**US Coastal Survey**

Notes

Coastal landscape and islands in particular – unique resource. Coast and Geodetic Survey. Exacting standards, high resolution, excellent spatial control. Two features of special value – (i) despite focus on coastline and hydrography, extended inland 3-5 miles or more and was comprehensive for many islands including Martha's Vineyard (one of largest comprehensive land masses – LI?), (ii) dated perfectly to 1844 and (iii) land work was directed by a Vineyarder – Henry L. Whiting.

Quality unprecedented, high standard. Enables complete overlay with modern landscape using GIS, detail provides qualities unavailable on modern maps – stonewalls, fences, specific agricultural use – like pasture vs tilled field or orchard; and in some cases separation of conifer versus hardwood forest.

Though Act authorizing formation of the USCS was Signed by Jefferson in 1807, languished until headed by Hassler, a mana with unique qualifications, global understanding of mapping techniques, familiarity with the latest technology and personal connections to the best instrument makers in the world. Swiss scientist and so had unrelenting demand for quality.

When we look back at these old maps we often see errors or shapes that convey an artistic quality, qualitative qualities, casual approach, crude techniques. Condescending assumption that science was poor, equipment was outdated, rigor was slight, standards low. Looking at CGS recognize that these represent a new era, new age of ability, sophistication, blending of mathematics, astronomy, engineering, oceanography, geography needed to meet completely new standards.

Just at the time and place where we would like a comprehensive view of the land, a squadron comprised of military men in training, veterans, civilians and scientists were organizing a wave of activities that spread across the coastal region of the Northeast and ultimately the growing country to yield the perfect view.

T Sheets – Topographic Sheets. Original working drafts for USCS charts. Sound, accurate, reproducible surveying methodologies, provide significant planimetric information. 1:10,000. 1850-mid 1900s. Scale yields detail unavailable from most earlier maps. Include triangulation points. So can register to project datum when transferring. Seamless coverage – homogeneous snapshot. [i]

DRF – Views generated just the same as travellers get today on ferry – what is that, very different perspective, easy to be misled. View shown of entrance to Vineyard Sounds from East (on 1861 chart bottom) shoes Indian Hill, Gay Head as an island and end of Elizabeth Islands to right.

Joseph Frederick DesBarres – army officer and a preeminent coastal mapmaker commissioned by British to prepare charts for eastern seaboard beginning 1760. 1774 Atlantic Neptune begun publishing became authority for navigation. Measured a base line; then form ends took angles with theodolite to objects; mapped on plain table; found all angles; went along shore; delineated the true shape of objects – headlands, points, bay, rock etc. (quote); Sloop was offshore laying down soundings in proper bearings and distances, remarking on the quality of the bottom; shallop sounded headlands, islands, rocks; boats went up bays into harbors, etc.

But relatively small scale; latitude and longitude science not adequate to provide regional geographic registration to contemporary datums. Individual areas are fine but over distance see shifts. Due perhaps to independent base lines that were subsequently tied together.[ii]

Hassler – divided USCS into three divisions – geodetic, hydrographic and topographic. First priority – extensive geodetic control network along entire coastline using prominent features – churches, spires, water towers, hilltops, chimneys. Could then expand network of triangulation points from these primary control points to pints that tied into plane table topographic work and hydrographic soundings. Better geodetic control, larger scale, better equipment, stronger theory.

Charts produced – 1:20,000 to 1:80,000 with 1:40,000 common. T an dH Sheets were work sheets. During this translation: geodetic controls omitted form final charts (so registration uncertain); 400-800% reduction in scale when compiled; symbology homogenized often deleting significant features. SO, original sheets are superior source.

Defined a national geodetic (horizontal) datum. First – "New England Datum". Established in 1879.[iii]

Notes from NOAA CGS Annual Reports and Web Page[iv]

Ferdinand Rudolph Hassler – 1770 Aarau, Switzerland – N German speaking. Father wealthy watch maker. Worked with Tralles in survey of Bern; developed personal collection of scientific instruments, books; met most eminent scientists in Europe; quite proficient in Math, geodesy, astronomy, meteorology, chemistry, physics, mechanical engineering. Collected copies of European weight standards.

Went to Phildeplphia, US center of science – member American Philosophical Society (TJ president of US and APS). Supported by John Vaughan philanthropist, proposed survey to Albany in part to establish meter as universal standard of lineal measurement – 1 10millionth of distance from Equator to North Pole. Helped stimulate national survey.

February 10, 1807
"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the President of the United States shall be, and he is hereby authorized and requested, to cause a survey to be taken of the coasts of the

United States, in which shall be designated the islands and shoals, with the roads or places of anchorage, within twenty leagues of any part of the shores of the United States; and also the respective courses and distances between the principal capes, or head lands, together with such other matters as he may deem proper for completing an accurate chart of every part of the coasts within the extent aforesaid."

Hassler selected from 12 applicants. Nothing until Madison. 1811 FH to GB for surveying instruments. War – stayed 4 years.

Congress wanted immediate results – charts for mariners, not science. Hassler – lasting value to humankind. Wanted to establish national mapping organization. Introduced plane table mapping with alidade to US.

"... all the data should be collected, to enable the government to judge with propriety of the plan of any public undertaking or service, such as roads, canals, means of defence of the country, &c. That the survey of the coast was to contain all these data, besides the mere outlines of the coast, and that they were as necessary as the soundings outside of the line of the coast, appeared to me too evident to admit of any doubt, and I would have considered the full aim of the work missed without them."(12)

Hassler details 13 steps in measuring a baseline (24), 6 steps in observing horizontal angles to systematically remove error (25), 7 steps for reading vertical angles (26), and 13 steps for the proper use of a hand-held reflecting circle (27).
Fieldwork: 1) reconnaissance for primary triangulation; 2) base line measurement; 3) primary triangulation including astronomic observations for latitude, longitude, and azimuth when possible; 4) secondary triangulation (at ten-mile or less intervals); 5) plane table mapping (by 1838 – 10 plane table parties); 6) sounding operations; and 7) measurement of a new baseline at the termination of a section of primary triangulation allowing the verification and closing out of all previous work in the section between baselines. #1-2 done by Hassler in spring before leaves on.
stations were generally placed well inland and followed high ridges to assure developing lines of sight of twenty to forty miles between primary stations.

