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# A. D. Bache and the coast survey

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# A. D. BACHE AND THE COAST SURVEY

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The Coast Survey is one of the oldest scientific agencies created by the Federal Government. Under the direction of Alexander Dallas Bache, the Survey has been called "ante-bellum America's greatest attempt at applied science."[1] This paper will examine the impact A. D. Bache's superintendency had upon the growth of the Survey (1843-1867). In order to achieve this objective this paper will examine the congressional legislative growth of the Coast Survey and other background information concerning the Survey. Next this paper will investigate the life and times of A. D. Bache. After a discussion of these two topics this article will study the relationship between Bache and the Survey.

On February 10, 1807, the Congress of the United States authorized the President of the United States "to cause a survey to be taken of the coasts of the United States."[2] President Jefferson, who was lobbied by the American Philosophical Society, requested this in his message to Congress. The dangers of travel due to unreliable navigational charts inspired this request. In that period over 600 million vessels (excluding coastal traffic) visited United States ports. This commercial traffic was important due to its merchant connection and its tarrif connection, the major source of income for the treasury.[3]

In response to this act many scientists submitted plans to perform the survey. The plan of Ferdinand Rudolph Hassler,

a Swiss scientist, was accepted. Mr Hassler travelled to Europe in 1811 to acquire the proper instruments for the Survey. However, the War of 1812 stranded the scientist in Europe until 1815. In 1816-1817 the Survey officially began with its survey of New York Harbor. Due to congressional pressure of finances and legislation which "prohibited the employment of civilians" (3 Statue 425), the Survey ceased operations in 1818.[4]

This transfer of power from civilian control to military colored the history of the Survey. Until 1832 the military undertook various surveys of the coast; however, these surveys were not triangulated nor coordinated and were below the standards set by Mr. Hassler. In fact, in 1819 Mr. Hassler presented his standards for the Coast Survey to the American Philosophical Society of Philadelphia. In 1832 a distinguished French astronomer reviewed these records and declared Mr. Hassler's procedures and surveying insturments "twenty years in advance of the science of Europe."[5]

On July 10, 1832, the Congress revitalized the Coast Survey with an Act (4 Stat. L., 570) which allowed the Coast Survey to "employ all persons in the land or naval services of the United States, and such astronomers and other persons as he [the president] shall deem proper." In 1834 work began under Hassler as a new base line along Long Island was chosen.[6] Work continued on the survey eastward and southward until Hassler's death in 1843 at which time the published survey

had covered coastlines from New York to Point Judith and southward as far as Cape Henlopen.[7]

The organization which Hassler left behind was a weakly administrated agency based on "the most advanced scientific principles of his day." Attempts by the Navy to assimilate the Survey, as well as controversy over costs and degrees of accuracy, led to administrative conflicts. Hassler's single-man operation which placed all surveying teams directly under his supervision fueled the fires of conflict. Although an 1854 Congressional investigation vindicated Hassler and his procedures, his inability to cooperate with congressional, executive, and military leaders and his inability to delegate responsibilities left his successor with a weak, limited organization with a questionable future.[8]

On December 12, 1843, Alexander Dallas Bache accepted the office of Superintendent of the United States Coast Survey from the Secretary of the Treasury.[9] This acceptance was a milestone in the history of the organization. In a tenure which lasted from 1843 until his death in 1867, the Coast Survey reached its zenith. It extended its investigations into all areas of science, and set precedents for governmental subsidy of scientific research.[10] In order to trace these changes, however, an examination of the background of A. D. Bache must be conducted.

