

## Spencer Fullerton Baird and the Foundations of American Marine Science

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In 1863, Spencer Fullerton Baird blazed a path that would be followed by thousands of future biologists when he came to Woods Hole, Mass., to undertake summer research. Until his death in 1887, Baird returned again and again to this delightful New England village. In the process, he established institutional foundations which deeply influenced the future of American marine science.

Spencer Baird was one of America's preeminent systematic zoologists in the mid-19th century. His bibliography included hundreds of contributions on reptiles, amphibians, fishes, and especially on mammals and birds. In a

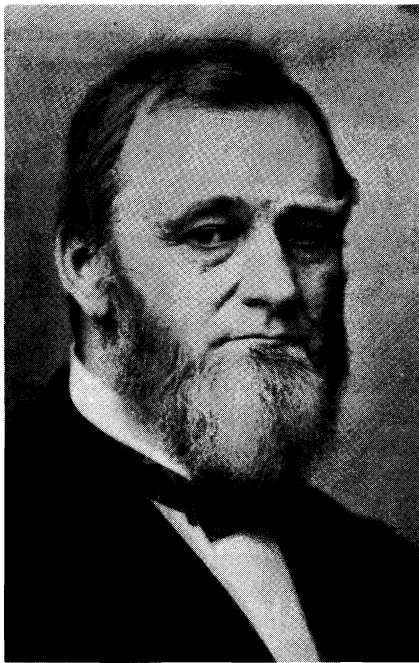
period prior to the establishment of the nation's great graduate schools or most of the other learned institutions that lent support to American scientists, Baird was fortunate to have an appointment as assistant secretary of the Smithsonian Institution, which then was directed by the physicist Joseph Henry. At that institution, Baird was especially active in developing the National Museum largely through his skill in obtaining generous Congressional appropriations. That museum would reach its full fruition after 1878 when Baird succeeded Henry as the Smithsonian's secretary.

In addition to this major effort, Baird became increasingly interested in marine biology during the decade of the 1860's as he combined vacations at various points along the eastern seashore with the collection and study of oceanic organisms. By 1870, when he returned to Woods Hole for a second summer, Baird was well aware that European biologists were turning to the mysteries of the oceans with increasing fascination. At that time, Anton Dohrn was laying the foundations for his famed research station at Naples, Italy, and within 2 years the HMS *Challenger* would embark C. Wyville Thomson and his scientific team upon an historic oceanographic cruise throughout the world's major oceans. In a more general sense, biological activity in the marine environment was promoted by Darwin's "Origin of Species," which had been published in 1859. For evolutionists, the

study of the oceans had special significance since the sea was believed to be the ancestral home of all life. Further, the flora and fauna of the oceans were remarkably diverse, abundant, and relatively simple compared with terrestrial forms. For all of these reasons, marine biology had special appeal to Baird, as it did to many other naturalists of his time (Schlee, 1973).

It was typical of the Smithsonian's assistant secretary that he could depend upon the assistance of the Federal government in undertaking his scientific enterprises. During the summer of 1870, probably because of the intercession of Baird's close friend, Senator George Edmunds of Vermont, who was vacationing at Woods Hole, a U.S. Revenue Service craft was loaned to Baird to assist in collecting marine specimens, including a number of species not previously reported as part of the fauna of Massachusetts. During that summer, Baird also became aware of a long-standing dispute in the Vineyard Sound and Buzzards Bay area, and for that matter along much of the rest of the northeast coast, which seemed to invite solution by cool scientific reason. Baird seized upon that controversy to establish a Federal agency that would be dedicated to the solution of practical problems, but also promised to support fundamental research in American waters.

The issue which was reaching a crisis in that summer of 1870 involved a classic conflict between competing groups seeking to use the nation's natural resources. On one side of the dispute were relatively well capitalized groups of men who erected fixed coastal nets and barriers, known as traps or pounds and a variety of other names, which made enormous catches of fish. On the other



Spencer F. Baird

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side were small-scale fishermen who typically fished by line from small boats, often for their personal subsistence, and the growing number of sport fishermen who came to the seashore for recreation. The latter groups were increasingly alarmed by the decline of such coastal species as the scup, sea bass, tautog, and striped bass, and soon concluded that their problem stemmed from the massive catches taken by fixed nets and barriers. The solution, in the opinion of the boat and sport fishermen, was simple. Fish traps and pounds should simply be outlawed by state law.

