

Sea Grant College Program  
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# Science, Politics, and the Sea Grant College Program

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*Abstract* During its eighteen-year history of research, education, and advisory activities, the National Sea Grant College Program has played a distinctive role in the nation's efforts to develop, use, and manage its marine resources. The partnership between Sea Grant universities, marine industries, and government agencies has resulted in demonstrable scientific and economic contributions. Despite these successes, the Reagan Administration has proposed termination of the program and embroiled it in a lengthy political struggle for survival. Should Sea Grant survive, its future success will depend increasingly on its ability to support an expanded basic research program.

Congress established the National Sea Grant Program in 1966 to hasten the development, use, and conservation of the nation's marine resources. After eighteen years of modest federal support—never more than \$42 million in any one year—twenty-one universities have been designated Sea Grant Colleges by the Secretary of Commerce, eight more have major institutional programs, and some 250 additional academic institutions have taken part in some aspect of Sea Grant research, education, and advisory activities. Despite its small size Sea Grant fills a distinct

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niche in the nation's ocean science and resource programs. This paper reviews the evolution of the Sea Grant program, describes features which have contributed to its success, and concludes with a discussion of issues bearing on its future.

### **The Beginnings, 1963–1970**

Oceans were high on the public agenda of the 1960s. Congress and the executive agencies were seeking ways to improve the performance of federal ocean activities and expand the political influence of the ocean agencies within the executive branch.<sup>1</sup> These efforts culminated with passage of the Marine Resources and Engineering Development Act of 1966 (P.L. 89-454). The act established a temporary cabinet-level council headed by the Vice President and a commission to chart a full-fledged national policy for the development and use of marine resources.<sup>2</sup>

Credit for the Sea Grant idea clearly belongs to inventor, engineer, and scientist Athelstan Spilhaus. Reflecting on the sorry condition of the American fishing industry in 1963, Spilhaus asked:

Why, to promote the relationship between academic, state, federal, and industrial institutions in fisheries, do we not do what wise men had done for the better cultivation of the land a century ago. Why not have "Sea Grant Colleges?"<sup>3</sup>

The idea sparked the enthusiasm of both professors and politicians.<sup>4</sup> In July 1965, Rhode Island Senator Claiborne Pell introduced legislation to create a network of Sea Grant Colleges which would conduct education, training, and research in the marine sciences and receive support from leases of outer continental shelf lands.<sup>5</sup> The bill moved through the House and Senate with unusual dispatch and was signed into law by President Lyndon B. Johnson on October 15, 1966.

Congress assigned the new program to the National Science Foundation (NSF) and directed that grants and contracts would go to "suitable public or private institutions of higher education, institutes, laboratories, and public or private agencies which are

engaged in, or concerned with, activities in the various fields related to the development of marine resources.”<sup>6</sup> The proposal to support Sea Grant with outer continental shelf lease revenues was scrapped in favor of a matching fund arrangement where federal funds would account for two-thirds and state, local, and private funds the remainder of support. For a decade there were no significant changes in the legislation establishing the program. In 1976 the Sea Grant Improvement Act (P.L. 95-461) set up a Fellowship Program, formalized a National Review Panel, and authorized separate appropriations for a special National Projects and International Program. This version of the Sea Grant charter was reauthorized four times. The only major change was to reinsert the word “College” in the title to emphasize that the goals of the program were pursued through universities.

The Foundation awarded its first major awards in 1968. After a brief stay in NSF, Sea Grant became one of nine ocean and atmospheric programs from five separate departments consolidated in July 1970 by Executive Reorganization Plan No. 4 which established the National Oceanic and Atmospheric Administration (NOAA) as an agency within the Department of Commerce. Rather abruptly the toddling \$6 million Sea Grant Program was relocated from a small science funding agency with close ties to the university research community, to a large confederation of environmental service and research bureaus with little interest or experience in supporting the Sea Grant mission.

### **Building a Network, 1971–1984**

Spilhaus’s vision and Pell’s political leadership provided the foundation for a national network of programs and individuals linked by a common commitment to the development and use of marine resources. The Secretary of Commerce designated the first four Sea Grant Colleges in 1971. During the next decade Sea Grant expanded the number of programs in the coastal and Great Lakes states, put in place advisory and education programs, continued to refine planning and review mechanisms, and articulated a set of values that held the geographically dispersed network together.

