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REPORT

OF

THE SECRETARY OF THE TREASURY,

COMMUNICATING

A report from the Superintendent of the Coast Survey, showing the progress of the survey during the year ending November, 1846.

December 10, 1846.

Read, and ordered that it be printed; and that 500 copies, in addition to the usual number, be printed—250 copies thereof for the use of the superintendent of the coast survey.

Treasury Department, *December* 10, 1846.

Sir: I have the honor to transmit, herewith, a report made to the department by Professor A. D. Bache, superintendent of the coast survey, showing the progress of the work during the year ending November, 1846.

All which is respectfully submitted.

R. J. WALKER,
Secretary of the Treasury.

Hon. Geo. M. Dallas,
Vice President of the United States, and President of the Senate.

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Coast Survey Station, Cape Ann, Mass.,
November 25, 1846.

Sir: I have the honor to present a report of the progress of the survey of the coast of the United States during the year ending with the present month, made in compliance with the regulations of the Treasury Department.

The report embraces the operations of the different surveying parties in the field, and the office work, including computations, drawing, engraving, and publishing of maps and charts. At the close an outline is given of the work proposed for the next fiscal year, with an estimate of the cost of execution.

The plan upon which the work has proceeded during the past two years contemplates the survey, at one and the same time, of different sections of the coast, and the publication of the resulting maps. Thus, in 1844-'45, the triangulation was begun in North Carolina, and a reconnaissance made on the Gulf of Mexico, from Mobile bay westward and eastward. At the same time, the work was vigorously prosecuted, in all its

National Oceanic and Atmospheric Administration

Report from the Secretary of the Treasury communicating the report of the Superintendent of the Coast Survey

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branches, in the eastern section, and in the Chesapeake section, and unfinished parts were completed on the coast between Point Judith and the capes of the Delaware.

In 1845–'46 the operations to the eastward, on the Chesapeake, and unfinished parts of the intermediate section, were resumed. The number of parties in North Carolina was increased, and the triangulation on the Gulf of Mexico was commenced, and provision was made in the estimates for adding further to the activity of the work in those sections during the latter part of the year. The reconnaissance of the coast of South Carolina and Georgia, and of the coast of Texas, was directed.

While the maps and charts founded on the previous work of the coast survey are gradually publishing, those also derived from the work of the current years are engraved and published without delay.

The plan thus developing has received the sanction of the heads of the Treasury Department, and of Congress; and the increased appropriation required by it has been asked for by the department, and granted by both houses of Congress, for two successive years. It has great advantages in point of economy, realized in part from the division of labor, and in part from prosecuting the work according to the season, at the north or south. It has great advantages in yielding results at once upon parts of the coast which otherwise would not be reached in years. It has a great advantage in recognising the work as essentially *temporary*—one to be finished as rapidly as is consistent with accuracy, and the results of which are to be given to the public as soon as they may safely be thus presented.

In two or three years more the whole system may be as fully developed as would be proper in an economical sense; and, while anxious to push the survey to its completion, and to cause it to yield fruit abundantly and in season, I do not desire to carry the appropriations for it beyond its just proportion. While deeply impressed with the importance of the work to the commerce and navigation of our whole country, while believing that a great saving of property and of life would be effected by the supply of accurate coast charts to our navigators, I am far from desiring to exaggerate this importance, or this saving, or to claim more liberal supplies for this work than are justly due to it. The discovery of the new South Shoal off Nantucket, the exploration of Horn Island channel in Mississippi sound, (sketches of which have been already published,) are illustrations occurring within the present year of the value of the work: a shoal six miles south of any known danger, lying directly in the usual track of vessels between New York and Europe, and in that often followed by coasting vessels between New England and New York, out of sight of land, unmarked and unknown except to the lost.

The extent of the shore line of our coast has been much under-estimated. Although it is not possible to determine it with precision, unless in parts recently surveyed, nevertheless the relative extents of different portions of it may be ascertained nearly enough to make a division into sections, each of which shall have about the same extent of shore line. If the coast bordering on the Atlantic and Gulf of Mexico were divided into nine such sections, including, in the estimate of extent of shore line, that of rivers to the head of navigation for coasting vessels, they would embrace, severally, Maine, New Hampshire, and part of Massachusetts; the remaining part of Massachusetts, Rhode Island, Connecticut, New York, and part of New Jersey; the remaining part of New Jersey, Pennsylvania, Dela-

ware, Maryland, and part of Virginia; the remaining part of Virginia, and the chief part of North Carolina; the remaining part of North Carolina, South Carolina, and Georgia; part of Florida; the remainder of Florida and Alabama; Mississippi and part of Louisiana; the remaining part of Louisiana and Texas. A more convenient division, as far as the purposes of the survey are concerned, and which will not materially disturb this equality, is into the following nine sections:

No. 1, or eastern section, from Passamaquoddy bay and the St. Croix, to Point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.

No. 2, from Point Judith to the capes of the Delaware, (to Cape Henlopen,) including the coast of the States of Connecticut, New York, New Jersey, Pennsylvania, and the greater part of Delaware.

No. 3, from the capes of the Delaware to the capes of the Chesapeake, (Cape Henry,) including the coast of a part of Delaware, of Maryland, and part of Virginia.

No. 4, from the capes of the Chesapeake to Cape Fear, including the coast of part of Virginia and the whole of North Carolina.

No. 5, from Cape Fear to Cumberland sound, (St. Mary's river,) including the coast of South Carolina and Georgia.

No. 6, from Cumberland sound (St. Mary's river) to St. Joseph's bay, on the west coast of the peninsula of Florida.

No. 7, from St. Joseph's bay to Dauphin island, at the entrance to Mobile bay, including the coast of part of Florida and the whole of the coast of Alabama.

No. 8, from Dauphin island to Vermillion bay, including the coast of Mississippi and a considerable part of that of Louisiana.

No. 9, from Vermillion bay to the boundary, including the remainder of the coast of Louisiana and the coast of Texas.

Of these sections the eastern (No. 1) includes the greatest extent of shore line, but also presents the greatest facilities for the execution of the work.

The survey of one of the nine sections (No. 2) is in general completed, and that of six others (Nos. 1, 3, 4, 5, 8, and 9) is in progress. The work remaining to be done in No. 2 can be executed gradually, as parties are disposable for it.

In sections 1 and 3 the work is in full progress, the field parties being engaged in different portions of the sections. These embrace the coast of Maine, New Hampshire, Massachusetts, and Rhode Island, and of part of Delaware, Maryland, and Virginia.

A full beginning of the survey has been made in Nos. 4 and 8, embracing the coast of North Carolina and part of Virginia, and the coast of Mississippi and Louisiana; and I shall present gradually the estimates necessary for giving the same efficiency to the work in these sections as in Nos. 1 and 3. The preliminary operation of a reconnaissance is not expensive. Next in order are the triangulations and astronomical observations, which prepare for the topographical and hydrographical parts of the work, so that the progress is one of increasing activity from the reconnaissance forward, until all the operations of the survey are embraced, when the limit of expenditure allowed for the section is reached.

Reconnaissances introductory to the operations in sections 5 and 9, on the coast of South Carolina and Georgia, and of Texas, have been ordered. In my estimate I shall include a sum for commencing the triangulations

and astronomical observations in these sections, and for at least the preliminary measurement of base lines.

It is easily seen that by this plan the survey of the whole coast may be completed within a very limited period of time, the number of sections under survey at the same time determining the period of completion of the entire work. Each section in which all the operations are in progress upon the present scale will cost about twenty-five thousand dollars per annum, comprising the cost of field work, of reduction and publication of results. This estimate supposes the same proportional aid heretofore had, under the law, from the services of officers of the army and navy.

Before the close of the fiscal year of 1847–'48, the survey will be in full activity in six sections, and may be carried on successfully in them for one hundred and fifty thousand dollars per annum, with the addition of such sums as may be necessary from time to time to meet the general items of expenditure, such as for procuring instruments, the increase in number and improvement in quality of which are absolutely necessary; the hire or purchase of the small vessels needed for the parties in the southern sections; current repairs of vessels, general office expenses, and the like. The use of steam vessels upon the work would increase the expenditure for certain years, but would be economical in regard to the amount of work which they would enable the hydrographic parties to do in a limited time.

The amount of the estimate submitted at the close of this report is less than that named above, because, in some of the sections, the work is only commencing.

The cost of publishing maps and charts is included in the estimates, so that charts of harbors of refuge and others of importance, and the general charts of different parts of the coast, will appear as the work advances. The experience of the past two years shows that five or six sheets can be published within the year—two to three sheets of general coast maps, and three to four of harbor maps, executed in part by contract, out of the office. The facilities of the office will increase as the young men under instruction there advance in their art. The back work, materials for which had accumulated in the office when I came into the charge of the survey, is publishing, without preventing the publication of results as they are obtained, so that by the time the work in the new sections is far enough advanced to yield its fruit year by year, there will be the means for immediate publication at hand, without materially enlarging or adding to the expense of that part of our establishment.

It will not be necessary to confine the work to the proposed six sections, requiring that the others should wait their turn for the completion of one of these before they can be begun. As the work in a section is progressive from its first beginning, by a reconnaissance, to its full development, so the closing of the operations is in succession. The primary triangulation in section No. 1 (eastern section) might be finished in two years from the present year. It is not necessary that it should be finished in that time, but only that it be kept sufficiently in advance of the secondary triangulation to furnish the checks required by the latter. A system of checks on the other part of the work should be devised and executed by the superintendent personally, which may occupy much time, and thus postpone, with advantage to the work generally, the completion of the eastern primary triangulation. If it were desirable, however, the primary triangulation might, reasoning upon the average rate of progress of the last three years, be completed in

two seasons more, leaving this party available for another section. In the primary work in No. 3, though it must necessarily be connected in a degree with the larger secondary, will be completed before the rest of the triangulation—say in four to four and a half years from the present—making this party available. It is altogether probable, in this progress, that the secondary triangulation parties will be disposable from the more northern section before the topography and hydrography are finished, and that by working part of the year to the north and part to the south, the newer southern sections may receive attention at an earlier date than would be otherwise practicable. It is but fair to assume, then, that the work may be going on in every section on the coast before the expiration of three years from July, 1847.

The off-shore hydrography I have not particularly spoken of, supposing it to go on step by step with the other parts of the work. The present plan of conducting it must, I am satisfied, be exchanged for a more effective and accurate one, though involving a greater expense. It will be necessary to use steam vessels for hydrographic purposes, if we would keep pace with the improvements of the day. The actual cost of working steam vessels is considerable; but the cost, measured by the work done, which is the real economical result upon which to reason, is, I am persuaded, less than that for sailing vessels. The experience of those officers upon the work who have used steamboats in sounding, heretofore, was shown, in the report of last year, to be decidedly in favor of their use; indeed, in some positions, as in the survey of the South Shoal of Nantucket, where the work can only be done for some four to eight weeks in the course of a season, they are indispensable to reasonable progress.

During the past year the parties of the coast survey (including those of reconnaissance) have been at work in fourteen States, viz: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Alabama, and Mississippi: a party is under orders for the coast of Texas, and a reconnaissance of a part of the coast of Florida will be made if practicable. The estimate herein submitted will carry the survey into seventeen States.

The withdrawal of all the officers of the line of the army for military service has been felt in the progress of the last season, and the further loss of the services of two officers of topographical engineers will sensibly retard one part of the work, or will require an expenditure not calculated upon when the estimates were made.

I must here observe that much of the efficiency of the hydrographic part of the survey, during the past year, has been the result of the very liberal action of the late and present Secretaries of the Navy, who, under the law authorizing their aid, have afforded every facility to the work. The cordial co operation of the officers of the navy with the department has given the highest degree of efficiency to this important part of the coast survey.

The progress of the work during the year ending with November, 1846, may be thus summed up:

In section No. 1, the primary triangulation has extended its lines into New Hampshire and Maine. The stations occupied being the most northerly ones in Massachusetts, one astronomical station has been occupied, and magnetic observations have been made at suitable points of the coast. The secondary triangulation of the southern part of Cape Cod has been completed, and the lines extended over the cape and the western shore of Massa-

chusetts bay. The secondary triangulation of Boston harbor has been commenced. The topography of Martha's Vineyard, the island of No Man's Land, of Nantucket, and of the main from Wood's Hole, to include Hyannis, has been completed. The survey of the shoals south of Nantucket, and of Nantucket sound, has been commenced. The harbors of Edgartown and Nantucket have been surveyed. Further observations, for differences of longitude from European observations, have been obtained at Portland, Cambridge, and Nantucket.

In section No. 2, magnetic observations for the chart of the Delaware and Little Egg Harbor have been made. Verifications of topography have been made. Additional observations for differences of longitude and for latitude have been obtained at Philadelphia. The currents of Long Island sound have been in part investigated. Additional soundings have been taken.

In section No. 3, the primary triangulation has been carried from the Kent island base south, to near the mouth of the Potomac. The primary triangulation across from the Chesapeake to the Capitol and naval Observatory has been in progress. Further astronomical and magnetic observations have been made. The secondary triangulation has been carried down the bay nearly as far as the primary, and has covered the Eastern bay, the Chester, Wye, Choptank, South and West rivers, and part of the Patuxent. The unfinished portion of the topography from the head of the Chesapeake to Baltimore, of the shores of the Patapsco and rivers north of it, has been completed. That of the Chester river and adjacent shores of the bay, the South and West rivers, and Sassafras, has been commenced. That of the western shore of Kent island has been in part finished. The hydrography has included the upper part of the Chesapeake, from Poole's island to the Susquehannah, and below Kent island to near the mouth of the Patuxent, the South and West rivers, Eastern bay, the Susquehannah, Northeast, Bush, Gunpowder, Middle, and Back rivers, and part of Chester river and its approaches.

In section No. 4, astronomical observations have been made at one station on Bodie's island. The primary and secondary triangulations have been carried over Albemarle and Roanoke sounds, from "the marshes" to Carroon's point, and the triangulation of the Pasquotank has been commenced.

A reconnaissance of the coast of South Carolina and Georgia (section No. 5) has been commenced.

In section No. 8, the primary and secondary triangulations have been extended from the entrance of Mobile bay, westward, to Horn island. Observations of tides and currents have been made, and the preliminary survey of Horn island channel has been made.

A reconnaissance of the coast of Texas (section No. 9) has been ordered.

The exploration of the Gulf stream, from the latitude of Sandy Hook to that of Cape Hatteras, has been made upon three sections across the stream.

The magnetic telegraph has been used to ascertain the difference of longitude between the Washington and Philadelphia Observatories, as an introduction to operations on a larger scale.

The determination of differences of longitude from Europe, by the chronometers of the Boston steam vessels, has been continued.

The office computations of the observations of 1844 and part of 1845 have been completed. The computations of astronomical observations, for difference of longitude from European observations, have made good progress.

The charts of New Bedford and Annapolis harbors, (surveyed in 1844,) promised in my last report, have been published; also the chart of Fisher's Island sound and the middle sheet of Delaware bay and river, the chart of Little Egg Harbor, a sketch of the newly discovered South Shoal ("new South Shoal") off Nantucket, (1846.) The chart of New Haven harbor is ready for printing. A sheet embracing the eastern entrance to Long Island sound, and one extending from Port Penn, on the Delaware, to the head of navigation, are nearly ready. The charts of New London and Syosset (Oyster bay) harbors are nearly engraved. Considerable progress has been made in engraving the charts of Holmes's Hole and Tarpaulin cove, both harbors of refuge, and the large sheet of the entrance to Delaware bay. An off-shore chart, from Point Judith to Cape Henlopen, has been commenced.

Drawings of a chart of the Patapsco, in two sheets, and of the coast on the south side of Long island, and several harbor charts, are nearly finished.

A more particular account of the different parts of the work will be found in what follows. The different operations of the survey will be classified, as heretofore, under the heads of—

1. The primary triangulations, and astronomical and other observations connected with them.
2. The secondary triangulations, and others connected with them.
3. The topography.
4. The hydrography.
5. The office work—including, first, the calculations of the survey; second, the drawing and reducing of maps and charts; third, the engraving, printing, and publishing of the maps and charts; fourth, the making and repairs of instruments.

The progress of the field operations will be stated under the heads of the geographical sections, into which the coast has been divided, in reference to convenience of surveying.

The office work will be reported in its different subdivisions.

The progress marked out for the work for the next fiscal year will then be given, with an estimate of the cost of its execution.

SECTION I—EASTERN SECTION.

From Passamaquoddy bay to point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.

The work in this section has been vigorously prosecuted; and, though the season has been remarkably unfavorable, the combined efforts of the different parties have produced a satisfactory progress; and, indeed, have pushed the work farther, in parts of the section, than was anticipated.

The labors of the hydrographic party have been rewarded by the discovery of a shoal to the southward of that known as the Nantucket South Shoal; and of a shoal spot in the Vineyard sound, where it was supposed there was deep water. They have thus rendered, in one season, important service to the commerce between Europe and the United States, and to the coasting trade; the dangers discovered being, as it were, in the highway of each. A particular reference to these and other details of the survey will be made under the head of the several operations of which it is composed.

1. *Primary triangulation.*—The general scheme of this triangulation was stated in the report of last year. It has been extended, by a reconnaissance, into the States of New Hampshire and Maine, by the occupation of two triangulation stations, the lines of sight from which pass into Maine and New Hampshire, and by astronomical and magnetic observations.

The reconnaissance was made, under my immediate direction, by assistant C. O. Boutelle, during part of June, July, and August, and resulted in the choice of Gunstock mountain, in New Hampshire, and of Agamenticus, in Maine, as stations in the principal chain of triangulation, and of Pattuccawa and of the Isle of Shoals for the minor chain. The bases Gunstock-Agamenticus, Gunstock-Pattuccawa, and Pattuccawa-Agamenticus, furnish the requisite facilities for extending the work along the coast of Maine. The stations and connecting sides are marked upon sketch A. Those unoccupied are marked (u.)

As the primary triangulation in this section is considerably in advance of the regular progress of the secondary work, I availed myself of the opportunity to execute, personally, an important part of the work to the south, which will be noticed in its proper place. The party under my immediate charge was transferred to the eastern section at the close of August, and remained in the field until the 4th of December, occupying the two stations marked (o) 1846, on sketch A. The very unfavorable character of the season for this work may be inferred from the fact that the first station, which, with average weather, would have occupied not more than three weeks, required seven to complete it, though the lines of sight were, in general, not long.

The difficulties at the Cape Ann station, with its long lines (the line to Gunstock is about 70 miles in length) and numerous points requiring observations in connected series, were enhanced by the unusually stormy character of the autumn weather.

The number of primary points observed upon have been 15, and of secondary points 3. These latter were for a connexion with the work in Boston harbor. The number of angles, independently measured, has been 20, and 1,164 observations have thus far been made in their measurement. The area of the polygon, including the work, is 388 square miles, estimating, as heretofore, the area of those triangles in which two angles have been measured at two-thirds, and of those in which one angle has been measured at one-third, of the real area of each.

The Cape Ann station (marked Thompson's in sketch A) was occupied as an astronomical station. The observations for latitude and time were made by Lieutenant T. J. Lee, of the United States topographical engineers, aided by assistant R. H. Fauntleroy. The observations for azimuth were made by me personally, with the occasional aid of assistants Boutelle and Fauntleroy. The instruments used in obtaining latitudes were decidedly better than those heretofore available for the purpose, consisting of a ten-inch Gambey theodolite, imported by assistant Blunt, and purchased for the survey at the close of last year, and of a zenith telescope, kindly loaned by Major J. D. Graham, of the United States topographical engineers. This instrument, adapted to the use of a method first (I believe) proposed by Captain Andrew Talcott, formerly of the corps of engineers, and used successfully by him, by Professor Courtenay, and by Lieutenant Emory of the United States to-

pographical engineers, has also yielded excellent results in the hands of Lieut. Lee and Mr. Fauntleroy. A similar one, with such improvements as use by the gentlemen before named had suggested, was ordered from Troughton and Simms, but, not arriving in time for the season's work, was replaced by the instrument loaned by Major Graham. I am happy to be able to state that the zenith telescope for the coast survey has since been received. The number of observations for latitude with the ten-inch Gambey was 1,322, and 120 sets of observations were made with the zenith telescope; the number of observations for time, as auxiliary to these, was 73. The new catalogue of the places of the stars, by the British Association for the advancement of science, gives great facilities for the use of the zenith telescope.

The observations for azimuth were made with the two and three-feet theodolites of the coast survey; the latter had been adapted more completely to this purpose by the addition of a clamp and tangent screw for slow motion in the vertical plane, and a graduated circle as a finder. The object of two sets of observations was to compare the results derived from different instruments, and from the elongations of different circumpolar stars; comparisons which will be continued, as important in their bearing upon the causes of difference of local determination of azimuths. The number of sets of observations for azimuth was 45.

Five hundred and forty observations of magnetic variation, dip, and intensity, were made by Lieut. T. J. Lee, assisted by Mr. Fauntleroy, at several stations in the Vineyard sound, and at Dorchester heights, near Boston harbor.

The instruments used were the portable ones, improved by Riddle, referred to last year, and a dip circle made by Barrow, successor to Robinson.

A meteorological journal, containing three observations, each day, of the temperature, the moisture of the air, (by the wet-bulb,) the direction and force of wind, clouds, and at Cape Ann station the pressure of the air, was kept by Mr. George Davidson.

The operations of my party during the last winter in North Carolina, and those of assistant Boutelle, under my immediate direction, in the same section, of Lieut. Lee and myself in the Chesapeake section, and of Lieut. Lee in the middle section, will be referred to under the head of those sections respectively.

During the winter, Lieut. Lee was engaged, with the assistance of Lieut. J. G. Martin, United States army, then attached to the coast survey, in recomputing his observations for latitude, and the observations made during the present season. Assistant Boutelle made, in the spring, the computations of his winter's work in North Carolina.

The astronomical observations at Nantucket, the special object of which was stated in my last report, have been continued by William Mitchell, esq. They have consisted of observations for latitude with the West Point circle and Professor Perry's transit, placed on the prime vertical of moon culminations, with the Massachusetts transit, and of such of the occultations computed by R. T. Paine, esq., as the weather permitted to be observed. They were interrupted for a time by the effects of the disastrous fire at Nantucket. Mr. Mitchell's house was saved from probable destruction by fire, and these instruments from injury, by the energy and skill of Lieut. Commanding Davis and his officers and men, who were on duty in the port of Nantucket.

The number of observations reported to August 24th were 200 moon culminations, 120 prime vertical intervals, and about 100 series of circle observations, generally of 10 repetitions each, besides the observations of the solar eclipse of the 25th April, and other results.

A portable clock, by Troughton, belonging to the coast survey, has been sent to Mr. Mitchell, to improve the means of keeping the time for observations generally.

Observations of the solar eclipse of April 25th, for longitude, were made, by my direction, at Portland, Maine, by Lieutenant Charles H. Davis, U. S. navy, assistant in the coast survey. They included the distances between the cusps, and differences of right ascension and declination of cusps and limbs. Lieutenant Davis acknowledges his obligations to Mr. Senter, of Portland, for the use of his transit instrument.

The observations communicated by W. C. Bond, esq., and the computations of S. C. Walker, esq., having rather a general than local object, I postpone the mention of them until the local work in each of the sections has been disposed of.

2. The reconnaissance for the *secondary triangulation* embraces the whole of Cape Cod and the shore of Massachusetts bay to Manomet hill, near Plymouth. The triangulation has been completed so far as to embrace the southern shore of the cape, with lines of sight to many of the stations farther north. The work has been under the charge of assistant C. M. Eakin, whose party took the field on the 10th of June, and left it, to be transferred to one of the southern sections, on the 21st October. A severe and painful accident, which prevented the possibility of working in person, caused the detention of assistant Eakin from the field in the earlier part of the season. The number of stations occupied by him was 13; the number of objects observed upon, 199—viz: 95 stations, 28 light-houses, 48 spires, 24 signals, and 4 beacons—and the number of angles measured was 3,582. The area contained in the work is 560 square miles. The triangulation is represented on sketch A. The same instrument has been used as heretofore, in this work.

Assistant Eakin was occupied, during the winter, in making duplicates and calculations of the work of the previous season, with a diagram and descriptions of stations.

3. The *secondary triangulation* of Boston harbor was commenced in the month of August, under an arrangement made to that effect with the commissioners of the Commonwealth of Massachusetts, with the approval of the Treasury Department. The work has been in charge of assistant C. O. Boutelle, who has made the reconnaissance for the whole work, and executed a considerable portion of the triangulation, including its connexion with the primary triangulation.

Between the 27th of August and the 30th of October, 17 stations were occupied, and angles measured upon 254 objects—viz: with the two-feet theodolite 173 angles, by 856 observations; and with the Gambey theodolite 87 angles, by 694 observations. The whole number of observations made was 1,550. The area included in the work is 204 square miles. At the main stations, the two feet theodolite was used; and at the less important, a six-inch Gambey theodolite, graduated to ten seconds, and reading by two verniers. This work is in addition to that provided for in my last report.

4. The *topographical work* of this section has embraced the northern

shore of the Vineyard and Nantucket sounds, from Wood's Hole eastward, to include Hyannis harbor, Martha's Vineyard, the small island of No Man's Land, and Nantucket. The topography of the shores of Boston harbor has also been commenced. The work is shown in sketch A, where the plane table sheets are marked 5, 6, 7, 8, 9, 13, 14, and 15. It has included, omitting the topography near Boston harbor, an area of more than 220 square miles, a length of 438 miles of shore line, including the shore line of ponds, and of 215 miles of roads. The area surveyed is one fifth greater than that executed last year in this section. The shores of two important harbors of refuge and of one commercial port are included in the surveys.

Sheets numbered 5, 13, 14, and 15 were assigned to assistant W. M. Boyce, and the first three have been completed during the season. The country embraced in these sheets is of varied aspect, that of No. 5 being undulating, and without wood; on Nos. 13 and 14 generally flat and wooded, and cultivated only in the vicinity of the villages. The area of the work executed between the 17th of June and 1st of October, when the report was made, is about 81 square miles; upon which 191 miles of shore line and 63 of roads have been chained. Assistant Boyce was occupied during the winter in putting in ink his work of the previous season.

The work done in section second, by assistant Boyce, at the close of 1845, has been referred to in my last report. He took the field on the 13th of May of this year, in the same section, for work, which will be stated in its proper place; and, closing his work on the coast of Massachusetts on the 8th of November, transferred his party to the North Carolina section, (No. 4.)

Assistant Boyce has had the use of a small vessel during the season.

Lieutenant E. O. C. Ord, United States army, was assigned to this party; but, before taking the field with it, was detached from the survey and ordered to duty with the army.

Sheet No. 4, commenced last year, has been finished, (see sketch A,) and Nos. 6, 7, 8, and 9 commenced and finished, by assistant H. L. Whiting, aided by Mr. Samuel A. Gilbert, and during the latter part of the season by Mr. W. E. Greenwell. The shore upon the Vineyard sheets, Nos. 6 and 7, is described as generally level and sandy, and cut up by numerous ponds; the interior is wooded. That embraced in the Nantucket sheets is more varied—the north shore being high and irregular, and ending in sand bluffs; the south shore level, and intersected by ponds. The work, generally, has not required the same amount of detail as that of the north side of the Vineyard; it has, however, included the towns of Edgartown and Nantucket.

Assistant Whiting took the field in May; but the early part of the season proving unpropitious, the work was not actually begun until about the first of June, between which time and the 20th of October the following progress was made:

Area surveyed, 139 square miles; extent of shore line, 145.5 miles; of shore line of ponds, 102.5 miles; of roads, 182 miles. The immediate party of assistant Whiting was transferred to Boston harbor in November, leaving Mr. Greenwell to complete the work on Nantucket.

