Assistant Henry L. Whiting from that date to July 18, and of myself since July 18.

Mr. W. T. Bright has been most attentive and efficient as clerk of the division since July 1.

There has been no change during the year in the system adopted for the reduction of the original field-sheets. Reductions by photography for the finished maps have been successfully continued. The number of plane-table sheets of which generalized tracings have been made during the year is fifty-two. Of these forty-three have been photographed on the reduced scale.

For harbor charts ten tracings of plane-table sheets have been made, viz: three for the

map of Kennebec and Sheepscot rivers, $\frac{1}{40000}$; two sheets for Hudson siver No. 1, from entrance to Sing Sing, scale $\frac{1}{60000}$; and five sheets for Patuxent river, Md., (lower sheet,) scale $\frac{1}{60000}$; of these five have been photographed on the reduced scale.

The number of draughtsmen employed is two less than at the date of the last report. The finished work of the division has been much interrupted by the unusual number of calls for compilations of maps and for sketches and tracings for military information. Drawings for the lithographic press have also occupied much of the time of two of the draughtsmen since the middle of June, but notwithstanding, owing mainly to the facility afforded by photographic reductions, the work of the division continues in advance of the engraving.

The work executed during the year is as follows :

Assistant M. J. McClery has been employed upon a photographic outline of coast map and chart No. 9, from Cape Neddick, Me., to Cape Ann, Mass.; he has also hachured part of this chart upon a duplicate photograph, on a scale of $\frac{1}{40000}$, as a guide for engraving the $\frac{1}{80000}$ reductions of the same; and upon the photographic reduction of coast map and chart No. 11, from Plymouth harbor to Hyannis harbor, Mass., in the same manner hachuring portions on a photograph of $\frac{1}{40000}$; and also upon a reduction of coast map and chart No. 21, New York bay and harbor, scale $\frac{1}{80000}$, filling in the topography upon an outline obtained by photography.

Mr. E. Hergesheimer has been engaged in reducing finished map of the Sheepscot and Kennebec rivers, Me., $\frac{1}{40000}$, and on verifications and projections. He has also been occupied in the generalization and preparation of sheets for photography, and in that department of the work has been engaged upon the following coast maps and charts, scale $\frac{1}{80000}$, viz: No. 7, from Musgongus bay to Portland harbor, Me.; No. 8, from Seguin island to Kennebunkport, Me.; No. 9, from Cape Neddick, Me., to Cape Ann, Mass.; No. 11, from Plymouth harbor to Hyannis harbor, Mass.; No. 21, New York bay and harbor; No. 29, from Isle of Wight, Del., to Chincoteague inlet, Va.; No. 30, from Chincoteague inlet to Great Machipongo inlet, Va.; No. 53, from Rattlesnake shoales to St. Helena, S. C.; No. 54, from Fripp's inlet, N. C., to Ossabaw sound, Ga.; No. 108, Matagorda and Lavacca bays, Texas, "G" San Francisco bay and approaches, (upper sheet,) and on Patuxent river, (lower sheet,) and preliminary chart of James river, Va., from City Point to Newport News Point. He has verified photographed negatives before they were engraved, and made tracings of and colored the photograph impressions of military map of the ground of occupation and defence of the army of the Potomac, of which twenty-five copies have been furnished to date to different superior officers of the army in much less time than could have been done by any other process. He has also made experiments upon shrinkage of paper.

Mr. A. Lindenkohl has been engaged upon the topography and hydrography of general coast chart No. I, from Quoddy Head to Cape Ann, Mass., $\frac{1}{400000}$; No. IV, from Cape May, N. J., to Currituck sound, N. C., $\frac{1}{400000}$; No. XVI, from Galveston bay to the Rio Grande, Texas, $\frac{1}{400000}$; has completed the hydrography of sub-sketch of approaches to San Francisco bay, $\frac{1}{400000}$, and added hydrography to chart of Coosaw river and Brickyard creek, S. C., and Pensacola harbor, Fla. He has continued the topography on coast map and chart No. 33, Chesapeake bay, from the mouth of Hudson river to the mouth of the Potomac, Va., $\frac{1}{80000}$; No. 36, Chesapeake bay, from York river to Cape Henry, Va., $\frac{1}{80000}$, and nearly finished the hydrography of coast map and chart No. 7, from Musgongus bay to Portland harbor, Me.; continued that of No. 54, from Fripp's inlet, S. C., to Ossabaw sound, Ga., and "G" San Francisco bay and approaches, (upper sheet.) He has made additions to chart of Chesapeake and Delaware bays, scale $\frac{1}{400000}$; compiled for lithographing chart of the coast from Cape Hatteras to Cape Florida, scale $\frac{1}{1200000}$; and of the Gulf coast in four sheets, scale $\frac{1}{600000}$; and made maps showing lines of equal magnetic declination on the Atlantic and Gulf coast, scale $\frac{1}{8000000}$. Also finished by contract harbor commissioners' map of New York bay and harbor, $\frac{1}{20000}$, and

has been engaged upon progress sketches, projections for field parties, projects, projections on copper, verifications, and made many special maps for the Superintendent.

Mr. L. D. Williams has made additions to the Congress map, added hydrography to general coast chart No. II, from Cape Ann to Gay Head, Mass., and reduced shore line on preliminary sea-coast chart No. 4, from Cape Cod to Saughkonnet Point, R. I., $\frac{1}{200000}$; begun the topography of Patuxent river, Md., (lower sheet,) $\frac{1}{60000}$; continued the topography of coast map and chart No. 8, from Seguin island to Kennebunkport, Me.; he has added topography to reduction of Ossabaw sound, Ga., $\frac{1}{30000}$; and continued the topography of Hudson river chart from entrance to Sing Sing, scale $\frac{1}{60000}$; has made projections for field parties, projections on copper, and verifications.

During the whole of the month of May and the greater part of the months of April and June Mr. Williams was absent on leave, employed on military service in command of a company of District of Columbia volunteers.

Mr. A. Strausz was employed upon the hydrography of coast map and chart No. 34, Chesapeake bay, from the Potomac river to the entrance to Pocomoke sound, Va., $\frac{1}{80000}$; No. 54, from Fripp's inlet, S. C., to Ossabaw sound, Ga., $\frac{1}{80000}$; No. 81, from Chassahowitzka river to Cedar Keys, Fla.; and also upon preliminary sea-coast chart No. 14, from Cape Roman, S. C., to Savannah, Ga., $\frac{1}{200000}$; has worked upon the topography of Port Royal entrance, S. C., $\frac{1}{60000}$; and was engaged upon the hydrography of Ossabaw sound, Ga., $\frac{1}{30000}$, until the 20th of March, when he left the office.

Mr. W. T. Martin, until April 23, was employed upon hydrography of coast map and chart No. 8, from Seguin island to Kennebunkport, Me., $\frac{1}{80000}$, and has filled in portions of topography upon a photographed outline of coast map and chart No. 29, from Isle of Wight, Del., to Chincoteague inlet, Va., to Great Machipongo inlet, Va., and revised the lettering on coast map and chart No. 35, Chesapeake bay, from the entrance of Pocomoke sound to the mouth of York river; also filled in topography and photographed outline of coast map and chart No. 54, from Fripp's inlet, S. C., to Ossabaw sound, Ga.; No. 81, from Chassahowitzka river to Cedar Keys, Fla., and continued the hydrography of coast map and chart No. 108, Matagorda and Lavacca bays, Texas, and was engaged on verifications up to April 23, when he resigned.

Mr. S. B. Linton was engaged upon reduction of topography of coast map and chart No. 35, Chesapeake bay, from the entrance to Pocomoke sound to the mouth of York river, Va.; No. 36, Chesapeake bay, from the mouth of York river to the entrance of the bay. He completed the topography and hydrography of Escambia and Santa Maria de Galvaez bays, Fla., $\frac{1}{30000}$, and topography of Patuxent river, Md., (upper sheet,) $\frac{1}{50000}$; strengthened the photographed edition and completed the hydrography of Drake's bay, Cal., $\frac{1}{40000}$. He worked upon progress sketches, projections, and had in hand hydrography of Coosaw river and creeks, S. C., $\frac{1}{40000}$, until April 23, when he resigned.

Mr. T. Jekyll entered the office 1st July, and has been engaged upon the topography of a photographed outline of Patuxent river, Md., (lower sheet,) $\frac{1}{60000}$; he has also drawn in lithographic ink Patuxent river, Md., (upper sheet,) $\frac{1}{30000}$; maps of lines of equal magnetic declination of Atlantic and Gulf coasts, Trowbridge's deep-sea apparatus, sketch of east end Santa Rosa island, Fla., sketch of Tortugas, Fla., lithographed sailing directions to chart of Port Royal entrance, S. C., verifications, and engraved notes on stone. Mr. Jekyll resigned on the 1st of October.

Mr. F. Fairfax has completed topography and hydrography of Napa creek, Cal., $\frac{1}{40000}$; has been engaged upon the triangulation sketch of Hudson river, $\frac{1}{6000}$ and $\frac{1}{100000}$, and has been employed upon projections for field parties, progress sketches, statistics, in lettering plane-table sheets, coloring maps, verification, and in tracing; he has also completed the photographed outline of topography of Barnstable harbor, Mass., $\frac{1}{20000}$.

Mr. H. Lindenkohl entered the office on the 12th June, and since that time has been

employed continuing the hydrography of Coosaw river and creeks, $\frac{1}{40000}$; hydrography of Hudson river No. 2, from Sing Sing to Poughkeepsie, $\frac{1}{60000}$; topography of coast map and chart No. 40, Albemarle sound, western part, $\frac{1}{80000}$; coast map and chart No. 41, Albemarle sound, eastern part, $\frac{1}{80000}$; has also added topography to chart of Savannah river, Ga., $\frac{1}{40000}$, and has made lithographic drawings, projections for field parties, and tracings.

Mr. J. W. Maedel has been engaged in making tracings of original sheets for the photograph; he has also drawn geological sketch coast of Labrador, $\frac{1}{3000000}$, for report of eclipse expedition; Coquille river entrance, Oregon, $\frac{1}{10000}$; has made diagrams, lithographic drawings, lettered plane-table sheets, and miscellaneous work.

Mr. B. Hooe, jr., has continued on tracings, statistics, and miscellaneous office-work.

Mr. W. H. Gardner has been engaged in tracing, and has generalized original topographical sheets for photography.

Mr. W. Fairfax has been engaged in tracing, marking limits of plane-table sheets on progress sketches, and engaged on statistics.

List of maps and sketches completed or in progress during the year ending November 1, 1861, arranged in order of sections.

Name.	Scale.	Description.	Remarks.
SECTION I.—*Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.*			
Progress sketch A	1-600,000		
Do ..... A *bis*	1-400,000		
Sheepscot and Kennebec rivers, Maine	1-40,000	Finished map	In progress.
Coast map and chart, No. 7, from Muscongus bay to Portland harbor, Maine	1-80,000	Finished map and chart	In progress; outline by photography.
Coast map and chart, No. 8, from Seguin Island light to Kennebunkport, Maine	1-80,000	do	Do.
Coast map and chart, No. 9, from Cape Neddick, Maine, to Cape Ann, Mass	1-80,000	do	Do.
Coast map and chart, No. 11, from Plymouth harbor to Hyannis harbor, Mass	1-80,000	do	Do.
General coast chart, No. I, from Quoddy Head to Cape Ann, Mass.	1-400,000	Finished chart	In progress.
Barnstable harbor, Mass	1-20,000	Finished map	In progress; outline by photography.
SECTION II.—*Coast of Connecticut, New York, New Jersey, and Delaware, north of Cape Henlopen.*			
Progress sketch, Hudson river, (in two parts)	1-100,000 1-200,000		
Coast map and chart, No. 21, New York bay and harbor	1-80,000	Finished map and chart	In progress; outline by photography.
Commissioners' map New York bay and harbor	1-20,000	Finished map	Completed.
Hudson river, from entrance to Sing Sing, New York	1-60,000	do	In progress.
Hudson river, from Sing Sing to Poughkeepsie	1-60,000	do	Do.
SECTION III.—*Coast of Delaware, south of Cape Henlopen; Maryland and Virginia, north of Cape Henry.*			
Progress sketch C	1-400,000		
General coast chart No. IV, from Cape May, New Jersey, to Currituck sound, North Carolina	1-400,000	Finished chart	In progress.
St. Mary's river, Maryland, (additions)	1-60,000	Finished map	Completed.
Chesapeake and Delaware bays, (additions)	1-400,000	Preliminary chart	Do.
Coast map and chart, No. 29, from Isle of Wight, Delaware, to Chincoteague inlet, Virginia	1-80,000	Finished map and chart	In progress; outline partly by photography.

List of maps, sketches, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION III—Continued.			
Coast map and chart, No. 30, from Chincoteague inlet, Virginia, to Great Machipongo inlet, Virginia	1-80,000	Finished map and chart	In progress; outline by photography.
Coast map and chart, No. 33, Chesapeake bay, from Hudson river to Potomac river, Maryland	1-80,000	do	Completed.
Patuxent river, Maryland, (upper sheet)	1-30,000	Preliminary chart	Do.
Patuxent river, Maryland, (lower sheet)	1-60,000	Finished map	In progress; outline by photography.
Coast map and chart, No. 34, Chesapeake bay, from Potomac river, Maryland, to entrance to Pocomoke sound, Virginia	1-80,000	Finished map and chart	Completed.
Coast map and chart, No. 35, Chesapeake bay, from Pocomoke sound to York river, Virginia	1-80,000	do	Do.
Coast map and chart, No. 36, Chesapeake bay, from York river to entrance, Virginia	1-80,000	do	In progress.
James river entrance, Virginia	1-80,000	Preliminary sketch	Completed by photography.
SECTION IV.—*Coast of Virginia, south of Cape Henry, and North Carolina, north of Cape Fear.*			
Progress sketch D	1-400,000		
General coast chart, No. V, from Currituck sound to Cape Fear, North Carolina	1-400,000	Finished chart	In progress.
General coast chart, No. VI, from Ocracoke inlet, North Carolina, to Charleston, South Carolina	1-400,000	do	Do.
Coast map and chart, No. 40, Albemarle sound, (western sheet)	1-80,000	Finished map and chart	Completed.
Coast map and chart, No. 41, Albemarle sound, (eastern sheet)	1-80,000	do	Do.
SECTION V.—*Coast of North Carolina, south of Cape Fear, South Carolina, and Georgia.*			
Progress sketch E	1-600,000		
General coast chart, No. VI, from Ocracoke inlet, North Carolina, to Charleston, South Carolina	1-400,000	Finished chart	In progress
Peliminary sea-coast chart, No. 14, from Cape Roman, South Carolina, to Savannah, Georgia	1-200,000	Preliminary chart	Do.
Coast map and chart, No. 53, from Rattlesnake shoals to St. Helena sound, South Carolina	1-80,000	Finished map and chart	In progress; outline by photography.
Coast map and chart, No. 54, from Fripp's inlet, South Carolina, to Ossabaw sound, Georgia	1-80,000	do	Do.
Coosaw river and Brickyard creek, South Carolina	1-40,000	Preliminary chart	Completed.
Port Royal and Broad rivers, South Carolina	1-60,000	do	Do.
Savannah river, Georgia, (additions)	1-40,000	Finished map	In progress.
Ossabaw sound, Georgia	1-30,000	do	Completed.
SECTION VI.—*Coast of Florida, from St. Mary's river to St. Joseph's bay.*			
Progress sketch F, (reefs and keys)	1-400,000		
General coast chart, No. X, from Cape Florida to Cape Sable, Fla.	1-400,000	Finished chart	In progress.
SECTION VII.—*Coast of Florida, west of St. Joseph's bay, and Alabama, east of Mobile bay.*			
Progress sketch G	1-600,000		
Coast map and chart, No. 81, from Chassahowitzka river to Cedar Keys, Florida	1-80,000	Finished map and chart	In progress; outline by photography.
Escambia and Santa Maria de Galvaez bay, Florida	1-30,000	Preliminary chart	Completed.
Cedar Keys, Florida, (new edition)	1-50,000	Finished map	Do.
SECTION VIII.—*Coast of Alabama, west of Mobile bay, Mississippi and Louisiana, east of Vermilion bay.*			
Progress sketch H	1-600,000		
Coast map and chart, No. 92, from Round island to Grand island, Louisiana, (additions)	1-80,000	Finished map and chart	Completed.

List of maps, sketches, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION VIII—Continued.			
Coast map and chart, No. 93, from Lake Borgne to Lake Pontchartrain, Louisiana	1-80,000	Finished map and chart	In progress.
Passe à Loutre, Mississippi delta	1-20,000	Finished map	Completed.
SECTION IX.—*Coast of Louisiana, west of Vermilion bay, and Texas.*			
Progress sketch I	1-600,000		
General coast chart, No. XVI, from Galveston bay to the Rio Grande, Texas	1-400,000	Finished chart	In progress.
Coast map and chart, No 107, from Oyster bay to Matagorda bay, Texas	1-80,000	Finished map and chart	Do.
Coast map and chart, No. 108, Matagorda and Lavacca bays, Texas.	1-80,000	....do	In progress; outline by photography.
SECTION X.—*Coast of California.*			
Progress sketch J, (from San Diego to Point Sal)	1-600,000		
Progress sketch J, (from Point Sal to Tomales)	1-600,000		
Napa creek, California	1-20,000	Finished map	In progress.
Approaches to San Francisco, (sub-sketch on 1-50,000 chart of San Francisco)	1-400,000	Sketch	Completed.
Drake's bay, California	1-40,000	Finished map	In progress.
SECTION XI.—*Coast of Oregon and Washington Territory.*			
Progress sketch K	1-600,000		
Progress sketch K *bis*	1-600,000		
Coquille river entrance, Oregon	1-10,000	Sketch	Completed.
MISCELLANEOUS.			
Gulf of Mexico, (in four sheets)	1-600,000	Preliminary chart	Do.
Atlantic coast, from Cape Hatteras to Cape Florida	1-1,200,000	....do	Do.
Diagram of Atlantic coast, with lines of equal magnetic declination.	1-8,000,000	Diagram	Do.
Diagram of Gulf coast, with lines of equal magnetic declination	1-8,000,000	....do	Do.
Trowbridge's deep-sea apparatus			Do.
Geology coast of Labrador, for report of eclipse expedition	1-5,000,000	Sketch	Do.

Report of Mr. Edward Wharton, acting in charge of Engraving Division.

U. S. COAST SURVEY OFFICE, *October* 31, 1861.

I have the honor to present the annual report of the operations of this division during the year ending October 31, 1861.

This division remained under the charge of Lieutenant J. R. Smead, U. S. A., from the date of the last annual report until April 24, when he was relieved from duty here by the War Department. Since that date the division remained under my charge, and I have been very materially assisted by Mr. C. C. Callan as clerk to the division, and whose valuable services it gives me pleasure to acknowledge.

The engraving upon copper, from reductions by photography, has been attended with complete success, the engravers, in each instance, proving the entire practicability of engraving from these reductions with as much facility as from hand reductions; and there are now four charts of the most important localities on our coast, of the $\frac{1}{600}\frac{1}{000}$ series, in process of engraving. A detailed account of these reductions, both as to scale and the method of representing the various features of the country, will be found in the report of last year.

The engraving force at present consists of twenty-three engravers of various degrees of skill. A list is given below with the grade of each engraver and the amount of work accomplished by each during the year. The engraving of the following finished maps and charts has

been completed, viz: coast charts Nos. 12, 13, and 14, $\frac{1}{80000}$, extending from Monomoy to Block island; coast chart No. 31, Chesapeake bay, No. 1, head of bay to Magothy river, $\frac{1}{80000}$; coast chart No. 33, Chesapeake bay, No. 3, Hudson river to the Potomac river, $\frac{1}{80000}$; Rappahannock river, No. 6, (lower sheet,) $\frac{1}{60000}$; St. Mary's river, Md., $\frac{1}{60000}$; coast chart No. 68, Florida reef, Key Biscayne to Carysfort reef, $\frac{1}{80000}$; coast chart No. 92, Mississippi sound, Round island to Grand island, $\frac{1}{80000}$; and additions and corrections in topography and lettering to coast charts Nos. 40 and 41, Albemarle sound, $\frac{1}{80000}$, previously reported as finished, have been engraved.

The following second class charts and sketches have been completed, viz: Patuxent river, Md., (upper sheet,) $\frac{1}{30000}$; North Landing river, Va., and N. C., $\frac{1}{40000}$; preliminary sea-coast chart No. 14, Cape Roman, S. C., to Tybee island, Ga., $\frac{1}{200000}$; Cedar Keys, Fla., $\frac{1}{50000}$; Passe à Loutre, Mississippi delta, $\frac{1}{20000}$.

And the following have been prepared for preliminary editions previous to their completion, viz: Ossabaw sound, Ga., $\frac{1}{30000}$; general coast chart No. X, Key Biscayne to Marquesas keys, Fla., $\frac{1}{40000}$; St. Augustine harbor, Fla., $\frac{1}{30000}$; Escambia and Santa Maria de Galvaez bays, Fla., $\frac{1}{30000}$; and Drake's bay, Cal., $\frac{1}{40000}$.

Considerable progress has been made towards completion upon the following important charts, viz: general coast chart No. II, Cape Ann to Gay Head, Mass., $\frac{1}{400000}$; coast charts Nos. 8, 9, 11, $\frac{1}{80000}$, embracing portions of the coast of Maine, all of New Hampshire, and a part of Massachusetts; coast chart No. 21, New York bay and harbor, $\frac{1}{80000}$, (the outlines of which have been engraved entirely from photographic reductions;) coast charts Nos. 32, 34, 35, 36, $\frac{1}{80000}$, being a portion of the Chesapeake bay series; coast chart No. 71, $\frac{1}{80000}$, a portion of the Florida reefs; and coast charts Nos. 106 and 107, $\frac{1}{80000}$, a part of the coast of Texas from Galveston to Matagorda; and the following harbor and other charts have been pushed forward towards completion, viz: Portland harbor, Me., $\frac{1}{20000}$; Sheepscot and Kennebec rivers, Me., $\frac{1}{40000}$; Hudson river, New York, (lower sheet,) $\frac{1}{60000}$; St. Simon's sound; Sapelo sound and Savannah river, Ga., St. Mary's river and Fernandina harbor, Fla.; western part of St. George's sound, Fla., $\frac{1}{40000}$; and San Pablo bay, Cal., $\frac{1}{50000}$.

The engraving force has been principally employed as follows:

Mr. McCoy, topographical engraver, has been employed during the year on the outlines and topography of coast chart No. 11, "Plymouth harbor to Hyannis harbor, Mass.," $\frac{1}{80000}$, taken from photographic reductions.

Mr. Knight, letter engraver, has engraved the soundings, lettering, title, and notes on general coast chart No. X, "Key Biscayne to Marquesas keys," $\frac{1}{400000}$; notes on coast chart No. 13, "Buzzard's bay to Martha's Vineyard," $\frac{1}{80000}$; lettering and notes on coast chart No. 33, "Chesapeake bay, No. 3, Hudson river to the Potomac river," $\frac{1}{80000}$; soundings and lettering on coast chart No. 36, Chesapeake bay No. 6, "York river to entrance of bay," $\frac{1}{80000}$; sailing directions, title and lettering on "San Pablo bay, Cal.," $\frac{1}{50000}$; and some additional lettering on coast charts Nos. 40 and 41, "Albemarle sound," $\frac{1}{80000}$; "San Francisco bay," and other charts.

Mr. Rollé, topographical engraver, has been employed principally upon the outline and topography of "coast chart No. 9, Cape Neddick to Cape Ann, Mass., $\frac{1}{80000}$," taken entirely from photographic reductions.

Mr. Enthoffer, topographical engraver, has been engaged during the year in engraving the topography upon the plate of "coast chart No. 8, Seguin island to Kennebunkport, Me., $\frac{1}{80000}$," and in the completion of the topography upon "coast chart No. 33, Chesapeake bay, No. 3, Hudson river to the Potomac river, $\frac{1}{80000}$."

Mr. Sengteller, topographical engraver, has completed the engraving of the sand upon coast chart No. 12, Nantucket sound, Mass., $\frac{1}{80000}$, (upper half,) and the topography upon coast chart No. 68, Key Biscayne to Carysfort reef, Fla., $\frac{1}{80000}$, and some miscellaneous retouching;

and is at present employed upon the topography of "coast chart No. 36, Chesapeake bay, No. 6, York river to entrance of bay, $\frac{1}{80000}$."

Mr. Phillips, topographical engraver, has completed the sand upon coast chart No. 12, "Nantucket sound," $\frac{1}{80000}$, (lower half,) and the topography upon coast chart No. 34, Chesapeake bay, No. 4, "Potomac river to Pocomoke sound," $\frac{1}{80000}$; also some miscellaneous retouching and additions to other charts; and is now engaged upon and nearly completed the topography on coast chart No. 35, Chesapeake bay, No. 5, "Potomac sound to York river," $\frac{1}{80000}$.

Mr. Metzeroth, topographical engraver, has completed the sanding upon coast chart No. 31, Chesapeake bay, No. 1, "Head of bay to Magothy river," $\frac{1}{800000}$; and has also engraved some additional sand on coast chart No. 33, Chesapeake bay, No. 3, "Hudson river to the Potomac river," $\frac{1}{800000}$; and is now occupied upon the topography of "Portland harbor, Maine," $\frac{1}{20000}$, in which he has made great progress.

Mr. Blondeau, topographical engraver, has been employed in engraving the topography upon general coast chart No. II, "Cape Ann to Gay Head, Mass.," $\frac{1}{400000}$, and coast chart No. 71, "Newfound Harbor key to Boca Grande key, Florida," $\frac{1}{80000}$, upon which he is now engaged.

Mr. Evans, topographical engraver, has engraved a portion of the topography upon Hudson river, New York, $\frac{1}{60000}$, and Sheepscot and Kennebec rivers, Maine, $\frac{1}{40000}$; and is now engaged upon and has nearly completed the sanding upon coast chart No. 32, Chesapeake bay, No. 2, "Magothy to the Hudson river," $\frac{1}{80000}$.

Mr. Barnard, topographical engraver, has been occupied in engraving sand upon "coast chart No. 33, Chesapeake bay, No. 3, Hudson river to the Potomac river," $\frac{1}{80000}$; "San Pablo bay, California," $\frac{1}{50000}$; and some miscellaneous work on coast chart No. 27, "Delaware bay and river, No. 1," $\frac{1}{80000}$, and No. 92, Mississippi sound, "Round island to Grand island," $\frac{1}{80000}$; and is now engaged upon the sanding of coast chart No. 34, Chesapeake bay, No. 4, "Potomac river to Pocomoke sound," $\frac{1}{80000}$.

Mr. A. Maedel, topographical engraver, has completed the topography upon Rappahannock river, Virginia, No. 5, Rappahannock river, Virginia, No. 6, $\frac{1}{60000}$; Cedar Keys, Florida, $\frac{1}{50000}$; St. Mary's river, Md., $\frac{1}{60000}$; and Patuxent river, Md., $\frac{1}{30000}$, and has engraved some additional topography upon coast charts 40 and 41, Albemarle sound, $\frac{1}{80000}$; and is now engaged upon the topography upon Sapelo sound, Georgia, $\frac{1}{30000}$.

Mr. Kondrup, miscellaneous engraver, has completed the outlines of coast chart No. 21, New York bay and harbor, $\frac{1}{80000}$, reduced entirely from photographic reductions and has engraved the soundings, title lettering, notes, sailing directions, outlines, and some topography upon Drake's bay, California, $\frac{1}{40000}$.

Mr. E. A. Maedel, letter engraver, has engraved the sailing directions and lettering on coast chart No. 68, Key Biscayne to Carysfort reef, Florida, $\frac{1}{50000}$; sailing directions, notes, and some lettering on coast chart No. 92, Mississippi sound, Round island to Grand island, $\frac{1}{80000}$; soundings on Patuxent river, Md., (upper half,) $\frac{1}{30000}$; and some miscellaneous lettering upon various charts, Nos. 12, 13, 14, 27, 31, and 32, $\frac{1}{80000}$.

Mr. Ogilvie, letter engraver, has engraved the title and some lettering on "coast chart No. 92, Mississippi sound, Round island to Grand island," $\frac{1}{80000}$; notes on Passe à Loutre, Mississippi delta, $\frac{1}{20000}$; title and sailing directions on "Western part of St. George's sound, Florida," $\frac{1}{40000}$; some dry sand on "St. Augustine harbor, Florida," $\frac{1}{30000}$; and on "Ossabaw sound, Georgia," $\frac{1}{30000}$; and is now employed upon the sand of "Savannah river, Georgia," $\frac{1}{40000}$.

Mr. Langran, letter engraver, has engraved the soundings, title notes, and sailing directions on "Cedar Keys, Florida," $\frac{1}{50000}$; title notes and lettering on "Escambia and Santa Maria de Galvaez bays, Florida," $\frac{1}{30000}$; soundings, lettering, and sailing directions on "St. Simon's sound, Georgia," $\frac{1}{40000}$; some lettering on "Western part of St. George's sound, Florida," $\frac{1}{40000}$;

corrections and additional soundings on "Preliminary sea-coast chart No. 14, Cape Roman, S. C., to Tybee, Geo.," $\frac{1}{200000}$, and considerable miscellaneous work.

Mr. Petersen, miscellaneous engraver, has engraved title and notes on "St. Simon's sound, Geo.," $\frac{1}{40000}$; lettering and notes on "St. Augustine harbor, Florida," $\frac{1}{30000}$; soundings, lettering, notes, sailing directions, and title on "Ossabaw sound, Georgia," $\frac{1}{30000}$; all the triangulation and lettering on "New Progress Sketch, Section II," 1–1 and 200,000; and some additional lettering and soundings on "Portland harbor, Maine," $\frac{1}{20000}$; and on "Preliminary sea-coast chart No. 3, Cape Small Point, Maine, to Cape Cod, Mass.," $\frac{1}{200000}$; besides being employed upon diagrams and miscellaneous work.

Mr. Bartle, topographical engraver, has been engaged principally in engraving the topography on "Coast chart No. 106, Galveston bay to Oyster bay, Texas," $\frac{1}{80000}$, in which he has made great progress. He has also engraved outlines and a portion of the topography on "Cedar Keys, Florida," $\frac{1}{50000}$, and some diagrams and miscellaneous work, and is now employed upon the topography of St. Mary's river and Fernandina harbor, Florida, $\frac{1}{20000}$.

Mr. W. A. Thompson, topographical engraver, has completed the topography upon "Western part of St. George's sound, Florida," $\frac{1}{40000}$, and a portion of the topography of "Coast chart No. 107, Oyster bay to Matagorda bay, Texas," $\frac{1}{80000}$; together with a large amount of corrections and additions to various progress sketches, and some miscellaneous work.

Mr. Benner, miscellaneous engraver, has engraved the sanding on "Rappahannock river, No. 6, Virginia," $\frac{1}{60000}$; a portion of the sand on Patuxent river, Maryland, (upper sheet,) $\frac{1}{30000}$; besides progress and other sketches, and some miscellaneous work.

Mr. Klakring, miscellaneous engraver, has been employed, almost continually, upon miscellaneous work, consisting chiefly of additions and corrections, both in topography and lettering. He has also engraved the soundings, bottoms, outlines, and some lettering upon "Escambia and Santa Maria de Galvaez bays, Florida," $\frac{1}{30000}$; the topography upon "Passe à Loutre, Mississippi delta," $\frac{1}{30000}$; title and lettering upon "Patuxent river, Maryland," $\frac{1}{30000}$; and a large amount of work on the progress sketches.

Mr. Sipe, miscellaneous engraver, has engraved the soundings, title, lettering, and notes on "Passe à Loutre, Mississippi delta," $\frac{1}{20000}$; the outlines of "Ossabaw sound, Georgia," $\frac{1}{50000}$; the notes of Patuxent river, Maryland, $\frac{1}{50000}$; and also some diagrams, progress sketches, and miscellaneous work.

Mr. J. G. Thompson, miscellaneous engraver, has engraved the outlines, soundings, lettering, notes, and topography on "North Landing river, Va. and N. C.," $\frac{1}{30000}$; and has been employed upon progress sketches, diagrams, and miscellaneous work.

Mr. Buckle has been engaged since his employment in perfecting himself in the use of his machine for punching, and has punched the soundings on "Coquilla river, Oregon," $\frac{1}{10000}$.

List of maps, preliminary charts, and sketches engraved or engraving during the year ending October 31, 1861, arranged in order of sections.

Name.	Scale.	Description.	Remarks.
SECTION I.			
Progress sketch A	1-400,000	Sketch	Engraved.
Do ....A *bis*	1-600,000	....do	Do.
General coast chart, No. 2, Cape Ann to Gay Head, Mass	1-400,000	General coast chart	Engraving.
Preliminary coast chart, No. 3, Cape Small Point, Me., to Cape Cod, Mass	1-200,000	Preliminary chart	Do.
Coast chart, No. 8, Seguin island to Kennebunkport	1-80,000	Finished map and chart	Do.
Coast chart, No. 9, Cape Neddick to Cape Ann	1-80,000	....do	Do.
Coast chart, No. 11, Plymouth harbor to Hyannis harbor	1-80,000	....do	Do.
Coast chart, No. 12, Nantucket sound, Mass	1-80,000	....do	Engraved.
Coast chart, No. 13, Buzzard's bay and Martha's Vineyard	1-80,000	....do	Do.
Coast chart, No. 14, Point Judith to Block Island sound	1-80,000	....do	Do.
Sheepscot and Kennebec rivers, Maine	1-40,000	Finished chart	Engraving.
Portland harbor, Maine	1-20,000	Finished harbor chart	Do.
Hyannis harbor, Mass., (corrections and additions)	1-30,000	....do	Engraved.
SECTION II.			
Progress sketch, New York bay and Hudson river, (new edition)	1-100,000	Sketch	Engraved.
Coast chart, No. 15, Long Island sound, (east,) corrections and additions	1-200,000 1-80,000	Finished map and chart	Do.
Coast chart, No. 16, Long Island sound, (middle,) corrections and additions	1-80,000	....do	Do.
Coast chart, No. 27, Delaware bay and river, No. 1, corrections and additions	1-80,000	....do	Do.
Coast chart, No. 21, New York bay and harbor	1-80,000	....do	Engraving.
Hudson river, (lower sheet)	1-60,000	Finished chart	Do.
SECTION III.			
Progress sketch C	1-400,000	Sketch	Engraved.
Chesapeake bay, No. 1, head of bay to Magothy river	1-80,000	Finished map and chart	Do.
Chesapeake bay, No. 2, Magothy to the Hudson river	1-80,000	....do	Engraving.
Chesapeake bay, No. 3, Hudson to the Potomac river	1-80,000	....do	Engraved.
Chesapeake bay, No. 4, Potomac river to Pocomoke sound	1-80,000	....do	Engraving.
Chesapeake bay, No. 5, Pocomoke sound to York river	1-80,000	....do	Do.
Chesapeake bay, No. 6, York river to entrance of bay	1-80,000	....do	Do.
Patuxent river, Maryland, (upper)	1-30,000	Preliminary chart	Engraved.
St. Mary's river, Maryland	1-60,000	Finished chart	Do.
Rappahannock river, No. 5	1-60,000	....do	Engraving.
Rappahannock river, No. 6	1-60,000	....do	Engraved.
Delaware and Chesapeake bays, (additions)	1-400,000	Preliminary chart	Do.
SECTION IV.			
Progress sketch D	1-400,000	Sketch	Engraved.
North Landing river	1-40,000	Preliminary chart	Do.
Albemarle sound, west, (additions)	1-80,000	Finished chart	Do.
Albemarle sound, east, (additions)	1-80,000	....do	Do.
SECTION V.			
Progress sketch E	1-600,000	Sketch	Engraved.
Preliminary sea-coast chart, No. 14, from "Cape Roman, S. C., to Tybee, Georgia"	1-200,000	Preliminary chart	Do.
Sapelo sound, Georgia	1-30,000	....do	Engraving.
St. Simon's sound, Georgia	1-40,000	....do	Do.
Savannah river, Georgia	1-40,000	Finished chart	Do.
Ossabaw sound, Georgia	1-30,000	Preliminary chart	Engraved.
SECTION VI.			
Progress sketch F	1-1,200,000	Sketch	Engraved.
Progress sketch F, (lower sheet)	1-400,000	....do	Do.
General coast chart, No X, Key Biscayne to Marquesas key	1-400,000	General coast chart	Engraving.
Coast chart, No. 68, Key Biscayne to Carysfort reef	1-80,000	Finished map and chart	Engraved.
Coast chart, No. 71, Newfound Harbor key to Boca Grande key	1-80,000	....do	Engraving.
St. Augustine harbor, Florida	1-30,000	Preliminary chart	Do.
St. Mary's river and Fernandina harbor, Florida	1-20,000	....do	Do.

List of maps, preliminary charts, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION VII.			
Progress sketch G	1–600,000	Sketch	Engraved.
Cedar Keys, Florida	1–50,000	Preliminary chart	Do.
Western part St. George's sound, Florida	1–40,000	do	Engraving.
SECTION VIII.			
Progress sketch H	1–600,000	Sketch	Engraved.
Coast chart, No. 92, Round island to Grand island, Mississippi sound	1 80,000	Coast map and chart	Do.
Escambia and Santa Maria de Galvaez bays, Florida	1 30,000	Preliminary chart	Do.
Passe à Loutre, Mississippi delta	1–20,000	do	Do.
Lines of deep-sea soundings, Gulf of Mexico	1–5,000,000	Sketch	Do.
SECTION IX.			
Progress sketch I	1–600,000	Sketch	Engraved.
Coast chart, No. 106, Galveston bay to Oyster bay, Texas	1–80,000	Coast map and chart	Engraving.
Coast chart, No. 107, Oyster bay to Matagorda bay, Texas	1–80,000	do	Do.
SECTION X.			
Progress sketch J, (lower)	1–600,000	Sketch	Engraved.
Progress sketch J, No. 2, (middle)	1–600,000	do	Do.
Drake's bay, California	1–40,000	Preliminary chart	Do.
San Pablo bay, California	1–50,000	Finished harbor chart	Engraving.
SECTION XI.			
Progress sketch K	1–600,000	Sketch	Engraved.
Coquilla river, Oregon	1–10,000	do	Engraving.
MISCELLANEOUS.			
Sketch showing progress of Coast Survey, (additions)		Diagrams	Engraved.
Gulf Stream chart		do	Do.
Diagrams of Gulf Stream exploration, 1860		do	Do.
Diagrams of variation magnetic declination, Key West		do	Do.
Diagrams of plan magnetic observatory, Key West		do	Do.
Diagrams of Mitchell's specimen cup and Gilliss's compass dividers		do	Do.

LIST OF COAST SURVEY MAPS, PRELIMINARY CHARTS, AND SKETCHES, ENGRAVED, GEOGRAPHICALLY ARRANGED.

1. *List of maps and charts engraved.*

No.		
1.	Richmond's island, Maine	1–20,000
2.	Newburyport harbor, Massachusetts	1–20,000
3.	Ipswich and Annisquam harbors, Massachusetts	1–20,000
4.	Rockport harbor	1–20,000
5.	Gloucester harbor	1–20,000
6.	Salem harbor	1–25,000
7.	Lynn harbor	1–20,000
8.	Boston harbor, (new edition,) 1859	1–40,000
9.	Plymouth harbor	1–20,000
10.	Provincetown harbor	1–50,000
11.	Monomoy shoals	1–40,000
12.	Coast chart, No. 12, Nantucket sound and shoals, Massachusetts	1–80,000
13.	Coast chart, No. 13, Buzzard's bay and Martha's Vineyard, Massachusetts	1–80,000
14.	Coast chart, No. 14, Point Judith to Block island	1–80,000
15.	Bass River harbor, Massachusetts	1–40,000

No. 16.	Wellfleet harbor, Massachusetts	1–50, 000
17.	Nantucket harbor.....do	1–20, 000
18.	Muskeget channel.....do...(new edition)	1–60, 000
19.	Hyannis harbor.....do	1–30, 000
20.	Harbor of Edgartown...do	1–20, 000
21.	Harbor of Wood's Hole..do	1–20, 000
22.	Harbor of Holmes's Hole and Tarpaulin Cove, Massachusetts	1–20, 000
23.	Harbor of New Bedford.....do	1–10, 000
24.	General chart of the coast from Gay Head to Cape Henlopen	1–400, 000
25.	Fisher's Island sound, Connecticut	1–40, 000
26.	Harbor of New London, Connecticut	1–20, 000
27.	Mouth of Connecticut river....do	1–20, 000
28.	Harbor of New Haven, Connecticut, (new edition,) 1852	1–30, 000
29.	Harbor of Black Rock and Bridgeport, Connecticut, (new edition,) 1852	1–20, 000
30.	Harbors of Sheffield and Cawkin's islands, (new edition,) 1852	1–20, 000
31.	Huntington bay, New York	1–30, 000
32.	Oyster bay or Syosset harbor, New York	1–30, 000
33.	Harbors of Captain's island, East and West Connecticut	1–20, 000
34.	Hempstead harbor, Long Island, New York	1–20, 000
35.	Hart and City island and Sachem's Head harbor, New York	1–10, 000
36.	Hell Gate, New York	1–5, 000
37.	Long Island sound—east	1–80, 000
38.	Do....do.....middle	1–80, 000
39.	Do... do.....west	1–80, 000
40.	New York bay and harbor, and the environs, New York, No. 1	1–30, 000
41.	Do.....do.....do.....do..... ...do.....No. 2	1–30, 000
42.	Do.....do.....do.....do..... ...do.....No. 3	1–30, 000
43.	Do.....do.....do.....do..... ...do.....No. 4	1–30, 000
44.	Do.....do.....do.....do..... .....do.....No. 5	1–30, 000
45.	Do.....do.....do.....do..... ....do.....No. 6	1–30, 000
46.	Do.....do.....do.....do..... ....do.....	1–80, 000
47.	Western part south coast of Long Island, New York	1–80, 000
48.	Middle part....do.....do.....do.....do	1–80, 000
49.	Eastern part...do.....do.....do.....do	1–80, 000
50.	Little Egg harbor, New Jersey	1–30, 000
51.	Delaware bay and river—sheet No. 1, Delaware	1–80, 000
52.	Do.....do.....sheet No. 2, Delaware, New Jersey, and Pennsylvania	1–80, 000
53.	Delaware bay and river—sheet No. 3	1–80, 000
54.	Chesapeake bay, upper series—sheet No. 1	1–80, 000
55.	Do.....do.....sheet No. 3	1–80, 000
56.	Patapsco river, Maryland	1–60, 000
57.	Harbor of Annapolis and Severn river	1–60, 000
58.	Mouth of Chester river, Maryland	1–40, 000
59.	St. Mary's river, &c.....do	1–60, 000
60.	Rappahannock river entrance, Virginia	1–60, 000
61.	Entrance to York river	1–60, 000
62.	Pasquotank river, North Carolina	1–60, 000
63.	Albemarle sound, North Carolina—sheet No. 1	1–80, 000
64.	Do.....do.....do.....sheet No. 2	1–80, 000
65.	Beaufort harbor, North Carolina	1–20, 000
66.	Charleston harbor, South Carolina, (new edition,) 1858	1–30, 000
67.	Key West harbor and approaches, Florida	1–50, 000
68.	Coast chart No. 68, Florida reefs—Key Biscayne to Carysfort reef	1–80, 000
69.	Entrance to Mobile bay, Alabama	1–40, 000

No. 70.	Mobile bay, Alabama	1–80, 000
71.	Cat and Ship Island harbors, Mississippi	1–40, 000
72.	Coast chart, No. 91, Mississippi sound, Bonsecour's bay to Round island	1–80, 000
73.	Coast chart, No. 92, Mississippi sound, Round island to Grand island	1–80, 000
74.	Entrance to Galveston bay, Texas, (new edition,) 1856	1–40, 000
75.	San Diego bay, California	1–40, 000
76.	Entrance to San Francisco bay, California	1–50, 000

2. *List of preliminary charts and sketches engraved.*

No. 1.	Adams's rock, Maine	1–1, 000
2.	Eggemoggin reach, Maine	1–20, 000
3.	Kennebec river.....do	1–30, 000
4.	Portland harbor.....do	1–20, 000
5.	Portland harbor, (commissioners' line,) Maine	1–10, 000
6.	York River harbor, Maine	1–20, 000
7.	Portsmouth harbor, New Hampshire	1–20, 000
8.	Stellwagen's bank, (2d edition.) Massachusetts	1–400, 000
9.	Boston bay, Massachusetts	1–175, 000
10.	Current chart, Boston bay, Massachusetts	1–100, 000
11.	Minot's ledge.....do	1–10, 000
12.	Sea-coast United States, No. 4, south part of Massachusetts	1–200, 000
13.	Nantucket shoals, Massachusetts—new edition	1–200, 000
14.	Tidal current, Nantucket shoals, Massachusetts	1–300, 000
15.	Sow and Pigs reef, Massachusetts	1–240, 000 & 1–20, 000
16.	Tidal currents, Long Island, New York	1–800, 000
17.	Pot rock and Way's reef.....do	
18.	Hudson river, lower sheet.....do	1–60, 000
19.	Buttermilk channel.....do	1–5, 000
20.	Beacon ranges.....do	1–40, 000
21.	Romer shoals and Flynn knoll...do	1–40, 000
22.	Changes in Sandy Hook, New Jersey	1–10, 000 & 1–40, 000
23.	Sea-coast Delaware, Maryland, and part of Virginia	1–200, 000
24.	Delaware and Chesapeake bays	1–400, 000
25.	Chesapeake bay, (upper series,) sheet No. 2	1–80, 000
26.	Patuxent river, Maryland, upper sheet	1–30, 000
27.	Do.....do.....lower sheet	1–60, 000
28.	Chincoteague inlet, Virginia	1–40, 000
29.	Sea-coast of Virginia and entrance to Chesapeake bay	1–200, 000
30.	James river, (upper sheet,) Virginia	1–40, 000
31.	Rappahannock river, No. 1....do	1–20, 000
32.	Do.....do.. No. 2....do	1–20, 000
33.	Do.....do.. No. 3....do	1–20, 000
34.	Do.....do.. No. 4....do	1–20, 000
35.	Do.....do.. No. 5....do	1–60, 000
36.	York river, from King's creek to West Point, Virginia	1–60, 000
37.	Wachapreague, Machipongo, and Metompkin inlets, Virginia	1–40, 000
38.	Ship and Sand Shoal inlets	1–40, 000
39.	Entrance to Chesapeake bay	1–100, 000
40.	Cape Charles and vicinity	1–80, 000
41.	Cherrystone inlet	1–40, 000
42.	Pungoteague inlet	1–40, 000
43.	Fishing or Donoho's battery, Maryland	1–80, 000
44.	Albemarle sound, North Carolina	1–200, 000
45.	North Landing river, Virginia and North Carolina	1–40, 000

No. 46.	Diagrams showing the effect of the wind in elevating and depressing the water in Albemarle sound		
47.	Hatteras shoals, North Carolina		1–120, 000
48.	Cape Hatteras	do	1–20, 000
49.	Hatteras inlet	do (fourth edition)	1–20, 000
50.	Ocracoke inlet	do	1–40, 000
51.	Sea-coast of North Carolina, from Cape Hatteras to Ocracoke		1–200, 000
52.	Wimble shoals, North Carolina		1–80, 000
53.	Beaufort harbor	do	1–20, 000
54.	New river and bar	do	1–15, 000
55.	Frying Pan shoals	do	1–120, 000
56.	Cape Fear river and New inlet, North Carolina		1–40, 000
57.	Entrance to Cape Fear river, (new edition,) North Carolina		1–30, 000
58.	Cape Fear river, from Federal Point to Wilmington, North Carolina		1–30, 000
59.	Gulf Stream explorations, 1853		1–5, 000, 000
60.	Diagrams, Gulf Stream explorations, 1853		
61.	Gulf Stream explorations, 1854		1–5, 000, 000
62.	Diagrams, Gulf Stream explorations, 1854		
63.	Gulf Stream explorations, 1855		1–5, 000, 000
64.	Diagrams, Gulf Stream explorations, 1859		
65.	Do	do do 1860	
66.	Gulf Stream chart from 1845 to 1860		
67.	Co-tidal lines, Atlantic coast		1–10, 000, 000
68.	Diagrams of secular variation of magnetic dip, Atlantic coast		
69.	Cape Roman shoals, South Carolina		1–100, 000
70.	Sea-coast of the United States, No. 14, South Carolina		1–200, 000
71.	Winyah bay and Cape Roman shoals	do	1–100, 000
72.	Winyah bay and Georgetown harbor	do	1–40, 000
73.	Bull's bay, South Carolina		1–40, 000
74.	Comparative chart, Maffitt's channel, South Carolina, (new edition)		1–5, 000
75.	Maffitt's channel, sections	do	
76.	North Edisto river, (new edition)	do	1–50, 000
77.	Romerly marshes	do	1–10, 000
78.	Savannah River entrance	Georgia	1–30, 000
79.	Savannah city, front and back rivers	do	1–20, 000
80.	Savannah river	do	1–40, 000
81.	Ossabaw sound	do	1–30, 000
82.	Sapelo sound	do	1–30, 000
83.	Doboy bar and inlet	do	1–40, 000
84.	St. Simon's sound and Brunswick harbor	do	1–40, 000
85.	St. Andrew's shoal	do	1–60, 000
86.	St. Mary's bar and Fernandina harbor, Florida, comparative chart		1–20, 000
87.	St. Mary's river and Fernandina harbor	do	1–20, 000
88.	St. John's river and entrance to Brown's creek, Florida		1–25, 000
89.	Mosquito inlet	do	1–40, 000
90.	Cape Cañaveral	do	1–60, 000
91.	Florida reefs	do	1–200, 000
92.	Turtle harbor	do	1–40, 000
93.	Beacons on Florida reefs	do	
94.	Coffin's Patches	do	1–20, 000
95.	Key Biscayne, Cape Sable and bases	do	1–60, 000 & 1–400, 000
96.	Legaré anchorage	do	1–20, 000
97.	Key West harbor, (second edition)	do	1–100, 000
98–103.	Key West tidal diagrams	do	