**Table 1**  
Sea Grant Programs

	Year Established
<i>Sea Grant Colleges and Regional Consortia<sup>a</sup></i>	
Oregon State University	1971
University of Rhode Island	1971
Texas A&M University	1971
University of Washington	1971
University of Hawaii	1972
University of Wisconsin	1972
University of California	1973
State University of New York and Cornell University	1975
University of Delaware	1976
State University System of Florida	1976
Massachusetts Institute of Technology	1976
University of North Carolina	1976
Louisiana State University	1978
University of Alaska	1980
University of Georgia	1980
University of Maine/University of New Hampshire	1980

<sup>a</sup>*Sea Grant Colleges and Regional Consortia*—The formal designation of “Sea Grant College” or “Sea Grant Regional Consortium” symbolizes a mutual recognition of continuing responsibility, both by the Department of Commerce and the institutions, to develop and maintain the excellence and public usefulness of their research, education, and advisory programs.

By 1985 there were thirty-one programs in twenty-nine coastal states and Puerto Rico, twenty-one of which had been designated Sea Grant Colleges (Table 1). Between 1979 and 1984 they had supported activities in thirty-eight states, plus Guam, and the District of Columbia. This growth was accompanied by the rapid expansion of the marine advisory service. Inspired in large part by the experience of the agricultural extension service, the advisory service is based on a network of coastal county agents and university specialists in a wide variety of marine-related fields. Among these are commercial fisheries, aquaculture, recreation, marine weather, law, transportation, economics, engineering, and seafood technology. By 1983 some 350 men and women served as Sea Grant’s link between university researchers and

Table 1 (continued)

	Year Established
University of Maryland	1982
University of Michigan and Michigan State University	1982
Mississippi/Alabama Sea Grant Consortium	1982
Virginia Graduate Marine Science Consortium	1984
University of Minnesota	1985
<i>Institutional Programs<sup>b</sup></i>	
University of Southern California	1972
University of Puerto Rico	1980
South Carolina Sea Grant Consortium	1980
New Jersey Marine Science Consortium	1981
Ohio State University	1982
Woods Hole Oceanographic Institution	1985
University of Connecticut	1985
<i>Coherent Area Programs<sup>c</sup></i>	
University of Illinois/Indiana	1984

<sup>b</sup>*Institutional Programs*—Those with a broad base of competence in marine affairs, long-range commitment to Sea Grant goals as shown by commitment of the institution's own funds as matching support; creation of organization necessary for management of the Sea Grant program; establishment of interdisciplinary research teams; and development of advisory service mechanisms.

<sup>c</sup>*Coherent Area Programs*—Generally consists of several related projects in either research, education, or advisory services.

those involved in ocean resource development, use, and management.<sup>7</sup>

From Sea Grant's inception in 1966, an estimated 7,000 students have been trained in Sea Grant educational programs, most at the graduate level. It appears that a majority of these students took their first job in the private sector; fewer found jobs in the public sector and schools and universities. Although Sea Grant accounts for a miniscule part of the federal ocean program, by 1983 it was involved in the training of five percent of all marine biologists, 19 percent of all ocean engineers, and 13 percent of all oceanographers graduating from U.S. institutions.<sup>8</sup>

With the establishment of Sea Grant institutions in the coastal and Great Lakes states, the next step in the evolution of the

system was to improve the approach to research planning. Advisory groups, usually comprised of representatives from government, industry, and the universities make recommendations for the general direction of research in individual Sea Grant programs. During the early 1980s ad hoc workshops began to play a key role in establishing and coordinating research agendas in areas as diverse as seafood technology, estuarine research, aquaculture, ocean law and policy, marine-related social science, and the implications of biotechnology for marine resource development.<sup>9</sup> This approach has provided an inexpensive and effective way to plan and coordinate research of national as well as state significance. It also has given prospective users of Sea Grant research and services a role in program development as well as an opportunity to describe problems and issues of particular concern to them.