REEFER TO REAR-ADMIRAL Reminiscences and Journal Jottings OF NEARLY HALF A CENTURY OF NAVAL LIFE BY BENJAMIN F. SANDS NEW YORK FREDERICK A. STOKES COMPANY PUBLISHERS

“The plane-table had become very popular with us all, being a most handy instrument for topographical work, and a great economy in time, since we could, upon the prepared sheets, place down all the features of the country and the details of its topography in pencil as we progressed, ready for inking in office-work, without the necessity of notes to be summarized at night and blotted with errors to be corrected on the succeeding day in the field as was usually the case when working with the surveyor's compass and chain. Upon the plane-table the work was done upon the spot, and proved itself as we went on, errors, if any, being promptly and easily detected and corrected before moving the instrument from the spot, thus making the sheet ready for the ink when removed, to

be replaced by others in succession during the season as we progressed. Moreover we felt the great relief this instrument gave us when we returned to the camp at the end of each day's work ; there was a certainty that the work was correct, and as it did not require revision we could always enjoy the rest and relaxation that followed upon a good day's work in the field.[v] "

Shifted camp every 10-12 miles. Often near an orchard, well or farm procuring butter, milk and eggs from the farm. Quite a caravan and commotion as moved through the landscape, among natives. Employed men form the local vicinity to get local nomenclature. Recorded all the familiar names.

Very popular to work for Hassler. Attracted the brightest naval officers for training: "The brightest of the young officers applied for this duty as an instructive school in a branch of their profession useful in peace or war, its objects being such as are as beneficial to our navy as to the commercial marine, and it being fitting and most proper that the naval officer should, as a part of his professional training, be well instructed in the methods and purposes of the coast survey, not only for the profit immediately to be derived from a thorough familiarity with our own coasts and harbors, but for future application of the knowledge thus attained, in the survey of foreign coasts and harbors and in the discovery of dangers to sea-going vessels such as were hitherto unknown and not suspected."

6 to group. Camped out – one tent with small one for cook-stove. One bed. Spoon fashion.

**CGS www**
1832 – dividing engine from Edward Troughton master instrument maker. Used in dividing circular instruments into ever finer angular divisions – valuable in theodolites. Finest machine tool in Western Hemisphere. Could discern one second of arc – better than 1:millionth.

1841 John Tyler president, new secretary of treasury. Caleb Cushing MA Senator challenged FH – egged on by officers interested in making charts. Wanted chronometric not triangulation survey. Over paid, delayed. No charts to date. Hassler waiting for a second southern baseline. And no engravers qualified. In US. Got two from Hamburg to start his group.

Alexander Dallas Bache – great grandson Benj Franklin, West Point at 15, graduated first in class. Taught UPenn; was a founder of the National Academy of Sciences and presided over 3 of first 6 meetings of AAAS. . Hired prominent scientists as assistants – Louis Agassi, Benjamin Peirce – Harvard, foremost mathematician; Maria Mitchell (first professional woman hired by US govt; able to attract great men – 25 rose to Brigadier General or higher from group working 1850-65; 1850-60 – highwater as ½ to 1% of total Federal budget.

Associated with growth in Geodesy, Geophysics, Hydrography (in the sense of measuring depths for nautical charting), Topography, and Oceanography, astronomy, geology, meteorology.

Hassler – incompromising two principles – accuracy and precision.

The topographic sheets included natural and cultural features: rock outcrops, cliffs, hills, and mountains; sand beaches and dune fields; coastal islands; marsh land; inlets; streams and rivers; the limits of pine and deciduous forests; cultivated fields; fence lines; roads, paths, and city streets; and piers, residences, commercial establishments, and public buildings.

“The principal tool used by the topographers was the plane table, a flat drawing board which could be attached to a tripod with an adjustable head which allowed leveling the board and orienting it with respect to direction. The topographer fastened a base projection with precisely plotted signals at a scale of 1:10,000 or 1:20,000 on the board and oriented it with respect to north. The topographer then occupied a series of known sites and observed selected cultural and natural features. The observing instrument was an alidade which was placed on the plane table and centered over the geographic location of the topographer's station on the projection sheet. The alidade was equipped with a straight-edge which lay in the same vertical plane as the alidade's line-of-sight. The topographer mapped features of interest by drawing rays along the straight edge emanating from the plotted geographic position of the topographer towards the observed feature. The intersection of rays drawn from various stations located the feature. Elevations were derived from vertical angle observations to the features…. Depending upon the nature of the terrain, culture, weather, and other factors, the topographer might have used supplementary methods such as chain and compass traverses, horizontal sextant angles, theodolite intersections, and, as a last resort, estimation and sketching.

Henry Laurens Whiting, the dean of Coast Survey topographers, wrote: "The limit of land and water is the most striking and important outline which exists in nature...."

Henry Laurens Whiting was the recognized leader of many talented topographers associated with the Coast Survey in the Nineteenth Century. It was said of Whiting that he could make a better map of the far side of a hill without seeing it than others could while standing before it. Whiting with CS 1838 until his death in 1897.

Resurveys became increasingly common towards the end of the decade.

