30th Congress, 1st Session. [SENATE.] Executive, No. 6.

LETTER

FROM THE

ACTING SECRETARY OF THE TREASURY,

COMMUNICATING

The report of the Superintendent of the Coast Survey, showing the progress of that work.

DECEMBER 15, 1847.

Read, and ordered that 1,250 copies, in addition to the usual number, be printed; 250 of which are for the Superintendent of the Coast Survey.

TREASURY DEPARTMENT, *December* 14, 1847.

SIR: I have the honor to submit, for the information of the Senate, the accompanying report made to the department by Professor A. D. Bache, superintendent of the coast survey, showing the progress of said work during the year ending October, 1847.

All of which is respectfully submitted.

McCLINTOCK YOUNG,
Acting Secretary of the Treasury.

Hon. GEORGE M. DALLAS,
Vice President of U. S. and President of the Senate.

Report of the Superintendent of the Coast Survey, showing the progress of the work during the year ending October, 1847.

AGAMENTICUS STATION, NEAR SOUTH BERWICK, MAINE,
November 1, 1847.

SIR: The regulations of the coast survey, requiring a report of its progress to be made at this time to the Secretary of the Treasury, to be laid before the President and Congress, I have the honor to submit, accordingly, a report for the last year. The field operations are generally brought up to the beginning of October by reports received from the assistants in charge of the several parties, and the progress of the office work is given to the first of November. At the close of the report is an outline of the work proposed for the next fiscal year, and an estimate of its cost.

In successive reports I have endeavored to develope the plan which I deem most advantageous for the survey of the coast, on the

National Oceanic and Atmospheric Administration

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

score of due progress, immediate results, and economy. In 1844, the operations of the survey embraced nine States; in 1845, thirteen, including three on the Gulf of Mexico; and in 1846, fifteen.

During the past year, field or office work has extended into the following *eighteen States on the Atlantic and Gulf of Mexico:* Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, and Texas. The estimates for the next year will provide for work in every State on the coast of the Atlantic and Gulf of Mexico.

As the work advances in each section the results are collected and will be published, each separate centre of work furnishing the same means for preparing preliminary charts, and the survey being carried on upon the same general plan, and by the same general methods in each section. The whole will finally form a connected survey of the coast of the United States, and before that time each independent centre will yield the same scientific data for maps. A base line, data for geographical position, (latitude and longitude,) for distances between points; for configuration of the shore and of the adjacent country; for the depth of water, character of bottom, strength and direction of currents, and rise of tides, are furnished by the operations of the survey in each and every section, and are all sufficient for preliminary charts, much more exact than (with a few exceptions) those now existing. The connected whole will give the higher elements, which no detached surveys can furnish, necessary for the more elaborate computations and results.

In the new sections, this plan enables us to give first attention to the points which, from their importance, or the want of knowledge in regard to them, most require it. As an illustration, may be mentioned the survey between Mobile and New Orleans, already in full progress, the results of which are important, not only locally and to the southwest, but to all the vast territory of the west which uses *New Orleans* and *Mobile* as its ports. This plan, too, reduces the estimate of the time of completion of the whole work to that of finishing each section, for which a few years afford approximate data, and the number of sections under survey, which must depend upon the appropriation deemed by the executive and Congress consistent with an economical administration of the government. The gradual extension of such a work has the advantage of training up agents to the due performance of its different parts upon the same general plan, and of establishing a system in the details necessary to insure regularity and uniformity and effective control of the whole.

Although the appropriate and most valuable results of the coast survey, are the furnishing of accurate maps and charts, yet there are striking results obtained from time to time which attest its value. In past years, the discoveries of Gedney's channel into New York harbor, of Blake's channel in Delaware Bay, of Blunt's, and of the breakwater, or through channel, on the ridges of Cape May, of the new south shoal, near Nantucket, with minor discove-

ries, were of this class. The year just ended, has afforded its contributions of the same kind in the examination of the ridge near Nantucket New South Shoal, in the discoveries of a new shoal in the channel east of the "Bass Rip," near the island of Nantucket, and of a shoal southeast from Great Point light, near the same island, dangers before unknown, and to be carefully avoided by navigators, and in the discovery of a depth of water in the channel at the entrance of Mobile bay of 20¾ feet. The first discoveries are important to the foreign, West India, and coasting trade; and the latter, not only to Mobile, but to the southwest generally. Particulars in regard to these discoveries are given in connexion with the progress of the work in a subsequent part of this report.

In pursuance of the plan so repeatedly sanctioned by the executive and Congress that I am bound now to consider it the settled policy of the survey, I stated last year, that six sections could be put under survey according to the modes then in use, for about one hundred and fifty thousand dollars per annum, with the addition of such sums as were required for general items of expenditure, such as the cost of instruments, the purchase or hire of small vessels, office expenses, and the like. Further, that the use of steam in the hydrographic part of the work, which was absolutely called for, would add somewhat to this cost, though economical, as returning many times its additional expense in accuracy and amount of work. The estimates for the present year included the sums required for preliminary operations in two sections—*South Carolina*, and *Georgia*, and *Texas*; and those for the next include the proper progress in these sections, and preliminary work on the coast of *Florida*. An estimate for the expense of one steam-vessel was made last year; and although the late period at which that vessel was received prevented a full season's use, yet it was plain that the advantages to be derived had not been overrated. During the next year, I propose to use the opportunity afforded, by the transfer of some of the revenue marine steam cutters to the coast survey, to test the advantages of the use of steam as fully as circumstances may permit.

At the close of the fiscal year, the work in its different branches will be found to be at least as far advanced as I promised in my last report.

The number of sheets of maps and charts now published, is sixteen; and, during the remainder of the fiscal year, at least five additional ones will be published. Besides these, two hydrographic sketches have been published, and two accompany this report.

I must acknowledge here the liberality of the Navy Department in its aid, under the law, to the hydrography of the coast survey. The distinguished heads of the department and of the bureaus have cheerfully done for us what the law, and their means permitted; and from their aid, the hydrographic officers have derived no inconsiderable part of the resources which have rendered their vessels and parties effective.

The aid extended by the War Department, is also gratefully acknowledged.

The officers of the line of the army withdrawn, from the exigen-

cies of the military service, from the survey, have shown themselves no less distinguished in arms than useful in science. Two have fallen on the field of battle, and three have been severely wounded. Their career has been followed by their former associates with affectionate interest.

The cheerful coöperation of the officers of both army and navy upon the coast survey, is looked back upon with gratification, and recognized as one of the main sources of the present prosperity of the work.

After stating the limits of the geographical sections into which, for convenience of surveying, and as having nearly equal extents of shore line, I have sub-divided the Atlantic and Gulf coast of the United States, and the nature of the operations of the survey I intend to give as brief a summary as practicable of the progress of the past year; then, under the head of each geographical section, to state more at large the amount of work done by each of the assistants and others concerned; then to state the amount of office work done; and, in conclusion, to give an outline of the progress practicable in field and office work for the next year, and to present the estimates required for its execution.

Dividing the coast of the United States into nine sections of nearly equal extent of shore line, to be surveyed as was done in my report of last year, we have the following sections:

No. 1. From Passamaquoddy bay to Point Judith.
No. 2. From Point Judith to Cape Henlopen.
No. 3. From Cape Henlopen to Cape Henry.
No. 4. From Cape Henry to Cape Fear.
No. 5. From Cape Fear to the St. Mary's river.
No. 6. From the St. Mary's to St. Joseph's bay.
No. 7. From St. Joseph's bay to Mobile bay.
No. 8. From Mobile bay to Vermillion bay.
No. 9. From Vermillion bay to the boundary.

The operations of the surveying parties include: 1st. *Reconnoissance*, general or particular, by which the plan of the work is laid down, or the stations actually to be used, determined. 2d. *Triangulation* of different orders for determining the relative positions of stations; primary or main, in which the positions are fixed with great accuracy, and control the work; secondary or tertiary, by which with less perfect means, numerous points are determined. 3d. *Astronomical observations*, by which the positions of the most important main points are fixed upon the surface of the earth. 4th. *Topographical work*, by which the coast line, the position of objects, and character of ground, and land communications are determined, so as to be represented on a map. 5th. *Hydrographical operations*, including sounding, determination of the character of the bottom, observations of tides and currents. 6th. *Magnetic observations*, to give the variation of the compass.

The work executed by the field parties passes to the office, where computations are revised, and independent computations made. The field work is assembled and reduced to a scale for publication;

the maps resulting from it are drawn, engraved, printed, and published.

The annexed table (appendix No. 1) will show the distribution of the parties in the different sections, during the surveying seasons appropriated to each section, for the year ending November, 1847. I have included in the table the parties in North Carolina actually under instructions, and by whom work will probably be commenced before the completion of this report.

The following progress has been made in the field and office work in the several sections:

Section I. The *primary triangulation* has been extended into the southern part of Maine; the stations in New Hampshire remaining to be occupied; it is yet considerably in advance of the secondary work. *Astronomical* and *magnetic* observations have been made at one station in New Hampshire, and one in Maine. At the latter, the performance of new and approved instruments has been compared. This important department of the survey has been put on a new and more perfect basis within the last eighteen months, by the introduction of astronomical instruments of a superior class. Differences of longitude from Europe, by chronometers, have been obtained, and astronomical observations for latitude and longitude at Cambridge and Nantucket. The *reconnaissance* for the primary work has extended north beyond Portland, Maine. The *secondary triangulations* of Cape Cod and Boston harbor and its vicinity have been completed, and that near Plymouth has been commenced. The *topography* of Boston harbor and its vicinity, from Scituate light on the south to Nahant Neck on the north, has been completed. The *topography* of the southern shore of Cape Cod has been carried eastward. The *hydrography* of Boston harbor and of its approaches has been completed; that of the shoals near Nantucket has made considerable progress. The *views* necessary for the charts of Edgartown, Nantucket, and the general coast chart, have been taken, and drawings sent to the office. The work in Boston harbor has been done according to an arrangement with the commissioners of the Commonwealth of Massachusetts, requiring its completion during the present season, and extending certain aid necessary to insure it.

All the arrangements for the immediate *reduction* of the work in Boston harbor, and the preparation of manuscript maps to be delivered in the spring, are made.

The *reduction* of the chart of Edgartown harbor has been made, and that of Nantucket is nearly completed.

The reduction of sheet No. 1, of the eastern series of coast charts, from Point Judith to Cape Cod, (to be completed in three sheets,) has been commenced. The *engraving* of the chart of Edgartown harbor is nearly completed. The chart of the harbors of refuge of Holmes' Hole and Tarpaulin cove, (Martha's Vineyard sound,) has been *published*.

Section II. *Verification* work required at one station, in connection with the primary triangulation, has been made. Observations for *difference* of *longitude* by *telegraph* have been successfully made; and

Washington city, Philadelphia, and New York, are connected by this novel and exact method, which in many cases will be an important aid in geodetic operations. Verification work of the *hydrography* in Long Island sound and at the entrance to Delaware bay, has been made, and some filling up required by the off-shore work within the limits of this section and No. 1, has been commenced.

Observations of *tides* and *currents* have been made in Long Island sound and Delaware bay. *Buoys* have been placed, by request of the Fifth Auditor, in Delaware bay and river, and the positions of those placed by the collector of New London have been determined. The system of *coloring buoys* according to certain general rules, denoting the purpose for which they are placed, and the side upon which they should be passed, has been introduced upon the Delaware, and extended to the New London district. It will be employed certainly in adjacent districts, and, if adopted generally and carefully executed, will prove a great convenience to navigators. The extension of off-shore *soundings* in the limits of this and the next section has been commenced.

A new *reduction* of the chart of New London harbor, from the topographical survey of the last season, has been made. The charts of Huntington bay, of Bridgeport, and Black Rock harbors, and of the anchorages of Cawkin's Island, and of Captain's Island east, and Captain's Island west, (Long Island sound,) have been *prepared for engraving*. Additions have been made to the off-shore chart from Cape Cod to Cape Henlopen. The drawing of the western sheet of Long Island sound has been nearly completed. The drawing of two sheets of the south side of Long Island has been nearly completed, as far as the materials for them are in the office. A *reduction* of the additional work, near Cape Henlopen, for the chart of Delaware bay has been made. The *engraving* of the eastern sheet of Long Island sound has been completed; additional work and alterations required having consumed much time.

Further progress has been made in the second sheet of the same chart. Sheet No. 2, of Delaware bay and river, has been completed; and No. 1, of the approaches, is within a few months of completion. The re-engraving of the NewLondon map is nearly completed. The *engraving* of the chart of Bridgeport and Black Rock harbor is well advanced, and that of Huntington bay has been commenced.

The *reduction* and *engraving* of the off-shore chart has made progress; one of the sheets of Delaware bay and river; the charts of Syosset harbor, or Oyster bay, and New Haven harbor have been *published*; and that of Fisher's Island sound has been republished with additions. There has been, at times, a greater demand for charts, formerly published for sale and distribution, than could be met by the number on hand.

Several of the plates have been copied by the *electrotype process*, preserving the originals from injury, and rendering possible an unlimited multiplication of copies from a single engraved plate. The engraving belonging to this section has been chiefly of work of

former years, or back work and of verification, and its completion, before full results of the work in the new sections are obtained, is most desirable, and will be most anxiously urged by all the means in my power.

SECTION III. The *primary triangulation* has been continued down the Chesapeake, towards the Potomac, which it will probably pass before the close of the season. Verification work has been executed at and near Kent Island base. *Astronomical observations* have been made at two stations—one near Annapolis; and one at Poole's island. *Magnetic observations* have been made at the entrance to the Patapsco, and near Baltimore, for the chart of Baltimore harbor and the Patapsco river. The *secondary triangulation* of the Chesapeake bay has been carried on with the primary. The *secondary triangulation* off Cape Henlopen has been extended to the southward, along the immediate shore of the ocean. The *topographical work* has employed four parties—one on the Chester river; one on the Eastern Shore of Maryland, near Eastern bay, the Wye, St. Michael's, and Choptank rivers; one near Eastern bay and the Choptank, and on the Western Shore, on the South river; and one up the bay, in the Sassafras river, and on the Western Shore, from Herring bay to the Patuxent.

The *hydrography* of the Sassafras river has been executed, and that of the Chester river has been completed, and its entrance proved to be a fine harbor of refuge. The *hydrography* of Eastern bay, and its rivers, and of the Chesapeake, from the work of the former seasons, nearly to the mouth of the Patuxent, has been completed. The *hydrography off shore*, south of Cape Henlopen, has been extended south of Indian river. A scheme of a chart of the Chesapeake has been prepared, and the *reduction* has been made of the upper sheet as far as the final completion of the triangulation justified; the reduction of the hydrography has been carried to the southern limit of the work executed. The *engraving* of this sheet will soon be commenced. In another season materials will be collected for a chart, on the usual coast scale, in three sheets, from the head of the bay to the mouth of the Potomac, and for more than one sheet of a chart, on a smaller scale, to embrace the whole bay, its rivers, and the exterior coast.

The *reduction* of the second sheet of the Patapsco river (its entrance) has been made. The *engraving* of the upper sheet of the chart of Baltimore harbor, and the Patapsco river, (in two sheets,) has been commenced, and has made considerable progress.

SECTION IV. The *primary* and *secondary triangulation* of Albemarle sound (North Carolina) has been continued, reaching the Chowan, and Roanoke, with its stations. *Astronomical* and *magnetic* determinations have been made at two stations on the sound, and one near the ocean. The *tertiary triangulation* of the rivers has been continued, and that of the Pasquotank is very nearly completed. The *topography* of the shores of the Pasquotank is complete, and the *hydrography* will soon be commenced.

Directions have been issued to the parties who are to take the field in this section during the season now commenced, and it is

expected that the work there, will, in a few weeks, be in full activity, embracing, during the season, all the operations of the survey and receiving in each nearly its full development. This is the first season that the regular succession of operations has rendered this practicable. A small vessel, adapted specially to hydrographical work in this section, has been built, and named in compliment to the honorable the Secretary of the Navy, to whose liberal aid, under the law, the hydrography of the coast survey is so much indebted.

Section V. The *preliminary reconnaissance* of the coast of South Carolina and Georgia has been nearly completed, and the more minute reconnaissance will be commenced in a few weeks. A site for a base will be fixed upon, and a scheme of triangulation made, stations established, and lines opened, preparatory to the triangulation of the coast between Charleston and Savannah.

Section VIII. A *base line* has been measured on Dauphin island at the entrace of Mobile bay; the *primary triangulation* of Mississippi sound has been extended; *astronomical* and *magnetic* observations have been made at two stations, one at the entrace to Mobile bay, and one on Mississippi sound. The *secondary triangulation* has been carried west to Cat island and the Louisiana shore near it. The *topography* of the entrance to Mobile bay, Dauphin island, Horn island, and Cat island, have been very nearly completed. The *hydrography* of the entrance to Mobile bay and of part of Mississippi sound has been nearly completed, and a hydrographical reconnaissance has been made of Cat island harbor. Instructions have been issued for beginning the season's work in this section, and will include, during its course, all the operations of the survey.

The citizens of Mobile having urgently requested it, a hydrographical reconnaissance of part of the bay will be made preliminary to the regular survey. A sketch of the entrance to Mobile bay, showing the channel as it now exists and the increased depth of water recently found to exist there, is appended to this report, (sketch E bis.) A sketch of the hydrographical reconnaissance of Cat island harbor, is also appended, (sketch E tris.) Materials are nearly collected for the entrance sheet of the chart of Mobile bay, which, according to the projects already made from such materials as we can now command, will include, in six sheets, a coast chart from Mobile bay to the Balize.

Section IX. A *reconnaissance* of the coast of Texas has been commenced from Galveston southward, and a portion of it is so far complete as to admit of beginning the secondary triangulation and astronomical observations, which have accordingly been directed, and the parties are now preparing for the duty. A small vessel specially adapted to this work has been built.

Details in regard to the operations in the several sections, and to the office work, are given in the following pages:

SECTION I.—EASTERN SECTION.

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

The survey has made good progress in this section. In consequence of an arrangement, under the authority of the Treasury Department, with the commissioners for the survey of Boston bay and harbor, by which that work was to be completed within the present season, the parties available for this section were chiefly concentrated there. The field-work is, at this date, so nearly completed as to render it certain that this undertaking will be successful, and the chart of the bay be produced by the labors of a portion of the parties of this section, in little more than one season. The triangulations and topographical work of the section, generally, have also advanced eastward, and the hydrography of the shoals off Nantucket, has been prosecuted during part of the season. The revenue steam vessel Bibb, having been loaned by the Treasury Department to the coast survey, the progress of the hydrography has been many times that which would have been made in a sailing vessel. A dangerous ridge near the Nantucket new south shoal has been examined, and two shoal spots, where the charts mark deep water, to the eastward and southward of Nantucket, have been found. Public notice has been given of these dangers, (appendix, No. 3,) and sketches which will enable the navigator to transfer their positions to his chart, are in preparation to accompany this report, (sketch A tris.) I append (appendix No. 2) a letter from the presidents of insurance companies, in New York, relating to the discovery of the new south shoal, received after my report of last year had been presented.

The progress of the different operations in this section, will be given under the different heads appropriated to them.

1. *Primary triangulation, &c.*—This work being considerably in advance of the secondary triangulation, I am enabled to devote a portion of each season to field duty in other sections of the survey, and to prosecute this triangulation only at such times as the season renders the work most profitable. One station in Massachusetts, (Thompson's, at Cape Ann,) and one in Maine, (Agamenticus, in York county,) have been occupied, the measurements at Cape Ann being supplementary to those of last year. One separate astronomical station (the Isle of Shoals, off Portsmouth, N. H.) has been occupied by Captain T. J. Lee, U. S. topographical engineers, and I used Agamenticus as an astronomical station, at which to make comparative observations with the new instruments recently brought into use in the survey.

The reconnaisance for continuing the triangulation, has been carried into the counties of Cumberland and Oxford, Maine, by Assistant C. O. Boutelle, under my immediate direction, and three of the points selected have been observed upon during the season. The sketch of the triangulation (sketch A) shows its plan. The stations yet unoccupied are joined by dotted lines, and the lines

joining the minor series of stations, the object of which has been explained in former reports, are less deeply marked than the others. The triangles are of good figure and both diagonals of the quadrilaterals joining the main stations are practicable for observation.

The number of primary points observed upon, has been 16; of additional points affording bases for the secondary work, 3; the number of angles independently measured, 31; and 1,450 observations have been made this year in their measurement. The area of the polygon, formed by joining the stations observed upon, is 2,204 square miles, reckoning at one-third the areas of the triangles composing the polygon, in which only one angle has been measured, and at two-thirds the areas of the triangles of which two angles have been measured. The two longest sides of the triangles observed, are 70 and 60 miles, and the shortest 18 miles.

Vertical angles for height were measured with the 12-inch Gambey theodolite, and with the micrometer of the 30-inch theodolite. The number of measurements was 126 on 12 points, including three light-houses.

At the Isle of Shoals, the latitude observations were made by Captain T. J. Lee, with the zenith and equal altitude instrument (zenith telescope) referred to in my last report, the time being obtained by a transit instrument. Fifty-four sets of transits of stars were obtained for time, and 125 observations for latitude made, upon 21 pairs of stars. The method used was that of Captain Talcott, the latitude being determined by observing differences of zenith distance of stars culminating within a short time of each other, and at nearly the same altitude, on opposite sides of the zenith. I mentioned in my report of last year, that the new catalogue of the British Association had given great facilities in the use of this method. By the observations at Thompson's, it appeared that seven determinations of the same pair of stars, gave the latitude with a probable error just equal to the mean probable error of the declination of a single pair of the stars from the catalogue, selected for obtaining the latitude at that station; and hence, that it is more necessary to multiply the number of pairs of stars observed upon, with the declinations as at present known, than to multiply observations on the same pair. Hence, the considerable number of pairs observed upon at the Isle of Shoals. At Thompson's, the mean probable error of a single determination, as deduced from a comparison of the several observations, was but seven-tenths of a second of space.

At Agamenticus, observations for latitude were made with the new zenith sector of the coast survey, with a transit placed on the prime vertical, and with the zenith telescope, just spoken of. The observations with the sector, and prime vertical transit, were made by myself, chiefly, assisted at different times by Captain T. J. Lee, and by Assistants R. H. Fauntleroy and C. O. Boutelle; and during the whole series of observations, by Mr. George Davidson. Those with the zenith and equal altitude instruments, were made by Captain T. J. Lee, assisted by Mr. C. P. Bolles. The number of observations, with the zenith sector, was 106 on 37 stars; with the zenith

telescope, 125 on 25 pairs of stars. The opportunity thus afforded, of a comparison of the instruments and the knowledge of their use by different observers, will prove most valuable to the work. A preliminary discussion of the latitude results of the coast survey the winter before the last, and a more particular one last winter, satisfied me that a better class of instruments must positively be introduced. We had tried in turn, carefully, Gambey theodolites, of six and ten inches; and repeating and reflecting circles had also been used. A twelve-inch Gambey theodolite, two zenith and equal altitude instruments, the new zenith sector, and transit instrument for the prime vertical, have been compared this summer. The results with the zenith instruments, and the transit, have proved very satisfactory.

The zenith sector is by Troughton and Simms, similar in construction to that designed by Professor Airy, for use in the trigonometrical survey of Great Britain. It has a telescope of 45 inches focal length, and 3¾ inches aperture, a graduated limb of 21 inches radius, upon which the readings are made by four micrometer microscopes, and three levels attached to the reversing plate at different heights. The reversing plate is cast in a single piece, and the object glasses of the telescope, and of the microscopes, are fastened into projections cast upon the plate turning in altitude, thus guarding against motion in joints of truss work or screws, where many pieces are used, and against flexure.

The portable transit is also by Troughton and Simms; has a telescope of 46 inches focal length, and 2¾ inches aperture, and the ys are supported upon massive brass columns, screwed into a stand also of brass. In connection with the prime vertical observations, made at Agamenticus, were others upon the same stars for difference of latitude at the Cambridge observatory, by the Messrs. Bond.

The time was obtained by a transit instrument, kindly loaned by Major James D. Graham; the observations being chiefly made by Mr. C. P. Bolles, and Mr. John H. Lane. The number of sets of transits of stars was 171.

One hundred observations were made (by me personally) on the pole star, near its greatest elongations, for azimuth, with the thirty-inch theodolite of the coast survey, and 75 on the elongation mark, in connexion with the observations on the star. The number of observations on the same mark, in connexion with the stations of the survey, was 52. The time at which the pole star attained its greatest elongation, enabled me to dispense frequently with the use of the mark, by observing directly upon the heliotropes at the station points.

Determinations of the magnetic variation, dip, and intensity, were made at Hull, (for the chart of Boston harbor,) at the Isle of Shoals, and for variation and intensity at Agamenticus, by Captain T. J. Lee; the dip at the last named station was observed by Assistant R. H. Fauntleroy. The instruments used, were those referred to in my former reports. A new circle, by Barrow, was employed at Agamenticus.

The other operations of the party under my charge, and of Cap-

tain Lee, when detached from me, will be mentioned under the head of sections III and VIII.

During the winter the computations of the field work of the preceding year were made, and the observations copied, so as to duplicate them.

At the astronomical station at Nantucket, important as the southern extremity of the longest arc of the meridian which can be determined on the New England coast, astronomical observations have been continued by William Mitchell, Esq., and his assistant. During the year 155 culminations of the moon, and of moon culminating stars, have been observed; 5 occultations of stars by the moon; 93 series of observations for latitude with the West Point repeating circle have been made; and 89 prime vertical intervals observed; 160 transits, for time, have also been taken.

The results of comparison of the chronometers of the Boston steam-vessels at Cambridge and Liverpool, which have been reported by Wm. C. Bond, Esq., have included, during the year, 52 determinations with 23 chronometers. Mr. Bond has, also, reported for use in our computations, observations of 14 occultations, and 46 moon culminations, and has made observations of stars on the prime vertical, in concert with those observed at Agamenticus.

2. *The secondary triangulation* of Cape Cod has been completed by Captain T. J. Cram, United States topographical engineers, detailed for coast survey service to replace Captain Jos. E. Johnstone, detached at the close of the last season for military service. Progress has also been made in that of the western shore of Massachusetts bay. The party of Captain Cram took the field in the latter part of May; between which time and the first of October, the triangulation shown in sketch A, was executed, furnishing points for the topography of Cape Cod. The number of stations from which observations were made, was 15; the number of objects observed upon, 41; including 15 stations, 7 light-houses, 17 churches, and 2 academies; the positions of which were determined by 2,366 observations, with a repeating theodolite of 12 inches diameter, constructed by Patten. The area of the polygon, enclosing the work, is 285 square miles. The work of this party included, also, some reconnaissance, in replacing signals blown down during the last winter, and in adding new stations to the triangulation previously laid out. The heights above tide of 17 stations have also been measured.

3. *The secondary triangulation* of Boston harbor was completed by assistant C. O. Boutelle, and extended both southward and northward to the limits of the proposed chart of the harbor, furnishing the points required by the plane table and by the hydrographical parties. The final connection with the primary triangulation was also made. Sketch A bis, shows the progress of the work, which includes the measurement on 407 objects, with a six inch repeating theodolite of Gambey, and upon 80 objects, with the two feet Troughton theodolite. The whole number of observations made was 2,626. The work was commenced by Assistant Boutelle in May, resumed after the reconnaissance for the primary

triangulation in August, and completed in November. The intervals in a year, almost filled up with field duty, have been occupied in revising computations made while in camp.

4. The *topography* of Boston harbor, and its vicinity, has occupied two parties—one a double party, having a chief and an assistant—during the whole season, and a third party during a considerable part of the season. The survey of the harbor and its approaches has been so nearly finished as to render it certain that this will be entirely completed before the winter sets in. The area surveyed has been 93 square miles; the extent of shore line 258 miles; the extent of roads, streets, and wharves, 325 miles. The entire work is shown upon sketch A bis, where the plane table sheets are numbered from 19 to 26.