Development of proposals for each state program follows a similar pattern, including extensive participation from industry, government, and academe in program planning; efforts to draw on the skills and resources in colleges and universities throughout each state; and an arduous process of peer review. Individual proposals which survive those reviews are submitted as part of each state's omnibus proposal to the National Sea Grant Office which typically requests additional peer reviews and conducts a site visit before determining the amount of funds the program will receive. The key distinction between evaluations performed by Sea Grant and most basic research funding agencies is that Sea Grant proposals must withstand not only the critical scrutiny of peer reviewers, but also must persuade prospective users that the research will contribute to the development, use, or management of marine resources.

This distinction is reflected in the well-defined set of values which serves to unify the network. Referred to as the Sea Grant ethic, it embraces a commitment to several fundamental ideas: that ocean issues can be most effectively tackled by many disciplines; that skills and resources in the nation's universities are the keys to expanded use of the oceans and their resources; that success in the oceans requires the full spectrum of basic, problem-oriented, and applied research; that these problems and

opportunities are best tackled cooperatively by scientists, government officials, industrial and commercial firms, and civic groups; that knowledge is not the exclusive province of academic scientists but should be widely shared and used; and that the country's ability to develop, use, and manage its marine resources depends on nurturing talent in all fields of study.<sup>10</sup>

The most important constraint on Sea Grant development has been the gradual increase in federal support and since 1973 the devastating effects of inflation, as reflected in Figure 1.

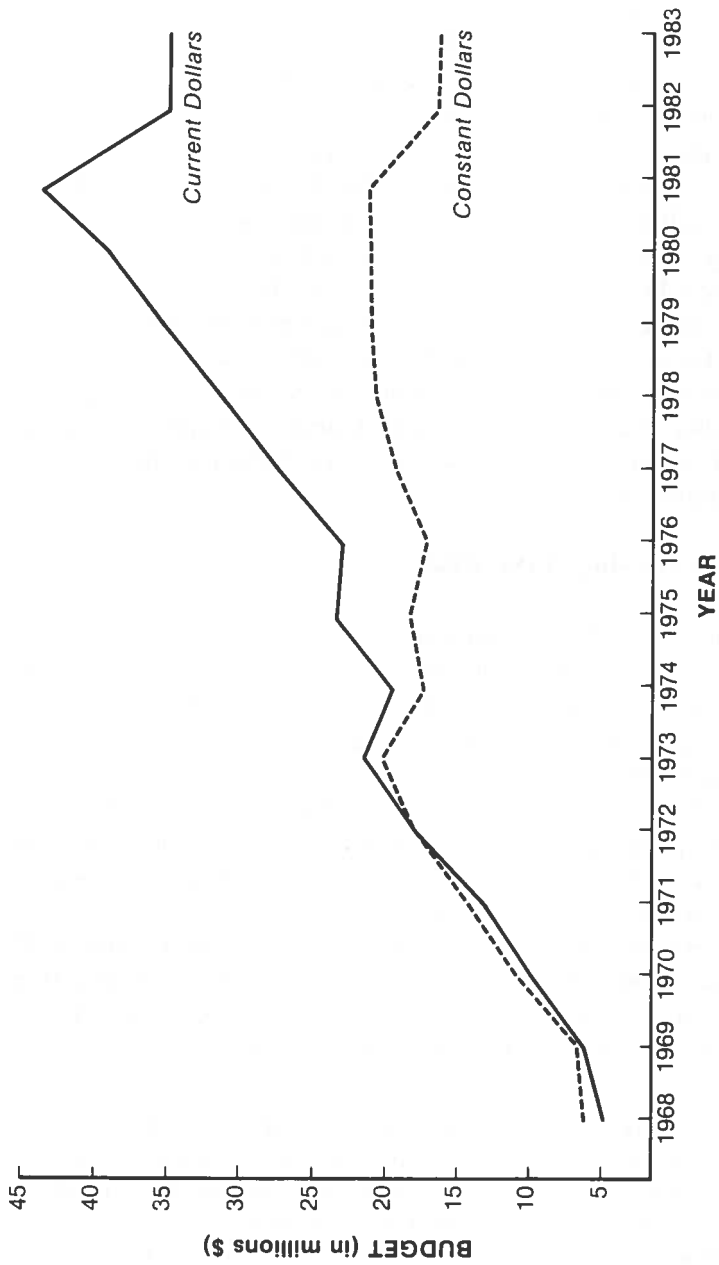
The typical budget pattern since 1976 has been for the Department of Commerce to reduce the amount proposed by the National Sea Grant Office, submit the reduced request to the Office of Management and Budget (OMB), which with few exceptions would further reduce the request to Congress. Congress would then—with some exceptions—sustain or increase the amount actually appropriated.<sup>11</sup>