As the politicians in southern New England contended with these demands and the vigorous counter arguments of the owners of the traps and pounds, Spencer Baird volunteered to undertake a scientific study of the coastal fisheries provided that Congress would appropriate the necessary funds. Baird's skill as a lobbyist and the influence of his many friends in Congress led in 1871 to an act authorizing the United States Commission of Fish and Fisheries. That body was charged with determining whether American fish stocks had, in fact, declined. If such a decline were established, the Commission was to determine its cause and to propose corrective measures. An initial appropriation of \$5,000 was allocated for these purposes and Spencer Baird agreed to serve as the director of the new agency for no additional salary beyond that received in his capacity as a Smithsonian official.

In 1871, Baird returned to Woods Hole, accompanied by a small group of scientific volunteers, and established his headquarters at a Light House Service building in Little Harbor. Taking advantage of provisions in the enabling legislation which encouraged other governmental agencies to render assistance, he obtained the services of three small Revenue Service and U.S. Navy craft to take scientific collections off the southern coasts of Massachusetts and Rhode Island. The approach defined by the new Commissioner was broad in nature, involving not only an examination of the quantity and location of marine species, but also the availability of their food supplies, the possible impact of parasites or diseases, and the influence of

weather, water temperature, salinity, and currents upon fish population.

Baird's study confirmed that there had been a decline in the numbers of fish off southern New England. He also concluded, much too hastily as it turned out, that man's intervention through the use of traps and pounds, especially by interfering with the spring spawning process, was one important factor in this decline. His recommended solution, however, was that these devices should be prohibited during only a portion of the spawning season rather than abolished outright.

Despite the crafty compromise developed by Baird between the outright elimination and unhindered use of traps and pounds, the state legislatures in Rhode Island and Massachusetts were not inclined to enact the regulations that he suggested. To add to Baird's distress, it also became evident in the following year that an enormous new year-class of the scup was present in the waters of New England, despite the failure to control the catches taken by fixed nets and barriers. It is not surprising that, after 1872, Baird was convinced that an understanding of the dynamics of oceanic populations was a much more complex matter than he had imagined when he began his work as the U.S. Fish Commissioner.

Insofar as Baird's scientific interests were concerned, the results of the Fish Commission's early operations were more promising. From his station in Woods Hole, Baird and his scientific associates received the enormous collections of marine life taken in the area and used these materials as the basis for a number of papers and monographs. Among these were life histories of the scup and a new catalog of coastal fishes prepared by Theodore Gill. William G. Farlow (1873), who expressed thanks to Baird for "opportunities for collecting. . . such as no American algologist has ever before enjoyed," assessed seaweeds in the area. An even larger series of invertebrate forms fell under the observant eyes of Addison E. Verrill of Yale. Verrill's 500-page monograph, "Report Upon Invertebrate Animals of Vineyard Sound and Adjacent Waters With an Account of the Physical Characters of the Region," was published in

the Fish Commission's first annual report in 1873 and represents an important landmark in the history of American marine biology. There was, of course, a practical rationale for this study, due to the importance of these forms as a food source for commercial fishes. Nevertheless, Verrill's research also demonstrated that Baird's vision of using the Fish Commission as a foundation for broad investigations in the marine sciences was being fulfilled.

Despite the disappointing practical results of the Fish Commission's first year of operation, Congress showed no inclination to halt annual appropriations for this new agency. Under these circumstances, there was a prospect that many additional contributions, perhaps similar in importance to Verrill's study, would continue to appear. These conditions were reminiscent of A. Hunter Dupree's assessment of the characteristics of much government science in the 19th century. Certainly, Dupree's (1957) observations that "practical problems tended to reach out in ever-widening circles of theoretical considerations," and "ad hoc organizations tended to become permanent" apply remarkably well to the Fish Commission.