Hydrographic goals: 1) to discover and make known the nature and location of hazards to navigation; 2) to assist navigators by defining and describing the nature and configuration of the sea-bottom; 3) to ascertain whether the winds, tides, currents, and sediments of an area would cause the sea-bottom configuration to change; 4) to predict the rate and direction of changes in sea-bottom configuration; and 5) to observe and predict changes that would result from human activity. Also - determination and survey of sites for

lighthouses, buoys, and other aids to navigation were also a major function of Coast Survey field parties in the 1850's.

Survey boats – whale boats, up to six oarsmen, coxswain, leadsman, anglemen, recorder and officer; precise positioning against azimuth intersections form shore observers coordinated by signaling or horizontal sextant angles on survey vessel;

Most surprising discovery of this era was Stellwagen Bank, on the main route into Boston harbor. 1854.

**Annual Reports**

1836 – nine parties with plane tables. Heliotropes received from Gottingen from inventor of instrument; winter bring together all of the observations;

1838 – Europeans now referencing Hassler's methods.

1839 –LI topo, hydro done to Gardner's Bay; also Block Island, CT and RI shores; Views made from water of lighthouses and entrances to harbors – provide guidance and warning.; all calculations made three-fold;

Got best quality of large drawing paper. Copperplates ordered in Vienna form Hungarian copper as best.

Projection and reduction of map of NY – done in duplicate form original otopgraphic maps to verify and prevent accidental errors;

"…it is evident that there will be no just comparison possible to be established between the results of the present survey, and the older ones…the certitude which results, to be obtained by the present survey shall give, will be the most important result."

1841 – began answering questions for Congress

"its value and labor cannot be judged…but by the quality alone, which to judge of, requires the same insight into the mathematical and physical sciences as the execution of the operation itself. The success in all these things depends not only upon the instruments and labor of the observer, but still more upon the perfection of the methods devised for the work."

132 volumes of observations and results; 40 of calculations and tables; 17 volumes of correspondence; 140 maps; 80 chaps;

*and I should like would be made*, comparatively to any other works, would certainly show that never so much valuable work of that kind has been obtained, in any country, and under any known arrangement, as there has been obtained, in the same time, at a proportionally equal expense, as in this survey of the coast of the United States, under the *present organization and administration of that work.*

The aim of the coast survey is, and has always been considered to be, by all the successive administrations since its existence, to furnish, with the fullest accuracy possible, all the geographical, topographical, and hydrographical data that may in any way be needed for the navigation and the defence of the coast, in their generality, and to the extent of the country in the rear of the coast, to which the valleys extend: that empty their waters into the Atlantic, and are thus separated from it by some chain of mountains, or what may be called the nearest chains of elevations separating the interior from the coasting countries; and that this work should also furnish the elements to any future map of the country desired, as it is by its nature so extensive, and so situated, as to furnish the elements of maps of all the States. In fact, some States have already united in the work, to extend these elements to the advantage of an accurate map of these States.

1832-41 $620,000 total budget

Can account for every moment of his time; detailed half-daily entries; remarks that he could account for his departure and arrival back from the field by hour and half-hour – made Mallory laugh at Senator Aycrigg.

That the Topographical bureau be directed to take all the detail surveys on land, including the military information necessary for the defence of the country, from points furnished by the general survey of the coast, and that the draughts prepared from the same be preserved in the War Department, for the exclusive use of the Government, while the navigator's chart shall exhibit no more of the inland districts than such as shall be necessary for the navigator, according to the system pursued in preparing the sea charts by the Governments of France and England.

Congress objects to Hassler using meters and decimals not feet and inches.

NOTE (5.)

"Survey of the coast" "must present the localities of all the passages and gorges that lead to these valleys, &c., because it must contain all that is needed for the proper defence of the coast in the case, of any attack whatsoever, just as much as the outlines of the coast and the soundings, because, like these, furnish the guide to the navigation," &c. (See this extract—military purposes, statistics, and article 47, for use of State surveys, 1834–'35, Doc. 2, page 372.) [*Hassler.*

*Light-house establishment*, 1842.

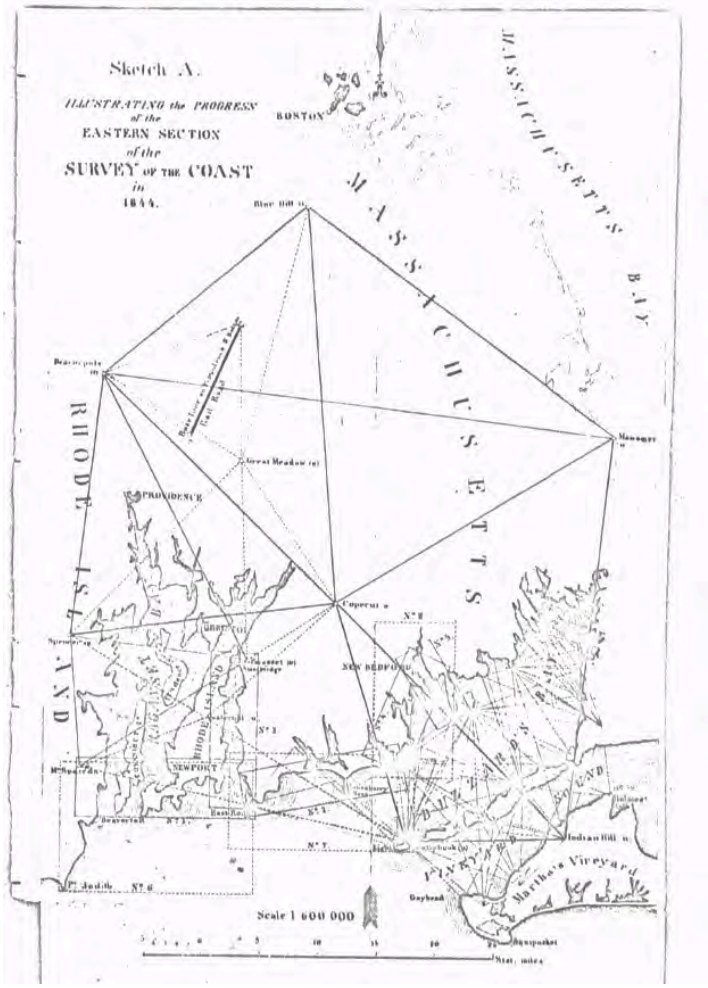
That some of our light-houses should be undermined by the encroachment of the sea, and have to be taken down and removed further back, is not strange; it is a circumstance they will always be liable to. It is no fault of those who selected the sites or built the light-houses. I have had an opportunity of observing the encroachment of the sea on our whole coast for thirty years, visiting every light-house in the United States once every year for sixteen years. Capes, with the ocean on one side, and the rapid current of some river on the other, as Cape Henlopen and Cape Henry, are the most liable to wash away; but your light-houses must be located at those capes, and must not be set too far back from the shore. The shore continuing to recede for a series of years will oblige you to remove some of your light-houses further back. This cannot be avoided. There

