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**SEA
GRANT
20 YEARS**

SEA GRANT

ASSOCIATION

AND

THE UNIVERSITY

OF

RHODE ISLAND

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SEA GRANT:
PAST, PRESENT, AND FUTURE

Twentieth Year
Commemorative Anniversary
October, 1985

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for

The Sea Grant Association
and
The University of Rhode Island

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The University of Rhode Island, Narragansett, RI 02882-1197
Office of the Vice President, Marine Programs

Dear Colleagues:

Welcome to Rhode Island, and especially welcome to the city of Newport—the site of the very first sea grant conference in 1965 and, appropriately, the site of the 1985 Sea Grant Week, marking the twentieth anniversary of sea grant.

Although much has changed since the first Sea Grant Conference, there are many, including Senator Claiborne Pell, Athelstan Spilhaus, and others who were part of that first meeting here in the Viking Hotel, still active in their support and promotion of the sea grant concept.

This conference is more than a commemoration of the past. Certainly it is a good time to take stock of where we have been and what we have accomplished, but it is equally important to give serious consideration to new national priorities concomitant with the opportunities and initiatives vested in the National Sea Grant College Program.

With your participation, Newport '85 can help guide us for the next 20 years. The University of Rhode Island is proud to join with the Sea Grant Association in hosting this conference, and we extend to you our wish for a most successful conference here in the Ocean State.

A handwritten signature in black ink, reading "John A. Knauss".

John A. Knauss
Vice President, Marine Programs



Welcome . . . from the Sea Grant Association

It is with the utmost pleasure that I welcome you to Sea Grant Week '85 and the commemorative events of the 20th anniversary of the meeting that established the Sea Grant College Program.

It is appropriate to mark this occasion with traditional ceremonies, awards, banquets, and speeches. It is more important, however, that we take this opportunity to evaluate the strengths and weaknesses of Sea Grant as it exists today, and to develop the goals and objectives which will nourish this concept as it expands to meet the challenges of the next century.

Times change, expectations are altered, and priorities reordered. Concepts, especially those well-proven, remain relatively constant. The sea grant concept provides a unique federal, state, and industrial partnership for public benefit through research, education, and advisory services. This is accomplished through a variety of programmatic and administrative mechanisms and techniques.

It behooves us, the sea grant community, to further identify the successes, and strengths, and potentials of sea grant as it exists today. Thus, may we choose the most promising of the many routes and opportunities which will lead us to a continued successful contribution to the nation through the understanding, development, and conservation of the marine resources of the United States.

Again—welcome! Share food and drink, enjoy the companionship of this sea grant family. More importantly, share your ideas, hopes, and aspirations for charting the future course of sea grant.

Though we pause briefly now to commemorate what has gone before and to honor those most responsible for our past success, it is the future of sea grant which must concern us most vitally. The concept has been developed, tested, and proven successful. Now let us move forward with renewed vigor, enthusiasm, and optimism as we begin the next two decades of sea grant activity.

It is my honor and pleasure to have served as president of the Sea Grant Association during this 20th year commemorative event. To each of you, thank you for your presence and participation.

A handwritten signature in black ink, reading "James I. Jones". The signature is written in a cursive, flowing style.

James I. Jones
President
Sea Grant Association

INTRODUCTION

“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?’”
—Athelstan Spilhaus, 1963

The vision of Athelstan Spilhaus—internationally known author, inventor, and scientist—became reality three-years later when the federal government enacted “The National Sea Grant College Program Act of 1966.”

Just as land-grant universities have been meeting the needs of America’s agricultural community for more than a century, sea grant colleges are meeting the growing challenges facing the nation’s marine community.

Thirty sea grant programs—located on every ocean and Great Lakes coast of this nation—provide a sophisticated network of marine research, education, and advisory services. These programs, on the cutting edge of science and technology, have strengthened and expanded relationships among campuses, state and federal government, and industry. Consequently, the United States is cultivating the sea—and spurring a new generation of “sea people.”

The marine community met in Rhode Island 20 years ago to sharpen the idea of a sea grant university. Two decades later, that same community has returned to the birthplace of sea grant to take stock of the program’s accomplishments and chart a future course in the continuing effort to understand, explore, develop, and conserve the oceans.

Three Goals

This commemorative publication has three goals:

- First, to celebrate milestones that have brought sea grant from an idea—a dream—to a well-managed, creative, scientific and technical enterprise at the nearly 300 institutions participating in the National Sea Grant College Program.

- Second, to highlight the program’s track record of accomplishment—and, gratefully acknowledge the hard work of the countless professionals, making up the sea grant team.

- Third, to throw a spotlight on sea grant’s future, pinpointing upcoming challenges and zeroing in on problem-solving opportunities likely to be tackled by a new breed of sea grant researcher perhaps drawn from a cadre of Sea Grant Association (SGA) Student Award recipients, sea grant interns, and sea grant-sponsored graduates of the nation’s universities.

Six Sections

Sea Grant: Past, Present, and Future is divided into six sections, each representing a different phase of the program's development.

Section One includes a copy of the commemorative program for Sea Grant Week '85. The October 20-24, 1985, meeting, celebrating the program's 20th anniversary, was co-hosted by the Sea Grant Association and The University of Rhode Island.

Only a small portion of the commemorative program was dedicated to sea grant's history, while the bulk of it assessed sea grant's accomplishments and probed its future.

The future was viewed in terms of new issues and relationships that would benefit from sea grant attention. New relationships, for example, might include closer ties between campuses and corporations, as well as possible changes in the links between sea grant and the federal government.

Rounding out Section One is an acknowledgment of the Sea Grant Week Planning Committee.

Section Two provides historic focus. Three papers—authored by John A. Knauss, Athelstan Spilhaus, and U.S. Sen. Claiborne Pell, three of the four "founding fathers" of sea grant—are reproduced in their entirety from the October, 1965, Newport, R.I., meeting, outlining "The Concept of a Sea Grant University."

A copy of the 1966 Sea Grant College Program Act, signed by the four acknowledged "fathers" of sea grant in a Capitol Hill ceremony on the eve of the legislation's 20th anniversary, also is included in the second section.

Section Three contains 20th anniversary reflections of the four "fathers" of sea grant—Knauss, Pell, Spilhaus, and former U.S. Rep. Paul Rogers—in statements specifically commissioned for this booklet.

Two sea grant directors, Robert Abel (1967-77) and Ned Ostenso (1977-present), have contributed their thoughts about sea grant—past, present, and future.

Section Four provides a list of nearly 300 participating sea grant institutions and a chronology of when various colleges and universities joined the sea grant movement. The National Sea Grant College Program has a grass-roots capability that plays pivotal roles in addressing a wide range of issues confronting U.S. marine interests. This section also acknowledges former sea grant directors and principal investigators; and contains a complete list of sea grant review panel members, and a comprehensive listing of sea grant interns. It also provides background on the National Sea Grant Depository.

Section Five is devoted to the Sea Grant Association (SGA), including a descriptive narrative, and lists of 1984-85 SGA officers, former association presidents, former SGA award winners, and SGA student award recipients.

Section Six offers a glimpse of sea grant's future as government, industry, and universities work together to develop the nation's marine resources and

technology in areas ranging from biotechnology and fisheries to water quality and management of the Exclusive Economic Zone.

A narrative, detailing sea grant's origins, is omitted in favor of directing readers to *Creating the College of the Sea: The Origin of the Sea Grant Program* by John Miloy and published in 1983. Miloy "provides a sharply drawn sketch of the circumstances and individuals who, in a remarkably short time, turned an idea into a major marine program." The publication by Miloy is available from the Marine Information Service, Sea Grant College Program, Texas A&M University, College Station, Texas 77843.

Readers also are directed to the *National Sea Grant College Program 1985-87*, published by the Sea Grant Association. Portions of that publication are contained in this booklet.

Track Record

On the eve of sea grant's 20th anniversary, the world was treated—in part by the Woods Hole Oceanographic Institution—to a striking example of just how much progress has been posted in marine technology.

An American and French team of researchers—employing state-of-the-art electronics and deductive-skills that Sherlock Holmes would envy—found the 73-year-old wreckage of the luxury-liner *Titanic*. The "unsinkable" ship, the object of speculation and a spate of romance-filled books and movies since it rammed an iceberg in the North Atlantic in April, 1912, was found more than two-miles below the ocean's surface—an underwater tomb for more than 1,500 souls.

This event, held up as it was to world-wide scrutiny, has become a symbol of the growing sophistication of marine technology—a technology that is increasingly being used to benefit civilization and improve the quality-of-life for the world's peoples.

The discovery of the *Titanic*, by capturing the public's imagination, has placed a spotlight on the potential for developing sea-based resources in a way not unlike Neil Armstrong's famous footprint on the moon, which galvanized public attention on the benefits of the space program.

While the discovery of the *Titanic*, and the exploits of America's astronauts aboard the space shuttle, place the nation's technological prowess on public display, they can tend to overshadow less spectacular—but no less meaningful—work by countless researchers nationwide.

America's two-decade investment in sea grant has contributed to developing the infrastructure and personnel training from which new technologies have emerged. But this investment also is netting major results in less visible areas, including the development of undersea technology, the study of sea life, the increased economic development of the nation's fisheries industry, prudent environmental management of coastal, off-shore, and other marine areas, and the exploration of vital natural resources below the waves.

It is impossible in the pages of a single booklet to recount the advances—large and small—registered by sea grant-sponsored research. But, the program's 20th anniversary would be incomplete without some public recognition of the diverse scope and range of these important programs:

- **Great Lakes Sea Grant Network**—First-time identification of the spawning grounds of various fish and the tracing of the sources, pathways, and fates of cancer-causing PCB's and other contaminants.

- **University of Alaska**—Research has led to increased harvests, while providing adequate protection for the commercially important Tanner crab.

- **California Sea Grant**—Tested new pharmacological compounds derived from marine organisms and developed storage techniques to keep fish fresh seven to nine days longer than conventional methods.

- **University of Southern California**—Pollution studies of Los Angeles and Long Beach harbors.

- **University of Delaware**—Corrosion of ships and off-shore structures cost industry \$1 billion annually. Research has verified that calcium-based deposits are more protective than magnesium-based ones.

- **Florida Sea Grant College**—Results of corrosion fatigue research on welded steel in seawater have been incorporated into American Petroleum Institute design practices for off-shore structures.

- **Georgia Sea Grant Program**—Biologists are isolating natural compounds from marine organisms to find pesticide prototypes that are more biodegradable than man-made pesticides now used in agriculture.

- **Louisiana Sea Grant College Program**—A \$300,000 sea grant investment in crawfish aquaculture research has spurred development of a \$70 million industry.

- **Massachusetts Institute of Technology**—Biotechnology researchers are working on ways to turn millions of tons of fish waste into profit centers for fishermen and into beneficial pharmaceuticals for doctors and patients. One project showed that shark cartilage inhibits the spread of blood vessels that feed tumors.

- **Michigan Sea Grant College Program**—Sea grant engineers have developed and tested effective, low-cost alternatives to expensive shore protection devices, lowering protection costs by up to 95 percent.