One reason for the permanence of the Fish Commission (it counts as one of its direct successors the National Marine Fisheries Service) was Baird's willingness to undertake a highly utilitarian program involving the hatching and redistribution of desirable species to replenish America's increasingly barren waters. To some extent, this new emphasis upon multiplying resources superseded Baird's interest in conserving these populations through regulation, a very difficult task due to the large number of states involved and the uncertainty of Federal authority in coastal and interstate waters. Baird did continue to recommend that states enact laws to protect the spawning process, restrict the taking of undersized fish, halt pollution, and build fishways on major rivers that would allow anadromous fish to reach their spawning grounds. But, despite the enactment of a number of measures along that line, basic inconsistencies between state regulations and a continuing problem of enforcement plagued

Baird's regulatory efforts to the end of his life.

The seemingly more feasible solution of supplementing natural populations of fish with a hatchery program was being pursued by several eastern states in the 1870's, especially as a result of political pressure from the sport fishing community. These efforts, however, needed to be augmented by the Federal government, and it was not long before contact was made with Spencer Baird. Largely as a result of his typically quiet but effective efforts on Capitol Hill, Congress appropriated the sum of \$15,000 in 1872 and directed the Fish Commission to introduce desirable species into the waters of the United States. The appropriation act specifically mentioned the propagation of salmon and whitefish and, remarkably enough, required that an effort be made to establish the Atlantic shad in the Gulf Coast and Mississippi Valley regions.

Working in close cooperation with state commissions, Baird undertook this new program with considerable enthusiasm. In fact, fish culture soon became the single most important activity of his organization. By Baird's death in 1887, annual appropriations for artificial propagation had grown to \$200,000 per year, out of the agency's total budget of \$268,000. The great majority of Baird's 105 employees in 1887 were engaged in fish culture at various locations in the United States. Also available to the commission was a ship built in the late 1870's, the *Fish Hawk*, that was specially designed as a floating hatchery.

This program was exceedingly popular, especially since Baird assured that young fish or impregnated ova were distributed to the entire nation, preferably through individual applications to the local congressman. In this way, he assured political support for an activity that was widely perceived as a humanitarian effort to improve the nation's food supply. A classic example was Baird's effort to introduce the German carp for pond culture on the nation's farms. The carp thrived in American waters and initially were received with enthusiasm. But, at the time of Baird's death it was evident that Americans did not share the European culinary taste for this species.

Further, the carp, having escaped from their ponds, were considered by most observers to be a trash species that crowded out more desirable fish, a problem that persists to the present day.

Baird also sought to replenish other inland fisheries in conjunction with state agencies. For example, the rainbow trout, originally found on the west coast, was established in other areas of the United States. Additionally, the Fish Commission pioneered the introduction of the German brown trout into this country. There also was a continuing but unsuccessful effort to halt the decline of the Great Lakes whitefish through hatchery operations.

So far as anadromous species were concerned, the Fish Commission concentrated much attention on hatching Pacific and Atlantic salmon. In addition to supplementing the runs in their local regions, Baird undertook the transplantation of Pacific species to the east coast. But, despite initial signs of success, these efforts were outright failures or at best yielded dubious results in maintaining salmon populations.

In accordance with Congressional directions, Baird worked with the Atlantic shad. Again, however, the results were uneven. Baird may have helped to maintain their runs on some rivers along the east coast, but the effort to establish the shad in the Gulf Coast and Mississippi Valley regions was an outright failure. On the other hand, shad were introduced successfully on the west coast. In a related program, the striped bass also were transplanted to Pacific waters.

Baird was not naive enough to believe that artificial propagation could have a general effect on oceanic species. But, in the 1870's he held forth the hope of using hatcheries to establish local schools of cod and other species in the coastal waters of New England. Starting in 1878, the Commissioner established such a facility at Gloucester, Mass., which was given credit for improved fishing in that area. Building upon that experience, the Commissioner then obtained a series of Federal appropriations between 1882 and 1885 to erect a hatchery, originally for cod, at Woods Hole. As Baird noted in his approaches to

Congress, Woods Hole was an ideal location due to its relatively mild winters, and pure, saline, and clear waters. The closeness of the village to New England's major fishing grounds was an added advantage. By 1885, two imposing buildings were completed, one of which housed fish culture apparatus and scientific laboratory facilities. The other was a residence for the Fish Commission's staff. At the time of Baird's death in 1887, major cod hatching operations had been underway at Woods Hole for only a short time. Nevertheless, there were reports that for the first time in many years, cod were being taken close inshore at Woods Hole, a happy circumstance that appeared to have resulted from the Commission's artificial propagation activity. In the longer run, however, it became evident that the effort to replenish coastal cod stocks was a failure (Bigelow, 1931).