Alexander Dallas Bache, a great grandson of Benjamin Franklin, was born in Philadelphia, Pennsylvania on July 19, 1806, to F. Richard Bache and Sarah Burnet (Dallas). At the

Although Bache's European study failed to be immedately adopted at Girard College, it was influential in Bache's reorganization of Philadelphia's secondary school system. Therefore, again Bache's abilities as an organizer and translator of policy were highlighted. His ability to absorb the best aspects of European educational systems and adapt them to the United States was a difficult task.[14]

From these achievements a man of great organizational ability and scientific understanding emerged. He was a scientist who could co-operate with the non-scientist. He was also a man who saw the need for interdisciplinary collaboration to achieve his goals. These qualities were well documented in the letters of recommendation sent to the Secretary of the Treasury, John C. Spencer, on behalf of Alexander Dallas Bache for the office of superintendent of the Coast Survey.

R. M. Patterson, a scientist who rarely involved himself in political appointments, felt the need to support Bache. Patterson wrote

> . . . for the place of Superintendent of the Coast Survey, his qualifications are-- a possession of the knowledge required for the performance of its duties, an untiring industry-- and a perculair talent for directing and combining the labor of others.[15]

Charles Davis, a professor from West Point, stated that a combination of praticial knowledge and profound science could bring the Survey's work to completion. Davis thought that his former student, Bache, was such a pratical man.[16]

From these recommendations A. D. Bache was appointed Superintendent of the ad hoc Coast Survey. His initial

action was to implement a new plan of organization and procedure which had been developed by a temporary board in 1843. This 1843 plan divided the coast into quadrants. Bache then appointed various field parties to survey these areas simultaneously working under his master plan and strict scientific standards. Hassler's single-man operation was discarded. An Assistant to the Superintendent headed the actual work of each field group, and a Disbursing Agent was in charge of the financial aspect of each field group. The Washington office, the central party, served as the informational group which received the raw data and sounding from the field parties. This central party processed the data and prepared and published the charts and maps which the Survey produced. Bache stood as the ultimate head of these groups.[17]

This organizational structure provided Bache's Survey with a threefold establishment of civilian control, military personnel, and leading scientists.[18] The civilian control insured the scientific integerity of the institution and the broadening of related scientific areas by the Survey (such as investigation into solar eclipses and terresterial magnetism). Army topographical engineers, who performed triangulation work on land, and naval hydrographic engineers provided the Survey with the necessary manpower in field groups. Lastly, the scientific element of the Survey maintained the accuracy and integerity of the Survey's maps and charts, as well as providing American scientists with a governmental forum.

This organizational extension allowed the Washington

office to accelerate the production of useful charts, an action which gained the Survey support from congressmen of the seaboard states. Each of these actions solidified the unsteady congressional roots of the organization. The addition of Texas in 1845 and the Pacific region in 1848 to the United States increased the coastline for the Survey to map, thereby, expanding the need for the Survey. However, while extending Survey actions Bache watched finances and continually showed a cost-conscious Congress the Coast Survey's excellent cost-effective statistics.[19]

Bache's employment policies also aided the growth and permanence of the Coast Survey. Bache did not rely on an elite group to accomplish the organization's work. Bache felt that anyone who could be trained for a specific task could be hired by the Coast Survey. This openness allowed the Survey to utilize funds to their fullest extent. This marriage between scientific theory and pratice permitted financial support of pratical as well as pure research.[20]

The Survey's experiments to improve map printing with the pantograph and copper etching were excellent examples of research merged with pratical application. Bache's experiments with magnetism also found pratical application with the use of the electro-magnetic telegraph to determine longitudes. The Survey even experimented with designs for submarine telegraph cable-laying equipment in order to improve its European triangulation connections.[21] These advnacements aided technology as well as the political position of the Coast

Survey.

The Coast Survey expanded its scientific functions beyond map production. Bache's interest in terrestrial magnetism was translated into 103 registration stations (by 1858) across the United States. The Survey, also, extended its investigations to tidal and current observations. The Survey mapped the tides of the Gulf of Mexico and enlarged its jurisdiction offshore to the Gulf Stream. Bache even had Professor Jacob Whitman Bailey of West Point examine the fossile remains taken from the sea bottom by hydrographic actions.[22]

Many times Bache's scientific curosity planted the seeds for future/applied research projects. In 1860 Bache requested an article by T. F. Schubert entitled "Essai d'un determination de la veritable figure de la terre". This was an orginal attempt to determine the figure of the earth using Newton's theories. This unquiry led to an investigation by the Coast Survey into the figure of the earth in order to improve the accuracy of the Survey's maps.[23]

In summation, one could see the growth of an organization spurned on by territorial expansion and internal jurisdictional expansion. One could also see an organization solidifying its future thru prestigious experimentation.