[*Swift*, p. 35.

The principle upon which the survey of the coast is conducted is, essentially, that which is known as the trigonometric method. By the relations which subsist between the sides and angles of a triangle, we are enabled, from certain known data, previously determined by actual measurement, to compute certain other parts which are unknown. For example: in a given triangle, by measuring one of the sides and the angles, the two remaining sides can be determined by computation. These computed sides then serve as bases for other triangles, and subsequently, by measuring the angles *alone* in the triangles thus formed, the work is extended *ad libitum*. This is called a triangulation, and may be made upon any part of the earth's surface upon which a line of a given extent can be measured.

1844 – Secondary triangulation to Buzzard's Bay, greater part of Vinuyard Sound, to East Chop of Holmes Hole. 24 stations, >6600 angles on 68 objects; ready for next year plane-table

Topo work in 2 parties – CT, BI, RI, W. Boyce and H. Whiting




1845 Topo on Buzzard's Bay shore, Elizabeth Islands and MV. Hydrography of Buzzard's Bay and part of Vineyard Sound

*From Narragansett bay, eastward and northward, to Massachusetts bay.*

If any incentive to exertion had been required in this section of the work during the past season, it must have been found in the accidents occurring within the knowledge of the different parties, from a want of information in regard to the dangers of this part of the coast. In the Vineyard sound a ship prepared for a whaling voyage to the Pacific struck, in good weather and with a fine and fair breeze, upon a shoal off Holmes' Hole, and this vessel had not entirely been released from peril, to be taken into harbor to refit, when a heavily loaded schooner struck near the same spot. The injury to the first of these vessels would have paid for the operations of the survey in this quarter more than twice over. The ship Centurion, lost on Nantucket south shoal during the summer for want of knowledge of the extent of the shoal and of the set and drift of the tides near and upon it, was insured for a sum beyond the whole appropriation for the field work of the year. These are only a part of the accidents which occurred in this region during the summer, the least dangerous portion of the year. There passed through the Vineyard sound within the last three years, (as appears from an interesting letter from William Mitchell, of Nantucket, appended to this report, appendix, No. IV,) four hundred and forty-seven ships, three thousand six hundred and sixty-four brigs, twenty-three thousand two hundred and sixty-two schooners, and nine thousand seven hundred and seven sloops; or a total of thirty-seven thousand and eighty vessels. The sound through which this trade is carried on in these vessels has many dangerous shoals, the limits of which are not defined on the existing charts. The pilots know the chan-

Primary triangulation done – CC, Buzzard's Bay, ACK.

Secondary triangulation – Vineyard Sound, ACK Sound, ACK island, part of CC.

Topo work – Head of Buzzard's Bay, E shore of bay, Elizabeth islands, part of MV. 178 square miles. 132 miles of shore, 171 miles of road.

Oct 1 through November on MV. Area near coast – rugged to broken, alternating rocky, sandy and marshy shores. Undulating with little wood. The country embraced in the interior of the sheet is, on the contrary, level, and covered with woods of scrub oak, interspersed with pines".

Astronomical observations at four stations – including Indian Hill. Need time (1125 times) latitude (6362) and azimuth – 937.

A meteorological journal, recording twice a day the temperature and moisture of the air, the direction and force of the wind, the character of the clouds, and proportion of sky covered, and once a day the pressure of the air, was kept at all the stations but three. The number of observations was, of the thermometer, 154; hygrometer, 154; barometer and attached thermometer, 82; other observations, 451.

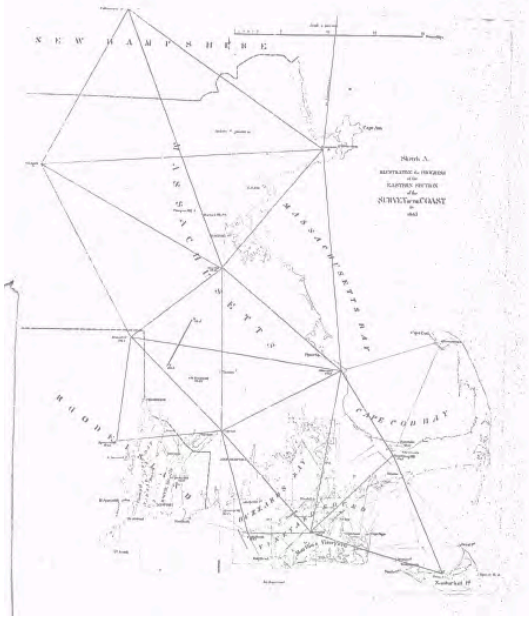
Winter – Whiting finished drawings of sheets of previous season and reducing New Bedford map for publication. Prepared plane table sheet projections for next season.