### **Political Awakening, 1981–1984**

Most state Sea Grant directors clearly recognized that the program's fortunes were tied directly to its budget. During the 1970s they regularly sought to influence budget deliberations and proposed legislation affecting the program through contacts with congressmen and their staffs, testimony, and compilation of information. These efforts were rarely intense or sustained because many of the programs had only begun to take shape, the program was still in the process of coalescing as a network, and the stakes involved only small budget increases.

There was little indication that this pattern would change with the election of Ronald Reagan. In fact, in its survey of the role and performance of federal programs, the conservatively-inclined Heritage Foundation found that Sea Grant

has an impressive record of success, primarily because it is based largely on local priorities and needs. It operates in partnership with State and local governments, private industry, universities, organizations and individuals concerned with or affected by ocean and coastal resources . . . a key element of Sea Grant is its outreach



**FIGURE 1.** Sea Grant funding levels in current and constant dollars, 1968-1983. Constant dollars for 1977-1982 were based on third quarter implicit price deflators, and constant dollars for 1983 were based on second quarter implicit price deflators.



mechanism whereby results of research are provided to users in industry, government agencies and the general public. *Sea Grant funding should be increased by 10 percent in real terms for the next five years.*<sup>12</sup>

The Sea Grant community was stunned to learn in early 1981 that the Office of Management and Budget (OMB) first recommended a drastic cut in program funding, then later total elimination of the program from the fiscal 1982 budget. OMB's task was to slash federal spending, and Sea Grant, as a university research program, clearly fell in the category of spending amenable to control. Moreover, Sea Grant was explicitly committed to the development of a full network of some twenty-five Sea Grant Colleges, plus additional participating institutions, a prospect whose fiscal implications were readily apparent to OMB examiners. The Administration did not, however, justify elimination of Sea Grant on fiscal grounds, but on the basis that the Sea Grant network was in place and that responsibility for its continued support could be turned over to the states and industry, "which are the primary beneficiaries of the projects undertaken by these institutions."<sup>13</sup>

The Sea Grant network moved quickly to counter the termination effort by compiling information demonstrating the contributions of the program, organizing for sustained political involvement, mobilizing constituent support for Sea Grant, and developing full-time representation in Washington. The first job was to demonstrate Sea Grant's contribution to the economy. Less than two weeks after the proposed termination, members of the ad hoc Sea Grant Task Force had compiled an extensive analysis of the economic impact of the program. Based on fifty-seven examples from twenty-six programs, economists estimated that the \$270 million of federal support for Sea Grant during its fourteen-year history had stimulated gross revenues and saving amounting to some \$227 million *annually* for marine industry, commerce, and government.<sup>14</sup>

Based on a survey of Sea Grant programs, it readily became apparent that elimination of federal funds would mean the end of the program. Contrary to the Administration's expectations, those states and universities providing matching funds intended

to reduce rather than increase their share of Sea Grant support in view of the Administration's efforts to terminate the program. In addition, the prospect of an enfeebled program removed any incentives for industry to increase matching support, most of which was in-kind, such as contributions of boat time, laboratory space, and equipment.

The second step was to form a task force under the auspices of the 30-member Sea Grant Association. The Task Force assumed responsibility for designing political strategy for the network, maintaining close contact with Congressional members and staff, presenting Sea Grant's case to Administration officials in the Department of Commerce and the Office of Management and Budget, and coordinating preparation and presentation of information and testimony.

The third step was to mobilize constituent support. In addition to the economic contributions of the program, its researchers, marine advisory agents, and administrators provided information and services to a diverse constituency. This included recreational and commercial fishermen, boaters, marina owners, offshore service companies, resource management agencies, teachers—many of whom received services judged sufficiently useful to stimulate calls and letters of support to Congressional committees important to Sea Grant.