Bache's shrewd leadership best served the Coast Survey during the Civil War. Most enemies of the Coast Survey saw the war as an excellent opportunity to liquidate Bache's organization, and since the Coast Survey depended on military

personnel, the Civil War did threaten to shut down Bache's operations. Bache, however, preserved the Coast Survey by cooperating with the war movement. In a letter to Charles A. Spencer of Washington, Bache offered the Survey's aid to the military. He provided the Army and Navy with charts and maps of the southern rivers, harbors, and costal areas, and Bache even sent out assistants to work directly with military field units.[24]

In order to aid the naval war, Bache proposed the formation of a committee to advise naval personnel about the blockade and amphibious operations against the South. In June 1861 the "Committee of Conference" was formed. Bache's major work for the Committee consisted of "Notes of the Coast", regional descriptions of the South's waterways. The Survey printed these confidential descriptions and distributed them to selected naval officers.[24a]

In 1863 Bache offered his aid in developing a plan to defend Philadelphia, his native city. In surveying the city Bache's assistant, H. L. Whitiny, made extensive sketches and charts of the city, and analized the approaches to the city. From these preliminary charts recommendations for fortifications of the city were made. Although Bache mainly coordinated this activity, his involvement insured accuracy of the report.[25]

Bache also aided the war effort outside of his office. For example, he served as a member of the U. S. Sanitary Commission, a committee concerned with public health. However,

whether inside or outside of his official position, Bache strengthened his organization by cooperating with the war effort. By adapting information for war usage, Bache was able to extend his institution's jurisdiction inward along certain rivers, thereby, increasing the work and permanance of the Coast Survey.[26]

Bache also moblized scientific opinion in support of his actions. The Lazzaroni, headed by Bache, were a group of

> professional physical scientists, mostly interested in geophysical problems, who admitted a few kindred souls from other fields to their ranks. Their interests and range of influence extended to all of the scientists and included much of the research performed in universities and the government. They were consciously promoting the development of a professional scientific community in America.[27]

Through this group, Bache and his followers worked for a governmentally supported central scientific organization. Although the group was unsuccessful in its aims, its support for the advancement of science was translated into special expeditions by the Survey (such as expeditions to observe solar eclipses).[28]

In conjunction with the Lazzaroni, Bache moblized the American Association for the Advancement of Science (AAAS), a lobbying group composed of scientists. Many of its more prominent members worked in association with the Coast Survey at some time. Benjamin Pierce, Louis Agassiz, and John Fires Frazer were three such men.[29]

The correspondence between Frazer and Bache detailed the

scientific/personal relationships which benefited Bache and his Coast Survey. John Frazer and A. D. Bache were close friends. Frazer, a former pupil and research aid of Bache, referred to Bache as grandfather in his letters. Bache, in turn, referred to Frazer as grandson in his replies. This mode of salutation exemplified the close nature of their friendship. The wide variety of topics discussed between the two men also demonstrated the free exchange which occurred between these two scientists.[30]

A letter from Bache to Frazer, dated April 14, 1846, discussed the upcoming solar eclipse, while a similar letter dated December 17, 1848, encompassed a friendly discussion of the difficulties of Coast Survey work. Another letter from Bache to Frazer dated June 2, 1849, discussed Coast Survey politics.[31] These three examples illustrated the manner in which Bache kept his associates abreast of scientific events and politics. The correspondence between Joseph Winlock and Bache exemplify the close association which Bache maintained with scientists throughout the nation.