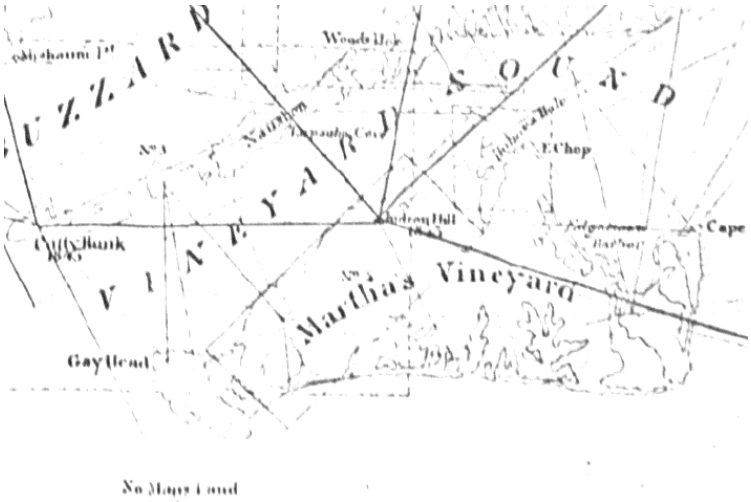
Beginning of May through November good for topo.

Work of this season will allow to publish charts for Tarpaulin Cove and Holmes Hole. Also most of hydrography for Cape Poge to Point Judith. Work on tides and currents around MV.

1. *Eastern section.*—The primary triangulation may be extended across the northern line of Massachusetts into New Hampshire, and some progress made upon the coast of New Hampshire. The secondary triangulation may be carried across Cape Cod and Massachusetts bays, and as far north as Plymouth. The topography of Martha's Vineyard and Nantucket may be completed, and that of the main be carried from Wood's Hole eastward to Monomoy point. The hydrography of the Vineyard sound and of the sound between Nantucket and the main (Nantucket sound) may be completed, and the dangerous shoals off Nantucket seaward be examined.

7. *Office work.*—The office work should consist, 1st, in the copying, reducing, and computing of the observations of the previous season, and in making drawings and projections of past or for future work; the arrangement of the observations of the past year for publication; the verification of calculations made by the field parties. 2d. The preparation of the materials for a map to extend from Point Judith to the east chop of Holmes's Hole, Martha's Vineyard, to include Buzzard's bay and the Vineyard sound, properly so called, and the commencement of the map itself. 3d. The reduction of the chart of the harbors of refuge of Tarpaulin cove and Holmes's Hole, on the Vineyard sound, and the engraving of the charts. 4th. The engraving of the second sheet of Long Island






Appendix IV . William Mitchell (ACK) to Bache describing trade through MV Sound and ACK South Shoal

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| In 1842 there were | 144 | ships, | 1,295 | brigs, | 7,551 | schooners, | 3,616 sloops. |
| In 1843 there were | 151 | " | 1,194 | " | 8,228 | " | 3,525 " |
| In 1844 there were | 152 | " | 1,175 | " | 7,483 | " | 2,566 " |
| | 447 | " | 3,664 | " | 23,262 | " | 9,707 " |

and to July, 1845, there were 122 ships, 805 brigs, 4,847 schooners, 1,796 sloops, passed Nantucket light-boat, (an immense amount of property indeed,) and yet there is no chart of this thoroughfare in existence that is worthy of the name.

1846 – Topo of MV, No Man's Land, ACK, and Woods Hole to Hyannis done. Shoals of ACK south and ACK Sound started. Edgartown and ACK harbors surveyed.

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

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

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

Area surveyed, 130 square miles; extent of shore line, 145.5 miles; of shore line of ponds, 102.5 miles; of roads, 182 miles. The immediate party of assistant Whiting was transferred to Boston harbor in November, leaving Mr. Greenwell to complete the work on Nantucket.

Engraving nearly done for Holmes Hole and Tarpaulin Cove. Map of coast form Point Judith to MV may be reduced and engraved. Chart of Edgartown may be reduced.

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.

Views needed for ACK and Edgartown taken and drawings sent to office. Reduction of two charts nearly completed. Engraving of Edgartown harbor nealy complete. Charts published Holmes Hole and Tarpaulin Cove.

1848 – Edgartown harbor chart published; ACK shoals engraved and published; ACK S Shoals hydography nearly done; Muskeget channel sounded out; Outer Cape topography underway – one party directed by Whiting. Views necessary for charts of Edgartown and

Nantucket and general coast taken. Reduction on ACK harbor chart made, ACK nearly done. Engraving on Edgartown harbor nearly completed; chart of Holmes Hole and Tarpaulin Cove published. Channel between Muskeget and MV carefully sounded. Lists numbers of copies of maps printed.

General report by section (region); reconnaissance; primary triangulation, secondary triangulation, topography; hydrography; office work; computations, manuscript charts, drawing, engraving, printing, next year's activities;

1849 – Each field party keeps a daily journal. Started work in California and Oregon.

1851 – Sketches for lighthouse locations at Holmes Hole and ACK. Description of archives and library – original and duplicate work; topographic and hydrographic sheets;

*Topography.*—Assistant H. L. Whiting, after the close of his work of revision on the Patapsco, noticed in my report of last year, was engaged in inking several sheets of his previous field-work (in Sections I, III, and V) until the 24th of May, when he received instructions for the season's operations in Section I. These were commenced at Cuttyhunk (see Sketch A, No. 5) on the 4th of June, for the purpose of showing, in detail, the topography of the southern part of the island and the "Sow and Pigs" rocks, upon which it is proposed to erect a light-house, and to furnish the shore-line and positions to the hydrographic party charged with the minute examination of the rocks and selection of a site for the light-house. This work was completed on the 14th of June; after which, until the 24th of that month, the party was occupied in the re-establishment of points on the south side of Martha's Vineyard (see Sketch A, No. 1) for the use of the hydrographic party, rendered necessary by the rapid wear of the cliffs there by the ocean.