No. 104.	Rebecca shoals, Florida	1–600, 000
105.	Reconnaissance of vicinity of Cedar Keys, Florida	1–300, 000
106.	Channel No. 4, Cedar Keys....do	1–30, 000
107.	Cedar Keys and approaches, (new edition)....do	1–50, 000
108.	Ocilla river	1–20, 000
109.	St. Mark's bar and channel	1–40, 000
110.	Middle or main and western entrances, St. George's sound, Florida	1–80, 000
111.	St. Andrew's bay....do	1–40, 000
112.	Entrance to Pensacola bay....do	1–30, 000
113.	Escambia and Santa Maria de Galvaez bays....do	1–30, 000
114.	Sea-coast of part of Alabama and Mississippi	1–200, 000
115.	Mobile bay, (second edition,) Alabama	1–200, 000
116.	Horn Island Pass and Grand bay, Mississippi	1–300, 000
117.	Do....do....do....(new edition)	1–40, 000
118.	Pascagoula river....do	1–20, 000
119.	Biloxi bay....do	1–40, 000
120–129.	Cat island tidal diagrams....do	
130.	Pass Christian....do	1–40, 000
131.	Delta of the Mississippi, Louisiana	1–60, 000
132.	Passe à Loutre....do	1–20, 000
133.	Gulf of Mexico, with profiles of deep-sea soundings, (new edition)	1–2, 400, 000
134.	Barataria Bay entrance, Louisiana	1–30, 000
135.	Pass Fourchon....do	1–10, 000
136.	Timballier Bay entrance..do	1–20, 000
137.	Isle Dernière, or Ship Island shoals, Louisiana	1–80, 000
138.	Atchafalaya bay....do	1–50, 000
139.	Entrance to Vermillion bay and Calcasieu river, Louisiana	1–30, 000 & 1–40, 000
140.	Sabine Pass, Texas	1–40, 000
141.	Sea-coast of Texas, from Galveston, south	1–200, 000
142.	Sea-coast of the United States, No. 31, part of Texas	1–200, 000
143.	San Luis Pass, Texas	1–20, 000
144.	Aransas Pass, Texas, (2d edition)	1–30, 000
145.	Entrance to Brazos river, Texas	1–10, 000
146.	Entrance to Rio Grande river, Texas	1–20, 000
147.	Diagrams of heights and lunitidal intervals of diurnal and semi-diurnal tides in the Gulf of Mexico	
148, 149.	Co-tidal lines, Gulf of Mexico, (2 plates)	
150.	Type curves	
151.	Wind curves, Cat island	
152.	Alden's reconnaissance, Western Coast; lower sheet, San Francisco to San Diego, (new edition,) California	1–1, 200, 000
153.	Cortez bank	1–100, 000 & 1–1, 200, 000
154.	San Diego entrance, (new edition,) California	1–150, 000 & 1–25, 000
155.	Geological map of San Diego, California	1–1, 608, 000
156.	Catalina harbor	1–15, 000
157.	San Pedro anchorage and vicinity of Santa Barbara, California	1–20, 000 & 1–40, 000
158.	Anacapa island, (sketch,) California	
159.	Anacapa island and east end of Santa Cruz island, California	1–30, 000
160.	Prisoner's harbor, Cuyler's harbor, and north anchorage San Clemente island, California	1–20, 000
161.	Santa Barbara, California	1–20, 000
162.	Eastern entrance to Santa Barbara channel, California	1–80, 000
163.	San Simeon, Santa Cruz, San Luis Obispo, and Coxo harbors, California	1–20, 000 & 1–40, 000
164.	Point Conception, California	1–40, 000

No. 165.	Point Piños, California	1–20, 000
166.	Monterey harbor..do	1–40, 000
167.	Monterey bay....do	1–60, 000
168.	Geological map of Monterey, California	1–150, 000
169.	Santa Cruz and Año Nuevo harbors, California	1–1, 200, 000 & 1–40, 000
170.	San Pedro harbor....do	1–20, 000
171.	Entrance to San Francisco bay....do	1–400, 000
172.	San Francisco city, (new edition)....do	1–10, 000
173.	Geological map of San Francisco....do	1–150, 000
174.	South Farrallone island....do	
175.	Tidal diagrams, Rincon Point....do	
176.	Pulgas base....do	1–400, 000
177.	San Antonio creek....do	1–20, 000
178.	Mare Island straits....do	1–30, 000
179.	Alden's reconnaissance, Western Coast; middle sheet, San Francisco to Umpqua river, California and Oregon	1–1, 200, 000
180.	McArthur's reconnaissance, Western Coast, from Monterey to mouth of Columbia river—sheet No. 1, (3d edition)	
181.	McArthur's reconnaissance, Western Coast, from Monterey to mouth of Columbia river—sheet No. 2, (3d edition)	
182.	McArthur's reconnaissance, Western Coast, from Monterey to mouth of Columbia river—sheet No. 3, (3d edition)	
183.	Alden's reconnaissance, Western Coast—northern sheet	1–1, 200, 000
184.	Point Reyes and Drake's bay, California	1–40, 000
185.	Drake's bay....do	1–40, 000
186.	Geological map of Point Reyes...do	
187.	Humboldt bay, (new edition,)....do	1–30, 000
188.	Trinidad bay....do	1–20, 000
189.	Shelter cove, Mendocino City, Crescent City harbors, and Port Orford or Ewing harbor, California and Oregon	1–20, 000
190.	Crescent City harbor, California	1–20, 000
191.	Umpqua river, Oregon	1–20, 000
192.	Mouth of Columbia river, Oregon, (2d edition)	1–40, 000
193.	Do.....do.....do	1–200, 000
194.	Entrance to Columbia river..do	1–40, 000
195.	Tidal diagrams, Rincon Point, San Diego and Astoria, California and Oregon	
196.	Co-tidal lines of Pacific coast	1–10.000,000
197.	Cape Disappointment, Washington Territory	1–20, 000
198.	Shoalwater bay....do	1–80, 000
199.	Alden's reconnaissance, Western Coast, from Gray's harbor to Admiralty inlet, Washington Territory	1–600, 000
200.	Greenville harbor, Washington Territory	1–20, 000
201.	Cape Flattery and Nèe-ah harbor, do	1–40, 000
202.	False Dungeness....do	1–30, 000
203.	New Dungeness....do	1–40, 000
204.	Washington sound....do	1–200, 000 & 1–600, 000
205.	Port Townshend, (new edition,)..do	1–40, 000
206.	Duwamish bay and Seattle harbor..do	1–40, 000
207.	Smith's or Blunt's island....do	1–20, 000
208.	Port Ludlow....do	1–20, 000
209.	Fort Gamble....do	1–20, 000
210.	Olympia harbor....do	1–20, 000
211.	Steilacoom harbor....do	1–30, 000
212.	Bellingham bay....do	1–40, 000

No. 213.	Blakely harbor, Washington Territory	1–10, 000
214.	Semi-ah-moo bay.....do	1–30, 000
215.	Base apparatus	
216.	Self-registering tide-gauge	
217.	Craven's current indicator	
218.	Craven's specimen box for deep-sea soundings	
219.	Mitchell's sea-coast tide-gauge	
220.	Figures to illustrate Appendix No. 33, 1854	
221.	Diagrams of secular variation in magnetic declination, 1855	
222.	Lines of equal magnetic declination	1–1, 500, 000
223.	Boutelle's scaffold for stations, and Farley's signals	
224.	Boutelle's apparatus for measuring preliminary bases	
225.	Diagrams to illustrate earthquake waves at San Diego and San Francisco	
226.	Diagrams of secular variation in magnetic declination, 1856	
227.	Sands's gas-pipe tripod	
228.	Sands's specimen box for deep-sea soundings and revolving heliotropes	
229.	Map of magnetic declination	
230.	Map of magnetic dip and intensity	
231.	Apparatus for measuring minor bases	
232.	Polyconic development of sphere	
233.	Diagrams illustrating telegraphic methods for difference of longitude	
234.	Diagrams showing injury to boiler of steamer Hetzel	
235.	Project limits for charts $\frac{1}{200000}$ and $\frac{1}{400000}$	
236.	Diagrams of winds of the Western Coast	
237.	Diagrams illustrating loss of magnetism	
238.	Apparatus for measuring preliminary base lines	
239.	Trenchard's tide-gauge	
240.	Mitchell's tide-gauge	
241.	Diagrams illustrating the descent of sounding weight and line in deep-sea soundings	
242.	Project limits for finished maps, $\frac{1}{80000}$, on the Atlantic and Gulf coasts	
243.	Three sketches illustrating the Superintendent's paper on currents near Sandy Hook	
244.	Diagrams of magnetic and meteorological observations at Girard College, Philadelphia, in 1840–'41–'42–'43–'44, and '45	
245.	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	
246.	Lines of equal magnetic variation for 1858	
247.	Trowbridge's improved deep-sea sounding apparatus	
248.	Mitchell's sub-current apparatus and form of pile for sea structure	
249.	Sketch showing progress of the Coast Survey to 1861	
250.	Plan of magnetic observatory at Key West	
251.	Diagrams showing results of magnetic observations at Key West	
252.	Mitchell's specimen cup and Gilliss's dividers	
253–274.	Progress sketches	

Report of Mr. George Mathiot, in charge of the Electrotype and Photographic Division.

COAST SURVEY OFFICE, *September* 30, 1861.

In accordance with the established usage of the office, I respectfully present the following annual report of the operations of this division:

Since the date of my last report (September 17, 1860) we have made sixty electrotypes of the engraved plates of the charts of the survey. Of this number thirty-six were "altos,"

or reverses of the engraved plates, and twenty-four were "bassos," or duplicates of the engraved plates, made from the "altos." I append a table of the engraved plates to which the process was applied.

The reduction of the original sheets of the survey by photography has continued in successful use during the year, and the application of photography has been extended to the copying of drawings and important tables, letters, and maps not produced in the office. By the process we have made thirty-one glass "positives" and one hundred and twenty-four glass "negatives," and two hundred and seventy-two paper prints. Attention has been paid to the improvement of the photographic process, and as a result of these efforts I am now enabled to announce that we are successfully producing plates two feet square.

During the year I have been assisted by Mr. D. Hinkle, and again commend him for the performance of every duty.

List of plates electrotyped in "Alto."

Name of chart.	No. made.
Long Island sound, middle part	1
Rappahannock river, No. 6	1
Long Island sound, eastern part	1
Seguin island to Kennebunkport	1
Fisher's Island sound	1
Monterey bay	1
Muskeget channel	1
South coast of Long Island, middle part	1
South coast of Long Island, western part	1
Savannah river	1
North Edisto river	1
St. Mary's river and Fernandina harbor	1
St. George's sound	1
Sapelo sound	1
Mississippi delta, Pass à Loutre	1
Portsmouth harbor	1
Beacons of Florida reefs	1
Chesapeake bay, No. 2	1
Nantucket harbor	1
Sea-coast chart, No. 14	1
Rappahannock river, No. 1	1
Do. do. No. 2	1
Do. do. No. 3	1
Do. do. No. 4	1
Do. do. No. 5	1
Chesapeake bay, No. 5	2
Portland harbor	1
Chesapeake bay, No. 6	1
Eastern part of Mississippi sound	1
New Bedford harbor	1
Wellfleet harbor	1
New London harbor	1
Gloucester harbor	1
Long Island sound, western part	1
Escambia and Santa Maria de Galvaez bays	1

List of Plates electrotyped in "Basso."

Name of chart.	No. made.
New London harbor	2
Gloucester harbor	2
Long Island sound, middle part	1
Do. do. eastern part	1
Do. do. western part	1
Rappahannock river, No. 6	1
Fisher's Island sound	1
Muskeget channel	1
Monterey bay	1
South coast of Long Island, middle part	1
South coast of Long Island, western part	1
Savannah river	1
North Edisto river	1
St. Mary's river and Fernandina harbor	1
St. George's sound	1
Charleston harbor	1
Chesapeake bay, No. 5	2
Chesapeake bay, No. 6	1
Portland harbor	1
Eastern part of Mississippi sound	1
New Bedford harbor	1

Table of photographs.

Subject.	Scale.	POSITIVES.		NEGATIVES.		PRINTS.	
		No.	Scale.	No.	Scale.	No.	Scale.
Coast chart No. 21—New York bay and harbor.							
Tracing of plane-table sheet No. 751	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 605	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 735	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 798	1-20,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1 80,000 1 of 1-40,000
Do do 487	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 599	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 789	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 808	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 810	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1 80,000 1 of 1-40,000
Do do 609	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 816	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 608	1-10,000	1	1-80,000	2	1 of 1 80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 586	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000

Table of photographs—Continued.

Subject.	Scale.	POSITIVES.		NEGATIVES.		PRINTS.	
		No.	Scale.	No.	Scale.	No.	Scale.
Coast chart No. 81—Cedar keys and vicinity.							
Tracing of plane-table sheet No. 780	1-20,000			1	1-80,000	1	1-80,000
Do do 705	1-20,000			1	1-80,000	1	1-80,000
Coast chart No. 54—Savannah river, &c.							
Tracing of plane-table sheet No. 380	1-10,000			1	1-80,000	1	1-80,000
Do do 383	1-5,000			1	1-80,000	1	1-80,000
Do do 385	1-10,000			1	1-80,000	1	1-80,000
Do do 379	1-10,000			1	1-80,000	1	1-80,000
Do do 803	1-20,000			1	1-80,000	1	1-80,000
Do do 809	1-20,000			1	1-80,000	1	1-80,000
Do do 803	1-20,000			1	1-80,000	1	1-80,000
Do do 809	1-20,000			1	1-80,000	1	1-80,000
Coast chart No 8.—Portland harbor and vicinity.							
Tracing of plane-table sheet No. 588	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 587	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 465	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 666	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 735	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 312	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 414	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 756	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 757	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 755	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 655	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Do do 466	1-10,000	1	1-80,000	2	1 of 1-80,000 1 of 1-40,000	2	1 of 1-80,000 1 of 1-40,000
Coast chart No. 9—Newburyport and vicinity.							
Tracing of plane-table sheet No. 556	1-10,000			1	1-80,000	1	1-80,000
Do do 396	1-10,000			1	1-80,000	1	1-80,000
Do do 397	1-10,000			1	1-80,000	1	1-80,000
Do do 341	1-10,000			1	1-80,000	1	1-80,000
Do do 459	1-10,000			1	1-80,000	1	1-80,000
Do do 440	1-10,000			1	1-80,000	1	1-80,000
Map of the District of Columbia from the plot-book of Washington.	2 in. to 1 mile.			1	1-30,000	2	1-30,000
Chart of the Potomac river from Alexandria to the Long Bridge, by the Navy Department.	1-10,000			1	1-30,000	2	1-30,000
Map of the physical geography of the United States.				1		6	
Coast chart No. 29—Sea-coast of Maryland and part of Virginia.							
Tracing of plane-table sheet No. 264	1-20,000			1	1-80,000	1	1-80,000
Do do 311	1-20,000			1	1-80,000	1	1-80,000
Do do 522	1-20,000			1	1-80,000	1	1-80,000
Do do 763	1-20,000			1	1-80,000	1	1-80,000
Do do 464	1-20,000			1	1-80,000	1	1-80,000
Three drawings of transit instruments				3, 1 of each.		6, 2 of each.	
Four letters containing tide-tables				4, 1 of each.		80, 20 of each.	

Table of photographs—Continued.

Subject.	Scale.	POSITIVES.		NEGATIVES.		PRINTS.	
		No.	Scale.	No.	Scale.	No.	Scale.
Coast chart No. 11.—Cape Cod and vicinity.							
Tracing of plane-table sheet No. 579	1-10,000	1	1-80,000	2	1 of 1-40,000 1 of 1-80,000	2	1 of 1-40,000 1 of 1-80,000
Do.....do.....368	1-10,000	1	1-80,000	2	1 of 1-40,000 1 of 1-80,000	2	1 of 1-40,900 1 of 1-80,000
Do.....do.....425	1-10,000	1	1-80,000	2	1 of 1-40,000 1 of 1-80,000	2	1 of 1-40,000 1 of 1-80,000
Do.....do.....612	1-10,000	1	1-80,000	2	1 of 1-40,000 1 of 1-80,000	2	1 of 1-40,000 1 of 1-80,000
Do.....do..... 455	1-10,000	1	1-80,000	2	1 of 1-40,000 1 of 1-80,000	2	1 of 1-40,000 1 of 1-80,000
Do.....do.....795	1-10,000	1	1-80,000	2	1 of 1-40,000 1 of 1-80,000	2	1 of 1-40,000 1 of 1-80,000
Map of part of Virginia in the vicinity of the city of Washington, by U. S. Coast Survey.	1-15,000	------	----------	1, in 2 plates.	1-30,000	2	1-30,000
The same, with additions	1-15,000	------	----------	2 { 1 in 2 plts. 1 in 6 plts.	1 of 1-30,000 1 of 1-20,000	14	10 of 1-30,000 4 of 1-20,000
The same, showing the woods	1-15,000	------	----------	1 in 2 plates.	1-30,000	16	1-30,000
Three tracings containing the hydrography of James river, Virginia.	--------	------	----------	1 in 4 plates.	1-80,000	3	1-80,000
Map of the approaches to New Orleans by the New Orleans and Opelousas railroad.	--------	------	----------	1	----------	1	----------
A sounding apparatus, (Trowbridge's)	--------	------	----------	1	----------	2	----------
U. S. Coast Survey map of the physical geography of Virginia.	1 in. to 10 miles.	------	----------	1	1 inch to 30 mls.	6	1-30,000
The same, with additions	1 in. to 10 miles.	------	----------	1 in 2 plates.	1 inch to 20 mls.	18	1-20,000
Do.....do.....	1 in. to 10 miles.	------	----------	1 in 4 plates.	1 inch to 15 mls.	6	1-15,000
Tracings of hydrographic sheets of the Potomac river.	--------	------	----------	1 in 3 plates.	1-80,000	3	1-80,000
Map showing the proportion of slaves to free persons in the slave States.	--------	------	----------	1	----------	5	----------
Sample of hachuring, (shaded hill)	1-10,000	------	----------	5	20, 30, 40, 50, 60, and 80 M.	5, 1 of each.	----------
Plane-table sheets Nos 805, 806, 607, 452, and 456, Drake's bay, Cal.	1-10,000	------	----------	5	1-40,000	5, 1 of each.	1-40,000
Plane-table sheet No. 557, Barnstable bay	1-10,009	------	----------	1 in 2 plates.	1-30,000	1	1-30,000
Three tracings of plane-table sheets Nos. ———, Sheepscot river, Maine.	--------	------	----------	3, 1 of each.	1-40,000	3	1-40,000
Finished photographs from tracings of plane-table sheets Nos. 396, 556, 260 (1,) 260 (2)	1-40,000	------	----------	4, 1 of each.	1-80,000	4, 1 of each.	1-80,000
Sketch of Mississippi river above the passes.	--------	------	----------	1	----------	2	----------

Report of Assistant Edward Goodfellow, in charge of Miscellaneous Division.

COAST SURVEY OFFICE, *Washington, October* 1, 1861.

I have to present herewith the annual report of the Miscellaneous Division, consisting of the printing office, map room, and office for distribution of maps and reports.

This division has been under my general supervision since the 1st of July, when Assistant R. D. Cutts left the office. The records have been kept by Mr. Charles Balmain, who succeeded Mr. W. M. Maynadier as clerk to the division early in May.

Much more than ordinary diligence has been shown, and extra labor willingly performed, by the employés in order to meet the largely increased demands of the War and Navy Departments during the past spring and summer for the maps and charts of the survey.

The preparation of the paper for printing, of the presentation copies of maps, and the repairs and backing of plane-table sheets, are in charge of Mr. W. Mertz, assisted, since August 23, by Mr. F. Housam. Mr. John Rutherdale, assisted by Mr. John Barrett, has printed most of the maps issued by the office. Mr. Henry C. Benner has been temporarily engaged as printer since June 1.

The usual statements showing the distribution of maps, charts, and sketches during the year, the distribution of the annual reports of the Superintendent, and the number of maps, charts, and sketches printed, are herewith appended.

Of the ten thousand copies of maps, &c., gratuitously distributed, (nearly three times the number of last year,) more than four thousand copies have been sent to the Naval Observatory, for the use of national vessels.

Statement of Coast Survey maps, charts, and sketches printed during the year.

SECTION I.

Progress sketch A	30
Progress sketch A *bis*	30
Eggemoggin Reach	50
Kennebec river	71
Portland harbor	95
York river harbor	52
Sea-coast of Maine, preliminary, from Seguin island to Kennebunkport	60
Portsmouth harbor	50
Newburyport harbor	40
Ipswich and Annisquam harbors	40
Rockport harbor	215
Lynn harbor	65
Boston harbor, $\frac{1}{40000}$	130
Stellwagen's bank	20
Plymouth harbor	29
Coast chart, preliminary, from Plymouth to Saughkonnet Point	168
Wellfleet harbor	300
Provincetown harbor	54
Bass River harbor	80
Nantucket harbor	40
Muskeget channel	65
Holmes's Hole and Tarpaulin cove	260
Wood's Hole harbor	90
Sow and Pigs reef	30
New Bedford harbor	209

SECTION II.

Progress sketch B	30
Long Island sound, eastern part	144
Do. middle part	144
Do. western part	144
South coast Long Island, eastern part	40
Do. do. middle part	80
Do. do. western part	60
Fisher's Island sound	160

SECTION III.

SECTION IV.

SECTION V.

Winyah bay and Cape Roman shoals	71
Bull's bay	50
Coast chart, (preliminary,) No. 14, from Cape Roman to Tybee island	75
Charleston harbor	473
Port Royal entrance	45
North Edisto river	100
Savannah river	100
Romerly marshes	70
Sapelo sound	178
Doboy bar and inlet	100
St. Simon's sound and Brunswick harbor	100

SECTION VI.

Progress sketch F	30
Do....do...F *bis*	30
St. Mary's river and Fernandina harbor	220
St. John's River entrance	91
Do.....do..upper	90
Musquito inlet	75
Cape Cañaveral shoals	100
Beacons on Florida reefs	101
Turtle harbor	50
Coffin's Patches	80
Key Biscayne and Cape Sable bases	80
Legaré anchorage	50
Key West harbor and approaches	250
Rebecca shoals	75
Tortugas shoals	100
Tampa bay	80

SECTION VII.

Progress sketch G	30
Cedar keys and approaches	56
Ocilla river	100
St. Mark's bar and channel	50
St. George's sound, eastern part	100
St. Andrew's bay	70
Entrance to Pensacola bay	375
Sea-coast of Alabama and Mississippi	100
Coast chart 91, eastern part of Mississippi sound	196
Middle part of Mississippi sound	100

SECTION VIII.

Progress sketch H	30
Mobile Bay	232
Mobile Bay entrance	50
Horn Island Pass and Grand bay	80
Pascagoula River entrance	70
Cat and Ship Island harbors	50
The Rigolets	111

Delta of the Mississippi	110
Passe à Loutre	115
Barrataria Bay entrance	145
Pass Fourchon	100
Timballier Bay entrance	100
Ship Island shoal	120
Atchafalaya bay	140
Entrance to Vermillion bay and Calcasieu river	100

SECTION IX.

Progress sketch I	30
Sabine Pass	105
Galveston entrance	50
Galveston bay	25
Sea-coast of the United States, No. 31	80
Coast chart No. 106, (preliminary,) from Galveston bay to Oyster bay	101
Coast chart No. 106, (preliminary,) from Oyster bay to Matagorda bay	101
San Luis Pass	140
Aransas Pass	130
Entrance to Brazos river	181
Entrance to Rio Grande river	105
Reconnaissance of Texas coast, and sketches of Espiritu Santo and San Antonio bays	15

SECTION X.

Progress sketch J	30
Reconnaissance of the Western Coast, upper sheet	40
Do ... do ... do ... middle sheet	35
Do ... do ... do ... lower sheet	10
Crescent City harbor	50

MISCELLANEOUS.

Chart of the Pleiades	100
Diagrams of observations at Girard College	30
Gulf Stream explorations for 1853–'54–'55	87
Diagrams of Gulf Stream explorations for 1853–'54	30
Saxton's metallic thermometer	12
General progress sketch	124
Compasses	100
Circular protractors	282
Specimen plates	300
Proofs	1,840
Quarterly proofs	200
Diagrams for tidal division	435
Total	17,591

List of Coast Survey maps distributed during the year, for sale, use of office, and gratuitously.

Names of charts.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Richmond's Island harbor		3	34	37
York River harbor	1	3	34	38
Newburyport harbor		6	34	40
Ipswich and Annisquam harbors		6	37	43
Gloucester harbor		6	36	42
Rockport harbor		1	78	79
Salem harbor		2	6	8
Lynn harbor		1	44	45
Wellfleet harbor		7	49	56
Bass River harbor			43	43
Boston harbor, $\frac{1}{40000}$	34	18	89	141
Boston harbor, $\frac{1}{120000}$			14	14
Plymouth harbor		7	39	46
Provincetown harbor		6	39	45
Harbor of Wood's Hole		6	85	91
Nantucket harbor			41	41
Edgartown harbor			2	2
Muskeget channel		1	50	51
Harbor of Hyannis		2	39	41
Harbors of Holmes's Hole and Tarpaulin Cove		2	43	45
Harbor of New Bedford	10	2	33	45
General coast chart from Gay Head to Cape Henlopen		7	78	85
Long Island sound, eastern sheet	30	7	53	90
Long Island sound, middle sheet	30	6	53	89
Long Island sound, western sheet	30	7	53	90
Fisher's Island sound		4	33	37
Harbor of New London		7	33	40
Mouth of Connecticut river		6	32	38
Harbor of New Haven		6	35	41
Harbors of Black Rock and Bridgeport		5	30	35
Huntington bay		2	31	33
Harbors of Sheffield and Cawkin's islands		1	42	43
Harbors of Captain's island, east and west		2	26	28
Oyster bay or Syosset harbor		1	29	30
Hart and City islands and Sachem's Head harbor		1	55	56
Hell Gate		8	31	39
New York bay and harbor and the environs, $\frac{1}{30000}$		8	25	33
New York bay and harbor and the environs, $\frac{1}{80000}$	20	17	114	151
Eastern part of south coast of Long Island		4	89	93
Middle part of south coast of Long Island		2	60	62
Western part of south coast of Long Island		1	36	37
Hempstead harbor		3	66	69
Delaware bay and river, upper sheet	44	23	55	122
Delaware bay and river, middle sheet	44	41	57	142
Delaware bay and river, lower sheet	44	30	54	128
Patapsco river	20	85	91	196
Mouth of Chester river		65	34	99
Harbor of Annapolis and Severn river	10	100	73	183
York river, upper sheet	1	74	74	149
York river, lower sheet	1	74	114	189
Pasquotank river		3	36	39

List of Coast Survey maps, &c., distributed—Continued.

Names of charts.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Beaufort harbor	11	18	71	100
Cape Fear river entrance	21	10	67	98
Cape Fear river, from Federal Point to Wilmington	----	10	101	111
Charleston harbor	64	249	241	554
Cat and Ship Island harbors	----	15	35	50
Mobile bay	21	87	108	216
Mobile bay entrance	10	9	46	65
Galveston entrance	----	47	32	79
Galveston bay	----	26	6	32
Key West harbor and approaches	25	41	131	197
Pensacola harbor	21	129	230	380
San Diego bay	----	9	51	60
San Francisco bay entrance	----	23	69	92
Preliminary charts of—Kennebec river entrance	----	----	96	96
Portland harbor	----	3	22	25
Portsmouth harbor	----	----	20	20
Sea-coast of the United States, No. 4	50	5	123	178
Minot's Ledge	----	3	78	81
Comparative map of Hudson river	----	1	44	45
Little Egg harbor	----	2	27	29
Delaware and Chesapeake bays	22	30	58	110
Delaware and Chesapeake bays with cotidal lines	----	1	22	23
Sea-coast of Delaware, Maryland, and part of Virginia	----	4	73	77
Patuxent river, upper	----	----	----	----
Patuxent river, lower	----	36	53	89
Rappahannock river, sheet No. 1, $\frac{1}{20000}$	----	71	39	110
Rappahannock river, sheet No. 2, $\frac{1}{20000}$	----	6	20	26
Rappahannock river, sheet No. 3, $\frac{1}{20000}$	----	6	20	26
Rappahannock river, sheet No 4, $\frac{1}{20000}$	----	6	20	26
Rappahannock river, sheet No. 5, $\frac{1}{40000}$	----	----	20	20
Rappahannock river, sheet No. 6, $\frac{1}{40000}$	----	----	20	20
James river, upper	----	----	30	30
James river, lower	----	17	55	72
Chincoteague inlet	----	46	56	102
Sea-coast of Virginia and entrance to Chesapeake bay	10	29	91	130
Norfolk harbor	1	63	112	176
Hampton Roads	21	79	122	222
Albemarle sound	----	8	67	75
Comparative chart of Beaufort harbor	----	----	----	----
Ocracoke inlet	----	3	6	9
Hatteras and Ocracoke inlets	1	3	69	73
Comparative chart of Cape Fear entrance	1	2	1	4
Cape Fear river and New inlet	----	----	10	10
Frying Pan shoals	----	2	44	46
New river and bar	----	3	67	70
Sea-coast of South Carolina	----	1	93	94
North Edisto river	----	38	51	89
St. Helena sound	1	30	60	91
Winyah bay and Georgetown harbor	----	48	30	78

List of Coast Survey maps, &c., distributed—Continued.

Names of charts.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Preliminary charts of—Port Royal entrance	----------	11	20	31
Entrance to Savannah river	20	43	116	179
Savannah city, Front and Back rivers	----------	3	11	14
Sapelo sound	1	38	70	109
Doboy bar and inlet	10	38	44	92
St. Simon's sound and Brunswick harbor	11	41	36	88
Romerly marshes	----------	39	56	95
St. Mary's bar and Fernandina harbor	----------	12	24	36
St. Mary's river and Fernandina harbor	10	52	70	132
St. John's river, from entrance to Brown's creek	1	42	40	83
St. John's river, from Brown's creek to Jacksonville	1	37	23	61
Comparative chart of St. John's river	1	----------	51	52
Florida reefs	2	3	24	29
Waccasassa bay	----------	8	42	50
Cedar keys	1	7	72	80
Legaré anchorage	----------	2	27	29
Tampa bay	----------	4	42	46
Ocilla river	----------	27	22	49
Apalachicola river	1	2	74	77
St. Andrew's bay	----------	6	33	39
Sea-coast of Alabama and Mississippi	1	3	115	119
St. Louis bay and Shieldsboro' harbor	1	1	60	62
Biloxi bay	----------	3	35	38
Mississippi City harbor	1	1	61	63
Grand Island Pass	1	26	45	72
Mississippi sound	----------	10	92	102
Delta of Mississippi river	10	33	94	137
The Rigolets	1	----------	21	22
Passe à Loutre	----------	----------	30	30
Atchafalaya bay	----------	27	43	70
Ship Island shoal	----------	26	9	35
Reconnaissance of coast of Texas	1	53	75	129
Sea-coast of United States, No. 31	----------	26	----------	26
Matagorda bay	11	26	42	79
Brazos river, entrance	----------	27	95	122
San Luis Pass	----------	27	46	73
Coast chart Galveston bay to Oyster bay	----------	----------	50	50
Coast chart Oyster bay to Matagorda bay	----------	----------	30	30
West coast reconnaissance from San Diego to San Francisco	----------	7	13	20
West coast reconnaissance from San Francisco to Umpquah river	20	9	13	42
West coast reconnaissance from Umpquah river to the boundary	12	7	17	36
Cortez bank	----------	----------	50	50
Prisoner's, Cuyler's, and San Clemente harbors	----------	1	33	34
San Clemente island, southeast end	----------	1	52	53
Santa Barbara	----------	2	30	32
Anacapa island	----------	1	35	36
San Simeon, Santa Cruz, San Luis Obispo, and Coxo harbors	----------	2	4	6

List of Coast Survey maps, &c., distributed—Continued.

Names of charts.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Preliminary charts of—Santa Cruz and Año Nuevo		1	35	36
San Pedro harbor			25	25
Monterey harbor		2	4	6
San Francisco harbor		7	58	65
San Pablo harbor			3	3
Humboldt harbor		1	52	53
Trinidad harbor		2	4	6
Port Orford, Shelter Cove, Mendocino city and Crescent city harbors		2	4	6
Entrance to Umpquah river		3	4	7
Entrance to Columbia river				
Shoalwater bay		2	29	31
Reconnaissance from Gray's harbor to Admiralty inlet	2	3	5	10
Cape Flattery and Nee-ah harbor		2	4	6
False Dungeness harbor		1	2	3
Port Townshend		2	34	36
Washington sound	12	6	5	23
Port Ludlow		2	34	36
Port Gamble		2	34	36
Blakely harbor		2	35	37
Bellingham bay		2	34	36
Steilacoom harbor		2	35	37
Semi-ah-moo bay		4	57	61
Sketches of—Eggemoggin Reach		2	64	66
Current chart, Boston harbor		1	1	2
Stellwagen's bank		3	61	64
Sow and Pig's reef		2	52	54
Romer Shoal and Flynn's Knoll		2	44	46
Changes in Sandy Hook		2	4	6
Potomac river			25	25
Wachapreague, Machipongo, and Metomkin inlets		18	56	74
Ship and Sand Shoal inlets		2	55	57
Cherrystone inlet		1	55	56
Pungoteague creek		1	63	64
Fishing or Donoho's battery		2	50	52
Sea-coast of North Carolina			87	87
Hatteras shoals		2	43	45
Hatteras inlet		1	3	4
Wimble shoals		1	56	57
Winyah bay and Cape Roman shoals		1	54	55
Bull's bay	1	38	112	151
St. Andrew's shoals		64	34	98
Atlantic coast from Cape Hatteras to Cape Florida		15	46	61
Mosquito inlet		2	42	44
Cape Canaveral		2	42	44
Rebecca shoals		2	22	24
Turtle harbor		1	42	43
Coffin's Patches		3	60	63
Entrance to St. George's sound	1	28	52	81
Beacons on Florida reefs		2	62	64

List of Coast Survey maps, &c., distributed—Continued.

Names of charts.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Sketches of—Horn Island Pass	----------	3	64	67
Pascagoula river	----------	2	55	57
Pass Christian	----------	3	54	57
Mississippi delta	----------	25	32	57
Pass Fourchon	----------	27	72	99
Entrance to Barrataria bay	----------	27	42	69
Timballier bay entrance	----------	----------	43	43
Vermilion bay and Calcasieu river	----------	26	41	67
Gulf of Mexico, northeast part	----------	----------	68	68
Gulf of Mexico, northwest part	----------	----------	132	132
Aransas Pass	----------	28	47	75
Sabine Pass	----------	27	48	75
Entrance to the Rio Grande river	----------	27	42	69
San Pedro anchorage	----------	1	1	2
Mare Island straits	----------	1	54	55
Point Piños	----------	1	1	2
Point Reyes and Drake's bay	----------	1	----------	1
Duwamish bay and Seattle harbor	----------	1	1	2
Sea-coast of United States, No. 26, from Mobile bay to Lake Borgne	----------	----------	2	2
Lines of equal magnetic declination	----------	1	8	9
Lines of equal magnetic dip and horizontal intensity	----------	1	8	9
Total	733	3,080	10,014	13,827

Distribution made during the year of reports of the United States Coast Survey for the years 1851, 1852, 1853, 1854, 1855, 1856, 1857, 1858, *and* 1859.

Names of States, &c.	Report of 1851.			Report of 1852.			Report of 1853.			Report of 1854.			Report of 1855.			Report of 1856.			Report of 1857.			Report of 1858.			Report of 1859.		
	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.
Maine	2	....	2	1	....	1	2	....	2	1	....	1	1	...	1	1	...	1	2	....	2	8	....	8	101	7	108
New Hampshire	3	...	3	...	...	....	2	....	2	1	....	1	1	..	1	1	....	1	1	....	1	3	....	3	70	11	81
Vermont	...	...	....	...	....	..	..	...	..	....	....	....	..	..	....	...	..	....	1	..	1	1	...	1	45	9	54
Massachusetts	1	..	1	2	....	2	5	..	5	7	....	7	10	....	10	10	...	10	14	1	15	29	1	30	281	28	309
Rhode Island	....	..	....	...	...	....	...	...	..	....	....	....	1	....	1	....	....	....	....	..	..	1	....	1	58	16	74
Connecticut	....	..	....	...	....	....	1	....	1	...	....	....	...	....	....	2	....	2	2	....	2	8	..	8	125	9	134
New York	5	1	6	5	1	6	9	1	10	8	1	9	10	...	10	11	1	12	25	3	28	66	5	71	452	49	501
New Jersey	2	....	2	2	..	2	2	...	2	4	....	4	4	....	4	3	..	3	5	...	5	17	....	17	107	8	115
Pennsylvania	3	....	3	3	....	3	2	....	2	2	....	2	3	..	3	5	....	5	10	....	10	32	....	32	318	46	364
Delaware	....	....	....	...	....	..	1	...	1	1	....	1	2	..	2	1	....	1	1	...	1	1	....	1	10	....	10
Maryland	..	...	...	...	...	...	1	....	1	1	....	1	2	....	2	1	....	1	3	....	3	7	...	7	104	4	108
District of Columbia	5	....	5	5	...	5	6	...	6	6	....	6	6	...	6	10	....	10	15	....	15	27	...	27	48	....	48
Virginia	....	...	....	2	...	2	3	....	3	3	....	3	2	....	2	2	....	2	3	....	3	6	....	6	86	8	94
North Carolina	..	...	..	...	....	....	....	....	..	....	....	..	1	....	1	....	....	....	2	...	2	4	..	4	40	2	42
South Carolina	....	...	....	...		...	1	...	1	....	....	....	...	...	....	...	...	....	..	...	..	2	....	2	95	7	102
Georgia	1	..	1	1	....	1	1	....	1	1	....	1	1	...	1	1	....	1	1	....	1	2	....	2	44	22	66
Alabama	...	..	....	....	..	...	....	....	..	....	....	..	...	....		....	....	...	....	..	....	...	....	....	38	10	48
Mississippi	....	..	..	....	...	....	....	....	....	....	....	...	...	..	....	....	....	....	....	....	....	2	...	2	22	1	23
Louisiana	...	..	....	....	..	....	....	....	..	....	....	..	...	....	....	....	....	....	....	....	....	....	....	....	25	1	26
Ohio	1	..	1	1	....	1	2	....	2	2	....	2	1	...	1	2	....	2	3	....	3	13	1	14	159	28	187
Kentucky	...	...	...	...	....	....	....	....	....	....	....	....	..	....	....	..	....	.	...	....	....	....	....	....	62	12	74
Tennessee	....	....	....	....	....	....	....	....	..	....	....	....	....	....	....	....		..	..	....	....	....	....	....	35	3	38
Indiana	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	..	....	....	3	....	3	77	7	84
Illinois	1	....	1	1	....	1	1	...	1	1	....	1	2	....	2	3	....	3	3	....	3	6	....	6	61	20	81
Missouri	1	....	1	1	....	1	1	....	1	1	...	1	1	....	1	1	..	1	...	..	....	2	....	2	46	7	53
Arkansas	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	..	....	....	..	....	.	...	...	....	2	1	3
Michigan	....	..	....	...	...	...	....	...	....	....	....	....	....	....	....	1	...	1	1	....	1	3	1	4	55	15	70
Florida	...	....	....	....	....	....	....	....	..	....	....	....	...	....	....	....	....	....	....	....	....	1	..	1	49	1	50
Texas	...	...	....	....	....	....	....	....	..	....	....	....	....	....	....	....	....	....	....	....	..	4	....	4	17	1	18
Iowa	....	1	1	...	1	1	....	1	1	...	1	1	...	1	1	....	1	1	....	1	1	2	1	3	30	12	42
Wisconsin	....	..	...	1	....	1	1	....	1	1	...	1	1	....	1	1	..	1	1	....	1	1	....	1	52	6	58
California	2	...	2	2	....	2	3	...	3	2	....	2	2	...	2	2	..	2	2	....	2	5	....	5	33	6	39
Minnesota	....	..	...	....	....	....	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	8	8	16
Oregon	...	...	...	....	..	....	..	....	..	....	....	....	....	....	....	...	...	..	..	....	....	....	....	....	11	1	12
Washington Territory	...	...	..	....	....	....	....	..	...	....	....	....	..	....	....	1	....	1	1	..	1	1	....	1	4	...	4
Nebraska Territory	...	...	..	....	....	...	....	1	1	...	1	1	....	1	1	....	1	1	..	1	1	....	1	1	1	1	2
Kansas Territory	....	..	..	...	....	....	....	..	....	..	....	....	...	....	....	....	....	..	....	....	....	....	....	....	6	....	6
New Mexico Territory	....	....	....	....	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	..	2
Utah Territory	....	....	....	....	....	..	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1
Coast Survey Office	6	....	6	6	...	6	10	....	10	6	....	6	8	..	8	11	....	11	26	....	26	28	...	28	172	3	175
Officers of the army	...	..	....	..	..	....	...	...	...	....	....	....	....	....	....	....	....	....	...	....	....	....	...	....	153	....	153
Members of Congress	6	..	6	8	...	8	10	....	10	14	...	14	16	....	16	19	....	19	26	....	26	58	....	58	20	....	20
Officers of the navy	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	..	1	....	1	1	....	1	151	....	151
Executive departments	...	...	.	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	195	....	195
Revenue bureau	..	..	..	...	....	....	..	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	30	....	30
National observatory	..	....	..	....	....	....	....	..	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	50	....	50
Light-house Board	....	....	..	....	....	....	....	..	....	....	....	....	....	..	....	....	....	....	....	....	....	....	....	....	30	....	30
Smithsonian observers	...	....	..	1	....	1	1	..	1	....	....	....	....	....	....	....	....	....	1	....	1	....	....	..	.....	.....	.....
Newspapers		..	...	.	....	....	....	....	....	....	....	....	....	....	..	....	....	....	....	....	....	....	....	....	6	....	6
Foreign	1	...	1	1	..	1	1	....	1	1	....	1	1	..	1	2	....	2	2	....	2	3	...	3	75	....	75
	40	2	42	43	2	45	66	3	69	63	3	66	76	2	78	91	3	94	152	6	158	349	10	359	3,662	370	4032

Report of Mr. W. L. Nicholson, acting in charge of lithographing division.

COAST SURVEY OFFICE, *October* 1, 1861.

The following report of the operations of the lithographing division is respectfully submitted:

This division was organized in the month of May last, in order to aid the regular copper-plate printing department in supplying speedily charts for the great demand made upon the office by the existing exigencies of the naval service, and also to afford the means of printing (under due supervision) a set of descriptive memoirs and sailing directions for the coast, for the use of the naval and military commanders.

The division was under the care of Professor W. P. Trowbridge, Assistant in the Coast Survey, until his assignment to duty in the field in August last.

Mr. E. Waller and Mr. D. B. Morgan were at first engaged on the transferring and printing, and, since the detachment of the former, his place has been supplied by Mr. C. G. Krebs.

Mr. W. B. McMurtrie and Mr. M. T. Johnstone have prepared the manuscript and binding of the memoirs.

The following has been the work from May 23 to September 1.

Seven charts have been transferred from copper to stone, and twelve charts and three diagrams have been placed on stone from drawings prepared for that purpose, and of these have been printed eleven hundred and sixty-eight impressions of charts, and four hundred and sixty-four of diagrams.

Ten memoirs, relating to different portions of the coast south of Delaware bay, have been prepared by and under the general direction of Professor A. D. Bache, Superintendent, and by Captain C. P. Patterson, hydrographic inspector Coast Survey, and of these some seventy copies of each, with an average of fifty pages in each, have been printed for distribution.

This division has been for but too short a period in operation to make necessary at present any remarks on its possible value for bringing out rapidly and cheaply, from time to time, charts preliminary and subordinate to the more highly finished and matured charts of the survey; as also its possible aid in the development of the processes of photo-lithography.

APPENDIX No. 13.

List of registered topographical sheets received subsequent to No. 754.

Localities.	State.	Scale.	Date.	Topographers.	Register number.
Rockland and Rockland harbor, Penobscot bay	Maine	1-10,000	1861	C. Ferguson	843
South Thomaston, Weskeag river, &c., Penobscot bay	do	1-10,000	1861	do	844
Sheepscot and Back rivers	do	1-10,000	1860	H. Adams, C. Ferguson	801
Back river and Montseag bay	do	1-10,000	1860–'61	C. Ferguson, H. Adams	802
Hoackoamoak bay and islands south of Phipp's Point, Back river	do	1-10,000	1861	H. Adams, O. Hinrichs	842
Casco bay, outer islands	do	1-10,000	1856–'58	A. W. Longfellow	757
Presumpscot river, mouth of, and islands in Casco bay	do	1-10,000	1855–'59	do	755
Casco bay, the Green islands	do	1-10,000	1856	do	756
Saco bay, north shore, including Stratten and Bluff islands, and Prout's Neck	do	1-10,000	1859	C. Fendall	759
Fletcher's Neck and vicinity	do	1-10,000	1859	do	760
Cape Porpoise and vicinity	do	1-10,000	1859	do	761
Isles of Shoals	New Hampshire	1-10,000	1859	do	762
From Hampton river to East Salisbury	do	1-10,000	1855	H. L. Whiting	835
Part of Boston harbor, including the outer and Brewster islands	Massachusetts	1-5,000	1860	do	830
Part of Boston harbor, including Gallop's, Lovell's, George's, Lighthouse, and Great Brewster islands	do	1-5,000	1860	do	831
Part of Boston harbor, including Long and Deer islands and Point Shirley	do	1 5,000	1860	do	833
Part of Boston harbor, including Thompson's and Spectacle islands, Moonhead and Squantum	do	1-5,000	1860	do	832
Part of Boston harbor, including Rainsford and Pettick's islands and Nantasket	do	1-5,000	1860	do	829
Barnstable harbor and vicinity	do	1-10,000	1859	A. M. Harrison	795
New York harbor, from Flushing bay to Hunter's Point	New York	1-10,000	1858	H. L. Whiting	808
Part of Brooklyn, including Williamsburg and Green Point	do	1-10,000	1859	F. W. Dorr	789
Part of Far Rockaway, Long Island	do	1-9,833	1860	do	798
Staten island, from New Brighton to Fresh Kills	do	1-10,000	1856	H. L. Whiting	816
Harlem river, east side, from High bridge to King's bridge	do	1-10,000	1859	C. Rockwell	775
Hudson river, from Spuyten Duyvel creek to Yonkers	do	1-10,000	1859	H. L. Whiting, C. Rockwell	810
Hudson river, from Yonkers to Hastings	do	1-10,000	1859	C. Rockwell	811
Hudson river, from Hastings to Irvington	do	1-10,000	1860	J. Mechan	800
Hudson river, from Irvington to Paulus Hook mountain	do	1-10,000	1859	do	770
Assateague island and Parker's bay	Maryland	1-20,000	1859	C. Ferguson	763
Elk river, east side, from Grove Point to Arnold's Point	do	1-20,000	1860	H. Adams	788

List of registered topographical sheets, &c.—Continued.

Localities.	State.	Scale.	Date.	Topographers.	Register number.
Patuxent river, from Point Peterson to Rattle creek	Maryland	1-10,000	1860	H. Adams	812
Patuxent river, from Rattle creek to God's Grace Point	do	1-10,000	1860	do	813
Patuxent river, from God's Grace Point to Point Sollin	do	1-10,000	1859	do	814
Patuxent river, from Point Sollin to Point Jones	do	1-10,000	1859	do	815
St. Mary's river	do	1-20,000	1858-'59	do	776
St. George's island, St. Mary's river	do	1-20,000	1859	do	804
Camden and Wade's Points, Albemarle sound	North Carolina	1-20,000	1861	J. Mechan	837
Chowan river, mouth of, Albemarle sound	do	1-20,000	1860-'61	do	824
Roanoke river, mouth of, Albemarle sound	do	1-20,000	1861	do	836
Durant's island, Albemarle sound	do	1-20,000	1861	do	825
Roanoke island, part of	do	1-20,000	1861	do	826
Bodie's island, part of	do	1-20,000	1860	do	791
From Cape Hatteras to Hatteras inlet	do	1-20,000	1860	do	790
From Hatteras inlet to Great Swash	do	1-20,000	1860	do	792
Georgetown harbor	South Carolina	1-20,000	1857-'58	H. L. Whiting	834
Bull's bay	do	1-20,000	1857	W. S. Edwards	772
From Fripp's inlet to Port Royal sound	do	1-20,000	1859	J. Seib, C. Rockwell	840
Daw island, Port Royal sound	do	1-20,000	1859	do	839
From Port Royal sound to mouth of May river	do	1-20,000	1859-'60	C. Rockwell	809
From May river to Savannah river	do	1-20,000	1859-'60	do	803
From Ossabaw sound to St. Catherine's sound	Georgia	1-20,000	1858-'9-'60	H. S. Du Val	841
Blythe island and Brunswick harbor	do	1-10,000	1856-'58	A. W. Longfellow	778
Florida peninsula, from Point Padgett to Point Andrew, (triangulation sketch)	Florida	1-69,000	1859	Captain M. L. Smith	765
Diego plains	do	1-20,000	1861	F. W. Dorr	822
North and Guano rivers, part of	do	1-20,000	1860	do	784
St. Augustine and vicinity	do	1-10,000	1859-'60	do	783
Indian river	do	1-10,000	1860-'61	C. Ferguson	785
Barnes's sound, part of	do	1-20,000	1859	C. T. Iardella	758
From Raccoon Point to Chassahowitzka river	do	1-20,000	1859	N. S. Finney	782
From Chassahowitzka river to Homosassa river	do	1-20,000	1860	do	781
From Homosassa river to Green Point	do	1-20,000	1858-'59	do	779
From Crystal river to Withlacoochee bay	do	1-20,000	1859	do	780
From Ocilla river to St. Mark's river	do	1-20,000	1859-'60	G. D. Wise	819
From St. Mark's river to Ocklockony bay	do	1-20,000	1859-'60	do	820
Ocklockony bay	do	1-20,000	1859	do	771
Santa Maria de Galvez bay	do	1-20,000	1860	F. H. Gerdes	797
Lakes Borgne and Pontchartrain, passes connecting	Louisiana	1-20,000	1858	W. S. Gilbert	773
Lake Pontchartrain, from Salt bayou to Bayou Bonfuca	do	1-20,000	1859	do	774

List of registered topographical sheets, &c.—Continued.