- **Mississippi-Alabama Sea Grant Consortium**—Barnacles and other sea organisms can hike fuel costs by \$1 million a year for large cargo carriers. Four patent applications, growing out of sea grant research, have been filed for new weapons designed to fight this problem.

- **New York Sea Grant Institute**—Farming of seaweed may prove economically feasible for use as feedstock or for conversion to natural gas or alcohol.

- **Oregon State University**—Sea grant-sponsored research is helping evaluate the feasibility and environmental consequences of deep-ocean seabed mining.

The technology and scientific understanding of the oceans, supported by

sea grant, is putting this nation in a much better position to manage the new 200-mile exclusive economic zone off the U.S. coastline and bolster national security.

Various sources were used to compile this commemorative publication. In some cases, they proved impossible to recheck. Consequently, the editors apologize for any spelling errors, omissions, or inaccuracies. Furthermore, personal statements contained in the publication do not necessarily reflect the opinions of the Sea Grant Association, the University of Rhode Island, or the editors.

Lynne Carter Hanson, the University of Rhode Island

Bob Aaron, National Association of State Universities and Land-Grant Colleges

John Kermond, National Association of State Universities and Land-Grant Colleges



SECTION I:

COMMEMORATIVE
ACTIVITIES

COMMEMORATIVE ACTIVITIES

Monday, October 21

- 9 a.m.-
12:30 p.m. **Session I**
Conference Rooms A-B-C
Welcome: President Edward D. Eddy, The University of
Rhode Island
- The First 20 Years**
- Session Chair: Francis H. Horn, President Emeritus, The
University of Rhode Island
- Sea Grant and Social Invention: The Formative Years**
Lauriston King, Assistant Director, Sea Grant Program,
Texas A&M University
- Panel: A Variety of Issues**
- Administration: William Gordon, Assistant Administrator for
Fisheries, National Marine Fisheries Service
 - University: John C. Calhoun, Jr., Deputy Chancellor of
Engineering Emeritus, Texas A&M University
 - Sea Grant Director: Robert Ragotzkie, Director, Sea Grant
Institute, University of Wisconsin-Madison
- New Horizons**
- Session Chair: Athelstan Spilhaus, Father of Sea Grant
- The Exclusive Economic Zone**
David Ross, Chairman, Department of Geology and
Geophysics, Woods Hole Oceanographic Institution
- New Technologies**
Robert Corell, Director, Marine Programs, University of
New Hampshire
- 12:30-
2 p.m. **Speakers' and Chairmen Luncheon**
(by invitation)
Bellevue Room
- 2-5 p.m. **Session II**
Conference Rooms A-B-C
- Today and Tomorrow**
- Session Chair: Sanford Atwood, Former Chairperson, Sea
Grant Advisory Panel, National Sea Grant College
Program
- The View as Seen By:**
- Universities: Dr. E.A. Trabant, President, University of
Delaware
 - Congress: Sen. Lowell P. Weicker (R-Ct.)
 - Administration: Dr. John McTague, Deputy Director, Office
of Science, Technology, and Policy

- 7-8 p.m. **Commemorative Sea Grant "Cash Bar"**
Coffee Area
- 8-10 p.m. **Commemorative Sea Grant Banquet**
Conference Rooms A-B-C
Keynote: Sen. Claiborne Pell (D-R.I.)
Sea Grant Association Award Recipient:
The Honorable Paul Rogers

TUESDAY, OCTOBER 22

- 9 a.m.-
12 Noon **Session III**
New Opportunities and Challenges
- Session Chair: Robert Abel, President, New Jersey Marine Sciences Consortium
- Discussion Panel:**
- Daniel Aldrich, Former Chancellor, University of California at Irvine
 - James S. Coles, Chairman, Executive Committee, Research Corporation of New York
 - Ferris Webster, Chairman, Universities National Oceanographic Laboratory System
- Summary: Beginning Our Climb to the Future**
- John A. Knauss, Vice President of Marine Programs, The University of Rhode Island

1984-85 Sea Grant Week Planning Committee

- James I. Jones**, President, Sea Grant Association, and Director, Mississippi-Alabama Sea Grant Consortium
- James C. Cato**, Chairperson, Council of Sea Grant Directors, and Director, Florida Sea Grant College Program, University of Florida
- John A. Knauss**, Vice President of Marine Programs, The University of Rhode Island
- William L. Rickards**, President-Elect, Sea Grant Association, and Director, Virginia Sea Grant Program, University of Virginia
- David B. Duane**, National Review Panel, National Sea Grant College Program
- John L. Kermond**, Assistant Director, Federal Relations, Marine Division, National Association of State Universities and Land-Grant Colleges
- J. Allen Martin**, Treasurer, Sea Grant Association, Texas A&M University
- Lynne Carter Hanson**, Executive Director, Center for Ocean Management Studies, The University of Rhode Island

Sharon H. Walker, 1985 Sea Grant Coordinator, and Educator-Communicator, Mississippi-Alabama Sea Grant Consortium

Walter J. Gray, Director, Division of Marine Resources, The University of Rhode Island

Joseph F. Farrell, Sea Grant Assistant Coordinator, The University of Rhode Island

Bonnie L. Blackburn, Marine Educational Program Coordinator, Sea Grant College Program, Texas A&M University

Mac V. Rawson, Associate Director, Sea Grant Marine Advisory Services, University of Georgia

Peyton L. Smith, Communications Coordinator, Wisconsin Sea Grant Institute, University of Wisconsin-Madison

C. Alan Krekel, Administrative Services Manager, Washington Sea Grant College Program, University of Washington

Fred Whitrock, Associate Attorney/Research Associate, Louisiana Sea Grant College Program, Louisiana State University

Manuel L. Hernandez-Avila, Director, Sea Grant Program, University of Puerto Rico

Robert W. Corell, Chairperson, Sea Grant Task Force, and Director, University of New Hampshire/University of Marine Sea Grant College Program, University of New Hampshire



Members of the Sea Grant "Family." From left to right: Robert Abel, Frank Wheaton, John A. Knauss, Senator Claiborne Peil, Paul Rogers, Athelstan Spilhaus, Ned A. Ostenso, Robert Corell, William Young.



SECTION II:

SEA GRANT— THE PAST



Newport, R.I., 1965. Keynote speakers at the first sea grant conference were, from left to right: Paul Tye, William Hargis, John A. Knauss, and Francis Horn.

THE CONCEPT OF A SEA-GRANT UNIVERSITY

Sponsored by
University of Rhode Island
Southern New England Marine Sciences Association

October 28-29, 1965
Newport, R.I.

INTRODUCTION AND SUMMARY

John A. Knauss, Ph.D., Scripps Institution of Oceanography, 1959. Since 1962 he has been Dean of the Graduate School of Oceanography, URI. A physical oceanographer, Dean Knauss has worked on problems of ocean circulation. He is presently Chairman of the Southern New England Marine Sciences Association.

The idea of a sea-grant college was first suggested publicly by Athlestan Spilhaus in the keynote address at the ninety-third annual meeting of American Fisheries Society, September 12, 1963. The suggestion of holding a conference to consider the idea was made early in 1964, but for various reasons, was shelved for a year. In the meantime, interest in the sea-grant concept grew, much of it sparked by an editorial in *Science* (September 4, 1964) in which Dean Spilhaus wrote as follows:

... "I have suggested the establishment of 'sea-grant colleges' in existing universities that wish to develop oceanic work. The sea-grant college would focus attention on marine science, and it would develop strengths in the applications of marine science in colleges of aquaculture and oceanic engineering. These would be modernized parallels of the great developments in agriculture and the mechanic arts which were occasioned by the Land-Grant Act of about a hundred years ago. Basic funds, undesignated except that they be used by sea-grant colleges, could be obtained in much the way that agricultural support has been obtained in the past. Establishment of the land-grant colleges was one of the best investments this nation ever made. The same kind of imagination and foresight should be applied to exploitation of the sea."

One of the persons who became interested in the concept of sea-grant colleges was Senator Claiborne Pell of Rhode Island. In fact, in the time between

the initial decision to hold such a conference and its first public announcement, Senator Pell introduced legislation to establish sea-grant colleges (S.2439, the National Sea-Grant College and Program Act of 1965).

In calling this conference on *The Concept of a Sea-Grant University*, I wrote, "More and more people seem to be interested in the idea of a sea-grant university, but I have not found much agreement as to what is involved or what form such a university might take; hence, the reason for this conference. I hope that the conference will provide an opportunity to discuss specific ways in which the concept might be implemented and the possible consequences to society if the sea-grant universities are established . . ." The response to our invitation was overwhelming. The official registration lists 224 persons attending; everyone of the 30 states that borders the oceans or the Great Lakes was represented. Dean Spilhaus's idea of sea-grant colleges had obviously struck a responsive chord in marine scientists and university administrators from all parts of the country. The fact that at least one United States Senator was actively involved in the program provided added interest in this conference.

In rereading the proceedings, now some two months after the conference, I have been struck by several things. The first is the general consensus that the sea-grant concept is not merely a call for more of what we are already doing, but is really a design for something quite different. It is a bringing together of science and engineering, of education at all levels, and a consideration of the social as well as the technological aspects of the problems of marine resources exploitation; in other words, an assault on the problems of the sea using all of the various kinds of intellectual resources generally associated with a university. The excitement generated by these ideas will long be remembered by those of us who participated in the conference.

The conference indicated possible future paths in achieving these objectives and alerted us to some of the pitfalls. No simple blueprint for a future sea-grant university emerged. It seems possible (and it is probably desirable) that several different approaches may be developed. It is unlikely that any single university will be able to do all things. Although the analogy with the land-grant movement was noted, so were the differences. The idea of containing within a single unit of a university (such as an old line college of agriculture) all of the necessary scientific, engineering, and sociological resources required in a sea-grant college may be unwise, even if possible.

The question of how such a program would be financed, and once financed, how administered, received some discussion. On one point there was considerable agreement; namely, that federal support should be largely handled through institutional grants and not on a project or individual grant basis. Several noted that the question of "who" administers the program might be considerably simplified if Senator Muskie's bill (S.2251) was passed establishing a Department of Marine and Atmospheric Affairs.

Questions that recurred in several different forms throughout the conference were, how many sea-grant universities should be established, and how is this decision reached. Perhaps because the sea-grant concept generated so

much interest, I had the distinct impression that some thought that all marine science was now going to be done in sea-grant colleges and if one's school were not so designated, one might as well close up shop. This obviously is not true, but the questions referred to above remained unresolved. One point that is clear is that if the sea-grant university is to solve some of the problems set for it by Dean Spilhaus with the funds envisaged by Senator Pell's legislation, the number of sea-grant universities will be limited, at least initially, since a certain critical mass is required in a given unit.

Certainly not all questions were answered or all problems solved at the two-day conference. Whether the conference was a "success" depends upon the criteria used. In terms of attendance, presentations, and excitement, I believe it was a success. Whether the ideas outlined at the conference will be developed to fruition remains to be seen. At the conclusion of the conference, the following resolution was unanimously adopted: "We enthusiastically endorse the concept of the sea-grant college as presented by Dean Spilhaus at this meeting and the general concept of Senator Pell's bill (S.2439), and we specifically recommend that Dean Spilhaus be given the opportunity to present his views to the appropriate government bodies."