5. The *topography* of Boston harbor was begun, according to an arrangement with the commissioners of the Commonwealth of Massachusetts, in November, by assistant Whiting, aided by Mr. Gilbert. The portion including the shore at South Boston, the city wharves, the shore near Charlestown and East Boston, will be completed before Mr. Whiting leaves the field.

6. The *hydrography* of this section has been executed by the party under the command of Lieutenant Commanding Charles H. Davis, United States navy, in charge of the surveying schooner Gallatin. The work (see sketch A) has included the completion of the soundings of the Vineyard sound proper, the survey of Edgartown and Nantucket harbors, a reconnaissance south of Nantucket, and a survey of the South Shoal, with the determination of a new shoal six miles southward of the well known Nantucket South Shoal. The charts of Edgartown and Nantucket harbors will be at once reduced, preparatory to engraving.

The whole season has been unfavorable to hydrographic operations. During the early part of it, delay was experienced from the difficulty in procuring seamen; and when the operations were commenced, on the 14th of June, they proceeded but slowly from the constant occurrence of storms and fogs. By a judicious arrangement of the work, however, a good deal has been accomplished. The harbors were reserved for work in boisterous weather; the roadsteads and the sound, and the outside, for more favorable times.

The method which I had adopted for surveying the South Shoal and the ground near it was by the determination, from two shore stations, of the positions of two vessels at anchor; and from these, again, the position of another vessel or of boats. Verifications by the introduction of a third shore station, and the measurement of angles from the station vessels and from the sounding vessel or boats, were included in the plan. All the preparations for this work were completed, when the tripods intended for the shore stations were destroyed by the disastrous fire which consumed a considerable part of the town of Nantucket, on the 13th and 14th of July.

These disasters repaired, the month of August was spent in surveying the shoals south of Nantucket, in the Gallatin, and with the aid of two small vessels hired for the occasion. I give the description of the discovery made by this party in the words of Lieutenant Commanding Davis:

"The most important result of this undertaking is the determination of a shoal, hitherto unknown, six miles to the southward of the known South Shoal, having only eight feet of water on it in some places, and lying, for a distance of nearly two miles, in an almost east and west direction. The position of this and the old South Shoal have been satisfactorily defined. Some soundings have been made between them, and the deep water has been followed out to the southward of the newly-discovered shoal. Specimens of bottom, varying frequently, and affording valuable indications to the navigator, have been preserved.

"Another important result is the determination of the set and velocity of the currents in this neighborhood. Six stations have been occupied for these observations. At three of the stations, 4, 3, and 2 ebbs, and as many floods, were observed; at the other three, only one complete series was made: the latter harmonize, however, perfectly with the former. At the three first stations the observations were made by Lieutenant Maffitt; at the last, by Passed Midshipman Foster. All these observations have been plotted upon both the circular and rectangular diagrams, by Lieutenant Maffitt; and you will be gratified by the agreement of the observations, as well as by the manner in which they are presented.

"It is well understood by the pilots that a knowledge of, and strict attention to the currents in this place, conduces more to safety than any familiarity with depths alone. The position of the shoals being accurately

given, it concerns the security of the vessel but little whether she is sailing in 10 or 20 fathoms of water; but it is indispensable to her security that her commander should know the course she is actually making *good*, in passing near one of these hidden dangers. The soundings vary much, and irregularly, about the Nantucket shoals. They are, moreover, deceptive, the deep water often leading up to the very verge of the shoals, and misguiding the navigator in a fog, and in the night; but if he knows that he may steer an east or west course, safely by the shoals, he has merely to be careful that his course is really made.

"There is no doubt that this point is frequently neglected. During my stay among the shoals, eight foreign trading vessels (square rigged) passed in sight; all of them, without exception, were carried out of their course by the disregarded influence of the current—some of them as much as two or more points. In several cases the course was changed upon seeing the Gallatin. She being herself a fixed object, (at anchor,) they were enabled to estimate by her the set of the tide; and but for that, it would have been unnoticed. I may add, too, that they all approached nearer to the newly discovered shoal than was prudent—six of them so near as to cause us serious apprehensions for their safety. Of this, of course, they were ignorant: they were then from 6½ to 7½ miles from the known South Shoal, and had reason to think that there was no less than six fathoms of water for many miles to the northward of them; but as the new shoal has bold water to the southward, a near approach does not of itself involve risk, if the currents are understood, and allowance is made for them.

"The manner in which one or more of the British packet steamers have lately been involved in the unknown dangers of this vicinity is explained by the discovery of the new shoal, and by the strength and direction of the currents. It was a matter of reasonable surprise that vessels travelling at a uniform speed, supplied with the best means of knowing their position at sea, and conducted by competent navigators, should have proved to be so much out of their reckoning; but the discovery of a shoal even more extensive than the *known* South Shoal, in a place where 6 and 9 fathoms are given in the chart, accounts for their supposed error. The survey, strictly speaking, was confined to the new shoal; but a reconnaissance beyond its limits showed that ridges, having on them only 20 and 24 feet of water, extended some distance to the northward and eastward. These are quite as dangerous as the shoal itself in bad weather; and even more so, as they lie more across the usual path of ships.

"I was very much struck with the treacherous character and appearance of the whole of this shoal ground. The deep water comes so close to it that a vessel may have a cast of 15 or 20, and even 25 fathoms, and in a moderate breeze be on shore in five minutes. In pleasant weather the outer shoal does not break so much as the inner; neither are the tide rips so strong. The only prudent course is to give it a wide berth—at least until the sea around it is better known. I desire most earnestly to press upon you the urgent necessity of making a comprehensive and careful survey of this whole region, in the manner contemplated in your letter of the 15th April. The want of it cannot be over-estimated, whether the dangers be considered, the lack of information, or the situation. The shoals south and east of Nantucket lie in the way of the largest and richest portion of the foreign and domestic commerce of the country. All the vessels from New York trading to Europe, and all those from Boston bound to any port on

the American coast, to the West Indies, or to the southern Atlantic ocean, pass in this vicinity; and of the coasting vessels, all those bound from Boston and places farther east, to any of the southern ports, are equally exposed. This includes the coasters between Boston and New York, many of which, encountering a head wind and tide at the entrance of Nantucket sound, run to the southward of the island, and follow the channel inside of the 'Old Man.' The mention of this last shoal reminds me that I found no pilot in Nantucket who would inform me what was the least water on it, and whether, or in what part, it could be crossed."

A preliminary chart or sketch, intended to show the position and general limits of the "new South Shoal," as determined by Lieut. Com. Davis, is given with this report. More perfect determinations will hereafter be presented; but this embraces data too new and important, in regard to position, and currents and soundings, to be withheld because the work is not finished.

In regard to the continuance of the work on or near these shoals, Lieut. Com. Davis gives the following opinions, which are entitled to much weight:

"My own slight experience here has impressed upon me so deeply the importance of continuing the survey with sufficient means, that I am only obeying a sense of duty in repeating my former opinions of its necessity. Many good ships, never heard of, have been wrecked here, and their scattered remains, carried to sea by the currents, have sunk there, and afforded no clue to their loss. The 'President' steam-packet, it will be recollected, was seen hereabouts for the last time. In my estimate for the next season's operations I have asked for a steam vessel. To proceed without one is bad economy. I have mentioned that there was one, and only one, entirely favorable day whilst we were at work on the South shoals. During this single day, with an indifferent steamboat more could have been accomplished than was executed by the sailing vessel, in which the soundings were made during the whole month. This statement is rigidly exact. What argument need be added to it to enforce the value of a steam vessel, useful everywhere, but indispensable here, on account of the peculiar and novel manner in which this survey is conducted? As this work is done under your own superintendence, and in conformity with your instructions, it would be out of place for me to speak of its method here. But I will allude to the delay and uncertainty attending a change of stations, already determined, to the dependence on the currents and winds in making this important change, and to the fact that the field of operations for the time is unavoidably circumscribed by these stations. If a steamboat is valuable in the surveys of inland seas, where signals and points of triangulation abound, and where the work may be so regulated as to fall in with the courses of the tides for the day, how much more so is it when the stations are few, and when the tide must be met to cover the whole ground, or else a half day be lost. I am aware that you are quite prepared, yourself, to give every facility to this work, and to allow to this section its fair proportion of an appropriation that is limited, compared with the least extent of the operations of the coast survey. The occasion may be thought, however, to authorize a small additional appropriation for the express object of surveying the Nantucket shoals."

This statement confirms in every respect the views presented in my report of last year in regard to the importance of introducing the use of

steam vessels into the work—views which were supported by the statements of the chiefs of the hydrographic parties of the survey. The use of steamboats in the hydrography was contemplated in the plan of reorganization of 1843, as an essential improvement, the Treasury Department being in specific terms authorized to decide the relative proportion of steam and sailing vessels to be used in the work. This provision has, however, remained inoperative for want of means. The Navy Department has, however willing to aid us, had no small steam vessels which could be spared for our work, and the expense of hiring, or even of working them, is beyond the range of our usual appropriation. True economy, which looks at results accomplished and their cost, and not merely at the sum expended without regard to results, requires that we should have the means of employing steam vessels upon the work; and, as the case of greatest exigency and most obvious utility, I select this one for including in the appropriation a sum necessary to hire and work a steamboat for two months.

The work of this party in the Vineyard sound has led them to the discovery of a shoal, having but thirteen feet water upon it, about 2½ miles S. by E. ½ E. from Tarpaulin cove light-house, in a part of the sound where not less than seventeen feet was believed to exist before, and where it is supposed that the ship Addison struck some thirteen years since. The fact that the depth of thirteen feet was not known to exist at that place is proved by the letter from three experienced pilots, addressed to Lieut. Com. Davis, and placed in the appendix No. 2.

Two rocks were also determined by Lieut. Com. Davis, which will find their places on the chart of Tarpaulin cove, the engraving of which is nearly finished.

The small part of the office work of this party remaining unfinished at the close of the last season was completed during the winter, under the direction of Lieut. Com. George S. Blake, then in charge of the party, and who was subsequently detached from the survey to take the honorable station of commander of the United States brig Perry. Lieut. Blake's long services upon the coast survey had given him a familiarity with the routine of the work which insured efficiency.

The work of the party of Lieut. Com. Davis during the winter consisted in the reduction of the observations in the Gulf stream, and of tidal observations. The discussion of the tidal observations at Old Point Comfort, where the series is very complete, was carried forward by Lieut. Com. Davis personally, under my immediate direction, so far as to free the curves from the effects of the moon's change of distance (parallax) and of declination.

The presence of the parties of Lieut. Com. Davis, U. S. navy, and of Lieut. Com. Goldsborough, U. S. navy, in the surveying schooners Gallatin and Wave, in the harbor of Nantucket, enabled them, during the disastrous fire of July 14, to render essential service to the inhabitants. This is acknowledged in the note of the selectmen of the town of Nantucket, (appendix No. 3 *bis*.)

Having reported, through the Secretary of the Treasury, the circumstances to the Navy Department, the approval of the conduct of the officers and men was given in the letter, (appendix No. 3.)

SECTION II.

From Point Judith to Cape Henlopen, including the coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.

The chief part of the field work in this section is completed. Certain verifications are indispensable, and may be gradually made, and occasional omissions, which appear when the maps are preparing for the engraver, must be supplied. All the field work to be done can be executed at intervals, as the services of assistants can be had, without detriment to the other parts of the work. The original design of the work in this section does not appear subsequently to have been followed out; but the omissions may be supplied as they are needed.

The following work has been executed in this section:

1. A *reconnaissance* has been made by Lieut. Henry Prince, U. S. army, to determine whether the triangulation on the outer coast of New Jersey might be connected with that of the Delaware river and bay, for the purpose of verification. The nature of the country to be examined (thickly wooded, and with few eminences) made this a work of great labor, and required many resources. The explorations of Lieut. Prince in New Jersey extended from Mount Holly to Cedar creek, and from Pine mount, near Blackwoodtown, to Leeds, at the mouth of the Little Egg Harbor river. (See sketch C.) They were conducted with caution, and led to the result that probably a connexion might be made; but that it would be difficult, and perhaps expensive. Other modes of verifying the work were then to be examined, and I relied upon Lieut. Prince for the service; but the claims of active duty with the army prevailed, and he was detached from the survey. The aptitude of this officer, from his first connexion with the work, and the experience which he was acquiring, rendered him every day more useful to the survey, and I parted with him with very great regret; postponing, for the present, this portion of the work. The evils of change are felt especially in such cases, where the assistant, becoming particularly valuable by local knowledge, his experience suddenly ceases to be available to the work.

2. *Magnetic observations* have been made in this section, to be communicated, for the use of the survey, by Doctor John Locke, of Cincinnati, at stations from New York bay to the head of navigation of the Delaware, and down the Delaware to the capes; and by Lieut. T. J. Lee, at Little Egg Harbor. The results for the variation will be at once used for the chart of Little Egg Harbor, which is ready for publication when the variation is sent to the office of the survey. The observations for variation (declination) and absolute horizontal intensity were made with Riddell's portable apparatus, and the dip with a dip circle by Robinson.

The following stations were occupied in the observations. (See sketches B & C.)

Finley's, Md.
Bloomingdale Asylum, N. Y.
Cole's, N. J.
Newark, N. J.
Whitehill, N. J.
Girard College, Penn.
Pine Mountain, N. J.
Hawkins's, N. J.
Port Norris, N. J.
Egg Island light house, N. J.
Cape May light-house, N. J.
Wilmington, Del.

Town Bank, N. J.
Sawyer's, Del.
Church's Landing, N. J.
Fort Delaware,
Bombay Hook light-house.
Lewistown Landing, Del.
Pilottown, Del.
Vanuxem's, (Bristol,) Penn.
Chew's, N. J.

3. The *topographical work* in this section has consisted, in part, of filling up some portions where the progress of the maps indicated the necessity, and in part of work of verification.

At the close of the last season a survey of Neapeague beach and its vicinity, at the eastern end of Long island, was made by assistant W. M. Boyce. A portion of the wharves of Philadelphia, embraced in a former survey by him, were measured; and, at the opening of the present season, some work in New Jersey, near Philadelphia, was also executed by him.

The local measurements of part of Philadelphia and its districts having proved difficult to reconcile, the measurements, from river to river, of certain principal east and west streets, was made by assistant J. J. S. Hassler; who also extended portions of the topographical sheets for the map of the Delaware, near Penn's grove, New Jersey, and Wilmington, Delaware, before resuming his work south of Cape Henlopen.

The work of verification was under the immediate charge of Lieutenant Humphreys, U. S. topographical engineers, assistant, and included the vicinity of New London and the eastern part of Long island. The plane table work required was executed by assistant J. B. Glück, between the 22d of September and the 2d of November. The necessity for a regular system of verification is made apparent by the report of assistant Humphreys, and will be the subject of communication to the department.

4. The *hydrography* in this section has consisted chiefly of observations of tides and currents in Long Island sound and New York bay, and of soundings necessary to complete the chart of the eastern end of Long Island sound. The off-shore work will be reported at the close of the next section.

The work of tides and currents, in charge of Lieut. Com. J. R. Goldsborough, commanding the surveying schooner Wave, was commenced on the 6th of June, between which and October 6th, the date of Lieutenant Goldsborough's report, twenty-six stations had been occupied successively between the eastern entrance of Long Island sound and the passage through Hell-gate, (sketch B.) Four consecutive tides had been observed at each station; chiefly when the sea was smooth and the wind light, so as to give the normal condition of the current. One station was occupied in New York bay, in the north channel, to investigate the effect of a northeasterly gale. The results were laid down upon diagrams as they were obtained. Temporary tide gauges were erected, at convenient places, near the current stations, the height of high and low water noted, and the time of high and low water and duration of slack water, for comparison, with time of change of current and of slack water, by the indications of the current. The tides have also been observed at Governor's island, New York harbor, and at Sandy Hook. Meteorological observations have been made in connexion with those of the tides at these stations.

This work was interrupted in July by the temporary change of station of Lieut. Com. Goldsborough to Nantucket: the interruption was, however, of but four weeks duration, the observations being resumed on the second of August. Lieut. Com. Goldsborough was occupied in the office during the last winter with the projection upon diagrams, and the comparison of

the results, of observations of currents made by him during the previous season.

On his return from the Gulf of Mexico, Lieut. Com. Carlile P. Patterson resumed the *sounding* work commenced by him last autumn, and, though much delayed by the unusually stormy character of the season, completed the supplementary soundings, and other work, as far as indispensably necessary to the eastern sheet of the chart of Long Island sound, which is nearly ready for publication.

SECTION III.

From Cape Henlopen to Cape Henry, including the coast of Delaware, Maryland, and part of Virginia.

The survey has been industriously prosecuted in this section in every branch of the work. The progress is shown in the annexed sketch, marked C. The primary triangulation, south of Kent island, has been carried down the Chesapeake nearly to the mouth of the Potomac; the reconnaissance for the primary triangulation, to connect the Capitol and Washington Observatory, and the head of navigation of the Potomac with the Chesapeake work, has been finished, and a portion of the stations have been occupied; astronomical and magnetic observations, in connexion with this work, have been made; the secondary triangulation of the Chesapeake bay, and tertiary triangulation of the rivers, has included the bay to the Patuxent river, the Chester, Wye, St. Michael's, and the Great and Little Choptank, on the Eastern shore, the South and West rivers, and a part of the Patuxent, on the Western shore. The unfinished topography of the shores of the Patapsco, and of the rivers to the north of it; the unfinished interior from the head of the bay to Baltimore; the shores of the South and West rivers and of the adjacent part of the bay; part of the shore of Kent island; part of the shores of the Chester and its approaches, and of the Sassafras, have been executed. The hydrography of the upper part of the Chesapeake bay has been completed; that of the bay south of Kent island has made considerable progress; and the soundings of the South and West rivers, of Eastern bay, of the Susquehannah to the bridge, of the Elk and Bohemia rivers, of the Bush, Gunpowder, Middle, and Back rivers, have been completed, and that of the Chester river has been commenced.

1. The general *reconnaissance* for the *primary triangulation* across from the Chesapeake to Washington was completed by Lieut. Henry Prince, United States army, and the more minute work for fixing the stations, putting up signals, and the opening of lines, was executed chiefly by himself and assistant C. O. Boutelle. A difficulty in regard to one of the lines developed itself, (Linsted Soaper's sketch C,) and a new station was selected by Lieut. Prince and assistant J. S. Williams. Lieut. Prince being detached from the coast survey, the examination and opening of the lines from the new station (marked Webb's in the sketch) were made by assistant Williams. This adds one to the probable number of stations required to make the connexion, as stated in my report of last year, making it four in all.

I commenced the *triangulation* by the occupation of Hill's (see sketch C) on the 18th of June, between which and the 13th of August three stations were occupied—one in Maryland, one in Virginia, and one in the District

of Columbia—and 27 angles measured, with the two-feet theodolite of the coast survey. The area embraced in the work is about 160 square miles; the number of primary points observed upon were, from the first station, four; from the second, two; from the third, three—total nine; other points and objects eighteen, including the Capitol and naval Observatory in Washington, the Georgetown Observatory, and three points on the Potomac, for connecting the secondary triangulation of that river and the primary triangulation, which will verify it. From two of the stations angles were observed upon the prominent objects in the city of Washington. Vertical angles for elevation were also observed with the six-inch Gambey theodolite, and differences of elevation by the micrometer attached to the two-feet theodolite. The number of regular observations for horizontal angles was 1,924; of incidental observations, partly with the six-inch Gambey, 170; and of observations for vertical angles, or for difference of elevation, 50. The Capitol and Washington Observatory were visible and observed upon from the three stations; the Georgetown Observatory could be seen from two only. The final reconnaissance for the points of secondary triangulation on the Potomac was made by Lieut. Humphreys.

2. The *primary triangulation* down the Chesapeake, south of Kent island, was continued by assistant Edmund Blunt, aided by Mr. J. R. Bolles. The reconnaissance was made and the measurement of the angles commenced on the 17th of May, between which time and the first of October, the date of Mr. Blunt's report, five primary stations had been occupied, and 2,628 observations made on twenty-four primary points. The stations are marked in sketch C, showing the progress of the survey in section No. 3; those which had been occupied at the date of the report being marked (o). The number of primary points observed upon from the different primary stations were, from the first, 5; from the second, 4; from the third, 6; from the fourth, 5; from the fifth, 4. 278 observations, also, were made from these stations upon 34 secondary and other points. Besides these, six secondary stations were occupied, and 264 observations made from them upon 37 points. The total number of observations made at the primary stations was 3,103.

Assistant Blunt used the twelve-inch repeating theodolite of Simms in this work. Since the date of the report of this work, an additional station has been occupied; and, before the close of the season, one if not two additional ones will be completed. The heavy cutting required upon the lines passing along the coast, and the unfavorable weather, retarded the work during part of the season; but the progress has been satisfactory, and the labor, as shown by the numbers just quoted, has been great. It furnishes bases for the triangulation of the Choptank, Patuxent, and other minor rivers, and extends nearly to the mouth of the Potomac.

This party was occupied during the winter in computing the observations for latitude and azimuth made during the previous season at Deakyne, on the Delaware, and in revising former computations of the observations made at Champlin's hill.

Lieutenant J. G. Martin, United States army, was assigned as an assistant to Mr. Blunt in the spring; but was relieved from the coast survey to join the army in the field, soon after the opening of the season.

3. *Astronomical* observations were made in this section by myself and Lieutenant Lee, United States topographical engineers. At station Marriott's, near the Chesapeake, the solar eclipse of April 25th was observed;

the observations including the beginning and end of the eclipse, and measurements of the distances between the cusps. The telescopes used were a five-feet Dollond, with wire micrometer and power of sixty, and a 3½-feet dialytic, by Plœssl, both being equatorially mounted. I was indebted for the loan of the former to Professor John F. Frazer, of the university of Pennsylvania; the latter belongs to the survey. The day was tolerably favorable for observation at the station, though occasionally the clouds were too dense to permit a clear view of the disks: the weather at the time of beginning was more favorable than at the close.

Observations for *latitude* were made at this station, by Lieutenant T. J. Lee, with the six-inch Gambey of the coast survey, and the zenith telescope before referred to, and kindly loaned by Major Graham. Transits for time were taken in connexion with these. The following is the number of observations of different kinds: 940 altitudes of Polaris, and 1,056 of southern stars, for latitude—95 sets in all; 50 sets of observations on 8 pairs of stars with the zenith and equal altitude telescope; 98 transits of stars for time.

4. *Magnetic* observations were made by Lieutenant T. J. Lee, at three stations of the Chesapeake triangulation, including one series at North Point, for the chart of the Patapsco river. The observations were for variation, (declination) dip, and intensity. The number of readings in the declination observations was 174; number of sets of deflections for intensity, 12—each set including deflections east and west of the meridian; number of sets of vibrations for intensity 6, each set including the observed time of 300 oscillations; number of sets of dip observations 9, each set including observations with one needle; poles direct and reversed. Lieutenant Lee completed these observations in July, and went to the eastern section to continue the series there.

5. The *secondary* triangulation has been under the charge of Captain Jos. E. Johnstone, of the topographical engineers, assisted during the early part of the season by Lieutenants Edward Murray and R. S. Ripley, United States army; and, upon their being relieved from coast survey service to join their companies, by Mr. Julius E. Hilgard. Lieutenants Murray and Ripley had been ordered to the work, to replace Lieutenants C. Benjamin and R. P. Hammond, who had been detached, and gave promise of making useful assistants. It is obvious, however, that frequent changes like this in a party must not only be of material inconvenience to its immediate head, but an obstacle to steady progress.

The sickness of Captain Johnstone left Mr. Hilgard in charge to complete a portion of the work; and subsequently, the triangulation of the Patuxent being rendered desirable by the progress of the hydrography, assistant James S. Williams, under the immediate direction of assistant Blunt, executed a portion of the work on that river. Captain Johnstone resumed his work, assisted by Mr. Hilgard, until, being himself detached from the coast survey to join the army in Mexico, the work again devolved upon Mr. Hilgard, by whom the triangulation of the bay and of the Patuxent river was resumed.

Captain Johnstone, during a connexion with the work of nearly three years, has so discharged the duties devolved upon him as to make his loss sensibly felt. His promotion made, no doubt, the claims of the military service paramount, but they were yielded to with reluctance.

With all these changes, the secondary and tertiary triangulations have

made reasonable progress, (see sketch C.) Between the 19th of April and 12th of October, thirty-five points had been established on the Chester river, and two near its mouth; thirty-two upon the Eastern bay and the rivers Wye and St. Michael's; thirty-seven on the Great and Little Choptank and tributaries; twenty-seven on the South and West rivers; and fifteen on the Chesapeake bay. The work on the bay is still in progress, and that on the Patuxent will be resumed and carried as far as practicable before the close of the season. The reconnaissance and selection of points has been made generally by Captain Johnstone personally; the measurement of the angles by Mr. Hilgard, whose zeal and the ability with which he has discharged these duties deserve notice here, as they have received it in the reports of the chief of his party.

This party also lent their aid during the month of August in setting signals for, and furnishing transportation to, the primary triangulation party of assistant Blunt. The greater part of the work has been computed soon after its execution, and sent to the office.

The office work of Captain Johnstone's party last winter consisted in the computations of the latitudes, longitudes, and azimuths of the work of the previous season, and in making duplicates of journals and of other books relating to their work.

6. A final reconnaissance to determine points for continuing the *secondary triangulation* of the ocean shore southward from Indian river has been directed, and will be commenced at once by Lieut. T. J. Lee, United States topographical engineers, should the season permit.

7. The *topography* of this section has been executed by assistants J. J. S. Hassler, George D. Wise, R. D. Cutts, and J. C. Neilson, and up to the first of October comprised an area of 288 square miles—580 miles of extent of shore line, and 518 miles of roads. In this estimate is comprised work at the close of the last season, not included in the report of last year. The shore line was furnished to the hydrographic parties of Lieutenant Commanding S. P. Lee and Lieutenant Commanding W. P. McArthur, working in the vicinities of the plane table parties. The sheets of assistant Hassler, near Cape Henlopen, completed the work required for the chart of the approaches to Delaware bay, and those by assistant Wise, near the Patapsco, completed the materials required for the Patapsco chart.

Assistant Hassler commenced his present work in the month of April in section No. 2, to which, in fact, a part of one of his sheets near Cape Henlopen properly belongs. Up to the first of October he had surveyed 86 miles of shore line, 209 miles of roads, and an area of 56 square miles. The general character of the country surveyed near Henlopen is described as level, swampy, and wooded, offering many impediments to work. On completing the sheets Nos. 1, 2, and 3 of the Delaware, and No. 1 south of Cape Henlopen, (sketch C,) the party was transferred to the Sassafras river, where they are still occupied. The field work of Mr. Hassler at the close of the last season has already been referred to in section No. 2. The office work consisted in putting in ink the topographical details of the previous season's work.

Assistant George D. Wise was in the field during a considerable part of the last winter, endeavoring, as the weather would permit, to complete the work required for the Patapsco chart, which was in the course of reduction for the engraver. Sheets Nos. 8 and 9, near the Patapsco, (see sketch C) have been completed by him, and sheet No. 6, including the Gunpowder,

Bush, and Back rivers, had been nearly completed, when it was necessary to transfer his party to the South river, (sheet No. 23) to furnish the shore line required by the hydrographic party in charge of Lieutenant Commanding S. P. Lee. The work executed since the last report comprises an area of 85 square miles, an extent of shore line of 239 miles, and of roads of 154 miles. Assistant Wise is now engaged on the shore line of sheet No. 19, sketch C. The party of assistant Wise have, during last year, had the use of a small vessel. They have been exempt from sickness during the season.