Joseph Winlock was an astronomer and mathematician who worked for the U. S. Naval Academy and Harvard Observatory. In 1857 Winlock was involved with the publication of the American Ephemeris and Nautical Almanac, a publication regulated by the Coast Survey. In correspondence between Winlock and Bache, dated January 2, 1857, to May 15, 1857, Winlock solicited Bache's aid in obtaining more constant financial support for the Nautical Almanac. Although Bache could not

obtain the full funding requested, his interest in Winlock's inquiry developed a congenial relationship between the two scientists.[31]

Bache's correspondence with various military leaders demonstrated his harmonius relations with the military. A. D. Bache's correspondence with Lt. General Robert Anderson exemplified these relations. Lt. General Robert Anderson was best remembered for raising the United States Flag over Fort Summter at the end of the Civil War. The exchange of letters between these two men was characterized by friendship. One letter, dated June 27, 1861, from Bache to Anderson discussed the tragedy of war, and another, dated July 29, 1862, was a personal note.[32]

Again, these letters reflected the character of Bache. He was a man who saw the need to compromise and maintain cordial friendships with the people who comprised the governmental/ political circles. He was also, however, a man who was honorable and loyal to his friends. He was a well liked and respected individual.[33]

From a more public perspective, the American Philosophical Society (APS) conducted an investigation into Mr. Bache's United States Coast Survey. The committee which examined the Survey was composed of R. M. Patterson, I. A. Kane, George M. Justice, F. O. Kendall, and John F. Frazer. Their results were read to the Society on January 19, 1849.[34]

The Committee's investigation originated with a letter from A. D. Bache

> . . . asking the confidence by the Society of the scientific character and results, the pratical results and of the proposals of the Survey, and writing any suggestions tending to improvements in the different departments.[35]

In the body of the report the committee emphasized the need for accurate navigation charts and the responsibility which the government had in underwriting the production of such charts. The committee drew such a conclusion from the government's dependence upon duties for operating expenses, and since the Survey's budget for the year (1884) was only 1/172 of the customs reciepts, the APS felt the budget was not extravagant.[36]

The committee proceeded to praise the scientific procedures and innovations adopted by Bache. The multi-phase computations for triangulation, the use of the electric telegraph, and the development of an accurate chronograph were endorsed in the report. The committee continued by commending the Survey's speed of chart production by the use of several field groups, and by the cooperation of all departments within the organization.[37]

The manner in which the Survey disseminated information enhanced the value of the Survey's work. The pricing schedule which placed the maps in range for most navigators allowed most who needed the charts to obtain them. This policy publicized previously unknown sunken ships and shoals and lessened the incidence of new shipwrecks. The discovery and publication of new channels into New York Harbor and Delaware

Bay increased the traffic of each Bay thereby increasing trade.[38]

The pratical knowledge obtained from pure research of the Survey was praised in the APS report. The development of laws which govern the sea's bottom sediment, the tidal and ocean currents in bays, and the Gulf Stream were cited in the report. In this acknowledgement, the APS was clearly referring to the benefits to American scientific research that the Coast Survey was producing.

In conclusion, the APS recommended to Bache the publication

> with in the interests of the Survey, of the observations upon the finished results are prominent, and of all others made during its projects as well as of the formulee for computation . . .[39]

This blanket statement provided the Coast Survey with a seal of approval from the most prestigious scientific society in the United States. Although this approval was given by scientists associated with Survey work (i. e. Patterson and Frazer), its importance should not be discounted. The most advanced American scholars of the period belonged to the APS and maintained the integrity of the Society.

The preceding facts and opinions paint a general impression of an organization. The rest of this paper will examine the Coast Survey's approach to two projects: (1) The Mobile Harbor Survey of 1860 and (2) The Expedition to the Solar Eclipse in Labrador, 1860.

On February 21, 1860, the United States Congress authorized the improvement of Mobile Harbor. In a letter to T.