A National Sea-Grant University Committee was formed. Initial membership at the time of the conference was: Dean Spilhaus; Donald Bevan, Associate Dean, College of Fisheries, University of Washington; Wayne V. Burt, Chairman, Department of Oceanography and Director of the Marine Science Center, Oregon State University; David C. Chandler, Director, Great Lakes Research Division, University of Michigan; W. M. Chapman, Director, Division of Resources, Van Camp Sea Food Company; William J. Hargis, Director, Virginia Institute of Marine Science; Galen E. Jones, Director, New Hampshire Marine Laboratory, University of New Hampshire; F. G. Walton Smith, Director, Institute of Marine Sciences, University of Miami; Donald E. Wohlschlag, Director, Institute of Marine Science, University of Texas; and myself as Committee Secretary.

At the conference we suggested that some of those attending might wish to submit comments for the record. At the time these proceedings went to press, some sixteen statements had been received. They are printed in the last section of these proceedings.

Successful conferences are the result of hard work by many individuals and credit is due the Committee on Arrangements and the staff of the Viking Hotel, Newport. Special thanks go to Polly Matzinger, Director of Publications at URI, for her help in getting these proceedings printed.

THE CONCEPT OF A SEA-GRANT UNIVERSITY

Athelstan Spilhaus, D.Sc., University of Cape Town, 1948. He has been Dean of the Institute of Technology at the University of Minnesota since January 1949. From 1961 to 1964, he served as Chairman of the Committee on Oceanography of the National Academy of Sciences—National Research Council. He is an internationally known author, inventor, and scientist.

President Horn, Senator Pell, Dean Knauss and friends, I don't suppose that many people have the pleasure and honor that I feel today on this occasion when at this wonderful place on the sea under the auspices of a fine university and with so many of those who've contributed much to the science of the ocean—that I feel on being invited to explore and develop with your help my own sea-grant university idea.

My friend, Dr. Chapman, wrote me about a year ago to ask whether the sea-grant university sprang full blown from my mind. I would say, rather, that it resulted from the recognition of a need, a conception, a period of labor, delivery at the right time, gradual acceptance of the young infant and I now hope that its sponsors here may make it have a productive and useful life.

When Harrison Brown formed the National Committee on Oceanography in 1957, some of us jokingly yet with much truth stated that our first objective would be to get our public leaders to at least be able to pronounce the word "oceanography." Harrison not only managed this but with his fellows on the committee succeeded in stirring an amazing public and legislative awareness of the importance of knowing about the sea.

Early on, we recognized the need to use engineering in support of the study of the sea. We had a panel of the National Academy Committee which devoted itself to special engineering devices, vehicle instruments, and the like. When I became chairman in 1961, I was already beginning to see that engineering in support of oceanographic research, while important, was not enough. And I recall being asked, in a joint meeting with the governmental Interagency Committee on Oceanography, what the task of the Academy group should be over the next five years, that I said marine science and oceanography were going strong but that the real gap was between our excellent science and the pitiful state of the U.S. performance in the exploitation of the sea. Our pitiful fishery effort—our poor merchant marine—the fact that when we needed a bathyscaphe we purchased it in Europe—all symptoms of a lack of purpose and a failure to apply our science through ocean engineering and biological engineering or aquaculture.

In 1963, in a keynote address to a national meeting on fisheries, I voiced my unhappiness and recalled that just about a hundred years before, a positive purposeful action had been taken by Congress to stimulate "the mechanic arts and agriculture"—the act that established land-grant colleges. There can be

no question that the Morrill Act establishing a land-grant fund for the support of such colleges, passed by Congress in 1859 but vetoed by President Buchanan and subsequently signed by Lincoln in 1862 contributed mightily, through the mechanic arts, to lead to our national preeminence in the mass production of things that people need—including agricultural products.

Why not then provide a focus, a commitment and continuing support in the context of sea-grant universities today to bring the United States to a position of leadership in ocean engineering and aquaculture?

After this talk, I received many letters expressing interest in the concept. One was from Professor Saila, of Rhode Island. As a result of his expressed interest I wrote to President Horn and Dean Knauss and received inspiring and heartening responses. They wanted to do something to explore the idea. Dean Knauss suggested early in 1964 that a conference be held—this is the conference.

Senator Pell, with a long interest in the sea, its contribution to his State and its potential, talked with me. I remember quipping to the Senator that Rhode Island would be a fine launching place for a sea-grant university in connection with its land-grant university—after all, I said, you have very little land.

So, you see, it is most appropriate that this first national conference on the sea-grant university concept should be held here where the original interest was sparked.

What is ocean engineering? From time to time we give names to assemblages of our different scientific disciplines for no better reason—and for the very good reason—that they apply and suit our principal current preoccupations. So polar science is all the good science that is done relating to the Arctic and the Antarctic. Space science is all good science that relates to space, or more facetiously any science that the National Aeronautics and Space Administration will pay for. Similarly, oceanography and marine science comprise the work of any scientist in any discipline who chooses to use the sea as focus for his intellectual endeavors.

On the other hand, in engineering the qualifying nouns become even more meaningful. The engineering problems of the polar regions are quite special and unique. How do you get rid of sewage when everything is frozen? How do you build foundations that sink in permafrost? How do you build structures in slowly flowing ice? Engineering for space, too, has its special problems. Metals can cold weld themselves together in the vacuum of space. Special lubricants are needed, and vacuum tubes may not need an outside cover. So it is in ocean engineering. Materials behave quite differently at the seven-ton-per-square-inch pressures encountered in the abyss. Structures must be built to resist the onslaught of marine borers and other living organisms that attack them and they must withstand entirely different catastrophic forces—earthquakes, currents, wave forces, and underwater landslides.

We must recall that where science aims at finding out enough about our environment to describe it and then to find common truths, engineering intervenes, alters, and uses the environment. The uses and controls that are found good—ones that society wants or can grow to want—industry repeats so that

they can be used by as many people as possible. There are two kinds of ocean engineering; there is that kind that has gone on for centuries, like the building of ships to get from one point of land to another, the building of dikes to keep the sea from encroaching on the land, but these are merely in support of peripheral activities of land based and oriented people not using the sea but withstanding its abuse of the land. There is another kind of ocean engineering, and that is the ocean engineering which must come about when we decide to intervene in the marine environment with the ultimate objective of using it, occupying it and enjoying it.

When you occupy a place whether it be an enemy country, uninhabited polar or desert wastes, the moon, the planets, or the depths of the sea, essentially you have to start by worrying about the five basic things for people to live; a way to get there and back, shelter while you're there, power, water, and food.

Of course, it's not necessary to occupy the ocean right now. We could wait, but somebody else would occupy it. Or, we can make the decision that we will occupy the ocean. We can choose freely to expend part of our efforts and apply our marine, scientific, and oceanographic knowledge toward the peaceful exploitation and colonization of the sea.

A way to get there and back, shelter, power, water, and food—to these five basics that we need for the occupation of land on earth must be added a sixth shared by the environments of space and the sea. We can live quite a while without food and water, but you could not have heard my last few sentences without breathing. The most fundamental ocean engineering that is going on today is the medical engineering on breathing at high pressures supported by the physiological science related to mammals breathing with their lungs full of water. The latter science may point to engineering developments way in the future, but at the present time men are spending weeks below hundreds of feet of water breathing mixtures mostly of inert helium, with just the right small percentage of oxygen so that at those depths it's compressed to about the oxygen pressure in the normal temperature.

Ocean medicine has found that helium does not give the narcotic effects "rapture of the deep" that comes from the great solubility of nitrogen in fatty nerve cells. Ocean medicine, by studying decompression, is beginning to overcome the dangers when the aquanaut comes up and reduces his pressure too quickly. If he does, the gases expand in bubbles, blocking arteries, attacking joints, and giving him the fatal "bends."

Of the other five basics, three deal mainly with physical engineering—the provision of new surface and submarine vehicles, structures under the sea, and power generators. But ocean engineering also includes food and water—fishing, fish farming, hybridizing marine plants, and even water divining in the sea, the search for undersea fresh water springs. In the meantime, we can, of course, desalt sea water, but this is a clumsy interim method. Ocean engineers must face problems quite different from usual engineering experience on land. Electrolysis dictates a different choice of metals. The mechanical stresses of current, waves, and undersea earthquakes are quite different from their coun-

terparts on land. Biological activity can bore, excavate, and undermine undersea structures, and other organisms can create unwanted noise. Thus, biological engineering is a necessary adjunct even to the physical engineering in the oceans. Biological engineering will play a far greater part in the oceans than it has in the physical engineering of the land. I do not mean to imply that the ocean engineer must be any more competent than the most competent land engineers. He must have a different mix of the basic sciences and, even more important, a different focus. The focus of the land engineer is to prevent the encroachment of the sea, to concrete up coastlines, to fill estuaries for land habitations. The ocean engineer will consider it more important that beaches and estuaries be retained or that even new ones be built, because they are the habitat of many valuable shellfish and the nursery of many fishes of the deep sea.

For many years while being engrossed in oceanography and marine science, and while being active in contributing engineering devices in support of this science, I recognized the gap that exists between the scientists and oceanographers who have made such great strides in describing and understanding the ocean environment—its shores, its bottom, its physical and living contents—between these scientists and the fishermen, navigators, sea captains and sailors who use the sea. The missing link is ocean engineering which will pull out many useful scientific findings and translate them into better ways of using the sea.

Up to now, the main uses of the sea were for surface ships and fishing. Surface ships operate at the worst possible level—on the surface of the sea. At this interface they are plagued by wind, waves, and ice. If they go a little way up or a little way down, they're better off. The harvesting and husbandry of the food we take from the sea is utterly primitive and has not in any sense kept pace with the magnificent progress in fertilizers, farm machinery, cross-breeding and hybridizing that has developed on the land.

It is worthwhile to catalog some more immediate and some more distant exciting potentially useful things we can do in and with the oceans. If some seem like irresponsible dreaming, remember we live in days where purposeful dreaming becomes reality so rapidly that it's almost regarded as respectable. If some seem like "stunts," it is worthwhile to remember that such spectacles that form milestones of human achievement contribute honestly to people's self-esteem. They are the necessary steps to give us the confidence to go on to even greater achievements. Yesterday's "stunt" is tomorrow's useful routine.

Remember, we are inventing the future, not merely predicting it. When people asked, "What will the new deep research submarines look for?" the best answer was: "For things we don't yet know." To survive in a new environment, true readiness is to be ready for the unexpected.

Let us start at the coastline. Instead of smoothing and concreting coastlines, we may scallop them to build as many harbors and estuaries as we can and to lengthen the total coastline of the earth. There is a snowflake figure in mathematics which shows that any area, however small, can be enclosed by

a line of infinite length. The smaller the scallops or harbors we build, the longer will be the coastline. But if our purpose is to provide seashore not only for the organisms in the sea but for peoples' recreation, the theoretical concept of infinity becomes finite in terms of the quantum of people size.