Assistant R. D. Cutts has been engaged upon sheets Nos. 5, 7, and 22, (sketch C,) of which 5 and 7, commenced last year, have been completed, and considerable progress had been made in No. 22 at the date of his report, September 30th. The area surveyed is 122 square miles, the length of shore line 131 miles, of roads 206, and of railroad 33½ miles. This includes the work done at the close of the last season, and not heretofore reported. The commencement of the season was unfavorable for field work in this as in the other sections; but the industry of Mr. Cutts, and the exemption of himself and party from sickness thus far during the working season, has enabled him to execute the amount of work reported. Mr. Cutts was engaged in the office during the last winter in drawing in ink the topography executed in pencil in the field during the previous season.

After the conclusion of the season in North Carolina, assistant Neilson was placed in charge of a plane table party, and during August, September, and October, worked upon sheets Nos. 11½, 11, and 12, sketch C. The work includes additions to a sheet of the western shore of Kent island, commenced by assistant H. L. Whiting, and the commencement of the sheets of the Chester river. The shore line was furnished to the hydrographic parties of Lieutenants Commandant Lee and McArthur, operating in the bay and in the Chester, in the vicinity of the plane table work. This work was closed, according to instructions, early in November, and assistant Neilson proceeded to North Carolina to resume operations there. The party has had the use of a small vessel belonging to the survey.

S. The *hydrography* of this section has made very satisfactory progress. Two parties have been engaged in it since the month of May—one in charge of Lieut. Commanding S. P. Lee, United States navy, commanding the schooner Nautilus, the other in charge of Lieutenant Commanding W. P. McArthur, commanding the schooner Vanderbilt.

The first section of the work of Lieutenant Commanding Lee extended from Poole's island to the mouth of the Susquehannah, (see sketch C,) and was completed between the 8th of May and 25th of July, including the soundings and observations of tides and currents. The stations occupied in observing the tides and currents are marked upon the sketch. The next section south of Kent island was commenced on the 10th of August, and the soundings had reached a line from Holland's point across the bay. At the date of the general report, October 1, 199 square smiles had been closely sounded out, 1,722 lines of soundings run, 2,150 hydrographic points established by angles observed on signals with the sextant, and 88,045 casts of the lead made. Since October 1st, additional work has been done extending the area to 278 square miles, and to the line marked on the sketch from Tilghman's point to Chew's station, on the western shore. The south and west rivers and part of eastern bay have also been sounded. Great credit is due to Lieutenant Commanding Lee and the officers of his

party for the zeal with which they have carried on the work during the whole season. This work completes the materials for a chart of the upper part of the Chesapeake bay, which will be reduced as soon as practicable.

The hydrography of the rivers, from the mouth to the head of navigation, was assigned to Lieutenant Commanding McArthur, who has sounded out, in the course of the season, (sketch C,) the Susquehannah, Northeast, Elk, and Bohemia rivers; Back creek to the canal, the Bush, Gunpowder, Middle, and Back rivers; and is now occupied on the Chester river, which is completed from Chester to the mouth. The necessary tidal observations have been made in connexion with this work.

Exploration of the gulf stream.

The brilliant success which has attended this work has been dearly purchased by the loss of the officer in charge of it, Lieut. Commanding George M. Bache. Of that loss I cannot trust myself to speak. His value as an officer is attested by the circumstances of his death. His services to the work are recorded in its archives and publications. His name is connected, as chief or as assistant, with the hydrographic work of New York bay and harbor, the coast of New Jersey, the approaches to the Delaware and the Chesapeake, and with the charts of Annapolis, Baltimore, and Little Egg Harbor. He was returning from his crowning work upon the survey, to which he had devoted all the resources of his science, experience, and ability—his whole matured mind—when overtaken by the hurricane of the 8th of September. Securing by his own exposure the safety of others, he was swept from the deck of the vessel which he commanded, and perished off that dangerous coast, the perils of which to others it was his object to diminish.

The vigor with which his mind was applied to his last work is shown in the informal reports of the results of his first cruise in July and August of this year, (appendix No. 3,) and his timely precautions in the hour of danger have secured to the work the chief results of his second and disastrous exploration.

The details of the closing events of that cruise, given in the concise but expressive language of the surviving officers of the brig Washington, are herewith presented, (appendix No. 4.) The expression of their deep sense of their loss, and their opinions in regard to the preparation for the dangers which they encountered, are also given, (appendix No. 5.) Justice to these officers, and especially to Lieutenant John Hall, upon whom the command of the brig devolved, and to the survivors of the crew, one and all of whom did their duty nobly in those trying days, requires the strongest and most public expression of thanks and of praise. I append a letter to the officers and men of the Washington, my report to the Treasury Department, the reply of the Secretary of the Treasury, (appendix No. 6,) awarding the need of approbation of the department having control of the work, and the letter of the Secretary of the Navy, expressing his concurrence in the views of the Secretary of the Treasury. The sense of the loss sustained by the work, in the death of Lieutenant George M. Bache, has been expressed by the assistants generally, and by the officers composing the several hydrographic parties, (appendix No. 7.)

The successful exploration of the Gulf stream was commenced in the first section of the survey in 1814, by Lieutenant Commanding Charles H. Da-

vis. The observations of Lieutenant Commanding George M. Bache this year have not only greatly increased the stock of previous information in regard to temperatures at various depths and the law of their changes, but have shown the division of the Gulf stream into two branches, or the separation of the hot water of the Gulf stream by cold water, a discovery the important practical bearing of which will at once be seen, and which must connect his name with the progress of discovery of this remarkable ocean stream.

The design of the season's work was to make several cross sections of the Gulf stream, exploring in each the temperatures at different depths, the currents, and other phenomena. Three sections were made—one from Sandy Hook, southeastward, and nearly perpendicular to the stream; one from Cape Henlopen; and the other from Cape Henry, perpendicular to the general course of the stream. Diagram No. 1 shows the positions occupied by the vessel or stations in making the observations, extending from latitude 39° 40′ north, and longitude 75° west, (and connecting with the work of Lieutenant Commanding Davis, in 1844,) to latitude 31° 40′ north, and longitude 66° 30′ west. The dates are given on the diagram, and the stations are numbered in the order in which they were occupied.

Diagram No. 2 contains the results of observation of changes of depth for a given temperature, as reported by Lieutenant Commanding Bache, on returning from his first cruise, (see appendix No. 3.) If two lines be supposed drawn in nearly a southeast direction on the first diagram, and so as to enclose between them all the stations occupied in the first cruise, the portion so cut out of diagram No. 1 is represented at the top of No. 2. The positions of the vessel are then projected on a vertical plane passing through one of the parallel lines enclosing the stations. The lines corresponding to the positions where observations for temperature at different depths were made are drawn upon this section, and the positions of the points of certain equal temperatures are marked at the proper depths. The distance from the first station at which the observations were made is shown in nautical miles upon the diagram. The change of temperatures within a distance of seven nautical miles at the inner or landward edge of the Gulf stream, is very striking; a temperature which occurs near the surface at one extremity, not being reached until a depth of nearly twenty fathoms at the other extremity. In the first cruise, 532 surface temperatures, 149 from five fathoms to 1,500 fathoms, were taken, and 17 specimens of the bottom collected in soundings. The temperature at 1,500 fathoms was 37° Fahrenheit, that at the surface being 82°. The surface temperatures which were observed hourly, were, except so far as entered in the note book with the deep sea temperatures, recorded in the log book, and lost with it; and the notes of currents and specimens of the bottom, and from the Gulf stream, were also lost when the deck cabin was swept from the vessel in the storm of the 8th of September. The study which Lieutenant Commanding Bache made of his results, as they were procured, caused him to enter surface temperatures generally in his note book of the deep sea observations. This book, containing the results of his labors, was most fortunately preserved by being placed by him in the care of J. J. Ricketts, esq., captain's clerk. The number of observations for deep sea temperature was 394, and one temperature was taken at 2,160 fathoms; giving 40° Fahrenheit at that depth, the surface temperature being 81°. No bottom was found in either of the deep

sea casts. In the former, the time occupied in drawing in the sounding line was two hours and a half; and in the latter, two hours and four minutes.

The diagrams numbered 3 are selected from among 14 reported by Lieutenant Commanding Bache at the close of the first cruise, as referred to in his letters given in the appendix No. 3, and as illustrating the difference in the law of temperatures with depth in the cold water near the coast, and in the warm water of the Gulf stream. The depths are laid off below the surface, (forming the abscissæ of the curves;) the temperatures horizontally from the left hand marginal line, (forming the ordinates of the curve.) The general form of the curves of temperature with depth was the subject of comment in the last annual report.

In the diagram No. 1, representing the results in the second and third sections, the hot water of the Gulf stream is found near the coast, at stations 8 and 7, and probably between 9 and 8, and near to 9. The stations 6 and 5, farther from the coast, are in comparatively cold water, and at 4 the warm stream is again met with. In section No. 2, stations 4 and 5 are on the edge of the inner cold stream, (the cold wall, as Lieutenant Bache termed it,) against which the hot water of the Gulf stream, in positions 6 and 7, flows. Stations 8 and 9 are in comparatively cold water, notwithstanding their more southerly position; and 10 and 12 in hot water, again gradually cooling, but uniting with the great body of the southern warm water, at positions 13, 14, and 15. These changes appear, but are less marked, in section No 1.

These valuable results will be arranged and collected for publication as speedily as possible. The mind in which they were stored in order, and whence the results would have been given without effort, and made productive for the future, is lost to the work and to the country.

SECTION IV.

From Cape Henry to Cape Fear, including part of the coast of Virginia and the coast of North Carolina.

The work in this section has occupied two parties. During part of the season, one astronomical and one triangulation party were employed, and during another part two triangulation parties. The preliminary measurement of a base has been made, and angles measured at one of the extremities, the latitude of one of its points determined, and the azimuth of the line itself. The lines of primary and secondary triangulations have extended over Albermarle and Roanoke sounds, from the marshes to Carroon's point, (see sketch D) and the tertiary triangulation of the Pasquotank has been commenced. Three parties are now under instructions for work in the same section, and either there or on their way; one for astronomical observations, one for primary and secondary triangulation, and another for tertiary triangulation and plane table work. One of these is provided with a vessel expressly built for the sound; and if the season should prove favorable this winter, there will be an opening for a hydrographic party in the spring. Last winter, especially the early part of it, and last summer, were unfavorable to work in this section. Two of the dreadful gales of this autumn have been especially felt upon this part of the coast—that of September 8th having carried devastation inshore as well as at sea.

1. The original design, in reference to the base apparatus for use in this

and the other southern sections, has been resumed, the contact lever having been applied, and a second set of bars prepared. The principles of the apparatus and its adjustments will be hereafter discussed. The site of a *base line* on Bodie's island, for the survey in this quarter, was originally determined by assistant J. C. Neilson, under the direction of assistant Ferguson. The site was adopted as well suited to the purpose of measurement, and as affording terminations easily connected with the triangulation, with a slight change merely, shown, by a closer examination, to give a surface more easily regulated for measurement. The line was marked out by assistant C. O. Boutelle, attached to my party, and a preliminary measurement and marking made in November last. As soon as the new compensating base apparatus could be made ready, dispensing with the contact principle which I had intended to apply to it, and adapting the microscopes formerly used by Mr. Hassler to the new compensating bars, I proceeded to the site of the base, but the winter had set in unusually early, and rain and high winds rendered the season unfavorable for such work. I found, too, that quite as much time would probably be saved, and advantage gained, as I had first supposed, by dispensing with the microscopes; and determined, therefore, to postpone this work to a more suitable opportunity, and in favor of the necessary *astronomical* and other observations. These were made by assistant C. O. Boutelle, aided by Lieutenant Edward Murray, United States army, during the months of January and February. The number of observations for latitude was 3,184; of azimuths observed by the elongation of the pole star, 12, including 72 observations; the number of transits for time, in connexion with the latitude and azimuth, was 77. The number of horizontal angles measured was 7, at the two stations, viz: the south end of the base and station (72) used in the approximate measurement of the base, the number of observations made being 326. Meteorological observations were also made in connexion with this work. The latitudes were observed with the six-inch Gambey theodolite of the coast survey; the azimuths and the horizontal angles for connecting the elongation mark with the ends of the base, with the two-feet theodolite. The horizontal angles at the south end of the base were measured with the Simms 12-inch theodolite, and from a tripod 15 feet above the ground. Previous to measuring these, a signal had been set up in the main by Mr. Boutelle, (Stumpy point) and one (on Chickamicomico) for extending the work southward. This work was satisfactorily completed by the close of the month of February, when assistant Boutelle began the reconnaissance already spoken of in the previous section No. 3, and Lieutenant Murray reported for duty to Captain Johnstone.

2. The *primary and secondary triangulations* in this section were executed by assistant Ferguson, aided by assistant J. C. Neilson. The party took the field on the 7th of November, the time between which and the 10th of December was employed in reconnoitring and putting up signals. Observations were then commenced at Carroon's point station, (see sketch D,) and continued until the 23d of December; and on the 26th, owing to the unfavorable appearance of the weather, assistant Ferguson deemed it advisable to break up the party. 247 observations for horizontal angles were made at Carroon's point with the 12-inch Simms theodolite generally used by assistant Blunt; the instrument was elevated upon a platform.

This work was resumed on the 21st of March, when authority was given to divide the party, assigning a separate tertiary triangulation to assistant

J. C. Neilson as soon as the preliminary arrangements for the main work were completed. The signals which had been thrown down or injured during the winter were reset, and the necessary lines between stations opened by cutting; in the course of which, three stations were occupied and 284 observations made in measuring angles, to obtain the directions of the lines, for the primary triangulation. Between the 11th of May and 2d July, 2 primary and 10 secondary stations (total 12) were occupied, and 3,387 observations made. Three additional stations have been partially occupied, at which 284 observations were made. The number of points observed upon from the primary stations was, from the first, 10; and second, 8; from the secondary stations, 69. The points are marked in the sketch D. The lines which have been observed on are full, and the others dotted. The sides of the primary triangles are marked with strong lines. The area covered by the primary triangulation is about 51 square miles, and by the secondary about 110 square miles. The reconnaissance extends from Nagg's head and Roanoke marshes to the mouths of the Currituck, Pasquotank, and Alligator rivers. The angles in the latter portion of the season were measured with a ten-inch Gambey repeating circle of the coast survey, to which a telescope of greater power than that originally attached to the instrument, and without a vertical circle, had been adapted by Mr. Würdeman.

3. The sketch shows the triangulation laid out and in part executed by assistant Neilson, on the Pasquotank. When this is completed, the topography of the shores will at once be executed, so as to give a chart of the river, or to use with the general work, as may be found desirable.

4. The astronomical and other observations connected with them, and the triangulations of the different grades, are now, as already stated, recommencing in this section. The increasing number of parties here employed to give effect to the operations of the work requires, of course, increased expenditures. It has not been possible, up to this time, from the information obtained, to ascertain what is the best season for surveying in this section; the opinions of those who judge of the weather for other purposes are imperfect guides, and the course is tentative until the experience of the parties runs through several years. The question is not whether work can be done at all in a particular section, at a particular season, but whether it can be done to the best advantage, so as to make it desirable to occupy that section at the time of the year in question.

SECTION V.

From Cape Fear to the St. Mary's river, including the coast of the States of South Carolina and Georgia.

In the gradual development of the work, provision has been made for a reconnaissance in this section to ascertain the nature of the triangulation which is practicable, the localities where a base or bases may be measured, and, in general, to determine operations necessary for a survey. The preliminary reconnaissance has been assigned to assistant J. S. Williams, who took the field for the purpose early in November. This work executed, the details of the survey of the section may be arranged understandingly; and I pledge myself, if means are furnished, to give the same efficiency to the work in this as in the other sections, and to make public the results as rapidly as they can be obtained.

SECTION VI.

From Dauphin island to Vermillion bay, including the coast of Mississippi and part of Louisiana.

The work in this section has been in the second stage of progress during the past year, namely, that in which the reconnaissances having been made, the operations determined upon, and the points of triangulation selected, the primary and secondary triangulations are commenced with auxiliary operations, and the hydrography is begun by reconnaissance and observations of tides and currents. The progress has been very satisfactory, the preliminary measurement of a base having been made, and the primary and secondary triangulations carried from the entrance of Mobile bay westward to the western end of Horn island: only requiring, to cover the whole area, the occupation of three primary stations on the main. The hydrography has produced at once an important result in the examination of Horn island channel from Ship to Dauphin island, through Mississippi sound. Interesting details in regard to this channel, and to the hydrography, will be found under the head of the hydrographic work in this section, and in regard to the tides, in appendix No. 8.

The parties have recommenced work, or are preparing to do so, in this section, strengthened by additions necessary to extend the operations; and should the appropriations desired be granted, all the operations of the survey will be in full progress in this section in the course of another year.

1. The *triangulations* and work connected with them in this section have been under the immediate charge of assistant F. H. Gerdes, aided by assistant R. H. Fauntleroy, and by Messrs. W. S. Walker and W. E. Greenwell. The reconnaissance made by Mr. Gerdes, in 1845, has served as the basis of his triangulation, which has been carried from Mobile point, westward, across the entrance of Mobile bay and Mississippi sound, to Horn island; connecting points on Dauphin, Petit Bois, and Horn islands with the main, and affording the basis for the hydrography of the sound and of the gulf. Sketch E shows the extent of the work. The primary stations are marked by a triangle; those which have been occupied being marked (o,) and those yet to be occupied to complete the scheme, (u.) The lines connecting primary stations are shown by strong full, or broken lines; those which have been observed upon being marked by the full lines.

The party reached their first station in December, and, finding the season unfavorable to triangulation, occasion was taken to complete the topographical survey of Dauphin island for the location of the base, to run and mark the line, and to make a preliminary measurement. About the 1st of February the measurement of angles was commenced, and this part of the work was continued until the 10th of July. Six stations, four primary and two auxiliary, were occupied by Mr. Gerdes, and observations made from them upon 25 signals for the measurement of 21 angles. The number of observations made was 723. The area covered by the work was about 257 square miles, computed in the manner heretofore explained. The shortest line in the triangulation (the base) was 6⅛ miles in length, and the longest 13¼ miles. The progress westward is 36 miles; but three stations on the main are still to be occupied, having been purposely reserved by Mr. Gerdes for a more favorable period of the year than that at which his work had reached them.

2. The *secondary* triangulation, chiefly made by assistant Fauntleroy, has extended over about 400 square miles. Twenty-three stations have been occupied, and observations made upon 153 signals and other objects. The stations are shown on sketch D, marked with a circle, and are connected by fainter lines than those which designate the primary work.

3. The topography of Dauphin island and of part of Horn island was executed by Mr. W. E. Greenwell.

It has been usually necessary in the primary work to raise the instrument considerably above the ground, upon a tripod, in order to overcome the curvature, and to place it above the stratum of air which is most disturbed by irregular heating and cooling.

The facilities required in regard to transportation were furnished by Lieut. Com. Patterson, in the surveying schooner Phœnix.

Assistant Gerdes acknowledges his obligations for assistance and information especially to Major C. A. Ogden, of the corps of engineers, whose knowledge of climate, localities, and other important matters, gained by long residence in this section, has been freely drawn upon.

Provision has been made, during the course of the coming season, for astronomical and magnetic observations in this section, and for commencing the plane table work.

Special report was made to the department of the gallant conduct of Messrs. W. E. Greenwell, W. S. Walker, and Samuel A. Gilbert, attached to this party, in the rescue, at the peril of their own lives, of two fishermen, whose small fishing vessels were wrecked in succession, during a gale, on a shoal, within sight of the camp at Dauphin island I append hereto an official report of the circumstances, by assistant Gerdes, my letter to the department, and the reply of the Secretary of the Treasury, awarding due praise to the conduct of these gentlemen. (Appendix No. 9.)

4. The *hydrography* of this section was necessarily limited to reconnaissance, and to observations of the tides. It was not found practicable to occupy all the tidal stations which were marked out; but at two of the chief points—Fort Morgan, at the mouth of Mobile bay, and Round island, in the middle of Mississippi sound—regular series of observations were commenced in January and February, and continued through the season, with meteorological observations in connexion with them.

An interesting communication from Lieutenant Commanding Patterson in reference to the tides observed at Mobile point, containing facts and inferences which may be useful to the navigator, is given in the appendix No. 10. The tides along the gulf coast are reported to be very irregular, depending mainly upon the winds, and a long series of observations will be required to make known fully their peculiarities.

Lieutenant Commanding Patterson states, however, that the observations already made, show the existence of spring and neap tides, the height of high water differing in the two by five inches, or one-half of the average total rise and fall in the twenty-four hours; and also the increase in the height of the tides in passing westward.

It appears that at Mobile point there is but one high and one low water; that is, one tide in the twenty-four hours. It would perhaps be premature to speculate on this and other deductions given by Lieutenant Patterson; but the whole subject is one which, in both a practical and scientific point of view, demands attention.

The examination of a channel north of Horn island, by which six feet

water more than by the main channel may be carried from Ship island to Dauphin island, has formed an important part of the results obtained by Lieutenant Commanding Patterson. A sketch of this work is appended, (sketch c.) The following is an extract from Lieutenant Patterson's report relating to this channel, and to the hydrography of this section generally:

"Upon inquiry of the best pilots, (among others, Captain Sutton, of the mail steamboat, who is justly considered one of, if not the best pilot upon the coast,) they informed me they would not attempt to bring up Mississippi sound from Ship to Dauphin island more than ten feet, and that nine feet was considered the depth of the channel at ordinary low water. This we fortunately found, as we have every reason to believe, *not* to be the greatest depth by *six feet!*

"Whilst beating up the sound in May, we found ourselves in a channel running along the north shore of Horn island, which, following up, we discovered to be deeper than the one generally used, and leading around the bar of that channel as a canal around the shoals of a river.

"This channel, in length about eight miles, I afterwards ran out by preliminary lines, with sufficient minuteness to give us every reason to believe *fifteen feet* can be carried through it at ordinary low water; and thus, in all probability, a navigation is opened through Mississippi sound for our largest class of merchant vessels from Ship to Dauphin island.

"This channel assumes, besides, an importance independent of its value to commence in a military point of view, as by it access can be had at all times to the excellent anchorage east of Round island by 15-gun sloops-of-war, and at ordinary high water by our 20 and 24-gun sloops, and second class steamers. This anchorage can, by means of this channel, be rendered a perfectly safe rendezvous for any number of vessels by very slight defences, as you will readily see by the plotting I have forwarded to the office.

"There is a chart, * * * * * by Mr. Wheeler, executed by authority of the State of Mississippi, upon which a single line of soundings, carrying fourteen feet, is laid down, agreeing in its general direction with that of the above channel. But, as the depths upon several other parts of this chart are put down for storm tides, we have a right to conclude such was the case in the present instance, thus reducing the depth at ordinary low water to eleven or twelve feet. Without wishing to deprive Mr. Wheeler of any claim he may justly possess to the discovery of this channel, the coast survey should derive the full credit of its rediscovery, if rediscovery it is, as the best pilots are in ignorance of its existence.

"If the small opportunities we had for sounding during the past season give a preliminary result such as this, what may we not expect as the coast survey advances in the navigation between Mobile and New Orleans, and between Ship island and the Balize? a part of coast less known than that of Oregon.

"The harbors of Ship Island inlet, and that under the north point of the Chandeleurs, demand our particular attention. Two such harbors of refuge, to say nothing of their importance in other points of view, are scarcely equalled upon our coast. They are perfectly safe for the most dangerous storms in the gulf—those from the eastward, southward, and eastward and southward—and could be entered with ease, during these storms, *without a pilot*, if accurate charts of the harbors and approaches are furnished, and proper light houses placed in proper places. In the want of these many

vessels are lost, the annual value of which would cover the expense of the light-house establishment in the gulf, and the whole coast survey for a year. To show the security of the Chandeleurs, this little vessel (of 65 tons) rode out, in that anchorage, with perfect ease and comfort, the most severe gales which have been known upon that coast for twenty years. In the same gale the revenue cutter in the harbor of Pensacola cut away her masts to prevent going on shore. Ship Island inlet is still more secure than this.

"As important as is the survey of Mississippi sound, that of Mobile bay and entrance is not less so. The tides and currents are nowhere more dangerous and intricate. The depth upon the bar varies in a series of years, and I am inclined to think the bar itself moves seaward.

"Upon Major Ogden's admirable chart, from a survey made in 18—, eighteen feet is given as the greatest depth upon the bar; but, going over it once at half tide, with quick casts, I had no less than twenty-one feet; and, as the rise and fall is but one foot, this gives twenty feet at ordinary low water. Should this prove to be the case, our heaviest steam-frigates could enter the bay to some distance above Fort Morgan. May not the increase of depth over the bar arise from its advance seaward?

An accurate chart of Mobile bay is the more necessary to settle a disputed question as to the existence of a deeper channel over the eastern extremity of Dog River bar, at its head. Some pilots believe this channel to exist, which is denied by others. The importance of such a channel to Mobile and the interests of Alabama is beyond calculation."

SECTION IX.

From Vermillion bay to the boundary, including the coast of part of Louisiana and the coast of Texas.

The necessity of commencing the survey at once, in this quarter, has been but too apparent in the course of last year. I have, with the sanction of the Treasury Department, made the necessary arrangements for the reconnaissance of this part of the coast. This source of expenditure not having been provided for by the estimates, and unforeseen expenses having necessarily been incurred by the withdrawal of most of the officers of the army serving upon the work, I undertook this new work with some hesitation. The aid derived under the laws of Congress from the use of a revenue vessel will prevent the work from being a source of much additional expense. The reconnaissance has been intrusted to assistant C. M. Eakin, who was under instructions to proceed as early as possible, in November, to Mobile, and thence in the revenue cutter Wolcott to Galveston, where the reconnaissance will be commenced.

SECTION X.

Determinations of differences of longitude from European observations.

The contributions to this part of the survey have been continued during the past year, by the collection of new observations, and the computation of those of former years. The solar eclipse of April 25th was observed; moon culminations and occultations obtained at points connected with the work. Through the courtesy of Commander Wilkes, United States navy,

the observations made by W. C. Bond, esq., at Cambridge, for the exploring expedition, were obtained; and the results of Lieutenant Gilliss, United States navy, have been communicated as the proof-sheets (of the publication ordered by the Senate) of his rich store of observations came from the press. A more detailed account of the observations obtained is given below, and the computations will be noticed subsequently, under another head.

1. The solar eclipse of April 25th was observed at my request, to be communicated for the use of the coast survey, by Lieutenant Charles H. Davis, United States navy, at Portland; at Cambridge, Massachusetts, by W. C. Bond, esq.; at Nantucket, Massachusetts, by William Mitchell, esq.; at Philadelphia, by Professor Kendall; at Marriott's, on the Chesapeake, by Lieutenant Lee and myself. At New York, clouds prevented the observations which Professor Loomis was prepared to make. By the courtesy of Lieutenant Maury, superintendent of the naval Observatory, we have the use of the results obtained there.

2. Transits of the moon, and of moon culminating stars, and occultations, have been observed for communication to the work—at Cambridge, by W. C. Bond, esq.; at Nantucket, by William Mitchell, esq.; and at Philadelphia, by Professor Kendall. Professor Kendall has also reduced a part of the observations heretofore made by him.

3. The determination of differences of longitudes by the transportation of chronometers has been continued by W. C. Bond, esq., who has communicated during the year ending with November, 1846, results obtained from forty-two comparisons of chronometers.

A notice of the progress of computation will be found under its proper head.

SECTION XI.

Determination of differences of longitude by the magnetic telegraph.