The work upon sheets Nos. 19, 20, 21, 21½, 23½, 25, and 26, has been executed since the date of my last report by Assistant H. L. Whiting, aided by Mr. W. E. Gilbert. The part comprising the inner harbor of Boston was surveyed between the 20th of October and 21th December of 1846, for the commissioners of Boston harbor, and a copy of the survey rendered. It comprised 31½ miles of shore line, including wharves; 8 miles of roads and streets, and an area of 3½ square miles. The intricate nature of the details, comprising the wharves of the city and suburbs, may be understood, when it is stated that in determining wharves alone the measured lines amounted to 1,250 in number. During the winter, Assistant Whiting and Mr. Gilbert were engaged in putting in ink the topographical sheets of Martha's Vineyard and Nantucket, surveyed during the previous season. The party resumed field work on the 20th of May. Since which time, and prior to October 9th, the work on sheets 20, 21½, 23½, and 25, has been entirely, and that on 26 very nearly, completed. The topography in the neighborhood of the city of Boston is very difficult of execution, from the variety of natural and artificial features to be determined, the number of streams, the broken character of the ground, the number of roads, villages, and detached buildings, to be determined. Sheets Nos. 19, 20, and 21, were surveyed on twice the usual scale, and include the shore and wharves of South Boston, the city of Boston, Charlestown, and the navy yard, and East Boston. Sheets Nos. 23½, 21½, take in the environs of Boston, from the Neponset river, on the south round to Chelsea ferry, and include the villages of Neponset, Milton Mills, Dorchester, Newtown, and the city of Roxbury, Cambridge, Cambridgeport, Somerville, Medford, Malden, and part of Chelsea. Nos. 25 and 26 include, also, several villages and a varied country, but with less of detail than those previously noticed. The area included in the season's work, to the date of Assistant Whiting's report, is 46 square miles; extent of roads, including railroads, 240 miles; canals, 4 miles; shore line, 121 miles. I have availed myself of Mr. Whiting's knowledge of topography and intelligent experience, in the use of the plane table, to secure uniformity in topographical details, by attaching other assistants to his party. The sickness of Mr. Gilbert, during part of the season, has proved an interruption to the work—the amount of which is, however, when

its nature is considered, highly satisfactory. Sheet No. 23½ has been put in ink and forwarded to the office to be transferred to the manuscript maps there preparing for the commissioners. Assistant Whiting is now engaged near Scituate, in completing the work in that quarter, and has instructions to prepare or compile a plan of the city of Boston for the maps just referred to.

Sheets Nos. 22½ and 23 (sketch A bis) were surveyed between the 24th of August and 20th of October, by Assistant James S. Williams. The first, includes the chief part of the islands in the lower bay, and the second, the peninsula of Nantasket. The area surveyed is 8¼ square miles, and extent of shore line 51 miles. Mr. Williams was indebted to Captain Sturgis, of the revenue marine, commanding the cutter Hamilton, for transportation, and the use of boats in his work, and acknowledges in his report the indebtedness of the coast survey to that gentleman, "for the interest he has felt in its progress, and the energetic aid he has contributed." It would be ungrateful not to take this occasion to make a more general acknowledgment of the kindness of Captain Sturgis to the parties of the coast survey, and his aid in forwarding the work since we have been in the vicinity of his cruizing ground.

Sheet No. 22 (sketch A bis) has been completed, and No. 24 commenced, by Assistant J. B. Glück—the former has been sent to the office to be transferred to the commissioners' map. Sheet No. 22, contains the topography from the Neponset river to Hingham harbor, embracing an area of 35 miles, an extent of roads of 69 miles, and of shore line of 54 miles. The country is similar to that already described, and there are no less than eleven villages or towns of larger or smaller size contained within it, viz: Milton Mills, Milton Hill, Railway Village, Quincy, Germantown, Bent's Point, Braintree Neck, Weymouth, East Weymouth, Weymouth landing, and North Weymouth, Hingham, and Hingham Plain. The roads passing through the villages are in many cases lined with dwellings.

5. The topography of Cape Cod from Hyannis harbor eastward, was commenced about the middle of September, by Assistant Alexander W. Longfellow, and sheet No. 15 (sketch A) is now in progress.

6. The *hydrography* in this section, including the survey of Boston harbor, of the shoals near Nantucket, and of Hyannis harbor and its approaches, has been under the charge of Lieutenant Commandant Charles H. Davis, U. S. N. The hydrographic sheets are numbered 1, 2, 3, and 4, on sketch A, and 5 on sketch A bis.

After the date of my report of last year, the survey of the approaches to Edgartown harbor (sketch A No. 2) was completed, and that of the harbor of Hyannis and its approaches (sketch A No. 4) commenced. About the middle of October, the party was transferred to Boston harbor, and executed the hydrography of the inner harbor of Boston on twice the ordinary surveying scale, furnishing a copy of the chart (the result of the joint labors of Lieutenant Commandant Davis and of Assistants Boutelle and Whiting) to the commissioners of the Commonwealth of Massachusetts. The satis-

factory manner in which this work was done, was handsomely acknowledged by Ezra Lincoln, jr., esq., on behalf of the commissioners.

During the winter, this party was engaged in reducing and plotting the work of the previous season in Martha's Vineyard Sound, Edgartown and Nantucket harbors, and on the Old and New South shoals, near Nantucket, in reducing the tidal observations at five stations in this part of the work, and in reducing and transferring to diagrams, the observations of currents. The usual duplicates of notes were made and the original volumes bound. The specimens of bottoms collected during the season's work were arranged and labelled.

Lieutenant Commandant Davis was also personally engaged, under my immediate direction, in carrying forward the discussion of the series of tidal observations at Fort Monroe, (Old Point Comfort,) to include the effects of the moon's parallax and declination, eliminating which the fluctuations caused by atmospheric changes appear as residual errors. The effect of changes of pressure and of winds upon the curve of height is already apparent. While the accumulation of these observations enables us to proceed in the successive steps of their complete discussion towards a prediction tide table, the new observations under the immediate direction of Lieutenant Commandant Davis, are made to pass through the previous stages of reduction. I availed myself also of Lieutenant Commandant Davis' personal labors to make a preliminary discussion of the tide wave in Long Island Sound, the result of which indicated the necessity for further observations and approximately the places where they should be made, and such observations were accordingly ordered.

The hydrographic work in Boston harbor (see sketch A bis) was commenced in June and continued in the schooner Gallatin, until by the transfer of the revenue steam-vessel Bibb to the coast survey, about the middle of July, the requisite facilities for work on the Nantucket shoals had been provided. The necessary repairs to the engine could not be made until August, thus limiting exceedingly the season for work on the shoals. During the short period when the weather permitted work, the use of the steam-vessel enabled the party to make very rapid progress. The results are reported by Lieutenant Commandant Davis, as follows: "My first object was to complete the examination of the ground between the Old and New South Shoals, and to determine the extent and character of the dangerous ridge to the northward and eastward of the New South Shoal, the existence of which was discovered last year. It was found that the water shoals on this ridge rapidly from twenty-three and twenty-four fathoms, to seven, six, five, and in one place four fathoms. In strong winds the sea must break here, and in a heavy gale the destruction of a vessel would be quite as certain as on one of the shoals."

"After running some lines to the northward of the Old South Shoal, I took up the survey of the 'Old Man' and 'Bass Rip' and the neighboring channels."

"In the channel to the eastward of the 'Bass Rip,' a shoal was

discovered having only sixteen feet of water on it, where two fathoms is marked on the best charts. Another shoal was found to the southward and eastward of Great Point light, of some extent, with sixteen and eighteen feet on it, where the charts give five fathoms. A sketch accompanies this report, showing the positions of these shoals and of the ridge. Currents were observed on board the station vessels, and frequent specimens of the bottom were taken. The great value of the latter will appear when the chart of this region is finished."

"The discoveries of the past and present year prove the great importance of this chart. Those now in the hands of navigators are neither accurate, nor sufficiently minute. The coast survey sheet, as it is projected, will supply coasting vessels with the means of passing safely through the channels that divide these dangerous shoals, and thus shorten their route, and will afford the great fleet of West India and European traders, whose course lies near the Nantucket shoals, the knowledge requisite to avoid them without a sacrifice of time, and to extricate themselves when unexpectedly involved."

"The results of our labor are anxiously looked for; no chart that can be issued from the office of the coast survey, will be more generally serviceable, or excite greater interest. It can probably be prepared in another season, with the constant employment of a steam vessel, provided that exclusive attention is given to this object during the months suitable for working in this exposed situation."

"The value of this chart would be very much increased by a light of sufficient power on Sankaty Head. The local, and general utility of this light, and the reasons for placing it here, rather than on Tom Nevers' Head, or elsewhere, may be reserved for a separate report."

The limits of the sounding sheet are shown on sketch A, where the sheet is numbered 1. After closing work on the shoals, Lieutenant Commandant Davis, in the Bibb, returned to Boston harbor to make the deep-sea soundings there, and Lieutenant Maffitt, U. S. N., was detached to run some lines of soundings in the Vinyard Sound, (sketch A, sheet No. 3,) and to complete the hydrography of Hyannis harbor and its approaches, which was accomplished by the 24th of September. (See sketch A, sheet No. 4.) Since that time, the whole party has been diligently engaged in finishing the work of Boston harbor for the commissioners; and there is now no doubt, that, notwithstanding all the hindrances of the season, the weather having been even worse for hydrography than that of last year, then considered so unpropitious, the work will be completed.

The plotting of the harbor work has been made to keep pace with the field work, so that the results will be transferred to the manuscript charts for the city of Boston, and State of Massachusetts, as rapidly as the draughtsmen can work. Provision for reducing the charts, for engraving, has also been made. Lieutenant Commandant Davis' opinions, founded on observations during the work, of the advantages of this chart, are thus given in his report.

"Among the advantages which the coast survey chart of this harbor will confer beyond any other, may be enumerated the following: it will give a complete knowledge of Broad Sound; it will show the highly important channel into the sound between Deer and Lovell's Islands, which has (only very recently) been used by our largest frigates; it will define some small channels, where coasting and freight vessels resort in great numbers, and where bare flats are now marked upon the common charts. It will expose some hidden dangers now known only to pilots. It will give satisfactory and intelligible sailing directions, and will define good anchorages."

I have already referred to the advantages obtained by the use of the steam vessel Bibb, during the small part of the past season when the vessel was employed. A full season's work with a steam-vessel would nearly or quite complete the survey of the dangerous ground near Nantucket, while sailing vessels will not accomplish it in several seasons. The additional expense for that one season is estimated at $6,000, a sum wholly insignificant when compared with the interests at stake. A memorandum of disasters occuring near Nantucket during the past year, by no means professing to be complete, and which states that the season has been remarkable for the small number of wrecks in that vicinity, chronicles the loss, either partial or total, of two brigs, four schooners, and one sloop—a mere tithe on which loss of property would have paid for the survey. Setting aside, then, all considerations of humanity, for each of these wrecks is attended with great risk to human life, if by an accurate chart of the region we could save a single coasting vessel every year, the survey would each year pay for itself four or five times over. If the "Centurion," lost on the new south shoal, could have avoided that danger then unknown to the navigator, the mere interest on vessel and cargo for one year would have paid for the survey.

It is proposed to reduce at once the work of this season on these shoals and to add it to the sketch of last year, and print and publish this, so that the results may be transferred to existing charts.

Lieut. Com. Davis acknowledges the obligations of the coast survey to Commodore Foxhall A. Parker, U. S. N., in charge of the navy yard at Charlestown, to Commander Crowninshield of the Franklin, and to Chas. W. Rand, esq., collector of the port of Nantucket.

The views required for the charts of Edgartown, Nantucket and Hyannis harbors, and for the general coast chart in their vicinity, were taken by assistant John Farley, and copies of them sent to the office.

As this report is preparing, I have received the melancholy news of the illness and death of Passed Midshipman James Foster, U. S. N., an intelligent and faithful officer of this party and late master of the steamer Bibb. The regrets which the commander of the party expresses will no doubt be deeply felt by his fellow officers. Mr. Foster's health having been impaired in coast survey service, he had been detached and leave of absence given to visit Europe.

He was about to sail when seized by the illness which terminated his life.

SECTION II.

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

The field work in this section has been chiefly of verification and filling up, and executed by the occasional services of parties temporarily disposable from other parts of the work. The progress made in the drawing and engraving of the back work in this section will be reported under the head of office work.

The utility of the channel discovered west of the Joe Flogger shoal in Delaware bay, by Lieutenant Com. George S. Blake, has been spoken of in former reports. Not only these views are confirmed from an entirely independent source, Judge Harrington of Delaware, but a new view has been opened, showing how little it is possible to foresee all the ramifications of usefulness in a work like this. In a letter addressed to me on the 26th of April, 1847, just after the publication of the middle sheet of the chart of Delaware bay, he says—"Your recent chart of the coast survey has brought into notice a channel in the Delaware bay and a harbor heretofore but little known, but which are to be of great importance to the coasting trade on these waters. I refer to Blake's channel and the inlet laid down in your chart as Simons's creek. An inspection of these soundings will show that this creek and Mahon's ditch (just below,) are the only harbors on the western shore between the breakwater and Reedy island, a distance of about thirty-five miles, which vessels in the winter and early spring have to run in constant apprehension of ice from the upper bay, being often compelled by every passing drift, to return to the capes. The western channel is very seldom impeded; vessels taking steam from Philadelphia consider themselves safe from ice when as low down as the 'buoy of the middle.' Ice seldom forms where the water is so salt, and the prevalence of westerly winds usually sets floating ice from above on the other side."

In a second letter Judge Harrington says: "This copy (of the the middle sheet of the coast survey chart of Delaware bay and river,) suggested the idea of an improvement company to facilitate communication by steamboats with Philadelphia, and for the export of produce coastwise. Such a company has been organized and incorporated; a road is opened from Dover to Dona; a wharf is nearly completed, and, in two weeks, a fine steamer will be running regularly between Dona and Philadelphia, and also between Dona and the breakwater by way of Blake's channel."

The buoys required to mark this channel, provided for by act of Congress at the last session, have been placed under the direction of Lieut. Com. J. R. Goldsborough, United States Navy, assistant in the coast survey. (See appendix No. 4.)

1. *Magnetic observations.*—The magnetic observations, at stations

in Long Island Sound, have been continued by assistant R. H. Fauntleroy, by whom the variation dip and intensity have been observed near Point Judith light-house; Watch-hill, near Stonington; Fort Wooster, near New Haven; near Sands' Point light-house; and near West Farms, New York. Twenty-seven series of observation for variation (declination) were made on 27 different days; 15 series for intensity, on 15 different days; and 19 series for dip, on 10 different days.

2. *Use of the electro-magnetic telegraph for differences of longitude.*—The use of the telegraph lines established between Washington and Jersey City, opposite New York, to obtain differences of longitude, has been continued during the present season, and the attempts to obtain differences of longitude, by this method, between Washington, Philadelphia, and Jersey City, have proved entirely successful. The arrangements explained in my report of last year were found sufficient for the continuation of the work. The superintendent of the national observatory, Lieutenant M. F. Maury, again directed the co-operation of that establishment. The observations at Philadelphia were under the direction of Professor Kendall, and those at New York under the direction of Professor Elias Loomis. The details of observation were arranged, and the connexion of the different parts secured, by assistant Sears C. Walker, of the coast survey, who was charged with the operation.

The principle of this method is well understood to consist in transmitting signals at a known or determined time, from one telegraph station to another, where they are noted by a time-keeper, well regulated to the time of the place. The difference in the times of giving and receiving the signals, according to the local time at at each station, is their difference of longitude expressed in time.

The signals are given at one of the stations by pressing a key, which causes the closing of the circuit. This closing it is intended shall be simultaneous with the ticking of a clock or chronometer at the station. The circuit being closed, if the electrical wave or current takes a sensible time to propagate itself, or to pass from one station to another, the absolute time of the signals reaching the second or receiving station is sensibly different from that of making the signal at the first or giving station. A coil about the poles of a horse-shoe magnet, of soft iron, forms part of the circuit through which the electrical effect is transmitted. Under its influence the soft iron becomes magnetic, attracting the soft iron bar (armature or keeper) delicately poised at a determined distance from the poles of the magnet; the movement of this keeper sets in action a local battery which gives sufficient power to make the dots and lines constituting the Morse telegraphic signals. The click of the keeper of this temporary magnet is compared, at the receiving station, with that of a clock or chronometer, thus marking the time at which the signal, made at a known time at the giving station, is received. From this explanation, it appears that there is liability to error: 1, in the clock times at the different stations. These are easily examined, and the most probable times assigned at each station, the personal equation for clock correction being determined

and allowed for, they may then be treated as if only very small errors existed. 2. The time of striking the trigger or key, to close the circuit, may not coincide with the clock beat. The error, if any, from this source is determinable by experiment; and careful experiment failed to detect a sensible amount. 3. The electrical effect may take a sensible time to be transmitted, and this may be known, if other sources of error could be got rid of, by transmitting signals from an eastern to a western station, and vice versa; and it may be rendered null in its effect upon determinations of differences of longitude such alternate transmission, or it may be examined in its combined by effect with the next error. 4. That of the sensible interval, if any exist, between the activity of the coil, its action in inducing magnetism in the receiving magnet, and the click of the keeper of this magnet. 5. The error in noting the fraction of a second as denoted by the clock. It was perceived that this difference in the estimate of fractions of a second, rendered the transmission of signals, by the beats of a well regulated sidereal clock, and their reception by another sidereal clock, of little avail, the time falling constantly upon the same fraction of the second. The transmission of signals, by beats of a mean solar chronometer, and the marking of the time of reception by a sidereal clock or chronometer, carries the fraction of the second over every part of the whole second, and once, at least, in ten minutes marks the coincidence of the beats of the two time-keepers. By observations of the coincidences, and the marking of intervals at the same station, the law by which each observer varied in the estimate of fractions of a second became known, and, of course, the differences (or receiving personal equations) of each observer, supposing them to be constant. Pains were taken to compare personal equations by all the observers. It turned out, finally, that this might have been done by transmitting signals; but, then, to have assumed it would have been to anticipate a result which was sought. The part of the error, then, of receiving signals from error of noting time, was ascertained numerically, and its value could be assigned within certain limits in any case. The inference is drawn from an examination of this class of personal equations, "that when the two clocks" (the one by which signals are given, and the other by which they are received, both being rated either to mean solar or to sidereal time) "do not coincide in their beats; the observers, on the average, set down the fraction of a second of the signal received too small." Of the five errors, then, which I have enumerated, the numerical values could be assigned to two, (viz: 1 and 5,) and one (viz: 2) was insensible. After assigning the values in any particular case to 1 and 5, there remain residual errors, caused by 3 and 4. Now, it is plain that both of these will affect the result alike; that is, will tend to make the time of receiving the signal later than it should be by the amount of retardation of the wave or current, and by the difference in the time of its reaching the spiral coil and the click of the keeper of the receiving magnet. But a comparison of the observations shows a very small residual quantity having just the opposite sign, the signal being apparently received *earlier* than it was given. From this,

the nullity of both these corrections, 3 and 4, is fairly inferred, and the interesting consequences follow, that "the telegraphic method of comparing clocks, distant two hundred miles from each other, is free from error when the method of coincidence of beats is employed, and that the probable error of the longitude, from this method, is the same as the mean result of the computed relative correction of the clocks for the nights of observation." An investigation of the probable value of such error shows that, under favorable astronomical circumstances, and with due care in the use of the transit instrument, "the astronomical difference of longitude, between any two stations of a trigonometrical survey, may be determined by telegraphic signals, with a degree of precision of the same order as that of the differences of latitude," the inaccuracy depending upon the same causes as the deviation of the plumb-line.

The very interesting and elaborate report of Assistant Walker, of which I have thus given the chief conclusions, will be published with the other results of the year. It contains, in separate sections—1, a discussion of the theory of Morse's telegraph; 2, of the difficulties in the use of the telegraph, from imperfect insulation; 3, the theory of the adjustment of the magnets; 4, the theoretical discussion of the errors of the clocks at the different stations is thoroughly made, and equations of condition are formed for deducing the most probable errors from the observations; 5, equations of condition are formed for giving the most probable difference of longitude from the observations. Under this head, the mode of giving and receiving signals is discussed; the essential character of the method of coincidences is insisted on; tables of personal equations for each observer, and each fraction of the second, are framed. The key-beat and armature-beat in giving signals, are found not to differ. The correction for time of transmission of electrical effect, or "circuit time," and for the armature-beats of the receiving magnet, are explained, and the whole of the physical circumstances are expressed in an algebraic form. 6. The corrections for errors of the clocks at the several stations are deduced and applied. Full tables of the observations at the several stations are given in this connexion. The corrections for the differences in noting time by the different observers, (or personal equations of clock corrections,) are next made. 7. The table of signals transmitted and received is given. 8. The results of this table are examined and compensated by the equations of condition. 9. Numerical values are assigned, from observation, to the quantities independently compared, and the consequences obtained which have been given above.

2. *Secondary triangulation.*—The charts of the south side of Long Island having shown, in replotting, the necessity for additional soundings, it was requisite that certain signals of the secondary triangulation should be erected, or new ones put up and determined. This work was commenced by Assistant C. M. Eakin; and, on his leaving this section to commence the survey of Mobile bay, was continued under the direction of Lieutenant Commandant Richard Bache, U. S. N.

3. The *hydrography* in this section has included the observations of tides and currents in Long Island sound and Delaware bay; work of verification in New Haven and Oyster bays, and of filling up off Cape May, and for the off-shore chart; in New London harbor, off Block island, and the coast of Rhode Island, for the first sheet of the eastern series of coast charts. Buoys have also been placed in Delaware bay, and the positions of those placed by the collector of New London have been determined. (See Appendix, No. 4.) The buoys have been colored according to a simple system, to indicate the purpose of the buoy, and the side on which it must be passed. The system is explained in a report by the late Lieutenant Commandant George M. Bache, to the Treasury Department, in Document No. 24, House of Representatives, 1838; an extract of which is appended. (See Appendix No. 5.)

4. The work of *verification* and *filling up* has been executed by the party under the command of Lieutenant Commandant Richard Bache, U. S. N., by whom a re-examination of part of the overfalls on the Cape May side of the entrance to Delaware bay, and of Crow shoal, near the entrance, has been made, and soundings have been taken in Rehoboth bay and Indian River inlet. Some buoys have also been placed by him; the positions of which are shown on sketch B (bis.)

Of the placing these buoys, their coloring, and the directions for sailing by them, due public notice was given. (See Appendix No. 6.) Of the channels over the Cape May ridges, now marked for the first time by buoys, Lieutenant Commandant Bache thus speaks, in his report of October 1st.:

"The channels, two of which were discovered by the coast survey, which have been buoyed out, will prove of great benefit. Ricard's channel" (so named from the pilot employed by Major Hartman Bache, of the United States topographical engineers, when this channel was first surveyed,) "allowing vessels of fifteen feet draught to pass out of the bay, with ease, at times when the wind would be ahead in the main ship channel, and in westerly winds placing them under the lee of New Jersey, an advantage which is lost by rounding the overfalls."

Independently of the necessity for filling up certain spaces requiring soundings at the entrance to the bay, the re-examination of the overfalls was made in consequence of the development on reducing the chart, of channel ways between the shoals on the northern side of the entrance to the bay. This fact was pointed out first by Assistant John Farley, and it was important that its bearings should be fully examined. The report of Lieutenant Commandant Bache will explain the nature of the examination which I required, and its results.

In it, he says: "I was directed to examine an alleged channel through the overfalls, with twenty-one feet water, as marked in the annexed sketch, and the branch from it, which is also shown upon the sketch, with other passages marked upon the same sketch, and to report in regard to them: 1st, the least depth of water, mean spring tides, and width of channel; 2d, their advantages and

disadvantages, compared with the present channel; 3d, the propriety of providing buoys and other marks; 4th, the character of the adjacent shoals, whether bluff or gradual, and the character of the bottom, whether mud or sand. The channels referred to are through the overfalls; the northern has twenty-one feet at low water, and varies in width from one-eighth to a quarter of a mile; the other has about the same depth, and varies in width from one-eighth to half a mile. Both are tolerably straight, but lumps occur in each near the western entrance. Those in the first channel are not of much importance, as they lie near the middle shoal and out of the fair way through the channel. I have, however, come to the conclusion that it would, at the present time, be useless to buoy out or otherwise to mark these channels. There is a seventeen feet channel close under Cape May, to the northward of the overfalls, and the main ship channel to the westward."

"The currents set irregularly across the channels in question, between shoal spots in some places, and in others through them, rendering it difficult to sail a direct course. The soundings are irregular and the shoals on each side abrupt." "The appearance of the spot is forbidding. On the north side is Somers's shoal, upon which the sea breaks in the calmest weather; on the southward are the breakers and rip of the middle shoal. In a fresh breeze all is confusion, and the channel could hardly be attempted without danger."

"The greatest advantage in the use of these channels is the making a lee under Cape May in northeasterly gales; but the breakwater on the western shore can be reached, and few would anchor under Cape May in a winter's easterly gale, could they do so without danger in entering, since the shifting of the wind to the northwest, which so commonly occurs, would place them on a lee-shore."

It seems that though these overfalls channels cannot be set down as among the prominently beneficial results of the coast survey, they may, nevertheless, under certain circumstances, prove of utility to navigators.

5. Lieutenant Commanding Bache's vessel was placed at the disposal of Commander Gedney, for certain examinations between the coast and gulf stream, in reference to general sailing directions for the off-shore chart. The work of the party was commenced in June, and at the commencement of October it was transferred to Long Island sound and the vicinity.

6. The observations of *tides* and *currents* in Long Island sound and Delaware bay have been made by the party under the command of Lieutenant John R. Goldsborough, United States Navy. Tidal observations, shown, by the discussion of the progress of the tide wave in Long Island sound, to be necessary, were commenced early in the season, and have included regular series, for not less than two lunations, at eight stations between New York and New London, viz: Governor's island, South Brother's island, Throg's point, Sands' point, New Rochelle, Huntington bay, Sheffield island, and New London. The discussion of these will show whether

further results are required. The current stations in Long Island sound; remaining unoccupied after the work of the last season, eleven in number, were taken up in turn and complete series of observations obtained for the direction and velocity of the current when uninfluenced by winds.

The observations of tides and currents at the entrance to Delaware bay were commenced on the 13th of August, and nineteen stations have been occupied, at which full sets of current observations have been made, and two tidal stations established in connexion with the former.

7. Much miscellaneous work has, in addition to their regular duty, been devolved upon this party, and has been executed with great promptness, and the results very clearly stated. Lieutenant Commandant Goldsborough also deserves credit for the vigilance which he exercises in regard to all matters incidental to hydrography. By setting before the collector of New London the method intended to be adopted by the coast survey of coloring buoys at the entrance to Delaware bay, a similar system was introduced into that extensive district, and the buoys having been placed by the collector have been colored and numbered under Lieutenant Commanding Golbsborough's direction, and their positions determined by an officer of his party. Directions for sailing by these buoys, fifty-five in number, and their places are given from Lieutenant Goldsborough's report in the appendix, No. 4, with the numbering and colors of the buoys. This system, if persevered in and extended, must be a great aid to navigation. The opinion of the intelligent collector of New London, Thomas Mussey, esq., is given in an extract from his letter to Lieutenant Commandant Goldsborough. (Appendix, No. 7.)

8. Work of verification has been made by this party in New Haven harbor, off the mouth of the Connecticut river, in Oyster bay, on the north side of Plumb island, and in the Delaware—the last mentioned being still in progress. Twelve buoys had also been placed in Delaware bay and river, (sketch B bis,) and their positions determined, and three remained to be put down. The list is given in appendix, No. 8, with the list of those placed by Lieutenant Commanding Bache.

The recommendations of Lieutenant Commanding Goldsborough, in regard to additional buoys and a light, have been already presented to the Fifth Auditor, and the chart of the mouth of Connecticut river will be prepared for publication, as suggested by him, and the additional soundings in the river be directed. Lieutenant Commandant Goldsborough acknowledges with thanks the aid rendered by Captain Cullum, of the corps of engineers, in reference to the tide guage at New London.

This party was engaged during the last winter at the office in making duplicates, reductions, and diagrams of the work of the previous season.

9. In consequence of information received from Lieutenant Commanding George S. Blake, in regard to changes in the channels and shoals of the Delaware near the Pea Patch, formerly surveyed

by him, I gave instructions to Lieutenant Commandant William P. McArthur, United States navy, assistant in the coast survey, to re-examine his locality, and obtained, through the kindness of the Secretary of the Treasury, the use of the revenue cutter on the station. Every facility was afforded to Lieutenant Commanding McArthur by Captain Robert Day, commanding the cutter.