Next, perhaps, we should heat up some coastal waters not only so that you can swim in them but also to make suitable warm water habitats for transplanting useful fishes that previously could not multiply there. With the coming rash of large nuclear reactors, waste heat is regarded by the land engineers as a problem because when it is introduced into cooling water, it produces profound ecological effects.

Many conventional conservationists consider any changes of this kind with the environment to be bad. But if we go about it in a sound engineering way, we can introduce waste heat into the sea in a number of different ways and find those effects on the ecology which are beneficial. Thereafter, this heat would no longer be waste but be useful.

Because land engineering with its parochial focus in conserving our land and preventing it being washed into the sea and because of the almost total use and reuse of fresh waters so that rivers will no longer flow into the sea, the sand that maintains beaches along the shorelines no longer simply comes down from the land. Beaches are not just there. Sand is continually being taken away to accumulate in the canyons on the continental shelves or even in the deep sea. We'll need to dredge the sand back and remake the beaches. The beaches will still be in dynamic equilibrium but one link in the cycle will be provided by man's intervention through ocean engineering. When we leave the shoreline, we will need vehicles to supplement the conventional ones which are so limited by the wind and wave at the air-sea interface. We need increasingly to go down in submarines or up in true air seacraft. Present seaplanes can only make emergency landings in the sea. We need the kind of air seacraft that can fly out, settle, do its work in a high sea, take off vertically, perhaps, and move on to the next job.

The present factory ships with their catchers that catch and process whales and fish will grow into floating oceanic cities. We are beginning to get inklings of how to quiet waves by punching holes in harbor walls, much the same as we punch holes in acoustical tile to absorb sound energy. With these elements as a beginning, floating artificial harbors or wave-stemming walls of the floating cities become possible. Or, more comfortable dwelling quarters may be floating stably a hundred feet or so below the surface where any wave motion is so damped out as to be unnoticeable. The artificial harbors and other mother ship platforms must be arranged to retrieve small submersibles, to retrieve them underwater so that a rendezvous in the high seas—a much more difficult job than a rendezvous in space—becomes unnecessary.

After surface cities, habitations floating under the water, the next step toward widespread structures on the bottom of the sea necessitates some ocean bottom engineering surveys. We'll need to develop bottom vehicles to travel between the ocean cities. But even before this, we'll have to develop a whole

body of knowledge on submarine soil mechanics. How will the ocean sediments support foundations and crawling vehicles? How stable will be the natural slopes or the embankments we construct on the ocean bottom? How does the bottom erode? And how well will it hold moorings? We need an expedition across the bottom of the Atlantic and the Pacific in crawling vehicles containing men to survey the terrain—a Lewis and Clark transocean bottom expedition. Until then we will not know how currents, erosion, and sediments will affect our engineering works. We do know from broken submarine cables that there are catastrophic phenomena much stronger than our concept of the “quiet in the deeps” would lead us to believe.

Also in advance of the widespread use of bottom structures we need to study the properties of materials at very high pressures. Materials suffer effects at these pressures which are quite outside the domain of ordinary land engineering. Glass apparently becomes less brittle. The analytical mechanics of thick shell structures must be tackled without the simplifications which are satisfactory for the thin shells we use on land.

Already, thanks to the work of the physiologists, divers can live and work a few hundred feet down. There seems every prospect that a thousand feet is now not out of the question. This refers to living at the ambient pressures. In the greater depths the structure to which we have referred, which will withstand the pressures, will be necessary. Once people can work and live at a thousand feet, the whole of the continental shelf, an area of 10 million square miles, larger than North America, is opened up as a new continent for our use. Oil drilling, mining, salvage, and even fish farming can be done by people down there and not, as now, on the end of the string from a wobbly surface.

So far I haven't mentioned power. And we are becoming accustomed to think that the potential of nuclear power is so great that we can dismiss other sources of power. The ocean is such a source, but it is termed a low-grade source because you need to imprison, or otherwise use, a great deal of sea water to get a usable quantity of power. So that in general the power of the sea has been regarded as a nuisance rather than a potential to be tapped. Usually when people think about the ocean's power, they think of tidal power and, indeed, there are several tidal powerplants operating; in fact, tidal power was used to mill grain a century ago in places like Maine.

But many times the tidal power potential exists in the difference in temperature between the top and the bottom of the ocean—the thermal gradient power. There are many places in the sea where differences of 10° occur over very short horizontal or vertical distances. So far, there is only one small thermal gradient plant in operation. With huge structures at sea, wave power becomes a possibility. It's not easy to harness the up-and-down motion of the waves in any practical or efficient way when we have small objects bobbing on the surface even though the wave energy withstood by a ship's hull may be many times that required to propel the ship. But with the size structure we envision—huge artificial harbors, and stable platforms, wave power becomes a possibility.

The ocean engineering in support of what we may call conventional fishing is already here. The behavioral scientists have a wealth of information on the response of fish to sonic, chemical, and electronic stimuli that may take the place of ordinary bait. And floating chemical engineering factories can take the whole catch, sort the fish automatically—trash fish for meal, more valuable fish for canning or freezing, and more importantly, count the species to keep a check on what is the renewable harvest.

Where existing advanced methods have been used in fishing, there is already the danger of overfishing—of making the whales become extinct—and this implies the urgent need, before we go much further in harvesting the living resources of the sea, to have a way of keeping an inventory of all the species we take from the sea so that we may be sure that they are renewed each year. And also to get an idea of how much we can increase the sustained yield when we intervene.

In gathering the living things of the ocean, ocean engineers should consider whether the other living things themselves, may do our building and collecting more efficiently than mechanical machines that we can devise. It would be very expensive to collect enough euphausiid shrimp, but whales collect and convert them very efficiently. Perhaps we should be breeding whales instead of exterminating them. Can we accelerate the coral animal to build reefs? Can we use shellfish to concentrate minerals? Can we plant seaweed to stabilize beaches? Can we hybridize the plants that grow in sea water, the seaweeds, and use them much more extensively as sea fruits and vegetables? Perhaps we can even contribute to the land by using the wealth of information on halophytes—salty habitat plants—not only to grow useful food in sea or brackish water but actually to desalinate water by the use of plants which concentrate salts within them. Seaweed is a good source of iodine, for instance.

These are the beginnings of farming the plants of the sea, but what about the animals? Plants are easier to farm and harvest because they may be rooted or even if they are floating they are easy to control. Shellfish, which are indeed farmed, are the next easiest for the same reason. Oysters, clams, and shrimp are cultured to a greater or lesser extent in ponds and semienclosed arms of seas. Next it is not much of a step to conceive of lobster traps on the bottom of the continental shelf, acres in extent—in fact, bottom fishes in general would seem to be most easily susceptible to fencing. Then how do we fertilize the sea? There are two ways in land farming; namely, plowing and adding nutrients. The counterpart of plowing in the sea is upwelling that brings nutrients from deeper water to the euphotic zone. The idea of doing this artificially by heating up the ocean with a nuclear reactor at the bottom has been thought of, but on analysis does not seem economical. But the waste heat from nuclear reactors for other purposes may well be used in this way. The motions of the sea itself, which indeed cause upwelling notably in such productive waters of the Humboldt Current, may be studied and ocean engineering intervention may devise ways of making the sea plow itself more efficiently.

How can we fertilize the sea? It is manifestly impossible to add sufficient

of the basic nutrients to open sea water, although this is possible in estuarine or pond water. In the sea it's stirred and mixed away, unlike the use of fertilizer on land. It does seem possible however, to add the trace substances once we know which are most important to growth. The study of trace elements, too, will lead us to more successful transplantedation of useful fishes from one area of the world to another. Then, too, by using what the marine scientists know about the food chain, we can eliminate some of the unnecessary and less useful species, that is, intervene in a way that might be called "weeding the sea."

One other aspect of the use of the sea which is already with us and may grow even faster and stimulate ocean engineering more than these "more serious" uses of the sea is the important part the sea can play in recreation of the people in an increasingly crowded land world. Already you can purchase a small sporting submarine for not much more than the cost of an automobile. Thousands of people go down in the sea in aqualungs. Millions of dollars are spent on boats, elaborate fishing equipment and underwater cameras for people's recreation at sea.

Perhaps some of the first underwater structures will be for recreation. As mass-produced underwater vehicles come within the reach of many, underwater resorts will develop where people will drive their submobiles and visit reefs, watch the oceanic wildlife in its natural habitat much the way we do in the wilderness and park areas on land.

These examples give you something of a vista of what ocean engineering can do in the sea and show you how engineering and technology can bring everyone close to the oceans and develop the sea's resources for everyone's use just as on land. Engineering has provided us with our dams, our fuels, our skyscrapers, highways, planes, ships, satellites, and the biological engineering which we call agriculture has supplied us with our abundance of good food. I have said that ocean engineering will fill the gap between marine scientists and those who use the sea. But we need a way of bringing the vast body of scientific knowledge about the sea to the people who use it. We need to bring knowledge of the ocean to people other than the scientists who develop it, and not only to the engineers but to all the professions that must be related in a vast world development of this kind. We need an educational plan far broader than the existing ones that produce excellent marine scientists. There is not a single activity of people that would not be affected by our man-in-the-sea program and there is hardly any facet of man's knowledge and experience that will not be needed to complement the ocean engineering effort.

Under the land-grant college program, scholars did not disdain to tackle hard practical engineering and biological engineering—that is, farming—problems in parallel with basic scientific work. In fact, often the arts of engineering and agriculture outstripped the sciences by building things and growing things better before physics, botany, or zoology quite understood why. Working in parallel, discoveries in the basic sciences were quickly put to use. So successful was this idea that we would be remiss if we did not use it as a blueprint for our ocean venture.

The sea-grant colleges not only would concentrate on applications of science to the sea, such as prospecting underwater, mining, developing the food resources, marine pharmacology and medicine, shipping and navigation, weather and climate, but they would relate these to the natural sciences which underlie them; to the social sciences, economics, sociology, psychology, politics and law, as they are affected by and, in turn, affect the occupation of the sea. They would also be associated with the liberal arts—literature, art, and history—which describe man's relation to the sea and enhance his enjoyment of it.

Just as the land-grant colleges were given in perpetuity grants of land for their experimental plots, in some cases lands in which mineral resources were found or that grew to be otherwise useful and served to provide income for the ongoing of the total enterprise, so sea-grant colleges should be given grants of seashore or lakeshore, seawater and bottom within territorial limits as their experimental plots to stimulate the development of aqua culture in the waters and the prospecting and ways of exploiting the natural resources of the sea bed. These watery grants would serve the additional purpose of preserving tracts of seashore and open waters from the fiercely competitive pressures due to increase of population and industrialization—preserve them not only as natural habitats for ecological studies but as the important nursery areas of high-sea fish and residences for in-store food fish and shell fish. The sea-grant college, to do its job, will also need its county agents in hip boots—an Aquacultural Extension Service that takes the findings of the college or university onto the trawlers, drilling rigs, merchant ships, and down to the submotels. The sea-grant college to do its job in aquaculture and ocean engineering will need sea home economics, too. Even if we had abundant protein from the sea today, a selling job would need to be done to remove taste prejudices and taboos, and this is done by such a down-to-earth service, yet one which touches more people than the erudite things we do in universities, as home economics. As we breed and farm fish, we will need to have fish vets, fish pathologists, and experts on the diseases and parasites that may plague our flocks in the sea or our plants. We will no longer be able to tolerate epidemics like the blooming of a red tide of dynaflagellates that make widespread fish kills and are concentrated by mollusks so that these poison people.