The establishment of lines of the magnetic telegraph between points connected by the triangulations of the coast survey furnishes an additional means of measuring the arc of a parallel, and a direct method of determining differences of longitude between the telegraph stations. An arrangement was made with the patentees of the telegraph, and with the companies between Washington and Philadelphia, and Philadelphia and New York, through the Hon. Amos Kendall, president, to allow the use of the lines after the business operations had closed for the day, under certain conditions. A line of wires was extended from the General Post Office to the naval Observatory, the superintendent of which, Lieutenant M. F. Maury, United States navy, had kindly offered the co-operation of himself and observers, to make the observations complete at the Washington terminus. A short line was carried from the main wires through the High School Observatory at Philadelphia, under the direction of Professor E. O. Kendall. A short wire was also carried from near the terminus at Jersey City to the station where Professor Elias Loomis had put up a five-feet transit and astronomical clock, kindly loaned for the purpose by Messrs. E. and G. W. Blunt.

The telegraphic connexions were thus complete; the use of instruments of the best character for obtaining time provided, and the services of excellent observers secured at the points of which the differences of longitude

were to be ascertained, by differences of local time, observed at the same instant of absolute time. To complete the arrangements as far as the telegraph wires enabled the electrical connexion between the different places to be made, required merely the means of producing an instantaneous effect, observable at all the stations. This was obtained by the sound of the striking of the delicately poised keeper of an electro-magnet. The electro-magnets furnished by Professor Morse were suitably arranged by Mr. Saxton, of the office of weights and measures, so as to secure their simultaneous striking, (within the limits of time which the ear could detect,) on the transmission of the galvanic current. The interval of time between the making of a contact to transmit the galvanic current, and the striking of the keeper upon a metallic plate close to it, was estimated at the twentieth of a second. It was found, in fact, so small that the ear could hardly detect it. The observers found it necessary to provide the means of communicating by the ordinary mode of telegraphing, by Professor Morse.

The arrangements of the system of signals, and for securing uniformity in the astronomical part of the work, and the clearing it from known errors of instruments, and from the effect of imperfect places of the stars, as given in the catalogues, were made by S. C. Walker, esq., whose zeal and ability have both been manifested, no less than his persevering spirit, in the course of these experiments. The advice and aid of Professor Morse and Mr. Vail were also of much advantage, and every effort has been made by the Hon. Mr. Kendall to facilitate the work. Professor Loomis continued his labors perseveringly, under the greatest discouragements and inconveniences. The numerous difficulties of detail in the management of the telegraph, and especially the imperfect insulation of the wires, has prevented the obtaining, thus far, of complete results between Washington and New York. It is a kind of work, however, in which, when success is once obtained, repetition of the results to any extent may be made at once, and we look confidently to a speedy and secure connexion by telegraph between the two cities.

The communication between Philadelphia and Washington was effected on the 19th of October, and results for difference of longitude obtained. Signals for time by the clock were transmitted, and the instant of transit of a star over the wires of the transit instrument was telegraphed. These are not yet cleared from personal equations,* constant errors affecting instruments and observers, though the plan provides ultimately for this, and they are small. They give for the difference of longitude between the two places, in time, 7 min. 34.3 sec.; that previously reported by Mr. Walker, from astronomical observations, was 7 min. 34 05 sec. A connexion is not yet completed by triangulation, wanting the line between the Chesapeake and Washington.

SECTION XI.

Office work—calculations, drawing, engraving, printing, instrument making, &c.

1. The usual office work of the parties consists in copying the journals of the previous season, recomputing their observations, and making draw-

* For a later statement, see the report of S. C. Walker, esq., appendix No. 11.

ings, the results of their work, or connected with it. The duties assigned to me during the year have kept me so much in the field, that, without an efficient assistant in the office, the work would fall into confusion. Lieutenant Humphreys, of the topographical engineers, has still filled the important place of assistant in charge of the office of the survey, and has, if possible, rendered more services to the work than during the previous year. I can but regret that merit like his in this service, which has been declared by law a part of that to which officers of the army shall be assigned, finds no appropriate reward or encouragement by promotion.

Lieutenant Humphreys was assisted in the several duties of the office during the last winter by Lieutenant E. O. C. Ord, United States army, and during part of the winter and spring by Lieutenant H. C. Pratt, United States army. These gentlemen also executed several drawings, tracings, and other work required, from the archives of the survey, for public purposes, and furnished by direction of the Treasury Department.

2. The recomputation of the observations of the field assistants has been made, as during the previous year, by assistant Theodore W. Werner, at New Haven, and Eugene Nulty, esq., at Philadelphia. The second computation of the observations of 1844 has been completed, and the observations of 1845 have nearly all been recomputed. The computation of the observations for horizontal angles in the primary triangulation of the eastern section, for 1844 and 1845, has been made by Mr. J. E. Hilgard, who has also been engaged upon other computations.

3. The computations of observations for differences of longitude from European observations have been continued by S. C. Walker, esq. A report has been received from him, giving the results of his computation of the longitude of Captain Wilkes's observatory on Capitol hill, from the observations of Lieutenant Gilliss made during the progress of the exploring expedition, and kindly furnished for use in advance of the publication ordered by the Senate of the United States. As this is a report in part merely, and the longitude is subject to modification by further reductions now in progress, I do not now give the result.

4. The importance of urging forward the computations of observations heretofore made, and accessible for use in the survey, having been brought before me by Mr. Walker, I applied, through the Secretary of the Treasury, to the Navy Department, for the services of Lieutenant James M. Gilliss, who had just completed the laborious task of reducing for publication the astronomical, magnetic, and meteorological observations made by him in connexion with the exploring expedition, and who was therefore fresh in the pratice essential to a rapid and complete execution of such work. The application was met in the spirit of encouragement to science which has characterized the action of the honorable Secretary; and Lieutenant Gilliss is now engaged in the reduction of observations of occultations and moon culminations for the coast survey.

5. The report made last year by W. C. Bond, esq., in relation to the new observatory at Cambridge, as deduced by Professor Peirce and himself from the computation of moon culminations and occultations, and comparisons by chronometers, gave for its longitude west of Greenwich $4h.\ 44m.\ 31.7s.$, to $32.4s.$ This result, carried to the High School Observatory at Philadelphia, exhibits a remarkable coincidence with the previous results obtained by Mr. Walker; which were: High School Observatory west of Greenwich, by computations reported in 1844, $5h.\ 0m.\ 40.6s.$; by report of

1845, the same; by Professor Peirce's computations of moon culminations, 40.5*s.*; by Professor Peirce's computations of occultations, 41.2*s.*; by Mr. Bond's comparison by chronometers, 40.5*s.* I append Mr. Walker's letter on this subject to my report, (appendix No. 12.)

6. I hardly venture again to touch upon the subject of publishing annually the results of the coast survey work. It would be useful to the work, and in a degree to the public, though technical and uninteresting to general readers. By the aid of Lieutenant R. S. Ewell and Lieutenant H. C. Pratt, United States army, who were attached to the office, I had hoped to make progress in this work; but a beginning was hardly made, before I lost the benefit of their services by their being detached from the work to join the army in the field. The fact is, that unless an appropriation is made to obtain the assistance necessary to carry on this work regularly, its execution can hardly be expected; for all that is appropriated, and all the aid that is obtained, under the law, from the Navy Department, is necessarily laid out in obtaining materials and in publishing results for *general* use.

Drawing, &c.—The maps of assemblage and record, and of progress, for the work of 1845, have been completed by Mr. Morven McClery.

Twenty-four sheets for plane table parties, and for the hydrographic parties of the Chesapeake, which require the projection of the meridians and parallels, have been prepared by Messrs. Fairfax, Glück, and McClery.

The following maps have been drawn: a map of Holmes's Hole harbor, on a scale of $\frac{1}{2000}$, was reduced and drawn by Mr. Morven McClery; the drawing of the hydrography being furnished by Lieutenant Commanding George S. Blake.

A map of Tarpaulin cove, on a scale of $\frac{1}{2000}$, was reduced and drawn by Mr. McClery; the drawing of the hydrography being furnished by Lieutenant Commanding George S. Blake.

The map of New Haven harbor, on a scale of $\frac{1}{5000}$, was completed by assistant John B. Glück.

A map of Syosset or Oyster bay, on a scale of $\frac{1}{5000}$, has been reduced and drawn by Mr. Glück.

A map of Huntingdon bay, on a scale of $\frac{1}{5000}$, has been reduced and drawn by Mr. Glück.

A map of the anchorage under Sheffield island, on a scale of $\frac{1}{2000}$, has been reduced and drawn by Mr. McClery; the drawing of the hydrography is not yet made.

A map of Sachem's Head harbor, on a scale of $\frac{1}{1000}$, has been drawn by Mr. McClery; the drawing of the hydrography being furnished by Lieutenant Commanding George S. Blake.

The drawing of the hydrography of the maps of Black Rock harbor, Bridgeport harbor, and of the anchorage under Cawkin's island, on a scale of $\frac{1}{2000}$, has been made, under the direction of Lieutenant Commanding George S. Blake.

The reduction and drawing of the western sheet of the map of Long Island sound has been commenced by assistant W. M. C. Fairfax, the verification of the drawing of this sheet having shown that the redrawing of it was necessary.

A map of the East river, from Throg's neck to the city of New York, on a scale of $\frac{1}{5000}$, forming part of the western sheet of the map of Long Island sound, has been reduced and drawn by Mr. Glück; the hydrography has not yet been drawn. The reduction and drawing of the second and

third sheets of the maps of the south side of Long Island, on a scale of $\frac{1}{80000}$, including the hydrography, have been nearly completed by Mr. Fairfax.

The drawing of the first sheet of the map from Point Judith to Nantucket, on a scale of $\frac{1}{80000}$, has been begun by Mr. Fairfax.

The drawing of the upper sheet of the map of Delaware bay and river, on a scale of $\frac{1}{80000}$, has been completed, and that of the lower sheet completed as far as the materials for it are in the office, by Mr. Fairfax.

The drawing of the hydrography of the Delaware, from Fort Mifflin to Trenton, was finished by Mr. Glück.

The reduction and drawing of the hydrography of the approaches to Delaware bay, for the lower sheet, were made by assistant John Farley.

A map of the off-shore soundings between Block island and Cape Henlopen, on a scale of $\frac{1}{400000}$, has been prepared in part by assistant Farley.

A map of Little Egg Harbor, on a scale of $\frac{1}{20000}$, has been reduced and drawn by Mr. McClery.

A map of the Patapsco river, Magothy river, and part of Chesapeake bay, on a scale of $\frac{1}{40000}$, has been reduced and drawn by Mr. A. de Palmenstein, the hydrography being reduced under the direction of Lieutenant Commanding George M. Bache.

Additions to the drawing of the eastern sheet of Long Island sound have been made by Mr. Glück, and others are now in progress.

The drawing exhibiting the progress of the triangulation of the coast survey, from its commencement, was completed, and a second, exhibiting the progress of the topography and hydrography, made by Mr McClery.

To lay down the meridian and parallel lines on the copperplates, requires great exactness and nicety, and has been done by Mr. Fairfax, who, during this year, projected them for the two sheets of the south side of Long Island, for the maps of New Haven harbor, Little Egg Harbor, Oyster bay, Holmes's Hole harbor, Tarpaulin cove, the East river from Throg's neck to New York, and for the off-shore map.

In addition to the preceding, Messrs. Fairfax, Glück, and McClery have done a considerable amount of contingent work, which cannot be enumerated in detail, but which has required much labor; such as computations of different kinds, plottings, drawings, diagrams, apparatus for reducing, tracings, &c.

Two copies of the models for topographical details, and of the conventional signs, have been made, for which temporary aid was obtained, and tracings of them, made principally by Mr. McClery, supplied to the topographical and hydrographical parties for use in the field.

The following hydrographic work was executed by Lieutenants Commanding C. P. Patterson and R. N. Stembel, U. S. navy:

The soundings on the coast of New Jersey, from Sandy Hook to Barnegat inlet, have been replotted, and the chart containing them finished—scale, $\frac{1}{40000}$.

A chart has been made of the North river, from the Battery to Fort Washington.

Lieutenant Humphreys verified the upper and lower sheets of Delaware bay, the maps of Holmes's Hole, Tarpaulin cove, New Haven, Oyster bay, Huntingdon bay, and Little Egg Harbor.

Engraving, printing, and publishing.

The same system in regard to engraving has been followed this year as during the last—the larger maps being executed in the office, and the hor-

bor maps generally by contract, out of the office. The difficulties of securing uniformity in execution have appeared even more forcibly than last year, and estimates in regard to time are quite as difficult as for the work in the office. The publication of the current work has been continued without interference with that of the back work, and we have not yet fallen sensibly behind the progress of the field work. A chart of Fisher's Island sound; charts of New Bedford and of Annapolis harbors, and the Severn river; one of the large sheets of Delaware bay and river, and a chart of Little Egg Harbor, on the coast of New Jersey, have been published during the year.

One of the large sheets of the map of Long Island sound, and another of the river Delaware, are receiving the finishing work; and the chart of New London harbor, the completion of which was deferred for some work of verification, must be ready for printing in a few weeks. The chart of New Haven harbor, engraved in New York, requires merely the last finishing work to make it ready for printing. Oyster bay, or Syosset harbor, an important harbor of refuge on the north side of Long Island, will be completed in less than three weeks; and nearly the same progress has been made in the engraving of the charts of Holmes's Hole and Tarpaulin cove. These three charts are executing by Messrs. Sherman and Smith, in New York. All these charts, except perhaps the last named, will be published in the course of the winter.

Considerable progress has been made in the following named plates: Nos. 2 and 3 of Long Island sound, from New London to New York; No. 1 of the Delaware bay, containing the approaches; off-shore chart No. 1, including the deep sea soundings in the second section of the survey.

Not having been able to obtain a proposal for engraving the map of the Patapsco river, Magothy river, and part of Chesapeake bay, out of the office, upon such terms as would insure its prompt completion, the engraving of it has not yet been commenced.

The topography of the Long Island sound map has been executed by Mr. Selmar Siebert, assisted by Mr. A. Rolle; that of Delaware bay by Mr. F. Dankworth, assisted by Mr. O. A. Lawson; the lettering and figures upon the maps generally are by Mr. J. Knight. Mr. Lawson has also executed the views upon all the charts; Mr. Rolle the chart of New London harbor; Mr. Lawson the chart of Little Egg harbor.

The sketches to accompany my report have been prepared by Messrs. Petit and R. Knight, apprentices in the office, and they have also engraved, for distribution, the preliminary chart of the new South Shoal, off Nantucket, examined by Lieut. Com. Davis, and that of Horn island channel, in Mississippi, by Lieut. Com. Patterson.

Assistant Farley, who has had the immediate charge of the engraving, reports favorably of the general progress in execution, discerning an improvement over that of last year.

Very successful experiments have been made during the year by Mr. Siebert in copying engraved plates by the electrotype process, and in forming copperplates for engraving by the same process. A beautiful specimen of map engraving, (executed some years since by Mr. Siebert,) with much minute work upon it, was copied so perfectly that the closest scrutiny failed usually in deciding which prints were produced from the original, and which from the electrotype copy. There was in fact greater difference in the appearance of two impressions from the same plate, than of two, one of which was from the original and the other from the electrotype copy.

On a review of my report of last year in regard to the progress of the engraving, I find that an under-estimate was made of the time required to complete the large sheet, No. 1, of Long Island sound, and Nos. 2 and 3 of Delaware bay, but that there was an equivalent over estimate of time for the work of the present fiscal year, and that we are now well advanced towards the execution of all that was promised within the time set for it.

There remains of the old work two sheets of Long Island sound to be finished, two of the south side of Long Island, several maps of harbors of refuge in Long Island sound, one sheet of Delaware bay, and the off-shore chart from Gay Head to Cape Henlopen, off the coast of Massachusetts, Rhode Island, New Jersey, and Delaware. All except the harbor charts and the Long Island sheets are commenced, and most of them are well advanced.

Printing.—Since the first of December, 1845, 985 sheets of the large map of New York bay and harbor, 200 of the small map of New York bay and harbor, 615 of the map of Fisher's Island sound, 922 of the map of New Bedford, 675 of the map of Annapolis harbor, 168 of the middle sheet of Delaware bay and river, 300 of each of the sketches for the yearly report of 1845, and 300 of the sketch of the newly discovered shoal off Nantucket, have been printed.

Publishing.—During December and January, 230 copies of sheets Nos. 5 and 6 of the large map of New York bay and harbor were distributed, under the act of Congress; since then, 70 sets of the large map of New York bay and harbor, 36 copies of the small map of New York bay and harbor, 300 copies of the map of New Bedford, and 300 copies of the map of Annapolis harbor, have been distributed under the same act; 20 copies of each of the above maps have been supplied to the Revenue Marine Bureau, by direction of the Treasury Department.

Under authority from the Treasury Department, 37 copies of the large map of New York, 49 of the small map of New York, 24 copies of the middle sheet of Delaware bay, 124 copies of New Bedford, 17 copies of Fisher's Island sound, and 60 copies of the Annapolis map, were supplied to literary and scientific institutions, and for use on the survey; 620 sheets of the large map of New York bay and harbor, 211 copies of the small map of New York bay and harbor, 99 copies of the middle sheet of Delaware bay and river, 435 copies of the New Bedford map, 195 copies of the Fisher's Island sound map, and 135 copies of the Annapolis harbor map, have been placed with the agents for sale; 300 copies of the sketch showing the position of the newly discovered shoal of Nantucket have been sent to the insurance offices of Boston and New York.

A circular was addressed to the members of the 29th Congress who had not previously been addressed, in relation to the distribution of coast survey maps, under the law of 1844. Previous to May last, 124 applications, in behalf of 560 institutions coming within the law, had been made by members of the Senate and House of Representatives. This was more than twice the number directed to be distributed. Representations have been made of the whole subject to the Secretary of the Treasury, who has, by the plan of reorganization, the direction of the publication of the results of the work. The cost of printing from the engraved plates is trifling, and is no impediment to a distribution proportioned to the demand for the charts. The number of plates now published is twelve, and will be increased within the year to seventeen; and the sale of the charts may soon be expected to

cover the cost of printing and distributing them. The literary and scientific institutions of the interior of the country have called for a large proportional share in the distribution, the State of Ohio ranking next to New York in the number of applications.

Making and repairs of instruments.—Instruments for all the parties of the work have been repaired and cleaned. This includes theodolites of every kind and size in use, all the heliotropes, telescopes, plane tables, sextants, compasses, chains, drawing instruments, &c.

Several additions have been made to the motion works of the first set of bars of the base-measuring apparatus, and the lever of contact and level arrangement added to it. The second set of the base apparatus, with all its appurtenances, has been finished. The adjustment of the first set for compensation has been prepared, and that of a second set very nearly so.

The principle has been first applied, I believe, in this apparatus, so to arrange the mass of the brass and iron bars that they should heat or cool equally in the same time. The delicate methods employed for adjustment have shown that the dimensions, as arranged by the ordinary tables of specific heat and conducting power, required modification, and that experiments must be resorted to upon pieces of the bars themselves. This practical test of a theoretical conclusion was most satisfactory.

Two heliotropes, upon an improved plan, have been made, and two heliotrope arrangements added to telescopes. An equatorial stand for the Plossl telescope was made; telescopes, Y's, and riding levels were made for the 10-inch and 6-inch Gambey theodolites, and for the Richer theodolite; clamps and tangent screws were made for the two 18-inch theodolites; a finder circle and vertical motion screws were made for the 30-inch theodolite; 5 theodolites, circles, and sextants were redivided; chains, scales, and drawing instruments have been made; stands for telescopes have been commenced; and alterations and additions made to many instruments, which need not be particularized further.

The *disbursements* for the work under the charge of Samuel Hein, esq., have gone on with their accustomed regularity. The expenses of the field parties have been brought to the condition where they can be estimated for the work generally with a great degree of certainty.

I ought not to close this portion of my report without expressing my sense of the zeal and industry with which the work has been carried forward by the assistants and others engaged in it. The work of each one has been represented, and shows more fully than any general expression can do the activity of each in his sphere of duty, and the results which he has produced. The difficulties encountered by each one can hardly be measured; nor are the reports made to dwell upon them, but upon what has been done in spite of them.

After studying the operations of the coast survey during the season of 1844, with the advantage of the advice and direction of the then Secretary of the Treasury, (the Hon. John C. Spencer,) I became convinced that they might be extended with great advantage and economy; that they might at once be made to embrace sections of the coast which, under the then plan of operations, would only be reached at the end of a considerable period of time; and that the publication of the new results might be made to keep pace with the execution of the work, while the materials already accumulated should be made public as rapidly as practicable. This plan was sanctioned by your immediate predecessor, and the estimates required for

its execution were approved. They subsequently were sanctioned by Congress. Under them, the work for which a reconnaissance had been already made was commenced in North Carolina, and a reconnaissance of the coast of the State of Mississippi and of parts of Alabama and Louisiana was made.

Thus encouraged, I gave a further development of the plan in my report of last year; and upon the estimates, which met the approval of the present Secretary and that of Congress, the directions of the year were based. They provided for the effective continuance of operations in the new sections in North Carolina and on the Gulf of Mexico, and for a reconnaissance on the coast of South Carolina and Georgia; to which that of the coast of Texas was subsequently added by direction of the Treasury Department.

The successive operations of the work are, first, a reconnaissance, which involves but a small expense; then, the commencement of the primary and secondary triangulations and the measurement of a base: these require new resources; then, in addition, the topography and hydrography give the full development to the work, and require a new scale of expenditure. Results are then furnished for calculation, reduction, engraving, and finally for publication.

The following estimates are founded on the continuance of the policy which has thus repeatedly received the sanction of the Executive and of Congress.

The work in North Carolina, and in Mississippi and Louisiana, will be ready for its full organization. The reconnaissance in South Carolina and Georgia, and in Texas, will require the commencement of the triangulation there. A reconnaissance of the coast of Alabama and Florida should be commenced.

The division of the coast into sections of nearly equal extent of shore line has been already described, and the numbering by sections has been adopted in describing the work of the past year. It will be followed in the summary of progress attainable during the next year, and in the estimates intended to provide for it.

In section No. 1, *the eastern section.*—The primary triangulation, and astronomical and other observations connected with it, may be continued in New Hampshire and part of Maine. The secondary triangulation of Cape Cod, the shores of Massachusetts bay and of Boston harbor, and its vicinity, may be completed. The topography of Cape Cod, and part of the southern and western shore of Massachusetts bay, may be executed. The hydrography of Nantucket sound may be extended seaward, and further progress made in that of the shoals south and east of Nantucket. Further progress may be made in the hydrography of Boston harbor. Charts of the harbor of Nantucket, and of the harbor of refuge of Edgartown, may be reduced. The map of the coast from Point Judith eastward to Martha's Vineyard, inclusive, may be reduced, and the engraving be commenced.

In section No. 2.—The work of verification in Connecticut and New York may be continued; the portions of omitted work necessary for the charts be supplied. The observations of tides and currents in Delaware bay may be continued, and those in Long Island sound be completed. Additional astronomical and magnetic observations may be made. The field work in this section is chiefly done. The engraving of the harbors of refuge in Long Island sound, and of the approaches to the Delaware, may be completed, the engraving of the off shore chart make con-

siderable progress, and the second sheet of the south side of Long Island be commenced.

In section No. 3.—The primary and secondary triangulations on the Chesapeake, south of the Potomac, and the secondary triangulation of the outer shore of the peninsula of the eastern shore, and of the Potomac river, may be continued, and some work of verification may be made. The necessary astronomical and magnetic observations may be in progress. The topography of the shores of the Chesapeake and of its tributaries may be extended as far south as the Potomac; the hydrography may have the same extension. The off-shore work in this section may be commenced. The computations, reductions, and drawings of part of the general chart of the Chesapeake and its rivers may be finished. The chart of the Patapsco may be in part engraved, and one of the Chester river, if found desirable, be commenced. The field operations in this section will continue in full activity, and the office work will increase.

In section No. 4.—The triangulations of Albemarle, Roanoke, and Pamlico sounds, may be continued; those of a part of the rivers completed, and of the ocean shore be commenced. The necessary astronomical and magnetic observations may be made. The topography of the shores of the sounds may make considerable progress. The hydrography, including the observations of tides and currents of the Albemarle sound, may be continued. The necessary computations and reductions for a chart of the Pasquotank, if found desirable, may be made; and those of the general chart of Albemarle sound may be begun.

These operations will give nearly its full development to the field work in this section.

In section No. 5.—The general reconnaissance may be completed on the coast of South Carolina and Georgia, as far as necessary to determine the operations required. The final reconnaissance of part of the coast may be made, and the triangulations be commenced.

In section No. 7.—The general reconnaissance of the coast of Alabama and part of Florida should be continued.

In section No. 8.—The primary and secondary triangulations of Mississippi sound may be continued westward, and the necessary astronomical and magnetic observations be made. The topography of the shores of the main and of the islands may be continued. The hydrography of the entrance to Mobile bay may be completed, and that of the sound make considerable progress. The computations, reductions, and drawings necessary for the first sheet of the general coast chart in this section may be made, and the engraving of the chart be commenced.

In section No. 9.—The reconnaissance of the coast of Texas may be continued and completed, as far as is necessary to commence the triangulations, and this latter work be commenced. It will be necessary to purchase a small vessel for the use of the party surveying in this section.

This plan of working embraces eight of the nine sections of the coast, and provides for obtaining, in a few years, approximate results in seven of them, and for their immediate publication. So little field work remains to be done in section No. 2, that parties can be employed there as occasion may serve; the principal expenditure will be for engraving. In regard to the expediency of putting more than six sections in *full activity*, I have doubts, as it might enlarge the scale of the work beyond the limits which would be approved. The proportionally greater progress of No. 3 will, in one or two years, permit the transfer of some of the parties to another section.

The following estimates are for the execution of the work just described. They are more probably under than over the amount which will be required for its execution; but have been made with all care, and, as far as the field work is concerned, are certain. They suppose the usual aid, under the law, from the War and Navy Departments, without which the operations would fall short of those enumerated in the list. The cost of preparing the work for publication, and of publishing the old work, as well as the new, is included in the cost of the different sections.

General item.—Current repairs and hire of vessels - -	$3,000
Purchase of instruments, books, maps, and charts - -	5,000
For rent, fuel, postage, materials for drawing, engraving, and printing, and for printing charts - - - -	6,000
Section I. To carry on the triangulation in Massachusetts and New Hampshire, the topography along the shores of Cape Cod and Massachusetts bay, the hydrography off Nantucket, to continue the work in Boston harbor, to make the astronomical and magnetic observations required, to make the calculations of the work in this section, to reduce and engrave the charts of the harbor of refuge of Edgartown and of Nantucket harbor, to engrave in part the chart between Point Judith and the east chop of Holmes's Hole, will require for section I - - - - - - -	25,000
Section II. To make the verifications required in this section, and to continue the astronomical and magnetic observations; to continue the observations of tides and currents in Long Island sound, New York harbor, and Delaware bay; to continue the off-shore hydrography, to engrave and publish charts of three harbors of refuge in Long Island sound, of the approaches to Delaware bay, and of the off-shore chart No. 1; to continue that of the south side of Long Island, work generally of former years, will require for section II -	17,000
Section III. To continue the triangulations of the Chesapeake south of the Potomac, of the outer shore, of the peninsula of the eastern shore, and of the Potomac, and across from the base to Washington, with some work of verification; to continue the necessary astronomical and magnetic observations; to make the calculations required by the work of the section; to continue the topography of the shores of the Chesapeake, the hydrography of the bay and rivers south of Kent island, and the off-shore hydrography; to make the computations, reductions, and drawings of part of the general chart of the Chesapeake and of its rivers; to complete the engraving of the chart of the Patapsco river, and to continue that of the Chester, will require for section III - -	30,500
Section IV. To continue the triangulations of Albemarle, Roanoke, and Pamlico sounds and of the rivers emptying into them, and of the ocean shores, and to continue the necessary astronomical and magnetic observations; to commence the topography of the shores; to commence the hydrography of the sounds and rivers, including the observations of tides and currents; to make the necessary computations, reductions, and drawings for the chart of the Pasquotank river, and to	

commence those of the general chart of the sound, will require for section IV about - - - - -	$18,500
Section V. To continue the reconnaissance and commence the triangulations on the coast of South Carolina and Georgia, including the purchase, if necessary, of a suitable vessel for this part of the work, will require for section V - -	11,200
Section VII. To continue the reconnaissance of the coast of Alabama and part of Florida, in this section, will require about	800
Section VIII. To continue the triangulations of Mississippi sound westward, and the necessary astronomical and magnetic observations; the topography of the shores and islands; the hydrography of the sound and of the entrance to Mobile bay, including the observations of tides and currents; to make the computations and reductions required for the work, and the drawing of the first sheet of the general chart, and to commence the engraving, will require for section VIII -	20,500
Section IX. To continue the reconnaissance of the coast of Texas, and to commence the triangulations, including the purchase of a vessel adapted to surveying purposes in this section, will require - - - - - -	8,500
Total - -	146,000

The estimates thus presented have been approved, after examination, by the head of the Treasury Department, charged by law with the control of the work.