The changes were found to consist in the closing of the so called Eastern channel, by the extension of the Bulk-head shoal to meet the spit extending from the upper part of the Pea Patch island. At the same time, Goose island channel, to the east of the Bulk-head shoal, had widened and deepened. The changes thus indicated were transferred at once to the coast survey chart, then nearly completed for publication. The importance of the hydrography of this part of the Delaware to the defences of the country, has caused repeated surveys to be made there, and will require constant attention to be paid, since the regime of the river appears by no means to be settled there, though hardly changing above and below. Lieutenant Commandant Richard Bache having reported to me further recent changes, I have directed a re-survey of the Goose island channel and its vicinity, by Lieutenant Commanding J. R. Goldsborough, which will be made before the season closes, and its results reported. One object of the coast survey should be, to ascertain those parts of the coast where changes are occurring, and, during the progress of the work, to ascertain the character and direction of those changes, and to provide every means for observing them in future, or data for controlling them when attention is turned to the necessity for this, as it must one day be. Such changes as have already been reported within three years, in the vicinity of important commercial depots, will not always be suffered to go on without attempts to direct them.

10. Collections of specimens of the bottom from soundings in this section, were first commenced by the late Lieutenant Commanding George M. Bache, United States navy, and have been added to every year since 1844, placed in small bottles for easy inspection, and duly labelled. It was the intention of that lamented officer to have classified them during the past winter, and to have placed characteristic specimens upon an off-shore chart on a suitable scale, thus enabling the eye to generalize the results so as to reproduce them methodically arranged, as upon a geological map. In addition to this, the microscopic examination of these specimens could hardly fail to develop interesting facts in regard to them, some of which might prove of importance to navigators, as all would be to general science. Professor J. W. Bailey, of West Point, kindly commenced an examination of this sort. "All the deep sea soundings," he says, (in a letter to me on this subject,) "are of the highest interest, being filled with organisms, particularly the calcareous Polythalamia, to an amount that is really amazing—hundreds of millions existing in every cubic inch of these green muds.

The most interesting specimen is the one labelled No. 1, latitude 38° 04′ 40″, longitude 73° 56′ 47″, 90 fathoms. This is crowded with Polythalamian forms, *mostly large enough to be recognized by*

a practised eye without the aid of a magnifier." A figure, or specimen which would enable a *practised eye* to recognise these forms —and Professor Bailey has promised to illustrate these researches by drawings—would render even this first inspection of practical value; the "large textilaria, having the form of a *truncated pyramid*, which characterizes No. 8, latitude 39° 31′, longitude 72° 11′ 20″, 89 fathoms, not being mistakable for the forms abundant in No. 1," it is to be hoped that Professor Bailey will carry so promising a subject to a conclusion. He may add another to the aids furnished by science to navigation.

SECTION III.

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

The progress of the work in this section is shown upon sketch C. The primary and secondary triangulation connected with it, will, before the close of the season, reach the mouth of the Potomac. Work of verification on the Delaware, and at and near the Kent island base has been executed; the secondary triangulation on the outer shore of the peninsula has been extended from Indian River southward, nearly, or quite, to the head of Sinepuxent bay. The topography of the shores of the South river has been completed, and, of the western shore from Herring bay to the Patuxent is nearly completed; on the eastern shore, the topography of the shores of the Sassafras river, of Eastern bay, and of adjacent islands, of the shores of the Chester, Wye, St. Michael's, Choptank, and their tributaries, has been completed. The hydrography of the Sassafras has been executed; that of the Chester, Wye, and St. Michael's, and of Eastern bay, has been completed; and that of the Chesapeake has been extended nearly to the mouth of the Patuxent.

In no part of the bay which the coast survey has yet reached, are the errors of the best maps now existing, so great as in this. The distance from Cove point, where there is a light-house, near the mouth of the Patuxent, to Meechin's neck, just opposite, is set down at 8¼, and 10¾ miles by two different authorities, while it is but 5⅞ miles. From Cedar point (the southern cape of the mouth of the Patuxent) to Meechin's neck, which is set down at 11 miles by the same authorities, is but 7½ miles.

1. The *primary triangulation*, and *secondary triangulation* of the Chesapeake bay connected with it, has been under the charge of Assistant Edmund Blunt, aided by Mr. John Locke, jr. The work was commenced on the 20th of May, when a station was occupied for verification, between which time and the last of October, 8 primary, and 18 secondary stations had been occupied. The angles were measured with the twelve inch repeating theodolite, constructed by Simms. At the eight stations, fifteen angles were measured by 232 series, made up of 2,737 observations. At the secondary stations, fifty-nine angles were measured by the same number

of series of repetitions, made up of 360 single observations. In his report, Mr. Blunt remarks: "The theodolite at base N, base S, and Taylor's, was raised ten feet above the ground, so as to give a good view of the signals at such times as it was suitable to observe. The poles at base N and base S were well secured with tripods, dressed by a carpenter, and made suitable for observing upon by bands of white cloth nailed around them, the parts which intervened between the bands being painted black. This enabled me always to determine the centre of the pole, the neutral tints alternating with the illuminated and darkest part of the pole."

"It was seldom the signals could be seen from either end of the base, and I feel justified in saying that, had I observed from the ground, much time would have been lost in waiting for suitable time for observation." The scheme of this triangulation as proposed, and its extent as already executed, are shown upon sketch C. The stations occupied are marked (o).

2. *Astronomical observations* were made at two stations and *magnetic observations* at six stations in this section, by Captain T. J. Lee, United States topographical engineers. At Taylor's, near Annapolis, the latitude was determined with the zenith telescope mentioned in referring to Captain Lee's observations in section I, with which 17 pairs of stars were observed, and 101 determinations obtained; also, with the new twelve inch Gambey theodolite, by observing nadir distances, the instrument having been adapted for use by this method. Sixty-seven transits of stars were observed for time, and 213 determinations made of the value of the micrometer screw of the zenith telescope, by observations on five different stars. At this station we have comparative results for latitude with the six inch Gambey theodolite and the zenith telescope. At Poole's island, 241 determinations of latitude were made by the zenith telescope on 38 pairs of stars, and 70 sets of ten repetitions of nadir distances were taken with the twelve inch Gambey theodolite. Mr. George Davidson assisted Captain Lee at this station.

The observations of the *variation* made last year at North point, at the entrance to the Patapsco, were repeated, but without change in the result; indicating that there is considerable local attraction at that place. The variation, dip, and intensity, were all observed at the Bodkin, opposite North point, and the variation at fort McHenry, near the city of Baltimore. The region is one of considerable local magnetic attraction, and the results for the chart of the Patapsco have been multiplied on this account. On the Chesapeake bay the declination, dip, and absolute horizontal intensity, were measured at Havre-de-Grace, at Poole's island, and Taylor's, near Annapolis.

Captain Lee was occupied during the last winter in computing the latitude and magnetic observations of the previous season.

3. *Secondary triangulation* of the peninsula. The extension of the triangulation south of Cape Henlopen has been a work of acknowledged difficulty; the ground has in turn been examined by several of the assistants of the survey, and the passage of the work south of Indian river, with sides of respectable length for secondary

work, has always been represented as a difficult thing. The choice seemed between measuring a supplementary base, and using very small triangles between Sinepuxent bay and Indian river, or using azumith lines. Early in the season this work was assigned to Assistant John Farley, who, after a minute reconnaissance found, that by considerable cutting upon one of the lines, he could succeed in continuing the triangulation southward, with sides not less than about two miles in length. This was a very satisfactory result, and the plan proposed was at once adopted. A sketch of the work already done is given in sketch C, and Mr. Farley is engaged in continuing it, having resumed his duties there after completing the sketches referred to in section I. Mr. Samuel Wainright was attached as aid to this party.

Mr Farley determined, during the season, the position of the new light-house at Cape May for the hydrographic party working in that vicinity.

4. The *topographical work* in this section has employed three parties during the whole season, and a fourth during a part of it. The sheets are numbered 6, 11¾, 14, 16 to 20, 22, 23, 24, and 25, on sketch C, showing the progress of the section. They cover an area of 387 square miles, a shore line of 743 miles, and an extent of roads of 641 miles—a considerable increase over the work of last year.

In the completion of the topographical sheets south of Cape Henlopen, Assistant J. J. S. Hassler surveyed, subsequent to the date of my last report and before the close of 1846, an area of 26 square miles, an extent of shore line of 55 miles, and of roads of 22 miles. During the winter he was employed in inking this work, and part of his topography upon the Delaware. He commenced work on the Sassafras river (sheet No. 14, sketch C,) on the 28th of April, 1847; between which time and the first of October he completed sheet No. 14, and had nearly completed No. 24. The area surveyed in these two sheets is 62 square miles; the extent of shore line 33 miles, and of roads 123 miles. The illness of Mr. Hassler from September up to a recent period, has prevented the completion of this work, and may detain him from the field in North Carolina, to which he was to have repaired.

The work accomplished by Assistant R. D. Cutts, subsequent to my last report, in 1846, was upon sheet No. 22, from West river to Herring bay, upon which 30 miles of shore line and 31 of roads were run, and an area surveyed of 26 square miles. This and previous work was put in ink by him during the winter in the office. The cost of the topographical work of the coast survey was shown in an able report from Mr. Cutts, made to me last winter, to compare advantageously with that of other land surveys of the same minuteness abroad, and of less minuteness at home; nevertheless, he was of opinion, that by organizing our parties in a different way, (a suggestion which I had made to him,) the cost might probably be reduced without impairing the efficiency of the work. This plan has been in the course of trial in his party during the season, an aid having been given to him capable of doing some of the manual work under his direction, and will be fully carried out at a future

time, as circumstances may warrant. The sheets nearly or quite completed by Mr. Cutts during the present season, are Nos. 11½, 16, 18, and 20, comprising a country full of intricate detail from streams which intersect it in every direction, and the banks of part of Eastern bay, the St. Michael's, Wye, and Choptank, with their various branches and tributaries. The area surveyed is 140 square miles, the extent of shore line 419 miles, and length of roads 158. Mr. Cutts had the use of the schooner Vanderbilt from the middle of July to the first of October. No case of sickness has occurred in his party.

Assistant Geo. D. Wise has been engaged chiefly upon the topography of sheets Nos. 23, 19, and 25, sketch C. During the first part of the season, he completed some work required upon his sheets of the Patapsco, and streams north of it, and then took up the interior of No. 23, the South river, of which the shore line had been executed last year. By the first of October, he had completed No. 19, including Tilghman's and Poplar islands, a part of Eastern bay and its creeks, and is now engaged upon sheet No. 25. The amount of work done to October 28th, comprises 92 miles of shore line, 232 of roads, and an area of 57 square miles. The country near the South river is rolling, and that in the other parts of Mr. Wise's work flat and open. The party has had but one case of severe illness during the season. Mr. Wise has, as usual, had the use of a small vessel for his work.

The topography of the shores of the Chester river, sheet No. 17, sketch C, commenced last year by Assistant J. Crawford Neilson, has been completed by him during the present season in the interval between the seasons in North Carolina. The area over which it extends is 76 square miles; extent of the shore line surveyed 114 miles, and extent of roads 72 miles. Mr. Neilson has had the use of a small vessel, belonging to the coast survey, in executing his work. He has had but one serious case of illness in his party during the season.

Verifications of parts of the topographical work of former years have been commenced by Lieutenant A. A. Humphreys, who has also visited the parties in sections I and III, to inspect the methods of working, with a view, especially, to uniformity in the modes of representing the ground.

5. The *hydrography* executed by the party, under the command of Lieutenant W. P. McArthur, United States navy, assistant in the coast survey, subsequent to my report of last year, and before the close of last season, consisted in sounding a large sheet of water, called Hawk's Cove, at the mouths of the Gunpowder, Middle, and Back rivers, thus connecting the soundings of these rivers and of the bay. During the winter, the notes of the work of the previous season were reduced, drawings made upon the publication scale of the charts of the rivers sounded out during the same time, and sailing directions prepared.

The first work of the present season was the completion of the hydrography of the Chester river—the approaches to which remained to be sounded at the close of last year's work. Between

the two bars, one extending southward from Swan Point, and the other northeastwardly from Love Point, (the north part of Kent island,) Lieutenant Commandant McArthur found a channel of 27 feet, and within this a capacious harbor of refuge—the importance of which to vessels navigating the bay, has induced him to recommend the publication of a separate chart of the entrance to Chester river—materials for which are now in the office.

Next, the soundings of the Sassafras river, of Eastern bay, of the Wye and Miles rivers were made, including an area of about 80 square miles. The Wye has no less than five fathoms of water at its entrance, and ten fathoms inside.

The sounding of the bay was continued from the limits of the work of Lieutenant Commandant S. P. Lee, of last year, nearly to the mouth of the Patuxent, to Cove Point. The whole work as reported, to the time when this party closed its labors to prepare for work in North Carolina, covered an area of 257 miles; the number of miles run in its execution was 1,531; the number of casts of the lead 78,678; the number of angles measured with the sextant to establish points 2,242. Sixty specimens of the bottom have been preserved and duly labelled. Sailing directions have been prepared for the bay from Cove Point to its head. During the first part of the season, Lieutenant Commandant McArthur had command of the coast survey schooner Vanderbilt, and subsequently of the coast survey schooner John Y. Mason.

The hydrographic party of Lieutenant Commandant S. P. Lee, was last year employed in the Chesapeake, south of Kent Island, and executed, between October first, the date of Lieutenant Commandant Lee's report, and the second of December, when the work closed, the soundings over 79 square miles, including in lines sounded in boats 340 miles, and in lines run in the schooner Nautilus 66 miles, or 406 miles in all. Seven hundred and ten hydrographic points were established by angles measured with the sextant, and 23,514 casts of the lead made. This work was duly plotted, and turned into the office. At the close of the season, Lieutenant Commandant Lee was transferred to the command of the brig Washington, undergoing repairs after her disastrous cruise of the autumn. The work executed by him in that vessel will be referred to, under the head of the exploration of the gulf stream and off-shore work, at the close of this section.

Exploration of the gulf stream and off shore work.—1. The surveying brig Washington was brought into Philadelphia, after the perilous cruise in which her lamented commander was lost, by Lieutenant John Hall, United States navy, the senior officer of the party. The vessel was above the water a wreck, and the examination made of the hull at the Philadelphia navy yard showed that many of the timbers were unsound, notwithstanding that the violent storms to which in succession the vessel had been exposed were borne without leaking. The use of the vessel, during part of the following surveying season, was accepted by the honorable the Secretary of the Navy as an equivalent for

the repairs required, a liberal course, which has saved this useful vessel to the coast survey.

2. Completely repaired and equipped, the Washington sailed, under the command of Lieutenant Commandant S. P. Lee, United States navy, for the Gulf of Mexico, in April, 1847. Having satisfactorily accomplished the duties assigned to him, Lieutenant Commandant Lee resumed his coast survey duty in the month of August, making, on his way to the United States, a section of the gulf stream, southeast from Cape Henry, for comparison with that of Lieutenant Commandant Geo. M. Bache, in 1846. The Washington, under her able commander, rendered service in the blockading of Laguna, the visit of the commission to Yucatan, and the expedition against Tobasco, the efficiency of which is acknowledged by Commodore Perry in the letter hereto appended, (Appendix No. 9,) and finished the duty assigned by the Navy Department by landing a bearer of despatches on the way to resume coast survey duty.

3. The observations for temperature at different depths in and across the gulf stream, off the coast of Virginia, North and South Carolina, Georgia, and Florida, were made for comparison with those taken last year in the same section, it being important to connect the several series of results in different years by observations which will show the changes in the character of the stream from one season to another in the same localities. The positions at which the observations were made this year, by Lieutenant Commandant S. P. Lee, are shown by the Arabic numerals in the chart attached to this report, and marked sketch D bis. Those occupied last year, by Lieutenant Commandant George M. Bache, in the same section, are indicated by the Roman numerals. The pains which were taken to obtain results in positions, differing but little from those of the former year, are fully apparent from an inspection of the chart, and the results are, as far as could be expected, confirmatory of those previously obtained. In representing the law of change of temperature by curves, the same peculiar forms characterize the curves in the cold water nearer the coast than the gulf stream, in the hot water of the gulf, and in the ocean beyond. The same general facts in regard to the peculiar distribution of temperature in a direction perpendicular to the stream are developed. The sudden rise from the cold water near the coast to the hot water of the gulf, forming, what Lieutenant Commandant Bache fitly called a cold wall confining the stream, the sudden fall of temperature from the gulf, its rise again, and then its fall, (though the section passes still southwardly,) appear in these observations of Lieutenant Commandant Lee. The positions of the alternations of hot and cold water do not correspond, nor was this at all to be expected. The observations of Lieutenant Commandant Bache, showed, in all three of the sections examined by him, a second branch of the gulf stream outside of the first, and separated from it by cold water. Those of Lieutenant Commandant Lee indicate more than one alternation of relatively hot and cold water. The interest of the subject increases the further it is ex-

plored. The comparative results of a mean of the temperatures from twenty fathoms down to 120, as deduced from the several positions at which observations were made in 1846 and 1847, are shown in the two upper curves of sketch D bis, attached to this report. The positions of the stations are projected upon a section across the stream. The lengths of the vertical lines or ordinates of the curve are proportional to the observed temperatures, and the distances between the ordinates to the distances between the stations. The curve of 1846 is dotted, that of 1847 is a full line. The eye traces by them the sudden rise of temperature to the axis of the gulf stream, indicated by the abrupt rise of the curve; the more gradual fall, and subsequent alternation of rise and fall, showing the forking of the gulf stream in 1846; the very sudden fall showing cold water actually in the stream in 1847, and subsequent rise; the more gradual descent and rise. The fact indicated by the sudden fall in the curve of temperature in the gulf stream, in 1847, is confirmed generally by the whole of the series of results of the two adjacent sections, and by an additional position occupied in the vicinity at which the observations at certain depths were repeated. The positions of the points of highest and lowest temperature, and the distribution of temperatures along the section, are different in the two years. So, also, are the mean temperatures—a fact which cannot be entirely explained by a difference in instruments—(those of 1846 having, with the exception of one, which was not used as being out of order, been lost with the lamented officer who used them in that year)—since, the curve of 1847 is both higher and lower than that of 1846 at the same depths. While referring to the instruments, I should state that, although those employed this year were by the same maker as those of the last, and were of the form which had been most approved, their construction was not as successful as that of former ones, and irregularities appeared in their performance, which caused the loss of valuable time, and required much perseverance to compensate. A comparison of the separate results of the different observers in the gulf stream, with the results of stationary observations for temperature at different depths in the ground, shows a small comparative amount of discrepancy in the ocean observations very encouraging as to the facility of obtaining normal results, and the reliance to be placed upon the observations.

The two lower curves of sketch D bis, show the changes of temperature deduced from a mean of the results from 120 to 480 fathoms. The dotted curve is that of 1846, and the full line that of 1847. The same general features are presented as in the temperatures at less depths. The same change of position, laterally, of the highest and lowest temperatures, in passing downward, is shown by both sets of curves, and a similar change of position of these same points, from 1846 to 1847, as indicated by the two sets of curves. These curves may be considered as representing the general character of the results from twenty to one hundred and twenty fathoms, and from one hundred and twenty to four hundred and eighty

fathoms, divested of the accidental irregularities shown at particular depths.

At position No. 9, which is just beyond (relatively to the coast) the hottest part of the gulf stream, where the temperature of the surface was found, by Lieutenant Commandant Lee, to be 82°; the temperature at the depth of 750 fathoms was 42°; and at 1,000 fathoms (about a mile and a seventh) was but 37°. The position is in latitude 31½°. In latitude 39½°, Lieutenant Commandant Davis found, in 1815, a temperature of 40° at the same depth. A table of comparative temperatures, at very considerable depths, is given in the Appendix No. 11.

4. Lieutenant Commandant Lee availed himself of an opportunity, while in the Gulf of Mexico, to run a line of soundings from Sisal to Alvarado. I am indebted to him for valuable suggestions in his report at the close of the season, in reference to practical details in the continuation of the observations in the gulf stream. The party under his command is now engaged in the off-shore work and deep soundings near and south of Cape Henlopen.

5. Lieutenant Commandant Lee acknowledges, in suitable terms, the kindness of Commodore Latimer, of the Pensacola navy-yard where the Washington touched on returning from the gulf.

6. In addition to the statements made last year, relating to the disasters of the brig Washington, I have been favored by Lieutenant John Hall, United States navy, first lieutenant of the vessel, with a letter, which, as containing particulars only known to himself, I deem it proper to put on record. (See Appendix No. 10.) It adds, if possible, to my former estimate of the coolness displayed by all in the midst of the extreme peril of that occasion.

7. In my last, it was stated that two of the sealed bottles thrown overboard, by Lieutenant Commandant George M. Bache, for the purpose of ascertaining the set and drift of the currents in and near the gulf stream, had come ashore near Nag's Head, North Carolina. The position where these bottles were thrown over, is shown, by the observations of temperature, to be nearer to the coast than the gulf stream. Their courses were westward and southward. The direct distance between the point of departure, and the point on the coast where the bottles were found, is about 310 nautical miles. The interval of time which elapsed, after the bottles were thrown from the vessel to the date of finding them, was about six days. On the 27th of June, 1847, a bottle was picked up on the coast of *Kerry, in Ireland*, which had been thrown from the brig Washington, on the 31st of July, 1846. (See Appendix No. 12.) The position from which this register of currents began its course was in 37° 39′ latitude, 69° N. longitude west, precisely on the *axis of the gulf stream*, as *shown by the temperatures*. The further prosecution of this interesting method of investigation will be attended to.

SECTION NO. IV.

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

The operations in this section (North Carolina) have included triangulation of different grades, astronomical and magnetic observations, and plane table work, and each has made a progress proportional to the means available for the parties employed. The primary and secondary triangulations of Albemarle sound have made good progress; the triangulation of the Pasquotank river has been completed, that of the Perquimons and Little river has been made, and of the Alligator river commenced. Observations for latitude and azimuth and for approximate longitude have been made at one station, and for latitude and azimuth at two stations, one on Albemarle sound, and one on Croatan sound. Magnetic observations have been made at three stations. The topography of the shores of the Pasquotank has been completed from the bridge over the outlet to the Dismal Swamp canal, north of Elizabeth city to the mouth.

More work could have been done had the appropriation permitted the complete outfit of each of the triangulation parties with a small vessel; but this was not the case, and the use of the same vessel necessarily interfered in a degree with the progress of each party. During the surveying season just commenced in that region, the work will receive nearly its full development by the addition of another plane table party, and of a hydrographic party. If the season is favorable, the triangulation of Albemarle sound and its rivers will be completed this year, and the plane table work of the shores and hydrography of the sound make considerable progress.

1. *Main and secondary triangulation* of Albemarle sound. This work has been continued by assistant William M. Boyce, who, at the close of the season in the eastern section, where he had been occupied near Cape Cod in Massachusetts, re-organized his party in this section. The work was commenced in December by putting up signals from North river point and Durant's island, near the entrance of Albemarle sound, to the mouths of the Roanoke and Chowan. During the season which closed on the 16th of June, five main and thirteen secondary stations were occupied. 52 angles were measured at the former, by 3300 observations, and at the latter, 86 angles, by 2,541 observations, with a ten inch repeating theodolite, constructed by Gambey, and having an extra telescope adapted to it in the office of the coast survey, specially for measuring horizontal angles. The longest line measured in the main series of triangles was about twelve, and the shortest eight miles. They rest upon a preliminary base measured twice with a wooden rod; the progress of the work this year will further connect this with two other preliminary measurements. The scheme of the triangulation and its progress are shown in sketch D of this section; the lines of the main triangulation joining stations, both of which

have been occupied, are marked strongly; those joining unoccupied stations are dotted, and secondary lines joining occupied stations or main lines, from an occupied station, are marked by the light full lines. The area included in the triangles, the angles of which are entirely or in part measured, is 190 square miles. 32 signals were erected for the work. In his report Assistant Boyce, says, "At all the stations where observations were made, elavations above the natural surface were required, varying from 6 to 20 feet, which rendered it necessary to erect scaffolds at all the points. At 9 of the stations occupied, the stands for the instrument were trees, either pine or cypress, cut off square at the elevation required, which I found to answer well and much more steady than any artificial structure which I had the means to erect. The platforms were made of course, independent of the stand in every case, no matter what the strength of the tree. When not aided by a tree, an artificial stand was made composed of three pieces of timber, 4 inches square, forming a tripod well braced together in every direction. 10 feet was the highest stand which I had occasion to use of this description, being generally aided by a little natural elevation, and I found them quite steady."

Pains have been taken to secure the station points as far as practicable, and to erect signals not likely to be easily blown over: the examination this season will show how far the means adopted have been attended with success.

There was much sickness in this party after the spring opened, and assistant Boyce himself was ill before commencing the work and after its close, the latter illness retarding materially the computations of this work and the execution of the drawing of Hyannis harbor from his plane table survey of the previous summer. In a few weeks, this party will be again at work in continuing the triangulation, and with increased facilities permitted by the increased appropriation of the present year.

2. The *astronomical* and *magnetic* observations were made by assistant C. O. Boutelle during last winter and spring. They include observations for latitude and azimuth at Stevenson's point near the entrance of Little river, (and about the middle of the length of the north shore of Albemarle sound,) and at Shellbank station, at the eastern entrance of Currituck sound, a few for approximate longitude by moon culminations at Stevensons' point, and observations of magnetic variation, dip, and intensity at these stations, and at the middle of the base formerly laid out on Bodie's island. The observations for latitude were made with the zenith telescope referred to in section 1, and by the method there described. At Stevenson's point, 608 measurements were made on 56 stars, and at Shellbank, 582 observations on 50 stars. In addition, careful observations were made to ascertain the value of the divisions of the micrometer, by measuring changes of altitude of the pole star near its greatest elongation and noting the times of observation. The time was obtained at both stations with a Troughton transit instrument, belonging to the coast survey, a new stand for which had been made by Mr. Wurdeman in the office. The azimuths were deter-

mined by the elongations of the pole star observed with the 10-inch Simms theodolite of the coast survey. The precautions necessary in the use of this instrument, which is not, however, well adapted to this kind of observation, appear to have been carefully studied by Mr. Boutelle; 110 observations for time and 8 sets for azimuth were made at Stevenson's point, and 113 for time and 10 sets for azimuth at Shellbank. The distance from Stevenson's point to the signal erected near the primary station at Reed's point was measured with a chain by Mr. Boutelle, and the length of the line joining the two stations deduced. Mr. Boutelle was assisted in the observations above referred to by Mr. George Davidson. The magnetic observations were made with the portable apparatus of Weber and Riddle, belonging to the coast survey, and with a Fox's dip circle kindly loaned for the purpose by Lieutenant M. F. Maury, U. S. N., superintendent of the National Observatory.

This party will resume its duties on closing the secondary triangulation in Massachusetts, instructions having already been given to that effect. Means of increased accuracy of results will be afforded by the instruments now furnished.

3. The *triangulation* of the rivers and *plane table work* of the shores of the Pasquotank were assigned to Assistant J. Crawford Neilson, who has completed the triangulation of the Pasquotank, of Little river, and the Perquimons, and commenced that of the Alligator river. The triangles of which the angles have been measured are shown upon sketch D. 48 stations were occupied in the work and 157 angles measured by 2,540 observations. The area of the work is 60 square miles. The topography of the shores of the Pasquotank was completed, and the sheet beautifully drawn in ink before the transfer of Mr. Neilson's party to the Chester, in section No. III, in July. The area surveyed was 122 square miles. As a piece of detached work this triangulation and plane table survey, rested upon a base measured by Mr. Neilson, and its computations were made by the methods used in local surveys. It will at once be connected with the general work, but we have gained a year on its completion in regular course by thus proceeding. The soundings finished, we shall at once proceed to the reduction and engraving of the preliminary chart.

At the last meeting of the Legislature of North Carolina a law was passed for facilitating the survey of the coast in that State. The report of Assistant Neilson acknowledges the obligation under which the coast survey is to General J. C. B. Ehringhaus, of Elizabeth City, for his attention to the details of this act.

4. In addition to his regular duty, Mr. Boutelle examined twice the site of the proposed base on Bodie's island. This line, originally reconnoitred in 1843, had been measured for preliminary purposes with a chain, and this measurement was repeated by Mr. Boutelle; it will strengthen the similar measurements already made, when the triangulation is fully connected with it this season. The site of this base was deemed as secure as that of any portion of the coast along which it passes, which has increased by the closing of inlets, and is generally considered to be still on the

increase. In March of 1846, (March 1st,) a severe storm brought the ocean over part of the sand flats on Bodie's island, and made some breaches in the straight line of the beach on the ocean side.