Mr. Whiting says, in regard to the Nashaquitsa (or Wequobsky) cliffs: "The highest cliffs on Martha's Vineyard are the 'Wequobsky cliffs,' called by Mr. Eakin 'Nashaquitsa cliffs,' on the highest point of which he put his triangulation station. This part of the south shore of the island is rather remarkable, from the fact that these cliffs draw in and form quite a *cove*, showing that the shore is washed away more at this point than any other, although the cliffs are one hundred and fifty feet high.

"When the signal was first put up in 1844 or '45, it was placed twenty-five feet from the edge of the cliff. Last year I went with Lieut. McBlair to show him where the signal was, and found it had been washed away. I noted a large rock, some ten or twelve feet back from the edge of the cliff, as a landmark at the time, and I now find this stone has been reached and has rolled down the cliff. My new station is about sixty feet inside the old point, and thirty-eight feet from the present edge of the cliff, making the encroachments of the sea upon these cliffs, of one hundred and fifty feet in height, some *fifty feet* (50) in *nine years*. This encroachment continues for some miles to the westward on the south side of the island. I found the beach washed in at 'Chilmark Pond station' about twenty or twenty-five feet, but this becomes less and less, until at the extreme southeast end of the island the shore seems to have increased, if anything; there is, however, not much change.

"As these and the Gay Head cliffs are quite known landmarks in this section of our coast, I thought these changes quite interesting facts."

It may be worth inquiry whether some effective means should not be adopted to preserve these landmarks.

Thence the party proceeded to the survey of the vicinity of Gay Head, (see Sketch A, No. 1,) which was finished on the 14th of July. On the height of Gay Head cliffs Mr. Whiting remarks:

"I find the Gay Head cliffs not so high as supposed. Prof. Hitchcock calls them one hundred and fifty feet, which they are generally considered, but they are only from one hundred and twenty to one hundred and thirty-five feet high. There is one small knoll, not on the edge of the cliff, which is one hundred and forty-five feet. The lantern of the light-house I make about one hundred and sixty-seven feet. All these heights are from mean low water. The highest land is near the middle of the Head, and is about one hundred and eighty-five feet."

Upon the completion of this work Mr. Whiting transferred his party to the

1854 Whiting prepared topo sheets for office work from Gay Head, Cuttyhunk, No Man's Land – with minute detail.

Tides – 4 hour difference West Chop and Menemsha Bight (12 miles); 3 ½ hour difference along straight shore only 4 hours.

1856 – resurvey shores of MV and Muskeget channel. To see changes on SE of island, by Whiting. Revised shorelines on the sheet.

1889

1886 annual report Appendix No. 9 – changes in shorelines and beaches of MV. Whiting. With special reference to new opening through Cotamy Beach – occurred during violent storm at very high tide, January 9-10, 1886. HW anticipates E movement of opening based on surveys made 1846, 1856, 1871, 1886. Verified in two subsequent surveys – 1887 and 1889. HW detailed report of latest resurveys – Appendix no. 14 – predicts E point of outlet will move eastward past Wasque Hills leaving a long canal passage-way between and outer beach and the land of Chappaquiddick.

*Supervision and inspection of topographical resurveys on Martha's Vineyard, No Man's Land, Naushon, in the vicinity of Wood's Holl, and on the southeasterly part of Long Island.*—The report submitted by Assistant H. L. Whiting of his duties of supervision and inspection of the topographical resurveys on Martha's Vineyard and adjacent islands, and on the main-land at Wood's Holl and vicinity, presents some interesting and valuable results of the comparison of old and new surveys in localities which are of interest to navigation as defining the important waterway of Vineyard Sound. The report closes with a notice of the resurvey on the south coast of Long Island in the vicinity of Westhampton, about fifty miles to the west of Montauk Point.

## Resurvey

Upon Martha's Vineyard and No Man's Land, the resurveys were executed by Assistant John W. Donn; upon Naushon and the Falmouth shore, by Assistant W. Irving Vinal, and on Long Island by Assistant C. T. Iardella.

For the details of the work of these several parties, the time occupied during the season of 1888, and the statistics, reference may be made to the reports of their chiefs, which will be found under separate headings in this and the next section.

Space is not available for more than a few extracts here from Mr. Whiting's very full description of the features, geological and topographical, of the localities under survey, and account of the changes due to natural causes in the shore-line. With regard to Martha's Vineyard he observes:

"The formation and material of the northerly part of Martha's Vineyard is of much the same character as that of Long Island and Block Island. This part of the Vineyard is marked by a succession of irregular hills, which, with the exception of the Manomet Hills near Plymouth, are the highest in southeastern Massachusetts, the highest summits being from about three hundred to three hundred and ten feet. In approaching Vineyard Sound from the southwest, the conical top of Prospect Hill is the first land seen from the sea.

"The territory of Gay Head, formerly an Indian reservation of Massachusetts, has an area of between five and six square miles, terminating at its western extremity in the curiously variegated clay cliffs which give the name to this remarkable head-land. The land of the peninsula of Gay Head is generally hilly; Molaska Hill, near the center, is about one hundred and eighty-five feet high. The southwest and northeast points of the peninsula, however are of beach formation. The highest land at Nashaquitsa is about one hundred and fifteen feet, and at Squipnocket about sixty-five feet.

"The triangulation executed by Assistant R. A. Marr in 1887, has furnished, as was intended, sufficient basis for the topographical resurveys which have been made during the past season of 1888 by Assistant J. W. Donn. I need hardly say that the accuracy and style of Mr. Donn's work has been of the first order in every respect, and more in detail than was the custom to follow in the earlier survey.

"The agreement in geographical position of the main features of the two surveys is, however, so far satisfactory that the comparison of them gives a reliable basis for measuring the changes effected by time and other natural causes during the interval of forty-three years since the first survey was made.