Having explained year by year the progressive steps in the extension of this work, and shown in the present report where that extension will cease, I would respectfully urge a continuance of that confidence which has hitherto been accorded to my estimates, and which the fulfilment of pledges heretofore given has, I trust, justified. It must be obvious, now, that the amount of work done is much more than proportional to the amount of the appropriation, and that the division of labor which is applicable to the work on an extended scale produces very considerable economy in its execution.

This is perhaps not the time to speak of more extended plans by which the method and system of the work on the Atlantic coast may be extended to the western coast of the United States. In a great national survey, uniformity is one of the most desirable objects. The maps and charts of our coast should have a common origin, that they may be consistent in plan and uniform in character. Without this requisite, they will fail in a degree to afford the greatest possible facilities to the navigator.

Should the time come when this extension is desired by Congress, it will be a stimulus to me to renewed exertion to have its execution intrusted to me, under the direction of the department of the government which has hitherto fostered the work, and with which the War and Navy Departments have of late years so cordially co-operated in measures for its extension and increased efficiency.

Very respectfully submitted by

ALEXANDER D. BACHE,
Superintendent United States Coast Survey.

Hon. R. J. WALKER,
Secretary of the Treasury.

Appendix No. 1.

Letter from the presidents of the insurance offices of Boston, relating to the discovery of the "New South Shoal," addressed to the Superintendent of the Coast Survey.

Boston, *December* 2, 1846.

Dear Sir: Please to accept our thanks for your polite attention in sending on the charts of the new South Shoal, recently discovered by the coast survey.

The determination of this hidden danger, lying, as it does, in the direct path of the great European trade from and to New York, of the West India trade from this and the eastern ports, and of the coasting trade between the New England and southern States, is a very valuable help to the security of our foreign and domestic navigation.

Since this discovery was announced, several cases have been recalled of vessels that have either actually struck the bottom or been in great peril in this vicinity. They were supposed to be near the old South Shoal, and to have been carried out of their course by strong currents or unavoidable mistakes in their reckoning. In some instances great blame has fallen on the commanders, as it now appears, without cause. Possibly the steam-ship President was lost on this spot.

The services hitherto rendered by the coast survey have promoted the best interests of the country, by contributing to lessen the loss of life and property on the water; and we have no doubt that other discoveries as valuable as this remain to reward its labors, particularly on the shores of the southern States.

With our best wishes for the prosperity of the work under your charge, and for personal welfare, we are your obedient servants,

J. INGERSOLL BOWDITCH,
President American Insurance Company.
JOSEPH BALCH,
President Merchants' Insurance Company.
THOMAS LAMB,
President Washington Insurance Company.
FRANCIS WELCH,
President Franklin Insurance Company.
ROBERT B. WILLIAMS,
President United States Insurance Company.
NATH. MERIAM,
President Mercantile Marine Insurance Co.
LEMUEL POPE,
President Boston Insurance Company.
C. CURTIS,
President Neptune Insurance Company.
S. W. SWETT,
President National Insurance Company.
C. W. CARTWRIGHT,
President Manufacturers' Insurance Company.
JOHN CLARK,
President Equitable Safety Insurance Company.
JOHN L. DIMMOCK,
President Warren Insurance Company.

JAS. H. ADAMS,
President N. E. Mutual Marine Insurance Co.
F. BACON,
President Boylston F. and M. Insurance Co.
JOHN G. NASRO,
President Tremont Insurance Company.
N. PARSONS,
President Hope Insurance Company.

A. D. BACHE, LL. D.,
Superintendent U. S. Coast Survey, Washington.

APPENDIX No. 2.

Copy of a letter from Lieutenant Commanding Charles H. Davis, U. S. navy, assistant coast survey, to Messrs. Smith, Hursel, and Luce, pilots, in regard to a shoal spot in the Vineyard sound, with their reply.

U. S. SURVEYING SCHOONER GALLATIN,
Holmes's Hole, July 10, 1846.

GENTLEMEN: A shoal spot has been discovered by this vessel about 2½ miles S. by E. ½ E. from Tarpaulin Cove light-house, having 13 feet water on it.

I am informed that hitherto the most respectable pilots of the Vineyard have not known the existence of less than 17 feet in this vicinity; and, also, that it is hereabouts that the ship Addison, Matthew Luce, pilot, is supposed to have struck, some thirteen years since.

Will you please give me your opinions, in writing, on these points?

Respectfully, your obedient servant,
CHARLES HENRY DAVIS,
Lieut. Com. schooner Gallatin.

Captain ELIJAH SMITH,
Captain JOHN HURSEL,
Branch Pilots for Nantucket and New Bedford.
Mr. RICHARD LUCE,
General Pilot and Inspector of Customs at Tarpaulin Cove.

HOLMES'S HOLE, *July* 10, 1846.

SIR: In reply to your letter of this date, we have to state that we have not known of the existence of less than 17 feet in the place described by you, and that we regard the discovery of 13 feet as entirely new.

It is in this vicinity that the ship "Addison" struck, about thirteen years ago.

Respectfully, your obedient servants,
JOHN HURSEL,
ELIJAH SMITH,
Branch Pilots for Nantucket and New Bedford.
RICHARD LUCE,
General Pilot and Inspector of Customs at Tarpaulin Cove.

Lieut. Com. CHARLES HENRY DAVIS,
Surveying schooner Gallatin.

Appendix No. 3.

Letter addressed to Lieutenant Charles H. Davis, commanding coast survey schooner "Gallatin," and to Lieutenant J. R. Goldsborough, commanding schooner "Wave," by the Secretary of the Navy.

Navy Department, *August* 3, 1846.

Lieutenant: I have received, through the Secretary of the Treasury, from Professor A. D. Bache, superintendent of the coast survey, a communication describing the important services rendered by the officers and crews of the surveying vessels "Gallatin" and "Wave," on the occasion of the late disastrous fire at Nantucket, accompanied by copies of the card of thanks rendered by the selectmen of that place, in behalf of the citizens, and of the special acknowledgments of the trustees of the Athenæum, and others, which papers have been placed upon the files of the department.

The department takes pleasure in availing itself of this occasion to express to yourself, and the officers and crew under your command, the great satisfaction with which these testimonials have been received.

I am respectfully yours, &c.,

G. BANCROFT.

Appendix No. 3 *bis*.

The selectmen of Nantucket, and citizens generally, tender their grateful acknowledgments to Lieutenant Commanding Davis, of the U. S. survey, and also to the commander of the cutter Wave, and the gallant crews of their respective vessels, for their well-directed and energetic efforts in saving property and checking the progress of the fire, on the night of the 14th instant.

Appendix No. 4.

*Letters of Lieutenant Commanding George M. Bache, U. S. navy, assistant in the coast survey, to the superintendent, relating to the exploration of the Gulf stream.**

U. S. Surveying Brig Washington,
The Gulf Stream, August 5, 1846.

My dear brother: I will first give you some of the incidents of the cruise, and then display its results, which are highly interesting. We completed all our gun fixtures and left New York on the morning of the 10th July, still about seven men short of our complement. The 11th to 13th were employed at Sandy Hook in ascertaining the local attraction of the compasses. The azimuth compass, which stands, when in use, nine feet

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* Note.—The diagram of positions referred to is attached to the report, (plate 6,) and called diagram No. 1. A section and specimens of the curves of temperature, with depth, are given on plate 7. A. D. B.

forward of the old binnacle, has an error of from 3° 3′ W. to 3° 50′ E.—the first when heading east, the last southwest; its least error, 39′, when heading N.NE.

Before leaving New York I had found a very convenient position for a steering compass, where it was not as much affected by the local attraction as it was in the original plan, and I had corrected the azimuth at W. by S. At south it is three-fourths of a point to the westward, and at north one-fourth of a point to the westward. The gentleman who corrected the compasses of the iron steamers has given up his establishment, I learned, on inquiry there. With the corrections I have for the compasses which I tabulated for use I can get along very well, until we have an opportunity of removing the cause of the local attraction. We were ready to leave Sandy Hook on the afternoon of the 13th, when a provoking occurrence took place to detain us. As the last load of water was coming off from the beach, two of the men ran away from the officer in charge of the boat. The watering place is immediately under the Highlands, at a place marked in the chart as the Shoal harbor. As we were too short-handed to afford to lose these men, and I had the advantage of coast survey topography, I determined to catch them. I had two copies of the map traced out in Ricketts's most hasty manner, embracing all the roads round the Highlands, and as far as Keyport, up Raritan bay and Red Bank, Shrewsbury river. The steamboat was to leave Keyport at 8 the next morning, and another from Red Bank at 10, and the men were to be caught before they could get on board of them.

The roads were systematically followed, and the water to Red Bank guarded.

Hall caught the men at 6 in the morning, at Keyport, having tracked and overrun them in the night, and brought them to Red Bank by 10, where he was to meet the other party by appointment. The topography was of great assistance, and enabled one party to communicate with the other, by leaving a letter at a house previously agreed upon. I give you this little history as being one of the many vexations incidental to sea life. All hands returned at 3 in the afternoon, and we got under way with a light breeze from the northward and westward. I stood out southeast; and the wind freshening, we arrived at our first position on the afternoon of the 15th. This position is on the edge of sounding. I here used principally the metallic thermometer, which appeared to be the favorite last summer. I combined it with the globe, letting down both occasionally in the same lead, but soon found they could not be used together. The globe takes a long time to cool, and must be allowed it; and should also be returned to the water immediately, to prevent it becoming heated. The metallic thermometer need not be kept down so long, but the unscrewing it and preparing it for another dip consumes some time. I began to be a little out of conceit of my present favorites, the globes, they were so slow.

I was prepared here to adopt a great improvement, to insure the perpendicularity of the line, by attaching to it, at the proper depth, a large India rubber buoy. As the vessel drifts, stray line is veered out, and the thermometer is certain to be in the proper position as long as you sink it. During the night I sailed about 25 miles further to the southeast, and took up the second position on the 16th. I thought it best to make the stations pretty close together on my first setting out, to feel my way along. Here the globes and sounding tubs were used, the tubs running very wild. The curves of these two stations are similar, the temperature decreasing very

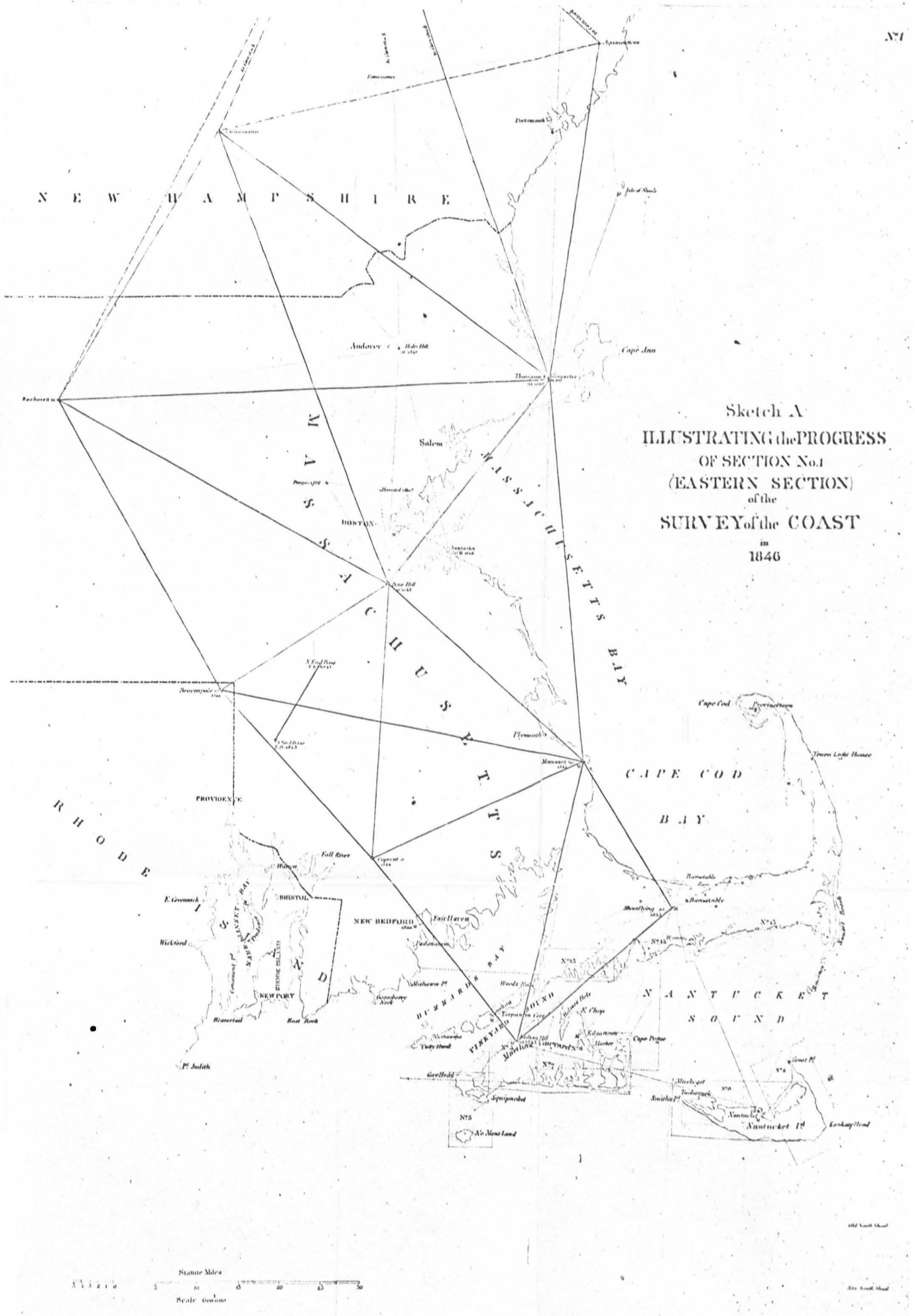
rapidly to 30 fathoms. You will perceive from the diagram of this day, (see diagram No. 3, position No. 2,) that I was very much puzzled to find out what was going on between 30 and 70 fathoms. The metallic thermometer was also used this day. During the night the wind came out from the eastward, with rain, and blew a gale on the 17th, which drove us to the southward. It rained also on the 18th. On the 19th we were again in position the third; and, after service, which we have had every Sunday, took temperatures down to 300 fathoms, using two globes and a marine thermometer, the marine thermometer answering pretty well down to 30 fathoms; but beyond that, in the trials I have made, I have not been able to depend upon it. Even down to that point I try it 3 times at one depth before I depend upon it. I have seen the upper valve open sometimes near the water's edge. I found it very inconvenient here using two thermometers on separate lines, as they got foul of each other, although at different extremities of the vessel.

The curve here, as at the second position, turned, or rather straightened, into no curve between 50 and 100 fathoms; and I thought it might be owing to my not having given the thermometer sufficient time to indicate small differences. So the next day, the 20th, I took up a position (the fourth) near the third, and spent time in investigating that part of the curve—with what success, you will see by the diagram. Globe stock rose high. This reminds me that I have omitted to mention in its proper place, on the 16th, that one of the metallic thermometers, after going down safely to 210 fathoms, was injured at 50 fathoms by water getting into the brass globe: how it got there, is strange. I screwed it together myself, as I had previously done, as tight, I thought, as I could; and yet the water was there when it came up. The only solution I have for it is, that the screw must have taken on the side of the mortise, and hung there; and yet that seems almost impossible. The thermometer did not appear to be injured at first, but it is so now.

The curves still show the same general features. On the 21st, occupied the fifth position, and brought up temperatures from 500 fathoms up—used two globes. The more I use them the greater my confidence becomes in them. In the cast of 500 fathoms, had 1,100 fathoms of line out—the buoy being attached at 500 fathoms to keep the line perpendicular. Time employed in hauling in the line 58m., and the index or level of the spirit in the thermometer was only 3½° above the register. Now here the globe was about 30 minutes hauling up through a temperature of from 38½° to 41°—say 20 minutes longer in from 41° to 49°, and 8 minutes from 49° to 74°—and had apparently heated only 3¼°; the index being 42°, while the register was 38½°. I think I have allowed too much in saying 8 minutes between 49° and 74°, for the line comes in quite fast after there are but 100 fathoms out. I have observed the same where the stratum of warm water is thin, as at these stations; but there is a great difference when we get into hot water. I determined in future to note the index as well as the register, as it might serve to let me know whether the register had been thrown out by a jar.

Curves still similar. Three bottles overboard;* tried the current NE.

* The latitude was 38° 47′ north; longitude, 70° 15′ west. One of these bottles came ashore eight miles south of Nag's Head, in North Carolina, where it was found by Captain Drinkwater; another one came ashore six miles south of Cape Hatteras, where it was found by Mr. Francis M. Paine. A. D. B.



Sketch A

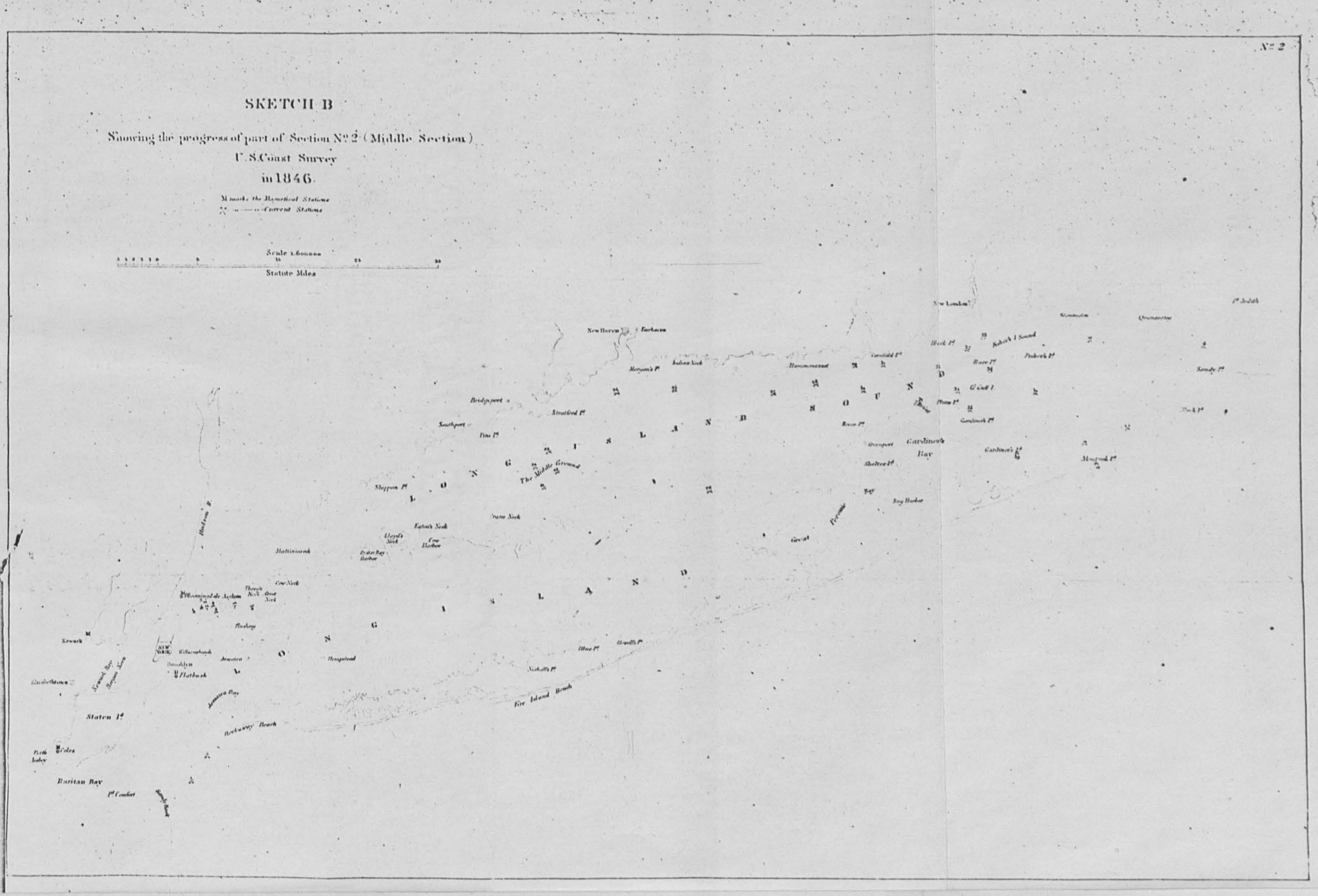
ILLUSTRATING the PROGRESS
OF SECTION No.1
(EASTERN SECTION)
of the
SURVEY of the COAST
in
1846

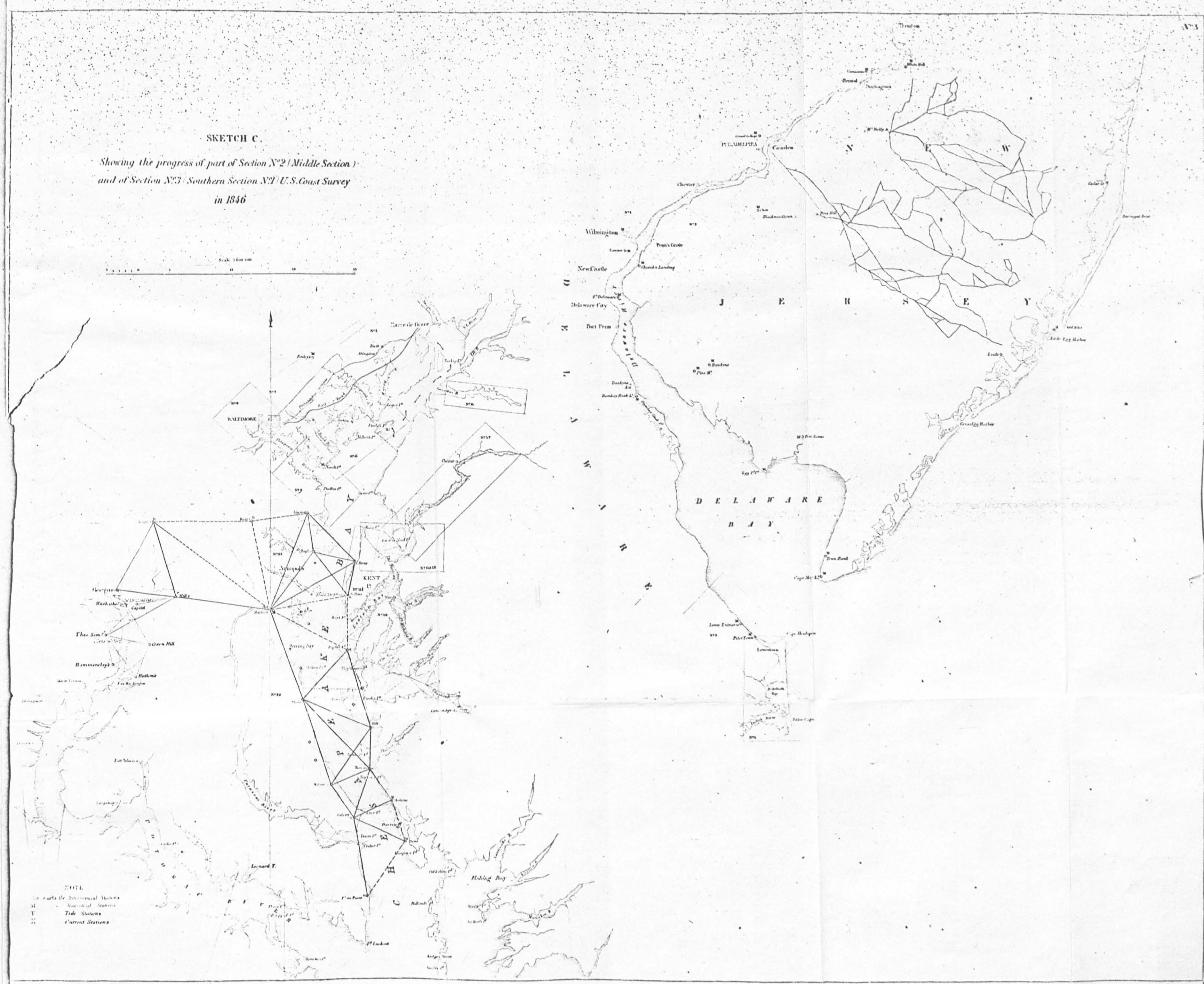
SKETCH B

Showing the progress of part of Section No 2 (Middle Section)
U.S.Coast Survey
in 1846.