Another major utilitarian program of the Fish Commission grew out of a diplomatic settlement in 1877 by which the United States paid Canada \$5.5 million for use of the Dominion's inshore fisheries. Baird had been the chief American scientific witness at the arbitration in Halifax, Nova Scotia, which granted this award, but he was convinced that it was an exorbitant judgement that overvalued the Canadian fisheries. In his opinion, it also failed to take into account the countervailing value of American waters which were available to the Canadians on a reciprocal basis. This conclusion and the prospect of further diplomatic negotiations after the Halifax settlement expired in the mid-1880's, led to Baird's interest in compiling detailed statistics and other information on the fisheries of the North Atlantic. In light of the Canadian-American controversy over fishing rights, which was hardly unique to the late 19th century, Baird also resolved to offer aid to American commercial fishermen that to some extent would offset the generous subsidies offered to the Canadian industry by its government. He also shared the hope of many American politicians and diplomats to make the United States independent of the Canadian inshore fisheries.

One of Baird's initial achievements was to plan a comprehensive survey,

prepared under the direction of his Smithsonian colleague, George Brown Goode, and entitled "The Fisheries and Fishery Industries of the United States." Baird arranged for this work to be sponsored by the U.S. Census Bureau and some of Goode's findings appeared in the Tenth Census of the United States. The total data collected, however, included insights into the social history of American fishermen, information on virtually every major fishing port in the United States, scientific descriptions of hundreds of species of fish, and practical details on fishing methods and grounds. Since this material was too extensive for inclusion in the census, Baird obtained a special Congressional appropriation in 1882 to print Goode's study as a separate seven-volume publication.

Also of significance to the history of American marine science was Baird's search for new fishing areas, preferably in waters as far removed from Canada as possible. In 1879, a commercial schooner out of Gloucester discovered off the coast of Massachusetts large quantities of a species, the tilefish, that seemed to have all of the merits of cod. Although it later was learned that this fish fluctuated widely in its abundance and hence was not always a viable commercial catch, Baird used the tilefish as a prime example of the benefits of a systematic exploratory program. On this basis, he was successful in 1881-82 in obtaining from Congress appropriations of \$190,000 for a famous ship, the *Albatross*, that may have been the first especially designed oceanic research vessel built anywhere in the world. This 234-foot steamer was delivered to the Fish Commission in 1883 and continued to make notable contributions to the oceanographic sciences over the next 38 years (Hedgpeth, 1945).

As promised by Baird, *Albatross* did undertake surveys with direct relevance to America's fishing industry. These included studies of the migrations of mackerel and menhaden and a pioneering investigation of the Gulf of Mexico, including the red snapper and shrimp fisheries. At the time of Baird's death, the ship also was preparing for a voyage to the Pacific Northwest, which, as

was true for the Gulf of Mexico, then was an area little used by American fishermen. But, as will be noted, the *Albatross'* contributions to economic ichthyology were limited by Baird's obvious preference to use the vessel for scientific surveys of the North Atlantic. One observer noted in 1891, for example, that the great majority of the ship's stations had been on the outer edge of the continental shelf "outside the ordinary range of fishing grounds" (U.S. Congress, 1891).

The Fish Commission also sought, after the Halifax arbitration of 1877, to improve the equipment used by American fishermen. For example, Baird demonstrated the value of gill nets, which had been developed in Europe, and laid the basis for a modest winter cod fishery off the New England coast. These nets were of particular interest since, through their use, it was possible to avoid the expense and difficulty of purchasing bait, much of which came from Canadian waters. The Fish Commission also introduced the beam trawl, another European device. This net proved its effectiveness, but it was little used by the American commercial fishing industry until after the turn of the century. Finally, Baird's agency promoted a new type of schooner to replace the speedy but dangerously unstable vessels used in the offshore fisheries. Baird's staff specifically designed a vessel named *Grampus* featuring a deeper hull and improved sail plan. *Grampus* was one of several prototypes that influenced the development of improved schooners after the mid-1880's.