Localities.	State.	Scale.	Date.	Topographers.	Register number.
Lake Pontchartrain, from Bayou Bonfuca to Ragged Point	Louisiana	1-20,000	1860	M. Scaton	796
Lake Pontchartrain, from Bayou Le Bar to Bayou Coushon	do	1-20,000	1860	M. Seaton	799
Point aux Herbs	do	1-20,000	1859	W. S. Gilbert	786
Chandeleur sound, western shore, from Sandfly to Crabtree	do	1-20,000	1858–'59	S. Harris	768
Chandeleur sound, western shore, from Barrel key to Point Chico	do	1-20,000	1858–'59	do	769
Passe à Loutre	do	1-20,000	1859–'60	F. H. Gerdes	794
West Côte Blanche bay, part of	do	1-20,000	1859	F. H. Gerdes, J. G. Oltmanns	764
West Côte Blanche bay, part of	do	1-20,000	1860	do do	793
Espiritu Santo bay and part of San Antonio bay and vicinity	Texas	1-20,000	1859	W. H. Dennis	766
San Antonio bay, part of, and vicinity	do	1-20,000	1859	do	767
San Antonio bay, part of, and St. Charles bay	do	1-20,000	1860	W. S. Gilbert	828
Aransas bay, northern part, and east end of Copano bay	do	1-20,000	1861	do	838
Copano bay, west end, and St. Mary's town	do	1-20,000	1861	do	827
From Second Chain island to Long reef, Aransas bay	do	1-20,000	1860	do	787
Aransas bay, part of, and entrance to Corpus Christi bay	do	1-20,000	1860–'61	do	823
Napa creek and city	California	1-10,000	1858	D. Kerr	777
Petaluma creek, from entrance to Lakeville	do	1-10,000	1860	A. F. Rodgers	817
Petaluma creek, from Lakeville to Petaluma city	do	1-10,000	1860	do	818
Drake's bay, from Briones to Wildcat	do	1-10,000	1859–'60	do	807
Drake's bay, from Wildcat to Point No. 1	do	1-10,000	1859–'60	do	806
Drake's bay, from Point No. 1 to Punta de los Reyes	do	1-10,000	1859–'60	do	805
Gray's harbor, part of	Washington Territory	1-20,000	1860	J. S. Lawson	821

APPENDIX No. 14.

List of registered hydrographic sheets received subsequent to No 683.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Off shore, from Machias bay to Eastern Point light	Me., N.H., and Massachusetts	1-300,000	1858-'59	Lieut. Comg. A. Murray	700
Coast between Damiscove island and Cape Small	Maine	1-40,000	1859	Lieut. Comg. J. Wilkinson	696
Kennebec river, northward from Bath	do	1-10,000	1858	Lieut. Comg. J. H. Moore	693
Bank off Union wharf, Portland harbor	do	1-5,000	1859	Lieut. Comg. J. Wilkinson	684
Casco bay, part of	do	1-20,000	1859	do	726
Coast from Cape Elizabeth to Kennebunkport	do	1-40,000	1859	Lieut. Comg. A. Murray	699
Hempstead harbor	New York	1-10,000	1859	Lieut. Comg. T. B. Huger	692
Diamond reef, New York harbor	do	1-5,000	1859	Lieut. Comg. J. Wilkinson	698
Off the Battery, New York harbor	do	1-5,000	1859	do	697
Hudson river, from Newburg to Barnegat	do	1-10,000	1859	Lieut. Comg. C.M. Fauntleroy	729
Hudson river, from Barnegat to Poughkeepsie	do	1-10,000	1859	do	730
Hudson river, from Poughkeepsie to Pell island	do	1-10,000	1860	do	735
Hudson river, from Pell island to Rhinebeck	do	1-10,000	1860	do	736
Little and Big Annemessix and Manokin rivers, Monic bay, and Wisconsin river	Maryland	1-20,000	1858-'59	Com. W. T. Muse	707
Patuxent river, from Holland's Point, 2, to Point Jones	do	1-20,000	1859	do	704
St. Mary's river, mouth of, and approaches	do	1-20,000	1859-'60	do	701
St. Mary's river	do	1-20,000	1859	do	695
Reconnaissance of White House, Mathias, and Lower Cedar Points, Potomac river	Virginia	1-10,000	1861	Capt. W. R. Palmer	738
James river, from Douthard to Westover, W.	do	1-10,000	1859	Com. W. T. Muse	705
North river, head of Currituck sound, reconnaissance of	N. Carolina	1-20,000	1859	J. Mechan	703
Currituck sound, reconnaissance of head of	do	1-20,000	1859	do	702
Off shore, from Cape Hatteras to Cape Fear	do	1-200,000	1859	Lieut. Comg. A. Murray	686
Coast from mouth of Cape Fear river to Tubb's inlet	do	1-40,000	1859	do	685
Deep-sea soundings, between Cape Fear and Charleston harbor	N. and S. Car.	1-300,000	1859	Lieut. Comg. J. P. Bankhead	694
Deep-sea soundings, between Winyah bay and Amelia island, (replotted from the original notes)	S. C., Ga., and Florida	1-300,000	1858	Lieut. Comg. T. B. Huger	717
Maffit's channel, Charleston harbor, (resurvey)	S. Carolina	1-10,000	1860	Lieut. Comg. J. P. Bankhead	718
Off shore, between Charleston harbor and St. Andrew's sound	S. C. and Ga	1-300,000	1860	do	728
Sapelo bar and approaches	Georgia	1-20,000	1859	Lieut. Comg. C. M. Fauntleroy	691
Ossabaw sound, and Vernon and Ogeechee rivers	do	1-20,000	1860	do	733
St. Augustine harbor approaches	Florida	1-10,000	1860	Lieut. Comg. A. Murray	712
St. Augustine harbor and North and Matanzas rivers	do	1-10,000	1860	do	711

List of registered hydrographic sheets, &c.—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Florida reefs, from Coffin's Patches to Boot key	Florida	1–20,000	1859	Lieut. Comg. T. A. Craven	714
Cedar keys, (resurvey)	do	1–10,000	1860	Lieut. Comg. J. J. Guthrie	713
Cedar keys, N. W channel, and Sea Horse channel bars	do	1–10,000	1860	do	716
St. George's sound, new channel	do	1–20,000	1858–'59	Lieut. Comg. J. K. Duer	688
St. George's sound, eastern part	do	1–20,000	1860	Lieut. Comg. T. S. Phelps	734
Apalachicola river, mouth of	do	1–20,000	1859	Lieut. Comg. J. K. Duer	687
Santa Maria de Galvez bay	do	1–20,000	1860	Lieut. Comg. T. S. Phelps	731
Escambia bay	do	1–20,000	1860	do	732
Pensacola harbor, shoal spot off navy yard	do	1–10,000	1860	Lieut. Comg. T. A. Craven	719
Tensaw, Spanish, and Mobile rivers, and Dog river bar, (resurvey)	Alabama	1–10,000	1860	Lieut. Comg. J. Wilkinson	737
Passe à Loutre	Louisiana	1–20,000	1860	Lieut. Comg. J. J. Guthrie	715
Matagorda bay, from Matagorda to Palacios	Texas	1–20,000	1859	Lieut. Comg. J. K. Duer	689
Matagorda bay, northwest part	do	1–20,000	1860	Lieut. Comg. W. Ronckendorff	727
San Pedro harbor and approaches	California	1–10,000	1859	Com. J. Alden	706
San Francisco bay, approaches and entrance	do	1–100,000	1858–'9–'60	do	721
Napa creek	do	1–10,000	1860	do	723
Petaluma creek, from entrance to Lakeville	do	1–10,000	1860	do	724
Petaluma creek, from Lakeville to Petaluma city	do	1–10,000	1860	do	725
Drake's bay	do	1–40,000	1860	do	720
Humboldt bay, entrance and part of	do	1–10,000	1859	do	710
Crescent City harbor and approaches	do	1–10,000	1859	do	690
Coquille river, reconnaissance of entrance and part of	Oregon	1–10,000	1860	do	722
Gulf of Georgia, part of, and entrance to Haro and Rosario straits	Wash. Ter	1–100,000	1858–'59	do	709
Haro and Rosario straits, entrance	do	1–20,000	1858	do	708

APPENDIX No. 15.

EXPERIMENTS TO DETERMINE THE RELATIVE SHRINKAGE AND EXPANSION OF PARCHMENT PAPER AND BACKED ANTIQUARIAN PAPER.—(SKETCH No. 31.)

DRAWING DIVISION, *June* 26, 1861.

DEAR SIR: I was directed by Lieut. Wilson, in pursuance of the Superintendent's orders in April last, to test the relative shrinkage and expansion of two samples of parchment paper and backed antiquarian paper. I prepared the longest possible strips in cross directions, $\frac{1}{2}$ inch wide, $81\frac{1}{2}$ inches being the length obtained. These had equal weights suspended and were attached at equal distances from the point of suspension to indices, the recording arm of which was 10 times the length of the one attached to the paper. By this means a very slight change in the paper was apparent on the scale.

The result was decidedly in favor of the backed paper, as will appear from the observations and diagram accompanying.

Yours, very respectfully,

E. HERGESHEIMER.

HENRY L. WHITING, Esq.,
Assistant Coast Survey, in charge of Drawing Division.

Record of observations of shrinkage and expansion of parchment paper and backed antiquarian paper made in April and May, 1861.

Date.	Hour.	Lengthwise strips.		Transverse strips.		Remarks.
		Parchment.	Backed.	Parchment.	Backed.	
	M.					
April 13	12 00	0	0	0	0	
	12 00	0	0	0	0	
	h. m.					
15	10 30	43.1	29.2	35.5	16 5	Weather cloudy.
	2 40	38.1	26.6	33.0	17.7	
17	9 30	46.9	30.4	40.6	21.5	Morning cloudy; afternoon clear.
	2 30	48.2	31,7	40.6	22.8	
18	10 30	50.8	33.0	43.1	22 8	Do. do.
	2 45	43 1	27.9	35.5	20 3	
19	9 30	55 8	34.3	45.7	25.4	Do. do.
	2 30	55.8	35.5	45.7	27.9	
20	9 30	63.5	38.1	52.0	30.4	Clear and pleasant.
	2 30	69.8	43.1	58.4	34.3	
22	10 00	43.1	27.9	35.5	20.3	Atmosphere hazy.
24	10 00	40.6	27.9	34.3	20.3	Morning clear; afternoon cloudy.
	2 30	45.7	30.4	38.1	20.3	
25	10 00	74.9	45.7	63.5	38.1	Clear all day.
	2 30	96.5	60.9	81.2	50.8	
26	10 00	80.0	50.8	66.0	39.3	Clear and warm.
	2 30	86.3	55.3	71.1	43.1	
27	9 30	67.3	43.1	55.8	33.0	Clear and pleasant.
	2 30	31.7	22.8	27.9	15.2	
29	9 30	76.2	45.7	62.2	38.1	Do.
	2 30	80.0	50.8	66.0	40.6	
30	9 30	78.7	45.7	55.8	33.0	Do.
	2 30	64.7	40 6	53.3	31.7	
May 1	10 00	76.2	46.9	63.5	38.1	Clear and very windy.
	2 30	88.9	55.8	73.6	44.4	
2	9 30	95.2	57.1	78.7	45.7	Clear and cold.
	2 30	90.1	50 8	63.5	40.6	
3	10 00	50 8	31.7	43.1	22.8	Cold and raining.
	2 30	50 8	31.7	44.4	22.8	
4	10 00	63.5	39.3	54.6	29.2	Do.
	2 30	62.2	38.1	53.3	27.9	
6	10 00	53.3	39.3	44.4	20.3	Do.
	2 30	*21.5	*7.6	*21.5	*12.7	
7	10 00	00.0	7.6	00.0	*6.3	Clear and pleasant.
	2 30	22.8	27.9	20.3	00.0	
8	10 00	38.1	30.4	25.4	7.6	Do.
	2 30	45.7	33.0	38.1	12 7	
9	10 00	53.3	31.7	48.2	25.4	Do.
	2 30	57.1	38.1	50.8	25.4	
10	10 00	55.8	38.1	48.2	25.4	Cloudy in morning; rain in afternoon.
	2 30	48.2	35.5	39.3	19.0	
11	10 00	38.1	29.2	31.7	12.7	Clear and pleasant.
	2 30	35.5	27.9	30.4	12.7	
13	10 00	30.4	25.4	25 4	11.4	Cloudy.
	2 30	25.4	22.8	20 3	10.1	
14	10 00	00.0	10.1	2.5	*2.5	Clear and pleasant.
	2 30	5.0	12.7	7.6	00.0	
15	10 00	27.9	25.4	25.4	12 7	Do.
	2 30	53.3	38.1	45.7	25.4	

Note.—The shrinkage and expansion are expressed in decimillimetres. The observations are all shrinkage, except those marked *.

APPENDIX No. 16.

REPORT UPON THE DETERMINATION OF THE LONGITUDE OF AMERICA AND EUROPE FROM THE SOLAR ECLIPSE OF JULY 28, 1851. BY PROFESSOR BENJAMIN PEIRCE, LL.D., &c., &c., &c.

CAMBRIDGE, *May* 31, 1861.

SIR: The solar eclipse of July 28, 1851, was pre-eminently adapted to the determination of the longitude of America and Europe. For this object it surpasses any other celestial phenomenon which is yet known to science either in the past or the future, and was observed under as favorable conditions upon each side of the ocean as can reasonably be desired. The beginning and the end were both repeatedly observed upon either continent by skilful observers, and the computation deserves careful and thorough elaboration. Criticism must first be directed to the observations themselves.

OBSERVATIONS OF THE TOTAL PHASE.

All the observations of the total phases are rejected from the discussion of longitude, because a slight error in the latitude of the observer is greatly magnified in its effect upon the computation of these phases, and has a corresponding influence in vitiating the results. These observations are also much affected by the jagged irregularities of the lunar disk.

EUROPEAN OBSERVATIONS, OF WHICH THE BEGINNING AND THE END, BOTH OBSERVED ON THE SAME PLACE, HAVE BEEN ADMITTED INTO THE COMPUTATION.

Gottingen.—Both phases were observed by Gauss, Westphal, and Klinkerfues.—(A. N., vol. 33, p. 47.) The accuracy of observation may be inferred from the mean coincidence in the time of duration, which was identical for the last two observers, and Gauss differed from them only by one second of time.

	Beginning.			End.		
Gauss	2*h*.	53*m*.	37.4*s*.	5*h*.	0*m*.	0.6*s*.
Westphal	2	53	39.4	5	0	1.6
Klinkerfues	2	53	40.4	5	0	2.6
Mean	2	53	39.1	5	0	1.6

The weight given to each of these means is 3. The latitude and longitude are from Dr. Gould.—(Am. N. A. for 1860.)

Latitude	51°	31′	47.9″	
Longitude	9	56	31.5	east of Greenwich.
Longitude	0*h*.	39*m*.	46.1*s*.	" "

Bonn.—Both phases were observed by Argelander, and the end was also observed by Wolff.—(A. N., vol. 33, p. 44.)

	Beginning.			End.		
Argelander	2*h*.	41*m*.	12.7*s*.	4*h*.	49*m*.	3.9*s*.
Wolff	..	..	..	4	49	4.4
Mean	..	..	..	4	49	4.1

The weight of the beginning is unity, and that of the end is 2. The latitude and longitude are from Dr. Gould.

Latitude	50°	43′	45.0″	
Longitude	7	06	6.9	east of Greenwich.
Longitude	0*h*.	28*m*.	24.46*s*.	" "

Königsberg.—Both phases were observed by D'Arrest, Marth, and Wichmann.—(A. N., vol. 33, p. 316.)

	Beginning.			End.		
D'Arrest	3*h*.	38*m*.	10.9*s*.	5*h*.	38*m*.	33.6*s*.
Marth	3	38	5.5	5	38	31.8
Wichmann	3	38	16.0	5	38	33.3
Mean	3	38	10.8	5	38	32.9

With some hesitation the weight of $2\frac{1}{2}$ is given to each of these means. The weight is diminished from the number of observers on account of the apparent inexperience of Marth and Wichmann's own doubt of the value of his observation of the beginning. The latitude and longitude are from Dr. Gould.

Latitude	54°	42′	50.4″	
Longitude	20	30	5.4	east of Greenwich.
Longitude	1*h*.	22*m*.	0.36*s*.	" "

Hamburg.—Both phases were observed by Rümker and Niebour, and the end was also observed by Rubbert and Porath.—(A. N., vol. 33, p. 36.)

	Beginning.			End.		
Rümker	2*h*.	50*m*.	18.4*s*.	4*h*.	56*m*.	44.6*s*.
Niebour	2	50	13.8	4	56	48.8
Rubbert	..	..	..	4	56	42
Porath	..	..	..	4	56	40
Mean	2	50	16.1	4	56	44.8

In taking the mean the weight $\frac{1}{2}$ is given to each of the two last observers, so that for the mean of the beginning the weight is 2, and for the end it is 3. The latitude and longitude are taken from Dr. Gould.

Latitude	53°	33′	7.0″	
Longitude	9	58	23.4	east of Greenwich.
Longitude	0*h*.	39*m*.	53.56*s*.	" "

Brussels.—Both phases were observed by Quetelet, Bouvy, and Beaufort.—(A. N., vol. 33, p. 38.)

	Beginning.			End.		
Quetelet	2*h*.	27*m*.	24.1*s*.	4*h*.	36*m*.	41.3*s*.
Bouvy	2	27	24.6	4	36	38.7
Beaufort	2	27	24.7	4	36	39.2
Mean	2	27	24.5	4	36	39.7

The weight of 3 is given to the beginning, and that of $2\frac{1}{2}$ to the end. The weight of the end is diminished from the number of observers, because all of them express doubts as to accuracy of the observation. The latitude and longitude are from Dr. Gould.

Latitude	50°	51′	10.7″	
Longitude	4	21	54.0	east of Greenwich.
Longitude	0*h*.	17*m*.	27.6*s*.	" "

Paris.—Both phases were observed by Villarceau, Boutillon, and Mathieu.—(Comptes Rendus de l'Acad. des Sci., vol. 33, p. 201.)

	Beginning.			End.		
Villarceau	2*h*.	20*m*.	53.7*s*.	4*h*.	30*m*.	43.4*s*.
Boutillon	2	20	54.7	4	30	40.4
Mathieu	2	20	53.6	4	30	40.6
Mean	2	20	54.0	4	30	41.5

The weight of 3 is given to each of these means. The latitude and longitude are from Dr. Gould.

Latitude	48°	50′	13.2″	
Longitude	2	20	21.9	east of Greenwich.
Longitude	0*h*.	9*m*.	21.46*s*.	" "

Padua.—Both phases were observed by Santini and Trettenero, assisted by Turazza, Minich, and Maggi.—(A. N., vol. 33, p. 30.)

	Beginning.			End.		
Santini	3*h*.	14*m*.	22.7*s*.	5*h*.	17*m*.	39.7*s*.
Trettenero	3	14	24.2	5	17	42.7
Mean	3	14	23.4	5	17	41.7

In taking the means a weight of $\frac{1}{2}$ is given to Santini's observation of the end, because he regarded it as uncertain. Hence the weight of the first mean is 2, and that of the second is $1\frac{1}{2}$. The latitude and longitude are from Dr. Gould.

Latitude	45°	24′	2.5″	
Longitude	11	52	15.4	east of Greenwich.
Longitude	0*h*.	47*m*.	29.03*s*.	" "

EUROPEAN OBSERVATIONS, OF WHICH THE DURATION IS RETAINED, BUT THE INDEPENDENT OBSERVATIONS OF THE BEGINNING AND END ARE REJECTED ON ACCOUNT OF THE UNCERTAINTY OF THE LONGITUDE.

Dantzic.—Both phases were observed by the five observers, Albrecht, Domke, Schütz, Schröder, and Reinbrecht.—(A. N., vol. 33, p. 328.)

	Beginning.			End.		
Albrecht	3*h*.	30*m*.	15.9*s*.	5*h*.	31*m*.	44.2*s*.
Domke	3	30	14.8	5	31	46.5
Schütz	3	30	11.3	5	31	45.2
Schröder	3	30	24.3	5	31	43.3
Reinbrecht	3	30	27.7	5	31	41.9
Mean	3	30	15.3	5	31	44.0

Mean duration, 2*h*. 01*m*. 28.7*s*.

In taking the mean the observations of the beginning by Schütz, Schröder, and Reinbrecht, reported as uncertain, are rejected, and the weight of 3 is given to the duration. The latitude of Dantzic is assumed to be that of the parish church given in the Connaissance des Temps for 1859. The longitude is a combination of various results.—(A. N., vol. 33, p. 365.)

Latitude	54°	21′	4″	
Longitude from Albrecht by chronometer	1*h*.	14*m*.	39.1*s*.	east of Greenwich.
Longitude from Hansen by occultation	1	14	44.4	" "
Longitude from Domke by eclipse of 1842	1	14	36.4	" "
Mean	1	14	40.7	" "
Mean	18°	40′	10.5″	" "

In using the mean of the longitudes, that determined by Domke is assumed to have half the weight of either of the others.

Marburg.—Both phases were observed by Schönfeld, Lesser, and Gerling, and the end was also observed by Nicolai.—(A. N., vol. 33, p. 123.)

	Beginning.			End.		
Schönfeld	2*h*.	49*m*.	02.81*s*.	4*h*.	56*m*.	9.67*s*.
Lesser	2	49	18.86	4	56	8.49
Gerling	2	49	21.35	4	56	10.48
Nicolai	..	..	....	4	56	8.49
Mean	2	49	20.10	4	56	9.28

Mean duration, 2*h*. 6*m*. 49.18*s*.

In taking the means, Schönfeld's observation of the beginning is omitted. The weight of 2 is given to the duration. The latitude and longitude of Marburg are taken from Encke's Jahrbuch of 1860.

Latitude	50°	48′	46.9″	
Longitude	8	46	16.1	east of Greenwich.
Longitude	0*h*.	35*m*.	5.07*s*.	" "

Rome.—Both phases were observed by Professor Secchi.—(A. N., vol. 33, p. 71.)

Beginning.	End.	Duration.
3*h*. 24*m*. 32.7*s*.	5*h*. 25*m*. 7.2*s*.	2*h*. 00*m*. 34.5*s*.

The weight of unity is given to the duration. The latitude and longitude are taken from the Greenwich Almanac of 1864.

Latitude	41°	53′	52.2″	
Longitude	12	28	40.5	east of Greenwich.
Longitude	0*h*.	49*m*.	54.7*s*.	" "

Frauenberg.—Both phases were observed by Galle, Brünnow, and Wolfers.—(A. N., vol. 33, p. 364.)

	Beginning.			End.		
Galle	3*h*.	34*m*.	59.50*s*.	5*h*.	35*m*.	52.06*s*.
Brünnow	3	34	60.25	5	35	46.20
Wolfers	3	34	61.75	5	35	51.70
Mean	3	34	60.50	5	35	49.99

Mean duration, 2*h*. 0*m*. 49.49*s*.

The weight of 3 is given to the duration. The latitude and longitude are taken from Galle.—(A. N., vol. 33, p. 364.)

Latitude	54°	21′	27.8″	
Longitude	19	41	7.5	east of Greenwich.
Longitude	1*h*.	18*m*.	44.5*s*.	" "

Kasan.—Both phases were observed by Liapunov, and the end was also observed by Simonov and Saweliev.—(A. N., vol. 34, p. 149.)

	Beginning.			End.		
Liapunov	5*h*.	41*m*.	16.6*s*.	7*h*.	25*m*.	27.6*s*.
Simonov	..	..	...	7	25	23.4
Saweliev	..	..	...	7	25	28.2
Mean	..	..	...	7	25	26.4

Mean duration, 1*h*. 44*m*. 9.8*s*.

The weight of $1\frac{1}{2}$ is given to the duration. The latitude and longitude are taken from Petersen.—(A. N., vol. 29, p. 306.)

Latitude	55°	47′	23.0″	
Longitude	49	7	59.0	east of Greenwich.
Longitude	3*h*.	16*m*.	31.9*s*.	" "

Rutzau.—Both phases were observed by Professor Anger.—(A. N., vol. 34, p. 31.)

Beginning.	End.	Duration.
3*h*. 28*m*. 20.9*s*.	5*h*. 29*m*. 51.9*s*.	2*h*. 1*m*. 31.0*s*.

The weight of unity is given to the duration. The latitude and longitude are taken from Anger.—(A. N., vol. 34, p. 31.)

Latitude	54°	42′		
Longitude	18	27	59″	east of Greenwich.
Longitude	1*h*.	13*m*.	51.9*s*.	" "

EUROPEAN OBSERVATIONS WHERE ONLY ONE PHASE IS RETAINED IN THE COMPUTATION.

Altona.—The end was observed by Petersen, Götze, Olde, Quirling, Sonntag, and Koop.—(A. N., vol. 33, p. 39.)

		End.	
Petersen	4*h.*	56*m.*	40.8*s.*
Götze	4	56	40.2
Olde	4	56	40.1
Quirling	4	56	39.6
Sonntag	4	56	38.8
Koop	4	56	36.8
Mean	4	56	39.9

The observation of Koop, being made with a comet-seeker, is rejected from the mean. The weight of 5 is given to the mean. The latitude and longitude are taken from Dr. Gould.

Latitude	53°	32′	45.3″	
Longitude	9	56	32.2	east of Greenwich.
Longitude	0*h.*	39*m.*	46.15*s.*	" "

Vienna.—The beginning was observed by Kunes and Oeltzen.—(A. N., vol. 33, pp. 127 and 416.)

		Beginning.	
Kunes	3*h.*	30*m.*	25.7*s.*
Oeltzen	3	30	24.7
Mean	3	30	25.2

The weight of 2 is given to the mean. The latitude and longitude are taken from Dr. Gould.

Latitude	48°	12′	35.5″	
Longitude	16	23	7.9	east of Greenwich.
Longitude	1*h.*	5*m.*	32.5*s.*	" "

Frankfort.—Both phases were observed by Dr. Lorey.—(A. N., vol. 33, p. 143.)

Beginning	2*h.*	48*m.*	23*s.*+*
End	4	57	1.1

The weight of unity is given to the observation of the end, and the beginning was estimated to be 10 to 20 seconds uncertain. The latitude and longitude are taken from Encke.—(A. N., vol. 38, p. 5.)

Latitude	50°	6′	45″	
Longitude	8	40	46.5	east of Greenwich.
Longitude	0*h.*	34*m.*	43.1*s.*	" "

Prague.—The end was observed by Jelinek, Safarik, jr., and Lukas.—(A. N., vol. 33, p. 203.)

		End.	
Jelinek	5*h.*	21*m.*	15.54*s.*
Safarik, jr.	5	21	15.54
Lukas	5	21	16.54
Mean	5	21	15.87

The weight 2 is given to the mean. The latitude and longitude are taken from Dr. Gould.

Latitude	50°	5′	18.5″	
Longitude	14	25	29.4	east of Greenwich.
Longitude	0*h.*	57*m.*	41.96*s.*	" "

* The beginning is probably two minutes later.

EUROPEAN OBSERVATIONS OMITTED FROM THE COMPUTATION.

Pillau.—Both phases were observed by Wienhold.—(A. N., vol. 33, p. 364.)

Beginning.	End.	Duration.
3*h*. 35*m*. 43.0*s*.*	5*h*. 36*m*. 10.0*s*.	2*h*. 00*m*. 27.0*s*.

The latitude and longitude are taken from Wienhold.—(A. N., vol. 33, p. 365.)

Latitude	54°	38′	23″	
Longitude	19	54	0	east of Greenwich.
Longitude	1*h*.	19*m*.	36.0*s*.	" "

Bern.—Both phases were observed by Wolf.—(A. N., vol. 33, p. 38.)

Beginning.	End.	Duration.
2*h*. 49*m*. 49*s*.†	4*h*. 56*m*. 20*s*.	2*h*. 06*m*. 31*s*.

The latitude and longitude are taken from A. N., vol. 32, p. 193.

Latitude	46°	57′	6.0″	
Longitude	7	26	24.8	east of Greenwich.
Longitude	0*h*.	29*m*.	45.65*s*.	" "

The observed duration corrected by two minutes is adopted.

Nebelung Haven.—Both phases were observed by Lieut. Geelmuyden.—(A. N., vol. 34, p. 373.)

Beginning.	End.	Duration.
2*h*. 41*m*. 34.1*s*.	4*h*. 45*m*. 51.1*s*.	2*h*. 4*m*. 17.0*s*.

The latitude and longitude are taken from Geelmuyden.—(A. N., vol, 34, p. 373.)

Latitude	58°	57′	39″	
Longitude	9	53	12	east of Greenwich.
Longitude	0*h*.	39*m*.	32.8*s*.	" "

The observed duration differs by nearly two minutes from the predicted, and is therefore rejected.

Christiana.—The beginning was observed by Hansteen.—(A. N., vol. 34, p. 372.)

Beginning	2*h*. 43*m*. 8.20*s*.

The latitude and longitude are taken from Dr. Gould.

Latitude	59°	54′	43.7″	
Longitude	10	43	41.4	east of Greenwich.
Longitude	0*h*.	42*m*.	54.76*s*.	" "

This observation appears to be discrepant from the mean of all the others by about thirty seconds, and is therefore rejected, although it was originally supposed to be capable of admission into the computation.

Kullick.—Both phases were observed by Peters and Schumacher, and the end was also observed by Marczynowski.—(A. N., vol. 33, p. 354.)

	Beginning.	End.	
Peters	12*h*. 8*m*. 25.07*s*.	14*h*. 8*m*. 25.67*s*.	sidereal time.
Schumacher	12 8 32.09	14 8 19.15	" "
Marczynowski	.. ..	14 8 16.14	" "

* Probably as much as twenty seconds too late —(W.) It was at first proposed to introduce this duration, but the preliminary comparison with prediction indicated a large discrepancy with other observations, which in the final reduction appear to exceed a quarter of a minute. It is therefore rejected.

† The beginning has been increased by two minutes to agree with prediction.

The beginning was obstructed by clouds, and at the end the telescopes of Schumacher and Marczynowski were shaken by the wind. The longitude of the place of observation is, moreover, not known with sufficient precision, and therefore the observations cannot safely be used. The latitude and longitude are from the A. N., No. 789.

Latitude	53°	33′	47″	
Longitude	21	40	52.5	east of Greenwich.
Longitude	1*h.*	26*m.*	43.5*s.*	" "

Kiel.—The beginning was observed by Weyer and Christensen.—(A. N., vol. 33, p. 27.)

	Beginning.		
Weyer	2*h.*	49*m.*	52*s.*
Christensen	2	49	54

These observations are rejected from the want of a sufficiently precise longitude.

Rostock.—Both phases were observed by Karsten.—(A. N., vol. 33, p. 37.)

Beginning	2*h.*	59*m.*	56.3*s.*
End	5	5	0.9

The beginning is reported to be inaccurate, and the longitude is not known with sufficient accuracy for the adoption of a single phase.

Kremsmunster.—Both phases were observed by Reslhuber, and the end was also observed by Fellöcker and Lettenmayr.—(A. N., vol. 33, p. 59.)

	Beginning.			End.		
Reslhuber	3*h.*	18*m.*	53.3*s.*	5*h.*	23*m.*	25.0*s.*
Fellöcker	..	..	...	5	23	22.6
Lettenmayr	..	..	...	5	23	19.6
Previous computation by Reslhuber	3	18	43	5	23	21

The agreement of these observations with the erroneous prediction invalidates them in my estimation to such an extent that I have rejected them.

Breslau.—Both phases were observed by Günther.—(A. N., vol. 33, p. 78.)

Beginning	3*h.*	27*m.*	17.07*s.*
End	5	30	14.94

These observations agree with the erroneous tables of the moon, which were adopted in the Berlin Jahrbuch and the Greenwich almanac, so much better than most of the other observations, except those at Kremsmunster, that I have rejected them.

Rixhöft.—The beginning was observed by Bush.—(A. N., vol. 33, p. 231.)

Beginning	3*h.*	27*m.*	39.8*s.*

I regret that I cannot ascertain the longitude with sufficient accuracy to retain this observation.

Toulouse.—Both phases were observed by Petit.—(Comptes Rendus, vol. 33, p. 201.)

Beginning, (inaccurate)	2*h.*	27*m.*	15.5*s.*
End	4	36	46.5

The longitude is not given with sufficient precision.

Fredericksvaern.—The beginning was observed by Smith and L'Abbadie.—(A. N., vol. 34, p. 372.)

	Beginning.		
Smith	2*h.*	41*m.*	40.28*s.*
L'Abbadie	2	41	44.6

The longitude is not known with sufficient precision to render these observations available for the present discussion.

AMERICAN OBSERVATIONS.

Princeton.—Both phases were observed by Professor S. Alexander.—(G. A. J., vol. 2, p. 52.)

Beginning.	End.	Duration.	Middle.
19*h.* 32*m.* 35.5*s.*	21*h.* 7*m.* 22.8*s.*	1*h.* 34*m.* 47.3*s.*	20*h.* 19*m.* 59.2*s.*

The weight of unity is given to the duration in the determination of the lunar elements, and that of $1\frac{1}{2}$ to the middle in the determination of the longitude of America and Europe. The value of the middle is diminished on account of the mode in which the time was probably determined, which is presumed not to have been done by means of a transit instrument, although the mode of determination is not stated. The latitude and longitude are taken from a communication of Assistant Schott to Professor Bache.

Latitude	40°	20′	41″	
Longitude	74	39	49.5	west of Greenwich.
Longitude	4*h.*	58*m.*	39.3*s.*	" "

Nantucket.—Both phases were observed by Professor W. Mitchel.—(G. A. J., vol. 2, p. 51.)

Beginning.	End.	Duration.	Middle.
19*h.* 55*m.* 34.6*s.*	21*h.* 33*m.* 47.1*s.*	1*h.* 38*m.* 12.5*s.*	20*h.* 44*m.* 40.8*s.*

The weight of unity is given to the duration, but the middle is not used in the determination of the longitude, on account of its discrepancy with the average of the other observations in America. The latitude and longitude are taken from Mr. Schott.

Latitude	41°	16′	57.2″	
Longitude	70	5	50.3	west of Greenwich.
Longitude	4*h.*	40*m.*	23.35*s.*	" "

Burlington.—Both phases were observed by Mr. Gummere.—(G. A. J., vol. 2, p. 52.)

Beginning.	End.	Duration.	Middle.
19*h.* 31*m.* 54*s.*	21*h.* 5*m.* 32*s.*	1*h.* 33*m.* 38*s.*	20*h.* 18*m.* 43*s.*

The weight of $\frac{1}{2}$ is given to the duration, and that of unity to the middle. The value of the observations is assumed to be less, because they are only given to the full second. The latitude and longitude are taken from Mr. Schott.

Latitude	40°	4′	43.6″	
Longitude	74	51	9.7	west of Greenwich.
Longitude	4*h.*	59*m.*	24.65*s.*	" "

New York.—Both phases were observed by Professor Hackley.—(G. A. J., vol. 2, p. 52.)

Beginning	19*h.*	35*m.*	55*s.*
End	21	11	50

These observations have been omitted.

Mount Pleasant.—Both phases were observed by Mr. Goodfellow, and the end was also observed by Lieutenant Trowbridge.—(G. A. J., vol. 2, p. 51.)

	Beginning.	End.
Goodfellow	19*h.* 50*m.* 32.92*s.*	21*h.* 38*m.* 29.27*s.*
Trowbridge	-- -- ----	21 38 27.48
Mean	-- -- ----	21 38 28.38

Mean duration, 1*h.* 47*m.* 55.46*s.* Middle, 20*h.* 44*m.* 30.65*s.*

The weight $1\frac{1}{2}$ is given to the duration, and that of 3 to the middle. The latitude and longitude are taken from Mr. Schott.

Latitude	44°	01′	35.2″	
Longitude	70	49	12.7	west of Greenwich.
Longitude	4*h.*	43*m.*	16.85*s.*	" "

Washington.—Both phases were observed by Mr. Ferguson and Professor Hubbard.—(G. A. J., vol. 2, p. 52.)

	Beginning.			End.		
Ferguson	19*h*.	21*m*.	32.77*s*.	20*h*.	50*m*.	37.94*s*.
Hubbard	19	21	29.59	20	50	38.08
Mean	19	21	31.18	20	50	38.01

Mean duration, 1*h*. 29*m*. 6.83*s*. Middle, 20*h*. 06*m*. 4.60*s*.

The weight of 2 is given to the duration, and that of 4 to the middle. The latitude and longitude are taken from Mr. Schott.

Latitude	38°	53′	38.9″	
Longitude	77	2	59.3	west of Greenwich.
Longitude	5*h*.	8*m*.	11.95*s*.	" "

Philadelphia.—Both phases were observed by Mason and Riggs.—(G. A. J., vol. 2, p. 52.)

	Beginning.			End.		
Mason	19*h*.	30*m*.	25*s*.	21*h*.	3*m*.	34*s*.
Riggs	19	30	29	21	3	36
Mean	19	30	27	21	3	35

Mean duration, 1*h*. 33*m*. 8*s*. Middle, 20*h*. 17*m*. 1*s*.

The value of unity is given to the duration, and that of 2 to the middle. The latitude and longitude are taken from Mr. Schott.

Latitude	39°	57′	2.9″	
Longitude	75	9	35.2	west of Greenwich.
Longitude	5*h*.	0*m*.	38.35*s*.	" "

Cambridge.—The beginning was observed by Walker, Bond, and Paine.—(G. A. J., vol. 2, p. 51.)

	Beginning.		
Walker	19*h*.	49*m*.	35.34*s*.
Bond	19	49	38.97
Paine	19	49	35.28
Mean	19	49	36.53

The weight of 2 is given to the mean. The latitude and longitude are taken from Dr. Gould and Mr. Schott.

Latitude	42°	22′	48.6″	
Longitude	71	7	33.7	west of Greenwich.
Longitude	4*h*.	44*m*.	30.25*s*.	" "

Georgetown.—The end was observed by Professor Curley.—(G. A. J., vol. 2, p. 53.)

End	20*h*.	50*m*.	30.05*s*.

The weight of unity is given to this observation. The latitude and longitude are taken from Mr. Schott.

Latitude	38°	54′	26.6″	
Longitude	77	4	32.3	west of Grenwich.
Longitude	5*h*.	8*m*.	18.15*s*.	" "

METHOD OF COMPUTATION.

The form of computation is the modified Bessel's form which is published in Peirce's Spherical Astronomy, (pages 322–337,) and which is adopted in the office of the American Nautical Almanac. The following are the formulæ, disposed in the order in which they are used:

$\lambda_1 =$ the (moon's—sun's) longitude.

$\beta_1 =$ the (moon's—sun's) latitude.

$\gamma =$ the angular distance of the sun and moon.

$u =$ the angle which γ makes with the circle of latitude drawn through the sun.

$\omega' =$ the angle which γ makes with the circle of declination drawn through the sun.

$\tan. u = \sin. \lambda_1 \cot. \beta_1.$

$\tan. \gamma = \tan. \lambda_1 \operatorname{cosec}. u.$

$l =$ the sun's longitude.

$\mathrm{O} =$ the obliquity of the ecliptic.

$\tan. (u - \omega') = \cos. l \tan. \mathrm{O}.$

$r =$ distance of the sun from the earth.

$\Pi =$ the sun's equatorial horizontal parallax.

$\pi =$ the moon's equatorial horizontal parallax.

$\Pi' =$ the mean value of $\Pi = 8''.5712.$

$$m = \frac{\sin. \Pi}{\sin. \pi} = \frac{\sin. \Pi'}{r \sin. \pi} = \frac{\sin. 8''.5712}{r \sin. \pi}$$

$$c = \frac{m \sin. \gamma \operatorname{cosec}. 1''}{1 - m \cos. \gamma}$$

$r_1 =$ distance of the moon from the earth expressed in earth's radii $=$ cosec. π.

$\alpha =$ the sun's geocentric right ascension.

$a =$ the sun's selenocentric right ascension.

$\delta =$ the sun's geocentric declination.

$d =$ the sun's selenocentric declination.

$d = \delta - c \cos. \omega'.$

$a = \alpha - c \sin. \omega' \sec. \delta.$

$\rho =$ the perpendicular from the earth upon the axis of the shadow.

$z =$ the distance from the moon's centre to the foot of this perpendicular.

$\omega =$ the angle which the plane of the sun, moon, and earth makes with the plane drawn through the sun and moon parallel to the earth's axis.

$\omega = \omega' - c \sin. \omega' \tan. \delta = (\alpha - a) \sin. \delta.$

$z = r_1 \cos. (c + \gamma.)$

$\rho = r_1 \sin. (c + \gamma.)$

$\mathrm{A} = \rho \sin. \omega.$

$y = \rho \cos. \omega.$

$\mathrm{H} =$ the apparent semi-diameter of the sun at his mean distance $= 959''.788.$

$\mathrm{K} =$ the ratio of the moon's radius to that of the earth $= 0.27264 = [9.435590.]$

$f =$ the angle of the penumbral cone of the moon.

$\mathrm{F} = \sin. \mathrm{H} + \mathrm{K} \sin. \Pi' = [7.6688048.]$

$$s = \text{the moon's heliocentric distance} = \frac{r \sin. \gamma}{\sin. (c + \gamma)} = r \left[1 - m \cos. (c + \gamma)\right]$$

$$\sin. f = \frac{\mathrm{F}}{s}.$$

$\rho' =$ the radius of the shadow upon the plane drawn through the earth's centre perpendicular to the axis of the shadow.

$\rho' = z \tan. f + \mathrm{K} \sec. f.$

$B = y + \rho'$.
$C = y - \rho'$.
$E = \cos.\ (d - f)\ \sec.\ f = \cos.\ d\ [1 + \tan.\ d \tan.\ f.]$
$F = \cos.\ (d + f)\ \sec.\ f = \cos.\ d\ [1 - \tan.\ d \tan.\ f.]$
$G = \sin.\ (d - f)\ \sec.\ f = \sin.\ d\ [1 - \cot.\ d \tan.\ f.]$
$H = \sin.\ (d + f)\ \sec.\ f = \sin.\ d\ [1 + \cot.\ d \tan.\ f.]$
$\theta =$ the latitude of a place.
$e =$ the earth's eccentricity $=$ [8.9122052.]
$1 - e^2 =$ [9.9970916.]
$\sin.\ \psi_1 = e \sin.\ \theta$.
$k = (1 - e^2)\ \sec.\ \psi_1 \sin.\ \theta$.
$h = \sec.\ \psi_1 \cos.\ \theta$.
$\lambda =$ the east longitude of the place.
$\mu =$ the hour angle of the moon for Greenwich.
$\mu_1 =$ the moon's hour angle for the place $= \mu + \lambda$.
$b = B - E k + G h \cos.\ \mu_1$.
$c = -C + F k - H h \cos.\ \mu_1$.
$m = \sqrt{b c}$.
$a = A - h \sin.\ \mu_1$.

At the instant of the beginning or end of the eclipse the values of m and a must be equal; but if they are not equal for the computed instant, the correction of the time is to be ascertained by the following formulæ:

$$\tan.\ \tfrac{1}{2}\psi = \frac{c}{m} = \frac{m}{b} = \sqrt{\frac{c}{b}}$$

$\mu' =$ [1.86167.]
$H' = \mu' \sin.\ d$.
$A' =$ the increase of A in one second.
$B' =$ the increase of B in one second.
$a' = A' - \mu' h \cos.\ \mu_1$.
$b' = B' - H' h \sin.\ \mu_1$.

$$\text{The correction of the time} = \frac{m - a}{a' + b' \cot.\ \psi}$$

The values of A, B, C, E, F, G, and H, are constructed by these formulæ for the hours $0h.$, $1h.$, $2h.$, $3h.$, $4h.$, and $5h.$, Greenwich mean time in table A.* These values, with those of μ, A' and B', are inserted in table B, and interpolated for every 5 minutes. The slight differences between the numbers of tables A and B arise from slight differences in the data, which are of no sensible importance.

The computations of the phases for the various places are then continued in table C. In making the computations for these phases of which the longitudes are not given in the preceding portion of the report, such longitudes and latitudes have been used as seemed to be given by the best authorities. But, since no use has been made of these computations in the determination of the received longitude, there is no necessity of any careful criticism of these elements.

The equations of condition for the correction of the moon's latitude, longitude, and horizontal parallax, and for the sum of the semi-diameters of the sun and moon, are obtained by the following formulæ:

$$D_t\ (m - a) = a' + b' \cot.\ \psi.$$

$$D\ s\ t = \frac{r_1\ (10)^6 \sin.\ 1''}{\sin.\ \psi\ D_t\ (m - a)}$$

* The tables are in manuscript.

$$D_\alpha t = -\sin.(\psi + u - \omega)\, D_s t.$$
$$D_\beta t = -\cos.(\psi + u - \omega)\, D_s t.$$
$$D_\omega t = [A + \tfrac{1}{2}(B + C)\cot.\psi]\sin.\psi\, D_s t.$$
$$D_\lambda t = 1 + \frac{H' h \sin.\mu_1 \cot.\psi + \mu' h \cos.\mu_1}{D_t (m - a)}$$

$\delta\alpha$ = the correction of the moon's longitude.
$\delta\beta$ = the correction of the moon's latitude.
$\delta\omega$ = the correction of the moon's horizontal parallax.
δs = the correction of the sum of the semi-diameters of the sun and moon.
$\delta\lambda$ = the correction of the eastern longitude of America from Europe.
δt = the correction of the computed time of observation = (the observed—the computed) time of the observation.

$$D_\alpha t\,\delta\alpha + D_\beta t\,\delta\beta + D_\omega t\,\delta\omega + D_s t\,\delta s + D_\lambda t\,\delta\lambda = \delta t.$$

The original plan was to determine from the combined equations of condition the corrections of the various lunar elements, as well as of the longitude. But it is at once apparent that the changes of the lunar parallax may almost exactly balance those of the longitude, so that the observations are inadequate to the investigation of both these elements. It is, moreover, probable that the tabular values of the lunar parallax and latitude given either by Hansen's or Adams's tables are too exact to admit of correction by the observations of the eclipse. These and other considerations led to the following modified plan of reduction:

MODIFIED PLAN OF REDUCTION OF THE OBSERVATIONS.

A new determination of the lunar elements was made from the American tables and from those of Hansen, and these computations are contained, respectively, in tables D and E. The comparative values of the elements from the different tables is continued in the following table:

	0h.			5h.		
Longitude originally used	123°	12′	28.13″	126°	17′	17.23″
Longitude from American tables	123	12	31.24	126	17	19.52
Longitude from Hansen	123	12	22.83	126	17	10.90
Latitude originally used	0	37	16.00	0	54	9.63
Latitude from American tables	0	37	15.40	0	54	9.47
Latitude from Hansen	0	37	14.49	0	54	8.55
Horizontal parallax originally used	1	0	28.4	1	0	33.4
Horizontal parallax from American tables	1	0	27.15	1	0	32.40
Horizontal parallax from Hansen	1	0	27.05	1	0	32.28

The values of $D_s t$, $D_\alpha t$, $D_\beta t$, $D_\omega t$, and $D_\lambda t$ were then computed in table F, and in the same table the corresponding corrections were made in order to reduce the basis of computation to Hansen's tables as the nearest approach to the requisite accuracy. The comparison with observation resulting from this reduction sufficiently attests the propriety of this step, and illustrates the great excellence of Hansen's tables.

The approximation to coincidence between the observed and computed times of the phases, resulting from this last reduction, affords the opportunity for preliminary criticism, and at once suggests the highly probable conclusion that the defects of observation are of such a kind as to act in opposite directions upon the first and last phases, so that they will partially disappear from the mean. It is, then, important to restrict the discussion to those observations in which the same observer observed both phases, and to divide the equations of condition into two sets, one of which involves the interval of duration and the other the mean time. The weight which should then be given to each equation is readily inferred from the previous criticism of the observations. The equations which involve the interval of duration are principally of use

in correcting the sum of the semi-diameters, but this element is of such inferior importance in the determination of the longitude of Europe and America that their introduction is practically a matter of form, and the final discrepancies between the observed and computed intervals of duration must not be introduced into the value of the probable error of the computed longitude.

In the final equations of condition the unknown quantities are the corrections of the sum of the semi-diameters of the lunar tabular longitude and of the eastern longitude of America from Europe. Their discussion is represented in the following form, and the numerical details are given in table G:

n = (observed—computed) time.
$\delta\alpha$ = the correction of lunar longitude.
δs = the correction of the sum of semi-diameters.
$\delta\lambda$ = the eastern correction of the longitude of America from Europe.

And each equation of condition is—

$$D_s t\ \delta s + D_\alpha t\ \delta\alpha + D_\lambda t\ \delta\lambda = n.$$

w = weight of each observation.
k = the nearest integer to the value of $w D_s t$.

And the first combined equation is—

$$\Sigma k\ D_s t\ \delta s + \Sigma k\ D_\alpha t\ \delta\alpha + \Sigma k\ D_\lambda t\ \delta\lambda = \Sigma k n.$$

The values of $\delta' s$ and n' are determined by the equations—

$$\Sigma k\ D_s t - \delta' s = \Sigma k n.$$
$$n' - n = - D_s t.\ \delta' s.$$

The values of $\delta D_\alpha t$ and $D_\alpha' t$ are next determined by the equations—

$$\delta D_\alpha t = \frac{\Sigma k D_\alpha t}{\Sigma k D_s t}$$
$$D'_\alpha t = D_\alpha t - \delta D_\alpha t.\ D_s t.$$
k' = the integer nearest to the value of $w D_\alpha' t$.