M marks the Magnetical Stations
M — — — M Current Stations

Scale 1:600000
Statute Miles





No. 3
SKETCH C.
Showing the progress of part of Section No. 2 (Middle Section)
and of Section No. 3 (Southern Section No. 1) U.S. Coast Survey
in 1846
Trenton
Bristol
Burlington
PHILADELPHIA
Camden
Chester
Wilmington
Penn's Grove
New Castle
Church's Landing
Delaware City
Port Penn
N E W
J E R S E Y
DELAWARE BAY
Cape May
Havre de Grace
BALTIMORE
Annapolis
KENT I.
Georgetown
Washington
Capitol
Oxen Hill
Hammersley's
Leonard T.
Fishing Bay
Pt. Lookout
NOTE
Astronomical Stations
Magnetical Stations
Tide Stations
Current Stations

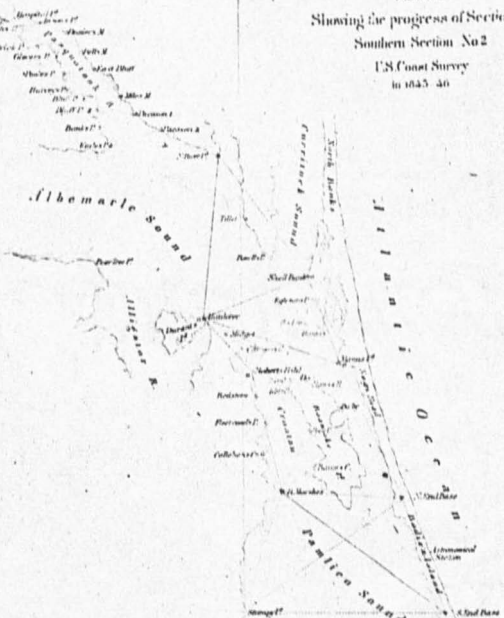
Sketch D

Shewing the progress of Section No 4

Southern Section No 2

U.S. Coast Survey

in 1845 46



Statute Miles

5 4 3 2 1 0 5 10 15 20 25 30

Scale 1/200000

SKETCH E

Illustrating the progress of the

SURVEY OF THE COAST

in Section VIII

GULF OF MEXICO

1850

Scale 1:500000

Statute Miles

Primary points —— △

Secondary " —— ○

Lines of Primary Δs obsd ——

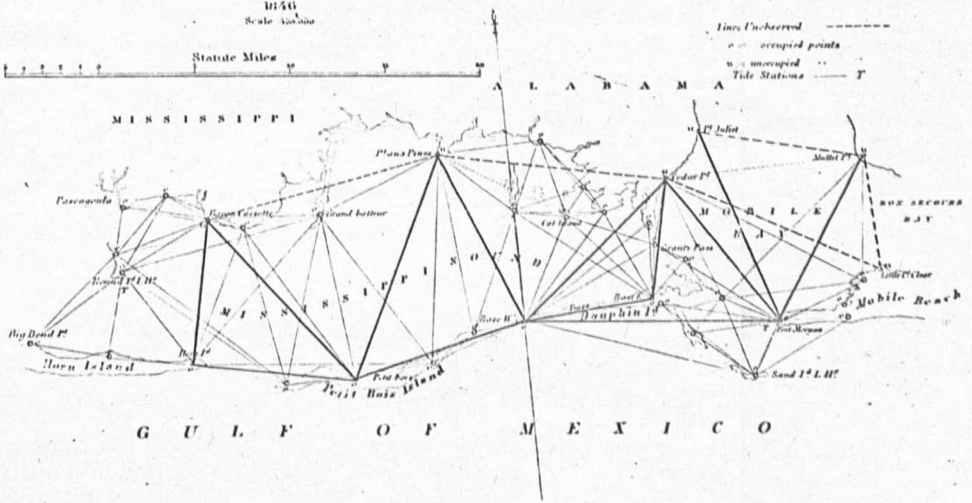
" " Secondary " ——

Lines Unobserved - - - - - -

o = occupied points

u = unoccupied "

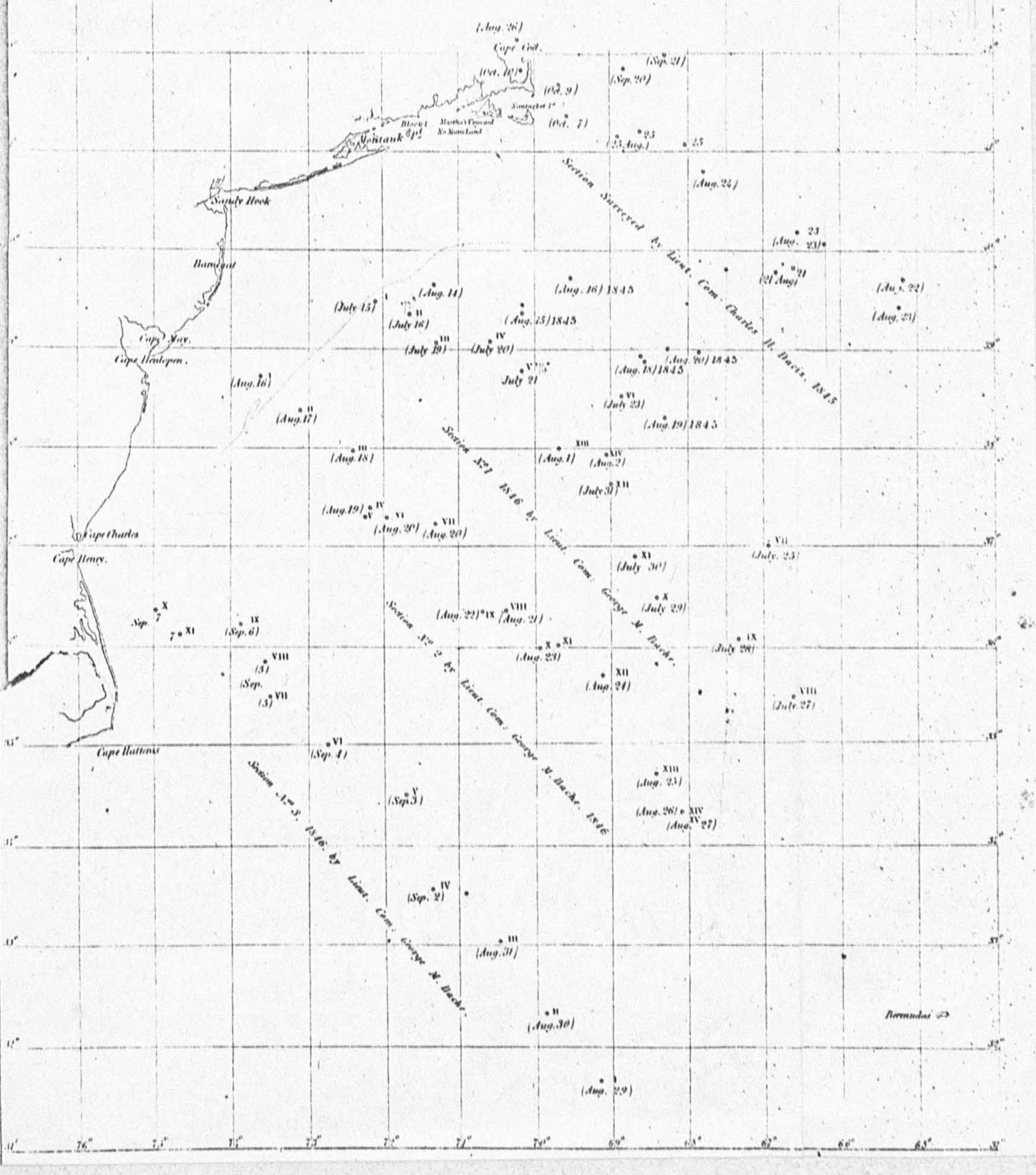
Tide Stations —— T



No. 6

Diagram illustrating the progress of exploration of the Gulf Stream in 1846,
by Lieut. Com. George M. Bache, U.S. Navy, Commanding U.S. Brig Washington.
(Assistant in the Coast Survey in charge of Hydrographic Party No. 2.)

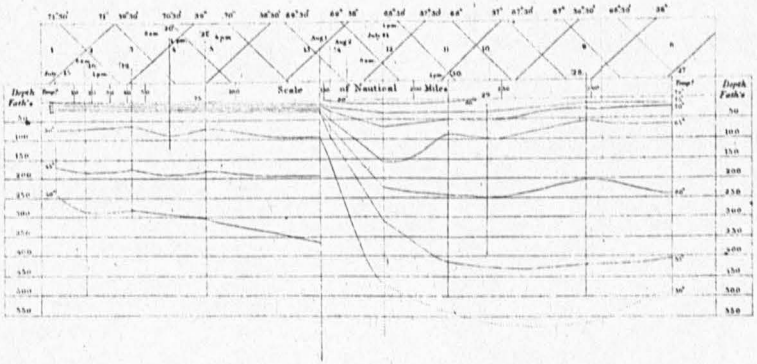
Diagram No. 1 showing the positions at which observations for temperature were made, at and below the surface. The positions occupied in 1845 for the same purpose, by Lieut. Com. Charles H. Davis, U.S. Navy, Assistant in the Coast Survey, are upon the Diagram.



Diagrams illustrating the progress of exploration of the Gulf Stream.

by Lieut. Com.ᵈ George M. Bache U.S.Navy, Commanding U.S.Brig Washington. (Assistant of Coast Survey in charge of Hydrographic party. №ᵒ 2.)

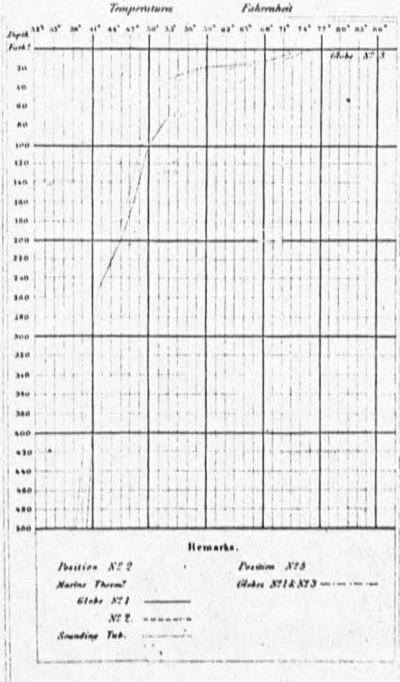
Diagram №ᵒ 2 showing the positions at which the observations were taken, and the temperatures at different depths, July and August 1846.



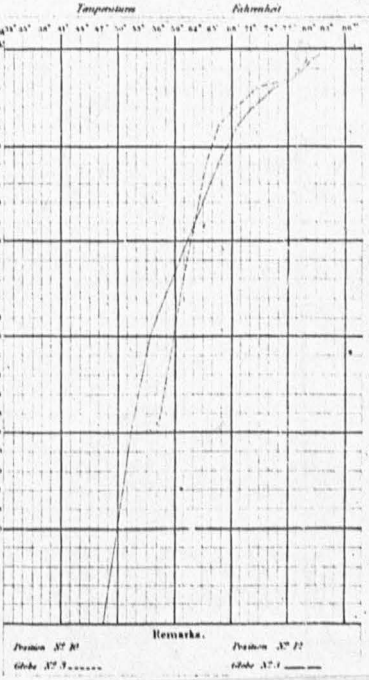
Section № 1

Diagrams №ᵒ3 and 4 Showing the changes of temperature with depth.

Position №ᵒ 2 Lat 39°42′ N. Long. 71°39′ W. July 16. and Position №ᵒ 3 Lat 38°48′ N. Long. 70°10′ W. July 21. 1846



Position №ᵒ 10 Lat. 36°39′ N. Long. 68° 21′ W. July 29 and Position №ᵒ 12 Lat. 37°39′ N. Long. 62°.00′ W. July 31. 1846



PRELIMINARY SKETCH

Showing the Position of the

SHOAL

RECENTLY DISCOVERED BY THE COAST SURVEY.

A.D. BACHE, SUPERINTENDENT.

Position determined by the Hydrographic party

under the command of CHAS H. DAVIS Lieutenant, U.S. Navy.

in 1846

1/100000

TIDAL NOTES

The direction of the arrows shows that the tides go entirely round the compass in every more or less Flood and Ebb. Near the shoals, the main body of the Flood runs to the Eastward, and that of the Ebb to the Westward, arriving in both cases a little to the North, or South of the Cardinal points. But the Flood begins to turn to the Southward, passing round to the West, and Ebb to the Northward, passing round to the East, about 1 Hours before the principal set and strength are attained.

Upon the Shoals, the tides run always across the line of direction, and are much more rapid. This makes a near approach to them, particularly dangerous on the side towards which the tide is setting.

The tide is never still. During the period called 'slack water' the velocity is rarely less than 1 mile & sometimes more than 1 mile. A careful attention to the tides is important in this vicinity.

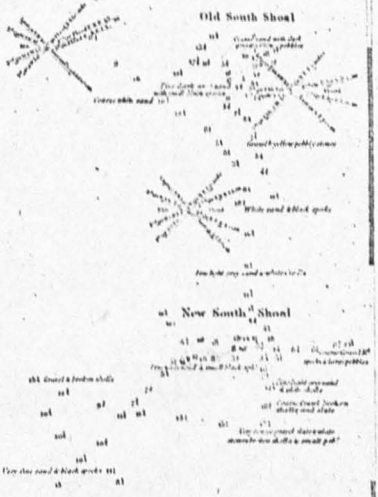
NOTES

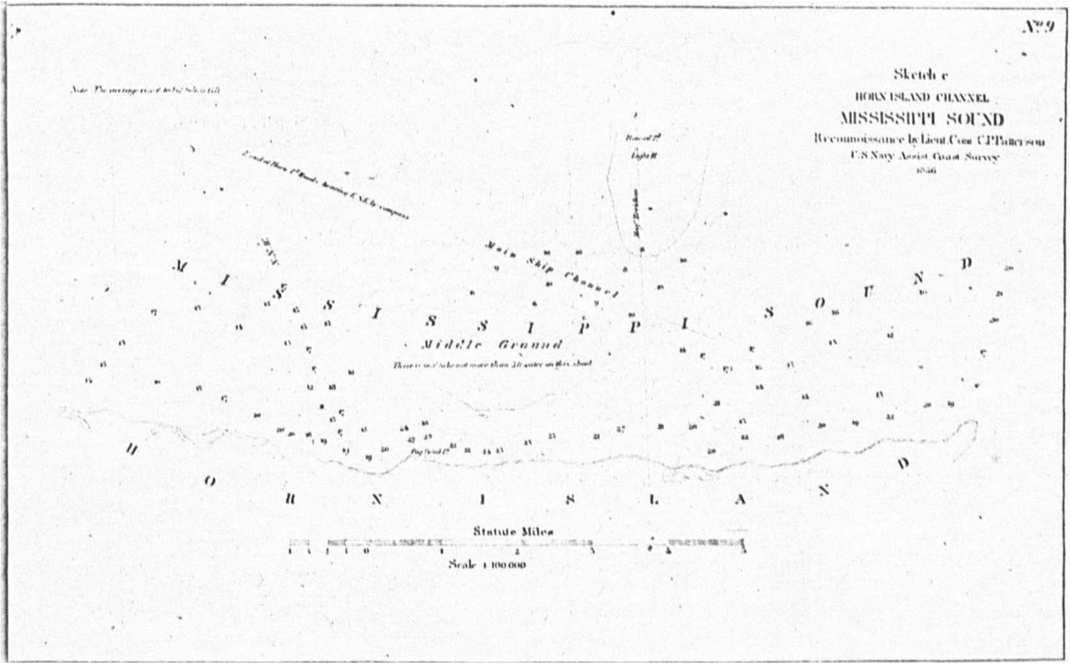
Longitude of South Toward Church 70° 46' 16" West from Greenwich. Latitude, 41° 16' 54"

The soundings within the dotted curves are in feet & fifths — outside of that in fathoms

The bearing of the centre of the New South Shoal from Sankaty Head by compass is S. S.E or S. 22° 32' E. its distance 19.37 miles. No part of the island of Nantucket is visible from this Shoal in the clearest weather.

Outline of Nantucket from map of William Mitchell Esq. of Nantucket.




No. 9
Sketch c
HORN ISLAND CHANNEL
MISSISSIPPI SOUND
Reconnoissance by Lieut. Com. C.P. Patterson
U.S. Navy Assist. Coast Survey
Main Ship Channel
MISSISSIPPI SOUND
Middle Ground
HORN ISLAND
Statute Miles
Scale 1:100 000

by N.; one mile per hour. During the night we had squalls of wind and rain; but I will say but little about these nights until I come to sum up. The 22d was too bad to do any thing, and we had moved but little from our position of yesterday. On the 23d, although out of position, having been driven to the northward by a southwester, which was too strong to carry any thing but a close reefed maintopsail and fore-trysail, I nevertheless carried the temperatures down to 60 fathoms; the water is becoming warmer, but there is no decided change in the curve. As yet, we have seen no gulf weed, although we have been on the look out for it. The current has been generally to the northward and eastward, except at the fourth position, where it ran gently to the southward; although the day before it was northeasterly, in nearly the same place. Our southwest gale continued through the 24th and 25th, with heavy squalls at night, having the pleasant accompaniments of thunder, lightning, and rain. On the night of the 24th, observed corposantos playing about the spindles of the conductors. At meridian of the same day, in latitude 37° 48', and longitude 67° 47', saw a quantity of gulf weed, in detached sprigs, for the first time. Temperature of surface has risen from 76° to 80° in the course of three hours. Weather too bad to take temperatures below the surface. On the 25th, still out of position to the northward, took temperatures as far as 100 fathoms—the first deep warm water casts. I steered as far to the southward on this day, and on the 26th, as I could get, to bring me on a southeast line from the first observations; 26th, saw large patches of gulf weed in streaks ranging from N. NW. to E. SE., as far as could be discerned. On the 27th, in latitude 35° 28', longitude 66° 34', being on the outer edge of the Gulf stream, with a westerly current, occupied the 8th position. Here, the features displayed were altogether different from the first 5 positions—the water being only 50° at 500 fathoms, while on the inner edge the same temperature is found at 100 fathoms. I regretted that I could not follow this hot water even to Bermuda, from which place we were only about 200 miles distant; but as I had not filled up the section, and the wind was favorable, I felt bound to retrace my steps. The day following (28th) I wrote to you by a stray vessel, a whaler, returning from the Western islands and bound to New Bedford, and enclosed copies of the diagrams made up to that time. It was the only chance we met with after entering the stream. This part of our cruising ground may properly be termed the desert of the Atlantic. It happens only by chance that a vessel's track lies across it. This vessel, and an English barque from Matanzas for Liverpool, are the only ones we met with.

On the 28th (in position No. 9) got temperatures from 400 fathoms, using two globes on the same line. This I find does not answer very well, as the upper globe, not being well situated, turned, probably, as the register came up out of place. On this day, (28th) latitude 36° 5', longitude 67° 20', the water was remarkably clear—gulf weed in small quantities. We are having now a fine harvest of observations, and I am in high spirits. Squalls every night; but I will say nothing about them yet.

On the 29th, (in position 10) and on the SE. line from New York, temperatures taken from 400 fathoms up. We are now between the eddy current from the eastward and the Gulf stream from the westward, the current being gentle to the northward; same curve as on the two preceding days.

Between the 29th and 30th, experienced the current of the stream setting

to the eastward. Took temperatures on the 30th, from 500 fathoms up, (in 11th position,) the warm water being deeper (as at 10th position) than it was on the 9th and 8th. We are now in the Gulf stream. Observations growing more and more interesting. On the 31st, water the warmest, and warm water the deepest; got a fine set of temperatures by the globe, from 600 fathoms up to 5 fathoms; current setting to the eastward. Here threw overboard a spar 28 feet long, with a gilt ball on top, and a weight at the heel, having at its upper end a brass case (one of Davis's old ones) marked with the latitude and longitude, and containing a request* that the position of the spar, when picked up, should be made known to the superintendent of the coast survey, and that the spar should be set adrift again. Threw bottles over also. We are now closing up with our first observations, and on the same line. During the night, experienced a strong easterly current. The next day (August 1st) took up position No. 13, and found the old system of curves again, the warm water being shallow. Took temperatures here from 1,500 fathoms up to 5; the intermediate ones being at 500 fathoms, 300, 200, 100, &c. The globes stood the pressure very well, and brought up a temperature of 1,500 fathoms. This cast was taken under peculiarly favorable circumstances; the first opportunity I had of getting so deep a cast; and still continuing the observations at lesser depths. My note book says: "Line commenced running out at 10h. 57m.; lead weighs 80lbs.; line out to 1,500 fathoms, at 11h. 36m.; a good up and down cast. Brig under close-reefed maintopsail and foretopmast staysail; wind light from southward; course, W. SW., $\frac{6}{10}$ of a mile per hour, which I had found, on trial previously, to counteract exactly the current.

[Sent the crew to dinner.]

At 12h. 27m. commenced hauling in the line, 30 men employed; this number includes our cooks and waiters. Globe came up at 2h. 56m.; register 37°, index 40."

Here we have an instance of my being able to dispense with the buoy, the only one of 14; and it was finding that we could keep our position over the line (which we had never been able to do before on account of the wind being unfavorable) that induced me to go to that depth.

Eleven of these positions out of thirteen I have brought into the section which I have prepared to send you, (see diagram No. 2, plate 7;) the 6th and 7th positions I have thrown out, as being too far out of line. On the 2d of August I added a small 12th; not uninteresting, however, as it comes in beautifully.

I would like to be with you when you look at and admire this section, as admire it you must, and speculate on it together. Here on the left we have the main current of the stream turned to the eastward, by Cape Hatteras, and butting up against a bank of cold water, which it overflows, and on the right mingling with a vast reservoir of warm water, which is probably brought there by the eddies from the stream itself. How beautifully the line is defined to the left or westward, and how well the observations of the 2d of August come in to verify the others! I hit upon this by having the marine thermometer going at the depth of 30 fathoms; and as soon as it brought up warm water, hove to and made the observations. The tracing of the cold wall from Hatteras up will be highly interesting, and will lead to useful practical results, if it is permanent, (and can it be

*Has not been heard of.—A. D. B.

otherwise?) It will afford and excellent sea mark; and I think a near approach may be indicated by inferior temperatures: at all events, a depth of 30 fathoms will do it, unless the stratum of warm water deepens, owing to winds or the season. Although we had worked pretty hard for the last three weeks, I hoped we might be able to get another section completed before returning to port. The principal reason for my abandoning this, is, that the chronometers begin to differ, and I am afraid to trust them too long: added to this, a gale sprang up on the 3d—one of the most violent ones we encountered. It was from the eastward, against the current, and we were in the strongest part of the stream. I determined to scud instead of "lie to," as I did not like to expose the brig to too heavy a sea; and by scudding we could get out of the stream. It blew very hard, and we came out of the stream at the rate of 10 miles an hour, under close reefed topsails and reefed foresail. I really believe it is blowing there yet. Yesterday I thought I would stand in to the breakwater, and correct the chronometers; but the wind will not allow us to make better than a northwest course, which will carry us to New York. It is better to go with the wind than to consume two or three days in beating up; and by to-morrow I hope to be in.

Now, a word about the meteorology of the Gulf stream, which is very peculiar. We were 21 days *off soundings in the Gulf stream* and its offset, and in that time had 15 bad nights—squalls of wind, requiring us to shorten sail to close-reefed topsails, rain sometimes in torrents, with lightning generally. The days were better; for we have missed our observations for latitude and longitude but three times, and have used the thermometers on 14 days. The temperature of the air may be stated, in general terms, to have ranged from 80° to 85° during the day, and from 75° to 80° at night. The temperature of the heavy rain 71°. The barometer has fallen but once—just before the last gale. The sea was in a perfect *foam for a short time*, while the wind blew the hardest; and it was the falling of the barometer which made me put the brig before the wind at its commencement. The brig has been improved very much in sailing, and all other respects, by taking in the ballast and the armament, and is much more comfortable and safer than she was before. Still she *leaks* very much in her upper works and decks, and continues to wet every one below, and we feel that we have to be very careful of her in heavy weather. A good hard gulf sea would rack her very much. By the time we make Sandy Hook we will have sailed 1,327 miles. We have taken 532 surface temperatures, 149 temperatures at from 5 fathoms to 1,500 fathoms, and collected 17 specimens of bottoms on soundings.

Your affectionate brother,

G. M. BACHE.

U. S. Brig Washington, New York,
August 12, 1846.

My Dear Brother: I was very much gratified that you should think so well of our results. I believe we crossed the stream nearly in the shortest line. Our course, if any thing, was a little too northerly, looking eastward. We crossed the current at right angles, in what I call the *offset* of the stream, where the warm water is shallow; for there the current was generally northeast, while our course was southeast. After passing into the body of the stream the current is more easterly, and we crossed it obliquely. At our southeasternmost station (July 27) we were in a west-

erly current of about half a mile an hour, as shown both by the run of the vessel and our observations from a boat. This continued throughout the 28th and 29th. We certainly crossed the stream, if current is the test, and were nevertheless in warm water. I think it is probable that this warm water is from the Gulf stream, and is whirled about by the eddies, which shift more than they do on the western side, and that we should have found our curves of temperature rise more gradually than they do on the western side—somewhere between our position of 27th July and Bermuda. I regretted very much not being able to follow this warm water to the southward and eastward; but the wind was from that direction, and the weather fine for completing the observations I had missed to the northward and westward. I do not doubt that the current proper of the stream sometimes makes that point, (July 27.) Rennell places his limit of the stream near it, a little outside. It is a very interesting spot, and I hope to visit it again some of these days. Speaking of Rennell, I received the copy imported from England just before he sailed, and have been very much assisted by it. On my next station I will get cold water to the eastward, unless the distance is unreasonable.

The sudden break on the western side is curious, indeed. The deep water of the stream, on being turned to the eastward, by the coast of North Carolina, appears to make a clear cut through the cold water on that side; while the surface water continues on its course more to the northward, in the bite between Cape Hatteras and Nantucket. This may be partly from a cause which is permanent—viz: the banks off the capes of Carolina turning the deep water, while it permits the surface current to continue on its course, separating it, as it were, from the main stream. And the southerly winds, which are prevalent at this season, may assist it now. The northwest winds of the winter would blow it further out on the surface. The cold wall I hope to find permanent, uninfluenced by the seasons.

You ask what was the depth at which bottom was had on August 1 and 2. No bottom was had throughout, after leaving the soundings, off the coast, although, on the 1st day, we got the deep cast of 1,500 fathoms. I had a Stellwagen attached to the lead, in hopes of bringing up bottom. I have not been unmindful of the uses of the tubs. Davis ordered two in Boston, according to his latest notion. I have tried them in various ways, and at different depths. They have failed to bring up water of a temperature due to the depth, except on one occasion. I would have doubted them this time if I had not tried the temperature myself twice with the thermometers. The difficulty, I think, is, that the valves are too small for the diameter of the tub, 12¾ inches to 5⅛ inches, or vice versa. There is not a clear passage of water through it, and all the jolting and shaking and drawing up and down does not fill it properly—and the water in it comes up too warm. If this is the only difficulty, it shall be remedied. I have ordered a section of a wooden pump 2 feet long, diameter 10 inches, bore 10 inches. The upper valve is easily placed in with leather. The lower valve requires some contrivance; but I think I can make it work well. The pump-maker has promised to let me have the whole concern this afternoon.

I will attend to the points indicated in your letter of the 9th. With my expectations considerably shorn by my experience in the gulf, the most I hope to do this season is to make three or four more sections—one from Cape May SE. by S., and return across to Norfolk; one intermediate, and return N. NW. to somewhere about Nantucket.

I did not get Maury on the Gulf stream before I left Washington. Can you send it to me at Norfolk? I would like to have a plate engraved for striking off diagrams, (No. 4;) I like to multiply the copies so as to have them ready to send off. I could get a plate engraved for $15, but it is too much to give when I can perhaps get it for nothing.

* * * * * * * * * * *

Your affectionate brother, GEORGE.

APPENDIX No. 5.

Copy of the log-book of the United States brig Washington.

September 7, 1846.—From meridian to 4, moderate breezes from the northward and eastward and cloudy weather, with a heavy swell from the southward and eastward during the first part of the watch; the vessel hove to with the foretopsail to the mast; employed observing deep sea temperatures; at 2 filled away and made sail to the northward and westward.

From 4 to 8, a fresh breeze and cloudy weather, with squally appearances; brig on a wind on starboard tack; at 5 furled foretop-gallant sail to relieve the helm; saw a schooner, on a wind, under short sail, standing to the northward and westward.

From 6 to 8, a fresh breeze from the northward and eastward, with a heavy swell from the southward and eastward; brig on a wind on starboard tack, and steering wild under courses, topsails, maintop-gallantsail, and eased off main sheet to relieve the helm—found that she steered much easier; at 8 hauled up the mainsail, luffed to and got a cast of the lead, 13 fathoms; gray sand and broken shells; at 6h. 30m. showed our colors to an English schooner, under reefed sails, standing to the northward and westward.

From 8 to midnight, a fresh breeze from the E. NE., and cloudy weather, with squally appearances; brig on a wind on starboard tack; at 9h. 15m. set the mainsail; at 9h. 30m., 10, and 11, got casts of the lead and bottom, each in 10 fathoms; at 11h. 20m. hauled up the courses, put the helm up, and, while in the act of wearing ship, discovered Smith's island, bearing W. by S.; stood for it until 11h. 30m., and then kept off S. by W; at 11h. 40m. hauled up S. SW. for Cape Henry; set the foresail; at 12, Smith's island light bore NW., a little northerly.

September 8, 1846.—Commenced with a fresh breeze from the E. NE., with thick and squally weather; at 12h. 20m. Smith's island light bore NW. ½ W.; lost sight of it immediately afterwards; at 2 hauled up NW., called all hands and took two reefs in the topsails; at 2h 30m. discovered land under the lee; wore ship to the southward and eastward, hauled on a wind, reefed and set the mainsail; got a cast of the lead in 5 fathoms water; at 3 pitched away the jib-boom, and commenced clearing away the wreck.