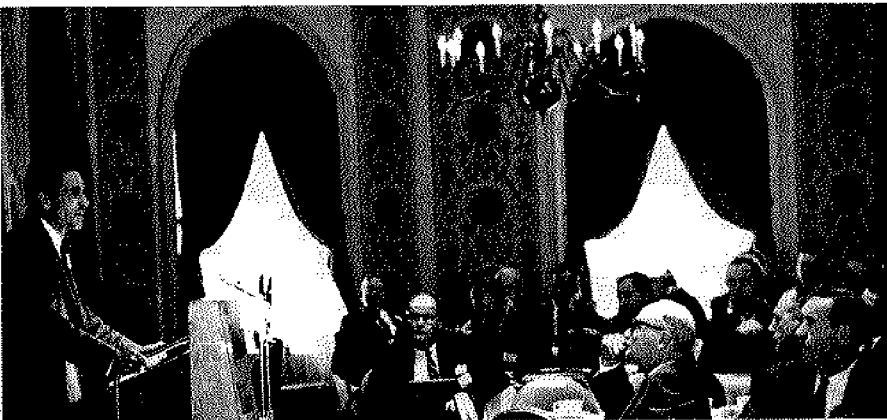
Law is an utterly important adjunct to any widespread exploitation of the sea. We need a clarification of the law of the sea and a way of, on the one hand, being able to grant rights so that a group investing capital in vast projects may be assured of some stability toward reasonable return and, on the other hand, better legal controls to prevent overfishing. Economics, too, must play a major role. The reason that nobody pays attention to preserving the inventory of whales in the sea and that nobody confines himself to a catch that is calculated to build up the stock and take the renewable amount as harvest, is an economic one. The whales in the sea are not on anyone's books as an economic asset. Public administration, with due regard to national and international politics, must find a way out of the dilemma that is posed when nobody owns what's

in the sea, and when nobody feels responsible for its controlled exploitation.

The marine engineer who emerges from our sea-grant institutions will be as different from the old-fashioned marine engineer as the satellite engineer is from the one who operates a heating plant. The aquaculturist will be different from the conventional fisherman. Oceanic engineering and aquaculture, the control of the sea for man's purposes, will take all our imagination and inventiveness as a magnificent challenge.

The oceans will offer us military, recreational, economic, artistic, and intellectual outlets of unlimited scope. Thus they'll offer us more space than space itself in which to remain human. The sea—beautiful and dangerous, elegant and strong, bountiful and whimsical—not only challenges us but offers to every "man in the street" the exciting participation of being a "man in the sea." Like a military operation where a war is not won until the area is occupied, we will master the sea only when we occupy it.

But to do this we must have sea-grant universities and colleges that focus with commitment on the sea—that seek to impinge all our intellectual disciplines on the mastery, exploitation, and preservation of the sea. Just as the scholars in the land-grant college developed a passion for the land and led not only, in ways to benefit by it, but also in the ways to preserve it—we must seek through a welding together of science, art, literature, engineering, medicine, law, public administration, and politics to develop a public which will not only homestead our new spaces in the sea but colonize and civilize them through an integrated interdisciplinary education in the sea-grant universities.



Newport, R.I., 1965. Senator Claiborne Pell addresses the over 200 strong audience gathered to discuss, explore, and expand the sea grant concept.

THE NATIONAL SEA-GRANT COLLEGE & PROGRAM ACT OF 1965

Senator Claiborne Pell, M.A., Columbia University. A native to Newport, Rhode Island, he was elected to the United States Senate in 1960. He served in the Coast Guard during World War II and is presently a captain in the USCGR. He has taken an active interest in maritime affairs and in oceanography, and has worked on the concept of legislation to establish an educational program at making maximum beneficial use of our country's marine resources.

Ladies and Gentlemen:

I am delighted to have this opportunity of sharing in this national conference to develop plans and ideas for implementing the concept of sea-grant colleges.

Under the sponsorship of the University of Rhode Island and the Southern New England Marine Sciences Association, this conference is of great meaning to our own State and to the goals we seek for advancing, in the best possible fashion, our knowledge of oceanography and education in the marine sciences. Such increasing knowledge and education can bring highly important benefits to Rhode Island and to the United States in the years ahead.

I am particularly delighted to participate in this conference with so many leaders distinguished in the broad area of oceanography. Dr. Horn, as President of the University, and Dean Knauss, as head of its Graduate School of Oceanography, have brought the University of Rhode Island to a position of not only state but national prominence. I have long admired the imaginative and pioneering programs established at URI. And it is also a singular pleasure for me to share in this conference with Dr. Athelstan Spilhaus, Dean of the Institute of Technology at the University of Minnesota. Dr. Spilhaus is a pioneer of the sea-grant college concept—which I have sought as a Senator to implement within the framework of new legislation.

As you may know, I have recently introduced in the Senate proposals for national sea-grant colleges and for a program of education aimed at making maximum use of our country's marine resources. They are an asset which we have only begun to explore. The legislation, I believe, can be of benefit to this University, to Rhode Islanders, and to our country as a whole.

Rhode Island has had a long and historic association with the sea. Eighty-eight years ago, Alexander Agassiz—a resident of this very city of Newport—organized the three cruises of the Coast Guard vessel, BLAKE. These voyages marked the first major efforts of the United States in oceanographic exploration. Until the end of the last century, the Alexander Agassiz laboratory in Newport—stemming from a concept originated by his father, Louis—was our nation's historic center of early research into the mysteries of the marine environment.

Thus Rhode Island can lay rightful claim to the beginnings of oceanographic studies which this University has so well expanded. A great deal more needs to be done, however, if we are to make full use of our potentials and develop the skills and understandings we will need for the future.

The oceans and their deeps constitute a last physical frontier here on earth which man has by no means fully investigated.

Until recent times, as President Johnson has pointed out, the oceans have been looked upon chiefly as "barriers to invasion." "We must now see them as links," the President has stated, "not only between peoples, but to a vast new untapped resource. It is becoming increasingly clear that there are large mineral deposits under the oceans. But before this treasure becomes useful, we must first locate it and develop the technology to obtain it economically. We must also learn more about marine biology, if we are to tap the great potential food resources of the seas."

President Kennedy in a message to Congress said that our "very survival" may hinge upon the development of our knowledge of the oceans and the resources they contain.

Emphasizing the growing concern of members of the Congress in oceanography is the number of legislative proposals in this area made during the first Session of the 89th Congress. Let me pay tribute, at this point, to the oceanographic pioneer of the Congress—Senator Warren Magnuson, whose bill, as I have said in the Senate, provides for the first time a clear statement of our nation's goals in oceanography, and a means to determine how the federal program can be organized most effectively to meet these goals.

My proposals, I believe, would serve to augment Senator Magnuson's concept of a well-coordinated National Council for Marine Resources and Engineering Development. Specifically, my proposals would help engender the skilled manpower and technology for the many important facets of evolving work in which the Council, envisioned by Senator Magnuson, would be engaged.

Under my bill, sea-grant colleges would be those supported by the act, either in part or in whole. The bill would provide immediate assistance to already existing institutions, enabling them to expand established programs and to develop corollary programs—as, for example, the University of Rhode Island's creation of a two-year school to train fisheries technicians.

As it is in so many other areas relating to our country's future accomplishments, education, I believe, is a key factor to the beneficial harvesting of the seas. We need more young scientists skilled in oceanography; but, just as importantly, we need the technicians to translate into practical results scientific theories and discoveries. We need more young engineers accomplished in the marine sciences, and we need the facilities and the equipment which imaginative and educated minds can help us produce.

In the past we have made tremendous strides forward in agriculture. Now we need to concentrate with equal zeal on aquaculture.

There is a close parallel between the National Sea-Grant College and Program Act of 1965 I have introduced in the Senate and the legislation,

originating almost 100 years ago, to establish the land-grant colleges which provided such a great stimulus to the development of agriculture. Modern methods of contour plowing, crop rotation, the development of hybrid plants and modern farm machinery and equipment, all testify to the increasing advances in agriculture which continue to benefit our country and its land.

Before the advent of the land-grant colleges, the average American farmer produced enough food to feed himself and four other people. Today one American farmer produces food for 37 people, including five in foreign countries. In other words, the American farmer has increased his productivity seven-fold.

Contrast this 700% productive increase with that of the average individual American fisherman—which stands at only 33% on a comparable basis over the same period of time—and we can conclude that today's farmer has increased his efficiency 20-fold over today's fisherman.

To further pinpoint these factors, statistics from the Bureau of Commercial Fisheries show that the average medium-sized U.S. trawler fishing the North Atlantic is 24 years old, that smaller trawlers have an average age of 27 years, and that a large percentage of our American fishing fleet is 50 years old. A man may be in the prime of life at these ages—but not a fishing vessel. Obsolescence in this case accompanies age—and, you might say, Neptune cruises the seas along with Davy Jones.

Our fishing industry employs today approximately half a million people whose catch is estimated to be worth a billion dollars to our national economy. Imports, however, provide more than half our country's supply of fishery products. The old days of American preeminence in the harvesting of the seas—the days, for instance, when the world whaling industry was dominated by American skills—have been washed back into the history books. We cannot, like King Canute, expect to turn back the waves, or reverse the tides of history, by mere demand or edict. But we can create new channels for our ingenuity to follow; and, just as we have made the land more and more valuable to us, so can we make the seas of ever increasing advantage.

Already our country is receiving a substantial amount of revenues from the ocean depths, chiefly from rents, royalties and bonuses from off-shore oil properties under governmental lease. Over the past 10 years these revenues have amounted to over \$1.5 billion. My proposals envisage using ten percent of these revenues annually for the sea-grant college program.

Not all the revenues are immediately available—a proportion is held normally in escrow. However, it can be predicted that by the means I suggest an annual sum of at least \$10 million would be available to finance the program. And we can also forecast that this amount would grow as the program itself made possible the expanded useful exploitation of marine resources. Thus, a cumulative and evolving process would be established. What better investment could we make from revenues which come from the seas? The same concept applied to the land-grant colleges; and that investment has been returned many, many times over.

In recent years our off-shore revenues have varied considerably. Last year they amounted to approximately \$100 million, and this amount is expected to increase during the current year. So that there can be appropriate funding for the program I envision, my bill calls for the deposit of ten percent of these revenues in a special account in the Treasury. They would then be available for appropriations on a stable basis.