Sanford, President of the Board of Mobile, Bache recommended the creation of a Harbor Commission to study the Harbor. The Board agreed to a three man council of Chief Engineer of the United States Corps of Engineers, Commander C. H. Davis of the Navy, and A. D. Bache. Once these technicalities had been completed, Bache established tidal stations. These stations observed the tidal flows within the harbor. After this information was gathered, hydrographic soundings began.[40]

Lieut. J. Wilkenson was the naval officer who was dispatched to the Survey for this period. From April to May (1860) Wilkenson surveyed Mobile Bay. Each month he provided monthly progress reports to the Washington Office (Bache). Although Bache was not actively involved in this field operation, he did supervise it more closely since this was a special survey.[41] In 1860 the Survey published the results of the Mobile Bay Project. According to the 1860 Annual Report of the Superintendent of the Coast Survey, the Mobile Project

> furnished important data for the direct purposes of the Coast Survey, besides rendering great service to the commerce and of the country generally.[42]

This correspondence illustrated the through nature of Bache's procedures and his cooperative nature with local officials. The requirement of Wilkenson's monthly reports demonstrated Bache's desire to maintain a tight control over the integrity of the project. Lastly, Bache's extensive report of the project in his Annual Report confirmed Bache's interest

in collecting and disseminating the work of the Survey.

On May 9, 1860 Congress passed a resolution authorizing the Coast Survey to send an expedition to Labrador to observe the pending solar eclipse. This resolution was supported and promoted by the American Philosophical Society and the Boston Board of Trade. These organizations felt that the observations would help verify geodetic work and lessen shipping accidents, respectively.[43] Therefore, the mobilization of public and scientific opinion was instrumental in gaining the passage of this congressional resolution.

Various scientists and educational institutions were subscribers to the expedition. The Smithsonian Institution; Columbia College (N. Y.); J. Lennox, Esq. of New York; Louillard Spencer, Esq.; and Dr. Thomas B. Wilson of Newark, Del. were some of the subscribers to the project.[44] This list of personalities and organizations demonstrated the importance accorded to Coast Survey expeditions and the interinstitutional cooperation which the Survey exercised.

The expedition made extensive physical observations such as temperature variances during the eclipse, dew point variances, ozone levels, tidal observations, moon observations and sky tint changes. Each scientist observed his specific interests. The interests of B. A. Gould (of Cambridge) rested with color observation while Joseph Henry of the Smithsonian was concerned with magnetic observations. All of this data collection was justified with pratical application. The Survey claimed that these observations would

make their publication more accurate thru confirmation of geodetic measurment procedures.[45]

According to the 1860 Annual Report of the Superintendent the 1860 Solar Eclipse Expedition was a great success. Narratives of observations by selected scientists were included in the Annual Report, as well as encyclopedic lists of physical data recorded.[46] Again the comprehensive publication of pure scientific fact demonstrated the Survey's belief that pure science and applied science fit hand in glove. The success of the mission and Labrador government cooperation with the Coast Survey exemplified the extensive, complete planning which preceded the field operation.[47]

In summation, as Dupree traced in his work, Science in the Federal Government, Bache recognized the positive relationship between science and the federal government. The "advanced state of astronomy" was directly related to its connection with navigation.[48] Bache hoped to establish an extensive network of governmental patronage with many scientific disciplines. Bache's quest for a central scientific agency and his extensions of the Coast Survey into pure research exemplified Bache's attempts to reach that goal.

Although a central governmental scientific agency was not created during Bache's lifetime, his exploits were not in vain. Bache's work with the Coast Survey (1843-67), and his work with the military during the Civil War, formed a close link between science and the federal government. Therefore, as Bache's child, the Coast Survey, grew, the ties between science and the bureaucracy

gained acceptance.

ENDNOTES

[1]Nathan Reingold (Compiler), Preliminary Inventory of the Records of the Coast and Geodetic Survey (Washington, D.C.: National Archives, 1958), p. 2.

[2]Gustavous Webber, Coast and Geodetic Survey, (Baltimore, Md., 1923), pp. 75-77.