From 4 to 8, heavy gales from the northward and eastward; thick haze and rain, with a heavy sea on: at 4h. 5m. hauled up the mainsail: at 5h. 30m. the brig much pressed—took in and furled the foretopsail: at 6h. 30m. hauled up the foresail, clewed down the maintopsail, split the foretopmast staysail, took the bonnet off the fore trysail: both the starboard boats filled and tore away from the davits; got the wreck of the jib and flying booms on board: at 8 called all hands; from 8 to meridian heavy gales from the

northward and eastward, thick mist and rain: at 8h. 30m. carried away the main yard in the lee quarter, clewed up and furled the maintopsail and set the fore trysail, with the bonnet off; bent a new main trysail, reefed and set it; carried away the gaff and both weather boats from the davits: at 10, *blowing a hurricane*, the water above the lee rails most of the time; hove overboard both of the lee guns, and cut away the mainmast, which brought the foretopmast, the fore yard, and the head of the foremast with it, leaving them hanging up and down the mast; got her before the wind, and hove overboard the two larboard guns; sounded in eight fathoms water, not able to see a cable's length ahead; the tops of the seas blowing completely over and on board of us, the men clinging to keep from being washed or blown overboard. At 11 let go the stream anchor, with a 6½-inch Manilla hawser, 180 fathoms in length, bent to it, in order to bring her head to the wind, for the purpose of anchoring. At 11h. 10m., while in the act of letting go the starboard anchor, shipped a heavy sea amidships and on the quarter, sweeping the deck fore and aft, and carrying with it the poop cabin, and nearly all the officers and men. She partly righted; all succeeded in getting on board again, with the exception of George M. Bache, lieutenant commanding, James Dorsey, Benjamin Dolloff, and John Fishbourne, quartermasters, Henry Shroeder, sailmaker's mate, Francis Butler, Lewis Maynard, Thomas Stamford, and William Wright, seamen, and Peter Hanson and Edward Grennin, ordinary seamen. On regaining the wreck, manned the pumps, cut away the foremast, and let go the starboard anchor, which brought her head to the wind; found the tanks, chains, kentledge, and every thing in the hold, had shifted, ripping up the berth deck; cleared away the chain and run it out to the better end; at the same time employed heaving overboard the kentledge and shot. The brig gradually righted; the gale abating, she rode to her anchors.

From meridian to midnight, blowing a gale from N. NW.; the wind having shifted at about 4 p. m., the sea running very heavy, but the brig riding easy at her anchors.

September 9, 1846.—Commences with (and until 4 a. m.) heavy gales from N. NW., with squalls and rain.

From 4 to 8, fresh gales from the N. NW., and occasional rain; rigged a jury foremast from a mast belonging to the Apprentice, and a mainmast from a stump of the old jib-boom. Both masts were secured by stout nouldings to the stump of the old ones; broke out and restowed the hold, the kentledge having shifted when the brig was on her beam ends; rigged for a fore yard-arm one of the lower booms, and bent for a foresail the lower studdingsail; bent the jib. At 2h. 20m. a brig bound to Savannah passed near and hailed us, but declined boarding us on account of the sea running too high; two schooners also passed us during the afternoon, but neither near enough to communicate. Saw the land at intervals, bearing N. by W. to S. by E. By means of the jury foremast got up the spare anchor from the main hatch and transported it to the larboard bow, and got it ready for letting go. A light house (supposed to be Cape Hatteras) in sight, bearing S. SW., distant 15 miles.

From 8 to midnight, fresh gales from the N. NW. and cloudy.

September 10, 1846.—Commences with a heavy gale from the N. NW. and a heavy sea running. At 0h. 15m. a. m. discovered the brig was dragging; let go the larboard anchor and veered to the better end of the chain, which brought her up.

From 4 to 8 a heavy gale from the N. NW., and a heavy sea running; the land in sight at intervals on the larboard beam.

From 8 a. m. to midnight heavy gales from the N. NW., with a very heavy sea on. In consequence of the exhausted state of the crew, permitted them to remain below all day; light-house in sight (supposed to be on Cape Hatteras) bearing S. by W. ½ W. per compass.

September 11, 1846.—During these twenty-four hours fresh breezes from the northward and westward, and squally. Manufactured a jury fore yard from such spars as were at hand, and on it bent the maintopsail for a foresail, and shifted the spar and sail which was intended for a foresail, and of it made a substitute for a main yard and mainsail.

September 12, 1846.—Commences with a fresh breeze from the northward, with a heavy sea running.

From 4 to 8, fresh breezes from the northward, and passing clouds.

From 8 a. m. to 8 p. m. fresh breezes from the northward, and clear at 6; called all hands and commenced heaving in on the cables; discovered the larboard chain to have parted ten fathoms from the anchor; hove in to sight the starboard chain and found the anchor gone; hoisted the jib and wore round to the southward; hauled on a wind, set the courses, mainsail, and main staysail, and stood off shore.

From 8 to midnight, a light breeze and passing clouds.

September 13, 1846.—Commences with a light breeze and thick hazy weather.

From 4 to 8, light breezes, with thick, hazy weather.

From 8 to meridian, a light breeze and foggy: at 11 called all hands to muster; rated Wm. Neef, Simeon Heath, and Samuel Berry from seamen to quartermasters; Richard Dougherty, Matthew Wheeler, Jacob Tudor, Peter Ellis, Thomas Holden, William Thadwick, and George Duff from ordinary seamen to seamen; mustered the crew and read Divine service.

From meridian to 4, a light breeze and clear, pleasant weather: at 1 hove to and spoke the American hermaphrodite brig J. Peterson, Thomas Wilson master, from Wilmington, North Carolina, bound to New York; a boat from the brig boarded us: at 3, having made a contract with the master of the J. Peterson to stay by and render us all the assistance in his power until our arrival in some harbor between Cape Henry and Newport, Rhode Island, he left the vessel, wore to the northwestward and made sail, the J. Peterson in company; saw a barque standing to the westward and eastward, with topmast carried away.

From 4 to 6, light breezes and clear pleasant weather; the brig J. Peterson in company on the lee bow.

From 6 to 8, light breezes from the southward and westward, and clear pleasant weather; spoke an American fore-and-aft schooner from Boston, bound to Washington, North Carolina, the J. Peterson in company.

From 8 to midnight, a light breeze and pleasant weather; the J. Peterson in company; burnt a blue light at 10 and 12 to show our position.

September 14, 1846.—Commences with a light breeze and clear pleasant weather; the J. Peterson on the lee bow.

From 4 to 8, first part calm; latter part light airs from the westward and eastward, and clear; discovered a wreck inshore of us, under jury-masts; brig J. Peterson in company.

From 8 to meridian, calm and pleasant; received from the J. Peterson two spars in the rough; crew employed in making and fitting fore yard; spoke the schooner John Alwyn, of Baltimore, Ricketson master, from New

Bedford bound to Baltimore; requested him to report us; saw several sail during the watch; at meridian spoke the steamer Palmetto, from Delaware breakwater, bound to Brazos Santiago, with government stores; got a small boat from her; latitude 35° 40′ north, longitude 75° west.

From meridian to 4, light airs and calms; employed fitting a main yard from the spars obtained from the Peterson; sent aloft for a maintopmast; a spare one received from the same vessel: at 4 the brig on the lee bow.

From 4 to 6, light airs from the southward and westward, and clear; bent and set maintopsail on main yard, made of spars obtained from the J. Peterson.

From 6 to 8, a light breeze from the southward and westward, and pleasant weather: at 8 got a cast of the lead, and bottom at 20 fathoms; hoisted one light at 8 at the mainmast-head; the J. Peterson in company on the starboard beam.

From 8 to midnight, light breezes and pleasant; the Peterson not in sight.

September 15, 1846.—Commenced with light breezes from the southward and westward, and clear: at 2 and at 4, sounded in 14 fathoms.

From 4 to 8 a light breeze and clear and pleasant weather: at 8 spoke the schooner Julia, from New York; informed us that Cape Henry bore W. NW., distance 60 miles; the J. Peterson in company on the starboard quarter.

From 8 to meridian, light breezes and clear pleasant weather: at meridian the J. Peterson in sight on the lee quarter, and a pilot boat on the weather bow standing for us.

From meridian to 4, light airs from the southward and westward, and clear. Received on board, from the J. Peterson, an anchor weighing 90 lbs.; got up and set fore-royal on fore yard, set main royal; spoke the pilot boat, but she could not furnish us with a pilot, having but one on board.

From 4 to 6, a light breeze and squally appearances. At 4h. 50m., spoken by the pilot boat Comet, of Baltimore; requested her to send a pilot on board of us. He said he refused *no man* a pilot, notwithstanding he hauled on a wind and stood to the southward, having two pilots on board his boat at the time. At 5h. 30m., shortened sail to a squall rising in the northward and eastward. The J. Peterson ahead on the larboard bow.

From 6 to 8, first part, a light breeze from the northward and eastward, with heavy squalls of wind; clearing to the northward and westward. At 12, sounded in 14 fathoms; passed by a vessel standing to the southward and eastward; set the spanker.

September 16, 1846.—Commences with a fresh gale and clear weather; during the watch sounded in from 12 to 18 fathoms water. No bottom at 18 fathoms. Several lights in sight; the J. Peterson not recognised.

From 4 to 8, fresh breezes, and clear; fitted an additional pair of main shrouds. At 6, sounded in 20 fathoms water; at 8, in 16 fathoms; passed a large French ship standing to the southward and westward. At 8, the Peterson astern.

From 8 to meridian, fresh breezes from the northward and eastward, and clear. At 10, set the courses, the fore close-reefed. Passed a French ship standing to the southward and westward, sounded in 15 fathoms; lost sight of the J. Peterson.

From meridian to 4, a fresh breeze and clear weather; two sails in sight, standing to the westward. This day put all hands on an allowance of half a

gallon of water per day—ascertained that at this rate there was sufficient on board to last 20 days; found that the beans and rice contained in the lockers had become saturated with water, and were smelling very badly—threw them overboard by order of the commanding officer.

From 4 to 6, a fresh breeze with a heavy sea on from the northward and eastward; lowered down and close-reefed the courses, and set them again.

From 6 to 8, a fresh breeze and clear; at 7, wore ship to the northward and westward; hauled down the old foretopmast staysail, and bent a small one; lowered the maintopsail and foresail, and reefed them. At 8, lying to under fore staysail, main staysail, and mainsail.

From 8 to midnight, a fresh breeze and clear weather; the brig lying to with her head to the northward and westward.

September 17, 1846.—Commences with a fresh breeze and pleasant—a heavy swell from the northward and eastward.

From 4 to 8, a moderate breeze from the northward and eastward, and clear. At 5h. 45m., made sail to courses, single-reefed, and foretopmast staysail. At 7, turned the reef out of the mainsail; showed our colors to a ship and a schooner standing to the northward.

From 8 to meridian, a moderate breeze and a heavy head sea; a ship in sight, at meridian, standing for us.

From meridian to 4, fresh breezes and clear. At 1, spoke the Bremen ship Albert, and requested her to board, and render us such assistance as our situation required. He promised to do so, but afterwards declined on account of the heavy swell; requested him to furnish us with a topgallant yard, which he put overboard for us, but which we were unable to reach from our drift, it being to windward of us; discovered a large sail to the southward and eastward standing for us, which proved to be the United States frigate Constitution, from Rio Janeiro, bound to Boston; a boat came alongside with offers of assistance. At 4, Lieutenant Hall went on board.

From 4 to 6, moderate breezes from the northward and eastward, with squally appearances to windward; wore ship to the leeward of the Constitution and hove to. Received from her a sextant, &c. At 6, she took us in tow; took in and furled all sail.

From 6 to 8, moderate breeze and squally weather; in tow of the Constitution.

From 8 to midnight, moderate breezes and hazy weather; brig in tow of the Constitution.

September 18, 1846.—Commences with a moderate breeze and cloudy; in tow of the Constitution.

From 4 to 8, light breezes and clear, pleasant weather; at 5h. 30m., the Constitution requested us to make sail, which was done accordingly; at 6h. 30m., wore ship in the Constitution's wake.

From 8 to meridian, light breezes and clear, pleasant weather; at 10 the Constitution veered a boat astern for us, and sent by it five breakers of water, containing about 15 gallons each, one spy-glass, one box candles, one lantern, and a lump of chalk.

From meridian to 4, moderate courses from the northward and eastward, and clear; received from the Constitution 7½ gallons whiskey, a few spars and sails.

From 4 to 6, a light breeze and pleasant weather; unbent the fore course,

and bent a foretopsail in place of it; the brig in tow of the Constitution, with but a slight strain on the tow-line.

From 6 to 8, light airs and pleasant; in tow of the Constitution.

From 8 to midnight, light breezes from the northward and eastward, and clear.

September 19, 1846.—Commences with fair weather and sheet lightning in the eastward; at 1, wore to the northward and eastward.

From 4 to 8, a moderate breeze and passing clouds; saw a brig standing to the northward and eastward; got a pull of the main rigging and brought the mainsail afresh to the yard.

From 8 to meridian, a light breeze and passing clouds; employed rigging a jib-boom; the U. S. frigate Constitution ahead.

From meridian to 4, a moderate breeze and pleasant weather; men at work *fitting sails, &c.; two sails in sight standing* to the northward and westward.

From 4 to 6, light breezes and clear; several sails in sight; sounded in 18 fathoms; broken gray sand.

From 6 to 8, light breezes from the northward and eastward, and clear.

From 8 to midnight, a light breeze and clear, pleasant weather; at 9h. 20m. wore to the southward in the Constitution's wake.

September 20, 1846.—Commences with light breezes and pleasant weather.

From 4 to 8, a light breeze and pleasant; at 6 wore ship to the northward and westward in tow of the U. S. frigate Constitution.

From 8 to meridian, a light breeze and clear, pleasant weather; received from the Constitution some water, spare spars, &c., and a kedge, weighing 400 pounds.

From meridian to 4, light breezes, with clear, pleasant weather; received from the Constitution some water, making in all received during the day 417 gallons; several sails in sight.

From 4 to 6, light airs from the northward, and clear; clewed up the mainsail and fore and maintopsails, to keep astern of the Constitution.

From 6 to 8, light breeze and pleasant weather; several sails in sight; during the watch a boat from the Constitution boarded a brig bound into Norfolk, and requested her to report them, with this brig in tow in distress; officers and crew all well.

From 8 to midnight, light breezes and pleasant; in tow of the Constitution.

September 21, 1846.—Commences with light air and calm; the Constitution ahead.

From 4 to 8, calm and pleasant; two sails in sight.

From 8 to meridian, light airs and pleasant weather; received from the Constitution 200 gallons of water.

From meridian to 4, a light breeze and pleasant; sent down the old foreyard and sent up a new one made from the foretop-gallant yard of the Constitution; frigate Constitution ahead with the tow-line attached.

From 4 to 6, light airs and pleasant weather; two sails in sight standing to the northward and eastward; the brig in tow of the Constitution; at 6 received a pilot on board for the Delaware.

From 6 to 8, light breezes and pleasant; Mr. Ricketson, master's mate, was transferred to the Constitution by order of the commanding officer; at

6h. 15m. cast off the hawser from the Constitution, and was taken in tow by the pilot boat; the frigate filled away; cheered her in parting company.

From 8 to midnight, moderate breezes from the northward and eastward, and clear; took in and furled the topsails and maintop-gallantsail.

September 22, 1846.—Commences with moderate breezes and clear weather; at 2h. 30m. tacked in the pilot boat's wake.

From 4 to 8, moderate breezes and pleasant; in tow of the pilot boat.

From 8 to meridian, light breezes from the northward and eastward, and clear; at 11 furled all sail and laid by the hawser, astern of the Enoch Turley, at anchor.

From meridian to 4, light breezes from the northward and eastward and pleasant weather; several sails in sight standing in for the capes of the Delaware.

From 4 to 6, light airs and pleasant; at 4 the pilot boat got under way and stood in for the Delaware, with us in tow.

From 6 to 8, light breezes from the northward and eastward, and clear, pleasant weather; at 8 cast off the pilot boat. Being inside the capes of the Delaware, Lieut. R. N. Stembel left in her for the breakwater, with despatches for Washington; made all sail and stood up the bay.

From 8 to midnight, a light air from the northward and eastward, and pleasant weather; brig standing for the light-boat in the Brandywine shoal, two miles distant, in charge of the pilot.

September 23, 1846.—Commences with (and until 4 a. m.) light airs from the southward and westward, and pleasant; at 1 anchored in 8 fathoms water, and veered to 15 fathoms chain; clewed down the topsails.

From 4 to 8, light airs from the westward and passing clouds; at daylight hove up the anchor, made all sail, and stood up the bay; at 6 boarded by a boat from the revenue cutter with offers of assistance.

From 8 a. m. to midnight, moderate breezes from the southward and westward, and pleasant; standing up the Delaware in charge of the pilot.

September 24, 1846.—These 24 hours light breezes from the southward to westward, and clear; at 1 came to off Chester; at 8 a. m. got under way and stood up the Delaware; at 2 anchored off the navy yard at Philadelphia; were boarded, with offers of assistance from the yard; sent the powder ashore; at 4 p. m. hauled alongside of the dock and secured.

—

Statement of Mr. Ricketson, pilot of the United States coast survey brig Washington.

Stood in on 7th September, and made Smith's Island light at 11 p. m.; cloudy, very heavy swell from SE.; wind NE., increasing to a gale; wore ship and kept off S. SW. to go into Norfolk; 12, lost sight of light bearing NW.; proposed to haul in to SW. about 1 a. m. on 8th. Wind increasing to gale, captain thought best to keep on one hour longer on that course, parallel to Smith's island; for, if struck on middle ground with such a swell, no chance. Time ought to have made Cape Henry light, weather thick and squally; 2 a. m. hauled in right for land, double reefed topsails, and reefed mainsail; land bold; and if not make light, make land; 2h. 30m. breakers and land ahead, running now before the gale S. SW.; if not fall in with light, go to sea. Wore ship and changed course to southward and eastward; pilot went below, captain on deck. Mr. Donaldson's account,

gale increased until 7½, when captain sent for pilot. Currents running to southward, with wind alongshore. Pilot said to captain, "Touch of equinox;" Thinks now it was a hurricane. 8h. 30m. (about) carried away main yard—good stick—blowing very heavy; broke about two-thirds way from starboard end. Only maintopsail on, clewed down; not safe to send up to reef sail; foretopsail—stay-sail. Took bonnet off fore-trysail (same as foresail of schooner) to set it. Endeavored to set main-trysail, but carried away gaff towards 10 a. m. At 10 Captain Bache ordered lee guns thrown over; water over lee railing. Before this, had spoken with Captain Bache to cut away masts; let go anchors, and bent kentledge on to bill of chain. Captain asked Mr. Stembel's opinion, who said, "By all means." Captain assented. Pilot (officer of deck) ordered weather rigging cut, and mast went over ten feet from deck; broke as soon as cut last shroud, carrying away foremast-head and fore-yard. Did not cut lee rigging, because vessel rolled so that if mast had gone to windward, a bad predicament. Helm put hard up so as to relieve vessel from mast, &c.; obeyed helm. Into trough from SE. went round NW., clearing wreck, and larboard guns thrown over; now lee-guns. Large gun lashed to deck and secured to kelson, so it was unmoved. Put helm hard up and wore ship to southward and eastward, about 11 a. m. Blowing perfect hurricane; pilot never knew it to blow so; sea making breach over vessel; white foam in every direction. Foremast still up and vessel in trough; Captain B. ordered hawser bent on stream anchor, (larboard side) and let go. This was foul; chain cat-stopper hard jammed. While endeavoring to saw chain off, sea struck vessel, (11½ a. m. about) and knocked over on beam ends. Sea curled over and tumbled upon vessel. Tremendous sea—crushing deck cabin, and sweeping deck of every thing. Keel out, shifting ballast to upper berths, 3 cwt. in weight; shifted water-tanks. Water and every thing in hold. Tore up berth deck, (deck hatches) beams and all; all but those lashed were washed over; sawing chain; cat-stopper chain. Stooping, felt crash, and found himself under water swimming to get head above water; found himself under lee of vessel, about two-thirds brig's length; vessel partly righted—railing under water; swam and got hold of starboard anchor. When getting on deck saw Captain Bache and several men overboard astern, apparently as if stunned or hurt; two quartermasters and one of the men bloody. The three quartermasters were at the wheel with captain, who was conning ship; wheel under cover of deck cabin. Wheel stanchion and every thing carried away. The three quartermasters lost. One of them said, "Take care of yourselves, shipmates." John Fishbourne overboard, holding on to fragment of wreck. Captain holding on to part of cabin, apparently as if stunned; did not speak nor make sign; thinks he saw pilot, who was trying to get some moveable article to bend on to end of line, and throw overboard. There was no such article, though he went to cabin gangway, and that was half full of water; pilot had talked with captain of this way of rescuing a man overboard; captain's arms over fragment of wreck and cabin; arms over and side resting; no marks on face; arms over, resting, and head sideways, looking towards brig; while thus, another sea came and almost suffocated pilot. This was the last he saw of the captain; sea came first over captain, and then pilot; was somewhat suffocated. Time, say 11h. 35m. This was the last he saw of captain. Pieces of wreck were buried in water; saw fragments afterwards. Same kind of crushing sea which had curled over vessel; smaller size; looked, but saw him no more. Men escaped chiefly by rigging, which was

reaming out, and some swam; greater part of crew washed off; captain, ieutenant Hall, pilot, Mr. Donaldson, on deck; pilot was officer of deck t this time. Got anchor cleared away from bow. Foremast sawed by re-aining quartermaster Alonzo. Rigging cut away to windward, and en began to saw; broke off before it was a quarter of the way off y sawing. Each man had to help himself. Crew obedient—not noisy. ome appeared terrified; Lewis, wardroom waiter, was so frightened that e walked overboard after he had regained the deck. Last order given by aptain was to "let go starboard anchor and give her whole length of chain;" sual tone of voice—seemed perfectly cool, just the same as he always gave rders; order to officer of deck, and he executed, giving orders to crew; nderstood he went down into wardroom after mast was cut away, and aid, "Now, gentlemen, I hope you will all say that I have done what you ll considered was for the best." If mast had not been cut away, vessel ever would have righted; not a soul would have been saved; Francis as in the captain's cabin; saw him a little distance from captain and uartermaster; captain was about 300 feet from vessel; all more or less hurt who were under the house; wheel-house each side; deck overhead rushing upon them; must have hurt them. This sea was at most severe art of gale; vessel was off near Nag's head; could see nothing; wind om northeast; sluices of water coming over them; could see a cable's ength, perhaps—sometimes not half; squalls. About six or seven miles om land, current now setting to southward right along shore; shot thrown verboard, and some part of kentledge from her side; all pumps kept go-ng; cabin partly filled with water; water broke in skylight and went own both cabin gangways; kentledge thrown into pilot's berth from next kelson; on starboard side Mr. Mullany badly bruised, and a boatswain's ate badly hurt in pit of stomach by being thrown against side; both boat-wain's mates wounded; one reason why pilot had to attend anchor him-lf; gale continued very severe until about one, and then abated; at 3 p. . moderated, and shifted round to northwest at 4; stream anchor had hafed entirely off hawser, by dragging; now one anchor holds; 8th, ended; ih, rigged jury masts; *Apprentices'* foremast rigged up for jury foremast, nd pieces of jib-boom for mainmast, which had swung alongside; spoken y vessel bound to Savannah; no assistance; men melancholy, but obeyed rders promptly; topsail with single reef cut out and bent to main yards by eef points; had cleared so as to see land, opening of New inlet; and Hat-eras light south about 18 miles; got out large anchor; night of 9th, drag-ed single anchor; let go best bower (sheet anchor) and payed out whole ength of chain; held; wind, dry norther; gale; vessel tight. 10th, con-nued to blow gale from north. On evening of 11th, tried to get anchors p, when chains parted; weather had moderated; stood out into Gulf tream; [asked quartermaster what they were doing scudding vessel before ind; told them to put helm down, and brought to wind, when he found aptain B. had given no such order; captain passing backward and for-ard;] overhauled by captain of Peterson, who, after remaining four days, ft them; contract to stay by brig until got into some port between New-ort, Rhode Island, and Cape Henry; gave anchor and helped to spars; as-isted them a good deal trying to get into nearest port (Norfolk;) weather-g Hatteras shoals required some running to southward; met Constitution 17th; hoisted signal for pilot, and took one on board; exchanged pilots; ut of danger on falling in with Constitution, 40 miles from Henlopen.

Cannot say if results are lost.

Thinks bodies will drive ashore; Captain's oil-cloth coat yellow—below knees; no uniform; no one had uniform; light blue pants; blue and white speckled woollen slippers; oil cloth coat buttoned round him; whiskers coming below neck; no beard on lips; hair long, black.

APPENDIX No. 6.

Statement of the officers of the United States coast survey brig Washington, in reference to the equipment, &c., of the vessel.

UNITED STATES BRIG WASHINGTON,
Philadelphia Navy Yard, October 3, 1846.

SIR: The undersigned officers, after mature consideration of the points upon which our opinions are requested in your letter of the 30th ult., viz: the equipment of the Washington for sea, the seaworthiness of her hull, and the effect, if any, of her armament in the gale of the 8th, respectfully report that her equipment was in every respect excellent; that she was well provided with spars, spare sails, rigging, &c.; that her hull was perfectly sound and seaworthy, which we conceive to have been incontestably established by her withstanding, without leak, the heavy shocks of the sea during the gale. Her armament was much lighter, in proportion to the vessel's tonnage, than that of her class employed in the naval service. The gunnades had been thrown overboard before the hurricane had reached its height; and the remaining gun, an eighteen-pounder, could have had no effect in causing the catastrophe which followed.

In every particular the Washington proved herself an excellent sea vessel; none similarly situated could have done better.

Permit us, sir, in conclusion, to express our sympathy with yourself and the family of our late beloved and lamented commander, in the irreparable loss which in him they and the country have sustained.

During the trying scenes which preceded his loss, his coolness and decision were remarkable: every thing that seamanlike skill could effect for the safety of the vessel he accomplished. He appeared never to think of himself, but, with his characteristic solicitude for the performance of his duty, only of preserving what related to that upon which he had been engaged during the cruise.

We are, respectfully, your obedient servants,

JOHN HALL, *Lieutenant Commanding.*
R. N. STEMBEL, *First Lieutenant.*
J. R. M. MULLANY, *Lieutenant.*
STEPHEN D. TRENCHARD, *Acting Master.*
EDWARD DONALDSON, *Passed Midshipman.*
F. K. MURRAY, *Passed Midshipman.*

Appendix No. 7.

1. Report of superintendent of coast survey to the Treasury Department, communicating the loss of Lieutenant Commanding George M. Bache and of ten petty officers and seamen of the brig Washington, in the hurricane of September 8, 1846.
2. Reply of the Secretary of the Treasury to the foregoing.
3. Letter from the Secretary of the Navy to the Secretary of the Treasury.

Holt's Station, near Andover, Mass.,
September 30, 1846.

Sir: I have the honor to transmit to the department a copy of the log-book of the United States coast survey brig Washington, received yesterday, embracing the occurrences from the 7th to the 22d inst. It contains the particulars of the disasters encountered during the storm of the 7th of September and hurricane of the 8th, in which the lamented commander of the vessel, Lieut. George M. Bache, United States navy, and ten of her crew, were lost. The names of the petty officers and men who perished with their commander are subjoined:

James Dorsey, Benjamin Dolloff, and John Fishbourne, quartermasters; Henry Shroeder, sailmaker's mate; Francis Butler, Lewis Maynard, Thomas Stamford, and William Wright, seamen; Peter Hanson and Edward Grennin, ordinary seamen.