The fourth aspect of the response was to establish permanent representation in Washington. Efforts to ensure that Sea Grant's interests were articulated in Washington had begun in 1967 with the formation of the Sea Grant Association and continued with recruitment of a part-time Washington representative in 1974. By 1977 the Sea Grant Association made a determined effort to develop stronger ties with the National Association of State Universities and Land-Grant Colleges (NASULGC), one of the most politically effective higher education organizations in Washington. Sea Grant directors, many of whom were from Land-Grant institutions, were well aware that the political resources of these schools were based on a long tradition of experience in state politics, the prestige of their presidents, and the personal skills of their Washington representatives.<sup>15</sup> By 1979 the Sea Grant Association shared support for a NASULGC governmental affairs specialist. In November 1983 the Association ap-

proved creation of a Marine Division that would incorporate many activities previously conducted by the Sea Grant Association, thus ensuring permanent representation in Washington.

The favorable response by Congress to Sea Grant was reinforced by the program's Congressional origins, constituent support, the demonstration of economic benefits, and the inability of the Administration to justify termination of federal support for the program. Although the Reagan policy-makers were directing their assaults on the shrinking number of controllable programs in the federal budget, they were still compelled to justify their decisions on specific programs—not aggregate reductions—when they brought their case to Congress. The Administration's arguments were easily refuted by reference to Sea Grant's origins, its evolution, and the benefits ascribed to it. These rebuttals, combined with credible evidence of the positive economic impact of many Sea Grant projects, and the virtual absence of negative or hostile criticism (even from the Administration) put the Administration's spokesmen at a sharp disadvantage. Congress has continued to restore funds for the program on each of the four occasions that it has been proposed for elimination.<sup>16</sup>

## **Discussion**

The budget battle compelled a hard look at where Sea Grant fits in the nation's ocean activities. By federal standards, Sea Grant is a very small program. Despite the modest investment of federal funds, however, it has been the subject of an unusual number of evaluation and oversight studies. These have examined the general effectiveness of the program,<sup>17</sup> Sea Grant's relationship to the National Oceanic and Atmospheric Administration,<sup>18</sup> the contributions of individual research projects,<sup>19</sup> and the attitudes and perceptions of academic marine scientists toward Sea Grant research.<sup>20</sup>

Several themes emerge. First, Sea Grant plays a unique and important role in the nation's marine program. Along with the Office of Naval Research and the National Science Foundation, Sea Grant provides the only sustained contact and source of funds between federal agencies with ocean responsibilities and universities with marine research capabilities. Moreover, Sea

Grant provides virtually the only research support for marine-related subjects outside the traditional academic fields of biological, physical, and chemical oceanography, and geology and geophysics. These include engineering, fisheries, and marine-related social sciences. Where NSF and ONR have remained steadfast in their support of the traditional fields of oceanographic research, Sea Grant has sought to direct its research investment toward areas of more immediate commercial or management interest, though at a much lower funding level. For example, in 1983 NSF support for the four major fields of oceanography was \$49.9 million compared to \$16.2 for Sea Grant support of some thirteen major fields.<sup>21</sup>

Second, Sea Grant's strength is built upon its ability to promote interdisciplinary marine research, education, and advisory activities responsive to both local and national needs. This strength is based on its legislative mandate and its decentralized management structure. Specifically, the law establishing Sea Grant took an extremely expansive view of what disciplines were related to ocean and coastal resources. These included (but were not limited to) the traditional fields in the marine sciences, engineering, marine technology, education, economics, sociology, communications, planning, law, international affairs, and public administration. Program management rests with Sea Grant directors at the universities rather than in Washington. Unlike their counterparts at ONR and NSF, Sea Grant directors are mainly responsible for orchestrating the right mix of skills and knowledge to develop the marine economy, not to develop and sustain the health of specific disciplines.