The memorable hurricane, of September 8th, (the greatest violence of which, at this point, was from the southwest,) brought the waters of Pamlico sound over the island to a mean depth of some five and half feet and for several hours in duration, and two outlets were formed, from the sound to the ocean, across the site of the base line. A graphic description of this terrific storm, and its effects is given by Mr. Boutelle in a letter which is appended, (appendix No. 13.) After an examination of these outlets, assistant Boutelle was of opinion that both must ultimately close, (one being a mere pond at low water, and the other being very shallow at the entrance on the sound and exit on the ocean side,) and advised the postponement of the measurement of the base until the following spring. An examination made in the spring of 1847, by assistants Boutelle and Neilson, showed, on the contrary, an increased depth in the southern outlet of 1846 at the sound entrance, with a probability of an increase instead of a decrease of depth. As the making of this so called inlet is of considerable interest to the people of this region, I propose to continue this examination from time to time as the parties of the survey may be in its vicinity. It is just south of Roanoke island, and north of the new inlet. Both ends of the proposed base remain, and will be used as stations in the survey; but the expense of crossing the inlet, or the irregular operation required to carry the base from one end to the other of the line, formerly proposed, renders it, in the present aspect of things, unadvisable to persist in the final measurement here. Another site has been examined by assistants Neilson and Boutelle, and a favorable report made upon it—the southern end of the base terminating near the north side of the inlet, and the other being seven miles to the northward of it. An easy connexion has been found for the triangulation.

5. The storms of the year 1846, unprecedented in violence in this region, within the recollection of those now living, carried away nearly all the signals of the primary and secondary triangulation of the year before. On learning this by the reports of assistant Boyce, I directed that Mr. Neilson, who had assisted in erecting the signals, should visit the station points, and restore those of which the marks could be found. This was accomplished satisfactorily before the close of the season; the stations, with two exceptions, recovered, and conspicuously marked.

SECTION NO. V.

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

At the close of October, instructions were given to Assistant James S. Williams, for the *reconnaissance* of the coast of this section. A general reconnaissance, and a subsequent minute recon-

naissance for a scheme of triangulation were contemplated. The first of these was made by Mr. Williams, between the beginning of November and the close of June, and the results were reported in writing and orally at our meeting in Charleston. Having taken a general view of the coast, a systematic reconnaissance was commenced in January, including the islands upon the coast, the passages between them and the main land, and portions of the main. The reconnaissance extended from the St. Mary's, (Georgia,) northward to the Ogeechee, (South Carolina.) The sites which promised to afford bases easily measured, and which might be suitably connected, were examined with more or less minuteness. The result is a clear classification of different portions of the coast reconnoitred, indicating the ease or difficulty of surveying it, the general location of the triangles, and the probable lengths of the sides attainable. The coast between Charleston and the Savannah river, to which attention will be first directed, is as far as Port Royal, entrance favorable for triangulation, and further south is difficult. Mr. Williams is now engaged (having closed his work at the north) in examining minutely the sites which promised most easy measurement of bases, and in determining the best scheme of triangulation. The general reconnaissance was made in the most satisfactory manner, and reported with minuteness and clearness.

The estimates for the next fiscal year contemplate the regular increase in the work and number of parties in this section, required by the preliminary operations now executing.

SECTION NO. VIII.

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

The survey in this section, in all its departments, has made satisfactory progress during the past year. A base line has been measured on Dauphin island; the primary triangulation has been continued by filling up at stations not already occupied; the secondary triangulation has been carried westward to Cat island and the adjacent shores; the topography of the entrance to Mobile bay, and part of the island chain from Mobile bay to lake Borgne, has been executed; the hydrography of the entrance to Mobile bay has been nearly completed, and that of Mississippi sound north of the base has made progress; a hydrographic reconnaissance of Cat Island harbor has been made. The series of tidal observations at Fort Morgan has been continued. The important discovery made of the the increased depth of water in the channel at the entrance to Mobile bay has already been referred to, and will be stated in detail in the account of the hydrographic work in this section. The sketch showing this result is marked (E bis.)

The interest taken by the citizens of New Orleans and Mobile, with whom I communicated while on duty in this section last spring, was highly encouraging. A correspondence with the citizens of Mobile in regard to the survey of Mobile bay is appended. (Appendix No. 14.)

1. *Measurement of base line.*—The site for the base line on Dauphin island was selected by Assistant F. H. Gerdes, after his general reconnaissance of this part of the coast in 1845; and two preliminary measurements with the chain were made at different times, under his direction, by Messrs. Walker and Greenwell. The site presents great facilities for measurement and connecting the base with the triangulation. It is exposed, as all sites near the ocean must be, to the gradual or sudden action of the water, but, as far as can now be foreseen, is likely to be permanent, so as if necessary to afford an opportunity for remeasurement. The base (see sketch E) was laid out from near the woods on Dauphin island westward for nearly seven miles to the western extremity of the island, which at that end is increasing. It has been kept as far as practicable from the gulf side of the island. It passes, first, through the firm salt marsh which borders the Mississippi sound, then over the dividing ridge of low sand hills, upon sand flats with scarcely a rise, again upon firm marsh or sand flats covered with short grass on the sound side of the island. All the preparatory arrangements were made under the direction of Mr. Gerdes before my arrival at Dauphin island.

The measurement of the base was made by me, assisted personally by Mr. Gerdes and his party, to which were attached Assistant Julius E. Hilgard and Mr. J. Hewston. The grading, where required, was done under the direction of Mr. W. E. Greenwell. The records were kept by Mr. Samuel Arthur. The apparatus was safely transported from Washington to Dauphin island, under the charge of Mr. Thomas McDonnell, who also aided in the measurement. Mr. Wurdeman, accompanied me to make the repairs which it was supposed might be required from time to time, to examine the apparatus, and to see the working of the different parts.

The base apparatus presented some novel features in construction, the adaptation of others not hitherto used in field work, and a choice of parts previously used by others. The general plan was devised by me and the details by Mr. William Wurdeman, by whom they were executed under my direction.

This is not the place to describe the base apparatus, but I may be allowed briefly to allude to its general features:

1. The measuring bars were upon the compensating system, first used, I believe, by Colonel Colby in Great Britain, and by Mr. Borden in the United States, but the mode of obtaining the compensation differed entirely from that used by either of these gentlemen.

2. A principle was introduced in reference to the dimensions of the bars, which, if at all recognised, has not been hitherto applied, though obvious enough. A bar of brass and a bar of iron of the same dimensions, exposed to the same source of heat, will not heat equally in equal times. This is well known to depend upon the different conducting powers of the two metals, their different specific heats, and the different powers of their surfaces to absorb heat. The bars, then, if of equal sections, when the temperature is rising or falling, have not the same temperature, and the system is not compensating. The surfaces are easily made to absorb equally by

the same coating, and the *sections must be so proportioned to each other that the bars will have the same temperature* when exposed to variable temperatures of the atmosphere and of the case containing them. Having arranged the sections approximately, using numbers taken from the books, the changes in length during increase or decrease of temperature were not perceived when microscopes were used supported upon wooden stands, or even upon stone blocks of small size; the means of measurement were not sufficiently delicate to perceive them, or they were masked by greater changes in the supports. When the level of contact was substituted for the microscopes, or when Mr. Saxton's reflecting pyrometer was employed, these changes became very perceptible, and it was necessary to resort to direct experiment upon the materials of the bars themselves to obtain even approximate compensation, and then to correct a small residual quantity by applying a covering more absorbent of heat to one bar than to the other. If such changes have not been perceived hitherto, it has been because adequate means were not used to detect them. I am indebted to Lieutenant A. A. Humphreys and to Mr. Joseph Saxton for the perseverance and skill with which the experiments necessary to a complete adjustment of the apparatus were made.

3. The lever of contact and level first used, I believe, in the adjustment of standard measures by Bessel, was applied to indicate the lengths of the bars. The levels were so delicate, that several divisions upon them made up a quantity entirely insignificant in the measurement. The doubt which I had was, whether the sensibility of the apparatus had not been carried too far. This was, however, entirely removed upon finding the rapidity and certainty with which it could be used. The contact of two adjacent measures was between a blunt knife edge and a plane of agate.

4. The trussed support for the bars adapted to bearing the apparatus at two points only, and the tin covering or tube which surrounded the whole, were similar in principle to those used by Mr. Borden, but differed entirely in the adaptation of them; the bars moved freely on the trussed frame upon rollers, and were not attached to the covering tube in which the trussed frame itself was merely supported. The tin covering was conical and was doubled.

5. The trestles admitted of the various motions required in placing the apparatus. The length of the whole, about twenty feet, (six metres,) gave a weight which permitted easy and rapid transfer by four men, when covered with several thicknesses of imperfectly conducting material to keep the fluctuations of temperature within moderate limits. In arranging so many and various details, it is not to be expected that some of them will not admit of improvement; but the performance of the apparatus was highly satisfactory, working with a rapidity and accuracy quite going beyond my most sanguine expectations, and making comparatively light the labor of all concerned by the excitement produced by expectations constantly surpassed. The contacts were usually made in much less time than the setting of the forward trestles for the next measure. The following statistics of the measurement will suffice for the pres-

ent, to show that we have obtained a useful auxiliary in a geodetic survey, especially when the difficulties of triangulation render advisable the measurement of frequent bases.

The greatest length measured in the course of a day, in the final measurement, was 183 tubes, equal to nearly seven-tenths of a mile; the least, 47 tubes, or one-fourth of a mile; the average, 104 tubes, or four-tenths of a mile. The whole measurement of nearly seven miles was completed in seventeen working days, not reckoning the time lost by bad weather, or occupied by change of camp, and by comparisons of the apparatus. The length of the apparatus was compared before and after the final measurement with a standard iron bar, with which it had been compared in the office, by using Mr. Saxton's reflecting pyrometer.

The accuracy with which a remeasurement of considerable length could be made, was tested more than once in the measurement, but it was determined to make a more complete direct trial by establishing intermediate marks, and noting by the micro-telescopes attached to the ends of the bars the deviation at intervals. The greatest deviation in the length of seventeen tubes was between one and two hundredths of an inch; the average in twelve cases of repetition, not regarding signs, was five thousandths of an inch, the final error at the end of the third of a mile remeasured was nothing. The probable error of remeasuring 112 yards was five thousandths of an inch, making in the whole length of the base, and supposing all the errors to fall in the same direction, which is physically most improbable, about five-tenths of an inch. The great practical difficulty found at the outset, was to obtain a mark which would stand unmoved in the sand, to which to refer the apparatus on recommencing a measurement; this was satisfactorily obviated after many experiments, and the marks, which I have just stated to have been placed at intervals, may be assumed generally to have been stationary from one measurement to another. Incidentally, this remeasurement gave a strong test of the perfect compensation of the apparatus, under sudden changes of temperature as well as for different stationary temperatures. A storm came up after the second measurement was commenced, which interrupted it for between one and two hours and cooled the air suddenly about four degrees. The second measurement was made at a lower temperature by some five degrees than the first, and under exposure to a sudden fall of temperature.

At the nearest whole measure to each mile, stone posts were planted in the sand and duly secured, and at the ends of the base monuments were erected and secured with great care to mark the extremities of the line. Smaller stones were also placed in the prolongations of the base and across it at the ends, giving lines intersecting upon the extremities of the base line. Full descriptions of these monuments and stones, and of their condition at the close of the work, have been recorded in the office of the survey. They have been visited once since the measurement by assistant Gerdes, and their condition reported. The whole time occupied by my party at the base, including the landing and reshipping of the apparatus, the pitching and striking the camp, and its removal from the east end towards the west end, the measurement, placing

monuments, trials of apparatus, &c., was six weeks, namely, from the 30th of April to the 12th of June. The final measurement (occupying 27 days) was commenced on the 12th of May and ended with the 8th of June, including in this period three days, when the camp was removed, and four Sundays. We were much indebted to Major Ogden, of the corps of engineers, for the important facilities which he afforded us.

2. *Primary and secondary triangulations.*—Both these triangulations, (see sketch E,) have been under the general direction of assistant F. H. Gerdes, who has chiefly executed personally the primary triangulation. Four stations have been occupied, three on the main near Pascagoula, and one on Horn Island, and observations made on 21 points with the eighteen inch Troughton theodolite of the coast survey. A special reconnaissance was also made to re-examine the secondary signals as far west as Cat Island. Mr. Gerdes also made all the arrangements, previous to the measurement of the base on Dauphin Island, which were in every respect satisfactory. The schooner Walker has afforded means of transportation for this party and the one engaged in astronomical observations.

3. *Astronomical observations.*—Observations for latitude and azimuth have been made by assistant R. H. Fauntleroy at two stations: Fort Morgan at the entrance of Mobile bay, and East Pascagoula in Mississippi. A zenith and equal altitude instrument having a four feet telescope, and made by Troughton and Simms for the coast survey in 1846, was used for the latitudes. At Fort Morgan, 159 determinations were made using 36 stars; at Pascagoula, 139 determinations, using 80 stars. The increased number of stars at Pascagoula was used from finding, on computing the results at Fort Morgan, that the mean probable error of one pair of the stars observed, (as indicated by the variations of the mean observations upon each separate pair, from the mean latitude resulting from all the observations,) was three times that of a single observation with the zenith telescope. The mean probable error of a single observation was 0″.48, the mean probable error of the declinations of a single pair of stars was 1″.48, three of the pairs of stars giving latitudes differing very considerably from the rest. As these results are wanted for immediate use, the remedy is, by multiplying the number of pairs of stars, which, from the different observatories where their declinations have been observed, and the different authorities upon which they rest, must, by their multiplication, eliminate any considerable errors. I have also been kindly promised the co-operation of Lieutenant Maury, superintendent of the National Observatory, in determining the declinations of the stars, which gave results for latitude differing from the mean of the others.

Observations for azimuth were made with the two feet Troughton and Simms' theodolite of the coast survey by the elongations of the pole star. At Fort Morgan, 10 elongations were observed, 66 horizontal angles with an elongation mark and stations were observed, each with the telescope direct and reversed. One hundred observations of transits of stars for time were made in con-

nexion with the observations for latitude and azimuth. At Pascagoula, 10 elongations of polaris were observed, 49 horizontal angles measured in connexion with them, and 80 transits taken for time. A few moon culminations were also observed. The transit instrument employed, was that already referred to as in use at Agamenticus, in section No. I.

4. *Magnetic observations* were made by Assistant Fauntleroy at both the stations just referred to, and consisted of 9 determinations of the declination (variation) by Weber and Riddell's portable declinometer, and 6 of absolute horizontal intensity with the same instrument.

In both the astronomical and magnetic observations, Mr. Fauntleroy was assisted by Mr. Joseph S. Ruth.

5. The *secondary triangulation* has been in general executed by Assistant Julius E. Hilgard, under the immediate direction of Assistant F. H. Gerdes. Mr. Hilgard has had M. J. Hewston with him as aid. The work, as shown by the lighter lines upon sketch E, accompanying this report, has been extended westward from Grand Batteur station beyond Cat island. It furnished all the points required by the planetable parties on the islands, including Petit Bois, Horn island, Ship island, and Cat island, to the Isle au Pied, near the Louisiana shore, covering an area of about 285 square miles. It supplies generally those required on the main, except such as will best be obtained in connexion with the main stations, and those in the bay of Biloxi. In two seasons, the secondary triangulation by Assistants Gerdes, Fauntleroy, and Hilgard, has advanced from Mobile bay nearly to Lake Borgne, about one hundred and ten miles. I cannot refrain from calling special attention to the zeal, energy, and industry thus manifested, especially due to the example of Assistant Gerdes, the pioneer in this section of the coast.

To complete the connexion between Mobile and New Orleans, requires the triangulation of Mobile bay; instructions for the execution of which have been already given to Assistant C. M. Eakin, and the progress through Lake Borgne and Ponchartrain, and across the neck to the city.

The party of Mr. Hilgard has encountered great difficulties for want of suitable means of transportation, and the work is much indebted to him for the continuance of his labors, until he included the important work near Cat island, at a season of the year which might have excused him from keeping the field, and under circumstances of considerable hardship.

5. The *topography* of this section has been executed by Mr. W. E. Greenwell, under the immediate direction of Assistant Gerdes. The topographical sheets are shown in sketch E, and are numbered 1 to 4. Of these, 2 and 3 are complete, the survey of Cat island on 4 is complete, and No. 1 is just commenced. The progress of this work is entirely satisfactory, when the difficulties under which Mr. Greenwell has labored, are considered. The increased appropriation of this year will enable me to afford additional facilities to his party.

6. *Hydrography.*—The hydrography of this section has been executed by Lieutenant Commandant C. P. Patterson, U. S. N., in the schooner Phœnix. After finishing some work of verification in Long Island sound, Lieutenant Commandant Patterson proceeded to this section in December last. Bad weather prevented work until the middle of February, when the sounding of Mississippi sound north of Dauphin island base was commenced. On my arrival in New Orleans in April, I found that many of the citizens desired an immediate examination of Cat Island harbor, with a view to its being made a stopping place for the British mail steamers to Mexico. In communication with Alexander Gordon, esq., President of the Mexican Gulf Railway, I ascertained the nature of the requirements in regard to Cat Island harbor, the answering of which did not interfere materially with the progress of our regular work, and directed a hydrographic reconnaissance, which was satisfactorily made by Lieutenant Commandant Patterson, and communicated under authority from the Treasury Department, to the parties more immediately interested. Having received a letter from the agent for publication of the maps of the British Admiralty, stating that, as there was a call for the chart of this reconnaisance, it was proposed to publish it in London, I have thought it advisable, lest the character of the work should be mistaken, and in reference to public use, to publish with this report, a *sketch* of the *reconnaissance* in question, (it does not profess to be a survey,) furnished by Lieutenant Commandant Patterson, on a scale suited to such a work. The triangulation and topographical survey of this part of section VIII having since been completed, an early opportunity will be taken to make and publish a proper *chart*. This small contribution to the interests of navigation in New Orleans may meanwhile be acceptable.

The sounding of the entrance to Mobile bay was next commenced by Lieutenant Commandant Patterson, and more than half of that work has been completed. The labors of the party here were rewarded by the important discovery of a depth of 20¾ feet in the channel at the entrance to Mobile bay, the bar having moved of late years seaward. The conclusions in reference to this are thus stated by Lieutenant Commandant Patterson in his annual report.

"The survey of the entrance to Mobile bay proves that remarkable changes have taken place since the survey by Major Kearney, United States topographical engineers in 1822, and that by Major Ogden, United States corps of engineers in 1841.

"Pelican island, in 1822, was 1,723 yards in length; in 1841, it was 2,757; and, in 1847, it had increased to 3,457 yards, making an increase of 1,735 yards in 25 years.

"The distance between the north end of the Pelican island and Dauphin island, in 1822, was 1,957 yards; in 1841, it was 788; and, in 1847, it was but 383 yards.

"Sand island, upon which stands the outer light-house, was, in 1822, but a small knoll of 131 yards across; in 1841, it was 1,542 yards in length; and, in 1847, it had decreased to 908 yards. Whilst Little Sand island, as it is called, where there was, in 1822, from

3 to 10 feet water, had made up into an island in 1841 of 952 yards in length, and increased to 2,625 yards in 1847.

"Upon the 'outer bar' the changes have been no less remarkable, as you will have perceived from my letter of the 25th of August.

"In 1822, the greatest depth which could be taken over the bar was 17 feet; in 1841, it was 19 feet; and, in 1847, it was 20¾ feet, each at mean low water.

"In 1822, the distance from the position in which Sand island light-house now stands to the shoalest water in the channel on the bar, was 3,446 yards; in 1841, it was 3,531; and, in 1847, it was 3,724 yards.

"Upon a line of soundings which took over the bar, in 1841, but 13 feet, in 1847 the depth was 20 feet.

"From these facts we see that the part of the bar ridge, consisting of the islands, has been constantly rising since 1822; whilst the bar itself has progressed slowly seaward, deepening in a ratio too great to be due alone to this progress. Gales from the seaward affect the bar and islands more or less, but these are accidents which appear to be eliminated in long periods of time, by a constantly acting cause or causes; *as the ratio of the making of* the islands is greater, so does the depth on the bar increase.

"May not the making of the islands be due to the normal action of currents? and the increasing depth on the bar, to the combined causes of its progress seaward? and the greater quantity and more rapid flow of water, in consequence of the contraction of the outlet caused by the very making of the islands?

"As this entrance is in a state of transition, unlike that of Pensacola, which appears to have arrived at nearly its stationary point, too much time, trouble, and care, cannot be given to the investigation of the causes.

"With the present depth our heaviest steam frigates can enter and find secure anchorage in Mobile bay; and, should the depth continue to increase in the same ratio it has for the last six years it will not be long before our largest frigates may do so also."

Public notice was given of these results of Lieutenant Commandant Patterson, with sailing directions prepared by him for the entrance to Mobile bay, (see appendix No. 13.) A sketch which he has furnished (sketch E bis) is appended to this report, and will prove useful in advance of the regular chart—materials for which will, however, be complete by the close of the present season.

I am indebted to Lieutenant Commandant Patterson for valuable remarks upon the different methods of obtaining the form of the bottom by sounding.

The party has had the misfortune to lose a valued and faithful officer, Acting Master Richard Allison, United States navy, whose disease was undoubtedly contracted from the exposure incident to the service in which he was engaged—a "misfortune to the navy and the coast survey, which have each lost an officer upright and honorable in character, ambitious in the performance, and faithful in the discharge of his duties—a yet greater misfortune to those

bound to him by closer ties, who have lost a warm hearted, generous, and self-sacrificing friend."

The respect due to Mr. Allison as an officer and co-laborer, was paid by the parties engaged in this work, who have placed on record their expression of the value of his services and their regret for his untimely fate. (Appendix No. 14.)

SECTION IX.

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

Circumstances having rendered it very desirable, in the opinion of the Secretary of the Treasury, that the survey here should be commenced at the earliest practicable moment, and the appropriation not permitting any considerable expenditure therein, I applied for, and obtained, the use of the revenue cutter, on the Mobile station, to furnish transportation and other facilities to the assistant who might be engaged in the work. Instructions were given, in the autumn of last year, to Assistant C. M. Eakin, to make a reconnaissance of the coast, beginning at Galveston and proceeding southward. A general examination commenced in January of the present year, was closed in the month of April. The reconnaissance was resumed by Assistant F. H. Gerdes, in October of this year, and it is to be feared that, with characteristic zeal, he has entered at too early a date upon the work, and that the dangerous illness which has seized him while returning to New Orleans is the result of the exposure during his reconnaissance. May his valuable life be spared to the work and to his adopted country!

The party of Assistant Fauntleroy is under instructions to proceed to this section, and to commence the astronomical observations required there; to measure a preliminary base, and to make the secondary triangulation of Galveston bay. The work in this section is, therefore, begun. The estimates of the present year include the progress which belongs to this early stage of the operations, and the purchase of a small vessel which has been made; and those of the next year, the further extension founded upon the work of the present.

OFFICE WORK.

The office has been, during the past year, under the charge of Lieutenant A. A. Humphreys, United States topographical engineers, assistant in the coast survey, whose indefatigable labors cannot be too highly or too often represented in my reports. Much of the organization which was experimental has passed into a regular system, and all results, as they are received, are duly disposed of according to rule, providing for their deposite, arrangement, and use, and for reports in relation to them. Those employed in the office have personal directions from competent officers, and, by means of registers, which are embodied in reports at

the close of every month, each one is secured due credit for the amount of labor which he performs. The drawing is directed by Lieutenant Humphreys personally; the engraving is under the immediate superintendence of Assistant W. M. C. Fairfax; the records, including books, maps, charts, and the instruments, are under the charge of Samuel Hein, esquire, the general disbursing agent of the coast survey; reports of the regular computations are made to Lieutenant Humphreys, and every month a general report is made by him to the superintendent, including the collected results of the office work under his direction, with a report of the instrument-maker's shop, and of the printing office, and proof sheets of the plates in the course of engraving.

At least two sets of computations generally are made—one by the field parties, and one by computers in or out of the office, not connected with the field work. These computations are compared by Lieutenant Humphreys, and if discrepancies are found, which cannot be reconciled, special report is made to the superintendent. If the computations agree, they are accepted, and the results noted to be used in the work. The astronomical results pass into the hands of the superintendent for discussion, and the geodetic are used in computing the co-ordinates for the maps. The magnetic results are recorded. The soundings are reduced by the hydrographical parties, who also generally compute the tidal and current observations, it being the duty of the chief of the party to verify the work. Forms are provided for these purposes. The tidal observations are discussed under the immediate direction of the superintendent.

To insure regularity in the making of maps, the following course is adopted: A project is made by the superintendent with the advice of Lieutenant Humphreys and Mr. Fairfax, and of the hydrographic officers engaged in the work. This is put into shape by a draughtsman from the best materials which can be collected. It serves to show the end towards which the work is to be directed; to fix the probable number of sheets of which the map must be composed; to determine the appropriate scale, and other details. It gives a unity of purpose to the work connected with the maps. The instructions of the superintendent indicate which sheet of a project is to be completed first; and, as the results come in from the field parties, they are arranged. The computations made, and all the notes collected which go to form the data for the map, the reduction of the map follows. These data are collected from the labors of many persons, in their different spheres, all brought to bear upon the same object. The triangulations, astronomical and magnetic observations, sailing directions, and hydrographic notes, are all concerned in the result. Lieutenant Humphreys verifies this, and it passes into the engraver's hands. When this system is fully acted upon, and the necessary checks in regard to the engraving are applied, the loss of time which follows from uncertainty of purpose, inaccuracies of drawing or engraving, will not occur.

There is nothing so difficult to introduce, and yet nothing more important, than a complete and thorough system of verification,

and this remark applies to field as well as office work. Impatience in obtaining results frequently induces this to be overlooked, but time is lost by the omission in the end. I am endeavoring gradually to introduce a system of verification throughout, which the cordial co-operation of all concerned in the work can alone make complete. Projects for the different kinds of office work are made and submitted to the superintendent at several periods of the year, as the work requires modification. An attempt is thus made to regulate the labors of all so as to produce visible results alike useful to the work and to the public, and encouraging to those engaged. The monthly reports indicate the degree of progress in the projected work. To keep all this, and more, which would require too much detail to enter into, steadily moving forward, requires peculiar qualities and qualifications in the assistant in charge of the office, which it has been my good fortune to find in Lieutenant Humphreys.

I proceed to give an account of the office work under the heads of computing, drawing, engraving, printing and publishing, and instrument making and repairs.

Computations.—The *recomputations of observations of 1816*, are, with very few exceptions, made, and many of those of 1817. It is difficult, without too great prolixity, to give an idea of the labors of a computer. In justice to the computers, however, I must give an abstract of their labors.

Eugene Nulty, esq., has computed the observations for azimuth at the north end of Kent island base, and at Bodie's island, North Carolina; for time and latitude at Nantucket; at Thompson's, Massachusetts, 2 volumes; at Marriott's Maryland; at Bodie's island, North Carolina, 2 volumes; at Stevenson's point, North Carolina; at Shellbank, North Carolina; the moon culminations and occultations observed at Nantucket.

Assistant Theodore W. Werner has revised the journals of measurement of the bases of 1844, and recomputed the following triangulations: The primary triangulation of the Delaware from Mr. Hassler's work down the bay, across the peninsula, and down the Chesapeake to the Kent island base; main triangulation in Croatan and Roanoke and Albemarle sounds; secondary triangulation near Cape Cod; primary and secondary triangulation of the Chesapeake south of Kent island; main and secondary triangulation in Albemarle sound, 1847; tertiary triangulation of the Pasquotank, North Carolina. He has revised the computations of horizontal angles, measured with elongation mark at Pascagoula; prepared ordinates for maps from triangulation near Cape Cod, Massachusetts; computed anew the quantities in the discussion of the coast survey latitudes by the superintendent; prepared new tables from formulæ by assistant J. E. Hilgard, under immediate direction of the superintendent, for geodetic differences of latitude and longitude, and azimuth, and revised the computations of part of the magnetic observations of 1845.

The computations of *differences of longitude from European observatories* have been continued by Assistant Sears C. Walker, at

times when not engaged in conducting the telegraphic operations, and in the computations and report relating to them. The labors of Mr. Walker are intended to embrace the problem of longitudes in its most extended sense; to include the collection and discussion of American observations, from all sources, and of corresponding European ones, contained in the records of observatories, transactions of societies, and in the scientific periodicals of the day. The collection already made by Mr. Walker is rich in results, the American observations embracing no less than five hundred occultations and one thousand moon culminations. The corresponding European observations amount to nearly two thousand. To facilitate the task of reducing such a mass of results, Mr. Walker has prepared blank forms, by which any computer, having the data furnished him, can carry through the steps of the reduction of his work, leaving a record of the steps of his work so as to admit of review or ready comparison with a second computation, in which the same forms are employed. These forms have been lithographed. By Mr. Walker's last and previous annual reports, it appears that he had completed the reduction of the moon culminations, in the coast survey collection, to the end of the year 1838, and of the greater part of the eclipses, transits, and occultations for Philadelphia and Washington, to the close of 1840. During the past year he has been engaged in reducing a portion of the extensive and valuable series of eclipses and occultations observed by W. C. Bond, esq., the most extensive series yet made in America. This work is only in part completed. The labor of reducing such a series, with the European observations, corresponding to them, for a period of twenty-seven years, during which no important phenomenon of this class, visible at Dorchester or Cambridge, has been omitted, can only be fully appreciated by those who are acquainted with the laborious routine of such computations.