The legislation I have introduced calls for administration of the sea-grant college program by the National Science Foundation. Although I remain open-minded on this subject and there may well be other proposals we will wish to consider, the National Science Foundation would seem a logical and appropriate choice. It is already engaged in helping support oceanographic undertakings in some 18 institutions of higher education, including the University of Rhode Island. The Foundation has achieved a reputation of excellence and has contributed substantially to scientific advancement in a great many areas which involve our national interest and our future goals. And these—both our national interest and the goals we seek for our nation—are basically involved in the concepts we are discussing at this conference. It has been suggested that we consider how best to orient our existing institutions within the concept of greater and more meaningful emphasis on oceanography—whether a sea-grant college should be constituted so as to focus entirely on studies in the marine sciences, or whether it should be oriented so as to offer a variety of education in other subjects. Dr. Leland J. Haworth, director of the NSF, has pointed out that “the outstanding characteristic of modern oceanography is the extent to which the fundamental sciences—physics, chemistry, and biology—are being used to develop understanding of the subject.”

It would seem to me best, for our long-range interests, to utilize our existing universities insofar as possible. I am a great believer in a broad-based education as an antidote to an age of increasing specialization. That is one of the prime reasons why I have worked during three Congresses toward the establishment of a National Foundation on the Arts and the Humanities—and let me say how very pleased I was when this legislation finally came to fruition a few weeks ago. I believe it can strengthen the whole fabric of our society in future years, in sharpening our awareness of excellence, in giving us a greater ability to evaluate the past in terms of the present and future. Dr. Haworth—in a statement submitted to our Senate Special Subcommittee on Arts and Humanities, under my Chairmanship, said he was convinced that the new Foundation would “ultimately bring added strength and vitality to our science and technology,” and Dr. Glenn T. Seaborg, Chairman of the U.S. Atomic Energy Commission, in testimony before the subcommittee on the legislation, said that “in a democracy it is essential that science and the humanities be firmly united in a creative partnership.”

Thus, it would seem to me that the university with a balanced program of education, with opportunities for expanding man’s knowledge in diverse fields, would be the ideal home for the sea-grant college concept—in a word, it would afford the opportunity to specialize in a relatively new and immensely

exciting scientific area, within the framework of broad-based higher education.

A sea-grant college, as I visualize it, would have, of course, special facilities, a special curriculum. Ideally, as in the case of the University of Rhode Island, it would be located on the sea itself, so that its students could have access to the kinds of technical equipment and facilities we will need increasingly to develop if we are to harvest the full potentials of the seas. Such facilities could include experimental stations, as adjuncts to the college, to develop new techniques in underwater mining, in ship design, and in the numbers of devices which will allow man to explore the ocean depths. We will also need to experiment in methods of conservation, and in developing the crops which the seas are now known to afford, and in seeking out new harvests and the means of making them most beneficial. In this connection, it is estimated that man derives only one percent of his present food requirements from the saltwater environment. It would be hard, indeed, to underestimate the beneficial food potential of the seas—particularly in view of the rapidly expanding population.

I do not believe that a sea-grant college need necessarily be based on the oceans themselves—in states bordered, for example, by the Atlantic or Pacific of the Gulf of Mexico—although as I have pointed out such locations would have certain advantages, and I believe these states could properly take the lead in the sea-grant college program. I would envision a national effort evolving with courses in oceanography offered at universities in our inland states, and of course in those bordering on the Great Lakes.

However, a national effort of this magnitude needs to begin in the right manner. At the outset it would seem best to utilize the resources of institutions which have already established a reputation of leadership in oceanography, such as the University of Rhode Island, to provide them with adequate funding so that they can become the nuclei around which a national effort and program can evolve. In a new and pioneering field, let us recognize the pioneers and provide them with the necessary facilities to lead us forward.

As our knowledge in oceanography grows, and indeed as integral to its development and beneficial uses, I can foresee great new opportunities opening up for the business community in our own state of Rhode Island and throughout the country. In fact, many businesses are now making plans to develop the type of special equipment we will require to explore the deeps—where the pressures are intense, where the environment is hostile to the human being, where man needs skillfully tooled devices made of non-corrosive materials to act as his arms and fingers to extract samples from the ocean floor.

It is interesting to note that some of the equipment we are developing for the exploration of outer space can also apply to our deep-sea explorations. Sophisticated electronic devices that will help chart the topography and content of the ocean floor, as well as having the applicability to the realms of outer space, are within the reach of our ingenuity. Here is where industrial research and development and the sea-grant college concept go hand in hand—for the trained technician helps the industry find new avenues for expansion, and these in turn create a demand for the greater skills which our educational process can provide.

Not long ago we celebrated Columbus Day. We thought in terms of discoveries made almost five centuries ago, and of man's quest across an ocean which men once thought flat and demon-surrounded, of watery abysses and plunges into a limitless unknown. We may have exorcised the demons and myths; but we are still only on the threshold of plunging into that unknown. The great White Whale of Herman Melville's imagination, the image of mystery and fascination, continues to travel the deeps. We know only that the plunge can be richly rewarding—in terms of man's increasing knowledge, in terms of the tangible benefits to our society.

We can estimate with considerable exactness, for example, that with modernized vessels, equipment and gear, the harvest of our off-shore fisheries can be increased ten-fold.

We know that our petroleum engineers and geologists believe we have only commenced to tap the vast submarine oil reserves which lie along portions of our coasts where the water is relatively shallow—and that vast additional oil reserves can be predicted at greater depths, and that their economic benefits simply await the development of our technology.

We know that gold is being mined off the Alaskan coast, and phosphorite for fertilizers off the coast of California.

We know that platinum, iron, chromium, tin and tungsten are among other valuable minerals to be mined from the ocean floor.

These are among the "known" factors in the great unknown area of the seas. And in a fashion we are like Columbus, on the threshold of new discoveries. We travel on different vessels in a different time—but let us make sure that we don't "miss the boat"—that we voyage forward in the best possible way. That is really what this conference is all about—and why I am so pleased to have had this opportunity of sharing with you my own views.



Newport, R.I., 1965. Pictured chatting in the foyer of the Viking Hotel were, from left to right: Athelstan Spilhaus, John A. Knauss, and Senator Claiborne Pell.

Eighty-ninth Congress of the United States of America

AT THE SECOND SESSION

*Begun and held at the City of Washington on Monday, the tenth day of January,
one thousand nine hundred and sixty-six*

An Act

To amend the Marine Resources and Engineering Development Act of 1966 to authorize the establishment and operation of sea grant colleges and programs by initiating and supporting programs of education and research in the various fields relating to the development of marine resources, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Marine Resources and Engineering Development Act of 1966 is amended by adding at the end thereof the following new title:

"TITLE II—SEA GRANT COLLEGES AND PROGRAMS

"SHORT TITLE

"SEC. 201. This title may be cited as the 'National Sea Grant College and Program Act of 1966'.

"DECLARATION OF PURPOSE

"SEC. 202. The Congress hereby finds and declares—

"(a) that marine resources, including animal and vegetable life and mineral wealth, constitute a far-reaching and largely untapped asset of immense potential significance to the United States; and

"(b) that it is in the national interest of the United States to develop the skilled manpower, including scientists, engineers, and technicians, and the facilities and equipment necessary for the exploitation of these resources; and

"(c) that aquaculture, as with agriculture on land, and the gainful use of marine resources can substantially benefit the United States, and ultimately the people of the world, by providing greater economic opportunities, including expanded employment and commerce; the enjoyment and use of our marine resources; new sources of food; and new means for the development of marine resources; and

"(d) that Federal support toward the establishment, development, and operation of programs by sea grant colleges and Federal support of other sea grant programs designed to achieve the gainful use of marine resources, offer the best means of promoting programs toward the goals set forth in clauses (a), (b), and (c), and should be undertaken by the Federal Government; and

"(e) that in view of the importance of achieving the earliest possible institution of significant national activities related to the development of marine resources, it is the purpose of this title to provide for the establishment of a program of sea grant colleges and education, training, and research in the fields of marine science, engineering, and related disciplines.

"GRANTS AND CONTRACTS FOR SEA GRANT COLLEGES AND PROGRAMS

"SEC. 203. (a) The provisions of this title shall be administered by the National Science Foundation (hereafter in this title referred to as the 'Foundation').

"(b) (1) For the purpose of carrying out this title, there is authorized to be appropriated to the Foundation for the fiscal year ending June 30, 1967, not to exceed the sum of \$5,000,000, for the fiscal year ending June 30, 1968, not to exceed the sum of \$15,000,000, and for

each subsequent fiscal year only such sums as the Congress may hereafter specifically authorize by law.

"(2) Amounts appropriated under this title are authorized to remain available until expended.

"MARINE RESOURCES

"Sec. 204. (a) In carrying out the provisions of this title the Foundation shall (1) consult with those experts engaged in pursuits in the various fields related to the development of marine resources and with all departments and agencies of the Federal Government (including the United States Office of Education in all matters relating to education) interested in, or affected by, activities in any such fields, and (2) seek advice and counsel from the National Council on Marine Resources and Engineering Development as provided by section 205 of this title.

"(b) The Foundation shall exercise its authority under this title by—

"(1) initiating and supporting programs at sea grant colleges and other suitable institutes, laboratories, and public or private agencies for the education of participants in the various fields relating to the development of marine resources;

"(2) initiating and supporting necessary research programs in the various fields relating to the development of marine resources, with preference given to research aimed at practices, techniques, and design of equipment applicable to the development of marine resources; and

"(3) encouraging and developing programs consisting of instruction, practical demonstrations, publications, and otherwise, by sea grant colleges and other suitable institutes, laboratories, and public or private agencies through marine advisory programs with the object of imparting useful information to persons currently employed or interested in the various fields related to the development of marine resources, the scientific community, and the general public.

"(c) Programs to carry out the purposes of this title shall be accomplished through contracts with, or grants 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, for the establishment and operation by them of such programs.

"(d) (1) The total amount of payments in any fiscal year under any grant to or contract with any participant in any program to be carried out by such participant under this title shall not exceed 66 $\frac{2}{3}$ per centum of the total cost of such program. For purposes of computing the amount of the total cost of any such program furnished by any participant in any fiscal year, the Foundation shall include in such computation an amount equal to the reasonable value of any buildings, facilities, equipment, supplies, or services provided by such participant with respect to such program (but not the cost or value of land or of Federal contributions).

"(2) No portion of any payment by the Foundation to any participant in any program to be carried out under this title shall be applied to the purchase or rental of any land or the rental, purchase, construction, preservation, or repair of any building, dock, or vessel.

"(3) The total amount of payments in any fiscal year by the Foundation to participants within any State shall not exceed 15 per centum of the total amount appropriated to the Foundation for the purposes of this title for such fiscal year.

“(e) In allocating funds appropriated in any fiscal year for the purposes of this title the Foundation shall endeavor to achieve maximum participation by sea grant colleges and other suitable institutes, laboratories, and public or private agencies throughout the United States, consistent with the purposes of this title.

“(f) In carrying out its functions under this title, the Foundation shall attempt to support programs in such a manner as to supplement and not duplicate or overlap any existing and related Government activities.

“(g) Except as otherwise provided in this title, the Foundation shall, in carrying out its functions under this title, have the same powers and authority it has under the National Science Foundation Act of 1950 to carry out its functions under that Act.