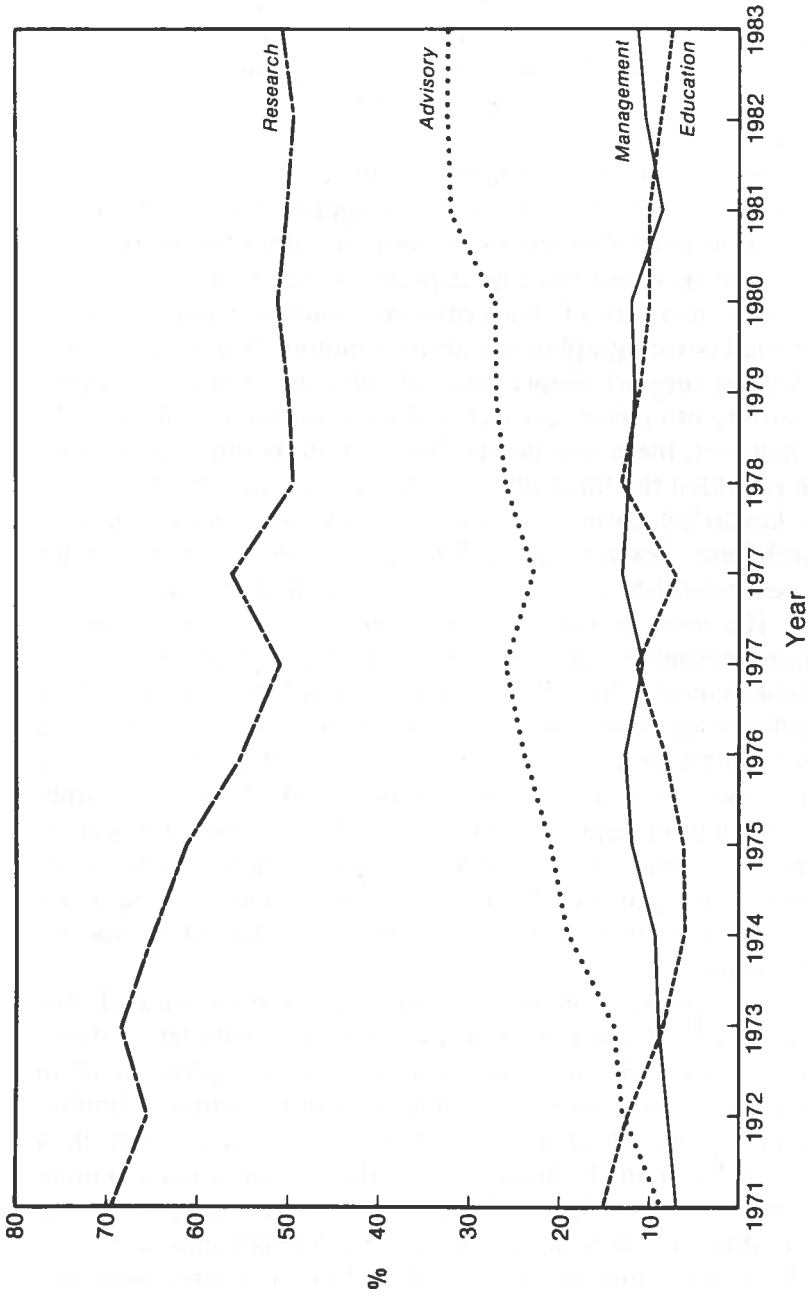
Finally, perceptions of the quality of Sea Grant research and administrative effectiveness depend largely on whether researchers are interested mainly in basic or applied research. Marine scientists who are oriented to basic research tend to be less favorably disposed to Sea Grant research, while those engaged in applied research tend to have a more positive view of the program. These views were reflected in the judgment of academic marine scientists that Sea Grant was too sensitive to political winds and the wants of different users, too prone to "target" various desired areas of research, too much concerned

with relevance, and too anxious to cite accomplishments in the real world.<sup>22</sup> At the heart of many of these comments was the tension between Sea Grant's emphasis on applied research and university scientists' desire to pursue basic problems of their own choosing.

The important point is that none of the evaluations challenged the basic goals or structure of the program. To be sure, there have been internal differences of opinion within the marine sciences network about specific aspects of Sea Grant's performance. Some measure of that criticism stemmed from the better established oceanographic research community's perception that total federal support simply was not adequate to support such a wide variety of marine research and educational activities. Until 1981, however, there was no challenge to the political consensus which provided the foundation for Sea Grant support.<sup>23</sup>

The key to Sea Grant's continued success is an expansion of its research base. Training and technology transfer mechanisms are now well established in Sea Grant education and advisory programs. The most productive use of these transfer mechanisms requires continued expansion of the research foundation upon which Sea Grant is based. But it is this part of the program which has suffered the most. Figure 2 shows the declining percentage of funds available for research, compared with other major areas of support, over a twelve-year period. For nearly seven years only about one half of federal Sea Grant funds has gone to research. At the same time, the inexorable increases in personnel costs linked to other parts of the program, particularly the advisory service, have further curtailed the prospects for additional research support.