The labors of Mr. Walker are directed to the following points: 1st. To make for the coast survey as extended a collection of astronomical observations, bearing upon the longitude, as practicable. 2d. To preserve, throughout, in the reductions, uniformity of method. 3d. To present, in successive annual reports, or when specially called upon by the superintendent, the best data for the longitudes of cardinal points which the tables and catalogues of the day enable him to furnish. 4th. To preserve the computations, and so to arrange the equations of condition, which they supply, that any subsequent modification of the data may be readily applied. The determination of the longitude of a cardinal point in the coast survey, by comparison of observations in the United States and Europe, with a degree of precision at all comparable to the results of the geodetic part of the survey, is a work of great difficulty. The object of Mr. Walker's labors is, to bring to bear so large a number of results that any new or isolated efforts cannot sensibly alter the conclusion, or impair confidence in it. The importance of this will be obvious to all who are acquainted with the difficulties encountered in fixing, in other national surveys, the geographical position of the central meridian.

Lieut. J. M. Gilliss, U. S. N., has completed during the year the reduction of the transits observed by Wm. C. Bond, esq., in 1839, copied the observations of 1840, and computed the instrumental and clock errors for a considerable part of the year. Mr. Bond having furnished for the coast survey a reduced copy of all his observations, these computations were discontinued and blanks prepared for reducing, for *differences of longitude*, the observations of corresponding moon culminations at Hudson, Washington, and Dorchester; and the European observatories of Cambridge, Greenwich, Edingburgh, Hamburg, Copenhagen, Kremsmünster, and Cracow. The corresponding observations of the year 1839, furnished 428 differences of longitude; the computations of which have been completed, and considerable progress made in those for the year 1840.

Reduction and drawing of Maps.—The following progress has been made in the reduction and drawing of maps up to the 7th of November, the date of the report of Lieut. Humphreys.

1. The drawing of one of the maps of Boston harbor, scale 1-20,000, for the commissioners of Massachusetts, has been commenced by assistant Morven J. McClery.

2. A map of Edgartown harbor, scale 1-20,000, has been drawn by assistant McClery. The reduction of the hydrography was furnished by Lieut. Com. Charles H. Davis.

3. A map of Nantucket harbor has been drawn, scale 1-20,000, by Mr. J. M. Wampler. The hydrography of this sheet is not yet reduced.

4. The reduction of sheet No. 1, of the eastern series of coast charts, from point Judith to Cape Cod, has been commenced by Mr. Fairfax, and continued by Mr. F. Schroeder.

5. A map of New London harbor, scale 1-20,000, has been drawn by assistant J. B. Gliick. The hydrography was reduced in 1846.

6. The reduction and drawing of New London harbor, scale 1-80,000, for the eastern sheet of Long Island sound, has been made by assistant Gliick, by whom, additional hydrography for the same sheet has been reduced.

7. A chart of Cawkin's island anchorage, (Long Island sound,) scale 1-20,000, has been drawn by assistant McClery. The hydrography reduced in 1846.

8. A map of the harbor of Black Rock and Bridgeport, scale 1-20,000, has been drawn by assistant McClery. The hydrography also reduced in 1846.

9. A chart of anchorages under Captain's island east, and Captain's island west, scale 1-20,000, has been commenced by Mr. W. Luce.

10 and 11. The reduction and drawing of the second and third sheets of the south side of Long Island, have been continued by assistant W. M. C. Fairfax.

12 and 13. Parts of the second and third sheets of Long Island sound have been reduced and drawn anew by assistant Fairfax.

14. A reduction of the western sheet of Long Island sound has been continued by Mr. Fairfax. The hydrography of the East

river, for the same sheet, has been reduced by Lieut. R. N. Stembel, U. S. N.

15. The soundings on the coast of New Jersey, from Barnegat inlet to Little Egg harbor, have been re-plotted, and the chart containing them finished by Lieut. R. N. Stembel, U. S. N.

16. The entrance sheet, of Delaware bay, scale 1-80,000, has been completed by Mr. Fairfax. Additional hydrography for the sheet, has been reduced by assistant Farley, and by Lieut. R. N. Stembel, U. S. N.

17. The off-shore chart, as far as materials for it are in the office, has been completed by Lieut. George M. Totten, U. S. N.

18. The entrance sheet of the Patapsco river and its approaches, scale 1-60,000, has been drawn by Mr. A. de Palmesteip.

19. The drawing of the upper sheet of Chesapeake bay, scale 1-80,000, has been commenced by Mr. McClery.

20. The hydrography of the Chesapeake, as far as completed, has been reduced to the scale of 1-80,000, by Lieut. George M. Totten, U. S. N.

The maps of assemblage and record of the work have been, in part, completed. Drawings of projects for intended charts of Boston harbor, Chesapeake bay, Mobile bay, and the approaches to New Orleans, have been made by Mr. McClery. Projections have been prepared for plane table and hydrographic parties, various tracings made for the parties of the coast survey, or from the archives for public purposes, and sketches made for the annual report of the superintendent.

The projections on copper for the maps, the engraving of which has been begun this year, have been made by Mr. Fairfax.

Engraving.—The engraving of the harbor maps of Holmes's hole and Tarpaulin cove, and of Oyster bay, or Syosset harbor, has been completed by Messrs. Sherman & Smith, of New York. The upper sheet of Delaware bay and river, has been completed by Mr. F. Dankworth, and Mr. J. Knight. The following maps are so nearly engraved, that they are reported as to be completed at different dates in December: Edgartown harbor, (Martha's Vineyard,) New London harbor, Connecticut, (re-engraved,) the eastern sheet of Long Island sound, Huntington bay, and the harbors of Black Rock and Bridgeport, Long Island sound. The entrance sheet to Delaware bay, will probably be completed in the spring of 1848. Considerable progress has been made in the upper sheet of the Patapsco and Baltimore harbor, and both sheets will probably be engraved soon after the close of the fiscal year. The middle sheet of Long Island sound is constantly in hands, but the period of its completion is yet uncertain.

The sketches accompanying this report have been engraved by Messrs. Petit and Knight, apprentices in the coast survey office.

The expansion of the field work has begun to produce an accumulation which the force of draughtsmen and engravers of last year could not surmount, but the arrears will be brought up by arrangements now commenced. It was found impracticable, even by enhanced prices, to induce those engravers who, in previous years,

had contracted to execute charts out of the office, to undertake further work.

Printing.—Since the first of December, 1846, the following number of sheets have been printed: 484 copies of the small map of New York bay and harbor; 120 sheets of the large map; 1,481 copies of New Haven harbor; 645 of New Bedford harbor; 1,061 of Little Egg harbor; 380 of Annapolis harbor and the Severn river; 225 of the upper and middle sheet of Delaware bay and river; 240 of Fisher's Island sound; 1,471 of the harbors of Holmes's hole and Tarpaulin cove; 1,140 of Oyster bay or Syosset harbor; 400 of the sketch of the New South shoal and Horn Island channel; making, in all, 7,647 sheets.

Publishing.—Up to the date of my last report twelve sheets of the coast survey maps had been engraved and published. Since then four have been added, making sixteen; and in a few weeks the engraving of four others will be completed.

Under authority of special act of Congress, and by direction of the Treasury Department, under the act reorganizing the coast survey, 1,104 maps have been distributed to scientific and literary institutions in the United States, (chiefly on application by members of the Senate and House of Representatives,) to departments of our own government, and to foreign governments, or used in the parties of the survey; 640 copies will probably be distributed in November. The distribution of the two sheets of Delaware bay and river has been sparingly made, on account of matching the sheets when the third is published—the different circumstances under which the sheets may be printed, or allowed to dry, determining a different shrinkage of the paper. 4,981 sets of maps have been turned over to the disbursing agent of the coast survey, to be placed with agents for sale. The low price at which the maps are afforded encourages the sale of them, and I have no doubt, that it ultimately will repay the cost of printing and paper.

Instrument-making and repairs.—The repairs required by the instruments of the field parties, generally, have been made as usual, during the current year, under the direction of Mr. Würdeman. A new stand for the two-feet (Troughton) transit; three stands, with divided circles, for thirty-inch telescopes; a reconnoitring telescope and stand; three new plane tables, from designs by Mr. Würdeman; a new telescope for the Patten theodolite, and one three-arm protractor have been made, besides additional parts for the new base apparatus. Two brass compasses, ten metre scales, eight twenty-metre chains, twelve steel rulers, four triangles, and other drawing instruments and apparatus for reducing maps, for electrotyping, &c., have been also made.

Disbursements.—The general disbursements have been, as last year, under the charge of Samuel Hein, esq., who has also particular charge of the records of the survey, and of the instruments, and the general agency for the sale of the maps and charts; all of which duties he has discharged with entire approval.

In my report of last year, I gave an outline of the successive extensions of the survey of the coast from 1844, and of the prelimi-

nary operations required to extend it still further, so as to embrace six sections of the coast, and to include operations in nearly every State on the Atlantic and Gulf of Mexico, the shores of which had not already been surveyed, with the simultaneous publication of the results of the work. This plan has frequently been shown to be characterized by economy, rapidity of progress, and speedy results. The division of labor, of which it admits, tends to economy and rapidity of progress; compensations are by it proportioned only to the difficulties, risks, and hardships of the work to be executed. The working seasons differing to the north and south, the same persons can, in many cases, be employed in the field in both a northern and southern section. The chiefs of five parties have, in this way, done duty in two sections within the past year. Thirty effective parties have been at work, in their appropriate season, in different sections; the necessary computations and drawings have been made, and engraving and printing have gone on, in due proportion to the field work. The cost of this has been, say one hundred and thirty thousand dollars. In 1841, (I do not go beyond the period of my own superintendence,) the cost of fifteen parties, with less office work in all the departments, was, say one hundred thousand dollars; exhibiting a large increase of work, at a small additional cost. The advantage of being able to select particular portions of the coast requiring immediate examination, is an incident to this mode of operating from which the work has not yet derived all the advantage which it may receive. The large number of States on the Atlantic and Gulf of Mexico, which derive direct advantage in each season from the progress of the field work, or the publications of the survey, is another incident of the plan not without its interest. The sanction of the Executive, and of Congress, having been given to it for three successive years, I am bound to furnish estimates accordingly for its prosecution. Although this has passed into the class of things settled by precedent, I hope the foregoing reference to the advantages of the plan will be excused, in consequence of the high importance which I attach to its development.

The regular progress of the survey of the coast will admit during the ensuing fiscal year, of the following operations in the different departments of the work. They are classified under the head of the geographical sections.

In Section No. 1. *The eastern section.* The primary triangulatoin, and astronomical and other observations connected with it, may be completed in *New Hampshire*, and continued in part of *Maine*. The reconnaissance for it may be extended nearly to the boundary. The observations for difference of longitude by electro magnetic telegraph may be continued. The secondary triangulation of the western shore of *Massachusetts Bay* may be completed, and may be extended east of Boston to *Salem harbor*. The topography (postponed last year to the execution of *Boston harbor*) may be completed; and that of part of the western shore of *Massachusetts Bay* be executed. The hydrography of the South Shoals and of the vicinity of *Nantucket*, may, if the estimate for a

steam vessel is allowed, be nearly, if not quite, completed. A chart of *Hyannis harbor* may be reduced, and its engraving commenced. The engraving of the chart of *Nantucket* may be finished, and the chart be printed and published. The engraving of the first sheet of the general coast chart, from *Point Judith*, *eastward*, may make considerable progress.

In Section No. 2. The work of verification in *Connecticut* and *New York* may be continued, and the omitted portions of the work necessary for the charts may be completed. The work of verification may make considerable progress. The observations for the normal condition of currents in *Delaware bay* may be completed, and those for the influence of winds upon them in *Long Island sound* and *Delaware bay*, make considerable progress. The engraving of the middle sheet of *Long Island sound* may be completed, the sheet be printed and published, and the engraving of the western sheet be advanced towards completion. The engraving of the *off-shore chart* may be completed within the year. The engraving of the second sheet of the *south side of Long Island*, may make considerable progress.

In Section No. 3. The primary and secondary triangulation of the *Chesapeake* may reach the mouth of the *Rappahannock*, and perhaps of the *York River*, and the necessary verifications may be made. The secondary triangulation of the outer shore of the peninsula, may be extended southward from *Sinepuxent bay* into *Virginia*. The necessary astronomical and magnetic observations may be continued. The topography of the eastern and western shores of the *Chesapeake*, to the limits of the triangulation of the present fiscal year, may be made. The hydrography of the bay may be continued southward from the mouth of the *Patuxent*. The off shore work south of *Indian river* may be continued, and if a steam-vessel is supplied, make very considerable progress towards the *entrance* of the *Chesapeake*. The computations required by a chart of part of the *Chesapeake* (on the scale adopted for the general coast charts) may be completed, and the drawing of the second sheet be made, and the engraving of the first sheet may be advanced towards completion. The engraving of the chart of the *Chester river* may be completed. The engraving of the second sheet of the chart of *Baltimore harbor* and the *Patapsco river*, may be completed, and the entire chart may be finished and published. This section, from the condition of the work on it, requires the largest expenditure upon it. The main triangulation is making evident progress towards the limits of the section.

In Section No. 4. The triangulation of *Albemarle sound*, and, probably, that of *Roanoke sound*, may be completed, and that of *Currituck* and *Pamlico sounds* be commenced. The final measurement of a base line may be made. The triangulation of the rivers of *Albemarle sound* and of part of the ocean shore, may be completed, and the topography of the river banks and ocean shore, in the same quarter, be completed. The hydrography of part of *Albemarle sound* may be completed, and, probably, some *off-shore* hydrography be executed. Materials will then be at hand for one

sheet of a map of *Albemarle sound*, and the computations, reductions, and drawings for this sheet, may be made. The exploration of the *Gulf stream*, off the coast, in this section, may be made. The engraving of the chart of the *Pasquotank*, may be commenced; the field-work, in this section, will receive its full development and the office work increase.

In Section No. 5. The triangulation of the coast, between *Charleston*, and the mouth of the *Savannah river*, (including the preliminary measurement of a base,) may make considerable progress. Astronomical and magnetic observations, required in connection with the triangulation may be made; the topography, and if steam-vessels be furnished, the hydrography in this section, (including the exploration of the *Gulf stream*, *off the coast*,) may be commenced.

In Section No. 7. The general reconnaissance of part of the *coast of Florida* may probably be commenced.

In Section No. 8. The primary triangulation of *Mississippi sound*, may possibly, and the secondary certainly, be completed. The triangulation of *Mobile bay* may be completed, and the chain of triangles, from *Mobile to New Orleans*, may be nearly completed. Further astronomical and magnetic observations may be made, the topography of the islands may be completed, and of the shores of the sound, make considerable progress. The hydrography of *Mississippi sound* and of *Mobile bay* and the *off-shore* work, may advance towards completion, if a steam-vessel is provided according to the estimate. The observations of tides and currents, may be continued; the necessary computations of the work, may be completed, the reduction of the entrance sheet, of a chart of *Mobile bay*, may be made and the engraving may probably be commenced. This work forms a part of a large chart in three sheets, to include the coast from *Mobile entrance to New Orleans*, the materials of which will be collected, and the several sheets, in turn, be reduced as the work advances. The field-work will receive its full development in this section.

In Section No. 9. The secondary triangulation of *Galveston bay* may be completed, and extended southward from *Galveston*. The primary triangulation may be commenced. The requisite astronomical and magnetic observations may be made. The topography, and perhaps the hydrography, may be commenced. Materials will be nearly collected for a preliminary chart of *Galveston bay*.

The following estimates include the cost of preparation and publication of the back work and current work, as well as of the field parties. They suppose the same aid now extended under act of Congress by the War and Navy Departments. The estimates have, after examination by the head of the department charged with the control of the work, and conversant with its progress, received his full sanction:

General items: Rent, fuel, postage, materials for drawing, engraving and printing, carpenters' work and materials. Instrument makers' materials. Blank books,

stationery, printing forms, binding. Transportation of instruments, maps and charts; purchase of new instruments, maps and charts..... $13,500

SECTION I. To extend the primary triangulation in *New Hampshire* and *Maine*, and make the reconnaissance and astronomical, and magnetic observations connected with it; the secondary triangulation of the western shore of *Massachusetts bay*, and the coast *north of Boston harbor*. The topography of *Cape Cod*, and of the coast of *Massachusetts bay*; the hydrography of the shoals off *Nantucket*. To make the calculations and reductions required by the work of this section; the reduction and drawing of a chart of *Hyannis harbor*; to complete the engraving of the chart of *Nantucket harbor*; to continue that of the coast chart *east* of *Point Judith*; will require for section I, including the extra cost of repairs to vessel and engine, and of maintenance of steam vessel for the hydrography, ($6,100,)..... 30,800

SECTION II. To continue the work of verification required in *Connecticut*, *New York*, and *New Jersey*, and the observations of currents in *Long Island sound* and *Delaware bay*, and to complete the off-shore hydrography; to complete the engraving of the middle sheet of the chart of *Long Island sound*, and to publish it; to continue that of the sheet next to *New York*, to complete the engraving of the off-shore chart, to continue that of the middle sheet of the *south side of Long Island*, (all these being from work generally of former years,) including, in the estimate for field work, the additional cost of a steam vessel for the time required by the off-shore work, ($1,750,)..... 17,400

SECTION III. To continue the triangulation of the *Chesapeake* to the *Rappahannock*, to make the necessary verifications; the secondary triangulation of the outer-shore from *Sixepuxent bay* into *Virginia*; to make the necessary astronomical and magnetic observations; to continue the hydrography of the eastern and western shores southward, to extend the hydrography to the limits of the triangulation in the bay and south of *Indian river*, on the outer coast, the extra cost ($2,150) of a steam vessel being included; to make the computations required by the work in this section; the drawing of a second sheet of the general chart of the *Chesapeake bay*; to continue the engraving of the first sheet; to complete the drawing of a chart of the harbor at the entrance to the *Chester river*; the engraving of the chart of the *Patapsco* and *Baltimore harbor*, and the publishing it, will require 32,900

SECTION IV. To complete the triangulation of *Albemarle* and *Roanoke sounds*, and to commence that of

Currituck and *Pamlico sounds*, including the final measurement of a base line; to continue the triangulation of the rivers of *Albemarle sound*, and part of the *ocean coast;* to continue the topography of the river and ocean shores; the hydrography of part of *Albemarle sound*; the exploration of the *gulf stream* off the coast of this section, (including $2,000 for the extra expenses of steam;) to make the computations, reductions and drawing of one sheet of a chart of *Albemarle sound*; to commence the engraving of a chart of the *Pasquotank*, will require.....	23,800
SECTION V. To commence the triangulation of the coast between *Charleston* and the mouth of the *Savannah river*, including the preliminary measurement of a base; to make the requisite astronomical and magnetic observations connected with the triangulation; to commence the topography, and, if a steam vessel is obtained, the hydrography, including the exploration of the *gulf stream* off the coast, (and extra cost for steam, $700,) will require.....	14,100
SECTION VII. To continue the general reconnaissance of the *coast of Florida* to the eastward from *Perdido bay*.....	1,200
SECTION VIII. To continue the primary triangulation, and to complete the secondary triangulation across the *Mississippi sound* and *Lake Borgne* into *Ponchartrain*, *Louisiana;* the triangulation of *Mobile bay;* the topography of the main shore of *Mississippi sound;* the hydrography of part of *Mobile bay* and *Mississippi sound*, and the observations of tides and currents; to make the computations required by the work; the reduction and drawing of entrance sheet of *Mobile bay;* the estimate includes ($3,700) for the extra cost of using a steam vessel.....	20,800
SECTION IX. To commence the secondary triangulation of *Galveston bay*, including the preliminary measurement of a base, and to extend it southward along the coast; to commence the primary triangulation of this section; to commence the hydrography and topography, will require.....	$10,500
Total estimate, including the use of steam vessels in hydrography in the sections specified.....	$165,000

These estimates will carry the work, by its field or office operations, into every State on the coast of the Atlantic and gulf of Mexico, and this in a regular progress, desirable on the score of due rapidity, usefulness and economy.

Although the law re-organizing the coast survey empowered the Treasury department to use steam-vessels in the hydrography, the

expense of their construction, repairs and working, have been obstacles not easily surmounted—the first being the greatest obstacle of all. I have brought the subject before the Department and Congress in successive reports, and last year estimated for the use of a single vessel, if one could be procured from the Navy or Treasury Department, so as not to throw the burden of construction or repairs upon the coast survey appropriation. The opinions of Lieutenant Commanding George S. Blake, Lieutenant Commanding Charles H. Davis, and Lieutenant Commanding George M. Bache, have been given in my reports of 1845 and 1846, at some length, all of them favorable to the employment of steam-vessels, on the score of accuracy and quantity of work, compared with sailing vessels. The remarks of these intelligent officers, will be found in the appendix to the present report, No. 15. The opinions of other, and no less able officers of the navy, attached to the coast survey, are known to be favorable to the use of steam-vessels, wherever work must be done in the vessel itself. The additional experience acquired by Lieutenant Commanding Davis, on the shoals near Nantucket, this season, confirmed his previous opinion, (appendix No. 16,) and leads to the remarkable conclusion, that fifteen times the amount of work has been done, under similar circumstances, this year, by the use of a steam-vessel, which was done last year, when using sailing vessels exclusively. The cost of the latter work was but four-and-a-half times that of the former, giving an economical result in favor of the use of steam, of between three and four-fold. The Treasury Department has, for some time, been persuaded of the valuable results which might be obtained, could suitable vessels be furnished; and an opportunity has lately offered, in the abandonment of the steam-marine for the revenue service, to furnish vessels for the coast survey, which have already been paid for by the government, and the repairs of which would, annually, have amounted to a sum not less, and from the nature and circumstances of this work, probably greater, than when used in the survey of the coast.

I have arranged the plans for the next fiscal year, and included, in estimating for the hydrography, the probable cost of using steam where it can be employed to advantage.

These estimates may, probably, cover the entire cost, though the experience of this season, with one steam-vessel, is inadequate to furnish data for more than an approximation. It is certainly not more than will be necessary for the service.

The estimates for the field-work are founded on a close control of expenditures, and observation of the actual wants of the parties. In proof that they are made with exactness, I would mention that the aggregate expenditures of the field parties, in the several quarters of 1846–'47, differed but $775 from the estimates exceeding it by that amount. I suppose, and indeed, know, that in every case the parties restrict their expenditures to the very verge of diminishing efficiency.

In conclusion, allow me to repeat my disposition, whenever the circumstances of the country shall be thought to justify or call for

it, to render the resources of the coast survey, in observers, costly instruments, and tried methods, available to the country in the survey of the more distant coast of the Pacific. A very slight enlargement of the present plan, would, with but little additional expense, include the survey of the whole coast of the United States.

Very respectfully submitted, by

ALEX. D. BACHE,
Superintendent of the U. S. Coast Survey.

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

APPENDIX No. 1.

Distribution of the parties of the coast survey upon the coast of the United States, during the surveying season in the different parts of the coast; from November 25, 1846, to November, 1847.

Number of section of survey.	Limits included in several sections.	Number of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
I.	Passamaquoddy Bay to Point Judith, including the coast of Maine, N. Hampshire Massachusetts, and Rhode Island.	1	Primary triangulation; astronomical and magnetic observations.	A. D. Bache, superintendent, and Captain T. J. Lee, U. S. topographical engineers, assistant.	Thompson's, Cape Ann, Massachusetts; Isle of Shoals, near Portsmouth, New Hampshire; Agamenticus, York county, Maine.
		2			
		3	Reconnoissance.....	C. O. Boutelle, assistant..	Southern counties of Maine.
		4	Secondary triangulation..	Captain T. J. Cram, U. S. topographical engineers, assistant.	Cape Cod, Massachusetts, and western shore of Massachusetts bay.
		3	Secondary triangulation..	C. O. Boutelle, assistant..	Completion of triangulation of Boston harbor and its vicinity.
		5	Topography	H. L. Whiting, assistant: S. A. Gilbert, aid.	Topography of western and northern shore of Boston harbor, Nahant peninsula; also southern of harbor in Cohasset.
		6	Topography	B. Gliick, assistant.....	Topography of western and southern shore of Boston harbor and its approaches.
		7	Topography	James S. Williams, assistant.	Topography of islands in Boston harbor, and of Nantasket peninsula.
		8	Topography	Alex. W. Longfellow, assistant.	Topography of Cape Cod, east of Hyannis; southern shore of cape.
		9	Hydrography	Lieut. Com. Charles H. Davis, U. S. N., assistant.	Hydrography of Boston harbor and its approaches; hydrography south and east of Nantucket, vicinity of New South Shoal, and of Great Rip; Hyannis harbor completed by Lieutenant Maffit, U. S. navy.
II.	Point Judith to Cape Henlopen; coast of Connec-	1	Magnetic observations...	R. H. Fauntleroy, assistant.	Point Judith, Stonington, New Haven, Sands's Point, West Farms, Long Island sound.

	ticut, New York, New Jersey, Pennsyvania, & Delaware.	2	Secondary triangulation..	C. M. Eakin, assistant...	Examination of stations formerly occupied by secondary triangulation.
		3	Hydrography	Lieutenant Com. Richard Bache, U. S. navy, assistant.	Verification work off Cape May; placing buoys in Delaware bay and river; verification work in Long Island sound; filling up off-shore work near Block Island and south side of Long Island.
		4	Hydrography	Lieut. Com. J. R Goldsborough, U. S. navy, assistant.	Observations of currents in Long Island sound and Delaware bay; placing buoys in Delaware river; determining positions of new buoys in New London district, &c.
I II & III	.....	.....	Topography	A. A. Humphreys, lieutenant topographical engineers, assistant.	Verification and inspection of topography in sections I., II., & III.
III.	Cape Henlopen to Cape Henry, including the coast of Delaware, Maryland, and Virginia.	1	Primary triangulation and secondary triangulation.	Edmund Blunt, assistant..	Verification work in Delaware and Maryland; continuation of triangulation of Chesapeake, from Kent island base southward, to the mouth of the Potomac river.
		2	Astronomical and magnetic observations.	T. J. Lee, captain topographical engineers, assistant.	Taylor's station, (Annapolis,) Poole's island. Magnetic observations at North Point, Bodkin, and Fort McHenry, for chart of Patapsco; also at Poole's island and Havre de Grace.
		3	Secondary triangulation..	John Farley, assistant ...	Triangulation of coast of Delaware, south of Cape Henlopen, continued southward.
		4	Topography	J. J. S. Hassler, assistant	Sassafras river, (Chesapeake;) western shore of Chesapeake from West river to Patuxent.
		5	Topography	R. D. Cutts, assistant ...	Eastern shore of Chesapeake; Eastern bay; Wye St. Michael's; Choptank.
		6	Topography	Geo. D. Wise, assistant..	South river completed; islands of Chesapeake south of Kent island, eastern shore, near Eastern bay.
		7	Topography	J. Crawford Neilson, assistant.	Topography of shores of Chester river to the bridge.
		8	Hydrography	Lieut. Com. W. P. McArthur, U. S. navy, assistant.	Entrance to Chester river completed; Eastern bay; St. Michael's Wye, and Chesapeake bay, nearly to mouth of Patuxent.
III & IV	.....	.....	Hydrography	Lieut. Com. S. P. Lee, U. S. navy, assistant.	Off-shore work south of Cape Henlopen; section of the gulf stream southeast from Cape Henry.
IV.	Cape Henry to Cape Fear; coast of part of Virginia and North Carolina.	1	Main and secondary triangulation.	W. M. Boyce, assistant..	Main and secondary triangulation of Albemarle sound, North Carolina.
		2	Astronomical and magnetic observations.	C. O. Boutelle, assistant..	Two stations occupied for determinations of latitude and azimuth—Shell Bank, near Nag's Head, and Stevenson's Point, Albemarle sound.
		3	Tertiary triangulation....	J. Crawford Neilson, assistant.	Rivers emptying into Albemarle sound; Pasquotank, Perquimons, Little river.

APPENDIX No. 1—Continued.