And the second combined equation is—

$$\Sigma k'\ D'_\alpha t\ \delta\alpha + \Sigma k' D'_\lambda t - \delta\lambda = \Sigma k' n';$$

in which

$$D'_\lambda t = D_\lambda t - \delta D_\lambda t.\ D_s t$$

and

$$\delta D_\lambda t = \frac{\Sigma k D_\lambda t}{\Sigma k D_s t},$$

the values of $\delta'\alpha$ and n'', are determined by the equations—

$$\Sigma k'\ D'_\alpha t.\ \delta'\alpha = \Sigma k' n'$$
$$n'' - n' = - D'_\alpha t.\ \delta'\alpha.$$

The value of $\delta D_\lambda' t$ and $D_\lambda'' t$ are then determined by the equations—

$$\delta D'_\lambda t = \frac{\Sigma k' D'_\lambda t}{\Sigma k' D'_\alpha t}$$
$$D''_\lambda t = D'_\lambda t - \delta D'_\lambda t.\ D'_\alpha t.$$
k'' = the nearest integer to the value of $10\ w D''_\lambda t$.

And the correction of the longitude is given by the equation—

$$\Sigma k''\ D''_\lambda t.\ \delta\lambda = \Sigma k'' n''.$$

The final errors of observation and corrections of the lunar elements are given by the equations—

$$\delta\lambda = 0s.38.$$
$$n''' = n'' - D''_\lambda t.\ \delta\lambda.$$
$$\delta a = \delta' a - \delta D'_\lambda t.\ \delta\lambda = -0''.34.$$
$$\delta s = \delta' s - \delta D_a l\, \delta a - \delta D_\lambda t.\ \delta\lambda = -2''.86.$$

The resulting longitude of Washington is—

$$5h.\ 8m.\ 11.57s. \pm 0.52s.$$

And of the other American places of observation the longitudes are—

	h.	*m.*	*s.*
Of Princeton	4	55	38.9
Of Nantucket	4	40	23.0
Of Burlington	4	59	24.3
Of Mount Pleasant	4	43	16.47
Of Philadelphia	5	0	37.97
Of Cambridge	4	44	29.87
Of Georgetown	5	8	17.77

The probable error of observation was derived from the formulæ—

$$\text{Mean error of observation} = \sqrt{\left(\frac{\Sigma\,(w\,n'''^{\,2})}{0.96\,n - 1.88}\right)} = 1.80s.$$

$$\text{Mean error of } \lambda = a\sqrt{\left(\frac{0.96}{\Sigma\,(k''\,D''_\lambda\,t)} + 0.04\right)} = 0.77s.$$

A final comparison of the observations of each phase with the computations corrected for the corrections of the lunar elements and of the longitude is contained in table H.

The comparative value of the observation of each phase of the duration and of the mean may be estimated by taking the squares of the errors of observation for each of the observations which is marked with the letter (*p*) in the column of remarks.

This gives for the sixteen observations of each phase made in Europe—

The average square of error of observation of beginning	=	5.40″
The same for end	=	7.45
Half the square of the duration	=	7.59
Double the square for the mean	=	5.15

For the seven American observations it gives—

The square of the average error of observation for beginning	=	21.26
The square of the end	=	14.75
The half square for the duration	=	29.71
The double square for the mean	=	6.13

For the combination of the twenty-three observations—

The square of the average error for the beginning	=	10.23
The square for the end	=	9.67
The half square for the duration	=	14.32
The double square for the mean	=	5.45

This comparison seems to justify the mode of reduction of the observations which was finally adopted, and to confirm the accuracy of the result in reference to the longitude of Europe and America.

Respectfully submitted by

BENJAMIN PEIRCE.

Prof. A. D. BACHE, LL.D., F. R. S.,
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APPENDIX No. 17.

REPORT OF PROFESSOR BENJAMIN PEIRCE, LL.D., ON AN EXAMPLE FOR THE DETERMINATION OF LONGITUDES BY OCCULTATIONS OF THE PLEIADES.

CAMBRIDGE, *November* 20, 1861.

SIR: I have commenced the reduction of the observations of the Pleiades' occultations with the period 1838–1842, inclusive. This is the only period, except the one which has just terminated, which contains any simultaneous observations upon this continent. It is peculiarly valuable, because within this period Bessel made his triangulation of the Pleiades.

I have thought it expedient to prepare for you a complete example of the computation of one of the simultaneous sets of observation within this period, in order that the mode of computation which I have adopted might be submitted to your criticism, and that you may be able to come to a definite opinion in regard to the probable accuracy of the results.

For this purpose I have selected the emersions for September 26, 1839. The following is a list of the observations, in which the stars are numbered in conformity with the catalogue upon page 196 of the Coast Survey report for 1856:

1. *Greenwich Observatory, (Gr. obs.,* p. 83,*) observed with south and east equatorial.*

Star's No.	Star's name.	Sid. time.	Instrument.	Remarks.
		h. *m.* *s.*		
1	*g* Celaeno	5 23 53.70	S. Equat	Very good.
1	*g* Celaeno	5 23 54.00	E. Equat.	
4	*e* Taygeta	5 56 50.63	S. Equat.	
11	*c* Maja	5 58 17.43	S. Equat.	

2. *Cambridge (England) Observatory (Camb. Obs.,* p. 254*) with five feet equatorial.*

Star's No.	Star's name.	Sid. time.	Remarks.
		h. *m.* *s.*	
1	*g* Celaeno	5 26 37.91	A little doubtful.
4	*e* Taygeta	5 57 31.53	Very exact.
11	*c* Maja	6 00 25.54	Very exact.

3. *Ashurst. (Mem. Ast. Soc.* xi., p. 289.*) Observer Snow.*

Star's No.	Star's name.	Sid. time.
		h. *m.* *s.*
1	*g* Celaeno	5 21 42.58
4	*e* Taygeta	5 55 19.08
11	*c* Maja	5 56 16.58

4. *Washington observatory on Capitol Hill, (Gilliss's obs.,* p. 104.*) Observer Gilliss with power* 47.

Star's No.	Star's name.	Mean S. time.
		h. *m.* *s.*
2	*b* Electra	10 22 52.6
1	*g* Celaeno	10 30 20.2
4	*e* Taygeta	10 39 59.3
11	*c* Maja	10 56 42.40

5. *Philadelphia High School Observatory,* (*Phil. Phil. Soc., pro.* I, pp. 229, 230.)

Star's No.	Star's name.	Mean S. time.			Observer.
		h.	*m.*	*s.*	
2	*b* Electra	10	32	4.73	Walker.
2	*b* Electra	10	32	7.97	Kendall.
2	*b* Electra	10	32	5.78	Riggs.
2	*b* Electra	10	32	5.13	Mason.
1	*g* Celaeno	10	39	57.09	Walker.
1	*g* Celaeno	10	39	57.67	Kendall.
1	*g* Celaeno	10	39	58.95	Riggs.
1	*g* Celaeno	10	39	57.04	Mason.
4	*e* Taygeta	10	49	58.93	Walker.
4	*e* Taygeta	10	49	59.52	Kendall.
4	*e* Taygeta	10	50	00.36	Riggs.
4	*e* Taygeta	10	49	59.33	Mason.
11	*c* Maja	11	6	34.69	Walker.
11	*c* Maja	11	6	35.04	Riggs.
11	*c* Maja	11	6	35.29	Mason.

6. *Boston, residence of Mr. Paine,* (*Phil. Phil. Soc., pro.* I, pp. 229, 230.)

Star's No.	Star's name.	Mean solar time.			Observer.
		h.	*m.*	*s.*	
2	*b* Electra	10	53	6.90	Paine.
1	*g* Celaeno	11	1	45.27	Do.
4	*e* Taygeta	11	12	36.43	Do.
11	*c* Maja	11	28	58.98	Do.

The latitude of Greenwich and the latitude and longitude of Cambridge are those given by Dr. Gould in the American Almanac. The latitude and longitude of Ashurst are given in the Memoirs of the Royal Astronomical Society, vol. xi, p. 287. The latitudes of Washington and Philadelphia are those given by Dr. Gould. The longitude of Washington Observatory is assumed to be $5h.\ 8m.\ 12s.$ The longitude of the observatory upon Capitol Hill $10s.25$ east of Washington Observatory, (Coast Survey Report for 1851, p. 481,) and the longitude of Philadelphia from Washington is found by Dr. Gould to be $7m.\ 33.64s.$ east.—(Nautical Almanac, p. 470.) The latitude and longitude of Paine's house were deduced from those of the Boston State-house on the authority of Walker.—(Phil. Ph. Soc., proc. I, p. 231.)

Boston State-house — Paine's house = 26″.7 N. in lat., and $0s.33$ E. in long.

And by Coast Survey Report for 1851, pp. 204, 206—

Cambridge Observatory — Boston State-house = 1′ 23″.89 N., and $48s.52$ W. in long.

And by Dr. Gould—

Latitude Cambridge Observatory = 42° 22′ 48″.60.

Longitude Cambridge Observatory — Washington = $23m.\ 41.54s.$ E.

Which gives—

Longitude Paine's house = — $4h.\ 44m.\ 14.6s.$

Latitude Paine's house = 42° 20′ 58″.

The following order of computation was then adopted:

The siderial time of mean noon at Greenwich for September 26, 1839, was found from the Tabulæ Regiomontanæ. The places of the moon for Greenwich sidereal, $3h.$, $4h.$, $5h.$, and $6h.$, were obtained from Hansen's lunar tables, and an ephemeris was interpolated for every

10*m.* from 3*h.* 50*m.* to 4*h.* 40*m.*, inclusive, and from 5*h.* 20*m.* to 6*h.* 10*m.*, inclusive, which contains the values of—

$$\alpha_m,\ \beta_m,\ \text{sin.}''\ \pi,\ \text{sin.}''\ \pi\ \text{sec.}\ \beta_m \text{ and } s - \alpha_m.$$

It is to be observed that I have adopted the notation—

$$\text{Sin.}'' = \frac{\text{sin.}}{\text{sin. } 1''} \qquad \text{tan.}'' = \frac{\text{tan.}}{\text{sin. } 1''}$$

The place of Alcyone is derived from the following table, which contains for the years 1838 to 1842 the mean right ascension and declination, with the constants for reduction to apparent place by the aid of the Tabulæ Regiomontanæ. The right ascension and declination for 1840 were given me by the kindness of Dr. B. A. Gould. This table also contains the constants for the computation of E and F (Coast Survey Report of 1856, p. 195) by the formulæ—

$$E = Aa_2 + Bb_2 + Cc_2 + Dd_2$$
$$F = Cc_1 + Dd_1$$

Mean places of Alcyone for the years 1838—1842, *with the constants for reduction to apparent places, and for the computation of* E *and* F.

Year.	Mean α_s	Mean β_s	a	b	c	d	a^1	b^1	c^1	d^1	c_1	d_1	a_2	b_2	c_2	d_2	$10^4 a_2$
	° ′ ″	° ′ ″															
1838	54 31 31.04	23 36 41.06	1.7258	9.4046	9 8022	9.9584	1.0642	9.9105_n	8.8578	9.3667	$4\ 6492_n$	4.4119	5 9363	4.4878	4.0898	4.2364	.8635
1839	54 30 37.81	23 36 29.49	1.7258	9.4046	9.8021	9.9585	1.0640	9.9106_n	8.8571	9 3666	4.6492_n	4.4118	5.9363	4.4877	4.0899	4.2365	.8637
1840	54 29 41.59	23 36 17.91	1.7259	9.4045	9.8019	9.9586	1.0639	9.9107_n	8.8564	9.3665	4.6492_n	4.4116	5.9364	4.4875	4.0900	4.2367	.8638
1841	54 28 51.38	23 36 6.32	1.7259	9.4044	9.8018	4.9587	1 0637	9.9108_n	8.8558	9.3664	4.6492_n	4.4114	5.9365	4.4874	4.0901	4.2368	.8640
1842	54 27 58.17	23 35 54.74	1.7259	9.4043	9.8016	9 9588	1.0636	9.9108_n	8.8551	9.3663	4.6493_n	4.4113	5.9366	4.4872	4.0902	4.2370	.8642

The right ascensions and declinations of the moon were computed directly from the formulæ on page 47 of the introduction to the tables of Hansen, without the use of the tables. The remaining computations are conducted by the formulæ in the Coast Survey Report of 1856, (pp. 192, 196,) with a few modifications and some auxiliary formulæ. Thus—

$$\text{Cot. } h' = \text{sin. } \beta_m \text{ cot. } \chi$$
$$g = \tfrac{1}{2} \text{ sin. } \beta_s{}^\circ \text{ sin. } 1''$$
$$z = g\ z_n \text{ sin.}''\ (\alpha'_m - \alpha_s{}^\circ)$$
$$\log.\ \alpha = 9.436500.$$

Moreover, instead of applying the corrections for precession and nutation to the ordinates of the stars, these corrections are applied with their signs reversed to the co-ordinates of the moon. Hence come the formulæ—

$$E = (1 + F)^{\frac{1}{A}}$$
$$x_m = \frac{F_1}{A} \text{ sin.}''\ (\alpha'_m - \alpha_s{}^\circ) \text{ cos. } \beta'_m$$
$$y_m = \frac{F_1}{A}\left(\text{sin.}''\ (\beta'_m - \beta_s{}^\circ) + Z\right)$$
$$x''_m = x_m - E\ y_m$$
$$y''_m = y_m + E\ x_m$$

The values of $\frac{1}{A}$ are readily obtained by means of the following table, and the values of $D_e\ p$ and $D_\lambda\ p$ from the formulæ—

$$D_e\ p = -\text{cos. } p \text{ cos. } (\theta - h'),$$
$$D_\lambda\ p = D_e\ p\ D_t\ l,$$

and each equation of condition becomes

$$D_e\ p\ \delta\ l + D_\lambda\ p\ \delta\lambda = \Sigma_2 - p = \delta\ p,$$

in which $\delta\ l$ is the increase of the moon's longitude in seconds of arc, and $\delta\lambda$ is the increase of

the western longitude of the place in seconds of time. In this first approximation no other corrections have been introduced. The longitudes of Cambridge and Ashurst have also been supposed to be accurate, as well as the longitudes of Philadelphia and Boston from Washington. The European observations have, therefore, given the correction of the moon's longitude by means of the equation

$$\delta l = \frac{\mathrm{S}\,(k\ \delta p)}{\mathrm{S}\,(k\ \mathrm{D}_c\ p)}$$

and this correction applied to the other observations has given

$$\delta' p = \delta p - \mathrm{D}_c\ p\ \delta l$$

$$\delta\lambda = \frac{\mathrm{S}\,(k'\ \delta'\ p)}{\mathrm{S}\,(k'\ \mathrm{D}_\lambda\ p)}$$

$$\delta'' p = \delta' p - \mathrm{D}_\lambda\ p\ \delta\lambda,$$

and the probable error has been computed from $\delta' p$ and $\delta'' p$ by processes which have been otherwise given.

Table of the values of $\Delta\beta$ *corresponding to those of* $\frac{1}{\Delta}$

1÷Δ	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
0	0 00	3 18	4 40	5 43	6 36	7 22	8 5	8 44	9 20	9 54
1	10 26	10 57	11 26	11 54	12 21	12 46	13 12	13 36	14 0	14 23
2	14 45	15 6	15 28	15 48	16 9	16 29	16 49	17 8	17 27	17 45
3	18 3	18 21	18 39	18 56	19 13	19 30	19 47	20 3	20 19	20 35
4	20 51	21 7	21 22	21 38	21 53	22 8	22 23	22 37	22 52	23 6
5	23 20	23 34	23 48	24 01	24 15	24 28	24 41	24 54	25 7	25 20
6	25 33	25 46	25 58	26 11	26 24	26 36	26 48	27 0	27 12	27 24
7	27 36	27 48	28 0	28 11	28 23	28 34	28 45	28 57	29 8	29 19
8	29 30	29 41	29 52	30 3	30 13	30 24	30 35	30 45	30 56	31 6
9	31 17	31 27	31 37	31 48	31 58	32 8	32 18	32 28	32 38	32 48
10	32 58	33 8	33 18	33 27	33 37	33 47	33 59	34 6	34 16	34 25
11	34 35	34 44	34 54	35 3	35 13	35 22	35 31	35 40	35 50	35 59
12	36 8	36 17	36 26	36 34	36 43	36 52	37 1	37 10	37 18	37 27
13	37 36	37 45	37 54	38 2	38 11	38 20	38 28	38 37	38 45	38 54
14	39 2	39 10	39 19	39 27	39 36	39 44	39 52	40 0	40 9	40 17
15	40 25	40 33	40 41	40 49	40 57	41 5	41 13	41 21	41 28	41 36
16	41 44	41 52	42 0	42 7	42 15	42 23	42 31	42 38	42 46	42 53
17	43 1	43 9	43 16	43 24	43 31	43 39	43 46	43 54	44 1	44 9
18	44 16	44 24	44 31	44 39	44 46	44 53	45 0	45 7	45 15	45 22
19	45 29	45 36	45 43	45 51	45 58	46 5	46 12	46 19	46 26	46 33
20	46 40	46 47	46 54	47 1	47 8	47 15	47 22	47 29	47 35	47 42
21	47 49	47 56	48 3	48 9	48 16	48 23	48 30	48 37	48 43	48 50
22	48 57	49 4	49 10	49 17	49 23	49 30	49 37	49 43	49 50	49 56
23	50 3	50 9	50 16	50 22	50 29	50 35	50 41	50 48	50 54	51 1
24	51 7	51 13	51 20	51 26	51 33	51 39	51 45	51 52	51 58	52 5
25	52 11	52 17	52 23	52 30	52 36	52 42	52 48	52 54	53 1	53 7
26	53 13	53 19	53 25	53 31	53 37	53 43	53 49	53 55	54 1	54 7
27	54 13	54 19	54 25	54 31	54 37	54 43	54 49	54 55	55 1	55 7
28	55 13	55 19	55 25	55 30	55 36	55 42	55 48	55 54	55 59	56 5
29	56 11	56 17	56 23	56 28	56 34	56 40	56 46	56 52	56 57	57 3
30	57 9	57 15	57 20	57 26	57 31	57 37	57 43	57 49	57 54	58 0
31	58 6	58 12	58 17	58 23	58 28	58 34	58 40	58 45	58 51	58 56
32	59 2	59 8	59 13	59 19	59 24	59 30	59 35	59 41	59 46	59 52
33	59 57	60 2	60 8	60 13	60 19	60 24	60 29	60 35	60 40	60 46
34	60 51	60 56	61 1	61 7	61 12	61 17	61 23	61 28	61 33	61 39
35	61 44	61 49	61 54	62 0	62 5	62 10	62 15	62 22	62 28	62 34

Table of the values of Δu corresponding to those of $\frac{1}{A}$

1÷A	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
0	0 60	3 36	5 6	6 15	7 12	8 3	8 49	9 32	10 11	10 49
1	11 23	11 57	12 29	12 59	13 28	13 57	14 24	14 51	15 17	15 42
2	16 6	16 30	16 53	17 16	17 38	18 0	18 21	18 42	19 3	19 23
3	19 42	20 2	20 21	20 41	21 0	21 18	21 37	21 55	22 12	22 30
4	22 47	23 4	23 21	23 33	23 54	24 10	24 26	24 42	24 58	25 13
5	25 28	25 43	25 58	26 13	26 27	26 42	26 56	27 11	27 25	27 39
6	27 53	28 7	28 21	28 34	28 48	29 1	29 15	29 28	29 41	29 54
7	30 7	30 20	30 33	30 45	30 58	31 10	31 23	31 35	31 48	32 0
8	32 12	32 24	32 35	32 47	32 59	33 10	33 22	33 34	33 46	33 57
9	34 9	34 20	34 31	34 43	34 54	35 5	35 16	35 27	35 38	35 49
10	36 0	36 11	36 21	36 32	36 42	36 53	37 3	37 14	37 24	37 35
11	37 45	38 55	38 5	38 15	38 25	38 35	38 45	38 55	39 5	39 15
12	39 25	39 35	39 44	39 54	40 4	40 13	40 33	40 33	40 42	40 52
13	41 2	41 11	41 21	41 30	41 40	41 49	41 59	42 8	42 18	42 27
14	42 36	42 45	42 54	43 3	43 13	43 22	43 31	43 40	43 49	43 58
15	44 7	44 16	44 24	44 33	44 42	44 50	44 59	45 8	45 16	45 52
16	45 34	45 43	45 51	46 0	46 8	46 16	46 25	46 33	46 41	46 50
17	46 58	47 6	47 14	47 22	47 30	47 39	47 47	47 55	48 3	48 13
18	48 19	48 27	48 35	48 43	48 51	48 59	49 07	49 15	49 23	49 31
19	49 39	49 47	49 55	50 2	50 10	50 18	50 26	50 34	50 41	50 49
20	50 57	51 5	51 12	51 20	51 27	51 35	51 42	51 50	51 57	52 5
21	52 12	52 19	52 26	52 34	52 41	52 48	52 56	53 3	53 10	53 18
22	53 25	53 32	53 39	53 46	53 54	54 1	54 8	54 15	54 22	54 30
23	54 37	54 44	54 51	54 58	55 5	55 13	55 20	55 27	55 34	55 41
24	55 48	55 55	56 2	56 9	56 16	56 23	56 29	56 36	56 43	56 50
25	56 57	57 4	57 11	57 17	57 24	57 31	57 38	57 45	57 51	57 58
26	58 5	58 12	58 18	58 25	58 32	58 38	58 45	58 52	58 58	59 5
27	59 11	59 18	59 24	59 31	59 37	59 44	59 50	59 57	60 3	60 10
28	60 16	60 23	60 29	60 36	60 42	60 48	60 55	61 1	61 7	61 14
29	61 20	61 26	61 33	61 39	61 45	61 52	61 58	62 4	62 11	62 17
30	62 23	62 29	62 35	62 41	62 47	62 54	63 0	63 6	63 12	63 18
31	63 24	63 30	63 36	63 42	63 48	63 55	64 1	64 7	64 13	64 19
32	64 25	64 31	64 37	64 43	64 49	64 55	65 1	65 7	65 13	65 19
33	65 25	65 31	65 37	65 43	65 49	65 55	66 1	66 7	66 13	66 19
34	66 25	66 31	66 37	66 43	66 49	66 55	67 1	67 7	67 13	67 19
35	67 25	67 31	67 37	67 43	67 49	67 55	68 1	68 7	68 13	68 19

PLEIADES' OCCULTATIONS OF SEPTEMBER 26, 1839.

Computation of moon's place for 3h., 4h., 5h., and 6h., Greenwich sidereal time, from Hansen's lunar tables; mean time of sidereal noon from the Tabulæ Regiomontanæ.

	h.	m.	s.
September 26, table VI	12	20	33.379
Nutation, table I			0.263
M′	−12	20	33.642
	11	39	26.358
M′ + l + d = −1h. 19m. 44s.842, table VII			13.065
Mean time	11	39	39.423
3h sidereal time	2	59	30.511
Mean time of 3h. sidereal time	−14	39	9.934
Fraction of day			0.6105316
Fraction of a day for 1h. sidereal time			0.0415529

Computation of the fundamental arguments.

	g.	Arg. 1.	2.	3.	4.	5.	6.
Day + fraction of day	269.6105316						
1839	21.7415352	70.531	31.066	74.781	59.196	65.070	127.203
10 periods	—275.5455131	54.316	6.673	84.946	121.977	48.715	62.061
Periods to be deducted		—72		—144	—144		—144
Argument for 3*h*	15.8065537	52.847	37.739	15.727	37.173	113.785	45.264
4*h*	15.8481066						
5*h*	15.8896595						
6*h*	15.9312124						

	Arg. 7.	8.	9.	10.	11.	12.	13.	14.	15.
1839	8.092	29.935	12.803	34.004	30.440	43.389	1.411	34.845	10.147
10 periods	30.199	20.657	0.536	42.042	10.228	32.447	0.180	32.119	3.409
Deduct				—72		—48		—48	
Argument	38.284	50.592	13.339	4.046	40.668	27.857	1.591	18 964	13.556

	Arg. 16.	17.	18.	19.	20.	21.	22.	23.	24.
1839	18.453	36.966	25.906	5.946	31.735	28.222	21.892	38.847	3.778
10 periods	4.161	36.889	40.105	7.592	36.830	16.941	12.067	37.128	18.284
Deduct		—40	—48		—40	—40	—24	—40	
Argument	22.614	33.855	18.011	13.538	28.565	5.163	9.959	35.975	22.062

	Arg. 25.	26.	27.		28.	29.	30.	31.
1839	14.065	0.04	6.70	1839	3519.0	2800	70542	98605
10 periods	21.652	0.97	15.39	Day of year	269.6	270	270	270
Deduct			—20	Deduct				
Argument	35.717	1.01	2.09	Argument for 3*h*	3788.6	3070	70812	98875

	Arg. 32.	33.	34.	35.	36.	37.	38.	39.	40.
1839	22.565382	15.303148	199.2909	113.887	158.415	14.9942	2.8681	0.0959	2.9562
Day of year	269.610532	269.610532	269 6105	269.611	269.611	269.6105	269.6105	269.6105	269.6105
Periods to deduct	—286.307434	—265.775291	—365.2596		—346.620	—278.7752	—261.5843	—268.2254	—268.7829
Correction	519	482							
Argument 3*h*	5.668999	19.138871	103.6418	383.498	81.406	5.8295	10.8943	1.4810	3.7838
4*h*	5.710552	19.180424	103.6834	383.540	81.448	5.8711	10.9359	1.5226	3.8254
5*h*	5.752105	19 221977	103.7249	383.581	81.489	5.9126	10.9774	1.5641	3.8669
6*h*	5.793658	19.263530	103.7665	383.623	81.531	5.9542	11.0190	1.6057	3.9085

	Arg. 41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
1839	1.1918	0.7665	5.0218	15.6055	3.2997	7.529	24.12	29.4	327.8	114.2
Day of year	269.6105	269.6105	269.6105	269.6105	269.6105	269.611	269.61	269 6	269.6	269.6
Periods of year	—256.2170	—269.1841	—272.2841	—263.3695	—269.6406	—273.217	—284.77			
Correction										
Argument 3*h*	14.5853	1.1929	2.3482	21.8465	3.2696	3.914	8.96	299 0	597.4	383 8
4*h*	14 6269	1.2345	2.3898	21.8881	3.3112	3.956	9.00	299.0	597.4	383.8
5*h*	14.6684	1.2760	2.4313	21.9296	3 3527	3.997	9.04	299.1	597.5	383.9
6*h*	14.7100	1.3176	2 4720	21.9712	3.3943	4.039	9.08	299.1	597.5	383.9

Computation of the fundamental arguments—Continued.

Table.	15.50.	15.75.	16.
IX	.07	.08	.09
X	1 87	2.01	2.13
XI	.25	.28	.30
Sum	2.19	2.37	2.52
XXXIX	1089		
XL	123		
XLI	3274		
XLII	9		
Sum	4495		

Table.	15.50.	15.75.	16.
Sum × 39.7	87	94	100
XII	1747	1607	1467
XIII	1412	1245	1086
XIV	3975	3833	3691
XV	25	61	117
XVI	899	872	834
XVII	68	65	102
XVIII	4031	3958	3878
XIX	1424	1414	1405
XX	1778	1728	1674
XXI	835	783	733
XXII	1130	1140	1148
XXIII	472	421	373
XXIV	135	134	132
XXV	844	860	875
XXVI	500	497	493
XXVII	550	590	626
XXVIII	65	57	56
XXIX	760	758	756
XXX	60	51	44
XXXI	16	15	15
XXXII	310	304	298
XXXIII	51	47	43
XXXIV	253	260	267
XXXV	72	69	67
XXXVI	172	181	189
XXXVII	114	114	114
XXXVIII	31	39	47
Sum	21816	21197	20630

	3*h*.	4*h*.	5*h*.	6*h*.
Sum of tables XXXIX—XLII	4495	4495	4495	4495
g	15.8065537	15.8481066	15.8896595	15.9312124
Sum of tables XII—XXXVIII	21064	20968	20874	20781
XLIII	.1897390	.1897979	.1898506	.1898968
XLIV	948503	947785	946925	945922
XLV	279006	279017	279027	279038
XLVI	3781	3783	3784	3786
XLVII	6017	5997	5977	5957
XLVIII	48577	48263	47947	47631
XLIX	27177	26627	26079	25532
L	46685	46628	46570	46510
LI	3429	3533	3637	3742
LII	31105	31088	31070	31052
LIII	25084	24985	24878	24761
LIV	7618	7421	7225	7029
LV	6052	6900	6848	6797
LVI	4880	4790	4700	4611
LVII	6734	6709	6684	6658
LVIII	78	78	78	79
LIX	311	311	311	311
LX	73	73	73	73
LXI	299	299	298	298
Z	16.1434797	16.1848803	16.2262581	16.2676155

Tables of true longitude.

	ω.	Π.	Arg. 51.		3h.	4h.	5h.	6h.
	°	°						
1839.....	13.24578	12.10670	165.3	Table IV log.....	4.16314	4.16305	4.16289	4.16279
269 days....	44.21248	29.96782	269.6	Log excess of Z....	9.54154	9.68845	9.57309	9.37740
.6105316....	.10035	6802	—365.2	Sum	3.70468	3.85150	3.73598	3.54019
For 3h.....	57.55861	42.14254	69.7	Number for log.....	5066	7104	— 5445	— 3469
4h.....	57.56544	42.14717	69.7	Table V.....	14.00642	14.58874	15.31642	15.89840
5h.....	57.57227	42.15180	69.8	f	14.05708	14.65978	15.26197	15.86371
6h.....	57.57910	42 15643	69.8	ω.....	57.55861	57.56544	57.57227	57.57910
				Π.....	42.14254	42.14717	42.15180	42.15643
				$f+\omega$.....	71.61569	72.23522	72.83424	73.44281
				$f+\Pi$.....	56.19962	56.80695	57.41377	58.02011
				Table VI	6688	6867	7049	7234
				VII	623.9			
				VIII	29.1	696.5	696.5	696.5
				IX	43.5			
				Products.....	—832.5	— 809.2	— 786.1	— 762.4
				Long.....	56.26514	56.87449	57.48336	58.09182
				l.....	56° 15′ 54″.50	56° 52′ 28″.16	57° 29′ 00″.10	58° 05′ 30″.55

Computation of latitude.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1839.....	67.498	36 431	34.963	2.428	56.75	27.92	0.64	27.51	30.39	19.91	10.53
10 periods	57.773	51.100	33.415	9.058	37.72	13.11	42.25	16.70	31.80	25.77	11.00
	—72	—72			—60			—30	—40	—36	
	53.271	15.531	68.378	11.486	34.47	41.03	42.89	14.21	22.19	9.68	21.53

	12.	13.	14.	15.	16.	17.	18.	Obliquity of the ecliptic.	
									° ′ ″
1839.....	13.34	20.77	12.55	6.35	9.55	23.0	7.8	1839.....	23 27 26.66
10 periods	29.19	16.30	06.38	4.00	23.21	1.2	2.8	269d.....	— .35
	—30	—30			—24	—24		Table IV.....	18.22
									1.08
	12.53	7.07	18.93	10.35	8.76	0.2	10.6	Obliquity = ε.....	23 27 45.31

	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.
1839.....	12.99492	161.080	2.9410	26.824	0.579	2.422	13.416	683.0	31.1	7.0
Day.....	269 61053	269.611	269.6105	269.611	269.611	269.611	269.611	269.6	269.6	269.6
	—258.24621	—376.403	—267.5791	—279.056	—264.425	—253.254	—247.872		—287.8	—260.5
For 3h.....	24.35924	54.288	4.9724	17.379	5.565	18.779	35.155	952.6	12.9	16.1
4h.....	24.40079	54.330	5.0140	17.421	5.607	18.821	35.197	952.6	12.9	16.1
5h.....	24.44235	54.371	5.0555	17.462	5.648	18.862	35.238	952.7	13 0	16.2
6h.....	24.48390	54.413	5.0971	17.504	5.690	18.904	35.280	952.7	13.0	16.2

Computation of latitude—Continued.

Table.	15.50	15.75	16.
VII	20.86	20.38	19.77
VIII	23.27	23.02	22.71
IX	8.28	8.93	9.55
X	12 61	12.86	13 12
XI	4.12	4.30	4.49
XII	3.06	2.93	2.80
XIII	1 96	2.12	2.29
XIV	.56	.46	.37
XV	2.12	2.20	2.27
XVI	1.63	1.61	1.59
XVII	.67	.71	.72
XVIII	.37	.34	.31
XIX	.12	.14	.16
XX	.88	.91	.94
XXI	1.30	1.31	1.33
XXII	.90	.92	.93
XXIII	.25	.22	.20
XXIV	.17	.13	.10
Sum	83.13	83.49	83.65

Table.	3h.	4h.	5h.	6h.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Preceding inequality	83.54	83.57	83.60	83.63
Table XXV	12 40.73	12 44.48	12 48.22	12 51.95
XXVI	31.54	31.60	31.66	31.72
XXVII	49.28	49 70	50.12	50.53
XXVIII	6.67	6.83	6.99	7.16
XXIX	17.58	17.79	18 01	18.22
XXX	12 95	13.16	13.28	13.60
XXXI	42.09	42.00	41.91	41.82
XXXII	40.15	40.15	40.15	40.15
XXXIII	.72	.72	.72	.72
XXXIV	.08	.08	.08	.08
XXXV	2.48	2.42	2.36	2.29
Sum	17 27.82	17 32.52	17 37.21	17 41.88
Table XXXVI^a	4 39 28.53	4 40 29.60	4 41 28.61	4 42 25.58
$s.''$ lat	4 56 56.35	4 58 02.12	4 59 05.82	5 00 07.46
Table XXXVII^a	22.23	22.48	22.72	21.96
Lat. $= \delta$	4 57 18.58	4 58 24.59	4 59 28.54	5 00 30.42
Table X of long. log	9.90008_n	9.88584_n	9.87130_n	9.85610_n
Sum of ineq. of lat	3.02029	3.02223	3.02415	3.02607
Product	2.92037_n	2.90807_n	2.89545_n	2.88217_n

Computation of parallax.

Table—	15.50	15.75	16.
I	.467	.392	.326
II	20	24	30
III	75	76	76
IV	.165	.176	.187
V	1.218	1.216	1.216
VI	90	.104	.118
VII	1.097	1.127	1.157
VIII	8	8	7
IX	73	69	69
X	10	3	7
XI	99	93	88
XII	.107	.100	93
XIII	34	33	32
XIV	11	13	15
Sum	3.474	3.434	3.421

Table.	3h.	4h.	5h.	6h.
	′ ″	′ ″	′ ″	′ ″
Preceding inequalities	3.429	3.426	3.424	3.422
Table XV	37.939	37.656	37.373	37.089
XVI	25 238	24.790	24.342	23.894
XVII	1.029	1.029	1.029	1.029
XVIII	46	51	57	64
XIX	.886	.858	.829	.801
XX	58 56.52	58 56.05	58 55.56	58 55.06
Sum	60 05.09	60 03.85	60 02.61	60 01.36
Table XXI	05.10	05.03	04.96	04.89
Π	60 10.19	60 08.88	60 07.57	60 06.25

Computation of right ascension and declination.

	3h.	4h.	5h.	6h.
Sin. l	9.9199230	9.9229721	9.9259488	9.9288546
Cos. l	9.7445672	9.7375703	9.7304145	9.7230939
Tan. l	.1753558	.1854017	.1955344	.2057607
Sin. ε	9.6000469	9.6000469	9.6000469	9.6000469
Sec. ε	.0374790	.0374790	.0374790	.0374790
Tan. ε	9.6375259	9.6375259	9.6375259	9.6375259
Sin. θ	9.3446141	9.3376172	9.3304614	9.3231408
Tan. η'	9.5574489	9.5664980	9.5634747	9.5663805
Tan. $(l+\omega)$	.2128348	.2228807	.2330134	.2432397
Cos. θ	9.9891151	9.9894688	9.9898183	9.9901636
Cot. θ	.6445010	.6518516	.6593569	.6670228
Sin. $(\eta'+b)$	9.6227198	9.6251253	9.6274668	9.6297455
Tan. $(\eta'+b)$	9.6647485	9.6676710	9.6705227	9.6733043
Sin. β	9.6118349	9.6145941	9.6172851	9.6199091
Tan. ψ	9.0093626	9.0052882	9.0009841	8.9964451
	° ′ ″	° ′ ″	° ′ ″	° ′ ″
η'	19 50 49.65	19 58 33.36	20 06 08.49	20 13 35.05
$\eta'+b$	24 48 08.23	24 56 57.95	25 05 37.03	25 14 05.47
$l+\omega$	58 30 32.61	59 05 46.58	59 40 55.55	60 15 59.67
ψ	5 50 03.09	5 46 48.30	5 43 24.46	5 39 51 64
α_m	52 40 29.52	53 18 58.26	53 57 31.09	54 36 08.03
β_m	24 08 55.07	24 18 44.85	24 28 24.41	24 37 53.73
Cot. h'	0.60247	0.60931	0.61630	0.62346
D $_{\Delta}l$	9.78500	9.78470	9.78440	9.78410
Cos. b	9.99838	9.99837	9.99836	9.99834
h'	14° 01′.4	13° 48′.7	13° 36′.0	13° 23′.2

Gr. sid. time.	α_m	β_m	Sin″ II	Sin″ II sec. β_m	S.	S−α_m
h. m.	° ′ ″	° ′ ″			° ′	° ′ ″
50	53 12 33.19	24 17 07.26	3.557377	3.597616	57 30	4 17 26.81
4 00	53 18 58.26	24 18 44.85	3.557351	3.597683	60	6 41 01.74
4 10	53 25 23.45	24 20 22.15	3.557324	3.597749	62 30	9 04 36.55
4 20	53 31 48.75	24 21 59.17	3.557298	3.597815	65	11 28 11.25
4 30	53 38 14.16	24 23 35.90	3.557272	3.597882	67 30	13 51 45.84
4 40	53 44 39.69	24 25 12.36	3.557246	3.597949	70	16 15 20.31
5 20	54 10 22.95	24 31 35.32	3.557140	3.598208	80	25 49 37.05
5 30	54 16 49.05	24 33 10.35	3.557113	3.598273	82 30	28 13 10.95
5 40	54 23 15.26	24 34 45.09	3.557087	3.598338	85	30 36 44.74
5 50	54 29 41.59	24 36 19.55	3.557060	3.598403	87 30	33 00 18.41
6 00	54 36 08.03	24 37 53.73	3.557034	3.598467	90	35 23 51.97
6 10	54 42 34.58	24 39 27.63	3.557007	3.598532	92 30	37 47 25.42

Computation of the place of Alcyone.

	For 1839.0		Aa	Bb	Cc	Dd	Aa	Bb	Cc	Dd	$E+51.38$	Seconds of a_s°
	° ′ ″						″	″	″	″	″	″
a	51 28 51.38	Sept. 17	1.6282	$.3668_n$	1.0685	$.2937_n$	42.48	−2.33	11.71	−1.97	51.39	101.28
β	23 36 06.32	27	1.6396	$.3663_n$	1.0703	.0397	43.61	−2.32	11.75	1.10	51.39	105.53
α	1.7258	Oct. 7	1.6509	$.3626_n$	1.0592	.6173	44.76	−2.30	11.46	4.14	51.39	109.45
b	9.4045											
c	9.8020		Aa^1	Bb^1	Cc^1	Dd^1	Aa^1	Bb^1	Cc^1	Dd^1	Seconds of β_s°	
d	9.9485						″	″	″	″	″	
a^1	1.0640	Sept. 17	.9664	.8729	.1235	9.7118_n	9.26	7.46	1.33	−0.51	23.86	
b^1	9.9106_n	27	.9778	.8724	.1253	9.4578	9.50	7.45	1.34	0.29	24.90	
c^1	8.8570	Oct. 7	.9891	.8687	.1142	.0354	9.75	7.39	1.30	1.08	25.84	
d^1	9.3666											
c_1	4.6492_n		Aa_2	Bb_2	Cc_2	Dd_2	10^4 Aa_2	10^4 Bb_2	10^4 Cc_2	10^4 Dd_2	-10^4 a_2	10^4 E
d_1	4.4118											
a_2	5.9364	Sept. 26.6	5.8522	5.4493_n	5.3583	4.3279	.712	−.281	.223	.021	−.868	−.188
b_2	4.4875											
c_2	4.0900		Cc_1	Dd_1	10^4 Cc_1	10^4 Dd_1	10^4 F					
d_2	4.2367	Sept. 26.6	5.9175_n	4.5030	−.827	.032	−.795					
$10^4 a_2$	.868											

For Sept. 26.6 a_s° 54 29 45.48

β_s° 23 36 24 89

log. $(1+F)^{-1}$ = log. F_1 .000035

log. (−E) 5.2742

g 3.9871

PLEIADES' OCCULTATIONS, SEPTEMBER 26, 1839.

Computation of the observations made at Greenwich.

h 9.795255 lat. 51 28 38.2

k 9.891388

$h \div k$ 9.903867

Gr. sid. time.	P.	Sin. $(s-a_m)$	Sec. $(s-a_m)$	Cosec 1″ ÷ P.	Sec. $(s-a_m) \div$ P sin 1″	Zech
h. m.						
5 20	3.393463	9.639142	.045703	1.920962	1.966665	4715
5 30	3.393528	9.674727	.054955	1.920897	1.975852	4616
5 40	3.393593	9.706912	.065183	1.920832	1.986015	4508
5 50	3.393658	9.736168	.076434	1.920767	1.997201	4393
6 00	3.393722	9.762866	.088762	1.920703	2.009465	4270

Gr. sid. time.	Tan″ $\frac{\Delta a}{\pi}$	$\frac{\Delta a}{\pi}$	$\frac{1}{2}\frac{\Delta a}{\pi}$	$s-a_m-\frac{1}{2}\frac{\Delta a}{\pi}$	Cos $\left(s-a_m-\frac{1}{2}\frac{\Delta a}{\pi}\right)$	Sec. $\frac{1}{2}\frac{\Delta a}{\pi}$
h. m.		′ ″	′ ″	° ′ ″		
5 20	3.037390_n	−18 09.73	− 9 04.86	25 58 41.91	9.953741	.000002
5 30	3.079871_n	−19 42.68	− 9 51.34	28 23 02.29	9.944375	.000002
5 40	3.105013_n	−21 13.53	−10 36.76	30 47 21.50	9.934021	.000002
5 50	3.134219_n	−22 42.11	−11 21.06	33 11 39.47	9.922632	.000002
6 00	3.160858_n	−24 08.27	−12 04.14	35 35 56.11	9.910150	.000003

Computation of the observations made at Greenwich—Continued.

Gr. sid. time.	Cot η	η	Cosec η	$\eta-\beta_m$	Sin $(\eta-\beta_m)$	Sec $(\eta-\beta_m)$
h. m.		° ′ ″		° ′ ″		
5 20	9.857610	54 13 43.6	.090788	29 42 08.3	9.695039	.061174
5 30	9.848244	54 48 45.9	.087633	30 15 35.6	9.702365	.063613
5 40	9.837890	55 27 12.5	.084250	30 52 27.4	9.710250	.066364
5 50	9.826501	56 09 06.9	.080652	31 32 47.4	9.718760	.069457
6 00	9.814020	56 54 33.7	.076856	32 16 40.0	9.727561	.072902

Gr. sid. time.	Q.	Cosec 1″ ÷ Q	Sec $(\eta-\beta_m)$ ÷ Q sin 1″	Zech	Tan″ $\frac{\Delta\beta}{\pi}$	$\frac{\Delta\beta}{\pi}$
h. m.						′ ″
5 20	3.539316	1.775109	1.836283	6378	3.240733_n	—29 00.70
5 30	3.536194	1.778291	1.841904	6295	3.244794_n	—29 17.07
5 40	3.532735	1.781700	1.848064	6206	3.249181_n	—29 34.89
5 50	3.529100	1.785325	1.854782	6110	3.253870_n	—29 54.15
6 00	3.525278	1.789147	1.862049	6008	3.258847_n	—30 14.83

Gr. sid. time.	α'_m	β'_m	$\eta-\beta'_m$	Corr. Σ	Σ	$\alpha'_m-\alpha^\circ_s$
h. m.	° ′ ″	° ′ ″	° ′ ″			′ ″
5 20	53 52 13.22	24 02 34.62	30 11 09.0	6361	3.000001	—37 32.36
5 30	53 57 06.37	24 03 53.28	30 44 52.6	6279	2.999892	—32 39.21
5 40	54 02 01.73	24 05 10.20	31 22 02.3	6190	2.999777	—27 43.85
5 50	54 06 59.48	24 06 25.40	32 02 41.5	6094	2.999654	—22 46.10
6 00	54 11 59.76	24 07 38.90	32 46 54.8	5991	2.999525	—17 45.82

Gr. sid. time.	$\beta'_m-\beta^\circ_s$	F ÷ A	Sin″ $(\alpha'_m-\alpha^\circ_s)$	Cos β_m	x_m	Z.
h. m.	′ ″					
5 20	26 09.73	53	3.352629_n	9.960585	3.313207_n	.6529
5 30	27 28.39	51	3.292074_n	9.960511	3.252636_n	.5418
5 40	28 45 31	49	3.221109_n	9.960439	3.181597_n	.3908
5 50	30 00.51	47	3.135479_n	9.960368	3.095891_n	.2184
6 00	31 14.01	45	3.027682_n	9.960299	2.988026_n	.0028

Gr. sid. time.	Sin.″ $(\beta'_m-\beta^\circ_s)$	Sin.″ $(\beta'_m-\beta^\circ_s)$ ÷ Z	Zech	y_m	E x_m	−E y_m	E x_m	−E y_m	x''_m
h. m.									
5 20	3.195821	2.5429	1242	3.197118	8.587	8.471	.04	.03	—2057.12
5 30	3.217055	2.6852	896	3.218002	8.527	8.492	.03	.03	—1789.07
5 40	3.236862	2.8461	619	3.237530	8.456	8.512	.03	.03	—1519.11
5 50	3.255390	3.0370	399	3.255836	8.370	8.530	.02	.03	—1247.06
6 00	3.272766	3.2700	233	3.273044	8.262	8.547	.02	.04	— 972.76

Gr. sid. time.	$\Delta_t\, x''_m$	$\Delta_t^2\, x''_m$	$\Delta_t^3\, x''_m$	y''_m	$\Delta_t\, y''_m$	$\Delta_t^2\, y''_m$	$\Delta_t^3\, y''_m$	Σ_2	Σ_2	$\Delta_t\, \Sigma_2$
h. m.										
5 20	268.05	1.91	.18	1574.44	77.56	—1.59	.01	3.000054	1000.13	—.26
5 30	269.96	2.09	.16	1652.00	75.97	—1.58	.03	2.999913	999.87	—.27
5 40	272.05	2.25		1727.97	74.39	—1.55		2.999826	999.60	—.29
5 50	274.30			1802.36	72.84			2.999701	999.31	—.30
6 00				1875.20				2.999570	999.01	

Computation of the observations made at Greenwich—Continued.

Star.	Gr. sid. time.	x''_m	y''_m	x_s	y_s	$x_s - x_m$
	h. m. s.					
1.	5 23 53.70	—1952.94	1604.84	—2208.22	637.85	—255.28
1.	5 23 54 00	—1952.80	1604.88	—2208.22	637.85	—255.42
4.	5 56 50.63	—1059.58	1852.38	—1882.75	1281.01	—823.17
11.	5 58 17.43	—1019.81	1862.86	—1372.17	928.22	—352 36

Star.	$y_s - y''_m$	$p \cos \theta$	$p \sin \theta$	Tan. θ	Sec. or cosec. θ	p
1.	—966.99	$2\ 407017_n$	2.985422_n	.578405	.014630	3.000052
1.	—967.03	2.407255_n	2.985440_n	.578185	.014644	3.000084
4.	—571.37	2.915190_n	2.756917_n	9.841427	.085393	3.000883
11.	—934.64	2.546987_n	2.970644_n	.423657	.028858	2.999502

Star.	p	Σ_s	$\Sigma_s - p$	θ	h'	$\theta - h'$	Cos. $(\theta - h')$	Cos. b	$D_e\ p$	$D_e\ p$
	"	"		° ′	° ′	° ′				
1.	1000.12	1000 03	—0.09	255 12.7	13 56.4	241 16.3	9.6818_n	9.9984	9.6802	0.479
1.	1000.19	1000.03	—0.16	255 12.3	13 56.4	241 15.9	9.6819_n	9.9984	9.6803	.479
4.	1002.03	999.10	—2.93	214 45.9	13 23.8	201 22.1	9.9691_n	9.9983	9.9674	.928
11.	998.85	999.06	0.21	249 20.6	13 23.2	235 57.4	$9\ 7481_n$	9.9983	9.7464	.558

PLEIADES' OCCULTATIONS, SEPTEMBER 26, 1839.

Computation of the observations made at Cambridge, (England.)

h	9.788161	Lat. ° ′ ″ 52 12 51.8	s.
k	9 895796	Long. 359 54 06.9 =	—23.54
$h \div k$	9.892365		

Gr. sid. time.	$s - a_m$	P.	Sin. $(s - a_m)$	Sec. $(s - a_m)$	Cosec. $1'' \div$ P	Sec. $(s - a_m) \div$ P sin. $1''$	Zech
h. m.	° ′ ″						
5 20	25 55 30.15	3.386359	9.640675	.046063	1.928056	1.974119	4634
5 30	28 19 04.05	3.386434	9.676110	.055354	1.927991	1.983345	4536
5 40	30 42 37.84	3.386499	9.708166	.065623	1.927926	1.993549	4430
5 50	33 06 11.51	3.386564	9.737311	.076918	1.927861	2.004779	4317
6 00	35 29 45.07	3.386628	9.763910	.089292	1.927797	2.017069	4196
6 10	37 53 18.52	3.386693	9.788258	.102809	1.927732	2.030541	4067

Gr. sid. time.	Tan.$''$ $\Delta_\pi a$	$\Delta_\pi a$	$\frac{1}{2} \Delta_\pi a$	$s - a_m - \frac{1}{2} \Delta_\pi a$	Cos. $(s - a_m - \frac{1}{2} \Delta_\pi a)$	Sec. $\frac{1}{2} \Delta_\pi a$
h. m.		′ ″	′ ″	° ′ ″		
5 20	3.031678_n	—17 55.67	— 8 57 8	26 04 27.9	9.953384	.000001
5 30	3.067080_n	—19 27.03	— 9 43.5	28 28 47.5	9.943980	.000002
5 40	3.099095_n	—20 56.31	—10 28.2	30 53 06.0	9.933588	.000002
5 50	3.128192_n	—22 23 36	—11 11.7	33 17 23.2	9.921158	.000002
6 00	3.154734_n	—23 48.02	—11 54.0	35 41 39.1	9.909632	.000003
6 10	3.179018_n	—25 10 14	—12 35.1	36 05 53.6	9.895949	.000003

Computation of the observations made at Cambridge, (England)—Continued.