[3]Edward W. Blunt,"The Coast Survey," Harper's New Monthly Magazine, March 1879, p. 506; see also, American Philosophical Society, "Report of the Committee Upon A. D. Bache's Letter Relative to the U. S. Coast Survey," Philidelphia, Pennsylvania, 1849, p. 2.

[4]Reingold, Preliminary, pp. 1-2.

[5]"Remarks Upon the Survey of the Coast of the United States," 15 February 1842, Entry 1 of"Letters Received Relating to the Coast Survey," 1832-59, 1861-64, Center for Polar and Scientific Archives, Record Group 23, National Archives, Washington, D.C.

[6]Webber, Coast Survey, pp. 75-76.

[7]Reingold, Preliminary, pp. 1-3; see also, Blunt, "The Coast Survey", pp. 506-21.

[8]Reingold, Preliminary, pp. 1-2; see also, "Remarks Upon the Coast. . .", Entry 1, Record Group 23.

[9]"Remarks Upon the Coast . . .", Entry 1, Record Group 23.

[10]A. H. Dupree, Science in the Federal Government (New York: Harper and Row Publishers, 1957), pp. 100-105; see also, Reingold, Preliminary, pp. 1-2, 6.

[11]National Portrait Gallery, The Lazzaroni (Washington,D.C.: Smithsonian Institution Press, 1972), pp.13-15; see also, William J, Youmans, Pioneers of Science in America (New York: D. Appleton Co., 1896), pp. 436-40.

[12]National Portrait Gallery, The Lazzaroni, pp. 13-15.

[13]Youmans, Pioneers, pp. 436-46; see also, Nathan Reingold, "Alexander Dallas Bache, " in The Dictionary of Scientific Biography, ed. Charles C. Gillispie (New York: Charles Scribner's Sons, 1974), pp. 363-64.

[14]Reingold, Dictionary of Scientific Bio., pp. 363-64.

[15]R. M. Patterson to John C. Spencer, November 22, 1843. "Letters Received Relating to the Coast Survey," Series 1, Record Group 23, Center for Polar and Scientific Archives, National Archives, Washington,,D. C.

[16]Charles Davis to John C. Spencer, December 1, 1843. "Letters Received Relating to the Coast Survey," Series 1, Record Group 23, Center for Polar and Scientific Archives, National Archives, Washington, D. C.

[17]Reingold, Preliminary, pp. 1-4.

[18]Dupree, Science, p. 100.

[19]Dupree, Science, pp. 100-02; see also, Blunt, "The Coast Survey", pp. 506-10.

[20]National Portrait Gallery, The Lazzaroni, p. 16

[21]The Coast Survey, Report of United States Coast Survey Showing the Progress of the Survey During the Year 1867 (Washington, D. C.: Government Printing Office, 1869), pp. 55-56.

[22]Blunt, "The Coast Survey", pp. 510-18.

[23]Dupree, Science, pp. 132-33.

[24] A. D. Bache to Charles A Spencer, May 25, 1861, American Philosophical Society Archives, APS Philidelphia.

[24a]Reingold, Preliminary, p. 15; see also, "Notes on the Coast of the United States," Series 17, Record Group 23, Center for Polar and Scientific Archives, National Archives, Washington, D. C.

[25]Reingold, Preliminary, p. 15; see also, "Records Relating to the Defenses of Philadelphia," Series 19, Record Group 23, Center for Polar and Scientific Archives, National Archives, Washington, D. C.

[26]Dupree, Science, pp. 132-33

[27]National Portrait Gallery, The Lazzaroni, p. vii.

[28]Dupree, Science, pp. 114-19.

[29]Dupree, Science, p. 114; see also, Youmans, Pioneers, pp. 436-40.

[30]Based on personal correspondence between John F. Frazier and A. D. Bache, 1843-1870, American Philosophical Society Library, APS, Philidelphia; see also, Youmans, Pioneers, pp. 440-45.