Number of section of survey.	Limits included in several sections.	Number of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
IV.	Cape Henry to Cape Fear; coast of part of Virginia and North Carolina—Continued.	3	Topography	J. Crawford Neilson, assistant.	Topography of shore of Pasquotank completed; rivers emptying into Albemarle sound.
		4	Topography	J. J. S. Hassler, assistant	Under instructions to commence topography of south shore of Albemarle sound.
		5	Hydrography	Lieut. Com. W. P. McArthur, U. S. navy, assistant.	Under instructions to commence hydrography of Albemarle sound and Pasquotank river.
V.	Cape Fear to the St. Mary's river; coast of South Carolina and Georgia.	1	Reconnoissance for main and secondary triangulation.	James S. Williams, assistant.	General reconnoissance completed from the Ogeechee to the St. Mary's; under instructions to commence minute reconnoissance.
VIII.	Mobile Point to Vermillion bay; coast of Alabama, Mississippi, and part of Louisiana.	1	Measurement of base	A. D. Bache, superintendent, and F. H. Gerdes, assistant.	Base on Dauphin island, at entrance to Mobile bay, measured.
		2	Primary triangulation and second'y connected with it.	F. H. Gerdes, assistant	Continuation of triangulation of Mississippi sound.
		3	Astronomical and magnetic observations.	R. H. Fauntleroy, assistant.	Two stations occupied—Fort Morgan, at entrance of Mobile bay, and Pascagoula, Mississippi.
		4	Secondary triangulation	Julius E. Hilgard, assistant.	Secondary triangulation extended westward to include Cat island and the adjacent shores.
		5	Topography	W. E. Greenwell	Entrance to Mobile bay; Petit Bois; Horn island; Cat island.
		6	Hydrography	Lieut. Com. C. P. Patterson, U. S. navy, assistant.	Mississippi sound, north of Dauphin island; entrance to Mobile bay; reconnoissance of Cat island harbor; tides, &c.
IX.	Vermillion bay to the boundary; part of Louisiana and Texas.	1	Reconnoissance for main triangulation.	C. M. Eakin, assistant	From Galveston bay southward.

APPENDIX, No. 2.

Letter from presidents of insurance companies in New York city, dated December 28, 1846, relating to the discovery of the New South Shoal off Nantucket.

DEAR SIR: We beg to return our thanks for your attention in sending us the charts of the New South Shoal off Nantucket, lately discovered by the coast survey.

The discovery of this shoal, lying so directly in the track of our vessels trading between this city and Europe is a most valuable aid to the security of our commerce and navigation.

The coast survey has already rendered essential services to the best interests of humanity, as well as of our country, and our best wishes are tendered for the success of its future labors and the welfare of those who have the charge of this important service.

JAS. D. OGDEN,
Pres. Atlantic Mar. Ins. Co.
WALTER R. JONES,
Pres. Atlantic Mutual Ins. Co.
N. G. RUTGERS,
Pres. General Mutual Ins. Co.
B. W. EWES,
Pres. New York Ins. Co.
A. B. NEILSON,
Pres. Sun Mutual Ins. Co.
THE MERCANTILE MUTUAL INS. CO.,
By JOSEPH WALKER, *Pres.*
THE PELICAN MUTUAL INS. CO.,
By J. HARRISON, *Vice Pres.*
THE MUTUAL SAFETY INS. CO.,
By ZEB. COOK, *Pres.*

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

APPENDIX, No. 3.

Relative bearings and distances of Old and New South Shoals; of ridge, discovered in 1847; of shoal discovered in 1847, in channel east of Bass Rip, and north of Bass Rip, &c.

NOTICE TO MARINERS.

The following discoveries have recently been made in the vicinity of the Nantucket Shoals by the hydrographical party of the coast survey employed in that section, under the command of Lieutenant Commandant Charles H. Davis, United States navy.

1. A dangerous ridge near the New South Shoal, lying in a

NNE. and SSW. direction, having on it four, five, and six fathoms, and deepening very rapidly outside to twenty and twenty-five fathoms, and inside to thirteen fathoms, on which the sea breaks in bad weather.

The following bearings are taken from the centre of this ridge:

Centre of New South Shoal S. 70° W., (true,) or W. by S., (magnetic,) distance four miles.

The middle of the Old South Shoal N. 17° W., (true,) or N. ¾ W., (magnetic,) distance six miles.

2. A shoal spot with sixteen feet of water on it, in the channel, way to the eastward of Bass Rip, from which Sankaty Head bears N. 34½° W., (true,) or NNW. ¾ W., (magnetic,) distance 4½ miles, and Great Point light N. 49½° W., (true,) or NW. ¼ N., (magnetic,) distance 10¾ miles.

3. A shoal, having 14 feet of water on it, to the southward and eastward of Great Point light, and north of Bass Rip, from which Sankaty Head bears S. 20½° W., (true,) or SSW. ½ W., (magnetic,) distance 4½ miles, and Great Point light N. 66½° W., (true,) or NW. by W. ¼ W., (magnetic,) distance 5¾ miles.

The above shoals were found where deep water has hitherto been supposed to exist. A sketch similar to the one issued from the office of the coast survey, to show the position of the New South Shoal, will be prepared and published as soon as possible.

The true bearings are given in this notice, to enable the navigator to transfer the places conveniently to his own chart.

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

APPENDIX, No. 4.

Extract from a report by Lieutenant Commandant J. R. Goldsborough, United States navy, assistant in the Coast Survey, containing a list of buoys, beacons, and spindles in the district of New London, from Branford Reef to Montauk.

Directions for sailing in Long Island and Fisher's Island sounds by the buoys, which are numbered, commencing at Branford harbor and going east to Montauk:

Vessels standing to the northward, keep to the westward of red buoys.

Vessels standing to the westward, keep to the northward of red buoys.

Vessels standing to the southward, keep to the eastward of black buoys.

Vessels standing to the eastward, keep to the southward of black buoys.

Sail either side of red and black striped; black and white perpendicular stripes mark a channel; buoys in best water.

APPENDIX No. 4—Continued.

No. of buoy.	Where situated.	Color of buoys.
1	Reef in Branford harbor	Red.
2	Brown's reef	Black.
3	Negro Head, north of Branford beacon	Black.
4	Wheaton's reef, near Thimble island	Black.
5	Brown's ledge	Red.
6	North end of Falkner's island	Red.
7	Charles's reef, off Madison	Black.
8	Middle reef, off Madison	Black.
9	Eastern reef, off Madison	Black.
10	Killingworth point	Black.
11	West side Killingworth harbor	Black.
12	East side Killingworth harbor	Red.
13	Stony island reef, off Killingworth	Black.
14	Crane's reef	Black.
15	Hen and Chickens	Black.
16	Off Cornfield point	Black.
17	West end sand shoals, south of Cornfield point, (broken.)	Cross striped—red and black.
18	East end sand shoals, south of Cornfield point.	Cross striped—red and black.
19	Saybrook bar	Black.
20	Griswold's rock	Black.
21	Hatchett's reef, in shore	Red.
22	Hatchett's reef, off shore	Black.
23	Black buoys, west of Black point	Black.
24	Pond reef	Black.
25	White rock	Black.
26	Two Tree island	Red.
27	North end of Bartlett's reef	Red.
28	Great Goshen reef	Black.
29	Little Goshen reef	Black.
30	Cormorant reef, SSW. of New London light-house.	Black.
31	Mercer's rock	Cross striped—red and black.
32	Southwest ledge	Red.
33	Black ledge	Black.
34	Can buoy, black ledge	Black.
35	Melton's ledge, New London harbor	Black.
36	Horseshoe reef, Fisher's Island sound	Black.
37	Long point	Black.
38	First buoy east of Long point	Red.
39	Second buoy northeast of Long point	Red.

APPENDIX No. 4—Continued.

No. of buoy.	Where situated.	Color of buoys.
40	Off Mouse island, south and west of Mystic light-house.	Red.
41	South and east of Mystic light-house	Red.
42	Ram island channel, east of Mystic light-house.	Red.
43	Northeast end of Ram island.....	Red.
44	Off Gates island, west of Whale Rock	Red.
45	North of Whale rock	Red.
46	Northwest point of Eel Grass ground.....	Red.
47	Ellis's reef, south of Ram Island spindle.	Black.
48	Young's rock, north of East End house, Fisher's island.	Red.
49	Wicopissett channel	Cross striped—red and black.
50	East of Latimer's reef.....	Black.
51	North Hill reef.....	Red.
52	Race point.....	Black.
53	Race rock	Black.
54	Little Gull island.....	Red.
55	Shagawannock reef	Red.

Beacons.

Where situated.

f.
:ticut river.

Spindles.

Lord's channel.
Latimer's reef.
On Whale rock.
East of Morgan's Point light-house.
South of Morgan's Point light-house.
Ellis's reef, south of Ram island.
On Sunflower reef.

APPENDIX No. 5.

Extract from a report by the late Lieutenant George M. Bache, U. S. Navy, to the Hon. Levi Woodbury, Secretary of the Treasury, dated November 22, 1838. (Doc. No. 24, House of Representatives, 25th Congress, 3d session.)

Some systematic mode of designating the positions of buoys would be of great utility, more especially, should an increase of their number be authorized. Such distinctions as will show on which hand a buoy is to be passed, whether it be on a rock, a detached shoal, or at the end of a spit, will assist even those who may be familiar with the navigation, and are particularly serviceable in narrow and tortuous channels.

To produce the best results from this, simplicity must be preserved, and, at the same time, a sufficient number of distinctions introduced. I would beg leave to suggest the distinction of colors, as being the most applicable, and refer to the accompanying chart, which displays the simple combinations of color deemed most advisable. On sailing up a sound, bay, or channel, or entering a harbor, all the buoys on spits extending from the shore, which are to be left on the right hand, are painted red; all those on the left hand, are painted black. Those on rocks, or very small shoals, around which are channels, are painted with alternate red and black rings; these, as their color would indicate, can be passed on either hand.

On the shoals, which are included between two buoys, the lower and right hand buoys are painted with alternate red and white rings; while the upper buoys and those to be passed on the left hand, are black and white. The red and black colors also indicate on which hand they should be left; the white being introduced merely to designate a detached shoal. This system is applicable to all the waters of the United States; the colors red and black have been selected on account of their showing best upon the water, and as all buoys are now painted, there can be no objection to it on the score of economy.

APPENDIX No. 6.

List of buoys placed in Delaware bay, by Lieutenant Com. Richard Bache, U. S. N., assistant in the coast survey; sailing directions.

NOTICE TO MARINERS.

The following spar buoys have been placed at the entrance of Delaware bay, under authority of the Fifth Auditor, and by direction of the superintendent of the U. S. coast survey, by Lieut. Com. R. Bache, U. S. navy, assistant in the coast survey.

No. 1 is painted red.

It marks the point of shoal (Prissy Vicks) off Cape May light-house. It stands in 18 feet water, bottom coarse gray sand and gravel; the shoal to NE. has 10 feet on it.

No. 2 is painted red.

Has letters B W, in black, on a square white board; it marks the southern end of the round or ENE. shoal. It stands in 18 feet water; bottom, fine gray sand, blue mud. The ENE. or round shoal has 3 feet water on it, and the shoal to S. and E. of the buoy has 7 feet; the channel way is close to the buoy.

No 3.—Cross-striped red and black.

It marks the SE. spit of Mummy shoal, and stands in 17 feet water; bottom, fine gray sand with black specks. The Mummy shoal has 6 feet water on it.

Blunt's channel is to westward of this buoy, (not yet buoyed out,) and Ricard's channel to the N. and E.

No. 4.—Cross-striped red and black.

With one fluke of anchor on top of buoy. It marks the southern spit of Crow shoal, and stands in 15 feet water; bottom, coarse gray sand and gravel. Crow shoal has 7 feet water on it. The Ricard channel is to the westward, and the ordinary Coasters' channel to the eastward of this buoy.

No. 5.—Perpendicular white and black stripes.

It marks the centre of Ricards' channel, and stands in 18 feet water; bottom, blue mud. Crow shoal to the eastward and Mummy shoal to the westward.

No. 6.—Perpendicular white and black stripes.

It marks the western entrance to Ricards' channel; stands in 19 feet water; bottom, fine gray sand and blue mud.

General Directions.

Vessels entering, keep to port of red buoys, starboard of black. Either side of red and black striped. Black and white perpendicular stripes mark a channel buoy.

Compass bearings of buoys from Cape May light.

No. 1.—SSW. $\frac{1}{4}$ W.
No. 2.—SW. by W.
No. 3.—WSW.
No. 4.—W. by N. little northerly.
No. 5.—NW. by W. $\frac{1}{2}$ W.
No. 6.—NW. by W. $\frac{1}{4}$ W.

Compass bearings of buoys from buoy No 1.

No. 2.—WSW. ¼ W.
No. 3.—W. ¼ N.
No. 4.—NW. ¾ W.
No. 5.—NW. little northerly.
No. 6.—NW.

The following sailing directions for entering Delaware bay are given by Lieut. Com. R. Bache, in connexion with these buoys:

Ricards' channel.—Vessels drawing 15 feet water can pass through this channel at ordinary low water, smooth sea.

Blunt's channel.—Not yet buoyed.

Through channel to breakwater.—Vessels drawing 16 feet water can pass through this channel at ordinary low water, smooth sea.

The rise of the tide may be estimated at 5 feet. Strong tides running, an allowance of two points must be made on the course steered, crossing the direction of the tides.

The lead is a guide. The shoals, although pretty steep, can be avoided by constant and true soundings.

When off the boarding houses on Cape Island, in the Coasters' or Cape May channel, buoy No. 1 will be seen bearing W. by N. ½ N., per compass; steer for it, leaving it close on board on starboard hand in passing. When up with No. 1, buoys Nos. 2, 3, 4, 5, and 6, in clear weather, will be in sight.

To pass through the "Through channel to breakwater."—This channel is narrow. On the SE. is a shoal with 7 feet water upon it, and the round or ENE. shoal is to the northward, and has 4 feet water on it, and the breakers show plainly in any breeze. When abreast of No. 1, stand W. ¾ N. towards buoy No. 3, keeping it open on the port bow a point, and gradually hauling up for it. When up with No. 3, leave it on the starboard hand, and steer SW. by S. for No. 2, which leave close on board on starboard hand, and continue on SW. by S. for breakwater.

To pass through Ricards' channel.—This channel lays between Crow and Mummy shoals; the Crow shoal having on it 7 feet water, and the Mummy shoal 6 feet water. After passing buoy No. 4, it is a good beating channel.

From buoy No. 1, steer NW. ¾ W. for No. 4, which leaves 1 on the starboard hand at a short distance, and steer NNW. westerly for No. 5, which pass on either hand, and haul up NW. ½ W. westerly for No. 6, which pass on either hand, and shape your course W. ¼ N., which brings you between the buoy of the Brown and light boat on the Brandywine shoal, in the main ship channel.

Note.—All soundings are given at low water.

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

APPENDIX No. 7.

Extract from a letter of Thomas Mussey, esq., collector of the port of New London, to Lieut. Com. John R. Goldsborough, United States Navy, assistant in the coast survey, relating to the coloring of buoys.

CUSTOM-HOUSE, NEW LONDON,
June 21, 1847.

DEAR SIR: Having more fully considered Mr. Bache's mode of painting and setting buoys, and the simplicity of the system to be adopted, which, when well understood, and extended along the coast, must render navigation in our waters almost as safe as the travel on a turnpike road; and feeling, as I do, a deep interest in rendering coast navigation safe and easy, I should be happy to avail myself of your aid in locating a large number of buoys I am preparing for Long Island and Fisher's Island sounds.

U. S. SURVEYING SCHOONER "WAVE,"
New Haven, June 24, 1847.

SIR: Your letter of the 21st instant, requesting my aid and assistance in establishing the position of buoys to be placed in Long and Fisher's Island sounds, and of a light-house to be erected on the North Dumpling, has been received.

I shall, without delay, communicate its contents to the superintendent of the coast survey, who, I feel assured, will cheerfully direct the aid and assistance asked for, should the means placed at his disposal permit him to do so, without too great a sacrifice of the interests of the coast survey.

Very respectfully, your obedient servant,

J. R. GOLDSBOROUGH,
Lieut. Com. U. S. Navy, Assistant Coast Survey.

APPENDIX No. 8.

List of buoys in Delaware bay and river, placed by the coast survey schooner Nautilus, Lieut. Com. Bache, United States Navy, and coast survey schooner Wave, Lieut. Com. J. R. Goldsborough, United States Navy, assistants coast survey.—Sketch B bis.

NOTICE TO MARINERS.

The following buoys have been recently placed in Delaware bay by the United States surveying schooners Nautilus and Wave:

No.	Where situated.	Shape.	Color of buoys.
1	Entrance to Coasters' channel.	Spar	Red.
2	Through channel to breakwater.	Spar	Red—cross arm of wood 14 inches long; ⅛ inch thick. Letters, B. W.
3	Mummy shoal spit.....	Spar	Cross stripes—red and black.
4	Crow shoal spit	Spar	Cross stripes—red and black. One fluke of an anchor fast to head of buoy.
5	Blunt's channel	Spar	Perpendicular stripes—white and black.
6	Ricard's channel.....	Spar	Perpendicular stripes—white and black.
7	Tail of Shears.....	Can	Black; copper vane 12 inches wide. Letters, T. S.
8	South spit of Flogger.....	Spar	Cross stripes—red and black.
9	Miah Maull shoal.....	Can	Red.
10	Blake's channel, west side.	Spar	Black.
11	Blake's channel, west side.	Spar	Black.
12	Blake's channel, Flogger..	Spar	Red.
13	Off Simons's creek, (Dona river.)	Spar	Black.
14	Upper spit, Flogger	Spar	Red.
15	Ship John Shoal.....	Can	Red.
16	Off Goose island, bulk head	Spar	Black.
17	Upper spit bulk head.....	Spar	Black.
18	Cherry island flats.....	Spar	Cross stripes—red and black.
19	South spit, Marcus Hook bar	Spar	Red.
20	South spit, Windmill island	Spar	Red.
21	Off Richmond	Spar	Black.

Sailing directions.

Vessels entering, keep to larboard of red buoys; to starboard of black; either side of cross striped, red, and black. Black and white perpendicular stripes mark a channel buoy in best water.

By direction of the superintendent of the United States coast survey.

APPENDIX No. 9.

Letter from Commodore M. C. Perry, commanding the United States squadron, in the Gulf of Mexico, to Lieutenant Commanding S. P. Lee, U. S. N.

U. S. FLAG SHIP MISSISSIPPI,
Anton Lizardo, July 4, 1847.

SIR: You will proceed with all practicable despatch to Mobile bay, or some point in the neighborhood, convenient to the southern mail route, and there land Lieutenant C. R. P. Rogers, bearer of despatches for Washington, giving him all the facilities in your power.

After executing this order, you will resume your duties upon the coast survey, in conformity with your instructions.

In detaching you from the Gulf squadron, I cannot but regret the loss of the services of your beautiful and efficient vessel, and I embrace this occasion of tendering to you, and to your officers and men, my thanks for the promptitude, zeal, and courage with which you have executed my orders.

I am, sir, with great respect, your most obedient servant,

M. C. PERRY,
Commanding Home Squadron.

Lieut. Com. S. P. LEE,
U. S. Brig Washington.

GENERAL ORDER No. 9.

U. S. FLAG SHIP GERMANTOWN,
Anton Lizardo, August 18, 1847.

The commander-in-chief has great satisfaction in communicating to the officers, seamen, and marines under his command, the enclosed extract of a despatch from the honorable Secretary of the Navy, bearing date the 23d ultimo.

M. C. PERRY,
Commanding Home Squadron.

To Lieut. Com. S. P. LEE, U. S. N.,
Commanding U. S. Brig Washington,
Coast Survey, Washington City, D. C.

Extract of a despatch from the honorable Secretary of the Navy, addressed to Commodore Perry, bearing date the 23d of July, 1817.

"I have read with the liveliest satisfaction your report of the conduct of the officers and men under your command in your operations against Tobasco. Success has signally crowned your enterprizes, and while great credit is due to those who served under your flag, the department is not insensible to your own highly meritorious share of the commendation which is justly due.

"You have displayed skill, valor, and energy; have disregarded personal privations and exposure, and done all which your country had a right to expect from you."

APPENDIX No. 10.

Letter from Lieutenant John Hall, United States Navy, First Lieutenant of the United States Coast Survey, Brig Washington, in the autumn of 1846, *relating to part of the disastrous circumstances of that season.*

BROOKLYN, NEW YORK, *March* 8, 1847.

DEAR SIR: Yours of the 5th instant is received. In the statement which you desire, I will confine myself to *about* the time of the decks of the Washington being swept by the sea which threw her on her beam-ends.

Having remained on deck until about 1, a. m. of the 8th, I turned in, and had not been asleep, when I heard it reported, from forward, that the jib-boom was gone. I jumped on deck, in my shirt sleeves, and commenced clearing away and securing the wreck.

The captain, seeing me exposed to the weather, sent a servant to me with my coat and a message; he being fearful that the wreck of the jib-boom might go through her bows.

I sent him word that it was safe; I had hardly done so, when the starbord waist-boat was torn partly from the davits, the order was given to cut her away. I jumped aft, and ordered the pendant tackles hooked on; the captain heard the order, and said, Hall, can you save her? I replied, I think I can, sir. I had the main pendant tackle hooked, when another sea tore her bows from the davits, and broke her nearly in two. I reported this to the captain, with "Shall I cut?" "Yes!" and in a minute she was clear of us; about this time the main yard carried away in the lee quarter, just over our heads. Captain wanted main trysail bent; had a new one below, which had never been bent; got it up. Captain, pilot, and myself on the trunk, attending to bending and setting it, when bent and reefed, hoisted it up, but had hardly presented its surface to the wind, when the gaff carried away, and the sail blew to pieces. Having now no after sail to keep her by the wind, and being on a lee-shore, captain ordered lee guns thrown

overboard. Threw them over, came aft, touched my cap, and reported.

About this time I had a conversation with the captain, when he determined to cut away the main mast; after it had fallen, put the helm up, clear the wreck, when before the wind throw overboard larboard guns, have anchors ready for letting go, (which I went forward to attend to,) put the helm down, check and bring her head to wind, with the stream anchor, (Porter's patent,) and let go starboard anchor, expecting both anchors to drag, but satisfied if the chains did not part; hurricane at its height, barometer on the rise; with foremast, got larboard anchor up from the main hatch, shackle chain, all ready, let go, as she drags, veer out on chain; is there a hope of the anchors not parting their chains, but only dragging. Yes, cut away the foremast she is only dragging *along*, and on shore, hurricane likely to blow itself out before we reach the breakers. If, however, the starboard chain parts, up helm, with the foremast get her before the wind, (a smooth beach,) if *possible*, drop foresail, but, at all events, the foremast will steer her, and drive her well up with the first breaker, go over her bows, and with it its mass of wreck, with all her kentledge, she must bilge, and the wreck forward may be the salvation of a few.

I have, as you will perceive, condensed the statement as much as possible. Should any part of it not be understood, I will be pleased to explain it.

Respectfully and truly yours,

JOHN HALL, *U. S. Navy.*

A. D. BACHE, Esq.,
Superintendent U. S. Coast Survey,
Washington City, D. C.

APPENDIX No. 11.

Table showing temperatures at depths below 700 fathoms, taken by Lieut. Com.'s C. H. Davis in 1845, George M. Bache in 1846, and S. P. Lee in 1847.

Depth.	Latitude.	Longitude.	Temperature.	Where taken.	Observers.	Date.	Remarks.	Temperature at surface.
Fathoms.	*Deg. min.*	*Deg. min.*						*Fahr.*
1,000	39 28	69 01¼	40	Nearer coast than gulf stream..	C. H. Davis.....	1845	.....	65
1,500	38 00	69 33	37	Edge of gulf stream nearest to coast.	Geo. M. Bache...	1846	From this, by curve, the temperature, at 1,000 f'ms, is 38°.	77
2,160	34 13	68 05	40	Far beyond axis of gulf stream .	Do ...	1846	From this, by curve, the temperature, at 1,000 f'ms. is 44½°.	81¼
700	34 31	71 45	44	Beyond gulf stream	Do ...	1846	.....	81
750	35 26	73 12	42½	In gulf stream.....	S. P. Lee	1847	.....	82
1,000	35 26	73 12	37	In gulf stream.....	Do	1847		
1,000	30 10	68 09	48	Very far beyond gulf stream ...	Do	1847	.....	81

APPENDIX No. 12.

Notice of the finding of a bottle thrown from the brig Washington, to indicate the direction of ocean current.

CURRENTS OF THE OCEAN.

A bottle was picked up on the 27th June last, on the coast of Kerry, Ireland, containing the following memorandum: M. Spotswood, M. R. C., Coast survey, U. S. brig Washington, July 31, 1846, latitude 37 degrees 39 minutes north; longitude 69 degrees west. G. M. Bache, lieutenant commanding gulf stream.—*N. Y. Herald ship news, August* 23, 1847.

APPENDIX No. 13.

Extract from letters from assistant C. O. Boutelle to the superintendent, dated January 10, *and February* 9, 1847, *relating to the new inlets formed across Bodie's island in* 1846.

The southern, and principal inlet, begins at about seven miles and one-eighth from the south end of the base. Its width, between high water marks, measured on the line, is 202 yards; between low water marks, 107 yards; deepest water on line, December 31, 1846, 6.5 feet below low water mark. The northern one begins at about seven miles and a half; its width on the line, between high water marks, is 162 yards; between low water marks, 36 yards; deepest water, 2.1 feet. These inlets were formed in the gale of September 8th, when the water from the sound overflowed the whole beach. A breach in the marsh had been made in the March gale, and a creek was formed across our line, extending nearly to the sea beach.

On the morning of the September gale, the sound waters were all piled up to the southwest, from the effects of the heavy northeast blow of the previous days. The weather was clear, nearly calm, until about 11 a. m., when a sudden squall came from the southwest, and the waters came upon the beach with such fury that Mr. Midgett, within three quarters of a mile of his house when the storm began, was unable to reach it until four in the afternoon. He sat upon his horse, on a small sand knoll, for five hours, and witnessed the destruction of his property, and (as he then supposed) of his family also, without the power to move a foot to their rescue, and, for two hours, expecting every moment to be swept to sea himself.

The force of the water coming in so suddenly, and having a head of two to three feet, broke through the small portion of sea beach which had formed since the March gale, and created the inlets. They were insignificant at first—not more than 20 feet wide—and the northern one much the deepest and widest. In the

westerly winds which prevailed in September, the current from the sound gradually widened them; and, in the October gale, they became about as wide as they are now. The northern one has since been gradually filling, and is now a mere hole at low water. West of the line the men waded across it in chaining; and at the bar our boat would not float over with the men in her. During the time I remained at Bodie's island, it filled sensibly.

In the March gale, the *ocean* broke through the sea beach, and inundated many of the lower parts of the island—such as the sand flats, &c.; but in the September gales it was the sound alone that overflowed the whole island, leaving only the tops of the highest sand knolls bare. Comparing the elevations of certain places, which Mr. Midgett pointed out as just above water, with the known heights of points on the base near them, I came to the conclusion that the water rose to the mean height of 5.5 feet above the lower sand flat. The waves ran very high, and broke over the top of a post seven feet above the flat.

APPENDIX No. 14.

Correspondence of the citizens of Mobile with the superintendent of the coast survey, in regard to the survey of Mobile bay.

MOBILE, *July* 23, 1847.

SIR: The undersigned, on behalf of the citizens of Mobile, request you (if, in your judgment, it should not be inconsistent with the ends you have in view, connected with the coast survey,) to direct a general hydrographic observation of the river and bay of Mobile, with a view to the improvement of the channels leading from Mobile to the lower harbor, and, as a consequence, the commercial advancement of this city. Your recent personal knowledge of the position of Mobile, as a point of great importance on the gulf of Mexico, both as to local and national concern, will, we trust, induce a favorable consideration of our wishes.

It is known to you that there is now in progress a reconnoissance of the route of a railroad to connect the gulf of Mexico with the western waters; that Mobile is fixed upon as the southern terminus, and that the mouth of the Ohio river will probably be selected as the western. In the completion of this road, the citizens of Mobile are, of course, deeply interested; and being convinced that the success of this project is to be equally beneficial to the country at large, as to themselves, they present it to your judgment as a leading motive for your compliance with the request expressed in this letter.

In connexion with this plan, we beg leave to call your attention also to another subject, which, while a matter of great local interest to us, is also of no less moment to the government, and those who look to it for aid in great national objects; we allude to the

selection of a suitable stopping place on the gulf of Mexico for the European steamers.