“(h) The head of each department, agency, or instrumentality of the Federal Government is authorized, upon request of the Foundation, to make available to the Foundation, from time to time, on a reimbursable basis, such personnel, services, and facilities as may be necessary to assist the Foundation in carrying out its functions under this title.

“(i) For the purposes of this title—

“(1) the term ‘development of marine resources’ means scientific endeavors relating to the marine environment, including, but not limited to, the fields oriented toward the development, conservation, or economic utilization of the physical, chemical, geological, and biological resources of the marine environment; the fields of marine commerce and marine engineering; the fields relating to exploration or research in, the recovery of natural resources from, and the transmission of energy in, the marine environment; the fields of oceanography and oceanology; and the fields with respect to the study of the economic, legal, medical, or sociological problems arising out of the management, use, development, recovery, and control of the natural resources of the marine environment;

“(2) the term ‘marine environment’ means the oceans; the Continental Shelf of the United States; the Great Lakes; the seabed and subsoil of the submarine areas adjacent to the coasts of the United States to the depth of two hundred meters, or beyond that limit, to where the depths of the superjacent waters admit of the exploitation of the natural resources of the area; the seabed and subsoil of similar submarine areas adjacent to the coasts of islands which comprise United States territory; and the natural resources thereof;

“(3) the term ‘sea grant college’ means any suitable public or private institution of higher education supported pursuant to the purposes of this title which has major programs devoted to increasing our Nation’s utilization of the world’s marine resources; and

“(4) the term ‘sea grant program’ means (A) any activities of education or research related to the development of marine resources supported by the Foundation by contracts with or grants to institutions of higher education either initiating, or developing existing, programs in fields related to the purposes of this title, (B) any activities of education or research related to the development of marine resources supported by the Foundation by contracts with or grants to suitable institutes, laboratories, and public or private agencies, and (C) any programs of advisory services oriented toward imparting information in fields related to the development of marine resources supported by the Foundation by contracts with or grants to suitable institutes, laboratories, and public or private agencies.

“ADVISORY FUNCTIONS

“SEC. 205. The National Council on Marine Resources and Engineering Development established by section 3 of title I of this Act shall, as the President may request—

“(1) advise the Foundation with respect to the policies, procedures, and operations of the Foundation in carrying out its functions under this title;

“(2) provide policy guidance to the Foundation with respect to contracts or grants in support of programs conducted pursuant to this title, and make such recommendations thereon to the Foundation as may be appropriate; and

“(3) submit an annual report on its activities and its recommendations under this section to the Speaker of the House of Representatives, the Committee on Merchant Marine and Fisheries of the House of Representatives, the President of the Senate, and the Committee on Labor and Public Welfare of the Senate.”

SEC. 2. (a) The Marine Resources and Engineering Development Act of 1966 is amended by striking out the first section and inserting in lieu thereof the following:

“TITLE I—MARINE RESOURCES AND ENGINEERING DEVELOPMENT

“SHORT TITLE

“SECTION 1. This title may be cited as the ‘Marine Resources and Engineering Development Act of 1966’.”

(b) Such Act is further amended by striking out “this Act” the first place it appears in section 4(a), and also each place it appears in sections 5(a), 8, and 9, and inserting in lieu thereof in each such place “this title”.

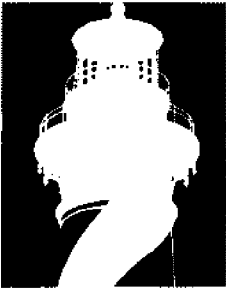
John W. McCormack
Speaker of the House of Representatives.

Stephen M. Young
~~Vice President of the United States and~~
Acting President of the Senate pro tempore

APPROVED

OCT 15 1966

Raymond J. Spence *Albert H. Gallman*
Charles F. Taylor *Paul Rogers*
John Thomas



SECTION III:

REFLECTIONS ON TWO DECADES OF SEA GRANT



Four "Fathers of Sea Grant" and the two National Sea Grant College Program Directors. From left to right: Robert Abel, John A. Knauss, Senator Claiborne Pell, Paul Rogers, Athelstan Spilhaus, Ned A. Ostenso.

REFLECTIONS ON TWO DECADES OF SEA GRANT

EDITOR'S NOTE: In commemoration of the 20th anniversary of the National Sea Grant College Act, original articles were commissioned from the "four fathers" of the legislation. These articles reflect the thinking and views of individuals who played pivotal roles in crafting the program—views shaped by two decades of progress since the legislation was enacted. The authors are: John A. Knauss, Claiborne Pell, Paul Rogers, and Athelstan Spilhaus. Additionally, articles were commissioned from two directors of the National Sea Grant College Program: Robert Abel and Ned Ostenso.

MARINE AFFAIRS: TWENTY YEARS OF PROGRESS

by John A. Knauss
Vice President of Marine Programs,
The University of Rhode Island



Sea grant was conceived in a time of great expectations. In 1965, nearly every aerospace industry was building a research submarine to explore inner space, the stock market was bullish on ocean industries, and the only disagreement in Congress was whether ocean policy should be formulated by a presidentially appointed commission (the Stratton Commission) or by an inter-agency committee, chaired by the vice president. Congress compromised by approving both.

Passage of sea grant legislation was swift, but by the time the program began to blossom in universities across the country, this nation had other concerns. Social unrest and second thoughts about our excursion into Vietnam were growing rapidly. Most industry wrote off their inner-space adventures and the oceans disappeared from the list of go-go mutual funds.

I doubt if the excitement of the sixties can be recaptured. However, those who yearn for the good old days some times overlook the remarkable growth in marine affairs of the past 20 years.

We have seen the growing concern of this nation in the preservation and wise use of our coastal areas as evidenced by enactment of coastal-zone management legislation, the rewriting of the Clean Water Act, and the passage of the Marine Protection, Research, and Sanctuary Act (the ocean-dumping act). Concern about proper management for our fisheries resources led to the passage of the Magnuson Fisheries Conservation and Management Act.

The off-shore oil industry moves even further seaward and into ever deeper water and into more hostile environments.

Containerization and roll-on, roll-off cargo handling has revolutionized port development.

Perhaps what best summarized that past 20 years is the comparison of the four conventions which emerged from the first United Nations Law of the Sea Convention in 1958 with the United Nations Convention on the Law of the Sea of 1982. That the United States has so far rejected the 1982 treaty because of concern about one major section is perhaps less important than what was attempted. What emerged was an ocean constitution, covering ocean uses and practices undreamed of not too many years ago.

Sea grant has been part of this increasing use and interest in the oceans. Whether it be coastal-zone management, marine tourism, estuarine pollution, or fisheries development, all have been impacted by sea grant. Industry, state and federal government are filled with graduates who learned their marine skills in sea grant programs. Ocean awareness has been heightened by sea grant school and community programs. It was the right program at the right time. The past 20 years have been good ones for the marine community and for sea grant. I trust the next 20 years will be as successful.

THE SEA GRANT COLLEGE PROGRAM

by Claiborne Pell
United States Senator
State of Rhode Island



Along with others who worked with me 20 years ago to establish the Sea Grant College Program, I look at the sea grant program today with considerable pride, real satisfaction, and with expectations of a bright future.

The basic idea behind the creation of the sea grant program was, and remains, quite simple. We had seen the extraordinary success of our nation's agriculture schools, the land-grant colleges, in developing American agriculture as the most productive in the world. The land-grant colleges did this by programs of education for those involved in agriculture, by applied research directed to agricultural problems, and by extension services that reached out to the farmers, processors, and marketers of agricultural products. The idea of sea grant was to apply this same system to the development and management of marine resources.

To put it quite simply, the idea has worked and worked very well. In the 20 years since the establishment of sea grant, there have been immense changes in the marine sciences, and sea grant has played an important role in those changes.

Twenty years ago, there were a mere handful of really good marine-science institutions in the United States. Today, primarily because of the sea grant program, every coastal state and Great Lakes state is served by competent and capable marine-science institutions, and many of them are not just good, but centers of excellence.

Twenty years ago, oceanography and the marine sciences tended to be somewhat isolated academic disciplines, with little contact or interaction with other academic disciplines or with marine industries. Today, through the sea grant programs, marine scientists work closely and effectively with experts in law, in economics, engineering, and the social sciences; with local and state government officials, and with citizens and businessmen who are dependent on marine resources.

An important strength of sea grant, often overlooked, is that the program has produced not merely a number of effective marine-science institutions, but a national network of colleges, universities, and institutes that share their thoughts and ideas, as well as the results of their research. Because of this, the sea grant program is not only an important asset to each state and region, but a true national asset.

Although a truly national program, sea grant draws its strengths from its roots—from the researchers in the field. Unlike many national programs, sea grant's research and work agenda is not dictated by government officials in Washington, but developed by those in the sea grant colleges who are closest to the problems and opportunities.

The Sea Grant College Program is fulfilling the vision we had in proposing it 20 years ago.

REMARKS FOR THE SEA GRANT COMMEMORATIVE BOOK

by Paul Rogers
Former United States Representative
State of Florida



It is difficult to believe that 20 years have gone by since the passage of the Sea Grant College Program. I well remember my first introduction to the sea grant concept which was given to me by Athelstan Spilhaus. Athel talked to me about his idea when he was in Palm Beach, Fla., as we met at the home of a mutual friend. The idea was novel but made eminent good sense, and Athel followed up with information materials after our visit. Then, of course, getting together with Claiborne Pell started us on the legislative path.

There were many strategy sessions in determining how to be assured of action by directing the legislation to the appropriate committees where Claiborne and I could have some effective input and control. There was a great deal of negotiation, and it was finally worked out successfully.

Sen. Warren Magnuson was helpful, as well as Congressman Alton Lennon and many others. Our hopes were cast in optimism, and I think everyone who has been a part of the Sea Grant College Program can take great pride in the many accomplishments. Our only restraint, really, has been the lack of adequate funding, but the response from the universities—starting with those conferences at the University of Rhode Island under the leadership of John Knauss, on through to the administration of the program beginning with Bob Abel's leadership—has been outstanding.

We will still have the persistent problem of lack of funding, and perhaps as we come together for this year's Sea Grant Week in Newport, R.I., we should begin to talk about the formation of the citizens' blue-ribbon National Commission for the Development of the Resources of the Sea. We need to direct public attention to how much needs to be done in order for our nation to have a leadership role in developing the vast resources of the sea.

SEA GRANT'S NEXT 20 YEARS

by Athelstan Spilhaus
Author, Inventor, Scientist



In the past 20 years, sea grant has accomplished a great deal. It has excited the interest of many institutions not previously committed to ocean interests. It has built a strong community of university people dedicated to its function of taking the advances in the marine sciences out of the laboratories and getting them into use.

This community adds to the nucleus of marine scientists in the universities, the engineers in private industry, and individuals in government who are devoted to the oceans. Sea grant indeed provides a transmission belt for carrying ocean science from the laboratories to public use and understanding. It has also importantly increased the awareness and thus reduced the unfortunate apathy to ocean affairs that exists in the United States.