Gr. sid. time.	Cot. η	η	Cosec. η	$\eta-\beta_m$	Sin. $(\eta-\beta_m)$	Sec. $(\eta-\beta_m)$
h. m.		° ′ ″		° ′ ″		
5 20	9.845750	54 58 03.2	.086808	30 26 27.9	9.704710	.064417
5 30	9.836347	55 32 54 5	.083754	30 59 44.2	9.711784	.066914
5 40	9.825955	56 11 06.8	.080482	31 36 21.7	9.719394	.069721
5 50	9.814525	56 52 44 0	.077006	32 16 21.5	9.727509	.072882
6 00	9.802000	57 37 50.3	.073341	32 59 56.6	9.736098	.076404
6 10	9.788317	58 26 28.8	.069507	33 47 01.2	9.745121	.080324

Gr. sid. time.	Q	Cosec. $1'' \div$ Q	Sec. $(\eta-\beta_m) \div$ Q sin. $1''$	Zech	Tan. $''$ $\Delta_\pi\beta$	$\Delta_\pi\beta$
h. m.						′ ″
5 20	3 539744	1.774681	1.839098	6337	3.250791_n	— 29 41.50
5 30	3.536663	1.777762	1.844676	6255	3.254702_n	— 29 57.62
5 40	3.533365	1.781060	1.850781	6167	3.258926_n	— 30 15.19
5 50	3.529862	1.784563	1.857445	6073	3.263444_n	— 30 34.17
6 00	3.526171	1.788254	1.864658	5972	3.268421_n	— 30 54.54
6 10	3.522310	1.792115	1.872439	5865	3.273296_n	— 31 16.25

Gr. sid. time.	α'_m	β'_m	$\eta-\beta'_m$	Corr. Σ	Σ_i	$\alpha'_m-\alpha^\circ_s$
h. m.	° ′ ″	° ′ ″	° ′ ″			′ ″
5 20	53 52 27.28	24 01 53 82	30 56 09.4	6320	2 999960	— 37 18.30
5 30	53 57 22.02	24 03 12.73	31 29 41.8	6239	2.999852	— 32 23.56
5 40	54 02 18.95	24 04 29.90	32 06 36.9	6151	2.999738	— 27 26.63
5 50	54 07 18.23	24 05 45.38	32 46 58.6	6055	2.999616	— 22 27.35
6 00	54 12 20.01	24 06 59.19	33 30 51.1	5954	2.999488	— 17 25.57
6 10	54 17 24.44	24 08 11.38	34 18 17.4	5846	2.999353	— 12 21.14

Gr. sid. time.	$\beta'_m-\beta^\circ_s$	F ÷ A	Sin. $''$ $(\alpha'_m-\alpha^\circ_s)$	Cos. β'_m	x_m	Z
h. m.	′ ″					
5 20	25 28.93	55	3.349910_n	9.960623	3.310588_n	.6476
5 30	26 47.84	52	3.288592_n	9.960549	3.249193_n	.5249
5 40	28 05.01	49	3.216591_n	9.960477	3.177117_n	.3808
5 50	29 20.49	47	3.129477_n	9.960405	3.089929_n	.2065
6 00	30 34.30	45	3.019352_n	9.960336	2.979733_n	9.9802
6 10	31 46.49	44	2.869900_n	9.960268	2.830212_n	9.6872

Gr. sid. time.	Sin. $''$ $(\beta'_m-\beta^\circ_s)$	Sin. $''$ $(\beta'_m-\beta^\circ_s) \div Z$	Zech	y_m	E x_m	— E y_m	E x_m	— E y_m	x''_m
h. m.									″
5 20	3.184383	2.5368	1260	3.185698	8.5846	8 4598	.04	.03	— 2044.47
5 30	3.206238	2 6813	903	3.207193	8.5234	8.4813	.03	.03	— 1774 95
5 40	3.226597	2.8458	619	3.227265	8.4013	8.4954	.03	.03	— 1503.52
5 50	3.245629	3.0391	397	3.246073	8.3542	8.5202	.02	.03	— 1230.04
6 00	3.263465	3.2833	226	3.263736	8 2539	8.5379	.02	.03	— 954.37
6 10	3.280229	3.5930	111	3.280384	8.1044	8.5545	.01	.04	— 676.37

Gr. sid. time.	Δ_t x''_m	Δ^2_t x''_m	Δ^3_t x''_m	y''_m	Δ_t y''_m	Δ^2_t y''_m	Δ^3_t y''_m	Σ_a	Σ_a	Δ_t Σ_a
h. m.	″	″		″	″	″				
5 20	269 52	1.91	.14	1533.56	77.83	— 1.61	.06	3.000015	1000.14	— .26
5 30	271.43	2.05	.14	1611.39	76.22	— 1.55	.04	2.999904	999.78	— 27
5 40	273.48	2.19	.14	1687.61	74.67	— 1.51	.07	2.999787	999.51	— .29
5 50	275.67	2.33		1762.28	73.16	— 1.44		2 999663	999.22	— .30
6 00	278.00			1835.44	71.72			2.999533	998.92	— .31
6 10				1907.16				2.999397	998.61	

Computation of the observations made at Cambridge, (England)—Continued.

Star.	Camb. sid. time.	Gr. sid. time.	x''_m	y''_m	x_s	y_s	$x_s - x''_m$
	h. m. s.	h. m. s.	"	"	"	"	"
1	5 26 37.91	5 26 14.57	— 1876.53	1582.28	— 2208.22	637.85	— 331.69
4	5 57 31.53	5 57 97.99	— 1033.62	1814.61	— 1882.75	1281.01	— 849.13
11	6 00 25.54	6 00 02.00	— 953.44	1835.68	— 1372.17	928.22	— 418.73

Star.	$y_s - y''_m$	$p \cos. \theta$	$p \sin. \theta$	Tan θ	Sec. or cosec. θ	p	p
	"						"
1	— 944.43	2.520732_n	2.975170_n	.454438	.025257	3.000427	1000.98
4	— 533.60	2.928974_n	2.727216_n	9.798242	.072272	3.001246	1002.87
11	— 907.46	2.621934_n	2.957827_n	.335893	.041916	2.999743	999.41

Star.	Σ_s	$\Sigma_s - p$	θ	h'	$\theta - h'$	Cos. $(\theta - h')$	Cos. b	$D_e\, p$	$D_e\, p$
	"		° ′	° ′	° ′				
1	999.87	— 1.11	250 38.9	13 53.7	236 45.2	9.7390_n	9.9984	9.7374	0.546
4	999.00	— 3.87	212 08.7	13 23.8	198 44.9	9.9763_n	9.9983	9.9746	0.943
11	998.92	— 0.49	245 13.8	13 23.2	231 50.6	9.7909_n	9.9983	9.7892	0.615

PLEIADES' OCCULTATIONS, SEPTEMBER 26, 1839.

Computation of the observations made at Ashurst, (England.)

h	9.797253	Lat.	° ′ ″ 51 15 58
k	9.890104	Long.	m. s. 0 17 31.5 = 1 10.1
$h \div k$	9.907149		

Gr. sid time.	$s - \alpha_m$	P.	Sin. $(s - \alpha_m)$	Sec. $(s - \alpha_m)$	Cosec. $1'' \div P$	Sec. $(s - \alpha_m) \div P \sin. 1''$	Zech
h. m.	° ′ ″						
5 20	25 32 05.5	3.395461	9.634538	.044638	1.918964	1.963602	4755
5 30	27 55 39.4	3.395526	9.670576	.053774	1.918899	1.972673	4650
5 40	30 19 13.2	3.395591	9.703149	.063880	1.918834	1.982714	4542
5 50	32 42 46.9	3.395656	9.732741	.075004	1.918769	1.993773	4428
6 00	35 06 20.5	3.395720	9.759733	.087198	1.918705	2.005903	4306

Gr. sid. time.	Tan $'' \Delta_\pi a$	$\Delta_\pi a$	$\frac{1}{2} \Delta_\pi a$	$s - \alpha_m - \frac{1}{2} \Delta_\pi a$	Cos. $(s - \alpha_m - \frac{1}{2} \Delta_\pi a)$	Sec. $\frac{1}{2} \Delta_\pi a$
h. m.		′ ″	′ ″	° ′ ″		
5 20	3.034754_n	— 18 03.30	— 9 01.6	25 41 07.1	9.954816	.000001
5 30	3.070752_n	— 19 36.92	— 9 48.5	28 05 27.9	9.945567	.000002
5 40	3.103282_n	— 21 08.46	— 10 34.2	30 29 47.4	9.935336	.000002
5 50	3.132825_n	— 22 37.75	— 11 18.9	32 54 05.8	9.924075	.000002
6 00	4.159759_n	— 24 04.62	— 12 02.3	35 18 22.8	9.911729	.000003

Gr. sid. time.	Cot. η	η	Cosec. η	$\eta - \beta_m$	Sin. $(\eta - \beta_m)$	Sec. $(\eta - \beta_m)$
h. m.		° ′ ″		° ′ ″		
5 20	9.861966	53 57 20.8	.092286	29 25 45.5	9.691390	.060000
5 30	9.852718	54 32 03.5	.089129	29 58 59.2	9.698726	.062388
5 40	9.842487	55 10 10.6	.085738	30 35 25.5	9.706630	.065084
5 50	9.831226	55 51 46.5	.082129	31 15 27.0	9.715071	.068113
6 00	9.818881	56 36 55.4	.078316	31 59 01.7	9.724013	.071503

Computation of the observations made at Ashurst, (England)—Continued.

Gr. sid. time.	Q.	Cosec. 1″ ÷ Q	Sec. $(\eta-\beta_m)$ ÷ Q. sin. 1″	Zech	Tan ″ $\Delta_\pi \beta$	$\Delta_\pi \beta$
h. m.						′ ″
5 20	3.539530	1.774895	1.894895	6399	3.236319_n	— 28 47.07
5 30	3 536346	1.778079	1.840467	6316	3.241385_n	— 29 03.32
5 40	3.532929	1.781496	1 846580	6227	3.245786_n	— 29 21.07
5 50	3 529293	1.785132	1.853245	6.32	3.250496_n	— 29 40.27
6 00	3.525454	1.788971	1.860474	6030	3.255497_n	— 30 00.89

Gr. sid. time.	α'_m	β'_m	$\eta-\beta'_m$	Corr Σ	Σ_i	$\alpha'_m-\alpha^\circ_s$
h. m.	° ′ ″	° ′ ″	° ′ ″			′ ″
5 20	53 52 19.65	24 02 48.25	29 54 32 6	6384	3.000024	— 37 25.93
5 30	53 57 12.13	24 04 07.03	30 27 56.5	6301	2.999914	— 32 33.45
5 40	54 02 06.80	24 05 24.02	31 04 46.6	6212	2.999799	— 27 38.78
5 50	54 07 03.84	24 06 39.28	21 45 07.2	6116	2.999676	— 22 41.74
6 00	54 12 03.41	24 07 52 84	32 29 02 6	6013	2.999547	— 17 42.17

Gr. sid. time.	$\beta_m-\beta^\circ_s$	F ÷ A	Sin.″ $(\alpha'_m-\alpha^\circ_s)$	Cos. β'_m	x_m	Z.
h. m.	′ ″					
5 20	26 23.36	53	3.351388_n	9 969572	3.312013_n	.6539
5 30	27 42.14	51	3.290795_n	9.960498	3.251344_n	.5292
5 40	28 59.13	49	3.219781_n	9.960426	3.180259_n	.3871
5 50	30 14.39	47	3.134091_n	9 960355	3.094493_n	.2157
6 00	31 27.95	46	3.026196_n	9.960285	2.986527_n	9.9998

Gr. sid. time.	Sin.″ $(\beta'_m-\beta^\circ_s)$	Sin.″ $(\beta'_m-\beta^\circ_s)$ ÷ Z	Zech	y_m	E x_m	E y_m	E x_m	−E y_m	x''_m
h. m.									″
5 20	3.199576	2.5487	1226	3.200856	8.5864	8.4751	.04	.03	— 2051.20
5 30	3.220662	2.6915	883	3.221596	8.5255	8.4958	.03	.03	— 1783.76
5 40	3.240327	2.8532	609	3.240985	8.4543	8.5152	.03	.03	— 1514.43
5 50	3.258726	3.0430	393	3.259166	8.3687	8.5344	.02	.03	— 1243.03
6 00	3.275984	3.2782	229	3.276258	8.2607	8.5505	.02	.04	— 969.40

Gr. sid. time.	$\Delta_t x'_m$	$\Delta^2_t x''_m$	$\Delta^3_t x'''_m$	y''_m	$\Delta_t y''_m$	$\Delta^2_t y''_m$	$\Delta^3_t y''_m$	Σ_3	Σ_2	$\Delta_t \Sigma_2$
h. m.	″	″		″	″	″			″	
5 20	267.44	1 89	.16	1588 06	77.67	— 1.62	.02	3.000078	1000 18	— 26
5 30	269.33	2.07	.16	1665.73	76 05	— 1.60	.05	2 999965	999.92	— .27
5 40	271.40	2,23		1741.78	74.45	— 1.55		2.999848	999.65	— .29
5 50	273.63			1816 23	72.90			2 999723	999.36	— .30
6 00				1889.13				2.999592	999.06	

Star.	Ash. sid. time.	Gr. sid. time.	x'_m	y''_m	x_s	y_s	$x_s-x''_m$
	h. m. s.	*h. m. s.*	″	″	″	″	″
1	5 21 42.58	5 22 52 68	— 1974.40	1610.58	— 2208.22	637.85	— 233.82
4	5 55 19 08	5 56 29.18	— 1065.82	1863.69	— 1882.75	1281.01	— 816.93
11	5 56 16 58	5 57 26 68	— 1039 55	1870.65	— 1572.17	928.22	— 332.62

Star.	$y_s-y''_m$	$p \cos \theta$	$p \sin \theta$	Tan. θ	Sec. or cosec. θ	p	p
	″						″
1	— 972.73	2.368882_n	2.987992_n	.619110	.019198	3 000190	1000.44
4	— 582.68	2.912185_n	2.765430_n	9.853245	.089306	3.001491	1003.44
11	— 942 43	2.521948_n	2.974249_n	.452301	.025493	2.999742	991.41

Computation of the observations made at Ashurst, (England)—Continued.

Star.	Σ_a	$\Sigma_a - p$	θ	h'	$\theta - h'$	Cos. $(\theta - h')$	Cos. b	$D_{\theta'} p$	$D_{\theta''} p$
	′	″	° ′	° ′	° ′				
1.....	1000.11	— 0.33	256 29.0	13 31.0	242 58.0	9.6575_n	9.9984	9 6559	0.453
4.....	999.16	— 4.28	215 30.0	13 24.0	202 06.0	9.9669_n	9.9983	9.9652	0.923
11.....	999.14	— 0.27	250 33.5	13 23.8	237 09.7	9.7349_n	9.9983	9.7395	0.540

PLEIADES' OCCULTATIONS, SEPTEMBER 26, 1839.

Computation of the observations made at Washington.

h	9.891734	Lat.	° ′ ″ 38 53 32.8	h. m. s.
k	9.795527	Long.	— 77 00 26.3 =	— 5 08 01.75
$h \div k$	.096207			

Gr. sid. time.	$s - a_m$	P	Sin. $(s - a_m)$	Sec. $(s - a_m)$	Cosec. $1'' \div$ P	Sec. $(s - a_m) \div$ P sin. $1''$	Zech
h. m.	° ′ ″						
3 50	— 72 42 59.5	3.489350	9.979933_n	.527008	1.825075	2.352173	1935
4 00	— 70 19 24.6	3.489417	9.979870_n	.472745	1.825008	2.297753	2194
4 10	— 67 55 49.8	3.489483	9.966953_n	.425123	1.824942	2.250065	2449
4 20	— 65 32 15.1	3.489549	9.959152_n	.382898	1.824876	2.207774	2700
4 30	— 63 08 40.5	3.489616	9.950438_n	.345111	1.824809	2.169920	2947

Gr. sid. time.	Tan. $'' \Delta_\pi \alpha$	$\Delta_\pi \alpha$	$\frac{1}{2} \Delta_\pi \alpha$	$s - a_m - \frac{1}{2} \Delta_\pi \alpha$	Cos. $(s - a_m - \frac{1}{2} \Delta_\pi \alpha)$	Sec. $\frac{1}{2} \Delta_\pi \alpha$
h. m.		′ ″	′ ″	° ′ ″		
3 50	3.471218	49 19.40	24 39.70	— 73 07 39.2	9.462760	.000011
4 00	3.465481	48 40.57	24 20.28	— 70 43 44.9	9.518559	.000011
4 10	3.458885	47 56.55	23 58.27	— 68 19 48.1	9.567332	.000011
4 20	3.451401	47 07.42	23 33.71	— 65 55 48.8	9.610499	.000010
4 30	3.443001	46 13.25	23 06.62	— 63 31 47.1	9.649075	.000010

Gr. sid. time.	Cot. η	η	Cosec. η	Q	$\eta - \beta_m$	Sin. $(\eta - \beta_m)$
h. m.		° ′ ″			° ′ ″	
3 50	9.558978	70 05 18.1	.026771	9.379675	45 48 10.8	9.855487
4 00	9.614777	67 36 50.1	.034028	3.386906	43 18 05.3	9.836221
4 10	9.663550	65 15 28.4	.041818	3.394669	40 55 06.3	9.816231
4 20	9.706716	63 01 26.4	.050027	3.402852	38 39 27.2	9.795647
4 30	9.745292	60 54 49.6	.058544	3.411343	36 31 13.7	9.774597

Gr. sid. time.	Sec. $(\eta - \beta_m)$	Cosec. $1'' \div$ Q	Sec. $(\eta - \beta_m) \div$ Q sin. $1''$	Zech	Tan. $'' \Delta_\pi \beta$	$\Delta_\pi \beta$
h. m.						′ ″
3 50	.156688	1.934750	2.091438	3533	3.238695_n	— 28 52.57
4 00	.138015	1.927519	2.065534	3751	3.226878_n	— 28 06.06
4 10	.121683	1.919756	2.041439	3966	3.214866_n	— 27 20.07
4 20	.107408	1.911573	2 018981	4177	3.202676_n	— 26 34.67
4 30	.094936	1.903081	1.998017	4385	3.190325_n	— 25 49.96

Computation of the observations made at Washington—Continued.

Gr. sid. time.	α'_m	β_m	$\eta-\beta_m$	Corr. Σ	Σ	$\alpha'_m-\alpha^\circ_s$
h. m.	° ′ ″	° ′ ″	° ″ ″			′ ″
3 50	54 01 52.59	23 48 14.69	46 17 03.4	3517	2.997894	— 27 52.99
4 00	54 07 38.83	23 50 38.79	43 46 11.3	3736	2.997587	— 22 06.75
4 10	54 13 20.00	23 53 02.08	41 22 26.3	3952	2.997776	— 16 25.58
4 20	54 18 56.17	23 55 24.50	39 06 01.9	4164	2.997962	— 10 49.41
4 30	54 24 27.41	23 57 45.94	36 57 03.7	4373	2.998145	— 5 18.17

Gr. sid. time.	$\beta'_m-\beta^\circ_s$	F ÷ A	Sin.″ $(\alpha'_m-\alpha^\circ_s)$	Cos. β'_m	x_m	Z
h. m.	′ ″					
3 50	11 49.80	42	3.223488_n	9.961388	3.184918_n	.3955
4 00	14 13.90	40	3.122786_n	9.961254	3.084080_n	.1940
4 10	16 37.19	38	2.993690_n	9.961121	2.954850_n	9.9356
4 20	18 59.61	38	2.812519_n	9.960988	2.773545_n	9.5793
4 30	21 21.05	39	2.502659_n	9.960856	2.463554_n	8.9533

Gr. Sid. time.	Sin.″ $(\beta'_m-\beta^\circ_s)$	Sin.″ $(\beta'_m-\beta^\circ_s)$ ÷ Z	Zech.	y_m	E x_m	−E y_m	E x_m	−E y_m	x''_m
h. m.									″
3 50	2.851136	2.4556	1516	2.852694	8.4591	8.1279	.03	.01	— 1530.79
4 00	2.931407	2.7374	794	2.932241	8.3583	8.2064	.02	.02	— 1213.59
4 10	2.998776	3.0632	375	2.999190	8.2291	8.2734	.02	.02	— 901.24
4 20	3.056753	3.4836	143	3.056934	8.0477	8.3311	.01	.02	— 593.65
4 30	3.107562	4.1543	30	3.107631	7.7378	8.3818	.01	.02	— 290.75

Gr. Sid. time.	$\Delta_t x''_m$	$\Delta^2_t x''_m$	$\Delta^3_t x''_m$	y''_m	$\Delta_t y''_m$	$\Delta^2_t y''_m$	$\Delta^3_t y''_m$	Σ_s	Σ_a	$\Delta_t \Sigma_a$
h. m.	″	″		″	″				″	
3 50	317.20	— 4.85	.09	712.38	143.18	— .58	— .09	2.997436	994.11	.44
4 00	312.35	— 4.76	.07	855.56	142.60	— .67	— .10	2.997627	994.55	.42
4 10	307.59	— 4.69		998.16	141.93	— .77		2.997815	994.98	.43
4 20	302.90			1140 09	141.16			2.998000	995.40	.43
4 30				1281.25				2.998184	995.83	

Star.	Wash. m. s. t.	Gr. m. s. t.	Gr. sid. time.	x'_m	y''_m	x_s
	h. m. s.	*h. m. s.*	*h. m. s.*	″	″	″
2	10 22 52.6	15 30 54.35	3 51 52.92	— 1470.71	739.37	— 2143.43
1	10 30 20.2	15 38 21.95	3 59 21.74	— 1233.68	846.45	— 2208.22
4	10 39 59.3	15 48 01.65	4 09 02.43	— 931.00	981.51	— 1882.75
11	10 56 42.4	16 04 44.15	4 25 48.27	— 417.27	1222.14	— 1372.17

Star.	y_s	$x-x''_s$ m	$y-y''_s$ m	p cos. θ	p sin. θ	Tan θ	Sec. or cosec θ
	″	″	″				
2	4.19	— 672.72	— 735.18	2.827834_n	2.866394_n	.038560	.132090
1	637.85	— 974.54	— 208.60	2.988800_n	2.319314_n	9.330514	9728
4	1281.01	— 951.75	296 50	2.978523_n	2.472025_n	9.493502_n	20114
11	928.23	— 954.90	— 293.92	2.979958_n	2.468229_n	2.488271	19657

Star.	p	p	Σ_a	Σ_a-p	θ	h	$\theta-h$
	″	″	″	″	° ′	° ′	° ′
2	2.998484	996.51	994.19	— 2.32	227 32.4	13 50.4	213 42.0
1	2.998528	996 62	994.52	— 2.10	192 05.0	13 48.9	178 16.1
4	2 998637	996.87	994.92	— 1.95	162 41.8	13 46.8	148 55.0
11	2.999615	999.11	995 66	— 3.45	197 16.5	13 43.1	183 33.4

Computation of the observations made at Washington—Continued.

Star.	Cos. $(\theta - h')$	Cos. b	$D_e\ p$	$D_t\ t$	$D_\lambda\ p$	$D_e\ p$	$D_\lambda\ p$
2	9.9201_n	9.9984	9.9185	9.7848	9.7033	.829	.505
1	9.9998_n	9.9984	9.9982	9.7847	9.7829	.996	.607
4	9.9397_n	9.9984	9.9311	9.7847	9.7158	.853	.520
11	9.9892_n	9.9984	9.9976	9.7846	9.7822	.994	.606

PLEIADES' OCCULATIONS, SEPTEMBER 26, 1839.

Computation of the observations made at Philadelphia.

h	9.885157	Lat.	° ′ ″ 39 56 31.0	h. m. s.
k	9.805395	Long.	—75 09 35.4 =	— 5 00 38.36.
$h \div k$	.079832			

Gr. sid. time.	P	$s - \alpha_m$	Sin. $(s - \alpha_m)$	Sec. $(s - \alpha_m)$	Cosec. $1'' \div P$	Sec. $(s - \alpha_m) \div P \sin 1''$	Zech
h. m.		° ′ ″					
3 50	3.482773	— 70 52 08.6	9.975327_n	.484686	1.831652	2.316138	2120
4 00	3.482840	— 68 28 33.7	9.968606_n	.435454	1.831585	2.267039	2355
4 10	3.482906	— 66 04 58.9	9.961010_n	.392103	1.831519	2.223622	2603
4 20	3.482972	— 63 41 24.2	9.952506_n	.353374	1.831453	2.184827	2847
4 30	3.483039	— 61 17 49.6	9.943060_n	.318517	1.831386	2.149903	3086

Gr. sid. time	Tan.′′ $\Delta_\pi \alpha$	$\Delta_\pi \alpha$	$\frac{1}{2} \Delta_\pi \alpha$	$s - \alpha_m - \frac{1}{2} \Delta_\pi \alpha$	Cos. $(s - \alpha_m - \frac{1}{2} \Delta_\pi \alpha)$	Sec. $\frac{1}{2} \Delta_\pi \alpha$
h. m.		′ ″	′ ″	° ′ ″		
3 50	3.460202	48 05.18	24 02.6	— 71 16 11.2	9.506658	.000011
4 00	3.453801	47 22.96	23 41.5	— 68 52 15.2	9.556871	.000010
4 10	3.446519	46 35.70	23 17.8	— 66 28 16.7	9.601199	.000010
4 20	3.438325	45 43.47	22 51.7	— 64 04 15.9	9.640735	.000010
4 30	3.429185	44 46.33	22 23.2	— 61 40 12.8	9.676278	.000009

Gr. sid. time.	Cot. η	η	Cosec. η	$\eta - \beta_m$	Q	Sin. $(\eta - \beta_m)$
h. m.		° ′ ″		° ′ ″		
3 50	9.586501	68 53 50.0	.030148	44 36 42.7	3.392849	9.846523
4 00	9.636713	66 34 35.5	.037350	42 15 50.7	3.400025	9.827724
4 10	9.681041	64 22 09.4	.044986	40 01 47.3	3.407634	9.808336
4 20	9.720577	62 16 40.2	.052952	37 54 41.0	3.415574	9.788481
4 30	9.756119	60 18 10.8	.061152	35 54 34.9	3.423748	9.768275

Gr. sid. time.	Sec. $(\eta - \beta_m)$	Cosec. $1'' \div Q$	Sec $(\eta - \beta_m) \div Q \sin 1''$	Zech	Tan.′′ $\Delta_\pi \beta$	$\Delta_\pi \beta$
h. m.						′ ″
3 50	.147593	1.921576	2.069169	3719	3.243091_n	— 29 10.17
4 00	.130738	1.914400	2.045138	3932	3.231681_n	— 28 24.78
4 10	.115935	1.906791	2.022726	4141	3.220111_n	— 27 39.97
4 20	.102944	1.898851	2.001795	4347	3.208402_n	— 26 55.82
4 30	.091546	1.890677	1.982223	4548	3.196571_n	— 26 12.40

Computation of the observations made at Philadelphia—Continued.

Gr. sid. time.	α_m	β'_m	$\eta - \beta_m$	Corr. Σ	Σ	$\alpha_m - \alpha^\circ_s$
h. m.	° ′ ″	° ′ ″	° ′ ″			′ ″
3 50	54 00 38.37	23 47 57.09	45 05 53.9	3706	2.997563	— 29 07.21
4 00	54 06 21.22	23 50 20.07	42 44 14.4	3914	2.997765	— 23 24.36
4 10	54 11 59.15	23 52 42.18	40 29 27.2	4122	2.997946	— 17 46.43
4 20	54 17 32.22	23 55 03.35	38 21 36.9	4329	2.998127	— 12 13.36
4 30	54 23 00.49	23 57 23.50	36 20 47.3	4535	2.998307	— 6 45.09

Gr. sid. time.	$\beta'_m - \beta^\circ_s$	F + A	Sin.″ $(\alpha_m - \alpha^\circ_s)$	Cos. β_m	x_m	Z
h. m.	′ ″					
3 50	11 32.20	44	3.242340_n	9.961405	3.203789_n	.4332
4 00	13 55.18	42	3.147476_n	9.961272	3.108796_n	.2433
4 10	16 17.29	40	3.027930_n	9.961139	2.989169_n	.0041
4 20	18 38.46	39	2.865317_n	9.961008	2.826364_n	9.6788
4 30	20 58.61	39	2.607552_n	9.960877	2.568846_n	9.1631

Gr. sid. time.	Sin.″ $(\beta_m - \beta^\circ_s)$	Sin.″ $(\beta_m - \beta^\circ_s) \div Z$	Zech.	y_m	$-E\,x_m$	$E\,y_m$	$-E\,x_m$	$E\,y_m$	z''_m
h. m.									″
3 50	2.840232	2.4070	1698	2.841974	8.4805	8.1162	.03	.01	— 1598.77
4 00	2.921780	2.6785	909	2.922731	8.3931	8.1970	.02	.02	— 1284.64
4 10	2.990023	2.9859	448	2.990511	8.2533	8.2647	.02	.02	— 975.21
4 20	3.048620	3.3698	185	3.048844	8.1006	8.3200	.01	.02	— 670.42
4 30	3.099888	3.9368	50	3.099977	7.8447	8.3742	.01	.02	— 370.21

Gr. sid. time.	$\Delta_t x''_m$	$\Delta^2_t x''_m$	$\Delta^3_t x''_m$	y''_m	$\Delta_t y''_m$	$\Delta^2_t y''_m$	$\Delta^3_t y''_m$	Σ_c	Σ_s	$\Delta_t \Sigma_s$
h. m.	″	″		″	″	″			″	
3 50	314.13	— 4.70	.06	695.08	142.02	— .64	— .10	2.997627	994.55	.41
4 00	309.43	— 4.64	.06	837.03	141.38	— .74	— .08	2.997800	994.96	.41
4 10	304.79	— 4.58		978.41	140.64	— .82		2.997936	995.37	.42
4 20	300.21			1119.05	139.82			2.998166	995.79	.41
4 30				1258.87				2.998346	996.20	

Star.	Phil. m. s. t.	Gr. m. s. t.	Gr. sid. time.	x''_m	y''_m	x_s
	h. m. s.	*h. m. s.*	*h. m. s.*	″	″	″
2	10 32 04.73	15 32 43.09	3 53 41.95	— 1482.01	747.61	— 2143.43
2	10 32 07.97	15 32 46.33	3 53 45.20	— 1480.31	748.38	— 2143.43
2	10 32 05.78	15 32 44.14	3 53 43.00	— 1481.46	747.85	— 2143.43
2	10 32 05.13	15 32 43.49	3 53 42.35	— 1481.80	747.70	— 2143.43
1	10 39 57.09	15 40 35.45	4 01 35.61	— 1235.02	859.60	— 2208.22
1	10 39 57.67	15 40 36.03	4 01 36.19	— 1234.72	859.74	— 2208.22
1	10 39 58.95	15 40 37.31	4 01 37.47	— 1234.05	860.04	— 2208.22
1	10 39 57.04	15 40 35.40	4 01 35.56	— 1234.99	859.61	— 2208.22
4	10 49 58.93	15 50 37.29	4 11 39.10	— 924.55	1001.60	— 1882.75
4	10 49 59.52	15 50 37.88	4 11 39.69	— 924.25	1001.83	— 1882.75
4	10 50 00.36	15 50 38.72	4 11 40.53	— 923.82	1002.03	— 1882.75
4	10 49 59.33	15 50 37.69	4 11 39.50	— 924.35	1001.78	— 1882.75
11	11 06 34.69	16 07 13.05	4 28 17.58	— 421.14	1235.07	— 1372.17
11	11 06 35.04	16 07 13.40	4 28 17.93	— 421.31	1235.15	— 1372.17
11	11 06 35.29	16 07 13.65	4 28 18.18	— 421.43	1235.20	— 1372.17

Computation of the observations made at Philadelphia—Continued.

Star.	y_s	$x_s - x'_m$	$y_s - y'_m$	$p \cos. \theta$	$p \sin. \theta$	Tan. θ	Sec. or cosec. θ
	″	″	″				
2	4.19	— 661.42	— 743.42	2.820477_n	2.871231_n	.050757	.126615
2	4.19	— 663.12	— 744.19	2.821592_n	2.871681_n	.050092	.126911
2	4.19	— 661.97	— 743.66	2.820838_n	2.871374_n	.050536	.126712
2	4.19	— 661.63	— 743.51	2.820615_n	2.871287_n	.050672	.126614
1	637.85	— 973.20	— 221.75	2.988202_n	2.345864_n	9.357662	.010991
1	637.85	— 973.50	— 221.89	2.988336_n	2.346138_n	9.357802	.010998
1	637.85	— 974.17	— 222.19	2.988635_n	2.346725_n	9.358090	.011011
1	637.85	— 973.23	— 221.76	2.988215_n	2.345883_n	9.357668	.010991
4	1281.01	— 958.20	279.41	2.981456_n	2.446242	9.464786_n	.017715
4	1281.01	— 958.50	279.18	2.981592_n	2.445884	9.464292_n	.017683
4	1281.01	— 958.93	278.98	2.981787_n	2.445573	9.463786_n	.017642
4	1281.01	— 958.40	279.23	2.981547_n	2.445962	9.464415_n	.017691
11	928.22	— 951.03	— 306.85	2.978194_n	2.466926_n	9.508732	.021504
11	928.22	— 950.86	— 306.93	2.978117_n	2.487039_n	9.508922	.021524
11	928.22	— 950.74	— 306.98	2.978062_n	2.487110_n	9.509048	.021535

Star.	p	p	Σ_s	$\Sigma_s - p$	θ	h'	$\theta - h'$
		″	″	″	° ′	° ′	° ′
2	2.997849	995.06	994.69	— 0.37	228 20.4	13 50.0	214 30.4
2	2.998595	996.77	994.69	— 2.08	228 17.8	13 50.0	214 27.8
2	2.998087	995.66	994.69	— 0.97	228 19.5	13 50.0	214 29.5
2	2 997901	995.18	994.69	— 0.49	228 20.1	13 50.0	214 30.1
1	2.999193	998.14	995.03	— 3.11	192 59.1	13 48.5	179 01.6
1	2.999334	998.47	995.03	— 3 44	192 50.4	13 48 5	179 01.9
1	2.999746	999.42	995.03	— 4.39	192 50.9	13 48.5	179 01.4
1	2.999206	998.17	995 03	— 3.14	192 50.2	13 48.5	179 01.7
4	2.999171	998.09	995.44	— 2.65	163 44.6	13 46.3	149 58.3
4	2.999275	998.33	995.44	— 2.89	163 44.7	13 46.3	149 58.4
4	2.999429	998.69	995.44	— 3.25	163 46.7	13 46.3	150 00.4
4	2.999238	998.25	995.44	— 2.81	163 45.4	13 46.3	149 59.1
11	2.999698	999.30	996.15	— 3.15	197 53.0	13 42.6	184 10.4
11	2.999641	999.17	996.15	— 3.02	197 53.4	13 42.6	184 10.8
11	2.999567	999.07	996.15	— 2.92	197 53.6	13 42.6	184 11.0

Star.	Cos. $(\theta - h')$	Cos. b.	$D_\theta p$	$D_t l$	$D_\lambda p$	$D_\theta p$	$D_\lambda p$
2	9.9159_n	9.9984	9.9143	9.7848	9.6991	.821	.500
2	9.9162_n	9.9984	9.9146	9.7848	9.6992	.821	.500
2	9.9160_n	9.9984	9.9144	9.7848	9.6992	.821	.500
2	9.9160_n	9.9984	9.9144	9.7848	9.6992	.821	.500
1	9.9999_n	9.9984	9.9983	9.7847	9.7830	.996	.607
1	9.9999_n	9.9984	9.9983	6.7847	9.7830	.996	.607
1	9.9999_n	9.9984	9.9983	9.7847	9.7830	.996	.607
1	9.9999_n	9.9984	9.9983	9.7847	9.7830	.996	.607
4	9.9374_n	9.9984	9.9358	9.7847	9.7205	.863	.525
4	9.9374_n	9.9984	9.9358	9.7847	9.7205	.863	.525
4	9.9376_n	9.9984	9.9360	9.7847	9.7207	.863	.525
4	9.9375_n	9.9984	9.9359	6.7847	9.7206	.863	.525
11	9.9988_n	9.9984	9.9972	9.7846	9.7818	.994	.605
11	9.9988_n	9.9984	9.9972	9.7846	9.7818	.994	.605
11	9.9988_n	9.9984	9.9972	9.7846	9.7818	.994	.605

PLEIADES' OCCULTATIONS, SEPTEMBER 26, 1839.

Computation of the observations made at Boston.

h	9.869333	Lat.	42 21 00	h. m. s.
k	9.826185	Long.	−71 03 39.1 =	−4 44 14.6
$h \div k$	.043148			

Gr. sid. time.	$s-\alpha_m$	P	Sin. $(s-\alpha_m)$	Sec. $(s-\alpha_m)$	Cosec. $1'' \div P$	Sin. $(s-\alpha_m) \div P$ sin. 1″	Zech
h. m.	° ′ ″						
3 50	− 66 46 12.3	3.466949	9.963282_n	.404039	1.847476	2.251515	2441
4 00	− 64 22 37.4	3.467016	9.955042_n	.364067	1.847409	2.211476	2667
4 10	− 61 59 02.6	3.467082	9.945871_n	.328164	1.847343	2.175507	2969
4 20	− 59 35 27.9	3.467146	9.935726_n	.295705	1.847277	2.142982	3136
4 30	− 57 11 53.3	3.467215	9.924563_n	.266213	1.847210	2.113123	3358
4 40	− 54 48 18.8	3.467282	9.912327_n	.239308	1.847143	2.086451	3374

Gr. sid. time.	Tan. ″ $\Delta_\pi \alpha$	$\Delta_\pi \alpha$	$\frac{1}{2} \Delta_\pi \alpha$	$s-\alpha_m - \frac{1}{2} \Delta_\pi \alpha$	Cos. $(s-\alpha_m - \frac{1}{2} \Delta_\pi \alpha)$	Sec. $\frac{1}{2} \Delta_\pi \alpha$
h. m.		′ ″	′ ″	° ′ ″		
3 50	3.432672	45 07.99	22 34.0	− 67 08 46.3	9.589258	.000009
4 00	3.434735	44 18.97	22 09.5	− 64 44 46.9	9.630048	.000009
4 10	3.415862	43 25.19	21 42.6	− 62 20 45.2	9.666642	.000009
4 20	3.406010	42 26.76	21 13.4	− 59 56 41.3	9.699694	.000008
4 30	3.395136	41 23.80	20 41.9	− 57 32 35.2	9.729703	.000008
4 40	3.383183	40 16.33	20 08.2	− 55 08 27.0	9.757063	.000007

Gr. sid. time.	Cot. η	η	Cosec. η	$\eta-\beta_m$	Q	Sin. $(\eta-\beta_m)$
h. m.		° ′ ″		° ′ ″		
3 50	9.632415	66 46 57.7	.036677	42 29 50.4	3.420239	9.829661
4 00	9.673205	64 46 12.7	.043541	40 27 27.9	3.427077	9.812169
4 10	9.709799	62 51 33.2	.050664	38 31 11.1	3.434173	9.794338
4 20	9.742850	61 03 01.5	.057969	36 41 02.3	3.441452	9.776266
4 30	9.772859	59 20 36.2	.065381	34 57 00.3	3.448838	9.758050
4 40	9.800218	57 44 12.5	.072833	33 19 00.1	3.456264	9.739783

Gr. sid. time.	Sec. $(\eta-\beta_m)$	Cosec. $1'' \div Q$	Sec. $(\eta-\beta_m) \div Q$ sin. 1″	Zech	Tan. $\Delta_\pi \beta$	$\Delta_\pi \beta$
h. m.						′ ″
3 50	.132350	1.894186	2.026536	4105	3.254005_n	− 29 54.71
4 00	.118681	1.887348	2.006029	4304	3.243550_n	− 29 12.02
4 10	.106575	1.880252	1.986827	4500	3.233011_n	− 28 30.02
4 20	.095857	1.872073	1.968830	4691	3.222409_n	− 27 48.79
4 30	.086371	1.865587	1.951958	4878	3.211766_n	− 27 08.40
4 40	.077877	1.858161	1.936038	5061	3.201108_n	− 26 28.91

Gr. sid. time.	α'_m	β'_m	$\eta-\beta'_m$	Corr. Σ	Σ_i	$\alpha'_m - \alpha^\circ_s$
h. m.	° ′ ″	° ′ ″	° ′ ″			° ′
3 50	53 57 41.18	23 47 12.55	42 59 45.2	4089	2.997966	− 32 04.40
4 00	54 03 17.23	23 49 32.83	40 56 39.9	4289	2.998140	− 26 28.35
4 10	54 08 48.64	23 51 52 13	38 59 41.1	4485	2.998309	− 20 56.94
4 20	54 14 15.52	23 54 10.38	37 08 51.1	4677	2.998475	− 15 30.06
4 30	54 19 37.96	23 56 27.51	35 24 08.7	4865	2.998637	− 10 07.62
4 40	54 24 56.06	23 58 43.45	33 45 29.1	5048	2.998794	− 4 49.52

Computation of the observations made at Boston—Continued.

Gr. sid. time	$\beta'_m - \beta^\circ_s$	F ÷ A	Sin.″ $(\alpha_m - \alpha^\circ_s)$	Cos. β_m	x_m	Z
h. m.	′ ″					
3 50	10 47.66	44	$3\ 284290_n$	9.961446	3.245780	.5172
4 00	13 07.94	42	3.200949_n	9 961315	3.162306	.3504
4 10	15 27.24	40	$3\ 0983.2_n$	9.961186	3.060538	.1489
4 20	17 45.49	39	2.968510_n	9.961058	2.929607	9.9852
4 30	20 02.62	40	2.783632_n	9.960929	2.744601	9.5153
4 40	22 18 56	40	2.461679_n	9.960802	2.422521	8.8712

Gr. sid. time	Sin.′ $(\beta_m - \beta^\circ_s)$	Sin.′ $(\beta_m - \beta^\circ_s) \div Z$	Zech	y_m	E x_m	−E y_m	E x_m	−E y_m	x''_m
h. m.									″
3 50	2.811347	2.2941	2201	2.813592	8.5200	8.0878	.03	.01	— 1761.07
4 00	2 896492	2.5461	1233	2.897767	8.4365	8.1722	.03	.01	— 1453.12
4 10	2.967191	2 8203	656	2.967887	8.3346	8.2421	.02	.02	— 1149.57
4 20	3.027551	3.1424	313	3 027903	8.2038	8.3021	.02	.02	— 850.35
4 30	3.080126	3.5648	118	3.080284	8.0188	8.3545	.01	.02	— 555.37
4 40	3.126661	4.2555	24	3.126725	7.6967	8.4009	.00	.03	— 264.53

Gr. sid. time.	$\Delta_t\ x''_m$	$\Delta^o_t\ x''_m$	$\Delta^s_t\ x''_m$	y''_m	$\Delta_t\ y''_m$	$\Delta^a_t\ y''_m$	$\Delta^a_t\ y''_m$	Σ_s	Σ_o	$\Delta_t\ \Sigma_o$
h. m.	″	″		″	″				″	
3 50	307.95	— 4.40	.07	651.04	139.24	— .77	— .09	2.998010	995.43	.39
4 00	303.55	— 4.33	.09	790.28	138.47	— .86	— .05	2.998182	995.82	.38
4 10	299.22	— 4.24	.10	928.75	137.61	— .91	— .02	2.998349	996.20	.38
4 20	294.98	— 4.14		1066.36	136.70	— .93		2.998514	996.58	.37
4 30	290.84			1203.06	135.77			2.998675	996 95	.37
4 40				1338.83				2.998834	997.32	

Star.	Boston m. s. t.	Gr. m. s. t.	Gr. sid. time.	x''_m	y''_m	x_s
	h. m. s.	h. m. s.	h. m. s.	″	″	″
2	10 53 06.90	15 37 21.50	3 58 21.13	— 1503 56	767.39	— 2143.43
1	11 01 45.27	15 45 59.87	4 07 00.92	— 1239.72	887.51	— 2208.22
4	11 12 36.43	15 56 51.03	4 17 53.86	— 912.91	1037.51	— 1882.75
11	11 28 58 98	16 13 13.58	4 34 19.10	— 429.26	1261.80	— 1372.17

Star.	y_s	$x - x''_m$	$y - y''_m$	$p \cos \theta$	$p \sin. \theta$	tan. θ	Sec. or cosec θ
	″	″	″				
2	4.19	— 639.87	— 763.20	2.806092_n	2.882638_n	.076546	.115597
1	637.85	— 968.50	— 249.66	2.986100_n	2.397349_n	9.411249	.013970
4	1281.01	— 969.84	243.50	2.986700_n	2.386499	9.399799_n	.013276
11	928.22	— 942.91	— 333.58	2.974470_n	2.523200_n	9.548730	.025607

Star.	p	p	Σ_s	$\Sigma_o - p$	θ	h'	$\theta - h'$
		″	″	″	° ′	° ′	° ′
2	2.998235	995.94	995.76	0.18	230 01.4	13 49.0	216 22.4
1	3.000070	1000.16	996.09	— 4.07	194 27.3	13 47.2	180 40.1
4	2.999976	999.94	996.50	— 3.44	165 54.3	13 44.9	152 09.4
11	3.000077	1000.18	997.11	— 3.07	199 29.0	13 41.4	185 47.6

Computation of observations made at Boston—Continued.

Star.	Cos. $(\theta - h')$	Cos. b	$D_e\ p$	$D_i\ l$	$D_\lambda\ p$	$D_e\ r$	$D_\lambda\ p$
2	9.9059_n	9.9984	9.9043	9.7848	9.6891	.892	.489
1	$0\ 0000_n$	9.9984	9.9984	9.7847	9.7831	.996	.607
4	9.9466_n	9.9984	9.9450	9.7847	9.7291	.881	.536
11	9.9978_n	9.9984	9.9962	9.7846	9.7808	.991	.604

SOLUTION OF THE EQUATIONS FOR THE CORRECTION OF THE MOON'S PLACE, AND OF THE LONGITUDE.

Equations for the correction of the moon's place.

Place.	Star.	$D_e\ p$	δp	k	$k\ D_e\ p$	$k\ \delta p$	$-D_e\ p\ \delta\lambda$	$\delta\ p$	$(\delta' p)^s$
			"				"	"	
Greenwich	1	.479	0.11	.5	.2395	.055	1.17	1 28	1.64
	1	.479	0.04	.5	.2395	.020	1.17	1 21	1.46
	4	.928	— 2.93	.9	.8352	— 2.637	2.27	— 0.66	0.44
	11	.558	0.21	.6	.3348	.126	1.36	1.57	2.46
Cambridge	1	.546	— 1.11	.5	.2730	— .555	1.34	0.23	0 05
	4	.943	— 3.87	.9	.8487	— 3.483	2.31	— 1 06	1.12
	11	.615	— 0.49	.6	.3690	— .294	1.50	1.01	1.02
Ashurst	1	.453	— 0.33	.5	.2265	— .165	1.11	0.78	0.61
	4	.923	— 4.28	.9	.8307	— 3.852	2.25	— 2.03	4.12
	11	.540	— 0.27	.5	.2700	— .135	1.32	1.05	1.10
Sum					4.4669	—10.920			14.02
								$\Sigma\ (\delta' p)^s$	22.71
									36.73

Equations for the correction of the longitude of America.

Place.	Star.	δp	$-D_e\ p\ \delta\lambda$	$\delta' p$	$D_\lambda\ p$	k'	$k'\ D_\lambda\ p$	$k\ \delta' p$	$-D_\lambda\ p\ \delta\lambda$	$\delta'\ p$	$(\delta' p)^s$
		"	"							"	
Washington	2	— 2.32	2.03	— 0.29	.505	1	.5050	— 0.280	0.28	— 0 01	0.00
	1	— 2.10	2.44	0.34	.607	1.2	.7284	0.408	.33	0 67	0.45
	4	— 1.95	2.09	0.14	.520	1	.5200	0.140	.28	0.42	0.18
	11	— 3.45	2.43	— 0.02	.606	1.2	.7272	— 0.024	.33	0.31	0.10
Philadelphia	2	— 0.37	2.01	1.64	.500	1	.5000	1.640	.27	1.91	3.65
	2	— 2.08	2.01	— 0.07	.500	1	.5000	— 0.070	.27	0 20	0.04
	2	— 0.97	2.01	1.04	.500	1	.5000	1.040	.27	1.31	1.72
	2	— 0 49	2.01	1.52	.500	1	.5000	1.520	.27	1.79	3.20
	1	— 3.11	2.44	— 0.67	.607	1.2	.7284	— 0.804	.33	— 0.34	0.12
	1	— 3.44	2.44	— 1.00	.607	1.2	.7284	— 1.200	.33	— 0.67	0.45
	1	— 4.39	2.44	— 1.95	.607	1.2	.7284	— 2.340	.33	— 1.62	2 66
	1	— 3.14	2.44	— 0.70	.607	1.2	.7284	— 0.840	.33	— 0.37	0.14
	4	— 2.65	2.11	— 0.54	.525	1	.5250	— 0.540	.29	— 0.25	0.06
	4	— 2.89	2.11	— 0.78	.525	1	.5250	— 0.780	.29	— 0.49	0 24
	4	— 3.25	2.11	— 1.14	.525	1	.5250	— 1.140	.29	— 0.85	0.72
	4	— 2.81	2.11	— 0 70	.525	1	.5250	— 0.700	.29	— 0.41	0.17
	11	— 3.15	2.43	— 0.72	.605	1.2	.7260	— 0.864	.33	— 0.39	0.15
	11	— 3.02	2.43	— 0.59	.605	1.2	.7260	— 0.708	.33	— 0.26	0.07
	11	— 2.92	2.43	— 0.49	.605	1.2	.7260	— 0.588	.33	— 0.16	0.03
Boston	2	0.18	1.96	2.14	.489	1	.4890	2.140	.27	2.41	5.81
	1	— 4.67	2.44	— 1.63	.607	1.2	.7284	— 1.956	.33	— 1 30	1.69
	4	— 3.44	2.15	— 1.29	.536	1.1	.5896	— 1.419	.29	— 1.00	1.00
	11	— 3.07	2.42	— 0.65	.604	1.2	.7248	— 0.380	.33	— 0.32	0.10
Sum							14.2040	—7.755			22.71

Equations for the correction of the longitude of America—Continued.