The consequences of this eroding research base are real. For example, without some realistic expectation of long-term, stable support, researchers shy away from Sea Grant, projects are often under-funded, and there is an inclination to support familiar kinds of research that promise short-term results rather than more broadly defined, innovative efforts.<sup>24</sup> From a management point of view, Sea Grant directors are confronted with the chronic dilemma of how to continue to support productive researchers over many years, yet still include new, promising sci-



**FIGURE 2.** Percent federal support by major program categories, National Sea Grant College Program, 1971-1983.

entists in the research program. Finally, and most important, Sea Grant has been limited in its ability to expand beyond an emphasis on applied work to support a more comprehensive portfolio of research ranging from short-term problem-solving to long-term investigation of basic processes.

There are three main strategies for tackling the research funding problem: first, reallocation of funds from within the existing budget; second, closer collaboration with the basic research activities of other federal agencies, in particular, the National Science Foundation and the Office of Naval Research; and third, additional federal funds. Necessity has already dictated that Sea Grant directors reallocate funds within their current budgets. The decline in research support is the result of what has been essentially level-funding of the program over the past five years coupled with rising personnel and overhead costs associated with advisory and education activities. Many directors have judged that it would be less disruptive to the overall program to curtail or eliminate research projects than to dismantle and then attempt to recreate the advisory service. In short, the amount of funds available for increased research support within the current budget is virtually nonexistent as long as Sea Grant managers and their Congressional supporters seek to sustain the delivery system which distinguishes Sea Grant from other marine research programs.

The second approach is to seek to expand the research foundation upon which Sea Grant is based by closer collaboration with the National Science Foundation and the Office of Naval Research. Despite occasional joint funding of researchers or conferences, Sea Grant has been largely isolated from the work of these two agencies for several reasons. First, academic marine scientists have tended to perceive applied research of the kind associated with Sea Grant as lower in quality and professional status than the basic research supported by NSF and ONR.<sup>25</sup> Second, oceanographers desire to pursue basic problems of their own choosing without the added obligation of responding to an often diverse range of interested groups outside the academic community. Third, Sea Grant has never had the legislative mandate or resources to support blue-water oceanography. Finally,

attention to the development of the Sea Grant network and the subsequent political turmoil of recent years have diverted attention from the interests shared by these research communities.

The fact is, however, that such mutual interests do exist. These center on the common stake in the health of academic marine research which requires long-term, stable funding, diverse sources of research support, modern equipment, and a flexible program of education and training. Specifically, Sea Grant, in order to fulfill its promise, must draw on a much wider research base than has been possible with past funding levels. In turn, the basic research community can, for example, pursue spin-offs from large field projects through Sea Grant, seek access to foreign waters through the modest international program, and benefit from the dissemination capability of the Sea Grant network.

A move toward closer collaboration within the marine research community promises to be mutually beneficial without compromising the distinctive values of either Sea Grant or more traditional oceanographic research. Among the first steps are mutual participation in review and planning activities, identification of current and past projects which have received joint funding, articulation of common objectives for the marine research community, and assessment of the way in which Sea Grant's modest international program can serve as a basis for expanded international research projects.

The third strategy—and the most obvious—is to seek increased federal support for Sea Grant research, particularly for the kinds of fundamental research likely to provide long-term benefits. Although Sea Grant has been identified as an applied research program, it has sought to encourage a liberal interpretation of what constitutes work appropriate for its support. For example, there is a clear recognition that advances in areas such as mariculture or the development of biomedicinals cannot be pursued in isolation from basic studies in genetics and biochemistry.<sup>26</sup> But the program has been severely constrained in the expansion of its reservoir of knowledge by a lack of funds and the tacit assumption by some members of key constituencies (e.g., Congress, advisory service, industry) that useful results can best come from short-term, problem-solving efforts, not



long-term investments in basic research. Studies of a number of Sea Grant research projects concluded that, in fact, those projects which ultimately made significant economic contributions were more speculative, and more broadly conceived, than those defined more narrowly and directed toward solution of specific problems.<sup>27</sup> Federal funds are critical because in addition to providing the major part of support, they also provide the leverage for attracting support from state and local government and industry. It is not a matter of federal funds being replaced by support from those sources, but of being augmented by them.