Spencer Baird had no hesitation in applying science to the practical ends specified in the expanding appropriations received by the Fish Commission between 1871 and 1887. But, Baird's close associates knew that his most fundamental interest was in using that agency as an engine for basic research in the marine sciences. In fact, taking what one friend (Goode, 1884) termed a "liberal and philosophical interpretation of the law," and recognizing that practical ends would be served by a "series of thorough inquiries into the general physical and natural history of the seas," Baird (1874) proceeded to undertake the

first sustained scientific study of American waters.

This aspect of the Fish Commission's program primarily was associated with its summer laboratories. Between 1872 and 1880, those stations were established at various points along the northeastern coast, ranging from Noank, Conn., to Halifax, N.S. Woods Hole, however, continued to hold a special attraction for Baird. He returned there in the summer of 1875 and then, in 1881, announced that henceforth Woods Hole would be his permanent base of operations. It was at that time that the Fish Commissioner began his campaign to obtain Congressional appropriations for facilities to hatch oceanic species at Woods Hole. That fine, deep-water port also would serve as a base for the Commission's vessels.

Both at Woods Hole and at the other locations used by Baird prior to 1881, simple laboratories were established for the Commission's use. Into these facilities came large collections of marine specimens originally collected by vessels of the Navy, Coastal Survey, and Revenue Service that were on loan to the agency. After the late 1870's, the Fish Commission's own ships, including *Fish Hawk* and *Albatross*, also were used for this purpose. To study these collections, Baird continued to invite volunteer scientists to join him for the summer. In the decade of the 1880's, the visiting investigators averaged about 15 in number. Aside from offering rich research materials for these biologists, Baird extended other inducements, including the opportunity to retain duplicate specimens and the prospect of publishing scientific papers in the annual reports and bulletins that were printed for the Fish Commission at government expense. A few of these scientists, who were considered temporary government employees, received small salaries for their summer work.

The central figure in Baird's scientific corps was Addison E. Verrill of Yale University, a well-known specialist in marine invertebrates. The Fish Commission also secured the services of a number of Verrill's students, including such men as Edmund B. Wilson and C. Hart Merriam who were destined for

scientific fame. Another dominant figure was George Brown Goode, who directed the Wesleyan College museum until 1877 when he joined Baird at the Smithsonian. Goode was the specialist in charge of the fishes collected by the Commission.

In the 1870's, the primary focus of Baird's scientific effort was on the continental shelf. Here enormous collections were taken by the Fish Commission, including hundreds of species that were new to science. The systematic zoologists associated with the Fish Commission categorized and described these specimens in numerous scientific papers. Such investigators as A. S. Packard of the Peabody Academy of Sciences also prepared papers on the distribution of marine life, including its relationship to physical oceanography, that were important contributions to the ecological literature on New England's waters. Other notable contributions included writings on marine botany by William G. Farlow of Harvard and a large number of papers by John Ryder, who was the Commission's full-time embryologist between 1880 and 1886.

In the late 1870's, however, the Fish Commission's attention increasingly turned to the deep waters of the continental slope and the oceanic basin, which at that time were areas little known to marine scientists. Some sense of the excitement felt by the Commission's investigators was conveyed by Goode's reaction to the organisms taken from 160 fathoms in the summer of 1877 at a station 44 miles off Cape Ann, Mass. Goode (Osborn, 1901) noted:

"It seems incredible that American naturalists should not then have known that a few miles away there was a fauna as unlike that of our coast as could be found in the Indian Ocean or the seas of China."

Three years later, Baird diverted his newly completed hatchery vessel, the *Fish Hawk*, from her normal duties and directed her to another station on the Gulf Stream slope. The *Fish Hawk*, in the Commissioner's words (Baird, 1881), returned with examples of a "most wonderful fauna, vastly exceeding in richness and extent anything known to science." It probably is no coincidence

that after 1880 Baird began his campaign to obtain funding for *Albatross*. Although this steamer was justified to Congress for use in developing commercial fishing grounds, *Albatross* was specially designed and equipped for deep-sea scientific research. Her first dredging station, occupied in 1883, was in waters with a depth of 1,400 fathoms, a most unpromising area for species of commercial importance.