"From the physical peculiarities of Gay Head, and the importance of its position as one of the main promontories of the coast marking the entrance to Vineyard Sound * * * it was deemed desirable to make the resurvey of the special features of the cliff on a larger scale than that usually given to the field work of ordinary shore topography. For this purpose a sheet was projected on a scale of 1–2500, or about 25.3 inches to a statute mile. On this sheet Mr. Donn made a very elaborate survey of the features of this remarkable cliff, which is the only one of its kind in the whole extent of our Atlantic coast.

"Owing evidently to the tenacious character of the clay of which the Gay Head Cliffs are composed, they have held their own much more firmly than might have been expected against the attacks of the sea, which at times dashes against their base with the violence of the heaviest storm breakers. the most apparent cause of the giving away of the base of the cliffs, which occasionally happens in slides of greater or less masses, seems to be the insidious action of springs and quicksands at their base.

"Although this head-land is exposed, as before remarked, to the full sweep of the ocean, the immediate shore and beach is guarded by the bed of bowlders which extend well out beyond the water-line. It was on one of these sunken bowlders that the ill-fated steamer *City of Columbus* struck. These 'rocks' as they are locally called, undoubtedly mark the former ground of the original head-land. The 'Devil's Bridge,' so called, confirms the theory and fact that the greater mass of them was deposited along the higher and more northerly part of the original drift.

"The waste of this remarkable head-land has already reached a line beyond its original summit, so that all future loss will lower its elevation, and that of the first order light, now not far from the crest of the cliffs, unless in the next retreat (one has already been made) a higher light-house structure is erected.

"Owing to the comparative smallness of the scale of the survey of 1845, and the worn condition of the older map and change in the position of the light-house as a main point of reference, it is difficult to make a close comparison and measurement of details. The very elaborate survey made by Mr. Donn will, however, preserve the record of the exact position of the cliffs, with all their varied physical and topographical features, from which a closer and more interesting knowledge of future changes can be obtained.

"The best comparison that can now be made shows, near the northwest point of the head-land, for a lateral distance of about three hundred and fifty feet, a slide or giving way of the summit line of the cliff, the greatest amount of waste of which is about ninety feet. From the same point eastward along the shore of the Sound for a distance of about fifteen hundred feet, the summit line of the bank has fallen back irregularly in various places. A former spur, nearly opposite the light-house, has given away a distance of about one hundred and twenty feet. Along the line of the Government land surrounding the light-house, there has been an average waste of from eighty to ninety feet. There has not been much apparent change in the position of the high-water line along this front of the head-land."

With regard to the resurvey of the shore topography of the small island of No Man's Land, lying about five and a half miles south a little east from Gay Head Light, Mr. Whiting observes that the scale of resurvey was 1–5000. Being so far outside of the larger islands, it is open to the action of the sea from all directions, and the earthy material of which it is composed makes it an easy prey to the consuming power of the waves. Full details of changes in the configuration of the shores since the first survey are given in Mr. Whiting's report.

Referring to Mr. Vinal's resurvey of Wood's Holl and vicinity, an account of which is given under a separate heading in this section, Mr. Whiting states, as a general result, after reviewing the detailed resurvey, which was executed on a scale of 1–5000, that no important change has taken place in the main features of the topography during the last forty-three years. This he deems somewhat surprising, particularly in the features of Wood's Holl, in view of the strength of the currents that are constantly rushing through its narrow and tortuous water-way, and it suggests an interesting field, he thinks, for physical investigation as to the power of imbedded bowlders and shingle, where no actual ledges seem to exist, to resist the forces of tidal currents of such high velocities.

*Additions of topographical details to the original surveys of Nantucket and Martha's Vineyard Islands.*—In furtherance of his assignment to the general charge and supervision of the topographical resurveys on the islands of Nantucket and Martha's Vineyard, Assistant Henry L. Whiting has submitted a report of the work executed by him under instructions issued early in July, 1888. This work has consisted mainly in adding to the topographical sheets the several county and town roads which have been laid out and opened on Martha's Vineyard since the original survey was made, in 1845.

The fact of the loss of most of the early triangulation points made it possible to locate these new features in harmony with the original work only by the use of such of the old plane-table points as could be identified, such as the chimneys of conspicuous houses, etc. Much time and labor were required to do this, more than would at first appear, because of the discrimination needed to ascertain by various tests which of the old points were used as bases in the original survey.

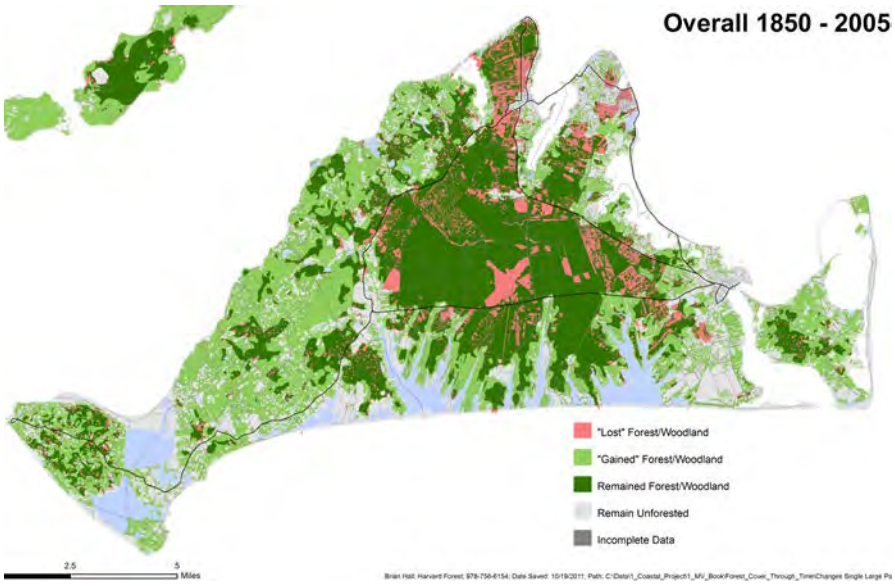
Whiting – surprising agreement in lining up maps; earlier one had only two points – Prospect Hill and Indian Hill. Too far apart to be used together. New roads added in red ink while leaving old for comparison.