Sea Grant managers already have reallocated funds within their programs. What is needed now is a clear strategy of expanding the research base for the program by more deliberate cooperation and collaboration with other federal agencies supporting marine-related research, and efforts to seek additional federal support in order to broaden the existing Sea Grant research effort. The management, delivery, and education parts of the program are well-established in many states, but without an increased investment of federal funds in the research component, these imaginative institutional inventions will be unable to realize their full potential for developing the marine economy.

## **Conclusion**

Sea Grant was the result of the fortunate coincidence of perceived need, dedicated leadership, good timing, and clear instincts for social invention. Over nearly two decades, and with a relatively small investment of federal funds, Sea Grant has succeeded in building a network of marine research, advisory and education activities on the shores of the Atlantic and Pacific Oceans, the Caribbean, the Gulf of Mexico, and the Great Lakes, and has generated significant economic returns in the form of new industries and savings to industry and government. It is the only national network of institutions and scientists whose primary concerns are ocean use and development. For those aware of the economic importance of the oceans<sup>28</sup> and Sea Grant's growing contribution to this part of the economy, it has been hard to understand the Reagan Administration's failure to distinguish

short-term budget savings achieved by eliminating the program from its demonstrated capacity to contribute to the economic goals of the Administration.<sup>29</sup> The structure of the program—research, advisory, education—was an imaginative adaptation of the land-grant analogy to the oceans<sup>30</sup> and, in turn, may serve as a model for current efforts to design institutional mechanisms which will bring about closer university, government, and industry collaboration for accelerated economic growth. But without an increased investment in the research component of the program and deliberate efforts to achieve far closer collaboration with other research funding agencies, Sea Grant will be severely inhibited in fully realizing the vision of its founders.

### Acknowledgments

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21. The following table suggests the distinctive program categories and average award size for Sea Grant and National Science Foundation marine research projects in Fiscal Year 1983:

Category	Average Size of Award (in dollars)
<b>SEA GRANT</b>	
Aquaculture	39,130
Living Resources (other than aquaculture)	31,318
Mineral Resources	24,249
Marine Biomedicinals, and Extracts	39,138
Social, Economic, and Legal Studies	27,754
Ocean Engineering	36,307
Resources Recovery, and Utilization	28,319
Transportation Systems	30,934
Research and Studies in Direct Support of Coastal Management	
Decisions	33,971
Ecosystems Research	22,667
Pollution Studies	28,594
Environmental Models	32,534
Applied Oceanography	22,315
Total Awarded for Research	16,178,478
<b>NATIONAL SCIENCE FOUNDATION</b> (Division of Ocean Sciences)	
Physical Oceanography	111,000
Marine Chemistry	72,000
Submarine Geology, and Geophysics	81,000
Biological Oceanography	71,000
Total Awarded for Research	49,900,000

22. Shannon and Palmer, *Federal Funding of Academic Marine Science*, pp. 128–131.

23. King and Shannon, "Political Networks in the Policy Process."

24. It is notable that the two studies which looked closely at the economic contributions of some 77 Sea Grant research projects over a five-year span judged that those showing the greatest productivity tended to be high-risk, broad-based projects, not those that appeared less risky at the outset. Furthermore, commercial use of broad-based research typically moved toward unanticipated and profitable industrial applications, outcomes far less likely for more specific and more narrowly defined projects. See Holloman et al., *op. cit.*; and Utterback and Linskey, *op. cit.*

25. Shannon and Palmer, *op. cit.*

26. R. R. Colwell, *Science* 222 (October 1, 1983).

27. Utterback and Linskey, *op. cit.*

28. Pontecorvo et al., *Science* 208 (May 30, 1980).

29. G. A. Keyworth II, *Science* 220 (June 10, 1983).

30. Although the Land Grant analogy was fundamental to the invention of Sea Grant, Sea Grant proponents should not lose sight of the fact that research, education, and advisory functions did not emerge full-blown in the Land Grant system, but were the product of a pragmatic, flexible set of institutions capable of change, adaptation, and innovation over many years. On the general subject of the Land Grant–Sea Grant analogy, see M. E. Silva, "Land Grant and Sea Grant," *Ocean Development and International Law*, this issue.