I have seen Lieutenant R. N. Stembel, despatched by Lieutenant John Hall, now commanding the Washington, to report orally the minute details of the cruise which terminated so disastrously; and also the pilot of the brig, Mr. B. F. Ricketson, whose information in regard to the intentions of his late commander in what related to the sailing of the vessel was of course minute.

The narrations show that every thing was done by officers and men which could be effected by human foresight and prudence, nautical skill, coolness and discretion, and naval discipline. The officers write in especial praise of the coolness, energy, and skill shown by their late commander; rising with the increasing exigencies from the commencement of the gale, which prevented their entrance into the Chesapeake, to the height of the hurricane off the coast of North Carolina, where he perished. The last manœuvre which he ordered, and which was executing when nearly all on deck were swept from it, was that to which, under Providence, the survivors subsequently owed their safety. The stream anchor had been let go, and the captain had given the order to "let go the starboard bow anchor and give the whole length of the chain," and was standing near the quartermasters, at the wheel, conning the vessel, when a heavy sea struck her, and, toppling over the side, poured a deluge of water down upon the decks, crushing the deck cabin, and tearing it and the berth deck from their fastenings; throwing the vessel completely on her beam ends, and sweeping those on deck into the raging sea. No one of those on the after part of the deck regained the vessel. Most of those on board believed that the vessel had struck; and all thought their commander and shipmates, who were seen clinging to fragments of the wreck, had merely preceded them in a struggle which was inevitable.

The subsequent letting go of the anchors, abatement of the hurricane, and shift of the wind along shore, gave the survivors hope of escape. Too much praise cannot be awarded to men who maintained the exactness and efficiency of discipline during such circumstances.

The measures of Lieutenant John Hall, upon whom the command devolved, were distinguished by good judgment; and, ably seconded by his gallant officers and crew, he succeeded in bringing the wreck of the Washington into the port of Philadelphia, through dangers which were sometimes imminent. Thanks and praise of the strongest character are due to the surviving officers, petty officers, and men of the Washington, from the department under which they are especially serving, and from the Navy Department, to which they belong, and will, I trust, be awarded to them by both. In testimony of the approval of the Treasury Department of their conduct, I would respectfully request authority to have a medal struck and presented to each one of the officers and crew, commemorative of the loss of Lieut. Com. Bache and the ten petty officers and seamen who perished with him, and of the perils through which the survivors have passed.

Thanks are due to Thomas Wilson, of the brig J. Peterson, who kept his vessel near the Washington for three days and supplied her with an anchor and two important spars; to Mr. Lewis, master of the steamboat Palmetto, who supplied her with a small boat; and to the master of the Bremen barque Albert, who endeavored to supply a top-gallant yard to her; but especially to Captain Percival, United States navy, commanding the United States frigate Constitution, who took the brig in tow, and who, with his officers, rendered every aid which kindness could suggest until the vessel was put in tow of the pilot boat Enoch Turley off the capes of the Delaware. It will be a melancholy satisfaction to me to be made the channel of communication of the thanks of the department.

The exploration of the Gulf stream has been a favorite object in the coast survey for a few years past. Guided by the experience of the last surveying season, when the exploration was first seriously commenced, by his own excellent judgment, his scientific skill, and his habits of close observation, Lieutenant Bache had made already this season a remarkably successful cruise, bringing home most interesting results. His mind stored with the facts already collected, he went upon a second cruise with improved means of observation, intending to explore the temperatures from the surface to great depths, to ascertain the direction and force of currents, and other phenomena of the Gulf stream, upon two sections across the stream south of that made during his first cruise; one beginning near Cape Henlopen, and the other off the coast of Virginia and North Carolina. He had brought his work to a successful termination. He and his officers were highly gratified with the results which, day by day, were collected and reduced. Rumor even says that he had made a capital discovery of a fact new and unsuspected in the character of the Gulf stream. He was returning prudently in advance of the time for the equinoctial gale, when, near the capes of Virginia—in fact, in sight of Cape Charles light—he met the gale which drove him southward, and the hurricane in which he perished. I am not yet informed how far the results of this second cruise have been saved in the wreck, but am led to believe that a considerable portion of the original notes remain; and it may even prove that the precautions which Lieutenant Bache took to secure the floating of the log-book and other papers may yet restore the whole of his labors to the work. Their collection and publication will be a pious duty.

I cannot close this report without adverting to the assistance derived in past years from Lieutenant Bache, in arranging the hydrographic details of the coast survey.

It will be my pride and pleasure to present his papers on the method of off-shore triangulation, of observing currents, and especially of the complete determination of those of New York bay and harbor. The collection and classification of specimens of the bottom, brought up in sounding, originated with him, and he expected to carry it through, next winter, by a classification of the specimens now collected. His mind was dwelling fruitfully upon the methods of observation, and the results, in the Gulf stream. His name is connected with every chart but one yet published by the coast survey, and will be identified with the work as responsible in part, or entirely, for the hydrography of the coast and harbors from the coast of New York to that of Maryland inclusive—so great has been his activity and success during the nine years of his service on the survey. We can now but bitterly deplore his loss, in the very height of his usefulness, from matured judgment, enlightened experience, and responsible position.

I would respectfully request that a copy of this report, and of the extract from the log-book which accompanies it, may be transmitted to the honorable the Secretary of the Navy, with the request that they may be placed upon the files of the department.

Very respectfully yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Letter of the Secretary of the Treasury, in reply to the foregoing letter from the superintendent of the coast survey.

TREASURY DEPARTMENT, *November* 14, 1846.

SIR: A faint hope, now no longer entertained, of the possible rescue of the late commander of United States coast survey brig Washington, and of the crew who perished with him, has delayed reply to your communication of the 30th September.

By the letters herewith communicated, and which you can forward to their proper destination, you will perceive that all your requests have been complied with

The skill, coolness, and courage exhibited throughout the whole period of the disastrous hurricane of the 7th and 8th September last, by the late commander of the Washington, George M. Bache, have been never surpassed.

His previous services rendered to the coast survey were great and valuable; they were about to produce results highly interesting to science, and useful to navigation, when he was lost forever to his country and to his friends.

He perished nobly, in the able and faithful discharge of his duty; and the execution, after his loss, of the last order he ever gave, insured the safety of the vessel, and of the surviving officers and crew.

The names of the brave and faithful seamen who perished with him deserve to be, and will be, recorded and remembered with gratitude and praise.

To Lieutenant Hull, who succeeded in the command, and the surviving officers and crew, the highest praise is due for their excellent conduct, as well before as after the loss of their lamented commander.

The medal can be prepared, as you propose, and presented to each one of the surviving officers and crew.

I am, very respectfully, your obedient servant,

R. J. WALKER.

Professor A. D. Bache,
Supt. U. S. Coast Survey, Washington.

Letter of thanks from the Secretary of the Treasury to Lieutenant John Hull, commanding U. S. survey brig Washington.

Treasury Department, *November* 16, 1846.

Sir: The thanks of this department are hereby tendered to you, and to the surviving officers and crew of the United States coast survey brig Washington, for their coolness, skill, and courage, as well during as after the hurricane of the 8th of September last.

Before the loss of your late lamented commander, George M. Bache, you proceeded to execute the orders given by him, which eventually secured the safety of the vessel, and, after he had perished, your conduct was also deserving of the highest praise.

This letter, with that of the superintendent of the coast survey to me, in which the facts are more fully detailed, together with all the accompanying papers, will be placed on the files of this department, as well as that of the navy, with the consent of the Secretary, as an abiding memorial of the great coolness, skill, and courage of the departed, as well as of the survivors of the late catastrophe.

I have also authorized the superintendent of the coast survey to have a medal struck, and presented to each one of the surviving officers and crew, commemorative of the loss of Lieutenant Commanding Bache, and the ten petty officers and seamen who perished with him, and of the perils through which the survivors passed.

I am, very respectfully, your obedient servant,

R. J. WALKER,
Secretary of the Treasury.

Lieut. John Hall, *U. S. N.*,
Com. U. S. brig Washington, coast survey.

Letter of the Secretary of the Navy to the Secretary of the Treasury in relation to the foregoing.

Navy Department, *November* 20, 1846.

Sir: I have the honor to acknowledge the receipt of your letter of the 16th instant, with its enclosures, in relation to the loss of Lieutenant Commanding George M. Bache, of the United States coast survey brig Washington, and ten of her crew, in the hurricane of the 8th September last.

This department concurs fully in the opinion entertained by yourself and Professor Bache, in regard to the conduct of Lieutenant Bache, and those who perished with him, on that melancholy occasion.

I am, very respectfully, your obedient servant,

J. Y. MASON.

Hon. R. J. WALKER,
Secretary of the Treasury.

Resolutions of assistants and others connected with the coast survey, in relation to the loss of Lieut. Com. George M. Bache.

A meeting of the officers of the hydrographical party No. 1, of the United States coast survey, was held on board of the surveying schooner Gallatin on Thursday, October 1, 1846, at Edgartown, to express the deep grief felt by them for the loss of their distinguished associate and friend, George M. Bache. At this meeting it was

Resolved, That the naval service of the country, and particularly that part of it engaged in the survey of the coast, has met, in the death of Lieut. Bache, with a real calamity, which can never cease to be regretted by those who have the honor and good of the navy and of the coast survey at heart:

That Lieut. Bache was gifted with uncommon talents, and had possessed and profited by opportunities for self-improvement, rare with naval officers, which qualified him, in a remarkable manner, for the duties of scientific exploration in the Gulf stream, in which he was engaged:

That, in his private intercourse with his brother officers, he always exhibited the highest integrity, amiability, and generosity of conduct and character:

That, in all the scenes of danger and trial which preceded his death, he displayed perfect presence of mind and great professional skill; and, moreover, that the last words which he addressed to his officers, when he called upon them to observe that he had done every thing in his power for the preservation of his vessel, and for the safety of those under his command, were the expression of a sentiment of disinterested devotion to the duties of his responsible station, such as was, in the highest degree, honorable to him as a man and as an officer.

And it was further

Resolved, That a copy of these proceedings be sent to his brother, the superintendent of the coast survey, and that he be requested to accept for himself, and to convey to Lieut. Bache's family, as far as may be becoming at this time, the assurance of the profound grief and sympathy felt by the officers on this mournful occasion.

At a recent meeting of the assistants and others connected with the United States coast survey, at Washington, the following resolutions were unanimously adopted:

The melancholy intelligence having been announced of the loss of Lieut. George M. Bache, of the United States navy, while in command of the

United States brig Washington, and engaged on duty connected with the survey of the coast, it was

Resolved, That by this afflicting dispensation the survey has sustained a deep and long to be deplored loss, in one of its most talented and efficient assistants, while we ourselves, have been bereft of a most excellent and esteemed friend; that we profoundly sympathize with his afflicted relatives and connexions, and, as expressive of this our feeling, that copies of these resolutions be transmitted to them.

Resolved, That, as a testimony of our regard, and as a tribute to his memory, we will wear the usual badge of mourning for thirty days.

Appendix No. 8.

Letter from Lieut. Com. Patterson, United States navy, to the superintendent of the United States coast survey, relating to the tides at the entrance of Mobile bay.

U. S. Surveying Schooner Phœnix,
Miss. Sound, May 4, 1846.

Sir: Below I send such results as I have been able to deduce from the register of the tide-gauge at the primary tidal station, Mobile point, from January 13th to May 10th, nearly four months.

1st. The mean height of the gauge stood at 3.44 feet.

2d. The maximum H. W. was on January 20th, after a gale of 36 hours from the eastward, and southward and eastward, the severest that has been known for 15 years, when the gauge stood at 4.96 feet.

3d. The minimum L. W. was on January 25th, after northerly weather for four days previous, when the gauge stood at 1.96 foot.

4th. The maximum rise took place on January 19th, during the above gale from the eastward and southeastward, when the water rose 2 feet.

5th. The minimum rise took place on January 31st, during very fresh NW. and W. winds, when the tide rose but 0.2 foot.

6th. The maximum fall took place on January 21st, immediately after the above SE. gale, and during fresh breezes from the northward, when the tide fell 2.2 feet.

7th. The minimum fall took place on January 18th, the day previous to the heavy S. E. gale, when the water fell but 0.15 foot.

8th. The maximum duration flood was on January 19th and 20th, during the heavy SE. gale, when it ran for 30 hours.

9th. The minimum duration of flood was on March 13th, the day succeeding a SE. gale, and during moderate NW. breezes, when it ran but for 3 hours.

10th. The maximum duration of ebb was on March 2d, the day after a SE. gale, and during fresh breezes from the northward, when it ran out for 19 hours.

11th. The minimum duration of ebb was on January 18th, corresponding with the minimum fall, when it ran out but for 2 hours.

12th. The maximum duration of slack-water H. W. was on April 23d, during a SE. wind, and when it had blown from that quarter for 6 days previous, the water remaining without a sensible fall for 10 hours.

13th. The minimum duration slack-water H. W. was on January

13th, at the commencement of an easterly blow, and subsequent to a spell of northerly weather, when it slacked but for 15 minutes.

14th. The maximum duration of slack-water L. W. was on May 5th, after an ebb of but three hours, and during a heavy SE. gale, when it remained down for 14 hours.

15th. The minimum duration of slack water L. W. was on January 14th, after an ebb of 13½ hours, and at the commencement of a SE. gale, when it remained slack but for 45 minutes.

16th. The mean rise has been 1.011 foot. The mean fall, 1.01 foot.

17th. The mean duration of flood 11h. 15m.; that of ebb, 10h. 15m.

18th. The mean duration of slack-water H. W. 1h. 39m.; that of L. W. 2h. 19m.

19th. The difference between maximum H. W. and minimum L. W. was 3 feet.

There has been so general a prevalence of easterly and SE. gales and weather during the period the observations have been taken, that no results approaching the normal action of the tides can be obtained; and I consequently would not venture on any thing more than the following very general results, which correspond with the prevalent ideas upon the subject:

1st. That there is but one tide in the 24 hours, and which is generally regular.

2d. That the average tide has been 1.01 foot.

3d. That during January, February, March, and to April 8th, the H. W. rose, with a few exceptions, in the p. m. hours. Since April 8th it has been, and still is, in the a. m. hours; having passed over midnight instead of meridian, as we would conclude it should from the sum of the means of flood and ebb, and both slack-waters being 25h. 19m.

4th. That should SE. weather succeed, as it generally has during the last winter, a spell of northerly, the tide will have a much greater rise than usual; the flood will run for nearly double its ordinary length of time, and the slack-water H. W. will increase with the SE. weather, until it obtains the duration of nearly a mean ebb.

5th. That the duration of slack-water L. W. increases with the continuance of southeasterly and northerly winds; an ebb of corresponding shortness preceding it in the first case, and succeeding it in the last.

6th. That sudden shiftings of the wind produce, generally, an almost immediate effect upon the tide.

7th. That, judging from a general comparison of the results with those of Mr. Troust's register, kept at Mobile city, the winds cause a greater range of the tide at the head of Mobile bay than at the entrance; the extreme there due to wind and tide having been 4.5 feet—that at Mobile point but 3 feet.

8th. That a few singular irregularities have taken place without apparent causes.

9th. That from a few tides kept at Mobile point, by Major Ogden, in September, 1843, a SE. and E. gale at St. Mark's, in the gulf, at the head of the peninsula, though totally unfelt here, caused a rise in the tide of 1 foot.

10th. That a distant SE. gale, evidenced by the small setting in, will generally cause a rise in the tide.

That the rise and fall of the water here is influenced, more or less, by

the luni-solar action, there appears to be but little doubt; but its definite action it is impossible to determine at present.

From the situation of the tide gauge at the embouchure of a bay which receives several large rivers, we would conclude *a priori* that the mean duration of ebb would exceed that of flood; but, during the period the observations have been taken, we find, on the contrary, the latter exceeds the former by one hour. This I can ascribe to no other cause than the prevalence of E. and SE. gales during that time.

From the above maxima and minima, you will at once see the difficulty of deducing any definite results without a most lengthy series of observations.

Yours, respectfully,

C. P. PATTERSON.

To A. D. Bache, LL. D.,
Superintendent Coast Survey, Washington, D. C.

Appendix No. 9.

Extract of a letter from Assistant F. H. Gerdes, United States coast survey, to Professor A. D. Bache, superintendent.

Coast Survey Station,
West End Base, Dauphin Island, May 24, 1846.

I have the pleasure to report to you the occurrences of yesterday at this station.

It had been blowing and storming very strongly several days, making any observations from the tripod impossible. Yesterday morning, after sunrise, we discovered a small vessel within a mile from us in the roaring breakers of the bar, and immediately after she disappeared. Searching from the scaffold with our glasses, we discovered a man clinging to some spars or other parts of the wreck, and drifting towards Petit Bois island. I hastened to make a signal to the surveying schooner Phœnix, anchored off to the north of us, when the quartermaster and five men came on shore in the long-boat. My gallant young gentlemen volunteered immediately to try to rescue the person seen on the wreck, and the crew of the long-boat joined them. Mr. Greenwell, a very experienced manager of a boat, took the helm; Messrs. Walker and Gilbert the bow oars, and four sailors the rest. With intense anxiety I watched them. They dashed in the surf, and for a long time were hidden entirely by the enormous waves; but, by skilful management, they succeeded in getting safely through, and at last in rescuing the poor sailor, who, by this time, was almost senseless.

But my horror was indescribable when, during my watching from the scaffold, I saw a second vessel, (a fishing sloop,) with one man in her, coming the same way, flying before the wind, although only a small jib was set. She also broached and upset instantly. The man contrived, after having been washed off twice, to lash himself to the wreck, and to make the most heart-rending signs for help. The boat meanwhile returned to shore, and the first sufferer was brought nearly senseless to camp, rubbed, put in blankets, and taken care of. Then I informed them of the second disaster; and unanimously the brave fellows exclaimed, "Well, we'll try it

again." The necessary implements for bailing (the boat was nearly swamped the first time) were taken in. They started again, and succeeded in getting safe through the surf, reaching the wreck, and releasing the second sufferer. Both men are in camp, and have recovered. The sloop was the *Rambler*, of Mobile; the first vessel, a large fishing boat, belonged to a man on Fish river, a husband, and father of four children. They went together, and worked usually the larger vessel, but got adrift under Pelican island, and could not keep free on account of the strong current and gale.

What inferences may be drawn from the above fact that even fishermen, in the very heart of their place of business, where they have been employed for years, are still unacquainted with the coast?

Appendix No. 10.

Letter of S. C. Walker, esq., to the superintendent of the coast survey, in relation to the differences of longitude of Philadelphia and Greenwich, by reduction of observations at Cambridge, Massachusetts.

Washington, D. C., *January* 13, 1846.

Dear Sir: I beg to acknowledge the receipt of copies of the report of Mr. Bond, relative to the longitude of the new Cambridge Observatory, N. E., from which it appears that the most recent determinations of this longitude are—(west of Greenwich)—

	hours.	min.	sec.
By moon culminations by Mr. Bond in 1839, 1840, and 1841, reduced by Prof. Peirce - - - -	4	44	31.7
By occultations observed by Mr. Bond in the years 1831 to 1839, inclusive, reduced by Prof. Peirce - - -	4	44	32.4
By Mr. Bond's report of direct comparisons, by chronometers transported in 1844 and 1845, between Cambridge, N. E., and Liverpool, England - - - -	4	44	31.7

I take occasion to remark, that a discussion of all the available sources of information in 1842, relative to the difference of longitude between the High School Observatory, in Philadelphia, and Mr. Bond's old Observatory, in Cambridge, N. E., gave me the value of 16m. 12.2s. in time.

Prof. Peirce places the new Cambridge Observatory 3.1s. west of the old Observatory. This gives between the present Cambridge, N. E., and the Philadelphia Observatory, the difference of 16m. 9.1s. Using this value, the reports of Mr. Bond furnish new results for the longitude of the High School Observatory, which now stands thus:

	hours.	min.	sec.
By S. C. Walker's report in 1844 - - - - -	5	0	40.6
By S. C. Walker's report in 1845 - - - - -	5	0	40.6
By Prof. Peirce's calculations by moon culminations -	5	0	40.5
By Prof. Peirce's calculations by occultations - -	5	0	41.2
By Mr. Bond's report by chronometers - - - -	5	0	40.5

This coincidence is quite gratifying, and furnishes a strong motive for

testing, with greater precision, the difference of longitude between Cambridge and Philadelphia.

Yours, respectfully,
SEARS C. WALKER.

To ALEXANDER D BACHE, LL. D.,
Superintendent United States Coast Survey.

APPENDIX No. 11.

Report of S. C. Walker, esq., to the superintendent of the coast survey, relating to determinations of differences of longitude by telegraph, &c.

WASHINGTON, D. C., *December* 4, 1846.

DEAR SIR: Since my last annual report, I have been chiefly engaged, in the time that could be spared from the pressing labors for the Observatory, in preparing for determination of difference of longitude between the stations of the coast survey, connected by the magnetic telegraph line. The Washington Observatory has been united to the line from the post-office northward. The Observatory of the Central High School of Philadelphia has been connected with the same continued line. Prof. Loomis's station, at Jersey City, has been connected with the northern terminus of the Philadelphia and Jersey City line. The requisite apparatus for giving and receiving signals was prepared by Mr. Saxton, consisting of five magnet-stands, of small size and easy transportation. For a minute description of the magnet-stand, and the mode of using it, I beg to refer you to the lithographed circular, and accompanying lithographed forms for registering and reducing the astronomical observations.

The right of constructing and using the line from the post-office to the Washington Observatory has been purchased of the patentees, and is now the property of the coast survey. The delay that occurred in the negotiations with the Telegraph Company, and the time required to complete the main line and the astronomical stations, prevented the trial of the method till the 1st of October. The first night in which signals were successfully passed between the Philadelphia and Washington Observatories was the 10th of October. For the result of that night's work—not as yet, however, corrected for personal equations—I beg to refer you to my partial report, dated October 22d. The Washington Observatory, according to that night's work, is found to be 7m. 34.306s. in time west of the Philadelphia Observatory. In my partial report of June 16th last I have given the longitude of Capt. Wilkes's Observatory, on Capitol hill, 5h. 8m. 4 60s.; hence Capt. Wilkes's Observatory is 7m. 24s. west of Philadelphia. In the interim, previous to the reduction of the recent triangulation which connects Capitol hill and the Washington Observatory, I have taken from Ellicott's original survey of Washington the westing of the Washington Observatory, = 10 05s. in time. This added to 7m. 24s. makes 7m. 34.05s. for the west longitude of the Washington Observatory. This result differs only 0.256s. from that of the telegraphic comparison of October 10th.

I submit the correction for personal equations as far as now known. I have often, in past years, compared personal equations with Prof. Kendall, and never found any sensible difference. For the Washington observers,

the equations of Messrs. Almy, Keith, and myself are as follows, for the clock correction by transits of stars:

Observed September 29th, 1846, (Almy—Keith)	$= +0.307s.$
Observed October 21st, 1846, (Keith—Walker)	$= +0.014$
Concluded, (Almy—Walker)	$= +0.321$
Concluded, (Almy—Kendall)	$= +0.321$
Uncorrected longitude, (+ east)	$= -7m.\,34.306$
Corrected longitude, by telegraph, October 10, 1846	$= -7m.\,33\,985$
Reported longitude, June 16th, by Gilliss's observations, 1838 to 1842	$= -7m.\,34.050$
Discrepancy	$= 0.065$

The longitude reported June 16th is effected with the personal equations of Lieutenant Gilliss, and the numerous observers at the more eastern stations. If we suppose the latter to compensate each other, that of Lieutenant Gilliss, compared with Professor Kendall and myself, from observations of October 22d, (at which time Lieutenant Gilliss visited the Washington Observatory,) is:

Observed October 22d, 1846, (Almy—Gilliss)	$= +0.271s.$
Concluded, (Gilliss, Walker = Gilliss, Kendall)	$= -0.050$

From this comparison it appears that Lieutenant Gilliss's observations correspond well with those of Professor Kendall and myself, and that there is no reasonable ground to suppose that any correction is required, in my report of June 16th, for Lieutenant Gilliss's personal equation. The coincidence between the two results, within 0.065*s.*, is too close not to be partly ascribed to accident. It affords, nevertheless, the highest encouragement for the prosecution of telegraph operations.

The violent storm of October 13th rendered the line nearly useless during the remainder of the month. Signals were, however, passed on the 22d from Philadelphia to Washington. The repairs of the line between Baltimore and New York in November, and the putting up of new wires, rendered it inexpedient to continue the comparisons.

The registering apparatus made by Mr. Pike for the coast survey, (three complete sets, with portable local batteries,) under the directions of Dr. Morse, have been just received. It does not appear that the operators at the Washington and Jersey City telegraph offices were at any time in October in conversation with each other. This accounts for our failure to pass clock signals between Jersey City and Philadelphia and Washington, and for the loss, in this respect, of the valuable observations of Professor Loomis. This want of success is to be attributed to the imperfect insulation of the old telegraph line from Baltimore to New York. Such imperfection is not necessarily incident to the method. The wires from Baltimore city to the Washington Observatory never failed, in the most violent storms, (even of the 13th of October,) to transmit signals night and day, when desired. The line from the post office to the Washington Observatory, erected by Dr. A. C. Goell, is the best specimen yet constructed, and should serve as a model for further progress. Great hopes are entertained that the new lines now being erected, with better materials and more perfect insulation than those of the old ones between Baltimore and Jersey City, will afford proper facilities for the successful application of the telegraphic method to the determination of longitudes, which gave so satisfactory a result on the 10th of October last.

The subject of the reduction of the astronomical observations now in the collection of the coast survey has received all the attention which my necessary labor for the Observatory would allow, and the preparation of the telegraph operations would spare. No new individuals of the first two classes are received. Those which have been received of classes second and third, viz: transits of mercury and eclipses of the sun, are only partially reduced. I do not expect, on the final reduction of them, much additional weight to be given to the longitudes already obtained. The classes of occultations, from the fourth to the eighth inclusive, present a great number of observations not yet reduced. As these have formed the basis of the longitudes of my former reports, I have been desirous to put the ninth class, that of moon culminations, in progress. For distinction's sake, the telegraph operations may be called the tenth class.

The coast survey has in its collection more than a thousand American observations of the moon culminations: these commence with the year 1838, and form an uninterrupted series up to the present time; some at one point, some at another, of the survey. I include those of Professor Loomis, at Western Reserve, on account of their coincidence in date, as well as of the valuable papers of Professor Loomis on the longitude of the Hudson Observatory, in the transactions of the American Philosophical Society. I have compared the American lists with the European lists from 1838 to 1845. The number of coincidences of one American with another, or with one European moon culmination, is near two thousand. I have prepared lithographed forms for computing the most probable longitude from one coincidence, and the most probable value for the result of an entire series. Previous to the filling of these blanks the series of observations must be freed from instrumental errors, if this has not been previously done by the observers. Since a large portion of the American series requires this application of the instrumental corrections, and since, after these corrections are applied, the series on hand accumulates faster than I can, as yet, find time to reduce them, I have deemed it necessary to ask for aid in this labor. Since Lieutenant Gilliss has been applied for and ordered on duty in the coast survey, he has corrected the American series for 1838, and is engaged with those of 1839. The series of 1838 being thus ready for the filling of the lithographic blanks, I have filled them to the number of 162 for the year 1838. These 162 coincidences are between Hudson, Washington, and Dorchester Observatories, and between some one of them and a European observatory. The number of results is not sufficient to warrant any modification of the values furnished in my previous reports.

Yours, respectfully,

SEARS C. WALKER.

To A. D. Bache, LL. D.,
Superintendent U. S. Coast Survey.