[31]Based on personal correspondence between Joseph Winlock and A. D. Bache, 1846-1857, American Philosophical Society Library, APS, Philidelphia.

[32]Based on personal correspondence between Robert Anderson and A. D. Bache, 1819-1865, Library of Congress: Manuscript Division, Washington, D.C.

[33]National Portrait Gallery, The Lazzaroni, pp. 13-15; see also, Joseph Henry, National Academy of Sciences Biographical Memoirs (Washington City: Home Secretary, 1877), pp. 181-212.

[34]APS, "Report of the Committee on A. D. Bache . . .", pp. 1-14.

[35]APS, "Report of the Committee on A. D. Bache . . .", p. 1.

[36]APS, "Report of the Committee on A. D. Bache . . .", pp. 2-6.

[37]APS, "Report of the Committee on A. D. Bache . . .", pp. 7-9.

[38]APS, "Report of the Committee on A. D. Bache . . .", pp. 10-12.

[39]APS, "Report of the Committee on A. D. Bache . . .", p. 16.

[40]"Mobile Harbor Special Survey," Series 16, Record Group 23, Center for Polar and Scientific Archives, National Archives, Washington, D. C.

[41]"Mobile Harbor . . ." Series 16, Record Group 23.

[42]The Coast Survey, Report of the United States Coast Survey Showing the Progress of the Survey During the Year 1860, (Washington, D. C.: Government Printing Office, 1861), pp. 17-18,88-90.

[43]"Records Relating to the Solar Eclipse of July 18, 1860," Series 15, Record Group 23, Center for Polar and Scientific Archives, National Archives, Washington , D.C.

[44]"Records Relating to the Solar Eclipse of July 18, 1860," Series 15, Record Group 23.

[45]"Records Relating to the Solar Eclipse of July 18, 1860," Series 15, Record Group 23.

[46]"Records Relating to the Solar Eclipse of July 18, 1860," Series 15, Record Group 23.

[47]The Coast Survey, Annual Report for the Year 1860, pp. 229-272.

[48]Dupree, Science, p. 117.

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This was an excellent article which explained the work of the Survey. It gave a brief history of the Survey. It also commented on the popular support of the Coast Survey's work.

"Methods of Study in Natural History," Philadelphia Inquirer 12 October 1863, p. 4 col. 3.
This article described the impact that the Coast Survey had on the study of natural science. It also commented on A. D. Bache's procedures and standards.

Philidelphia, Pennsylvania. American Philosophical Society Library. John F. Frazer Correspondence 1843-1870.
This collection was an excellent source of information for Bache's scientific/personal relationships. The letters in this collection commented on Bache's position in the scientific world.

_____. American Philosophical Society Library. Joseph Winlock Letter Box.
This collection was a good source for the thesis. Its contents examined Bache's ability to deal with scientists and politicians.

_____. American Philosophical Society Library. APS Archives. "Report of the Committee Upon A.D. Bache's Letter Relative to the U. S. Coast Survey." 19 January 1849.
This very helpful source examined the Society's view upon the scientific quality of the work done by the Coast Survey.

Washington, D.C. National Archives. Center for Polar and Scientific Archives. Record Group 23. Records of the Coast and Geodetic Survey.
This record group served as the main preliminary source for this thesis. Entry 1 provided letters of recommendations for A. D. Bache. Entry 14 provided information concerning Bache's research on magnetism. Entry 15 provided information dealing with the 1860 expedition to observe the solar eclipse in Labrador. Entry 16 provided information concerning the Mobile

Harbor special survey. Entry 17 provided information about Survey cooperation with the Navy during the Civil War. Entry 19 provided information concerning Bache's surveying the city of Philadelphia's defenses. The published Annual Report of the Superintendent (1844-60) proved useful in supplementing the information in this record group.

Washington, D.C. Library of Congress: Manuscript Division. Robert Anderson Papers 1819-1919.
Although these papers displayed Bache's military connection, they failed to be as useful as expected.

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