*Topographic resurvey of parts of the north and south shores of Martha's Vineyard.—Also of the shore line of No Man's Land.*—In pursuance of instructions issued early in July, 1888, Assistant John W. Donn organized a party for the resurvey of the north shore of the Island of Martha's Vineyard from Tashmoo (or Chappaquonsett) Pond to Menemsha Bight, thence to Gay Head, and from Gay Head along the south shore to Wec-quobska Cliffs, taking in also the outlying island of No Man's Land. At Tashmoo Pond and Wec-quobska, the extremities of the projected shore line work, junction was to be made with the resurveys of Assistants Whiting and Vinal, which had been previously completed.

Work was begun July 12 at Indian Hill, and advanced east and west along shore, including a margin of topography of varying width, averaging about a quarter of a mile. Upon finishing this work between Tashmoo and Menemsha, the party was moved in August to Gay Head, and an elaborate survey of the cliffs and eastward slope of that locality was made upon a scale of 1–2500, or 25.34 inches to the statute mile. Contour lines were run for every five feet of elevation, thus thoroughly developing the surface. As the weather was generally fair and free from high winds during the progress of this survey, the conditions were very favorable for the completion of a map of Gay Head, which will serve as a true basis for future comparisons.

The heights of several prominent objects were determined by lines of levels connecting them with the bench-mark established by Assistant Henry Mitchell, in 1857, at Menemsha Bight. The base of the light-house tower upon the cliff, and the tops of two large bowlders at the northwest and southwest curves of the shore around Gay Head were the principal points. These bowlders were selected for the purpose of discovering the degree of subsidence of bowlders by the action of the sea, in connection with the receding of the shore.

Upon the transfer of the party to No Man's Land, the shore and cliff-lines of the island were surveyed, and the heights of the principal cliffs were determined, but no resurvey of the interior was made, contours having been carried over the surface by Assistant Whiting in his survey of 1855. The island is entirely bare of trees and covered with grass, so that little or no surface degradation occurs by reason of winds or waves.




Pair this with a map showing the conservation areas that conserve the dark green intact regions.

[i] EOEA 2006
[ii] EOEA 2006
[iii] EOEA 2006
[iv] ***THE COAST SURVEY 1807-1867*** http://www.lib.noaa.gov/noaainfo/heritage/coastsurveyvol1/CONTENTS.html
[v] Sands 1899

**Price:** $529.00

**Title:** *(A No. 5) Preliminary Chart of Muskeget Channel Massachusetts.*

**Description:** One of the better mid 19th century large format maps of Martha's Vineyard. This rare map depicts most of the island of Marthas Vineyard though does cut out its southwestern portion. Towns, villages, farms, and roads are all beautifully rendered. So too are nautical indications, oceanic depths, and undersea features. There are views of both Holmes' Hole Harbor and the entrance to Muskeget Channel. There is also a Telescopic view of the Cape Poge lighthouse. This map was created under the direction of A. D. Bache, Superintendent of the Survey of the Coast of the United States and one of the most influential American cartographers of the 19th century.
**Date:** 1859
**References:** None found.

**Cartographer:** The Office of the Coast Survey, founded in 1807 by President Thomas Jefferson and Secretary of Commerce Albert Gallatin, is the oldest scientific organization in the U.S. Federal Government. Jefferson created the "Survey of the Coast," as it was then called, in response to a need for accurate navigational charts of the new nation's coasts and harbors. The spirit of the Coast Survey was defined by its first two superintendents. The first superintendent of the Coast Survey was Swiss immigrant and West Point mathematics professor Ferdinand Hassler. Under the direction of Hassler, from 1816 to 1843, the ideological and scientific foundations for the Coast Survey were established. These included using the most advanced techniques and most sophisticated equipment as well as an unstinting attention to detail. Hassler's devised a labor intensive triangulation system whereby the entire coast was divided into a series of enormous triangles. These were intern subdivided into smaller triangulation units that were then individually surveyed. Employing this exacting technique on such a massive scale had never before been attempted. Consequently Hassler and the Coast Survey under him developed a reputation for uncompromising dedication to the principles of accuracy and excellence. Unfortunately, despite being a masterful surveyor, Hassler was abrasive and politically unpopular, twice loosing congressional funding for the Coast Survey. Nonethelss, Hassler lead the Coast Survey until his death in 1843, at which time Alexander Dallas Bache, a great-grandson of Benjamin Franklin, took the helm. Bache was fully dedicated to the principles established by Hassler, but proved more politically astute and successfully lobbied Congress liberally fund the endeavor. Under the leadership of A. D. Bache, the Coast Survey completed its most important work. Moreover, during his long tenure with the Coast Survey, from 1843 to 1865, Bache was a steadfast advocate of American science and navigation and in fact founded the American Academy of Sciences. Bache was succeeded by Benjamin Pierce who ran the Survey from 1867 to 1874. Pierce was in turn succeeded by Carlile Pollock Patterson who was Superintendent from 1874 to 1881. In 1878, under Patterson's superintendence, the U.S. Coast Survey was reorganized as the U.S. Coast and Geodetic Survey (C & GS or USGS) to accommodate topographic as well as nautical surveys. Today the Coast Survey is part of the National Oceanic and Atmospheric Administration or NOAA. Click here for a list of rare maps from the U. S. Coast Survey.