We are of the opinion that Mobile possesses every requisite to justify a recommendation of it for this purpose. The depth of water at Mobile, you are aware, is abundant, which is not the fact (as far as we know) at any other place, on the gulf, thought of as a depot for those vessels. We have an ample supply of bituminous coals of the finest quality on our interior rivers, and nearer to the gulf than at any other point in the United States. We have good water, easily obtained from the city water-works and the rivers emptying into the bay, an excellent market for vegetable and animal food of all kinds, and, at Fort Morgan, all the conveniences of wharf and harbor already afforded.

You will excuse, we trust, our dwelling with some earnestness on those topics, which, in our opinion, indicate Mobile as well entitled to the favor of government and its officers; and we are satisfied that an observation of our bay and harbor, such as we ask for, must contribute greatly to bring the natural advantages of our city properly before Congress. Let it be remembered that we are distant from the junction of the Ohio and Mississippi rivers only four hundred and forty miles, from Nashville four hundred miles, and from the city of St. Louis five hundred and ninety miles; for several miles inward from the gulf, that our harbor is equal, if not superior, to any other which has heretofore attracted attention; that we are in an unusual degree exempt from tropical diseases; that vessels can be loaded and sent to sea from Mobile bay at a less expense, and carrying more water than from New Orleans; that Mobile in her exports of cotton is the *second*, and in the value of her exported products the *third* city of the Union; and that the success of our railroad, as a mail and military measure alone, would justify any degree of aid from the General Government; and we trust you will not consider us unreasonable in urging the object of this communication.

The improvement of our channels, from the upper to the lower bay, will not be expensive; and the effect will be to advance our commerce, increase our population, and give a new, healthful, and convenient naval station on the gulf.

The interest you manifested in the subject, to which we have alluded, when we had the pleasure of seeing you here, must excuse our confidence in your readiness to join us in such efforts for our own and the general improvement, as we have endeavored to show you are within our reach.

With great respect, your obedient servants,

To Professor A. D. Bache,
Superintendent of the United States Coast Survey.

COAST SURVEY STATION,
Gloucester, Massachusetts, August 10, 1847.

GENTLEMEN: I have the honor to acknowledge the receipt of your letter on behalf of the citizens of Mobile, in which you request that a general hydrographic reconnoissance may be made of Mobile bay in connexion with the survey of the coast, if not inconsistent with the general progress of the work, and appeal to the recent personal examination made by me of the portion of the coast in your vicinity to sustain your views of the natural as well as local importance of such a work. You dwell with a becoming pride upon the resources of the country of which Mobile is, or may easily be made, the outlet; upon the facilities for navigation afforded by your noble bay, and upon your plans for extending the means of communication with it, and the advantages of your city as a commercial port.

You are no doubt right in supposing that all the advantages which Mobile bay affords, can be presented best to view by a sufficiently minute representation upon a chart, of the entrance, the lower and upper bays, and the shores; and that such a representation would be a strong inducement to exertion to render better that which, naturally, was so good, and required so little from art.

It is the object of the coast survey to furnish such a representation sufficiently minute for all purposes of commerce and navigation. The more detailed examinations necessary for the immediate sites for defence, or of localities for artificial improvement, do not form a part of the design of the work.

Such a chart as you thus desire, it will be my earnest endeavor to furnish at as early a day as practicable. The land-work at the entrance to the bay is already nearly completed; the soundings have been in great part made; and observations of the tides have been carried on in connexion with the work for nearly two years. Had the last winter been favorable for our work, we should have been able to present to you a complete chart of the entrance to the bay; and such an one must be completed early in the coming surveying season. The base line was measured by me personally, aided by Assistant F. H. Gerdes; the trigonometrical operations have been executed by Assistant Gerdes, or, under his immediate direction, by Assistant Hilgard; the astronomical and magnetical determinations have been made by Assistant Fauntleroy; and the hydrographic work by the party of Lieutenant Commandant C. P. Patterson, United States navy, assistant in the coast survey. Their operations will be continued from season to season, so as to furnish as soon as practicable a chart of the coast from Mobile to New Orleans.

In compliance with the spirit of your letter, I propose, as soon as a party is disposable for the purpose, say as early as October, to commence the triangulation of Mobile bay from the present work, at the entrance, up to the city; and, as soon as points can be furnished by the triangulation party, to have the necessary soundings

and observations of currents made, and the topographical survey of the shores of the bay executed.

You are aware that time is required to obtain reliable results from such a work, and I expect your favorable consideration of the efforts already made and making, even though the completion of the work should not keep pace with your desires or with mine. The extent of our work is great, and the means furnished limited, requiring careful consideration of the best times and seasons for working in different parts of the coast, in order to obtain the largest return for expenditures and a due regard to the pressing wants of navigation in different parts of the Union.

In order to anticipate somewhat the results which the regular operations would furnish, and thus *explicitly* to meet your wishes, I will direct the officer in charge of the hydrographic party in your section to make, on his return to you, a reconnoissance of such parts of the bay as may be most important as indicating, from comparisons with former and future surveys, the changes which are going on, and which should be carefully examined from time to time. The results of this examination will be furnished whenever and wherever deemed useful.

I have reasons to believe that facts which will interest you have already been developed by the work at the entrance to Mobile bay; but, as they have not yet reached me in an official form, I postpone, for the present, specific notice of them.

I cannot close this reply to your communication without expressing the strong personal interest which I feel in the progress of the coast survey in your section—an interest which was awakened by considerations of the importance of the gulf coast, and our very inadequate knowledge concerning it has been greatly enhanced by all the circumstances of my recent visit and examination, including among them the active interest manifested by the citizens themselves in the present and future progress of the survey, of which your letter is one of the exponents.

Very respectfully, yours,

A. D. BACHE,

Superintendent United States Coast Survey.

APPENDIX No. 15.

Sailing directions for Mobile bay, by Lieutenant Commanding C. P. Patterson.

NOTICE TO MARINERS.

The recent survey of the entrance to Mobile bay, by Lieutenant Commanding C. P. Patterson, U. S. N., assistant in the coast survey, shows that the best water in crossing the bar is now to be found by bringing Sand island light-house, to bear north 19 degrees west, (true,) north 26 degrees west, (by compass,) about a ship's length to the westward of the east end of Dauphin Island woods,

and running for it. This course carries 20¾ feet over the bar at mean low water. The bar deepens gradually on the inside, and rapidly to eight fathoms on the side towards the sea.

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

APPENDIX No. 16.

Letter of Superintendent of Coast Survey in behalf of himself, of Assistant Gerdes, and others, of their parties, to Lieutenant Commanding C. P. Patterson, in relation to the decease of Passed Midshipman and Acting Master Allison, U. S. N., of the surveying schooner Phœnix. Resolutions passed by the officers in relation to the same, transmitted by the Superintendent to the honorable the Secretary of the Navy.

CAMP AT EAST END OF BASE DAUPHIN ISLAND,
May 10, 1847.

SIR: On behalf of the assistants and other officers of the parties employed in this section of the survey of the coast of the United States, I beg leave to convey to you, and to the officers of the hydrographic party under your charge, the unfeigned expression of deep regret at the melancholy loss which the navy and the coast survey has sustained by the decease of Passed Midshipman Allison. Those gentlemen who have for the past year been his associates in the work, feel peculiarly the loss of this excellent and amiable officer, and all mourn the sufferings and death which have resulted from exposure in the faithful discharge of his duty by this excellent officer.

Please to convey these expressions of condolence to your officers, and accept them from me, personally, as from the other members of the coast survey parties here.

Yours, very respectfully,
A. D. BACHE,
Superintendent U. S. Coast Survey.

Lieut. Com. C. P. PATTERSON, *U. S. N.*,
Assistant Coast Survey.

At a meeting of the officers of the United States coast survey schooner *Phœnix*, held May 6, Lieutenant Commanding C. P. PATTERSON was called to the chair, when the following preamble and resolutions were unanimously adopted:

Whereas it has pleased Almighty God, in his infinite and inscrutable wisdom, to take from amongst us, in the midst of health and happiness, our esteemed and loved messmate, Acting Master RICHARD ALLISON: Therefore—

Resolved, That, in the death of Mr. ALLISON, the country has been deprived of the services of an honorable, high-minded, and

meritorious officer, and his family and friends of one whose many noble points of character endeared him to their hearts.

Resolved, That, in testimony of our esteem for his memory, we will wear the usual badge of mourning for thirty days.

Resolved, That the chairman write a letter of condolence to his family, and that a copy of these resolutions be forwarded therewith.

C. P. PATTERSON, *Chairman*.

U. S. C. S. Schooner Phœnix,
Pascagoula, May 6, 1847.

APPENDIX No. 17.

Extracts from former reports of Lieutenant Commanding George S. Blake, U. S. N.; Lieutenant Commanding Charles H. Davis, U. S. N., and Lieutenant Commanding George M. Bache, U. S. N.; assistants in the coast survey, in regard to the use of steam vessels in sounding.

1. Extract from a report by Lieutenant Commanding George S. Blake, U. S. navy, assistant in the coast survey, to the superintendent: (Report of superintendent for 1845.)

"In regard to the use of steam vessels in the survey, upon which you request my views, I would observe, that the employment of such vessels, of *suitable construction and equipment*, would, in my opinion, conduce very much to accuracy, despatch, and economy. To accuracy, because the rate of running would be more uniform than that of sailing vessels; the lines of soundings could be run with more system, and a vast amount of useless labor thereby be avoided. To despatch, because, in light winds and calms, which prevail much upon our coast in summer time, where sailing vessels can do little or nothing, steamers could work with perfect success. They could also work with much more success, under all circumstances, than sailing vessels, being independent, in a great measure, of the direction of the wind and of tides. To economy, because a very much greater amount of work could be performed by a steamer in a given time, than by a sailing vessel, and with fewer men. I am convinced, in short, that steamers are as much to be preferred for surveying as for any other purpose whatever. It is proper to add, that I speak from experience on this subject, steamers having occasionally been attached, for short intervals, to my command."

2. Extract from a report by Lieutenant Commanding Charles H. Davis, U. S. N., assistant in the coast survey, to the superintendent. (Report of superintendent, 1845.)

"I believe that the present expense of this purchase (steam vessels,) would be amply repaid by the greater amount of work they

would perform. Their superiority to sailing vessels in sounding, both in rapidity and certainty, makes the argument in favor of their employment to be this: that, with them, the coast of the United States can be surveyed in one-half the time consumed by the present means."

3. Extract from a report by Lieutenant Commanding George M. Bache, U. S. navy, assistant in the coast survey to the superintendent. (Report of superintendent for 1845.)

"In the deep waters of the Chesapeake bay, which have been gone over, the angles as well as soundings have been taken from the vessel. There are many difficulties and delays in working a vessel under canvass. It is only with a moderate and steady breeze that the work can be laid out to advantage; frequent alterations in the force or direction of the winds are great impediments. Light airs and calms put a stop to all sounding operations, unless the stations are sufficiently near to be distinguished from the boats. On this account, I have long thought that the use of steam-vessels, on the off-shore and bay work, would contribute to the accuracy, expedition, and convenience of the work; and, if properly managed, would prove more economical than sailing vessels for the extent of surface surveyed. On a steamer, such lines of soundings could be run as would best display the features of the bottom, without closing upon, or partly running over, the lines of soundings which had been previously established. This is sometimes unavoidable in working under sail, particularly when distant from shore stations. During light weather and calms, when the sailing vessel would be comparatively idle, the steamer going at a moderate and steady rate over smooth water, would be working to the best advantage, and with the greatest accuracy and convenience. It is evident that much more and better work, of this kind, can be done from a steamer than a sailing vessel. As regards the comparative economy of the two kinds of vessels, I can only speak in more general terms. The same expenditure for outfits and renewal of sails, would not be incurred; on the other hand, the expense of repairs of machinery, and cost of fuel, would be heavy items; but, when the greater amount of work is considered, the cost of it would probably be lessened. As the triangulation progresses down the wide part of the bay, I am confident that, to keep pace with it on the water, either one or more hydrographical parties must be added to the force now here, or that steamers must be speedily introduced."

4. Extract from a report by Lieutenant Commanding Charles H. Davis, United States navy, assistant in the coast survey, to the superintendent. (Superintendent's report, 1846.)

"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 the 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 (Nantucket shoals) 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 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 every where, but indispensible here, on account of the peculiar and novel manner in which the 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 where the stations are few, and where the tide must be met to cover the whole ground, or else half a 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 vast extent of the operations of the coast survey. The occasion may be thought, however, to authorize an appropriation for the express object of surveying the Nantucket shoals."

Remarks in report of 1846 of superintendent of the coast survey on the foregoing:

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 re-organization 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.

APPENDIX No. 18.

Report of Lieutenant Commandant Charles H. Davis, United States Navy, assistant on the coast survey, on the use of steam-vessels in sounding, made subsequent to the use of the revenue steam-vessel Bibb, under his command.

UNITED STATES STEAMER BIBB,
Boston Harbor, September 30, 1847.

DEAR SIR: The following statement of the comparative advantages of steam and sailing vessels, in the service of the coast survey, is derived from my own experience and observation during the present season of active employment.

It must be premised that steam vessels are required only in large fields of work, where long lines can be run, and where the depth is sufficient for ordinary navigation.

In such cases, the superior advantages possessed by the vessel propelled by steam over the sailing vessel, may be classed under two heads, direct and indirect.

Of the direct advantages, the first in importance, is the independence of steam upon wind and tide. Having the means of going in any direction, the surveyor is able to make a comprehensive and careful project of his work, and to carry it out with certainty; while, with sails only, he is obliged to accommodate his traverse to the direction of the wind and the course of the tide, and generally much time is lost in retracing his steps to windward to obtain a suitable position for continuing and connecting his work. As the wind and tide are constantly changing, the plans which depend upon them must change also; those which have been adopted must be left unfinished and new ones be taken up, and thus blanks remain upon the sheets, to fill which is attended with difficulty and loss of time. The greatest evil here, however, is the loss of accuracy, the consequence of a want of system and previous arrangement.

The most favorable days for sounding are those on which the sea is calm, and then the steamer will accomplish the best work, both in amount and quality; but the sailing vessel lies idle for want of motive power.

When sounding in deep water it is often necessary to lessen the speed in order to get the depth accurately, and to ascertain the character of the bottom. The steam-vessel does this easily, without diverging from her track; the sail vessel must change her course to lie to. By this, time is lost, labor is increased, and the continuity of the lines is broken.

So again, if places unexpectedly occur which demand careful examination, the steam-vessel, moving equally well in all directions, can resume her position when the examination is completed. The other must frequently begin anew.

The speed at which the steamer moves can be regulated with ease and precision; and equality of speed contributes to correct-

ness. The sailing-vessel is almost always unequal in her rate of going for any considerable length of time.

The strict test of the relative value of these two methods of working is the cost of each, compared with the results produced. This test shows very largely in favor of the steam-vessel. The hydrographical party under my command was employed on the Nantucket shoals, during the month of August, 1846, with sailing vessels only, and in 1847 the same party was employed there with the addition of a steam-vessel to its former force.

On both occasions the hire of tenders and the pay of pilots was nearly the same. It will only be necessary, therefore, to compare together the expenses of the two principal vessels—the schooner Gallatin, in 1846, and the steamer Bibb, in 1847.

The current expenses of the Gallatin are estimated at $100; those of the Bibb at $450, or four and a half times as much. But the work executed by the latter exceeded that of the former in the proportion of at least fifteen to one; and it is here that the ability of the steam-vessel, to move without regard to wind and tide, is particularly valuable. The numerous shoals and ridges over which the sea readily breaks, can only be approached with safety in calm weather; and near them the current runs with such rapidity that a sail vessel requires a good breeze to stem its force. It is impossible, therefore, for the latter to pursue the work systematically. The loss, too, of the best days, those in which the wind is light or calm, is unavoidable.

By the mention of this field of survey, I am led to speak of the indirect advantages of the steam-vessel, the chief of which is her power to tow other vessels where they are wanted.

On the Nantucket shoals, two or three vessels are anchored as stations. Their positions are to be frequently changed. This is done by the steamer without the delay occasioned by the lack of wind, &c.

It is to be counted among the incidental advantages of a steam vessel, that she works on an even keel; and the inclination of sailing vessels, on the contrary, frequently increases the ordinary fatigue and labor; that she can move into narrow places or stop at a particular spot, less room for manœuvreing being required; that she can begin work at pleasure, and continue it until the latest hour, not being compelled to allow for a failing or contrary wind, or an ebbing tide, to get a secure anchorage before night; that she has no sails to interfere with signals while engaged in company with other vessels; that her greater height makes her more conspicuous when observed on from fixed stations, and in the same way is convenient to observers on board when the signal points are distant; the limits of work are thus extended; finally, that she is moved without fatigue to her crew, which, in sailing vessels, is an obstacle to progress.

C. H. DAVIS.

A. D. Bache, L. L. D.,
Superintendent United States Coast Survey.

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14. Correspondence of the citizens of Mobile with the superintendent of the coast survey, relating to the survey of Mobile bay.

15. Sailing directions for Mobile bay, by Lieutenant Commandant C. P. Patterson, United States navy, assistant coast survey.

16. Letter of superintendent of coast survey, in behalf of himself, of Assistant Gerdes, and others of their parties, to Lieutenant Commandant Patterson, in relation to the decease of Passed Midshipman and Acting Master Allison, United States navy, of the surveying schooner Phœnix. Resolutions passed by the officers of the schooner Phœnix, in relation to the same, transmitted by the superintendent to the honorable the Secretary of the Navy.

17. Remarks of Lieutenant Commandant George S. Blake, United States navy, Lieutenant Commandant Charles H. Davis, United States navy, and Lieutenant Commandant George M. Bache, United States navy, assistants in the coast survey, in regard to the use of steam vessels in the hydrography of the coast survey.

18. Additional remarks of Lieutenant Commandant Charles H. Davis, United States navy, on the employment of steam-vessels in the coast survey 1847.

ERRATA.

Page 16, line 1, for two fathoms, read ten fathoms.

Page 64, line 12, appendix, for N 34½° W, read N 84½° W; and for N N W ¾ W, read W N W ¾ W.

SKETCH A

Showing the progress in Section N° 1

U.S.Coast Survey

in 1847

MAINE

NEW HAMPSHIRE

MASSACHUSETTS

MASSACHUSETTS BAY

CAPE COD BAY

RHODE ISLAND

Mount Pleasant

Portland Light

Cape Elizabeth

Cape Neddock

Isle of Shoals

Cape Ann

Salem

Boston

Plymouth

Provincetown

Highland Lt.

Nauset Lt.

Hyannis Harbor

Edgartown Harbor

Cape Pogue

Nantucket

Nantucket Shoals

Old South Shoal

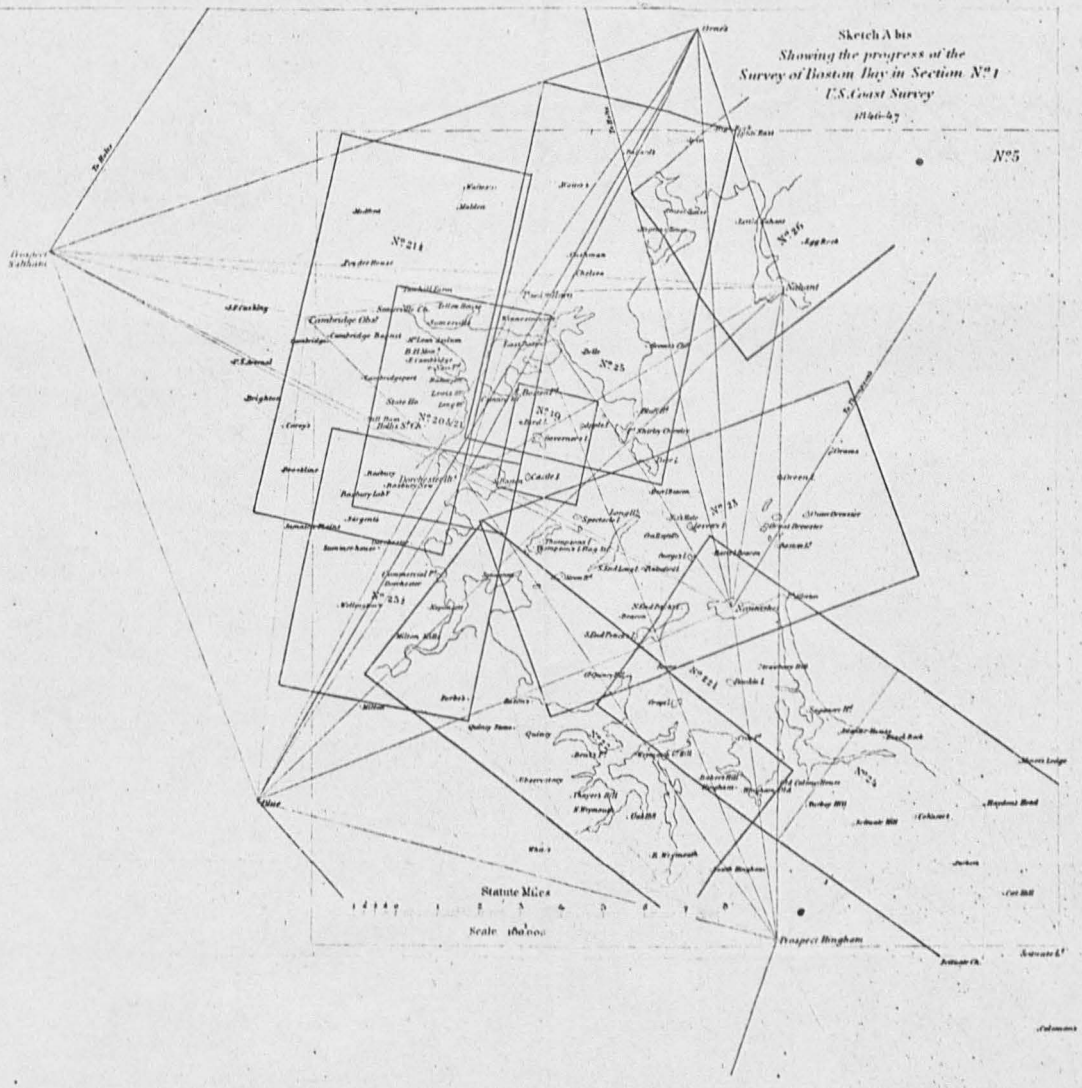
Statute Miles

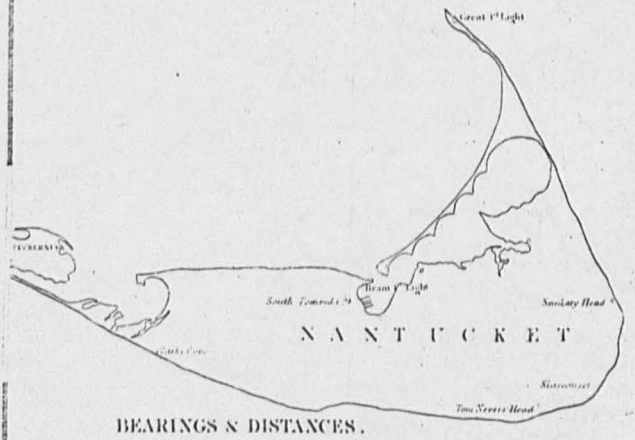
Scale 200 to an inch

O Signifies Occupied Station.
U do Unoccupied do
A do Astronomical do
M do Magnetic do
X do Current do
T do Tidal do

Signifies Lines between primary occupied stations
do occupied & unoccupied stations
unoccupied stations
Secondary stations

Limits of Plane Table sheets on this sheet. Limits of Hydrographic sheets on broken lines


Sketch A bis
Showing the progress of the
Survey of Boston Bay in Section N°1
U.S. Coast Survey
1846-47
N°5
N°214
N°25
N°19
N°20 & 21
N°23
N°22
N°24
Statute Miles
Scale 1 Inch
Prospect Hingham



Sketch A iris.

16 feet Shoal spot discovered in 1847

New Shoal discovered in 1846

18 feet

BEARINGS & DISTANCES.

From middle of Old South Shoal Sankaty Head bears North 22° East (true or Nby E ¼ E (Magnetic) dist. 12¼ Miles.

From middle of New South Shoal discovered in 1846 the Middle of Old South Shoal bears N.A° E. (true or N by E (Magnetic) dist 6¼ Miles.

From Middle of Rocks discovered in 1847, the ends of New South Shoal bears N.E½° W (true or W by S. Magnetic) dist. 1 Miles, and the middle of the Old South Shoal N.E½° W. (true or N.1 W. Magnetic) dist 6 Miles.

From 16 fet Shoal to the Summit of Bass Rip, discovered in 1847, Sankaty Head bears N84½° W (true or W.N.W. ¼ W. Magnetic) dist 6 ¼ Miles, and Great Point Light N 42½° W. (true or NW. ¼ N. (Magnetic) dist 10 ¾ Miles.

From 16 fet shoal to the North of Bass Rip, discovered in 1847, Sankaty Head bears S.80½° W. (true or S.S.W. ½ W. Magnetic) dist. 11 Miles, and Great Point Light N.60½° W. (true or NW by W ½ W (Magnetic) dist 4 ¼ Miles.

PRELIMINARY SKETCH

Showing the Positions of the

NEW SOUTH SHOAL, & OTHER DANGERS

RECENTLY DISCOVERED BY THE COAST SURVEY.

A.D. BACHE, SUPERINTENDENT.

Positions determined by the Hydrographic party

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

in 1846 & 1847

1 Statute Mile

TIDAL NOTES

The direction of the arrows shows that the tides generally pound the compass in every successive Flood and Ebb (on the South shoals, the main body of the Flood runs to the Eastward, and that of the Ebb to the West and Anyone) to both sides a little to the Nether 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 11 hours before the principal set and strength are attained.

Upon the South Shoals, the tides run always across their 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.

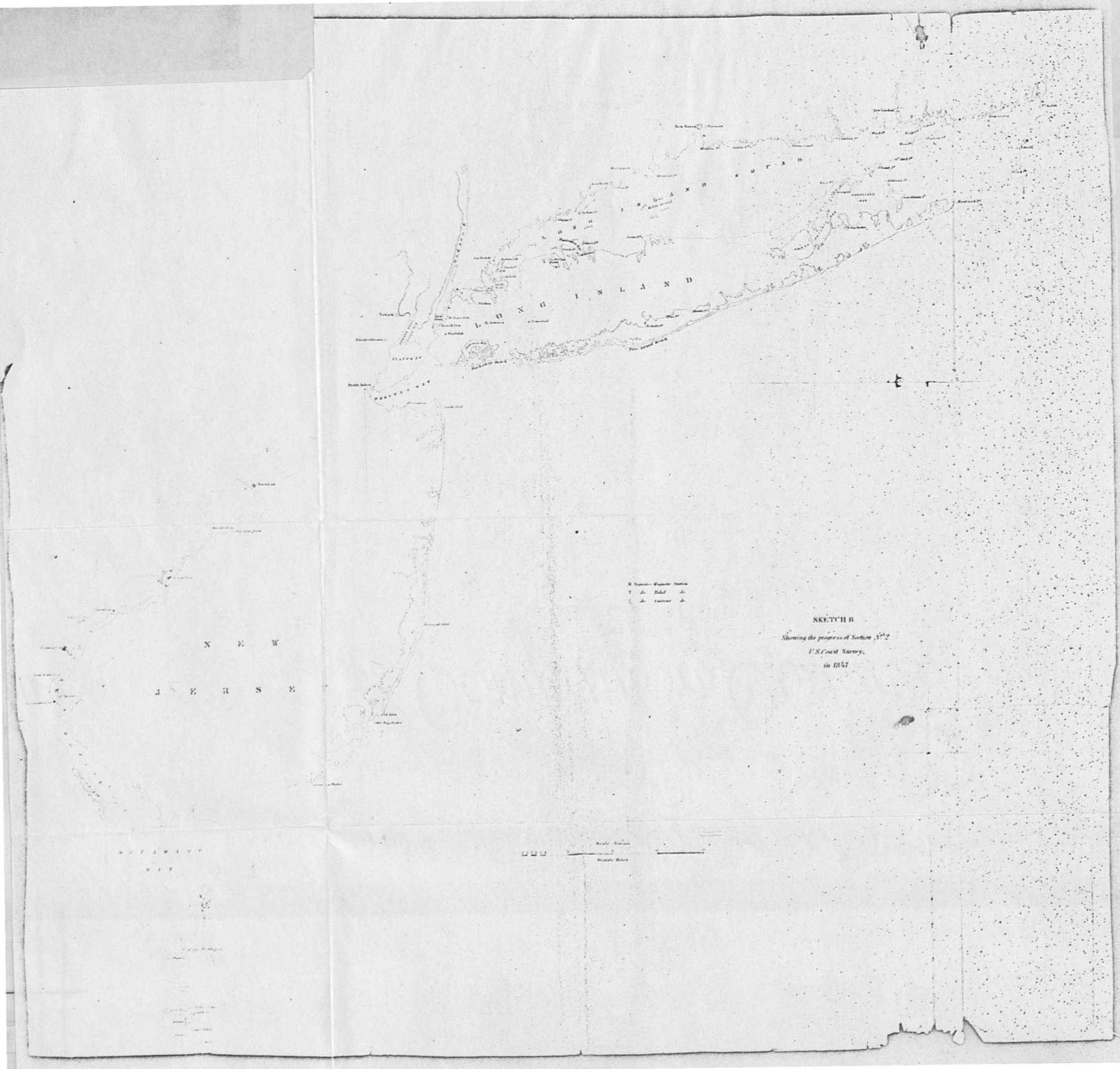
The tide is never still. During the period called "slack water" the velocity is rarely less than 1 mile & sometimes more than 2 miles. A careful attention to the tides is important in this vicinity.