4.4669	0.650006	14.2040	1.152411	36.73	1.5651
−10.920	1.038223_n	− 7.755	0.889582	31	1.4914
$\delta\lambda = -2''.44$	0.388217_n	$\delta\lambda = 0s.55$	9.737171		0.0737
				¼ (14.2040)	0.8514
					9.2223
					9.6112
				Constant.	9.8290
				0.276	9.4402

	h.	m.	s.
Assumed longitude of Washington	−5	8	12.00
δl			0.55
Corrected longitude of Washington	−5	8	$11.45 \pm 0s.276$ or $\pm 0s.310$
Corrected longitude of Cambridge	−4	44	29.91

The difference between these results and those obtained from the reduction of the same observations by Mr. Sears C. Walker, and which are published in the proceedings of the Philosophical Society of Philadelphia, (vol. i, p. 232,) is mainly due to the improved lunar parallax given by the tables of Hansen. The importance of this element is indicated by Mr. Walker in the Coast Survey Report of 1851. The results, now given, are to be taken as a first approximation, and are liable to correction for lunar parallax, the places of the stars, and the inequalities of the lunar disc. It is easy to ascertain the ultimate reduction of probable error which could possibly be obtained from these corrections, and hence to infer the final accuracy of this method of ascertaining the longitude. Thus the occultations of each star observed in England may be subjected to a common correction, and the same system of correction may be applied to the American observations. The following table contains the several steps of the process, and the reduced probable error is found to be about 0.17*s.* of time in the longitude of Washington. It may then be inferred that the probable error of the longitude which will result from all the occultations of the Pleiades will not exceed 0.05*s.* of time. But this estimate does not include the probable error arising from the error of the constant portion of the lunar parallax. The actual probable error of this constant cannot be assumed to be less than 0.″1 of arc, which corresponds to 0.15*s.* of time in the longitude of America.—(See p. 480 of Walker's report in the Coast Survey Report of 1851.) But I am quite confident that the occultations of the Pleiades will correct this constant, so that its probable error will be reduced by one-half its present amount, so that it is reasonable to conclude that *the probable error of the final longitude resulting from all the occultations of the Pleiades will not exceed one-tenth of a second of time.*

The computations have been performed in duplicate by Mr. Charles S. Peirce, who has detected some small errors, which will be introduced into the future computations.

Place.	δ''_p				δ'''_p				$(\delta'''_p)^2$			
	Star 1.	Star 2.	Star 4.	Star 11.	Star 1.	Star 2.	Star 4.	Star 11.	Star 1.	Star 2.	Star 4.	Star 11.
	″	″	″	″	″	″	″	″	″	″	″	″
Greenwich	1.28		−0.66	1.57	0.40		0.54	0.36	.16		.35	.13
Greenwich	1.21				0.23				.05			
Cambridge	0.23		−1.06	1.01	−0.55		0.19	−0.20	.30		.04	.04
Ashurst	0.78		−2.03	1.05	−0.10		−0.78	−0.16	.01		.61	.03
Washington	0.67	−0.01	0.41	0.31	1.27	−1.26	0.85	0.47	1.61	1.59	.72	.22
Boston	−1.30	2.41	−1.00	−0.32	−0.70	1.14	−0.53	−0.16	.49	1.30	.32	.03
Philadelphia, W.	−0.34	1.91	−0.25	−0.39	0.26	0.64	0.18	−0.23	.07	.41	.63	.05
Philadelphia, K.	−0.67	0.20	−0.49		−0.07	−1.07	−0.06		0.	1.14	0.	
Philadelphia, R.	−1.62	1.31	−0.85	−0.26	−1.02	0.04	−0.42	−0.10	1.04	0.	.18	.01
Philadelphia, M.	−0.37	1.79	−0.41	−0.16	0.23	0.52	−0.42	0.	.05	.27	0.	0.
Sum									3.78	4.71	2.25	.51

$$5\left(\delta_p'''\right)^2 = 11.25$$

$$\delta_p''' = \delta_p'' - \text{mean of } \delta_p'' \text{ for place and star.}$$

Place.	Star.	Mean of δ_p'				
		s.				
Europe	1	0.88	11.25	1.0512		1.0512
Europe	4	—1.25	31	1.4914	24	1.3802
Europe	11	1.21		9.5598		9.6710
			¼ coeff.	.8514		.8514
				8.7084		8.8196
America	1	—0.60		9.3542		9.4098
America	2	1.27	Const.	9.8290		9.8290
America	4	—0.43	0".152	9.1832	0".169	9.2388
America	11	—0.16				

All of which is respectfully submitted by

BENJAMIN PEIRCE.

Prof. A. D. BACHE, *LL.D., F. R. S., Superintendent U. S. Coast Survey.*

APPENDIX No. 18.

ABSTRACT OF THE REPORT OF DR. B. A GOULD, ASSISTANT COAST SURVEY, ON THE DETERMINATION OF LONGITUDE AT ALBANY, N. Y., BY THE TELEGRAPHIC METHOD.

CAMBRIDGE, *April* 4, 1861.

DEAR SIR: In conformity with your wishes, I have the honor to submit an abstract of my report upon the difference of longitude of the cities of Albany and New York, as deduced from the observations made for the purpose in 1858.

The observers were Messrs. George W. Dean and Edward Goodfellow, assisted by Messrs. A. E. Winslow and A. T. Mosman, and the plan of observation and modes of reduction and computation have been, in all respects, according to the usual practice of the Coast Survey for telegraphic measurements of longitude.

The station point in Albany was in a small wooden building erected for the purpose in the grounds of the Dudley Observatory, the block on which the transit instrument rested being 35.075 feet to the eastward of the meridian circle. The New York station was in the private observatory of Lewis M. Rutherford, esq., at the corner of Second avenue and Eleventh street, and two feet eleven inches east of the point occupied by Mr. Walker in the longitude determinations made by him for the Coast Survey in 1848.

For transit instruments the two portable instruments of the Coast Survey, Nos. 4 and 6, were employed; the former at Albany, the latter at New York. They are essentially similar, each having a clear aperture of about twenty-eight Paris lines, and a focal length of forty-six inches, and being used with an eye-piece magnifying about 100 times. Their diaphragms were provided with five equidistant "tallies," each consisting of five vertical threads at intervals of 2*s*.5 equatorial time, the spaces between the nearest threads of the adjacent tallies being about 5*s*.

In Albany the transit instrument was mounted in the ordinary way, its iron frame resting upon a granite block three feet wide and one foot thick, which was imbedded in the ground to the depth of three feet, and rose to a height of thirty inches above the flooring. In New York

this mode of mounting was impracticable; and by permission of Mr. Rutherford the Y plates of his own transit instrument were cut away somewhat and readjusted for the reception of our telescope, which was then swung between his two freestone piers.

The Hardy clock of the Coast Survey was suspended upon the brick foundation wall of the NW. basement room of the Dudley Observatory, this position seeming to afford the best security against sudden or extreme variations of temperature. A pair of insulated copper wires, passing from the clock to the station, connected in one galvanic circuit the clock, the two observing keys at the transit instrument, a commutator or circuit changer, and two chronographs— the one a spring governor and the other an ordinary telegraph register. The Kessel's clock was hung upon Mr. Rutherford's clock-pier, and was included in a galvanic circuit similar in all respects to that at Albany.

The ground connexion at each station was formed by a large copper plate buried some feet deep in the earth, and was connected with the office of the New York, Albany, and Buffalo Telegraph Company by a temporary line of No. 9 iron wire, about a quarter of a mile being put up specially for the purpose in Albany, and about three miles in New York. The company very liberally placed their best wires at our disposal after 9 o'clock every evening, and through the obliging courtesy of James D. Reid, esq., the general superintendent, and of Messrs. Cutler and Whiting, the local superintendents, every desired facility was afforded us. The wires employed were those designated in the office as Nos. 5 and 6. The latter, No. 6, weighs 400 pounds to the mile, and passing up the west bank of the Hudson to Troy, where it crosses the river on the bridge, descends the river on the east side, following the high road to New York. Its entire length between the two stations, as nearly as I can estimate, is 179 miles. Wire No. 5 passes down the west side of the river to a point 7 miles below Newburgh, where it crosses by a submerged cable. It is at least 25 miles shorter than the other, but is much smaller, weighing only 250 pounds to the mile. Its length from station to station may be estimated as 153 miles.

The programme adopted for the work, after the instruments had been satisfactorily adjusted, contemplated, in the first place, observations for determining the errors of azimuth, collimation, and clock time at each station, on every clear evening till the telegraphic exchanges of star signals should be completed; and both before and after these exchanges on the nights when they were made. Secondly, a satisfactory series of star transits telegraphically exchanged on three nights in the first position of observers, viz: with Mr. Dean in Albany and Mr. Goodfellow in New York, together with observations on two nights for determining the personal equation. Thirdly, a similar set of observations on three nights for longitude signals, and two for personal equation in the second position of observers, viz: with Mr. Goodfellow at Albany and Mr. Dean at New York. And, finally, a sufficient number of observations on circumpolar and other stars over all the twenty-five threads of the diaphragm, to determine the intervals of these threads as perfectly as possible. In addition to this general programme it was arranged that all the circumstances of the observations should be varied as much as possible; sometimes the full strength of the batteries, and sometimes very few cups being employed, and the direction of the current being reversed from time to time. During the first part of each night's work the signals were to be recorded by means of the Hardy clock, at Albany; and during the last part by means of the Kessel's clock, at New York. And as usual, also, in all our telegraphic longitude determinations reversals of each transit instrument and readings of the ether level were to be made alternately with the observations of transits. The exchange of star signals was to be regarded as satisfactory when the transit of the star over not less than fifteen threads was observed at each station, and well recorded upon both chronographic registers at both stations. The minimum number of such exchanges required in each position of observers was sixty, or an average of twenty stars a night.

This programme was thoroughly carried out in all points, notwithstanding various obstacles

which embarrassed our operations to an extraordinary degree. And the general principle was carefully followed, that no opportunity should be lost of varying the incidental circumstances of the observations as often and as much as possible. For instance, the strength of the galvanic current was varied from the maximum to the minimum amount consistent with convenience of telegraphic communication; the different wires were often interchanged, &c. It is needless to add that special care was taken that the positions of the observing keys should be such as to avoid unnecessary fatigue of the observer's hand or arm.

The experience of previous years had shown that the most desirable magnitude for signal-stars is between the fifth and sixth degree. In selecting the list of stars to be employed, this was kept in mind; yet stars of all magnitudes between the second and seventh were included in the list. The mean magnitude of all the signal stars observed was 5.3 M., according to the estimates carefully made for another purpose, under my direction.

All preliminary work having been completed, the regular series of observations was begun May 12, and continued until June 18. During this period, there were made for the determination of time and instrumental corrections at Albany 96 observations of circumpolar, and 138 of zenithal and equatorial stars, the average number of threads noted at each observation being 21; and at New York 50 observations of circumpolar, and 195 of other stars, each over 18 threads upon an average. Of course, the telescope was uniformly reversed during transits of circumpolars, to eliminate and determine the error of collimation, excepting in those cases where the observations were intended for the determination of the thread intervals of the diaphragm.

Exchanges of star transits by telegraph between the stations were made in the first position of observers, May 24, 28, June 2, and in the second position, June 8, 17, 18. Upon these six nights 180 complete observations were telegraphed from Albany to New York and 205 from New York to Albany, each observation consisting upon the average of transits over 19 threads. The number of different stars whose transits were thus exchanged was 52. The total number of observations satisfactorily exchanged, and for which the signals from each place were well recorded upon both registers at both stations, is 157, and the average number of threads at each station for these observations is 18.

The comparisons for personal equation between Messrs. Dean and Goodfellow were made on the nights of June 5, 6, 19, 20, complete observations being obtained on 86 stars. For each of these stars one observer noted the transits over the 1st, 3d, and 5th tallies, while the other took the intermediate ones, the 2d and 4th; and since they alternated in this arrangement, the mean result of each successive pair of stars is derived from twenty-five taps by each observer, and is free from any error originating in the telescope itself. Observations were made in like manner for redetermining the personal differences between Messrs. Dean and Goodfellow and myself.

The stars observed for instrumental corrections and local time were selected from the lists of 48 circumpolars and 132 "time-stars," specially prepared by me, heretofore, for the use of the Coast Survey. The observations of each night, and, when needful, for the different parts of each night, were combined according to the method of least squares. The following table gives the results for the corrections due to the instrument in azimuth and collimation, and for the clock correction, from May 22 to June 18. The column s. shows the number of stars employed in the determination, and the "probable error" of each determination is affixed.

Instrumental corrections needed at Albany.

Date.		Time.		c.	a.		Δ t.		s.
		h.	m.	s.	s.	s.	s.	s.	
May	22	12	30	+0.013	—0.189	±0.046	—1.591	±0.034	7
	24	13	0	+0.059	—0.308	0.030	—5.077	0.043	11
	27	15	0	----------	—0.174	0.013	—11.933	0.025	15
	28	13	0	+0.029	—0.258	0.013	—14.380	0.022	10
		18	0	+0.048	—0.242	0.018	—14.924	0.020	11
	29	14	0	----------	+0.038	0.020	+3.532	0.028	11
June	1	13	15	+0.034	+0.155	0.015	+3.569	0.024	9
	2	13	15	+0.045	—0.059	0.029	+3.515	0.049	12
		18	15	+0.039	+0.124	0.018	+3.209	0.023	12
	4	13	30	----------	----------		+1.834	0.067	4
	7	14	0	+0.055	+0.167	0.024	—0.847	0.032	9
	8	14	0	+0.037	+0.027	0.021	—1.952	0.022	11
		18	30	—0.104	+0.198	0.013	—2.259	0.016	4
	10	15	0	+0.057	+0.263	0.011	—5.716	0.011	9
	16	14	15	+0.017	—0.051	0.025	—24.283	0.029	13
	17	14	40	—0.022	—0.053	0.032	—28.198	0.042	10
		19	0	+0.005	—0.100	0.028	—28.846	0.024	9
	18	14	30	+0.006	—0.090	0.017	—31.679	0.028	16
		19	0	+0.006	—0.016	±0.019	—32.285	±0.016	11

Instrumental corrections needed at New York.

Date.		Time.		c.	a.		Δ t.		s.
		h.	m.	s.	s.	s.	s.	s.	
May	22	12	30	—0.255	+1.982	±0.024	—0.965	±0.024	10
	24	13	0	—0.218	+2.278	0.045	—0.952	0.045	9
		17	0	—0.190	+2.521	0.005	—1.064	0.010	7
	28	13	0	—0.077	—0.281	0.032	—5.518	0.024	10
		18	0	—0.096	—0.204	0.042	—5.859	0.033	7
	30	13	0	—0.094	+1.725	0.009	—2.556	0.023	10
June	1	13	30	----------	—0.457	0.027	—1.942	0.027	12
	2	13	0	+0.039	—0.085	0.037	—2.459	0.027	10
		18	0	+0.025	+0.149	0.023	—2.815	0.021	8
	3	13	45	+0.042	+0.196	0.012	—1.124	0.016	4
	7	14	0	+0.026	—0.029	0.025	—2.774	0.014	9
	8	14	0	+0.004	+0.256	0.028	—2.603	0.018	6
		19	0	+0.026	+0.082	0.019	—2.726	0.019	10
	10	13	30	+0.020	—0.216	0.021	—2.655	0.020	10
	17	14	0	+0.034	—0.198	0.017	—4.498	0.016	12
		18	30	----------	—0.210	0.081	—4.764	0.053	5
	18	14	0	+0.010	—0.231	0.016	—4.319	0.015	12
		19	15	+0.072	—0.100	±0.021	—4.380	±0.022	11

The horizontal lines indicate an intentional change made in the adjustment of the instrument or of the clock.

It will be seen that the amount of motion in azimuth is quite considerable on some nights. In Albany this seems to be due to some extent to the motion of the hill on which the observatory stands, a motion of which the existence is abundantly confirmed by other observations, and which I found very manifest in the great meridian circle of the observatory. In New York, the motion, though often greater, was less regular, and indeed less capable of measurement, by reason of the proximity of the instrument to the paved thoroughfares and massive mason work of the city. A regular increase of the azimuthal correction during the evening was indicated, the effect corresponding to a motion of the western end of the axis in a southerly direction.

The values of the corrections in collimation and azimuth, and of the clock rates deduced from the tables already given and employed in the reduction of the longitude signals, on the six "telegraph nights," are as follows. They were assumed as constant during the exchange of signals, except the azimuth of the transit instrument in New York, which has been assumed as varying proportionally to the time on four of the nights.

Collimation and azimuth corrections, and hourly clock rate.

ALBANY.

Date.	Time.	c.	a.	Hourly rate.	Date.	Time.	c.	a.	Hourly rate.
	h. m.	s.	s.	s.		h. m.	s.	s.	s
May 24	13 0	+0.05	—0.30	—0.072	June 8	16 0	+0.05	+0.10	—0.060
28	15 15	+0.05	—0.25	—0.110	17	17 0	+0.05	—0.06	—0.150
June 2	15 45	+0.05	+0.08	—0.040	18	16 45	+0.05	—0.08	—0.135

Collimation and azimuth corrections and hourly clock-rate.

NEW YORK.

Date.	Time.	c.	a.	Hourly rate.
	h. m.	s.	s.	s.
May 24	13 0		+2.278	
		—0.19		—0.030
	17 0		+2.521	
28	15 15	—0.08	—0.250	—0.060
June 2	13 0		—0.085	
		+0.03		—0.050
	18 0		+0.149	
8	14 0		+0.256	
		+0.02		—0.020
	19 0		+0.082	
17	16 0	+0.03	—0.200	—0.050
18	14 0		—0.231	
		+0.04		—0.020
	19 15		—0.104	

For the telegraphic signals of transits of stars exchanged for longitude, the records upon each of the four chronographs have been independently read off by two different assistants, and all cases where the discordance between the two readings exceeded 0s.02 have been exam-

ined and corrected. The means of the two readings furnish the data employed. There are thus at our disposal four complete records of every telegraphic signal made during the observation, each signal giving the time of an observed transit over a single thread, and the number of such signals averaging, as already stated, 18 at each station for each star exchanged. The records of the Morse register, and of the spring governor at each station, are usually accordant within narrow and well established limits, depending upon the amount of irregularity in the motion of the one or the other of these two chronographs between two successive clock-beats. When their discrepancy has exceeded a prescribed limit of permissible discordance, the records have been again examined and one or both values rejected, if the circumstances of the case seemed to require it. The mean between the readings of the spring governor sheets and the Morse register fillets was then adopted as the record of the transit at that station. The records at the two stations differ from each other theoretically only by the interval of time required by the telegraphic signal for traversing the wire once in each direction; for the clock signals, which mark the beginning of each second, are recorded earlier at the station where the clock itself is, while the observation signals, given by the observer at the other station, are recorded later on the same register, and *vice versa*. A mean between the times recorded at the two stations will thus be free from the effect of their delay in transmission, while the difference between them will afford a measure of its amount.

The moments of observed transit over the several threads, being thus determined, have been reduced to the corresponding time for the mean of all the threads, to permit the application of Peirce's criterion, which has been employed in every case to exclude bad observations and to guard against unauthorized rejections.

Finally, the mean of the several threads corrected for errors of azimuth and collimation was adopted as the time of transit, and the interval between the times for the two stations afforded the desired measurement of the longitude.

The following table exhibits the values furnished by different stars and on different nights. The stars are designated by their numbers in the Catalogue of the British Association, from which the list was selected. The values rejected by the criterion, and therefore not incorporated into the result, are inclosed in brackets.

Individual measurements of longitude.

Star.	May 24.	May 28.	June 2.	June 8.	June 17.	June 18.
	s.	s.	s.	s.	s.	s.
4741	----------	57.507	----------	----------	----------	----------
4758	----------	.624	----------	----------	----------	----------
4783	----------	.493	----------	----------	----------	----------
4797	----------	.417	----------	----------	----------	----------
4816	----------	.357	----------	----------	----------	----------
4841	----------	.663	----------	----------	----------	----------
4870	57.568	.513	----------	----------	----------	----------
4897	----------	.228	57.457	----------	----------	----------
4942	----------	.425	.539	----------	----------	----------
4974	.493	.506	.454	----------	----------	----------
4991	.540	.370	.482	----------	----------	----------
5026	.285	----------	.370	----------	----------	----------
5048	.532	.490	.496	----------	----------	----------
5075	----------	.428	.532	----------	----------	----------
5092	----------	.570	----------	----------	----------	----------
5122	----------	.412	.718	----------	----------	----------
5143	.425	.403	.560	----------	57.449	----------

Individual measurements of longitude.—Continued.

Star.	May 24.	May 28.	June 2.	June 8.	June 17.	June 18.
	s.	s.	s.	s.	s.	s.
5178	57.171	57.267	57.443	.....	57.779	.....
5192	.564	.476	.388	57.252	57.309	.....
5236	.....	.371	.....	.251	[58.144]	57.204
5259	.370	.445	.486	.429	57.544	.459
5302	.475	.488	.553	.458	.430	.442
5316	.....	.542	.....	.....	.146	.....
5348	.....	.566	.690	.....	.321	.310
5385	.382	.464	.539	.....	.538	.513
5432	57.353	.377	.356	.....	.569	.485
5444	.....	.....	.....	.....	.....	.228
5480	.....	.269	.460	[.140]	.280	.356
5496	.....	.580	.368	.689	.630	.471
5535	.....	.676	.....	.645	.....	.340
5546	.....	.299	.....	[.068]	.....	.304
5596	.....	.491	[.972]	.153	.189	.330
5617	.....	.442	.646	.605	.662	.425
5644	.....	.660	.723	.....	.550	.427
5714	.....	.318	.589	.....	.....	.....
5731	.....	.598	.458	.277	.537	.528
5775	.....	.621	.....	.....	.....	.264
5795	.....	57.622	.....	.668	.....	[.118]
5834	.....	.....	.474	.660	.372	.403
5847	.....	.....	.511	.292	.683	.377
5874	.....	.....	.457	.248	.700	.....
5895	.....	.....	.436	.....	.....	[.170]
5922	.....	.....	57.459	.424	.266	.347
5944	.....	.....	.....	.388	.594	.525
5986	.....	.....	.....	.....	.505	.387
6005	.....	.....	.....	.572	.359	.279
6033	.....	.....	.....	.429	.305	[.097]
6056	.....	.....	.....	.272	.556	.491
6084	.....	.....	.....	.....	.448	.459
6109	.....	.....	.....	.....	.421	57.224
6147	.....	.....	.....	57.551	.374	.....
6178	.....	.....	.....	.....	57.475	.....

From these several determinations we find the following mean values :

	First position of observers.			Second position of observers.		
	May 24.	May 28.	June 2.	June 8.	June 17.	June 18.
	s					
Mean value of difference of longitude	57.430	57.472	57.505	57.434	57.464	57.383
Mean error of one measurement	±0.109	±0.118	±0.099	±0.186	±0.164	±0.098
Mean error of result	±0.031	±0.020	±0.019	±0.043	±0.032	±0.020
Corresponding weight	80	250	277	66	128	250

And combining the several mean values of the longitude according to their respective weights—

Mean difference of longitude, first position	57″.481
Mean difference of longitude, second position	57″.414
Both	57″.448

Had we employed the five additional measurements which were excluded by the criterion, this value would have been increased by 0″.003.

A thorough discussion of the observations for personal equation gives us the following results for the interval by which Mr. Goodfellow tapped later than Mr. Dean.

Date.	No. stars.	G—D.
June 5	26	+0.043
6	22	0.016
19	20	0.104
20	20	+0.081
Mean of 4 nights		+0.061
Mean of 88 stars		+0.059

Or rejecting four very discordant stars, and three which were discredited by the observer at the time, the remainder give—

Date.	No. stars.	G—D.
June 5	25	+0.035
6	20	0.009
19	18	0.082
20	18	+0.057
Mean of first 2 nights		+0.021
Mean of last 2 nights		+0.069
Mean of all 4 nights		+0.045

We may by various modes of arranging and classifying the stars observed arrive at some conclusions, positive or negative, regarding the source of the marked difference between the personal equation of one or both observers on June 5 and 6, and that existing June 19 and 20.

The mean of the equatorial reductions to the mean for the fifteen threads of tallies 1, 3, 5, in the New York transit, No. 6, lamp west, with which instrument and in which position all four series of observations were made, is — 0s.012. For the ten threads of tallies, 2 and 4, the reduction is + 0.018; so that the value of G—D should be increased when Mr. Dean led, and decreased when Mr. Goodfellow led, by 0s.030 sec. δ. The smallest value of sec. δ for any

of the stars is 1.07; the largest value, 1.31; the mean value, 1.14; so that the correction for inequality of diaphragm is ± 0s.034. Applying this correction we find—

Date.	D. led.		G. led.		Mean.
	G D.	No.	G—D.	No.	
	s.				
June 5	+0.026	13	+0.039	12	+0.033
6	0.010	10	0.007	10	0.009
19	0.092	2	0.072	10	0.082
20	+0.051	9	+0.061	10	+0.056
	0.045		0.045		0.045

The absolute accordance of the means is of course purely accidental, but it shows clearly that the small nervous disturbance incident to the leading and to the observation of 15 threads rather than 10 did not affect the amount of personal difference.

Next, dividing the stars observed for personal difference into two classes, according to their brightness, the first class including all brighter than the 5th magnitude, and the second all fainter than this limit, we find for the values of G—D—

Date.	Class I.		Class II.	
	G—D.	No.	G—D.	No.
June 5	+0.020	13	+0.051	12
6	+0.014	12	0.006	10
19	+0.047	10	0.127	8
20	+0.056	7	+0.056	12
Mean ...	+0.054		+0.060	

The merest glance at these values shows that for the stars brighter than the fifth magnitude the personal equation is much smaller and very much more constant than for the fainter stars. As already stated, the mean magnitude of the signal stars exchanged was $5^m.3$; so that the corresponding personal difference would be decidedly below the value + 0s.045 found as the mean of all.

It therefore seems the more judicious course to take the simple mean between the results obtained in the two positions of the observers, or, in other words, to adopt the value + 0s.0335 which these results indicate, and to regard the personal equation as thus entirely eliminated. The resultant value for the longitude will differ by only 0s.003 from that obtained by applying the personal equation + 0s.040 to each individual determination. The value adopted is, therefore, Albany, east of New York, 57s.45, which cannot, I think, differ more than one or two hundredths of a second from the truth.

If instead of combining our results according to their dates we include in one series all

the measurements made in each position of observers, the values deduced will differ very slightly from the preceding. The figures will then be—

	All observations.		Applying criterion.	
	No. stars.	Diff. Long.	No. stars.	Diff. Long.
		s.		*s.*
In first position	76	57.484 ±0.010	75	57.477 ±0.009
In second position	78	57.417 ±0.012	72	57.428 ±0.011
Mean	154	57.450 ±0.008	147	57.453 ±0.008

The measurements by the respective clocks are—

Clock.	I position.		II position.		Mean.	
	No. stars.	Diff. long.	No. stars.	Diff long.	No. stars.	Diff. long.
		s.		*s.*		*s.*
Albany clock	43	57.462	36	57.421	79	57.444
New York clock	32	57.497	36	57.435	68	57.464
Mean by Wts	75	57.477	72	57.428	147	57.453

The observations in the first and second position differ theoretically by twice the amount of the personal equations.

A strong corroboration of our adopted value is furnished by an independent subsidiary discussion of the right ascensions of the stars employed. The observations made at the station whose clock is graduating the record give for each star a value $\Delta\alpha = \Delta t - \omega$, but observations made by means of the clock at the other station furnish the analogous quantities $\lambda \pm \Delta\alpha = \Delta t - \omega$, the upper sign applying when the eastern clock is in circuit. Inasmuch as every exchange of star transits thus gives one value of $\Delta\alpha$ and one of $\lambda \pm \Delta\alpha$, we may combine the mean of the values obtained for the former with the mean of each of the latter, and so obtain a value for the longitude, which, although not derived from data strictly independent, may yet be fairly regarded as an independent determination. Of course such a value is inferior in precision to that which is free from the influence of errors in the adopted clock correction and personal equation; still the following table shows how fully this mode of determination corroborates the previous result. The values of $\lambda \pm \Delta\alpha$ are corrected for personal equation, by substracting, on the first three nights, and adding on the last three, the quantity 0*s*.034.

Star.	Albany clock.				N. Y. clock.				Mean $\Delta\alpha$	Alb. obs.		N. Y. obs.	
	Alb obs.		N. Y. obs.		Alb. obs.		N. Y. obs.						
B. A. C.	$\Delta\alpha$	No.	$\lambda + \Delta\alpha$	No.	$\lambda - \Delta\alpha$	No.	$\Delta\alpha$	No.		λ	Wt.	λ	Wt.
	s.		*s.*		*s*		*s.*		*s.*	*s.*		*s.*	
4741	+0.036	1	+57.509	1	.....	....	.....	....	+0.036	.....	.....	57.473	6
4758	+0.005	1	57.595	1	.....	....	.....	....	+0.005	.....	.....	.590	6
4783	+0.026	1	57.485	1	.....	....	.....	....	+0.026	.....	.....	.459	6
4797	+0.528	1	57.911	1	.....	....	.....	....	+0.528	.....	.....	.383	6
4816	+0.176	1	57.499	1	.....	....	.....	....	+0.176	.....	.....	.323	6

TABLE—Continued.

Star.	Albany clock.				N. Y. clock.				Mean $\Delta\alpha$	Alb. obs.		N. Y. obs.	
	Alb. obs.		N. Y. obs.		Alb. obs.		N. Y. obs.						
B. A. C.	$\Delta\alpha$	No.	$\lambda+\Delta\alpha$	No.	$\lambda-\Delta\alpha$	No.	$\Delta\alpha$	No.		λ	Wt.	λ	Wt.
	s.		s.		s.		s.		s.	s.		s.	
4841	—0.163	1	+57.466	1					—0.163			57.629	6
4870	+0.175	2	57.682	2					+0.175			.507	8
4897	—0.768	2	56.541	2					—0.768			.309	8
4942	—0.127	2	57.321	2					—0.127			.448	8
4974	+0.531	3	57.981	3					+0.531			.450	10
4991	+0.074	3	57.504	3					+0.074			.430	10
5026	+0.118	2	57.411	2					+0.118			.293	8
5048	—0.022	3	57.450	3					—0.022			.472	10
5075	—0.029	2	57.417	2					—0.029			.446	8
5092	+0.063	1	57.599	1					+0.063			.536	6
5122	+0.152	2	57.683	2					+0.152			.531	8
5143	—0.001	4	57.441	4					—0.001			.442	12
5178	—0.356	4	57.040	4					—0.356			.396	12
5192	+0.082	5	57.473	5					+0.082			.391	13
5236	—0.536	4	56.724	4					—0.536			.260	12
5259	+0.105	6	56.560	6					+0.105			.455	14
5302	—0.090	5	57.389	5	+ 57.579	1	—0.125	1	—0.108	57.471	6	.497	13
5316	+0.334	1	57.514	1	57.337	1	+0.171	1	+0.252	.589	6	.262	6
5348	—0.144	2	57.205	2	57.780	2	—0.185	2	—0.164	.616	8	.369	8
5385	—0.148	2	57.411	2	57.474	2	—0.047	2	—0.098	.376	8	.509	8
5432	—0.070	2	57.491	2	57.327	2	+0.001	2	—0.035	.292	8	.526	8
5444	+0.266	1	57.528	1					+0.266			.262	6
5480	+0.060	3	57.352	3	57.490	2	—0.160	2	—0.028	.462	8	.380	8
5496	—0.140	3	57.490	3	57.378	2	+0.056	2	—0.062	.316	8	.552	10
5535	—0.074	2	57.452	2	57.574	1	+0.068	1	—0.027	.547	6	.479	8
5546	—0.266	2	56.954	2	57.810	1	—0.545	1	—0.359	.451	6	.313	8
5596	+0.198	3	57.456	3	57.520	2	+0.180	2	+0.191	.711	8	.265	10
5617	—0.172	3	57.426	3	57.529	2	—0.019	2	—0.111	.418	8	.537	10
5644	—0.060	2	+57.462	2	57.488	2	+0.169	2	+0.054	.542	8	57.408	8
5714					57.479	2	—0.060	2	—0.060	.419	8		
5731					57.523	5	—0.034	5	—0.034	.489	13		
5775					57.620	2	—0.178	2	—0.178	.442	8		
5795					57.557	3	—0.077	3	—0.077	.480	10		
5834					57.596	4	—0.126	4	—0.126	.470	12		
5847					57.585	4	—0.152	4	—0.152	.433	12		
5874					57.281	3	+0.198	3	+0.198	.479	10		
5895					56.214	2	+1.090	2	+1.090	.304	8		
5922					57.336	4	+0.056	4	+0.056	.392	12		
5944					57.748	3	—0.212	3	—0.212	.536	10		
5986					57.496	2	—0.016	2	—0.016	.480	8		
6005					57.544	3	—0.106	3	—0.106	.438	10		
6033					57.337	3	—0.027	3	—0.027	.310	10		
6056					57.475	2	+0.082	2	+0.082	.557	8		
6084					57.566	3	—0.139	3	—0.139	.427	10		
6109					57.505	2	—0.148	2	—0.148	.357	8		
6147					57.610	2	—0.112	2	—0.112	.498	8		
6178					+57.779	1	—0.270	1	—0.270	57.509	6		
Means by Wts.										57.480		57.428	
											57.454		

These results differ by the sum of the transmission time in the two directions, which, from this rough determination, would seem to be 0s.052, or about half this amount in each direction. Their half sum gives, as the best value obtainable from this mode of combination, 57s.454 from 152 observations.

In this abstract of our results I have not entered upon the question of velocity of the telegraphic signals. This has been thoroughly discussed, and the results by the two wires compared, but it has no bearing upon the purpose of the present report, inasmuch as the time of transmission has been completely eliminated. The average time of transmission of a signal was three hundredths of a second.

Finally, the individual determinations classified according to stars, give, as the mean result, $57s.446 \pm 0s.012$ from 52 different stars.

The thorough accordance of our final values, no matter what the principle adopted in their combination, renders it very improbable in my judgment that the adopted result can be in error by more than the hundredth part of a second.

The longitude of the station point in New York, as determined by Mr. Walker, was—

0h. 12m. 15s.47 east from Washington, (Observatory.)
0 11 26s.07 west from Cambridge, (Observatory dome.)

Hence, we have for the longitude of the station point in Albany—

0h. 0m. 57s.45 east from New York.
0 13 12s.92 east from Washington.
0 10 28s.62 west from Cambridge.

The geodetic reduction to the meridian circle of the Dudley Observatory is 0s.034, and to the centre of the dome the reduction is — 0s.051.

Very respectfully, your obedient servant,

B. A. GOULD.

Professor A. D. BACHE,
Superintendent United States Coast Survey.

APPENDIX No. 19.

OBSERVATIONS OF THE SOLAR ECLIPSE OF 1860, JULY 18, MADE AT THE COAST SURVEY STATION, GUNSTOCK MOUNTAIN, NEW HAMPSHIRE, BY PROFESSOR A. D. BACHE, SUPERINTENDENT UNITED STATES COAST SURVEY.

1. Coast Survey station Gunstock is in the township of Guilford, Belknap county, New Hampshire, latitude 41° 31′ 03″ N., longitude 71° 21′ 50″ (4h. 45m. 27s.4) approximate, west of Greenwich; and has an elevation of about 2,440 feet above the mean level of the sea.

The instruments having been carefully readjusted for the purpose, hourly observations of magnetic declination and horizontal force, in connexion with regular meteorological observations, were made two days before, and (except the observations of the horizontal force*) continued for two days after the eclipse.

On these four days during the two hours next preceding the time of beginning, and the two following that of the end of the eclipse, the magnetic and meteorological observations were made half-hourly, and during the times corresponding with that of the eclipse they were made every two minutes, and during the eclipse itself observations of the temperature of the air and solar radiation were made every half minute. So far as practicable, all these observations were made simultaneously with similar ones which were assigned for the party sent to Cape Chudleigh, Labrador, under the charge of Professor Alexander.

* In a violent storm on the morning of the 19th the bifilar tent was blown down, deranging the instruments to such an extent as to prevent further observations of horizontal force.

During the mornings of July 16 and 17, at times corresponding with that of the eclipse on the 18th, observations of the transits of solar spots, and drawings of the same, were made in connexion with the drill practice of the aids in counting and noting time; experiments were a so made with screens of different colors, &c., &c.

The weather on the morning of the 18th proved remarkably favorable. From sunrise until 10 a. m. scarcely a cloud obscured the sky, the temperature of the air ranging from 59° to 65° Fahr., with a light breeze from the southwest at no time exceeding two miles an hour.

The instrument which I used was a Dollond telescope of six feet focal length and aperture of four inches, (C. S. No. 1,) equatorially mounted, and provided with a dark box for projecting the image of the sun upon a screen. After some experiments the magnifying power of 64 was selected for observing the times; but for making drawings of the spots the power 187 was used. With the power 64, the diameter of the sun's projected image was 5.7 inches. The transits were observed upon a white screen, with parallels in red.

2. *First contact.*—The minutes, seconds, and half seconds, were counted aloud by Mr. Toomer, who was stationed at the chronometer.

	h.	*m.*	*s.*
First contact of an elevation on moon's limb	7	22	46.1
First contact of true line of limb			48.1
Disk fully on (two accordant observations)	7	22	51.6

The point of contact agreed precisely, as observed, with previous computation. The elevation referred to above was the western of two which were noticed shortly afterward. Contact had certainly not taken place at 45*s*., and probably not at 48*s*. The sun's limb was well defined, with but little tremulous motion.

Mr. McDonnell, who observed the contacts with a Fraunhofer telescope of 46 inches focal length and an aperture of three inches, with a power of 84, noted the time of disk fully on as 7*h*. 22*m*. 51*s*.6.

Mr. Dean observed the contacts with the telescope of the 30-inch theodolite, (No. 1, C. S.,) having a focal length of 46 inches and aperture of three inches, and using a power of about 175, with the darkest shade of London smoke. This instrument being at some distance from the others, he noted the time from a sidereal chronometer.—(Hutton, No. 202.) The observed time of disk fully on was 7*h*. 22*m*. 53*s*.7 Gunstock mean time; but Mr. Dean remarks that this is perhaps two seconds too late.

When the moon's limb had fully passed, I noticed two prominences near the point of beginning, the westerly one having made the first contact. This certainly had not occurred at 41*s*., and probably not at 44*s*. The edge of the moon was well defined, and had but little apparent motion.

3. *Position of spots.*—The adopted nomenclature denotes groups of spots by capital letters, A, B, C, D, &c., and in individual members of groups by the small letters, *a*, *b*, *c*, *d*, &c. The field of the telescope was divided into octants by four spider-lines, and the eight radii distinguished by numerals 0 to 7, 0 denoting the north, 2 the east, 4 the south, and 6 the west lines, respectively. The following four sets of transit observations were made, on the 17th and 18th July, to determine the position of the spots.

I. JULY 17.

No. 1.				No. 2.				No. 3.				No. 4.				No. 5.			
Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.
			h. m. s.				*h. m. s.*				*h. m. s.*				*h. m. s.*				*h. m. s.*
⊙	I	3	10 55 05.0	⊙	I	3	11 04 36.0	⊙	I	5	11 08 50.8	⊙	I	3	11 12 39.0	⊙		1	11 21 46.8
	II	1	19.8		II	1	48.7		II	3	56.5		II	1	49.0		II	3	51.2
	III	0	40.2		III	0	05 10.0		III	0	09 22.0		III	4	13 11.7		III	0	22 17.2
A*b*	I	1	56 13.2	A*b*	I	1	41.6	B*a*	I	3	10 00.0	B*b*	I	3	50.0	C	I	3	23 28.8
	II	0	23.2		II	0	52.8		II	4	10.8		II	4	14 12.2		II	4	53.0
	III	7	10 56 33.0		III	7	06 03.7		III	5	21.8	C	I	3	16.5	E		1	24 06.2
				D	I	3	28.7[1]	E	I	1	11 10.0[1]	D	I	3	31.0		II	0	18.2
					II	4	07 04.9		II	0	22.8	B*b*	III	5	36.5	C	III	5	19.2
				⊙	I	4	25.3		III	7	35.0	C	II	4	48.0	E	III	7	31.8[2]
				D	III	5	42.3	⊙	I	0	37.0	D	II	4	15 06.0	⊙		0	Lost.
				⊙	II	7	45.3		II	7	12 05.3	C	III	5	21.1		II	7	59.6
					III	5	11 08 04.4		III	5	11 12 06.8	⊙	I	4	27.5		III	5	25 03.5
												D	III	5	42.8		I	3	32.3
												⊙	II	7	Lost.		II	1	45.7
													III	5	11 16 05 4		III	0	26 07.3
																C	I	3	27 10.8
																	II	4	44.0
																	III	5	28 17.8
																⊙	I	4	23.0
																	II	7	41.0
																	III	5	11 29 01.7

(1) Middle of spot observed.

(2) Observation late.

II. JULY 18—BEFORE THE ECLIPSE.

No. 1.				No. 2.				No. 3.				No. 4.			
Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.
			h. *m.* *s.*				*h.* *m.* *s.*				*h.* *m.* *s.*				*h.* *m.* *s.*
⊙	I	3	6 58 45.5	⊙	I	1	7 02 52.0	⊙	I	3	7 08 51.3	⊙	I	3	7 13 15.8[4]
	II	1	55.2		II	3	59.8		II	1	09 18.8		II	1	48.8
	III	0	59 18.3		III	0	03 23.8		III	4	33.2		III	4	14 00.4
Ab	I	1	35.8	*Ab*	I	1	32.3	*Ba*?	I	3	48.8[3]	*Bb*	I	3	16.8
	II	0	50.7		II	0	55.9		II	4	10 12.8		II	4	47.8
	III	7	7 00 06.8		III	7	04 20.0		III	5	37.0		III	5	15 19.8
⊙	I	4	01 33.8?	E	I	1	05 02.0[1]	⊙	I	4	11 48.8	⊙	I	4	16 15.8
	II	7	56.9		II	0	16.8		II	7	12 01.8		II	7	26.2
	III	5	7 02 08.9		III	7	31.8[2]		III	5	7 12 32.0		III	5	7 17 02.0[4]
				⊙	I	0	38.8								
					II	5	06 04.8								
					III	7	7 06 10.2								

III. JULY 18—DURING THE ECLIPSE.

No. 1.				No. 2.				No. 3.			
Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.
			h. *m.* *s.*				*h.* *m.* *s.*				*h.* *m.* *s.*
⊙	I	3	7 52 05.2	⊙	I	3	7 56 35.7	⊙	I	3	8 00 31.8
	III	4	39.4		III	4	57 14.2		III	4	01 12.8
Ba?	I	3	53 00.5	*Ba*?	I	3	31.5	*Ba*?	I	3	27.3
Bb	I	3	04.6	*Bb*	I	3	35.8	*Bb*	I	3	31.0
Ba?	II	4	18.5	*Ba*?	II	4	53.0	*Ba*?	II	4	51.0
Bb	II	4	26.7	*Bb*	II	4	58 00.8	*Bb*	II	4	59.2
Ba?	III	5	35.8	*Ba*?	III	5	13.8	*Ba*?	III	5	02 14.8
Bb	III	5	48.2	*Bb*	III	5	26.8	*Bb*	III	5	27.2
⊙	I	4	54 55.0	⊙	I	4	59 28.6	⊙	I	4	03 27.0
	II	7	55 12.9		II	7	44.3		II	7	39.9
	III	5	7 55 29.8		III	5	8 00 09.1		III	5	8 04 10.0

(1) Middle of spot observed. (2) Middle of front spot. (3) Line of spots coinciding with 3. (4) Perhaps 10s. late.

IV. JULY 18—AFTER THE ECLIPSE.

No. 1.				No. 2.				No. 3.				No. 4.			
Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread	Time A. M.
			h. *m.* *s.*				*h.* *m.* *s.*				*h.* *m.* *s.*				*h.* *m.* *s.*
⊙	I	1	11 04 57.2	⊙	I	3	11 08 56.8	⊙	I	3	11 12 43.8	⊙	I	3	11 17 18.2
	II	3	05 03.7		II	1	09 06.8		II	1	13 10.4		II	1	37.2
	III	0	28.3		III	0	30.2		III	4	24.7		III	4	56.0
Ag	I	1	34.4	*Ag*	I	1	43.8	*Ba?*	I	3	36.0	*Ba?*	I	3	18 11.8
Ab	I	1	37.8		II	0	57.4	*Bb*	I	3	40.2	*Bb*	I	3	15.7
Ag	II	0	55.9		III	7	10 10.0	*Ba?*	II	4	14 02.3	*Ba?*	II	4	31.0[2]
Ab	II	0	57.5	D	I	3	36.8[1]	*Bb*	II	4	10.0	*Bb*	II	4	41.8
Ag	III	7	06 16.2		II	4	11 13.8	D	I	3	23.2	*Ba?*	III	5	57.8
Ab	III	7	Lost.	⊙	I	4	45.8	*Ba?*	III	5	29.8	D	I	3	59. ?
E	I	1	07 09.1[1]	D	III	5	53.8[1]	*Bb*	III	5	43.3	*Bb*	III		19 09.6
	II	0	20.0[1]	⊙	II	7	12 01.0	D	II	4	15 08.2	D	II	4	39.8[1]
	III	7	30.8[1]		III	5	11 12 27.1	⊙	I	4	39.8	⊙	I	4	20 10.8
⊙	I	0	44.8							7	48.0	D	III	5	23.5
	II	7	08 07.9					D	III	5	55.7	⊙	II	7	23.5
	III	5	11 08 18.2										III	5	11 20 57.0

(1) Middle of spot observed.

(2) Observation late.

IV. JULY 18—AFTER THE ECLIPSE—Continued.

No. 5.				No. 6.				No. 7.				No. 8.			
Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.	Object.		Thread.	Time A. M.
			h. m. s.				h. m. s.				h. m. s.				h. m. s.
⊙	I	1	11 25 15.3	⊙	I	3	11 35 01.8	⊙	I	3	11 39 11.8	⊙	I	3	11 43 06.8
	II	3	36.8		II	1	21.6		II	1	28.0		II	1	40.5
	III	0	55.8		III	4	39.8[2]		III	4	47.8[1]		III	4	51.3
Ab	I	1	55.8	*Ca*	I	3	36 25.2[2]	*Bb*	I	3	40 08.2	*Bb*	I	3	44 03.8
	II	0	26 24.8		II	4	37 00.8		II	4	33.3	*Ca*	I	3	29.6
	III	7	52.0			Clouds.			III	5	41 00.4	*Bb*	II	4	37.2
Fa	I	1	27 28.2	⊙	I	4	37 55.0	*Ca*	II	4	08.5?	D	I	3	47.8[3]
	II	0	38.2		II	7	38 07.0		III	5	47.5	*Ca*	II	5	45 00.5
	III	7	47.8[1]		III	5	11 38 39.8	⊙	I	4	42 02.8	*Bb*	III	5	13.0
⊙	I	0	28 10.7						II	7	15.8	D	II	4	35.2[3]
	II	5	36.1						III	5	11 42 47.6	*Ca*	III	5	59.7
	III	7	11 28 42.0									⊙	I	4	Lost.
													II	7	46 12.5
												D	III	5	26.8
												⊙	III	5	11 47 00.9

(1) Instrument unsteady on account of wind.

(2) Clouds.

(3) Middle of spot observed.

4. *Occultation of spots.*—From 7*h*. 37*m*. till 8*h*. 20*m*. observations were made of the passage of the moon's limb over these spots, as also the third of the preceding series of spot transits. The moment of greatest obscuration passed while I was thus engaged, but from 8*h*. 24*m*. to 8*h*. 25*m*. measures of the degree of obscuration were taken. Subsequently the emersions of the spots were noted.

The following are the observed contacts with other spots:

DISAPPEARANCES.