The task of studying the rich collections of deep-water specimens taken in the 1880's was divided between Addison E. Verrill and his students, who handled the invertebrates, and George Brown Goode, who worked with the fishes. Eventually, Verrill wrote almost 100 papers based on the Fish Commission's collections. Goode collaborated with Tarleton H. Bean, who had access to the more modest collections of deep-sea fishes obtained by Alexander Agassiz during his private cruises in the steamer *Blake*. In 1896, Goode and Bean published their results in "Oceanic Ichthyology." With a degree of chauvinism the authors noted that the 49 new genera and the 147 species of deep-sea fishes covered in their monograph represented a greater number than had been obtained by *Challenger* in her famous oceanographic cruise.

Aside from these fundamental contributions to marine biology, Baird also developed in the 1880's an ambitious plan to use his base at Woods Hole as the nucleus for a much broader program of research and education. In constructing this facility, Baird obtained advice from Anton Dohrn whose marine station at Naples was already famous in the world of science. One of Dohrn's practices that was followed at Woods Hole was to sell research tables to other institutions, which in the case of Baird's laboratory included four universities and colleges: Johns Hopkins, Harvard, Princeton, and Williams. In addition, the Fish Commissioner controlled, through wealthy friends, a quantity of land that was adjacent to his own building. Baird's benefactors were willing to donate or lease these lots to other scientific institutions that might be willing to join the Fish Commissioner at Woods Hole.

Baird's overall plan was spelled out in 1882 in a personal letter to Daniel C. Gilman, the President of Johns Hopkins University (Baird, 1882). The Fish Commissioner proposed to make available excess land in the vicinity of his buildings to universities or colleges desiring to erect special laboratories or summer schools of natural history for their students. As a further inducement, he suggested that the occupants of the tables in the Fish Commission's laboratory would offer a series of lectures to combined classes of these students. Additionally, Baird offered to construct a common mess. Presumably, the rich scientific collections brought in by the commission's vessels also would be available for this informal university of marine biology.

The Fish Commissioner's vision was not fulfilled during his lifetime. To a large extent, this was due to an embarrassing dispute that began in 1885 when an official of the new Administration of Grover Cleveland charged that the Fish Commission's rather elaborate facilities at Woods Hole, which included a residence building and scientific laboratories, far exceeded the intent of Congress in making funds available for a marine fish hatchery. Baird's friends in Congress soon forced this investigation to be dropped, but in the 2 years remaining in his life, Baird was very cautious about undertaking any activity that might be questioned. That certainly included the establishment at Woods Hole of a summer university under the inspiration and guidance of a government agency.

Nevertheless, it also needs to be noted that a significant part of Baird's dream would be realized in 1888-89 when his long-time friend and summer laboratory associate, Alpheus Hyatt, took a leading role in establishing the Marine Biological Laboratory (MBL). Although that institution was entirely separate from the Fish Commission, Hyatt (1888) suggested that the MBL was a direct outgrowth of Baird's educational scheme. Of course, in the longer run, the MBL was joined by other scientific institutions, including the Woods Hole Oceanographic Institution. One can only conclude that, if Spencer Baird were alive

today, he would be pleased, but not entirely surprised, by the distinguished research and educational enterprises that are located in this area.

In looking back at Baird's stewardship of the Fish Commission through the first 16 years of its existence, one must be impressed by the continuities between the late 19th century and our own time. After all, the issues that his agency addressed are familiar ones, including the dynamics of marine populations, efforts to maintain and enhance the productivity of commercial fisheries, direct aid to the fishing industry through improved techniques and exploratory fishing, and finally a vigorous program of basic research. But, in the largest context, Baird perhaps can best be remembered as one of the able institution builders of a century ago who recognized the essential need for universities, museums, and

government agencies to support and encourage an American scientific community that was then in its infancy. The foundations laid by such men as Spencer Fullerton Baird were the essential precondition for the thriving marine scientific community that is so visible in the Woods Hole of today.

(Note: Unless otherwise indicated, this paper is based upon the author's "Spencer Fullerton Baird and the U.S. Fish Commission: A Study in the History of American Science." Arno Press, N.Y., 1978.)

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