NOTES

Longitude of South Towered Church 70°-0'-0" W. (Greenwich). Latitude, 41° 16' 32"

The soundings within the dotted curves are in feet & reduced to outside of that in fathoms

No part of the Island of Nantucket is visible from the New South Shoal in the clearest weather.

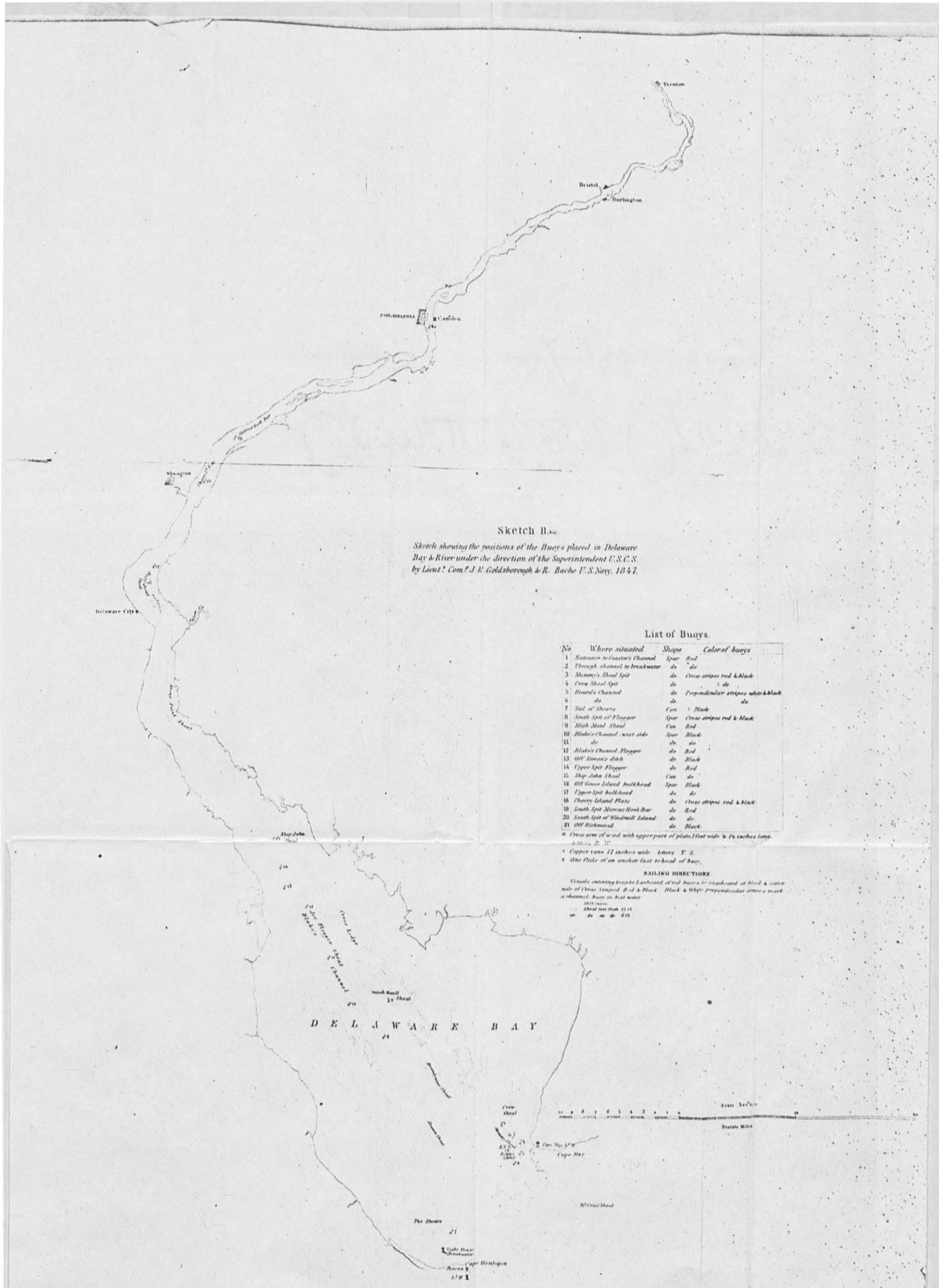


SKETCH B

Shewing the progress of Section N.º 2

U.S. Coast Survey,

in 1847



Sketch B.[No.]

Sketch shewing the positions of the Buoys placed in Delaware Bay & River under the direction of the Superintendent U.S.C.S. by Lieut.[t] Com.[d] J.R. Goldsborough & R. Bache U.S.Navy. 1847.

List of Buoys.

No	Where situated	Shape	Color of buoys
1	Entrance to Coaster's Channel	Spar	Red
2	Through channel to breakwater	do	do
3	Mummy's Shoal Spit	do	Cross stripes red & black
4	Crow Shoal Spit	do	do
5	Ricard's Channel	do	Perpendicular stripes white & black
6	do	do	do
7	Tail of Shoars	Can	† Black
8	South Spit of Flogger	Spar	Cross stripes red & black
9	Mish Mash Shoal	Can	Red
10	Blake's Channel, west side	Spar	Black
11	do	do	do
12	Blake's Channel, Flogger	do	Red
13	Off Simon's ditch	do	Black
14	Upper Spit Flogger	do	Red
15	Ship John Shoal	Can	do
16	Off Cross Island bulkhead	Spar	Black
17	Upper Spit bulkhead	do	do
18	Cherry Island Flats	do	Cross stripes red & black
19	South Spit of Marcus Hook Bar	do	Red
20	South Spit of Windmill Island	do	do
21	Off Richmond	do	Black

* Cross arm of w'ed with upper part of plate, 1 foot wide & 14 inches long.
Letter F. W.

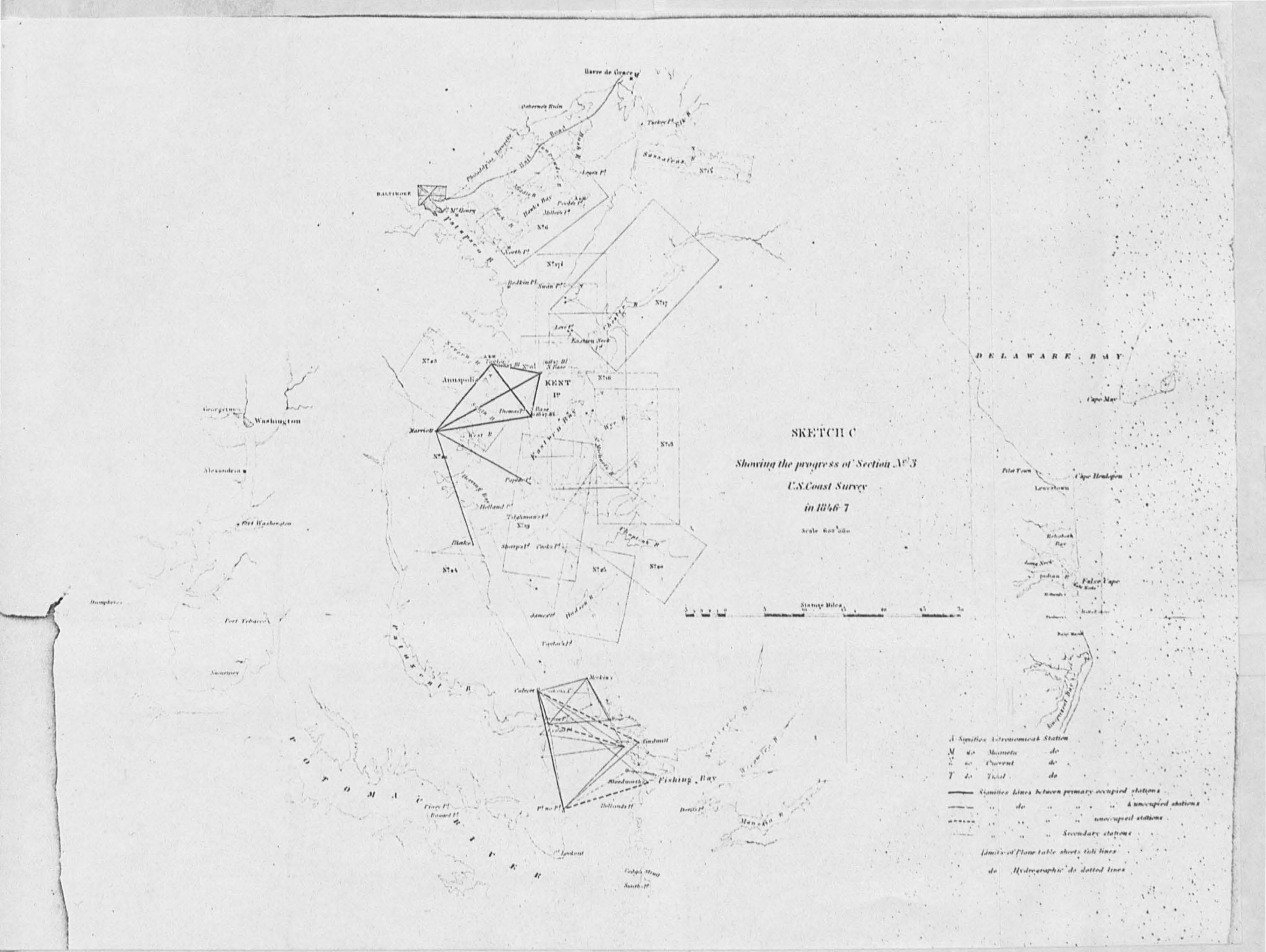
† Copper vane 12 inches wide. Letter F. S.

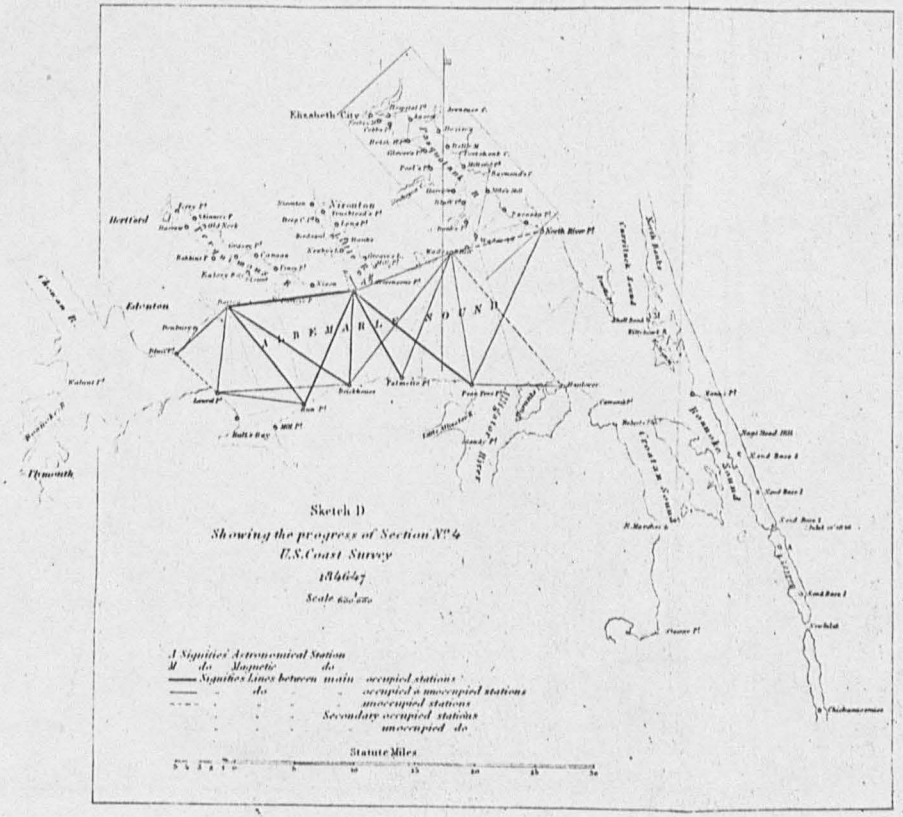
‡ One Fluke of an anchor fast to head of buoy.

SAILING DIRECTIONS.

Vessels entering keep to Larboard, of red buoys, & Starboard of black & either side of Cross Striped Red & Black. Black & White perpendicular stripes mark a channel, buoys in best water.

1819 survey
Shoal not less than 12 ft
do do do 6 ft


Havre de Grace
BALTIMORE
Annapolis
KENT
Washington
Alexandria
Port Tobacco
Piscataway
Fishing Bay
DELAWARE BAY
Cape May
Lewestown
Cape Henlopen
False Cape
SKETCH C
Showing the progress of Section N°3
U.S. Coast Survey
in 1846-7
Scale 600,000
Statute Miles
Signifies Astronomical Station
Signifies Lines between primary occupied stations
Limits of Plane table sheets full lines
do Hydrographic do dotted lines



Sketch D

Showing the progress of Section No 4

U.S. Coast Survey

1846&47

Scale 600 mile

A Signifies Astronomical Station

M do Magnetic do

Signifies lines between main occupied stations

do do occupied & unoccupied stations

unoccupied stations

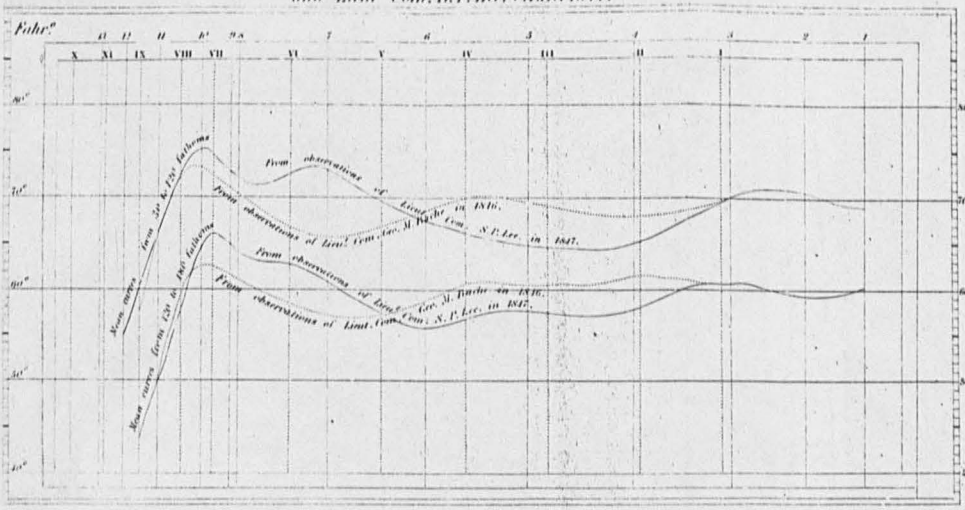
Secondary occupied stations

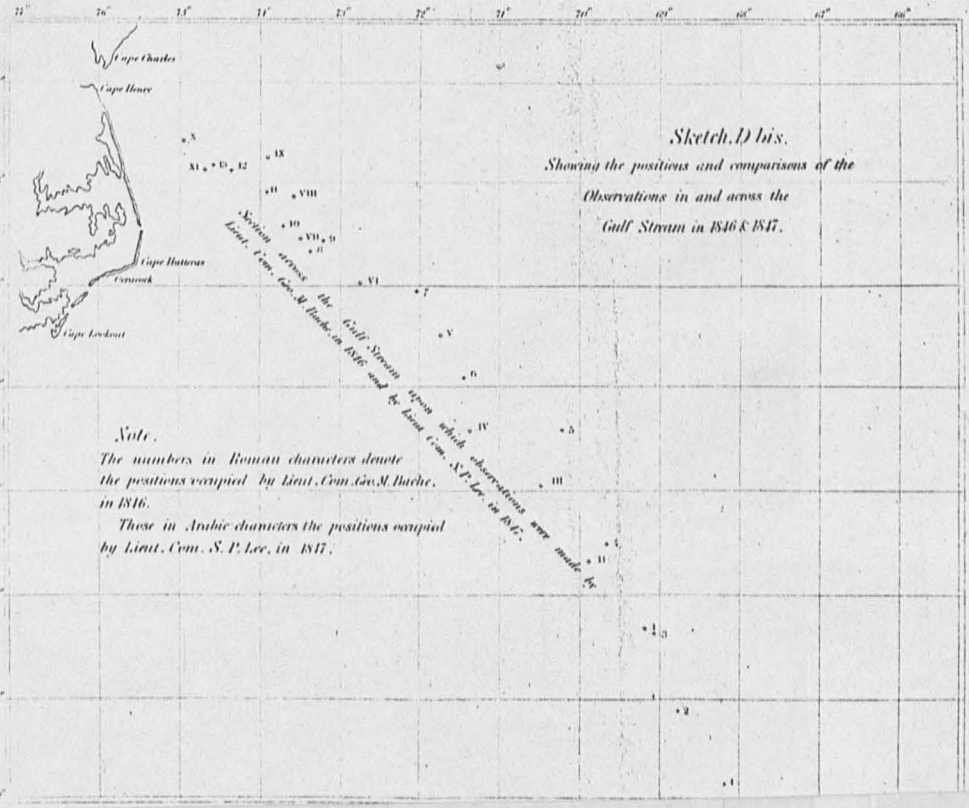
unoccupied do

Statute Miles

0 1 2 3 4 5 10 15 20 25 30

Comparison of Observations in the Gulf Stream by Lieut Com. Geo. M. Bache, U.S.N. 1846 and Lieut Com. S.P. Lee, U.S.N. 1847.





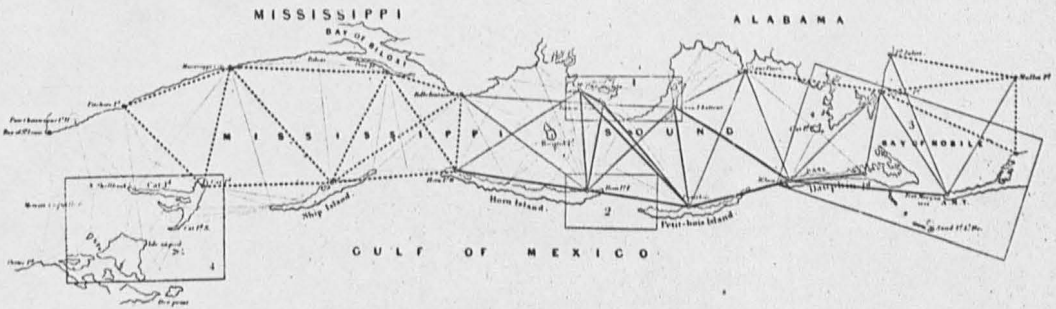
Sketch D his.

Showing the positions and comparisons of the Observations in and across the Gulf Stream in 1846 & 1847.

Note.

The numbers in Roman characters denote the positions occupied by Lieut. Com. Geo. M. Bache, in 1846.

These in Arabic characters the positions occupied by Lieut. Com. S. P. Lee, in 1847.



A *Signifies Astronomical Station*
M *Magnetic Station*
C *Current Station*
T *Tidal Station*

——— *Lines between primary occupied stations.*
——— *do do occupied & unoccupied stations.*
..... *Lines between primary unoccupied stations.*
..... *do do secondary stations.*

SKETCH. E.

Showing the progress in Section N°. 8.

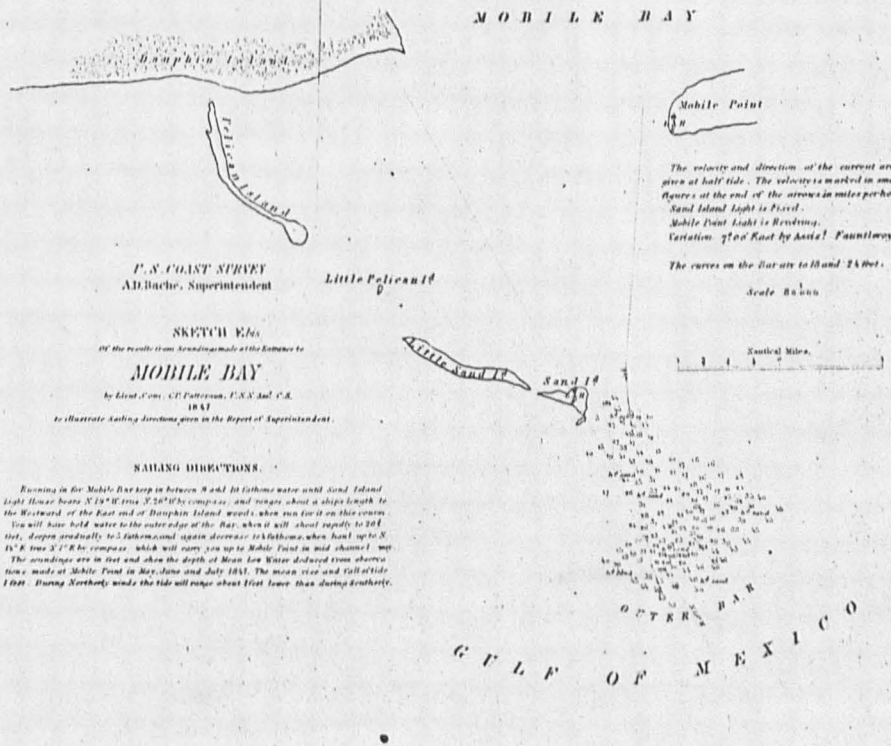
U. S. Coast Survey,

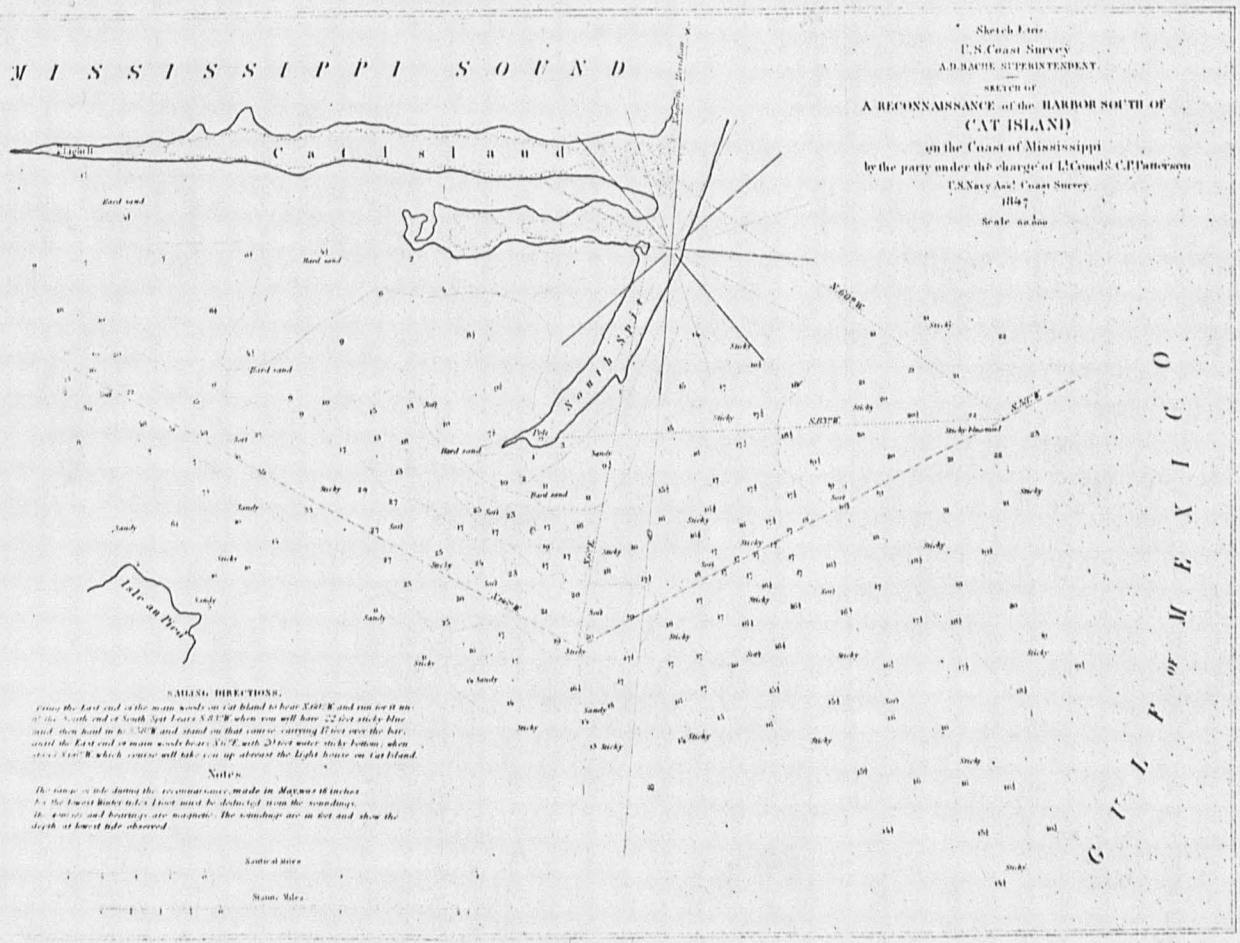
in 1846-7

Scale 1/600,000

Statute Miles

0 5 10 15 20 25


MOBILE BAY
Dauphin Island
Pelican Island
Mobile Point
The velocity and direction of the current are given at half tide. The velocity is marked in small enclosed figures at the end of the arrows in miles per hour, thus (1)
Sand Island Light is Fixed.
Mobile Point Light is Revolving.
Variation 3°00' East by Azimuth Fauntleroy in 1847
The curves on the Bar are to 18 and 24 feet.
Scale 80000
U.S. COAST SURVEY
A.D.Bache, Superintendent
Little Pelican Id
SKETCH
Of the results from Soundings made at the Entrance to
MOBILE BAY
by Lieut. Com. C.P. Patterson, U.S.N. and C.S.
1847
to illustrate Sailing directions given in the Report of Superintendent.
Little Sand Id
Sand Id
Nautical Miles.
SAILING DIRECTIONS.
Running in for Mobile Bar keep in between 8 and 10 fathoms water until Sand Island Light House bears N 19° W true N 26° W by compass, and ranges about a ships length to the Westward of the East end of Dauphin Island woods, when run for it on this course.
You will have bold water to the outer edge of the Bar, when it will shoal rapidly to 20 feet, deepen gradually to 5 fathoms, and again decrease to 4 fathoms, when haul up to S 19° E true S 1° E by compass, which will carry you up to Mobile Point in mid channel way.
The soundings are in feet and show the depth at Mean Low Water deduced from observations made at Mobile Point in May, June and July 1847. The mean rise and fall of tide 1 foot. During Northerly winds the tide will range about 1 foot lower than during Southerly.
OUTER BAR
GULF OF MEXICO



Sketch Exhi
U.S. Coast Survey
A.D. BACHE SUPERINTENDENT

SKETCH OF

A RECONNAISSANCE of the HARBOR SOUTH OF CAT ISLAND

on the Coast of Mississippi

by the party under the charge of Lt Comdg C.P. Patterson
U.S. Navy Ass't Coast Survey
1854
Scale 20000

SAILING DIRECTIONS.

Bring the East end of the main woods on Cat Island to bear N 81° W and run on it until the South end of South Spit bears S 81° W when you will have 22 feet sticky blue mud; then haul in to S 59° W and stand on that course carrying 17 feet over the bar, until the East end of main woods bears N 81° E with 5½ feet water sticky bottom, when steer N 81° W which course will take you up abreast the light house on Cat Island.

Notes

The range of tide during the reconnaissance, made in May was 18 inches
For the lowest Water take a Level mark in distinct from the soundings
Its courses and bearings are magnetic. The soundings are in feet and show the depth at lowest tide observed.

Statute Miles