Name of spot.	Mean time. h.	m.	s.
A*d*	7	37	40.3
A*g*			49.3
A*c*		38	10.0
A (first contact of penumbra)			38.3
A*b* (first contact)		39	25.8
A*b* (complete disappearance)		40	02.7
A (edge of black part)			12.4
A (complete disappearance of penumbra)			45.8*
E (first contact of penumbra)	8	15	28.5
E (first edge of black part)		16	04.8
E (complete disappearance of penumbra)			25.0
F*a* (first edge—gray)		17	28.7
F*a* (second contact)			43.2*
F*b* (first edge)	8	19	01.8†

REAPPEARANCES.

	h.	m.	s.
A (first appearance of penumbra)	8	29	27.8‡
A*b*			38.2
A*b* (first appearance of black part)		30	13.0*
A*b* (white crevice)			28.9§
A (complete appearance of penumbra)		31	25.3
A*d* (first edge)			38.0§
A*d* (last edge)			50.8§
F*b*	9	10	48.3§
F*a*		09	‖
E (first part of large spot)		16	55.2
E (second part of large spot)		17	13.9
E (small spot)			26.3

The black part of spot E was double, the larger part preceding, and the longer diameter of each portion running from northwest to southeast. The white crevice in spot A was first seen on the 18th, being on the southeast side.

	h.	m.	s.
5. *Last contact.*—Limbs apparently in contact	9	30	49.9
Separation supposed to have occurred			50.6
Separation certainly had occurred	9	30	53.6

The second of the above was made a fraction of a second later by an independent observation. The point of contact was, as in the ingress, exactly accordant with computation. A power of 64 was used, as at the beginning, a higher power being found to be no improvement. The first and last contact were observed on yellow paper; the transits of spots on white.

Mr. McDonnell, observing with the Fraunhofer telescope, noted the last contact a fraction of a second later.

Mr. Dean, using the theodolite and sidereal chronometer, as before, observed it at 9*h*. 30*m*. 49*s*.2.

* Uncertain. † Somewhat uncertain. ‡ Too late. § Good. ‖ Within about 30*s*.

The errors and rates of the chronometers were well determined by *Mr. Toomer*, on the nights before and after the eclipse, with a 26-inch transit instrument, by Würdemann, observing nine zenith and circumpolar stars (with reversal of instrument) on each night. The chronometer corrections have been applied to the times as given above.

6. *Phenomena.*—The moon's limb was frequently observed to be quite irregular; at 8*h*. 40*m*. and 9*h*. it had the appearance of extended table-lands, separated by deep valleys and high mountain peaks. At 9*h*. 20*m*. the outline was observed to change considerably, particularly near the western cusp, where the disk apparently became suddenly elongated.

At about 8*h*. 20*m*. an appearance was remarked in the southeast limb which looked upon the screen like a mass of cumulus clouds; the tops illuminated, the bases gray in shadow, and the dark line appearing like the shapes of their bases. The shape and degree of illumination seemed to vary rapidly; this was, however, probably an illusion, as the dark lines were stationary, and their forms persistent under the best illumination. They were repeatedly noticed during the eclipse, and were quite noticeable at 1*h*., and, though less marked, were quite well seen at 1*h*. 30*m*. p. m. The next day the dark limbs had opened out into spots.

APPENDIX No. 20.

OBSERVATIONS OF THE SOLAR ECLIPSE OF JULY 18, 1860, MADE AT THE COAST SURVEY OFFICE, WASHINGTON, D. C., BY CHARLES A. SCHOTT, ASSISTANT UNITED STATES COAST SURVEY.—(Sketch No. 29.)

The observations were made at a station in the vicinity of the Coast Survey office, in latitude 38° 53′ 03″.8 N.; longitude 77° 00′ 07″.8 W. from Greenwich; these values being derived by direct measurement from the trigonometrical station at one of the office buildings.

The telescope was the one ordinarily used by me for observing solar spots, (Fraunhofer and Utzschneider, C. S., No. 12,) of four feet focal length, and equatorially mounted. A power of 55 was used, and the sun's image projected against a screen in a dark box. The last contact, and the contacts with the solar spots, were observed with a power of about 175. The local time was determined with a Gambey sextant, from observations of equal altitudes of the sun, using a mean time chronometer, (Kessels, No. 1287.)

Both before and after the eclipse two sets of observations of the solar spots were taken, according to the mode of observation employed by Mr. Carrington.

About 4½ a. m. the sky was clear, but gradually a haze rose over the river, and interfered in some degree with the observations of the first contact. These were—

Chron. time.				Observer.	
11*h*.	26*m*.	09.2*s*.	—1*s*.5	Chas. A. Schott.*	Same telescope.
		09.5		A. S. Wadsworth.	
		06.5		J. H. Patton.	
		07.6		L. F. Pourtales.†	
				W. L. Nicholson.‡	
Mean	11	26	07.8		
	—4	29	40.8	chron. correction.	

July, 17*d*. 18*h*. 56*m*. 27.0*s*. mean time of first contact.

*The correction 1*s*.5 is from a close estimate of the interval of the same limit of projection at last contact, (allowing for difference in power of telescope,) the moon producing a sensible indentation at 9*s* 2. The exact point of contact was marked by a spider line.

†Observed with a smaller telescope (C. S., No. 27) direct, with a red shade-glass, the pocket chronometer being compared with No. 1287 before and after the observation.

‡Observation not satisfactory, the telescope being too small.

At 12*h*. 29*m*. 08*s*. (chron. time) the spot marked 241, accompanied by a smaller one, seemed to slide down a slope on the moon's limb, and gradually disappear. It was only on this part of the limb that the lunar outline was irregular.

			Chron. time.		
The small spot north of 236 reappeared			12*h*.	19*m*.	30*s*.
Spot 239, first contact			12	21	02
Spot 239, last contact			12	21	53
Spot 242 reappeared, (Wadsworth obs.)			12	49	15
Spot 241	do.		12	50	39
Spot 239	do.	penumbra	1	03	02
	do.	small nucleus	1	03	29
	do.	large and 2d nucleus	1	04	03.5
	do.	second limb	1	04	16
	do.	last contact penumbra	1	04	50

Assistant Wadsworth remarked a perceptible change of outline on spot 239 as it disappeared behind a lunar elevation. I saw neither change of color nor of outline in any spot. Upon the opposite (or western) cusp there was a remarkable change in the moon's outline. This was noticed towards the close of the eclipse. About this time the undulation of the moon's limb increased, and remained so until the eclipse was over.

Observations of last contact.

Chron. time.				Observer.
1*h*.	20*m*.	46.5*s*.		Chas. A. Schott.
		47.3		A. S. Wadsworth.
		47.5		J. H. Patton.
		45.3		L. F. Pourtales.
1*h*.	20*m*.	44.5*s*.+1*s*.0		W. L. Nicholson.
Mean	1	20	46.4	
	—4	29	41.6	chron. correction.

July, 17*d*. 20*h*. 51*m*. 04.8*s*. mean time of last contact.

The following observations were taken for position of solar spots, according to Mr. Carrington's method:

July 18, *a. m., chronometer* 1287.—*Before the eclipse.*

	S.			W.		S.			W.
	h.	*m.*	*s*	*s.*		*h.*	*m.*	*s.*	*s.*
⊙ *u*	10	24	02.5	02.3	⊙ *u*	10	28	18.2	17 9
⊙ *l*			06.2	06.0	⊙ *l*			19.0	18.8
236 *u*			44.8	44.8	236 *u*			59.2	58.9
237 *l*		25	04.7	04.5	236 *u*		29	45.7	45.5
238 *l*			08.0	07.8	240 *l*		30	04.0	04.0
236 *u*			31.0	30.8	241 *u*			28.8	28.5
240 *l*			50.1	49.9	239 *u*			28.8	2-.5
241 *u*		26	12.1	12.0	242 *u*			31.7	31.8
239 *u*			12.1	12.0	241 *u*			36.5	37.2
242 *u*			17.1	17.1	242 *u*			40.1	40.0
241 *u*			24 0	24.0	239 *u*			53.5	53.4
242 *u*			25.2	25.0	240 *l*			58.8	58.5
239 *u*			41.6	41.5	⊙ *l*		31	29.1	28.9
240 *l*			44.0	44.0	⊙ *u*			31.8	31.8
⊙ *l*		27	13.5	13.5					
⊙ *u*			19.8	19.8					

NOTE—*u* indicates upper transit. *l* indicates lower transit in reference to centre of wires. Observations marked S, taken by myself. Observations marked W, taken by Assistant Wadsworth. Contacts called out by Mr. Patton. Observations are somewhat affected by the wind. Thin clouds near the eastern horizon.

[c] Mr. Nicholson observed with a larger telescope than before, and is certain of having anticipated the last contact by 1*s*.

After the eclipse.

	S.			W.		S.			W.
	h.	*m.*	*s.*	*s.*		*h.*	*m.*	*s.*	*s.*
⊙ *l*	1	58	24.1	24.0	⊙ *l*	2	02	16.0	15.9
⊙ *u*			26.2	26.0	⊙ *u*			16.0	15.9
236 *u*		59	05.5	05.0	236 *u*			56.5	56.5
237 *l*			21.2	21.0	237 *l*		3	15.0	15.0
238 *l*			24.2	23.7	238 *l*			18.0	17.0
237 *l*			42.5	42.7	237 *l*			32.8	32.5
236 *u*			47.0	47.0	236 *u*			40.7	40.5
238 *l*			54.1	54.0	238 *l*			45.4	45.3
240 *l*	2	00	05.7	05.7	240 *l*			58.0	58.0
241 *u*			35.1	35.0	241 *u*		4	27.1	26.8
239 *u*			35.1	35.0	239 *u*			27.1	26.8
241 *u*			40.2	40.0	241 *u*			31.7	31.5
239 *u*			57.0	57.0	239 *u*			48.5	48.3
240 *l*		01	06.8	06.8	240 *l*			58.0	58.0
⊙ *u*			37.0	37.0	⊙ *l*		5	29.5	29.5
⊙ *l*			37.3	37.3	⊙ *u*			29.5	29.5

The following table shows the heliographic positions of the spots:

Spot, No.	Astronomical date.	Latitude.	Longitude.
	d.	° ′	° ′
236	July 17.823	N. 19 30	254 36
237	.897	S. 5 57	245 45
238	.897	S. 9 05	239 00
239	.823	N. 16 50	178 45
240	.823	S. 18 35	184 30
241	.823	N. 9 25	188 14
242	.749	N. 8 35	184 05

Respectfully submitted,

CHAS. A. SCHOTT, *Assistant U. S. C. S,*

Prof. A. D. BACHE, *Superintendent United States Coast Survey.*

APPENDIX No. 21.

OBSERVATIONS OF THE SOLAR ECLIPSE OF JULY 18, 1860, MADE AT CAMBRIDGE, MASSACHUSETTS, BY B. A. GOULD, ASSISTANT UNITED STATES COAST SURVEY.

The eclipse was observed very satisfactorily at the Cloverden station of the Coast Survey. All the observations were made by Mr. Searle, except the beginning, which was observed by me. The telescope has an aperture of 4.6 inches, and a magnifying power of about 80 times was employed. The error and rate of the chronometer were thoroughly determined by a series of transit observations on several successive nights before and after the eclipse; so that no error except that of the observers' perception need be apprehended.

	Cloverden S. T.			M. T.		
Beginning of eclipse	3*h.*	10*m.*	14*s.*	19*h.*	24*m.*	01*s.*
Spot B,* 1st contact	3	26	22	19	40	06
Spot A, 1st contact	3	28	07	19	41	05
Center of large spot, 1st contact	3	28	36	19	42	20
Double spot C, (together,) 1st contact	4	04	20	20	17	58
Spot D, 1st contact	4	07	04	20	20	42
Large spot. Complete emersion of black portion	4	14	01	20	27	37
Spot B, 2d contact	4	15	42	20	29	18
Spot D, 2d contact	4	53	13	21	06	43
Double spot C, (I,) 2d contact	5	01	51	21	15	20
Double spot C, (II,) 2d contact	5	02	17	21	15	45
End of eclipse	5	16	37	21	30	03

The observations were in sidereal time, and the limit of probable error is estimated, both by Mr. Searle and by me, as not exceeding three seconds.

Respectfully submitted by

B. A. GOULD.

CAMBRIDGE, *July* 23, 1860.

APPENDIX No. 22.

DISCUSSION OF THE SECULAR CHANGE OF THE MAGNETIC INTENSITY (HORIZONTAL AND TOTAL) ON THE ATLANTIC, GULF, AND PACIFIC COASTS OF THE UNITED STATES.—BY ASSISTANT CHARLES A. SCHOTT.

COMPUTING DIVISION, COAST SURVEY, *January* 19, 1861.

DEAR SIR: In conformity with the Superintendent's directions, the secular change of the magnetic declination and inclination for stations in the vicinity of the coast of the United States has been investigated, and in order to complete these papers there remained the discussion of the magnetic intensity. I herewith respectfully submit so much of this investigation as the present state of the material will permit, thinking that a collection of the observations, reduced to the same absolute scale, would be of advantage at this time for the purposes of comparison or discussion. The table of results for horizontal and total intensity, here given, should therefore be considered as preliminary to the investigation of the secular change which it is proposed to resume hereafter.

The collection of magnetic intensities embraces stations on the Atlantic, Gulf, and Pacific coasts, and a few inland and foreign stations, and is believed to contain all observations, taken a sufficient number of years apart, for the recognition of changes of intensity. It includes horizontal as well as total intensity (with but a few exceptions) at 36 stations, for which the total number of observations is over 270.

The earlier observations, before the introduction of Gauss's method of expressing the force in absolute value are imperfect, and should be considered as subject to slight corrections. They involve the secular change of the total force at the base stations, Woolwich or Toronto, of which we have as yet but a very imperfect knowledge. It may be considered as fortunate that the total force at Woolwich has apparently undergone little or no change since absolute determinations were made. Dr. Lamont, in his discussion and delineation of isomagnetic lines in central Europe, arrives at the same conclusion. At Toronto, also, the secular change is very small. In the conversion of the relative into absolute numbers, the value 10.388 for total intensity at Woolwich, in absolute scale, corresponding to 1.372 of the arbitrary scale, has been used and is considered as constant in the conversion of the earlier observations. The

* The letters are not the same for the same spots, as in the paper, Appendix No. 20.

results given by General Sabine, in the volume for 1846 of the Philosophical Transactions of the Royal Society, were of the greatest advantage in the conversion of the various relative numbers; the determinations at many stations depending, either directly or indirectly, on the value for Toronto. The total intensity at this station, in the arbitrary scale, is 1.836 between 1842 and 1846; and the total intensity, in absolute measure, may be taken as 13.91, answering very nearly for the years between 1845 and 1851. The connexion with Toronto is particularly valuable for the extensive series of Dr. Locke, for which purpose the intensity at Cincinnati had to be carefully discussed. General Sabine adopts 13.59 for the total force in absolute measure, (1.795 in arbitrary scale,) answering between the years 1838 and 1844. For that period the horizontal intensity at Cincinnati may be taken equal to 4.548, Toronto being 3.540 (nearly.) From the observed total intensity and dip the horizontal intensity is obtained by means of the relation $X = \varphi \cos.\theta$. The magnetic observations of the U. S. Coast Survey were commenced in 1844, and with some exceptions, in the earlier years, the absolute horizontal intensity was observed at each station. The total intensity was deduced from the observed dip.

The intensity is expressed in English units (grain and foot.) For the conversion of the intensities exp essed in French units (millimeter and milligramme) the multiplier 2.1695 was used. For the conversion of relative results into absolute the necessary information is given in the notes appended to the tables.

The localities are arranged in geographical order, commencing in the northeast, proceeding to the southward and westward, and terminating with the stations on the Pacific coast.

The first column for each station contains the reference number; the second, the date arranged chronologically; the third, the name of the observer; the fourth, the reference to the observations; the fifth, the locality; and the sixth and seventh, the horizontal (X) and total φ, magnetic intensity, expressed in absolute measure.

QUEBEC, CANADA.

Latitude 46° 48′; longitude 71° 14′.

					X	ϕ
1	1842.7	Lefroy	Phil. Trans. R. S., 1846	Roy. Art. Barracks	3.040	13.78
2	1845.5	Younghusband	----do----	Wolf's Monument	3.032	13.63
3	1859.6	Schott	U. S. C. S	----do----	2.991	13.60

PORTLAND, MAINE.

Latitude 43° 39′; longitude 70° 16′.

1	1845.5	Locke	Phil. Trans. R. S., 1846		3.430	13.44
2	1851.7	Hilgard	U. S. C. S	Bowdoin hill	3.450	13.54
3	1859.6	Schott	----do----	----do----	3.456	13.30

PORTSMOUTH.

Latitude 43° 05′; longitude 70° 43′.

1	1850.7	Hilgard	U. S. C. S	Kittery Point	3.500	13.48
2	1859.6	Schott	----do----		3.496	13 57

NEWBURYPORT.

Latitude 42° 48′; longitude 70° 49′.

					x	ϕ
1	1850.7	Hilgard	U. S. C. S	Plum island	3.530	13.56
2	1859.6	Schott	do	do	3.528	13.53

GLOUCESTER, CAPE ANN.

Latitude 42° 36′; longitude 70° 38′.

1	1849.7	Keely	U. S. C. S	Beacon hill, on Eastern Point	3.618	13.48
2	1859.6	Schott	do	do do	3.645	13.86

SALEM.

Latitude 42° 32′; longitude 70° 52′.

1	1849.7	Keely	U. S. C. S	Fort Lee	3.487	------
2	1855.7	Schott	do	do	3.489	14.04

BOSTON.

Latitude 42° 20′; longitude 71° 02′.

1	1839.5	Loomis	Am. Phil. Soc., vol. VIII		3.658	13.39
2	1842.5	Locke	Phil. Trans. R. S., 1846		3.664	13.37
3	1846.8	Lee	U. S. C. S	South Boston heights	3.587	13.18
4	1855.7	Schott	do	do do	3.544	13.26

NANTUCKET.

Latitude 41° 17′; longitude 70° 06′.

1	1846.6	Lee	U. S. C. S	On North Beach, west of and near harbor light.	3.653	13.05
2	1855.7	Schott	do	do do	3.626	13.16

CAMBRIDGE, MASS.

Latitude 42° 23′; longitude 71° 07′.

1	1842.5	Locke	Phil. Trans. R. S., 1846	B's Mag. Obs'y	3.657	13.47
2	1842.8	Lefroy	do do	do	3.665	13.55
3	1845.5	Locke	do do	do	3.618	13.39
4	1856.6	Friesach	Ac. Sci. Vienna, vol. XXIX, 1858.		3.542	13.01

PROVIDENCE, R. I.

Latitude 41° 50′; longitude 71° 24′.

1	1836.0	Bache and Courtenay	Am. Phil. Soc., vol. V, 1837	North of Brown University	3.770	13.72
2	1839.5	Loomis	Am. Phil. Soc., vol. VIII		3.726	13.41
3	1842.7	Lefroy	Phil. Trans. R. S., 1846		3.715	13.48
4	1855.6	Schott	U. S. C. S	University grounds	3.590	13.24

SPRINGFIELD, MASS.

Latitude 42° 06′; longitude 72° 32′.

					x	φ
1	1835.0	Bache and Courtenay	Am. Phil. Soc., vol. V, 1837	Rear of Pinchyn house	3.721	13.65
2	1859.6	Schott	U. S. C. S	Corner Chesnut and East Worthington streets.	3.691	13.60

NEW HAVEN.

Latitude 41° 17′; longitude 72° 55′.

1	1839.5	Loomis	Am. Phil. Soc., vol. VIII		3.832	13.35
2	1842.5	Locke	Phil. Trans. R. S., 1846		3.813	13.42
3	1842.8	Lefroy	do do	Grove street	3.821	13.42
4	1844.7	Renwick	U. S. C. S	Yale College	3.818	13.33
5	1847.7	Fauntleroy	do	Fort Wooster	3.667	13.53
6	1848.7	Ruth	do	Pavillion	3.768	13.29
7	1848.7	Ruth	do	Fort Wooster	3.609	13.26
8	1848.7	Ruth	do	Oyster Point	3.761	13.28
9	1855.7	Schott	do	do	3.690	13.18

MONTREAL, CANADA.

Latitude 45° 30′; longitude 73° 35′.

1	1842.7	Lefroy	Phil. Trans. R. S., 1846	St. Helen's	3.064	13.78
2	1843.3	Lefroy	do do	do	3.083	13.80
3	1843.6	Bache	Manuscript discus. 1861	do	3.109	13.62
4	1845.5	Younghusband	Phil. Trans. R. S., 1846	On mountain	3.011	13.53
5	1859.6	Schott	U. S. C. S	McGill University	3.111	13.68

TORONTO.

Latitude 43° 39′; longitude 79° 21′.

1	1843.0	Lefroy and Younghusband	Phil. Trans. R. S., 1846	Magnetic Observatory	3.537	13.90
2	1845.5	Lefroy	Toronto Obs., vols. II and III	do	3.544	13.93
3	1846.5	do	do	do	3.538	13.90
4	1847.5	do	do	do	3.534	13.88
5	1848.5	do	do	do	3.530	13.92
6	1849.5	do	do	do	3.537	13.95
7	1850.5	do	do	do	3.532	13.95
8	1851.5	do	do	do	3.530	13.95
9	1852.5	do	do	do	3.515	13.89

ALBANY.

Latitude 42° 39′; longitude 73° 43′.

1	1835.0	Bache and Courtenay	Am. Phil. Soc., vol. V, 1837	Yard, Franklin house, State street.	3.578	13.53
2	1842.8	Lefroy	Phil. Trans. R. S., 1847		3.579	13.60
3	1844.5	Locke	do		3.582	13.56
4	1844.5	do	do	Greenbush	3.571	13.55
5	1855.6	Schott	U. S. C. S	do	3.587	14.03
6	1856.7	Friesach	Ac. Sci. Vienna, volume XXIX, 1858		3.575	14.00
7	1858.4	Dean	U. S. C. S	Dudley Observatory	3.574	13.74

West Point.

Latitude 41° 23′; longitude 73° 57′.

					X	φ
1	1835.0	Bache and Courtenay	Am. Phil. Soc., vol. V, 1837	Mil. Acad., rear of Prof. Courtenay's house	3.866	13.71
2	1842.5	Lefroy	Phil. Trans. R. S., 1846		3.881	13.67

New York.

Latitude 40° 43′; longitude 74° 00′.

1	1822.5	Sabine	Brit. Ass. Report, 1838	Columbia College	3.981	13.62
2	1835.0	Bache and Courtenay	Manuscript discussion, 1861	do	3.973	13.48
3	1841.5	Locke	Phil. Trans. R. S., 1846	do	4.018	13.51
4	1841.5	do	do	Lunatic Asylum	4.015	13.48
5	1842.7	Lefroy	do	do	4.008	13.49
6	1844.5	Locke	do	Columbia College	4.010	13.51
7	1844.5	do	do	Lunatic Asylum	4.007	13.48
8	1844.5	Renwick	U. S. C. S	Columbia College	4.071	13.64
9	1846.3	Locke	do	Bloom. Asylum	4.009	13.44
10	1846.4	do	do	Mount Prospect	4.053	13.45
11	1855.7	Schott	do	Bedloe's island	3.920	13.40
12	1855.7	do	do	Governor's island	3.926	13.25
13	1855.7	do	do	Receiving Reservoir	3.938	13.27
14	1860.8	do	do	Mount Prospect	4.052	13.61

Sandy Hook, New York Bay.

Latitude 40° 28′; longitude 74° 00′.

1	1844.7	Renwick	U. S. C. S	Near light-house	4.077	13.66
2	1855.7	Schott	do	do	3.917	13.30

Princeton.

Latitude 40° 21′; longitude 74° 40.′

1	1839.5	Loomis	Am. Phil. Soc., vol. VIII		4.041	13.55
2	1840.5	Locke	Phil. Trans. R. S., 1846		4.018	13.48
3	1842.8	Lefroy	do	Near college	4.009	13.50
4	1844.5	Locke	do	Pott's wood	4.013	13.49

Philadelphia.

Latitude 39° 58′; longitude 75° 10′.

1	1835.0	Bache and Courtenay	Am. Phil. Soc., vol. V, 1837	Yard, Professor Bache's dwelling, Chestnut street.	4.195	13.58
2	1836.7	Bache	Manuscript discussion, 1861	Yard, Professor Bache's dwelling, Chestnut street.	4.159	13.46
3	1839.5	Loomis	Am. Phil. Soc., vol. VIII		4.149	13.41
4	1841.5	Locke	Phil. Trans. R. S., 1846	Girard College	4.172	13.51
5	1842.5	do	do	do	4.174	13.52
6	1842.8	Lefroy	do	do	4.176	13.50
7	1843.6	Bache	Manuscript discussion, 1861	do	4.172	13.46
8	1844.5	Locke	Phil. Trans. R. S., 1846	do	4.162	13.47
9	1846.4	do	U. S. C. S	do	4.143	13.42
10	1855.7	Schott	do	do	4.226	13.89

* Determination made when this report was in press:

11	1862.6	Schott	Manuscript discussion	Girard College	4.088	13.30

Cape May, N. J.

Latitude 38° 56′; longitude 74° 57′.

					x	φ
1	1846.5	Locke	U. S. C. S		4.255	13.36
2	1855.7	Schott	----do	Light-house	4.182	13.23

Baltimore.

Latitude 39° 16′; longitude 76° 35′.

1	1840.7	Bache	Manuscript discussion, 1861	Near Washington monument	4.265	13.49
2	1841.5	Locke	Phil. Trans. R. S., 1846	St. Mary's	4.261	13.47
3	1841.5	----do	----do	City	4.238	13.50
4	1842.8	Lefroy	----do	Washington monument	4.238	13.49
5	1856.7	Schott	U. S. C. S	Fort McHenry	4.203	13.43

Washington.*

Latitude 38° 53′; longitude 77° 00′.

1	1842.5	Lefroy	Phil. Trans. R. S., 1846	Capitol grounds	4.347	13.51
2	1844.5	Locke	----do	Georgetown	4.282	13.38
3	1844.5	----do	----do	Capitol grounds	4.313	13.42
4	1844.5	----do	----do	Mag. Observatory, Capitol	4.282	13.62
5	1845.2	Lee	U. S. C. S	Coast Survey office	4.240	13.41
6	1845.9	----do	----do	------do	4.233	13.38
7	1851.5	Dean	----do	Georgetown, Causten	4.229	13.20
8	1855.7	Schott	----do	Smithsonian grounds	4.338	13.64
9	1855.7	----do	----do	Georgetown, Causten	4.250	13.40
10	1856.7	----do	----do	Coast Survey office	4.309	13.48
11	1856.7	----do	----do	Capitol grounds	4.308	13.46
12	1859.6	----do	----do	Coast Survey office	4.307	13.51
13	1860.7	----do	----do	------do	4.319	13.45

St. Louis, Missouri.

Latitude 38° 37′; longitude 90° 15′.

1	1839.5	Locke	Trans. Am. Phil. Soc, vol. IX, 1846.		4.705	13.45
2	1856.8	Friesach	Ac. Sci. Vienna, vol. XXIX, 1858.		4.927	13.15

East Pascagoula.

Latitude 30° 21′; longitude 88° 32′.

1	1847.5	Ruth	U. S. C. S	One mile east of the river in the village.	6.220	12.61
2	1855.0	Hilgard	----do		6.174	------

* Determination made when this report was in press:

14	1862.6	Schott	Manuscript discussion	Coast Survey office	4.255	1.28

NEW ORLEANS.

Latitude 29° 57′; longitude 90° 04′.

					X	ϕ
1	1857.0	Friesach	Ac. Sci. Vienna, vol. XXIX, 1858.		6.352	12.52
2	1858.3	Dean	U. S. C. S	Public sq., Basin st	6.286	12.49

HAVANA, CUBA.

Latitude 23° 09′; longitude 82° 22′.

1	1801.0	Humboldt	Brit. Ass. Report, 1838		(6.104)?	(10.23)?
2	1822.5	Sabine & Hansteen	do do			11.30
3	1857.0	Friesach	Ac. Sci. Vienna, vol. XXIX, 1858.		6.923	11.25

MEXICO (CITY.)

Latitude 19° 26′; longitude 99° 05′.

1	1803.9	Humboldt	Becquerel	Convent San Augustin	(6.686)?	(9.96)?
2	1856.9	Sonntag	Smith'n Cont'ns to Know., vol. XI.	do do	7.576	11.45

SAN DIEGO.

Latitude 32° 42′; longitude 117° 13′.

1	1839.5	Belcher	Phil. Trans. R. S., 1843	Tongue on eastern side	6.142	11.32
2	1853.8	Trowbridge	U. S. C. S	Plaza near custom-house	6.271	11.72

SAN PEDRO.

Latitude 33° 46′; longitude 118° 16′.

1	1839.8	Belcher	Phil. Trans, R. S., 1843	On a small island 3 miles N. of San Pedro.	5.913	11.28
2	1853.9	Trowbridge	U. S. C. S		6.114	12.12

SANTA BARBARA.

Latitude 34° 25′; longitude 119° 40′.

1	1831.5	Douglas	Rep. Brit. Ass., vol. VI, 1838.		5.861	11.96
2	1839.8	Belcher	Phil. Trans. R. S., 1843	At landing place	5.925	11.48

SAN LUIS OBISPO.

Latitude 35° 11′; longitude 120° 44′.

1	1831.5	Douglas	Rep. Brit. Ass., vol. VI, 1838.		5.754	11.96
2	1854.1	Trowbridge	U. S. C. S	At the cave near the landing	6.002	11.90

MONTEREY.

Latitude, 36° 38′; longitude, 121° 54.

					X	ϕ
1	1831.0	Douglas	Rep. Brit. Ass., vol. VI, 1838	Near landing place	5.629	12.04
2	1839.8	Belcher	Phil. Trans. R. S. 1843	do	5.666	11.71

SAN FRANCISCO.

Latitude, 37° 48′; longitude, 122° 27′.

1	1829.5	Erman	Rep. Brit. Ass., vol VI, 1838			12.00
2	1831.2	Douglas	do	do	5.495	12.09
3	1839.8	Belcher	Phil. Trans. R. S. 1843	Yerba Buena island	5.524	11.81

FORT VANCOUVER.

Latitude, 45° 37′; longitude, 122° 36′.

1	1830.8	Douglas	Rep. Brit. Ass., vol VI, 1838		4.442	12.78
2	1839.7	Belcher	Phil. Trans. R. S. 1843	Room and garden	4.475	12.74

CAPE DISAPPOINTMENT.

Latitude, 46° 17′; longitude, 124° 02′.

1	1830.8	Douglas	Rep. Brit. Ass., vol. VI, 1838		4.436	12.67
2	1839.8	Belcher	Phil. Trans. R. S. 1841–'43	Baker's bay, landing place	4.394	12.52

NOTES TO THE PRECEDING ABSTRACT OF MAGNETIC INTENSITIES.

A Von Humboldt's results in 1801 and 1803 depend on an assumed value for Woolwich, 10.39; General Sabine's result of 1822 depends upon the same value. For want of a knowledge of the secular change these early results are extremely doubtful.

Mr. Douglas's observations on the Western Coast in 1830 and 1831 were reduced to absolute measure by assuming Woolwich 10.39, and his results for horizontal intensity at San Luis Obispo and Santa Barbara in 1831 depend on Monterey, 5.629.

Professor Bache's and Professor Courteney's results in 1835 and 1836 depend on Dublin and Edinburg and New York.—(See Trans. Amer. Phil. Society, Philadelphia, vol. vii, new series, part i, 1840; also, vol. v, part iii, 1837.)

Professor Loomis's results in 1839 depend on New York, 4.012 and 13.52.

Professor Bache's results of 1840 depend on Philadelphia, 4.160.

Dr. Locke's results in 1841 and 1842 depend on Toronto, 3.540, and those in 1845 on Toronto, 3.544; see, also, the adopted values for Cincinnati in the preface.

Professor Bache's results of 1843 depend on Toronto.

Professor Renwick's results in 1844 are given as published by General Sabine in the Phil. Transactions for 1846—(from a communication by Professor Bache, Superintendent United States Coast Survey.) His results for Columbia College, New York, Sandy Hook, and Yale College (New Haven) were made to depend on the same series.

Dr. Locke's results in 1846 depend on Cincinnati, 4.550, adopted in 1856. His results in Coast Survey annual report of that year are based upon the same value.

The total force at Toronto was computed from the horizontal force and the dip, given in vol. iii of the Toronto Magnetical and Meteorological Observations.

The secular change of the intensity can best be ascertained from observations taken at the same station and with the same instrument as at Toronto, for instance. In the present case, however, we have in general neither of these essential conditions, and the results deducible depending on various observers, instruments, and localities, cannot claim to be more than approximations, particularly when we consider the comparatively short interval of time elapsed since measures of the intensity were first taken.

The comparison of the results, *inter se*, at any one station shows, in the differences, the combined effect of the error of observation and instrumental constants, of local deviation, of disturbances at the time of observation, and of errors due to regular variations in the intensity, if not allowed for. The secular change of the intensity, in its total effect, is small, compared with the above irregularities, and it can, therefore, be ascertained only by a combination of results at a number of stations. For this purpose I have formed two nearly equal groups of the observed horizontal intensities at each station and compared their resulting mean, from which the annual effect of the change is made out. For Toronto the annual decrease of force is 0.0026, in vol. ii; it is changed to 0.0037 ± 0.0009 in vol. iii. The first value, however, is here preferred.

Two groups have been formed, one for the Atlantic, the other for the Pacific coast, and a few stations were omitted on account of uncertainty in the earlier determinations.

In the following tables, showing the results for each locality, the column headed $\frac{y}{x}$ contains the annual change in parts of the force, a minus sign indicating decrease of horizontal force; the column headed i contains the interval of time expressed in years between the two groups, and the last column contains the number of observations:

Atlantic group.

Locality.	$\frac{y}{x}$	i	n	Locality.	$\frac{y}{x}$	i	n
Quebec	—0.001	15.5	3	Montreal	—0.0003	9.5	5
Portland	+0.0004	11.0	3	Toronto	—0.0007	4.0	9
Portsmouth	—0.0001	8.9	2	Albany	—0.0001	15.2	7
Newburyport	—0.0001	8.9	2	West Point	—0.001	7.5	2
Gloucester	+0.0008	9.9	2	New York	—0.001	13.2	14
Salem	+0.0001	6.0	2	Sandy Hook	—0.003	11.0	2
Boston	—0.003	10.2	4	Princeton	—0.001	3.7	4
Nantucket	—0.001	9.1	2	Philadelphia	—0.0001	8.6	10
Cambridge	—0.003	8.4	4	Cape May	—0.002	9.2	2
Providence	—0.002	12.0	4	Baltimore	—0.001	8.2	5
Springfield	—0.001	24.6	2	Washington	+0.0002	12.2	13
New Haven	—0.005	7.5	9	East Pascagoula	—0.001	7.5	2

Pacific group.

Locality.	$\frac{y}{x}$	i	n	Locality.	$\frac{y}{x}$	i	n
San Diego	+0.002	14.3	2	Monterey	+0.001	8.8	2
San Pedro	+0.003	14.1	2	San Francisco	+0.001	8.6	3
Santa Barbara	+0.001	8.3	2	Fort Vancouver	+0.001	8.9	2
San Luis Obispo	+0.002	22.6	2	Cape Disappointment	—0.001	9.0	2

Giving weights in reference to i and n, we find for stations belonging to the Atlantic group an annual *decrease* of 0.0011, (parts of horizontal intensity,) and for stations on the Pacific coast an annual *increase* of 0.0015, (parts of horizontal intensity.)

In reference to the secular change in the total intensity, it may be remarked that the agreement in the tabular numbers at each station is not as good as for the horizontal intensity, owing to the additional uncertainty in the observed dips which were used in the computation of the greater number of results.

Appendixes Nos. 32 and 33 of the Coast Survey report for 1856 contain the discussion of the secular change of the dip for stations on the Atlantic and Pacific coasts, and the conclusions reached within the geographical limits of the former were, that the dip attained a minimum about the latter part of 1842, and that the present annual *increase* of the dip is about $2\frac{3}{4}'$. On the Western Coast it was found that the dip was on the increase, (probably since 1836,) with an annual rate of about $2'$. From the above data the secular change in the total intensity can be inferred. Thus, on the Atlantic coast, (within the limits of the dip discussion,) at the present time, it is slightly on the *increase;* the amount, however, is hardly perceptible in the preceding abstract of results. On the Pacific coast the total intensity is now, also, slightly on the *increase.*

Yours, very respectfully,

CHAS. A. SCHOTT,

Ass't Coast Survey, in charge of Computing Division.

Capt. W. R. PALMER, *Top. Engineers,*

Ass't Coast Survey, in charge of Coast Survey Office.

APPENDIX No. 23.

NEW DISCUSSION OF THE DISTRIBUTION OF THE MAGNETIC DECLINATION ON THE COAST OF THE GULF OF MEXICO, WITH A CHART OF THE ISOGONIC CURVES FOR 1860. BY ASSISTANT CHARLES A. SCHOTT. (SKETCH No. 30.)

COMPUTING DIVISION, COAST SURVEY, *June* 28, 1861.

DEAR SIR: A new discussion of the distribution of the magnetic declination for the coast of the Gulf of Mexico having been approved by you, I herewith respectfully submit the results obtained by using all the material now available, and referring the same to a common epoch, viz: the first of January, 1860. This report is accompanied by a chart, showing the isogonic lines for the epoch stated. For comparison, see the curves obtained in your first discussion of 1856 (improved from that of 1855) for an epoch ten years prior to that now adopted.

Observations.—The list of observed magnetic declinations on and near the Gulf of Mexico, referred to January, 1860, and arranged in a convenient geographical order, has been made up from observations by parties of the United States Coast Survey, to which a few others have been added from other sources. They are all of comparatively recent date, the oldest date admitted being 1840. In all cases the latitudes and longitudes are given according to the best authorities available; for some stations, however, the longitudes are still very imperfectly known, and may possibly be found in error by several minutes, (of arc;) for these we have to wait for new determinations.

In the discussions of the magnetic declinations on the Gulf (and the Atlantic and Pacific coasts) for the epoch 1850, see Coast Survey reports for 1855, appendix No. 47, and for 1856, appendix No. 28, with charts, by A. D. Bache, Superintendent, and J. E. Hilgard, Assistant. The total number of stations entering in these discussions was 16; these have now been increased to 36. The comparatively small differences in the isogonic lines for the two epochs,

1850 and 1860, are, therefore, not entirely due to the effect of the secular change during a decennium, but depend, also, on the largely increased material now brought to bear on the result.

Secular change.—The observations of 1815 and 1857 at Havana, Cuba, indicate an annual change of nearly +1′.5, (the sign + indicates an increase of west declination.) The formula on page 325 Coast Survey report of 1855 gives +1′.5. The discussion of the observations at Savannah, Georgia, in Coast Survey report of 1859, page 300, gave +1′.8. These numbers have been adopted for the reduction of the Florida observations from the date of observation to the epoch adopted, (1860.0.) The following observations were collected for Key West, viz: February, 1829, W. A. Whitehead found 6° 25′ east, (see map of Florida, topographical engineers, 1846.) In 1843 the variation at the custom-house is stated to be 6° 02′ east, (see report of Com. L. M. Powell, United States navy.) Comparing the mean of these observations with the value found in 1860, (see table further on,) the annual increase seems to be as much as +3′.5—a value certainly too great. The discussion in Coast Survey report, 1859, page 300, gives the annual change for Mobile, Alabama, +1′.1, and from two observations at East Pascagoula, Mississippi, made in June, 1847, and January, 1855, the annual change is +0′.5. Proceeding further to the westward, at New Orleans, Louisiana, from the observations of Lason, in 1806, (—8° 03′,) and of Assistant Dean, in April, 1858, (—7° 52′,) the annual change appears to be very small, (+0′.2,) and will propably reach zero in western Louisiana. Of the secular change on the coast of Texas we have as yet no positive information, and consequently no attempt has been made to refer the observations to a later epoch. This reduction, if ascertained hereafter, will probably be found small, and may possibly have the opposite sign from that on the eastern side of the Gulf.

LIST OF OBSERVED MAGNETIC DECLINATIONS ON THE GULF OF MEXICO, AND REFERRED TO THE EPOCH 1860.0

The stations are arranged in geographical order, beginning on the southeast and ending on the southwest; the negative sign indicates, in conformity with present usage, an easterly declination. The latitudes and longitudes are given separately.

No.	Locality.	Reference.	Date of observation.	Declination (variation of magnetic needle) observed.	Reduction to epoch, 1860.0.	Declination, Jan. 1860.0.
				° ′	′	°
1	Havana, Cuba	C.S.Rep., 1855, p. 324, and 1859, p. 304.	Jan. 1857	—5 15	+ 4	—5.19
2	Sand Key, Florida Reef	Coast Survey Report, 1856, page 220...	August, 1849	—5 29	+16	—5.22
3	Key West, Florida Reef	Coast Survey Report, 1860	July, 1860	—4 46	— 1	—4.78
4	Tortugas Light-house, Florida	Report of Com. Powell, U.S.N.	1843	—6 15	+26	—5.82
5	Cape Florida	Coast Survey Report, 1856, page 220...	Feb. 1850	—4 25	+15	—4.17
6	Egmont Key, Tampa Bay	Report of Com. Powell, U S.N.	1843	—5 25	+26	—4.98
7	Depot Key, Cedar Keys	Coast Survey Report, 1856, p. 220	March, 1852	—5 20	+12	—5.13
8	Fernandina, Florida	Coast Survey Report, 1858, page 192...	April, 1857	—4 02	+ 4	—3.97
9	St. Mark's Light, Florida	Coast Survey Report, 1856, page 220...	April, 1852	—5 29	+12	—5.30
10	Dog Island Light, Florida	Coast Survey Report, 1856, page 220...	April, 1853	—5 51	+ 9	—5.70
11	Apalachicola, Florida	Coast Survey Archives	Jan. 1860	—6 12	0	—6.20
12	St. George's Island, Florida	Coast Survey Report, 1856, page 220...	April, 1853	—6 02	+ 9	—5.88
13	Eufala, Alabama	Coast Survey Report, 1858, page 192...	April, 1860	—5 12	0	—5.20
14	Cape St. Blas, Florida	Coast Survey Report, 1856, page 220...	Jan. 1854	—6 07	+ 8	—5.98
15	St. Joseph's Bay, Florida	Report of Com. Powell, U.S.N.	1843	—6 24	+20	—6.07
16	Hurricane Island, St. Andrew's Bay	Coast Survey Report, 1856, page 220...	Feb. 1854	—6 12	+ 8	—6.07
17	Pensacola, public square	Coast Survey Report, 1858, page 192...	June, 1858	—6 47	+ 2	—6.75
18	Barkley Point, Pensacola	Coast Survey Archives	Jan. 1861	—6 42	— 1	—6.72
19	Lower Peach Tree, Alabama	Coast Survey Report, 1858, page 192...	April, 1857	—6 02	+ 3	—5.98
20	Fort Morgan, Alabama	Coast Survey Report, 1856, page 220...	May, 1847	—7 04	+14	—6.83
21	Mobile City	Coast Survey Report, 1858, page 192.	Feb. 1857	—6 52	+ 3	—6.82
22	East Pascagoula, Mississippi	Coast Survey Report, 1856, page 220...	Jan. 1855	—7 09	+ 3	—7.10
23	Mississippi City	Coast Survey Report, 1860	March, 1855	—7 22	+ 3	—7.32

List of magnetic declinations on the Gulf of Mexico—Continued.

No.	Locality.	Reference.	Date of observation.	Declination (variation of magnetic needle) observed.	Reduction to epoch, 1860.0.	Declination, Jan. 1860 0.
				° ′	′	°
24	New Orleans City	Coast Survey Report, 1858, page 192	April, 1858	−7 52	0	−7.87
25	Cubitt, Mississippi Delta	Coast Survey Report, 1860	Dec. 1859	−7 32	0	−7.53
26	Passe à Loutre, Mississippi Delta	do	Dec. 1859	−7 30	0	−7.50
27	Fort Livingston, Louisiana	Coast Survey Report, 1856, page 220	Jan. 1853	−7 38	+ 1	−7.63
28	Isle Dernière, Louisiana	do	Feb. 1853	−8 19	+ 1	−8.30
29	Cote Blanche, Louisiana	Coast Survey Archives	March, 1860	−8 22	0	−8.37
30	Gaines's Ferry, Sabine River	Trans. Am. Phil. Society, 1846	May, 1840	−8 41		−8.68
31	Mouth of Sabine River	do	Jan. 1840	−8 40		−8.67
32	Dollar Point, Texas	Coast Survey Report, 1856, page 220	April, 1848	−8 57		−8.95
33	East Base, Galveston Island	do	March, 1853	−9 05		−9.09
34	Jupiter, Texas	do	May, 1853	−9 09		−9.15
35	Mouth of Rio Grande	do	Nov. 1853	−9 01		−9.02
36	Ringgold's Barracks, R. G.	Major Emory, Mex. Boundary Report	1853	−9 15		−9.25

Geographical positions of the preceding magnetic stations.

No.	Locality.	Latitude.	Longitude west of Greenwich.	No.	Locality.	Latitude.	Longitude west of Greenwich.
		° ′	° ′			° ′	° ′
1	Havana	23 09	82 22	19	Lower Peach Tree	31 50.4	87 32.6
2	Sand Key	24 27.2	81 52.7	20	Fort Morgan	30 13 9	88 00 3
3	Key West	24 33	81 48.2	21	Mobile	30 41.6	88 01.8
4	Tortugas	24 38	82 53	22	East Pascagoula	30 20.7	88 31.8
5	Cape Florida	25 40.4	80 09.8	23	Mississippi City	30 22.9	89 01.0
6	Egmont Key	27 36.1	82 45.3	24	New Orleans	29 57.4	90 03.5
7	Depot Key	29 07.5	83 02.8	25	Cubitt	29 09.9	89 13.6
8	Fernandina	30 40.6	81 27.7	26	Passe à Loutre	29 11	89 01.0
9	St. Mark's	30 04.4	84 10.6	27	Fort Livingston	29 16.7	89 49
10	Dog Island	29 46.8	84 38	28	Isle Dernière	29 02.0	90 54
11	Apalachicola	29 43.2	84 59	29	Cote Blanche	29 44.1	91 41.9
12	St. George's	29 35	85 03	30	Gaines's Ferry	31 28.3	93 44.6
13	Eufala	31 53.7	85 04.9	31	Sabine River	29 43.9	93 51.5
14	St. Blas	29 39.7	85 21.6	32	Dollar Point	29 26.0	94 52.7
15	St. Joseph's	29 52.0	85 23 2	33	East Base	29 12.9	94 55.4
16	Hurricane Island	30 04.4	85 39.3	34	Jupiter	28 54.8	95 20.1
17	Pensacola	30 24 6	87 12.0	36	Rio Grande	25 57.4	97 07.6
18	Barkley Point	30 24.6	87 12.0	36	Ringgold Barracks	26 23	98 43

Method of reduction.—The interpolation formula for the distribution of the magnetic declination on the Gulf is that generally used for discussions extending over a considerable area necessarily taking in second differences. It was first proposed by the Rev. H. Lloyd in 1838.—(See the eighth report of the British Association, vol. VII, p. 91; Magnetic Survey of Great Britain, by Major Sabine, section III, Ireland, by the Rev. H. Lloyd.) It is as follows:

$$Z = L + M\,x + N\,y + P\,x^2 + Q\,xy + R\,y^2 + \&c.$$

For greater convenience it may be written in the following form:

$$D = D_0 + d + x\,dL + y\,dM + z\,dL\,dM + p\,dL^2 + q\,dM^2 + \cdots\cdots$$

where

D = resulting declination,

D_0 = an assumed declination for the epoch adopted, and the mean latitude and longitude, d its correction,

dL = difference of latitude, dM = difference of longitude.

x, y, z, p, q, as well as d, are to be determined by application of the method of least squares from the observations themselves.

To adapt this formula to the spherical surface, a slight alteration has been introduced, by multiplying the terms involving d M by cos. L.—(See, also, Lloyd's paper in the fifth report of the British Association, 1835.)

The conditional equations assume, therefore, the form:

$O = D_o - D + d + x\,dL + y\,dM \cos. L + z\,dL\,dM \cos. L + p\,dL^2 + q\,dM^2 \cos.^2 L$,

the terms of the third and higher order having been omitted. The normal equations are formed by the usual process.

Combination in groups.—For greater convenience of the determination of the values of d, x, y, z, p, q, in the general expression, the above thirty-six stations have been arranged and combined in six groups, as had been done in 1855. The results are as follows:

Groups.	No. of stations.	Mean latitude.	Mean longitude.	Mean declination, 1860.0.
		°	°	°
I	1, 2, 3, 4, 5	24.49	81.82	—5.04
II	6, 7, 8, 9	29.37	82.86	—4.85
III	10, 11, 12, 13, 14, 15, 16, 17, 18, 19	30.32	85.81	—6.05
IV	20, 21, 22, 23, 24, 25, 26, 27, 28, 29	29.80	89.43	—7.53
V	30, 31, 32, 33, 34	29.75	94.55	—8.91
VI	35, 36	26.17	97.92	—9.13
	Mean	28.32	88.73	—6.92

In forming these groups we have the advantage of shortening the discussion by saving the formation of normal equations, and also, what is of special importance, we lessen the effect of any local deviation, which frequently affects the results injuriously. Hereafter, when a greater number of observations can be made available, it will be proper to combine the observations in a greater number of groups, making their area and number of stations in each as nearly equal as may be practicable. The present discussion should be considered as a second approximation, the first having been published in the Coast Survey reports of 1855 and 1856. Equal weights have been given to the results of each group. In the numerical computation I was assisted by Mr. Wiessner, of this division.

From the above six groups, the following resulting equation was deduced:

$$D = -7°.44 + 0.084\,dL - 0.375\,dM \cos. L - 0.022\,dL\,dM \cos. L + 0.0142\,dL^2 + 0.0170\,dM^2 \cos.^2 L.$$

This expression will give the magnetic declination for January, 1860, expressed in degrees and decimals.

$$dL = \text{Lat.} - 28°.32, \text{ and } dM = \text{Long.} - 88°.73.$$

It represents the normal declinations as follows:

Group.	Observed declination.	Computed declination.	Difference.
	°	°	°
I	—5.04	—5.05	+0.01
II	—4.85	—4.85	0.00
III	—6.05	—6.05	0.00
IV	—7.53	—7.53	0.00
V	—8.91	—8.91	+0.00
VI	—9.13	—9.11	—0.02

Applying Peirce's criterion to the differences between the observed and computed values for the thirty-six stations, it was found that two values were excluded, viz: the first, Havana, (difference + 0°.56,) and the nineteenth, Lower peach tree, (difference + 0°.51.) Omitting these stations the groups and equations were reformed with the following results:

New groups.	No. of stations.	Mean latitude.	Mean longitude.	Mean declination, 1860. 0.
		°	°	°
I	2, 3, 4, 5	24 82	81. 68	—5. 00
II	6, 7, 8, 9	29. 37	82. 86	—4. 85
III	10, 11, 12, 13, 14, 15, 16, 17, 18	30. 16	85. 62	—6. 06
IV	20, 21, 22, 23, 24, 25, 26, 27, 28, 29	29. 80	89. 43	—7. 53
V	30, 31, 32, 33, 34	29. 75	94. 55	—8. 91
VI	35, 36	26. 17	97. 92	—9. 13
	Mean	28. 34	88. 68	—6. 91

$$D = -7°.25 + 0.019\ dL - 0.377\ dM \cos. L - 0.018\ dL\ dM \cos. L - 0.0266\ dL^2 + 0.0159\ dM^2 \cos.^2 L.$$

The coefficients of the terms dL and dL^2 are necessarily very uncertain, owing to the want of observations in the middle of the Gulf; the small curvature of the isogonic lines principally depends on these terms; the observations, however, are nearly equally represented by either expression, I or II. Intersections for each line between 4° and 9° were next computed, and the curves plotted for each equation, when it was found that a mean curve between the two answered most satisfactorily. The mean expression, or—

$$D = -7°.35 + 0.052\ dL - 0.376\ dM \cos. L - 0.020\ dL\ dM \cos. L - 0.006\ dL^2 + 0.0165\ dM^2 \cos.^2 L,$$

$$dL = \text{Lat.} - 28°.33,\ dM = \text{Long.} - 88°.70,$$

was therefore adopted. The stations 1 and 19 have therefore not been entirely rejected, but received less weight, which is allowable, since they were near the limit of rejection in system I.

Comparing the above expression with that deduced for January, 1850, with a less number of observations, (see Coast Survey report for 1855, pp. 302, 303—the signs should there first be changed to have east declination, indicated by a minus sign,) the agreement of the isogonic lines for the two epochs is such as to show that no important alteration was produced by the introduction of the new observations.

The agreement between the observed and computed values is as follows:

Number of station.	Declination, 1860. 0.			Number of station.	Declination, 1860. 0.		
	Observed.	Computed.	Difference.		Observed.	Computed.	Difference.
1	—5°.19	—5°.63	(+0°.44)	19	—5°.98	—6°.72	(+0°.74)
2	—5. 22	—5. 09	—0. 13	20	—6. 83	—7. 02	+0. 19
3	—4. 78	—5. 10	+0. 32	21	—6. 82	—7. 01	+0. 19
4	—5. 82	—5. 55	—0. 27	22	—7. 10	—7. 21	+0. 11
5	—4. 17	—4. 07	—0. 10	23	—7. 32	—7. 38	+0. 06
6	—4. 98	—5. 03	+0. 05	24	—7. 87	—7. 74	—0. 13
7	—5. 13	—4. 97	—0. 16	25	—7. 53	—7. 49	—0. 04
8	—3. 97	—3. 99	+0. 02	26	—7. 50	—7. 42	—0. 08
9	—5. 30	—5. 42	+0. 12	27	—7. 63	—7. 68	+0. 05
10	—5. 70	—5. 65	—0. 05	28	—8. 30	—8. 01	—0. 29
11	—6. 20	—5. 81	—0. 39	29	—8. 37	—8. 23	—0. 14
12	—5. 88	—5. 85	—0. 03	30	—8. 68	—8. 83	+0. 15
13	—5. 20	—5. 71	(+0. 51)	31	—8. 67	—8. 77	+0. 10
14	—5. 98	—5. 98	0. 00	32	—8. 95	—8. 96	+0. 01
15	—6. 07	—5. 96	—0. 11	33	—9. 09	—8. 96	—0. 13
16	—6. 07	—6. 08	+0. 01	34	—9. 15	—9. 02	—0. 13
17	—6. 75	—6. 69	—0. 06	35	—9. 25	—9. 07	—0. 18
18	—6. 72	—6. 69	—0. 03	36	—9. 02	—9. 05	+0. 03

The probable error of any single representation (omitting 1, 13, and 19) is, accordingly,

$$\varepsilon = 0.845 \frac{\Sigma \triangle}{\sqrt{n(n-6)}}$$ (See Coast Survey report, 1856, Appendix No. 59.)

$$\varepsilon = \pm 0^{\circ}.11 = \pm 6'.5$$

In the first discussion (Coast Survey report, 1855, p. 303) this error is stated to be 3′.3. In this case, however, the number of observations was small for the accurate determination of this quantity; besides, in three groups, each consisting of but one station, the error must necessarily be zero.

Yours, very respectfully,

CHAS. A. SCHOTT,

Assistant U. S. Coast Survey, in charge of Computing Division.

Professor A. D. BACHE,

Superintendent U. S. Coast Survey.

APPENDIX No. 24.

NEW DISCUSSION OF THE DISTRIBUTION OF THE MAGNETIC DECLINATION ON THE COAST OF VIRGINIA, NORTH CAROLINA, SOUTH CAROLINA, AND GEORGIA, WITH A CHART OF THE ISOGONIC CURVES FOR 1860. BY ASSISTANT CHARLES A SCHOTT.—(SKETCH No. 32.)

COMPUTING DIVISION COAST SURVEY, *July* 2, 1861.

DEAR SIR: In compliance with your desire, I have submitted the observed magnetic declination along the coast of Virginia, North and South Carolina, and Georgia to a new discussion, and constructed a map showing the resulting isogonic lines for the epoch January, 1860.

The present discussion may be considered as an extension of your discussions in 1855 and 1856.—(See Coast Survey reports for 1855, Appendix No. 47, and for 1856, Appendix No. 28, on the general distribution of terrestrial magnetism in the United States, from observations made in the U. S. Coast Survey and others, by A. D. Bache, Superintendent, and J. E. Hilgard, Assistant U. S. Coast Survey.) The epoch is now brought forward ten years, and the method of discussion has been slightly changed.

Secular change.—For Section III the annual change has generally been adopted as + 2′.5 for the present time. At Williamsburg, Virginia, the increase was found + 3′.7.—(Coast Survey report, 1859, Appendix No. 24.) It is only an approximation, and certainly too great. The value + 2′.5 has been adopted for the coast between the capes of the Chesapeake and Cape Fear. At Charleston the formula (Coast Survey report, 1859, Appendix No. 24) gives + 3′.2 for 1850 and 1860, a value apparently one minute too high, but borne out by five observations as collected in the Coast Survey reports of 1855 and 1859. To these the following additional values can be added: Variation at Charleston February, 1784, 5° 15′ east, and in October, 1785, 5° 45′ east, by Joseph Purchell, surveyor. (Both values appear to be somewhat too great.) In October, 1847, it was 2° 15′ east.—(See a pamphlet by Charles Parker, Charleston, 1849.) The latter value agrees well with those previously collected. For Charleston + 3′.0 has been adopted. For Savannah, Ga., we have the values + 1′.5 and + 1′.8 for the epochs 1850 and 1860, (Coast Survey report, 1859, Appendix No. 24,) which values have been adopted. For Florida the value + 1′.5 has been used.—(See preceding discussion of the Gulf of Mexico magnetic declinations in June, 1861.)

The observations.—The stations selected are all of comparative recent date, and are 21 in number, within the geographical limits of the discussion. The observations have all been made by parties of the Coast Survey. In the following table, containing the names, reference,

date, and resulting declination for the epoch 1860.0, west declination, as well as westerly increase, is indicated by the sign +. A second table contains the latitude and longitude of each station according to the latest determination.

No.	Locality.	Reference.	Date.	Observed declination. (Variation.)	Reduction to 1860.0.	Declination, 1860.
				° ′	′	°
1	Richmond	Coast Survey Report, 1858, page 192	Sept. 1856	+0 15	+ 8	+0.38
2	Petersburg, Roslyn	Coast Survey Report, 1856, page 219	Aug. 1852	+0 27	+19	+0.77
3	Cape Charles	Coast Survey Report, 1858, page 192	Sept. 1856	+1 35	+ 8	+1.72
4	Cape Henry	do	do	+1 28	+ 8	+1.60
5	Old Point Comfort	do	do	+1 15	+ 8	+1.38
6	Norfolk	do	do	+1 36	+ 8	+1.73
7	Shellbank	Coast Survey Report, 1856, page 219	March, 1847	+1 45	+32	+2.28
8	Stevenson's Point	do	Feb. 1847	+1 40	+32	+2.20
9	Bodie's Island	do	Dec. 1846	+1 13	+33	+1.77
10	Raleigh	do	Jan. 1854	−0 45	+15	−0.50
11	Wilmington, De Rosset	do	June, 1854	−1 14	+14	−1.00
12	Smithville	Coast Survey Report, 1860	May, 1859	−0 38	+ 1	−0.62
13	Columbia	Coast Survey Report, 1856, page 219	Feb. 1854	−3 02	+15	−2.78
14	Georgetown, Allston	Coast Survey Report, 1853, page 220	Dec. 1853	−2 07	+15	−1.87
15	Breach Inlet	do	April, 1849	−2 16	+27	−1.82
16	Edisto, East base	do	April, 1850	−2 54	+24	−2.50
17	Port Royal	Coast Survey Report, 1860	Feb. 1859	−3 04	+ 2	−3.03
18	Tybee	Coast Survey Report, 1856, page 220	April, 1852	−3 32	+13	−3.32
19	Savannah, Hutchinson's island	Coast Survey Report, 1858, page 192	May, 1857	−3 28	+ 4	−3.40
20	Fernandina	do	April, 1857	−4 02	+ 4	−3.97
21	Macon	Coast Survey Report, 1856, page 220	Jan. 1855	−4 36	+ 8	−4.47

Geographical positions.

No.	Locality.	Latitude.	Longitude west of Greenwich	No.	Locality.	Latitude.	Longitude west of Greenwich.
		° ′	° ′			° ′	° ′
1	Richmond	37 31.7	77 25.7	12	Smithville	33 55.0	78 00.8
2	Petersburg	37 14.4	77 23 5	13	Columbia	34 00.0	81 02.0
3	Cape Charles	37 07.3	75 57.9	14	Georgetown	33 21 7	79 12.3
4	Cape Henry	36 55.6	76 00.1	15	Breach Inlet	32 46.3	79 48.7
5	Old Point Comfort	37 00.0	76 18.1	16	Edisto	32 33.3	80 10.0
6	Norfolk	36 51.0	76 17.0	17	Port Royal	32 17.7	80 38.4
7	Shellbank	36 03 3	75 43.8	18	Tybee	32 01.5	80 50.6
8	Stevenson's Point	36 06.3	76 10.7	19	Savannah	32 05.3	81 05.2
9	Bodie's Island	35 47.5	75 31.6	20	Fernandina	30 40.6	81 27.7
10	Raleigh	35 46.8	78 37.8	21	Macon	32 50.4	83 37.6
11	Wilmington	34 14.0	77 56.5				

Method of discussion.—The interpolation formula, proposed by the Rev. H. Lloyd in 1838, (see the 8th report of the British Association, vol. vii, p. 91,) has been used in a slightly altered form in this discussion, as explained in my recent investigation of the magnetic declination on the Gulf of Mexico in June, 1861. We have—

$$D = D_0 + d + x\,d\,L + y\,d\,M \cos. L + z\,d\,L\,d\,M \cos. L + p\,d\,L^2 + q\,d\,M^2 \cos.^2 L,$$

where,

D = resulting declination.

D_0 = an assumed declination for the epoch adopted (1860.0) and the mean latitude and longitude, d its correction.

$d\,L$ = difference of latitude, $d\,M$ = difference of longitude.

x, y, z, p, q, as well as d, are to be determined by application of the method of least squares from the observations themselves.

In order to lessen the effect of local deviation the observations have been combined in groups, suitably selected for the most reliable determination of the above six unknown quantities. Equal weights have been given to the mean result of each group.

Combination.	Stations.	Mean latitude.	Mean longitude.	Declination 1860.0.	Combination.	Stations.	Mean latitude.	Mean longitude.	Declination 1860.0.
		°	°	°			°	°	°
1	1, 2	37.38	77.41	+0.58	6	13	34.00	81.03	—2.78
2	3, 4, 5, 6	36.98	76.14	+1.61	7	14, 15, 16	32.90	79.73	—2.06
3	7, 8, 9	35.98	75.81	+2.08	8	17, 18, 19	32 14	80.85	—3.25
4	10	35.78	78.63	—0.50	9	20	30.68	81.46	—3.97
5	11, 12	34.07	77.97	—0.81	10	21	32.84	83.63	—4.47

A graphical construction of the isogonic lines, by means of the above ten combinations, at once shows that the three stations on Albemarle sound (7, 8, 9) are greatly affected by local deviation, the extent of which we are not able to define for want of more observations; it is probable that stations 1 and 2 are affected in an opposite way; taking a mean value, therefore, of the first three combinations we may hope to eliminate as much as possible the effect of these deflections on the general system. To simplify the process of elimination of the unknown quantities two other contractions of combinations were made, viz. 4 and 5, and 7 and 8, thus forming the following six final groups:

Group.	Combinations.	Stations.	Mean lat.	Mean long.	Decl. 1860.0.
			°	°	°
I	1, 2, 3	1 2, 3 4 5 6, 7 8 9	36.78	76.45	+1.42
II	5	11 12	34.07	77.97	—0.81
III	4, 6	10, 13	34.89	79.83	—1.64
IV	7, 8	14 15 16, 17 18 19	32.52	80.30	—2.65
V	9	20	30.68	81.46	—3.97
VI	10	21	32.84	83.63	—4.47
Mean			33.63	79.94	—2.02

The formation and solution of the six equations furnished the following expression:

$$D = -2°.02 + 0.346\, d\,L - 0.669\, d\,M \cos. L - 0.206\, d\,L\, d\,M \cos. L - 0.0876\, dL^2 - 0.0586\, d\,M^2 \cos.^2 L.$$

$d\,L$ = lat. − 33.°63 and $d\,M$ = long. − 79.°94.

The substitution in the original equations leaves the residuals + 0.01 in (1) and (2) and − 0.01 in (5) and (6), equations (3) and (4) are strictly fulfilled.

The observations are satisfied as follows:

Number of station.	Declination 1860. 0.			Number of station.	Declination 1860. 0.		
	Observed.	Computed.	Difference		Observed.	Computed.	Difference.
	°	°	°		°	°	°
1	+0.38	+0.73	—0.35	12	—0.62	—0.91	+0.29
2	+0.77	+0.71	+0.06	13	—2.78	—2.62	—0.16
3	+1.72	+1.93	—0.21	14	—1.87	—1.76	—0.11
4	+1.60	+1.84	—0.24	15	—1.82	—1.97	+0.15
5	+1.38	+1.62	—0.24	16	—2.50	—2.58	+0.08
6	+1.73	+1.59	+0.14	17	—3.03	—2.89	—0.14
7	+2.28	+1.60	+0.68	18	—3.32	—3.10	—0.22
8	+2.20	+1.34	(+0.86)	19	—3.40	—3.16	—0.24
9	+1.77	+1.55	+0.22	20	—3.97	—3.99	+0.02
10	—0.50	—0.53	+0.03	21	—4.47	—4.48	+0.01
11	—1.00	—0.69	—0.31				

The probable error of any single representation (omitting the large local difference of station (8)) is $= \pm 0°.19$ or $\pm 11'.6$.

Owing to the scanty material, the general curvature of the isogonic lines, as computed for each degree of declination between $+ 1°$ and $- 4°$ by the above formula, seems to be somewhat greater than what might have been expected from the discussion of the adjoining sections, and it is therefore desirable that the formula be used only within the strict geographical extent of the places of observation. A slight compromise has been made in the graphical representation of the $- 4°$ curve as resulting from the above expression and that found in the discussion for the Gulf of Mexico. The $+ 1\frac{1}{2}° + 2° + 2\frac{1}{2}°$ and $+ 3°$ curves have been added from a recent discussion of the section III magnetic observations, 44 in number.

Whether such local deflections, extending over a considerable area, as noticed on Albemarle sound (stations 7, 8, 9) and elsewhere on our seacoast, are constant, or whether they are produced by variations in the rate of secular change, or, in other words, whether they are stationary or shifting with the general change of the isogonic lines, is a subject of inquiry which must be reserved for the future, as it can only be ascertained by repeated and careful observations. For the present it suffices to apply a correction to the computed values as resulting from the above formula, which correction is given (with the proper sign) in the column of differences in the preceding table. These differences may serve, hereafter, for the construction of lines of equal anomaly, (isabnormal lines) which will plainly exhibit the extent and centres of the disturbed regions, together with the amount of deflection.

Yours, very respectfully,

CHARLES A. SCHOTT,
Assistant United States Coast Survey, in charge C. D.

Prof. A. D. BACHE,
Superintendent United States Coast Survey.

APPENDIX No. 25.

REPORT ON OBSERVATIONS OF THE SOLAR SPOTS MADE AT THE COAST SURVEY OFFICE, WASHINGTON, D. C., FROM AUGUST, 1860, TO DECEMBER, 1861, BOTH INCLUSIVE, BY CHARLES A. SCHOTT, ASSISTANT UNITED STATES COAST SURVEY.

The continuation of part of the results of my observations of the solar spots, noticed in your last year's report, (1860, Appendix No. 25, pp. 324–326,) is herewith respectfully submitted. The observations have been made in the same manner as explained in detail in that report. During my temporary absence from Washington between July 9 and October 28, 1861, while engaged on field duty, the observations were attended to by Assistant L. F. Pourtales. The interruptions of ten days in August and of nine in September are due to unfavorable weather. I was also assisted by Mr. J. H. Patton and by Mr. J. Wiessner, by the former in noting transits, by the latter in noting time, since May last. The observations were made generally between the hours of one and two.

Table of observed number of groups of solar spots and of single spots, from August, 1860, to December, 1861, together with the resulting monthly relative numbers for the same period.

Day of month.	1860.										1861.																					
	August.		September.		October.		November.		December.		January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
1	7	15	6	19	.....	.....	5	27	.....	.....	.....	.....	.....	.....	8	31	...	....	10	17	8	16	...	...	12	38	.....	.....	6	12	.....	.....	.....	.....
2	7	12	.....	.....	7	19	.....	.....	11	38	5	9	.....	.....	10	35	10	29	9	10	6	21	10	18	12	12	7	37	.....	.....	.....	.....	.....	.....
3	.....	.....	.....	.....	.....	.....	.....	.....	11	24	.....	.....	.....	.....	8	31	12	29	....	....	8	24	10	12	10	33	10	48	6	23	.....	.....	.....	.....
4	5	9	6	7	.. ...	.....	7	17	12	22	7	11	3	5	.....	.....	10	32	10	20	....	....	...	...	.....	.....	.....	.....	5	27	7	11	6	19
5	.....	.....	8	10	10	21	11	24	9	23	6	11	.....	.....	5	29	6	11	....	....	....	....	7	13	5	16	.....	.....	5	19	.....	.....	7	14
6	7	9	8	22	9	20	10	20	8	27	5	9	5	11	.....	.....	7	26	....	....	....	....	...	....	7	19	.....	.....	.....	.....	.....	.....	7	17
7	9	16	9	15	.....	.....	8	26	8	24	.....	.....	3	6	5	16	....	....	7	9	....	....	....	....	.....	.....	.....	.....	6	14	6	22	8	17
8	10	18	7	14	6	19	10	23	.....	.....	4	17	4	6	.....	.....	....	....	..	. ..	7	14	6	8	5	18	.....	.....	.....	.....	6	16	7	15
9	.. ...	.....	.....	.....	6	12	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	1	2	6	8	7	11	7	21	5	7	.....	.....	.....	....	.....	.....
10	9	27	4	11	5	12	.....	....	.....	.....	7	17	5	13	6	13	....	....	..	....	5	6	10	17	.....	.....	.....	.....	.....	.....	.....	.....	5	7
11	10	27	4	5	.....	.....	.....	.....	9	24	.....	.....	4	4	6	13	4	4	0	0	2	2	8	13	.....	.....	.....	.....	4	12	.....	.....	5	10
12	.....	.....	5	8	8	18	7	16	8	23	.....	.....	7	19	. ....	.....	....	....	0	0	2	3	6	16	.....	.....	.....	....	8	21	.....	.....	6	17
13	.....	.....	5	10	9	14	6	20	7	18	5	7	8	17	7	19	3	5	2	7	5	7	5	18	.....	.....	.....	.....	.....	.....	5	9	6	19
14	.....	.....	7	11	.....	.....	7	18	6	11	.....	. ....	.....	.....	.....	.....	2	4	2	7	6	12	...	...	.....	.....	.....	.....	10	46	.....	.....	5	21
15	7	14	6	18	8	25	7	17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	5	7	21	...	...	.....	.....	.....	.....	7	43	.....	.....	.....	.....
16	8	18	.....	.....	5	11	7	12	.....	.....	.....	.....	10	19	6	11	...	..	1	2	9	27	....	....	.....	.....	.....	.....	.....	.....	5	19	7	20
17	8	14	....	.....	5	9	.....	.....	4	6	.....	.....	.....	.....	.....	.....	4	13	3	3	8	16	7	20	.....	.....	.....	.....	.....	.....	.....	.....	7	22
18	6	12	.....	.....	6	11	.....	....	4	6	.....	.....	.....	.....	.....	....	5	9	3	7	9	27	8	8	.....	....	.....	.....	6	63	....	.....	.....	.....
19	.....	.....	.....	.....	.....	.....	5	12	.....	.....	4	5	....	.....	5	10	....	....	....	....	8	22	5	13	.....	.....	11	36	.....	.....	4	22	6	17
20	5	17	.....	....	.....	.....	5	11	.....	.....	6	9	10	20	8	17	....	....	....	....	9	31	5	10	9	19	10	28	.....	.....	.....	.....	.....	.....
21	.....	.....	8	15	.....	.....	5	7	4	8	6	10	9	22	9	16	7	11	4	4	11	34	.....	.....	12	50	.....	.....	.....	.....	2	9	7	15
22	6	12	6	12	5	13	8	12	8	20	6	15	.....	.....	10	12	....	....	4	6	10	28	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23	7	15	.....	.....	4	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	17	6	8	...	...	10	19	.....	.....	9	24	.....	.....	.....	.....	.....	.....
24	9	14	7	21	6	9	9	11	8	9	.....	.....	.....	.....	7	9	10	23	5	12	7	13	8	36	15	51	8	32	7	23	.....	.....	5	10
25	8	26	6	18	6	11	8	12	.....	.....	.....	.....	4	19	8	11	....	....	5	13	7	11	9	19	....	....	.....	.....	.....	.....	.....	.....	.....	.....
26	.....	.....	8	16	6	9	.....	.....	6	9	.....	.....	4	9	.....	.....	13	23	....	..	6	6	12	35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
27	4	16	.....	.....	4	6	.....	.....	5	13	5	22	6	15	11	23	13	22	9	17	5	10	....	...	.....	.....	.....	....	.....	.....	.....	.....	.....	.....
28	.....	.....	9	12	.....	.....	7	22	.....	.....	6	14	8	18	.....	.....	...	....	8	15	4	7	....	...	.....	.....	7	26	5	37	.....	.....	5	12
29	7	12	9	17	.....	.....	.....	.....	....	.....	3	7			12	33	10	26	6	10	....	....	9	19	.....	.....	.....	.....	4	24	....	....	.....	.....
30	5	13	.....	.....	.....	.....	.....	.....	.....	.....	3	6			10	25	....	....	7	10	....	....	9	33	7	42	5	43	5	13	3	10	5	10
31	6	13			.....	.....			3	6	3	6			9	25			10	21			10	47	8	29			7	13			.....	.....
Mean.	86.1		81.1		78.0		90.4		90.0		61.6		73.5		98.9		95.2		58.5		83.3		99.7		121.5		111.2		86.7		62.3		76.6	

The following table contains the monthly relative numbers (according to Wolf) for the years 1860–'61, as observed at Washington, D. C.:

Month.	1860.	1861.	Month.	1860.	1861.
January	68.4	61.6	September	81.1	111.2
February	73.5	73.5	October	78.0	86.7
March	83.6	98.9	November	90.4	62.3
April	56.3	95.2	December	90.0	76.6
May	91.4	58.5			
June	97.6	83.3	Annual mean	83.0	85.7
July	99.8	99.7			
August	86.1	121.5	No. of days of observation	233	193

A comparison of Professor Wolf's revised numbers for 1860 (see his Mittheilungen, xii, pp. 69–71) with mine, shows that the factor with which the above figures had been multiplied to refer them to the standard of his telescope is 1.19.

On two days, viz: the 11th and 12th of May, 1861, I found the sun without any spots.

The observations for heliocentric latitudes and longitudes of spots have been continued as in the preceding year.

Yours, very respectfully,

CHAS. A. SCHOTT,
Assistant U. S. Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 26.

EXTRACTS FROM THE REPORT OF SUB-ASSISTANT F. W. DORR, DESCRIBING THE GENERAL CHARACTER OF THE COAST OF FLORIDA, ABOVE ST. AUGUSTINE.

BOSTON, *February* 21, 1861.

SIR:

* * * * * * * * * * *

Below Diego Plains the general characteristics of the outside beach, the sand hills, and other surface features, are in every respect similar to the parts surveyed just north of St. Augustine.*

The Guano river scarcely merits the name, yet it retains all the characteristics of a river to its head, its channel and shoals being as well defined throughout as those of the North river, of which it is only a branch.

Six feet of water can be had in the North river up to its head in Diego Plains, upwards of eighteen miles north of St. Augustine. At that place it divides into two large creeks. Above the mouth of the Guano river ten feet may be carried to within a mile of the head of the main river. The channel, however, is very intricate. * * * * * * * The San Pablo road, which was taken as the inland boundary of the plane-table work, follows the coast between the St. John's and St. Augustine, at distances varying between three-quarters of a mile to a mile and three quarters. The coast line above St. Augustine is remarkably straight. At low water a firm, level sand beach is exposed, sixty to ninety metres wide. Two distinct ranges of sand hills of nearly equal elevation, being from

* Appendix No. 30, Coast Survey Report for 1860.

twenty to thirty feet high, rise from the beach and again fall into a belt of woods between the beach and the open prairies of the interior. This belt of sand hills and woods has a breadth of from a quarter to a half mile. In going northward one of the ranges of sand hills disappears abruptly, and thence on the elevations in the other rarely exceed fifteen feet.

The sand hills are mostly covered with scrub palmetto and with a long, stiff grass, which keeps them more compact than similar features on other parts of the Atlantic.

The prairie is generally level, with occasional ponds, a few scattered pines, clumps of palmetto, and hummocks of small live-oak, and is backed by the sandy pine barren. * * *

Yours, very respectfully,

F. W. DORR.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 27.

EXTRACTS FROM THE REPORT OF SUB ASSISTANT G. H. BAGWELL, RELATIVE TO THE CHARACTER OF ST. JOSEPH'S BAY (SOUTH) AND CLEARWATER HARBOR, FLORIDA.

ONANCOCK, *Virginia*, *March* 29, 1861.

SIR:

* * * * * * * * * * *

South of Anclote Keys, the western coast of the Florida peninsula is easy of access, and affords ample facilities for the rapid prosecution of the survey. Bold, prominent bluffs appear in striking contrast with the low, swampy border of the coast above.

Nine feet of water can be carried through Anclote inlet into St. Joseph's bay. The channel is nearly straight, and runs about northeast, midway between South Anclote and Hog island.

Anclote river, abreast of the inlet, is a small stream running back about ten miles through the pine barren. Its entrance is obstructed by oyster bars, affording only a narrow, crooked pass for fishing boats. There are springs of fresh water about a mile up the river.

Clearwater inlet affords twelve feet of water (at ordinary high tide) which can be carried up to the landing. A reef makes out about two miles on the west side of the inlet, curving a little east of north. Its north point is cleared by the range of a low pine and palmetto on the south end of Hog island. The best water is within thirty yards of the reef, and the channel is plain inside of it. Not more than six feet can be carried through St. Joseph's bay. The channel is very crooked and badly marked, and in some places not more than forty feet wide. The smallest coasters rarely attempt the passage through the lower part of the bay.

There are no settlements on the coast between Bayport and Clearwater. A post office has lately been established at the latter place with a weekly mail to Cedar Keys. Only three families reside there. * * * * * * * *

Very respectfully, your obedient servant,

GEORGE H. BAGWELL.

Prof. A. D. BACHE,
Superintendent United States Coast Survey, Washington, D. C.

APPENDIX No. 28.

EXTRACTS FROM THE REPORT OF SUB-ASSISTANT N. S. FINNEY RELATING TO THE FLORIDA COAST AND WATERS NEAR BAYPORT.

BRUNSWICK, *Glynn County, Ga., April* 3, 1861.

DEAR SIR: * * * The character of the topography and the coast generally are the same as described in my previous reports, consisting of a belt of low, soft marsh from one to three miles wide, bordered on the inside by dense forests of pine, palmetto, cedar, and oak, and on the outside by extensive mud flats and coral and oyster reefs. These extend in many places several miles into the Gulf of Mexico, and are cut up by numberless small creeks and bayous, the whole being nearly dry at low water, and the entire surface almost overflowed when the tide is in.

Bayport, the only settlement immediately on the Gulf in the range of coast between Clearwater harbor and Cedar Keys, is situated at the junction of the Wekawatchee and Mud rivers, on a point of land or hammock, which is separated, in part, from the main land of the peninsula by a belt of marsh.

During the summer the village is a favorite resort for the people of the interior, on account of its good air and for bathing and fishing. It contains about forty houses in all, and in ordinary times about as many inhabitants. For some years a considerable trade has been carried on in cedar wood, large quantities being exported to New York for the manufacture of lead-pencils.

The harbor at Bayport is of small capacity and very shallow, not admitting craft requiring over four and a half feet at ordinary high water. Vessels drawing twelve feet find safe anchorage, with smooth water, near Beacon Rock signal, four miles west of Bayport.

The navigation of the coast of Florida near Bayport is dangerous in the extreme, by reason of the sharp jagged rocks and reefs so profusely scattered about. These, in many cases, lie just below the surface at low water, rendering it impossible to see them in time to avoid danger. * * * * * * * * * *

With much respect, I am, your obedient servant,

N. S. FINNEY, *U. S. Coast Survey.*

Prof. A. D. BACHE,
Sup't U. S. Coast Survey, Washington, D. C.

APPENDIX No. 29.

EXTRACTS FROM THE REPORT OF LIEUT. GEORGE BELL, U. S. A., ASSISTANT COAST SURVEY, DESCRIBING THE COAST OF TEXAS BETWEEN THE SABINE AND GALVESTON BAY.

WASHINGTON, D. C., *May* 1, 1861.

SIR: * * * * * * * * * *

East Bay (Galveston) shoals gradually for miles, and from its head, the mouth of East Bay bayou, to a distance of four miles to the west or southwest, a continuous soft black mud flat extends, covered at low tide with a few inches of water, and cut up with channels.

The tide at the head of the bay is small, the north winds producing very low water, and the east and south winds high, depending upon their strength. After entering the bayous over the flats a depth of from six to ten feet can be had for miles. The average width of these channels is only forty feet.

General examinations have been made by parties interested in trade for connecting the

waters of the Sabine and East bay by a canal. The route proposed is by several bayous emptying into the former, and by a small cutting in the vicinity of East Bay bayou.

The general direction of East Bay bayou is nearly parallel to the Gulf coast for about nine miles, and thence to the northward. Its average distance from the coast is less than three miles and a half. The bayou is supplied in part by others entering on both sides from the prairies which they drain.

From the head of East bay to the High islands the land is low wet prairie, covered with ponds, and in many places impassable for wagons. The High islands are the only highlands on the Gulf shore, between Galveston island and the Sabine, and probably the highest on the coast of Texas. Some parts of them are heavily timbered, and all are susceptible of cultivation. Their elevation is from eighty to one hundred and fifty feet above high water, and their area about two thousand acres. The central point of the islands is about a mile and a quarter from the Gulf shore.

From the High islands to the Sabine all is prairie; in some places impenetrable marsh to a breadth of seven miles in wet seasons. Small bayous run through in various directions, and enter into lakes or ponds. Firm land, at all seasons, cannot be found short of six to nine miles from the Gulf, and at many places not short of fifteen or twenty miles. * * *

After passing High islands fresh water can be had only from ponds in the prairie or from wells dug near the sand hills along the Gulf shore.

In very violent southerly winds nearly all the prairie, for some distance back from the shore, is covered by water from the Gulf. * * * * * *

I have the honor to be, very respectfully, your obedient servant,

G. BELL, *Lieut. U. S. A., Assist. Coast Survey.*

Prof. A. D. BACHE,
Sup't U. S. Coast Survey.

APPENDIX No. 30.

EXTRACTS FROM A REPORT BY SUB ASSISTANT J. S. LAWSON, SHOWING THE GENERAL CHARACTER OF KOOS BAY, OREGON.—(SKETCH No. 26)

U. S. C. S. BRIG R. H. FAUNTLEROY, *Koos Bay, Oregon, September* 7, 1861.

SIR: * * * * * * * * * *

With the slight information which we had been able to pick up, before sailing from San Francisco, I declined to risk the vessel by entering Koos bay until some examination had been made of the bar and channel. This was done by the sailing master of the Fauntleroy; and in answer to the signal agreed upon, in case the depth of water should be found favorable, I ran the brig in. The least water we had was two and a half fathoms, it being half-flood as we passed in.

Koos bay is very irregular in outline. Its general shape is somewhat like that of the letter U with the convexity to the northward. A number of sloughs make out from it, some of which are navigable a few miles for vessels drawing ten feet, but the passages are very narrow.

Koos river empties into the head of the bay, and will admit boats to a distance of fifty miles from its mouth, where a small slough emptying into Coquille river is so near as to leave a portage of only a mile and a half between the two waters.

Excepting the peninsula which skirts the ocean, from the entrance of the bay northward, the entire country is an immense forest of various species of the pine. No land for cultivation is found without clearing, and even the bottom lands on Koos river, which present very excellent soil, have to be cleared of the thick growth of laurel, myrtle, and maple trees.

The bar off the harbor lies quite close to the entrance, and at the lowest tides has not less than nine or ten feet of water. It is about a quarter of a mile wide from north to south, but considerably less from east to west. Vessels going either in or out do so on the flood tide, as the water is smoother then than it is on the ebb. The currents run with great velocity, and the ebb causes a heavy break unless the sea is remarkably smooth. The bar is a shifting one, moving to the northward in summer and southward in winter. It has moved considerably to the northward since we arrived, in June.

The north point of the entrance is a low sandy flat, across which was a narrow channel when we reached the bay, leaving then a tolerably large island. So much of this is now washed away that only a small patch is seen at mean high water. At spring tides it is entirely covered. Some change like this takes place every year, and the constant drifting of the sands must have a great effect in altering the channel and bar.

The southern shore is a precipitous rocky bluff, extending from the inside of the entrance as far as Cape Gregory. This, of course, does not change, but the beaches around it alter considerably. Places in which the bed rock is at times bare will, at others, be covered by several feet of sand, always, however, presenting bold sides to the channel inside of the rock which lies at the south side, and which has been known to be on low water mark.

The channel in the bay presents a good depth of water. It passes along the western shore, and vessels should be careful to avoid being set near the eastern shore, as several reefs make off from the rocky bluff which forms that side, opposite to and a mile above the entrance. There is a rock, with nine feet at low water, the position of which will be accurately determined and marked on the chart, if practicable, before the close of the season.

A tugboat is employed at the entrance, saving much time in the passage of vessels in and out of the bay. The peninsula which separates the bay from the ocean is composed entirely of sand, some of the hills on it attaining an elevation of a hundred feet. The sand shifts so much, with strong winds, that in one case the part of a hill on which one of the signals had been set gained fifteen feet in height in the course of a few weeks.

The trade of Koos bay consists of lumber and coal. Of the former, the laurel, myrtle, &c., are extensively used on the Western Coast in the manufacture of furniture. There are at present two saw-mills in operation, capable of turning out about fifteen thousand feet per day. The coal is quite inferior and is not suited for steam vessels, but is much used for stationary engines and for domestic purposes. * * * * * * *

Very respectfully,

JAS. S. LAWSON, *Sub-Assistant.*

Prof. A. D. BACHE,
Sup't U. S. Coast Survey, Washington, D. C.

APPENDIX No. 31.

EXTRACTS FROM OFFICIAL REPORTS RELATIVE TO THE OCCUPATION OF PORT ROYAL SOUND, S. C., BY MILITARY AND NAVAL FORCES OF THE UNITED STATES, AND STATEMENT OF ASSISTANT C. O. BOUTELLE IN REGARD TO THE CO-OPERATION OF HIS PARTY.

Extract from the annual report of the Hon. Secretary of the Navy, 1861.

* * * * * *

It was found that naval stations and harbors of refuge (on the southern coast) during the tempestuous seasons would be indispensable if hostilities were to be continued, and the stations thus secured could also be made the points of offensive military operations. Shortly after the attention of government was drawn to this subject a board was convened, under the auspices

of the Navy Department, consisting of Captain Samuel F. DuPont and Charles H. Davis, of the navy, Major John G. Barnard, of the army, and Prof. Alexander D. Bache, of the Coast Survey, to whom a thorough investigation of the coast and harbors, their access and defences, was committed. Several elaborate and valuable reports of great interest, exhibiting, in minute detail, the position, advantages, and topographical peculiarities of almost every eligible point on the coast were the results of this important commission.

Letter from the president of the commission referred to by the Secretary of the Navy.

WASHINGTON, *October* 2, 1861.

SIR: On closing, for the present, the labors of the mixed conference, in which I have presided, I cannot but express the high opinion I have been led to entertain of the usefulness and merit of the contributions of the Coast Survey to our knowledge of the sea-coasts, sounds, and bays of the Atlantic and Gulf borders of the United States, without which the deliberations of the conference could not have been successfully conducted.

Very truly, your friend and obedient servant,

S. F. DUPONT,
Flag-Officer, President.
C. H. DAVIS,
Commander, Secretary.

A. D. BACHE, L.L.D.,
Superintendent U. S. Coast Survey, Washington, D. C.

Extracts from the report of Flag-Officer S. F. DuPont to the Navy Department.

FLAG-SHIP WABASH, OFF HILTON HEAD,
Port Royal Harbor, S. C., November 6, 1861.

* * * * * *

The department is aware that all the aids to navigation had been removed, and the bar lies ten miles seaward, with no features on the shore-line sufficient to make any bearings reliable. But, by the skill of Commodore Davis, the fleet-captain, and Mr. Boutelle, the able Assistant of the Coast Survey, in charge of the steamer Vixen, the channel was immediately found, sounded out and buoyed. * * * On the evening of Monday Captain Davis and Mr. Boutelle reported water enough for the Wabash to venture in. * * * * On the morning of Tuesday the Wabash crossed the bar.

S. F. DUPONT,
Flag-Officer, Commanding South Atlantic Blockading Squadron.

Extract from the report of Brigadier General T. W. Sherman to the War Department.

HEADQUARTERS EXPEDITION CORPS,
Port Royal, S. C., November 8, 1861.

* * * * * *

It is my duty to report the valuable services of Mr. Boutelle, Assistant in the Coast Survey, in assisting me with his accurate and extensive knowledge of this country. His services are invaluable to the army as well as to the navy, and I earnestly recommend that important notice be taken of this very able and scientific officer by the War Department.

T. W. SHERMAN, *Brigadier General Commanding.*

Report of Assistant C. O. Boutelle.

U. S. COAST SURVEY STEAMER VIXEN,
Port Royal Bay, S. C., November 8, 1861.

DEAR SIR: We are in possession of this noble harbor, and the flag of the Union again floats over two places in South Carolina.

Commodore DuPont intended to resume the attack on Wednesday morning, but a violent gale from the westward prevailed until the afternoon of that day. The Wabash, with only auxiliary steam power, would have worked to great disadvantage in it, and yet, as every hour probably added to the strength of the enemy, whose works were full in our view, to defer opening fire required moral courage in the commander of a higher degree than that called for in fighting.

Our engine gave out on Wednesday, the 5th, in the morning, and it was not until near night that we were again in working order. The R. B. Forbes came to me to say that the Augusta and Dale, steam gunboat and sloop-of-war, were outside. I reported the fact to the commodore, and he expressed so earnest a wish to get them in before the attack that I determined to bring them in at once, though night had already come on. The Augusta draws 13 and the Dale 16 feet. We ran down about 8 p. m., and anchored a boat, with a Fresnel lantern in it, at the entrance of the channel. I then went to the two vessels and communicated the commodore's orders. Both captains were ready to go in if I would take the responsibility of leading them. The Augusta took the Dale in tow, and we passed in without trouble, having no cast less than 19 feet, and I had the satisfaction of reporting to the flag-officer their arrival at half past eleven o'clock p. m. Running outside again I anchored the Vixen at the entrance, in readiness to bring in the Ericcson and the Baltic, drawing 20 and 22 feet. The former vessel came off the shoal on Wednesday, after thumping heavily, and losing five horses belonging to the general staff.

At sunrise we anchored a large spar buoy at the entrance of the south channel. Mr. Platt and Mr. Jones, 1st and 2d officers of this vessel, were then sent on board of the Baltic and Ericcson, respectively, and I led in with the Vixen at half flood. We had no cast less than 27 feet, and I can say with certainty that vessels drawing 25 feet may come in at all ordinary tides.

The Wabash started for the batteries at 8.30 a. m. She was preceded by the Bienville, and followed by the Susquehanna, Mohican, Seminole, Pawnee, Pocahontas, Curlew, Penguin, Augusta, Seneca, Ottawa, Unadilla, Pembina, Isaac Smith, Vandalia, (in tow of the Augusta,) and the R. B. Forbes. The sight was grand, and my only regret was that special duty rendered it imperative that we should not take part in the action.

After anchoring the Baltic and Ericcson, I went on board of the Atlantic with General Sherman and witnessed the fight. The fleet sailed around in an ellipse, under slow steam, each vessel delivering its broadside as the guns were brought to bear. The Wabash, with her tremendous batteries of eight-inch guns on two decks, fairly reeled, as each division fired in succession. At the first turn the fleet went so near that many shells passed over into the woods beyond. As the vessels came around the second time they passed a little further out, and the shells went directly into and around the works of the enemy. Gun after gun ceased firing on shore, until at last only one gun replied to the vessels. As the fleet was about coming around for the third time that gun also ceased, and the flag of the fort came down. Soon we saw a barge from the Wabash pulling in-shore with a flag of truce in her bow, and in a few minutes more the flag of the United States was raised on shore. At the sight of it shouts went up from the troops around us. The whole fleet of transports was soon in motion, and with bands playing and soldiers shouting the vessels passed into the bay and anchored around the flag-ship.

On visiting the Wabash I found, to my utter surprise, that on board one man only had been killed and two wounded. In the entire squadron no officer was killed. The loss is about ten men killed and not many more wounded.

The commodore at once sent five vessels over to Bay Point to engage the fort there; but the enemy had evacuated it in haste, leaving tents, clothing, and other species of personal property, as well as arms and ammunition.

To-day I have been with General Sherman on a reconnaissance up Beaufort river and through Skull creek—the inland passage which leads from Port Royal sound to Savannah river. He does us the honor to say that a large share of the credit of the success here is due to the Coast Survey.

Commodore DuPont desires me to present his regards to you, and say that he will, as soon as possible, express his appreciation of our services, and thank you for the aid rendered by sending our party here.

Mr. Platt, first officer of the Vixen, has afforded me very efficient aid in this whole matter. By skilful seamanship he saved the vessel from injury and probable loss in the fearful gale of Friday and Saturday last. By his knowledge of hydrographic work and his unceasing labor since we reached Port Royal, he has contributed in no small degree to our success.

All the officers of the party in the Vixen deserve commendation for the manner in which each has added, in his sphere, to our successful work. I take especial pleasure in mentioning the labors of Mr. Willenbucher, the hydrographic draughtsman of the Vixen. He made on the voyage three tracings of Hilton Head island, with the entire topography, for the generals of the expedition, and has sketched a view of the battle, which will be sent to you when completed.

Yours, respectfully,

CHAS. O. BOUTELLE, *Assistant U. S. Coast Survey.*

Professor A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 32.

OFFICIAL ORDERS UNDER WHICH THE SURVEYING STEAMER ACTIVE AND HYDROGRAPHIC PARTY OF COMMANDER B. F. SANDS, U. S. N., ASSISTANT COAST SURVEY, WERE EMPLOYED IN AUGUST AND SEPTEMBER, 1861.

HEADQUARTERS OF THE ARMY,
Washington, June 5, 1861.

SIR: The general-in-chief directs that you act in concert with the naval commander on the Pacific station in preventing, so far as your means will permit, any plans the secessionists may attempt to execute for subjecting or annexing Lower California to the so-called Southern Confederacy.

I am, sir, very respectfully, your obedient servant,

E. D. TOWNSEND,
Assistant Adjutant General.

Brigadier General SUMNER, *U. S. Army,*
Commanding Department of the Pacific, San Francisco, Cal.

[Indorsed.]

HEADQUARTERS OF THE PACIFIC,
San Francisco, August 13, 1861.

Official.

RICHARD C. DRUM,
Assistant Adjutant General.

COMMANDANT'S OFFICE,
Navy Yard, Mare Island, Cal., August 23, 1861.

SIR: I have called your command to the yard for the purpose of placing the magazine, which is threatened by report to be attacked, under your protection.

You will, after towing the United States ship St. Mary's to the anchorage off San Francisco, return to this island and anchor off the magazine, placing your command in such a position as to enable you to defend the public property from any attack that may be attempted. Guns will be placed on shore, with such officers and men as can be mustered, to co-operate with you in protecting the premises. A rocket, gun, or blue light will give me warning, if exhibited in due time.

Very respectfully, &c., &c., &c.,

WM. H. GARDNER, *Commandant.*

Commander B. F. SANDS,
U. S. Steamer Active, Mare Island, Cal.

HEADQUARTERS DEPARTMENT OF THE PACIFIC,
San Francisco, California, October 18, 1861.

SIR: The general commanding the department acknowledges with great pleasure the valuable services rendered by the United States Coast Survey steamer Active, under your command, in the transportation of troops and supplies from this city to San Pedro, California.

Very respectfully, your obedient servant,

RICH'D C. DRUM, *Assistant Adjutant General.*

Commander B. F. SANDS, *U. S. Navy,*
Commanding U. S. C. S. Steamer Active.

APPENDIX No. 33.

HEADQUARTERS CHEAT MOUNTAIN DIVISION,
Philippi, December 13, 1861.

SIR: During the campaign of 1861 in Western Virginia it was determined to construct defensive works on the summit of Cheat mountain. The superintendence of these works was assigned to Lieutenant Colonel Samuel A. Gilbert, 24th Ohio, (now colonel 44th Ohio,) under whose direction the works originally laid out, as well as others devised by himself and Colonel Ammen, were constructed. In the execution of this duty Colonel Gilbert exhibited superior skill and untiring industry, and I cheerfully bear testimony to his valuable services as engineer.

Very respectfully, your obedient servant,

J. J. REYNOLDS,
Brigadier General Commanding Division.

A. D. BACHE, *Superintendent U. S. Coast Survey.*

APPENDIX No. 34.

LETTER TO THE SECRETARY OF THE TREASURY COMMUNICATING THE RESULT OF AN EXAMINATION MADE WITH REFERENCE TO THE EXPEDIENCY OF ESTABLISHING A LIGHT-HOUSE AND PLACING BUOYS AT THE ENTRANCE OF GRAY'S HARBOR, W. T.

COAST SURVEY OFFICE, *August* 21, 1861.

SIR: Referring to the letter, dated April 22, from the department, directing that a preliminary survey should be made to ascertain the necessity for a light-house at Gray's harbor,

Washington Territory, or for buoys to mark the bar and channel, I have the honor to transmit in reply the following extracts from a report made by Sub-Assistant James S. Lawson. To these will be added the conclusions of Capt. C. P. Patterson, chief of the hydrographic office, whose experience and intimate acquaintance with the requirements of trade and commerce on the western coast are such as to entitle his opinion to great weight in any question like the one now presented.

Mr. Lawson says :

"The only possible good a light-house could serve at Gray's harbor would be to mark out its position, and this can be done well enough by the one at Shoalwater bay; but for some reason the light at Shoalwater has been discontinued, and possibly is not yet restored, though there is a much larger population there, and a great deal more trade, than at Gray's harbor. The mud flats are so extensive that at least nine-tenths of the bottom of the harbor is bare at low water. The trade merely amounts to bringing the supplies needed by a few settlers, and by the military post on Chehalis river. These, in all, during seven months of last year, reached only one hundred and twenty-five tons. There are no exports, the difficulty of approaching the shores being such as to hinder the development of any trade in lumber as yet, though the shores are heavily wooded.

"The interests of settlers at Gray's harbor will be better served by the placing of buoys to mark the bar, and the channel into the bay, as also that leading from the entrance of the harbor to Point Hanson and the north channel. I would also recommend that a buoy be placed on the end of the south spit, where the water probably breaks during heavy winter weather as much as four and five miles off shore. The buoys should be like those at Columbia river, and should be well secured."

Captain Patterson remarks as follows :

"In regard to the question of erecting a light-house at Gray's harbor, I fully agree with the reasons and conclusion of Mr. Lawson. A light-house there is, at present, and will be for many years, totally unnecessary. The interests of the small local trade will be best secured, as suggested by Mr. Lawson, by the placing of proper buoys. The buoy recommended by him for the end of the south spit would be of great service to the coasting steamers."

Fully concurring in the conclusion reached by Captain Patterson and Mr. Lawson, that it is inexpedient to erect a light-house at Gray's harbor, I would respectfully suggest that a copy of this communication may be furnished to the Light-House Board, so as to place on file the recommendations in regard to buoys.

Very respectfully, yours,

A. D. BACHE,
Superintendent United States Coast Survey.

Hon. S. P. CHASE,
Secretary of the Treasury.

INDEX OF SKETCHES.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

Please Note:

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

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