Sea grant is a constructive program but it is not constructive to merely congratulate ourselves on the small steps that have been accomplished. It is more useful to focus on what it has not done and still needs to be done in the next 20 years.

What sea grant has not done is that it has not stimulated or participated in what one might call heavy ocean engineering toward important national

goals. This certainly is not the fault of the program. Great national goals for the United States in the ocean have been formulated nowhere, have little support in Congress, and do not seem to enlist public excitement such as that which made our space program fly.

There are great things which we can accomplish in the ocean. We have the tools and the ability to carry them out. The only thing needed is the will, and purpose, and backing of our leaders in government to set some goals and to see that they are accomplished.

There are some marvelous goals which can be defined which would weld together universities, industry, and government and would be daring enough to excite great public support. I will mention just two.

President Reagan took a most constructive step in extending the United States' sphere of activity in the sea by declaring the Exclusive Economic Zone. But what has been done with this new territory for the benefit of our people? What has been added from it for better living and improved economy since this declaration? Virtually nothing.

To really utilize these zones, we need to have centers off the east coast, in the Gulf, and off the west coast. We need to revive the idea of multi-purpose sea cities to provide these centers which would serve as deep-water ports, for preliminary fish processing, and the rapid turnaround of fishing vessels, for the utilization of power from the sea and from the sea bed, in situ, for suitable energy intensive industries.

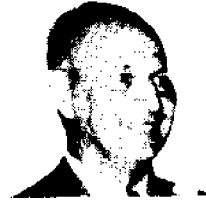
These exciting centers, necessitating as they would, the use of all our marine science, engineering, and economic know-how would be the focus of interest for visitors from land and stimulate a renewed interest in what the ocean can do for the United States. They would form the three capital cities for the new territories. The Japanese are joining islands with undersea tunnels never before thought possible. Can we leave the building of sea cities entirely to their daring leadership?

Another great goal is to pursue and extend the colonization and use of the Arctic Ocean. We have a magnificent start by private industry at Prudhoe Bay. There are economic resources further out in the Arctic that promise reward. There are the possibilities of trans-Arctic transport, shortening sea routes to Europe. It is truly a frontier which we have not adequately extended. The Russians' sea vehicles negotiate the Arctic better than we do. There is the equivalent of a new city a year going up in the Russian area bordering the Arctic. If to go to the Arctic to stay and use its resources were made a national goal, it too would be grand enough and exciting enough to turn the hearts and the imagination of the American people seaward again.

Sea grant, in the next 20 years, must play, in addition to all else it does, a strong role in formulating and carrying out projects of the scale that will once again make the United States a truly maritime nation.

NEWS AND VIEWS OF SEA GRANT

by Robert B. Abel
President
New Jersey Marine Sciences Consortium



My views of the origination and development of the sea grant program are offered in the perspective of one who:

1. Was permitted a ring-side seat at the executive/legislative sessions which gave birth to the program,
2. Had executive authority over the program for its first decade (plus one week!) in two different organizations,
3. And was the only person who has experienced the management perspectives of both the Washington bureaucracy and campus administration.

An experienced and talented Senate staff member once opined that the sea grant legislation almost was the last of its kind, whose methodology would probably never be repeated. What this person was referring to was the *laissez-faire* mandate given by the Congress to the implementing agency. In effect, the Congress said "here is money; spend it wisely; make up your own rules; and if you show results, we'll give you more money."

It was certainly thrilling to have an act of Congress all one's own and to know that we had the helm of a ship with minimal command obstructions. This was the way it was in the National Science Foundation. The sea grant staff was allowed gratifying autonomy and a feeling of being well nourished and cared for. Memory still is extremely vivid of the very first day aboard the foundation when surrounded by four walls, a secretary, two desks, and \$1 million of borrowed ("reprogrammed") money—the questions that kept recurring were—"How did I ever wind up here?" and, "What the hell do I do now?"

Almost four years later, the emergence of the National Oceanographic and Atmospheric Administration was greeted with drums and bugles; they are muted these days, to say the least. The transition from the National Science Foundation to the Department of Commerce was a bit of a shock; in fact, little time was allowed for the feeling to set in, since the first budget process took place almost immediately! It certainly was a cold bath!

Some time later, I accosted the young man sent to the foundation from the White House to persuade my colleagues and me to move with the program, on the grounds that the president was personally interested in it and wanted it to grow. All I received from my pains, however was a "who let you in?" response.

In spite of Bob White's magnificent efforts to elevate sea grant in the eyes of the Office of Management and Budget, a sort of schizophrenic reaction must have taken place somewhere in the bowels of that organization, because the

budget examiners who previously had sung our praises in the National Science Foundation now accused us of being "con-artists!"

At any rate, the transition finally enlightened me as to Shakespeare's meaning when he put into MacDuff's mouth the immortal words: "know ye that from my mother's womb was I untimely ripped!"

The very best memories are those of a partner—Hal Goodwin—and a staff considered by some to be the finest in Washington and an advisory board that had been termed the toughest and most competent in the entire government. I really cannot adequately express my feeling of pride in these two groups and my gratitude for the enormous assistance and support they provided throughout that decade.

An important issue which originally had seemed easier to solve than it turned out, was sea grant's relationship with industry. During the first two or three years, I made frequent trips around the country to industries with marine components. The proposition was that by investing a small amount of money (in matching funds) in our network, they would reap large rewards in terms of developed services and products.

I have come to realize since those early days that sea grant must be bolder, more imaginative, and more pragmatic in its whole approach to industrial affiliation. Nonetheless, this still must be considered a major, if not *the* major, goal for sea grant. It definitely is the way for sea grant to go, and the brunt of development responsibility probably ought to lie upon the sea grant directors and their colleagues in the universities. A degree of initiative must, of course, come from the national office, but it should be the function of that office mainly to react to, rather than initiate, these moves.

Finally, sea grant should be proud of its accomplishments in the two short decades of its existence. If encouraged, sea grant may well emulate the spectacular successes of the land-grant federal program (now more than 100 years old), even though the work of sea grant is in a medium infinitely more complex than that which the land-grant program confronted.

Hopefully, new heroes will emerge who will have the necessary understanding and patience to give this fine sea grant program the down-field blocking that it badly needs and clearly deserves.

THE NEXT 20 YEARS

by Ned A. Ostenso
Director
National Sea Grant College Program



The framers of the original National Sea Grant College legislation and those who laid the foundation for its implementation were exceptionally perceptive and farsighted. They recognized that most important marine-resource problems are multifaceted, requiring interdisciplinary approaches for their solution. They also realized that a necessary ingredient for success was the two-way transfer of discovery into application and of need into innovation.

These insights stood in stark contrast to the realities of those times and, sadly, these times. The normal mode for federal funding of research is along traditional disciplinary lines, reflective of the conventional governance of our academic institutions. Further, our research sponsorship and institutions conspire to segment the vital continuum between searching for knowledge and producing more tangible benefits to our society.

From this fortunate heritage, we now have a robust sea grant program that may be viewed as operating at three levels.

At one level, through a university-staffed marine advisory service, sea grant deals directly with those who are trying to develop or better utilize marine resources. Marine advisory agents and specialists not only transfer existing technologies to users, but also communicate needs to a cadre of scientists who may be able to address them through targeted research. This activity is critical to improving the disaggregated and underdeveloped sectors of our national marine economy.

We are past the rapid growth stage in establishing marine advisory services. The focus of management is now on improvement and coordination. Toward these ends, individual state marine advisory services are now linked through five regional networks for the sharing of expertise. These regional networks are in turn coordinated through regular meetings of regional representatives and/or all the advisory service directors.

Additionally, increasing attention is being given to the professional development of the marine advisory corps, and to the exploitation of the latest information processing technologies. We are well-advanced in linking the advisory agencies together with personal computers and providing them with access to central information data bases.

At another level, the national Sea Grant College Program emphasizes pursuit of research in coherent "packages." These are targeted towards clearly identified needs such as the biochemistry/physiology of salmonid smoltification; controlling the complete life cycle of "wild" species in captivity; understanding environmental impacts on fish-stock recruitment, etc.

The creation of a central management information system, the holding of specialized workshops and symposia, and the development of programmatic strategies have enhanced our effectiveness in pursuing goal-oriented research with a national network of participating specialists. Clearly, much more needs to be done and this level of activity will be a continuing management challenge.

At the third level, sea grant supports fundamental research relevant to marine-economic development. Although this has been a little-recognized aspect of the program, it already has begun to pay off. For example, by the time the importance of modern biology/biochemistry to fisheries and aquaculture was recognized widely, sea grant already was supporting more than \$2 million in biotechnology research. When a cholera scare associated with Gulf of Mexico crabs occurred, the basic research was on hand to address the problem. Furthermore, fungi and microbes have been developed genetically that digest and decompose a variety of toxic synthetic organics—the nation's most pernicious pollution problem.

Our effectiveness in orchestrating coherent national programs of fundamental research has been improved by strengthening the role of subject-area specialists within the Office of Sea Grant.

To refill the coffers of knowledge that led to sea grant developments in the first two decades of our existence, strategic research must be the growth area for the National Sea Grant College Program in the future.

In summary, the continuing management challenge for the sea grant program will be balancing basic (strategic) versus applied (tactical) research, meeting local needs while addressing national objectives, and exercising leadership without stifling the inflow of new ideas.

We must continue to emphasize the multidisciplinary approach, while university structures, professional loyalties, and the most other federal research sponsors function along disciplinary lines.

Finally, we must make every effort to satisfy the diverse public and private constituencies which have legitimate interests in the program, some through the provision of matching funds.

These are worthy challenges.



SECTION IV:

SEA GRANT—
THE PRESENT

SEA GRANT— THE PRESENT

Participating Institutions

Twenty years of careful growth and development has spawned more than 300 sea grant programs in 42 states, U.S. territories, and the District of Columbia. Participating institutions include:

ALABAMA

Dr. James I. Jones
Director
Mississippi-Alabama Sea Grant
Consortium
Caylor Building
Gulf Coast Research Laboratory
Ocean Springs, Miss. 39564
601/875-9341

Auburn University
Marine Environmental Sciences
Consortium
Talladega College
Tuskegee University
University of Alabama
University of Alabama-Birmingham
University of South Alabama

ALASKA

Mr. Donald H. Rosenberg
Director
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Kodiak Community College
Sheldon Jackson College
University of Alaska, Anchorage
University of Alaska, Cooperative
Extension Service
University of Alaska, Fairbanks
University of Alaska, Juneau

ARIZONA

University of Arizona

ARKANSAS

University of Arkansas

CALIFORNIA

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California Sea Grant College
Program

California Academy of Sciences
California Institute of Technology
California State Polytechnic University,
Pomona

University of California-San Diego
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619/452-4440

California State University-Long Beach
California State University-Northridge
Humboldt State University
Moss Landing Marine Laboratories
San Diego State University
San Francisco State University
San Jose State University
Scripps Institution of Oceanography
Southern California Coastal Water
Research Projects
Southern California Ocean Studies
Consortium
Stanford University
University of California, Berkeley
University of California, Davis
University of California, Irvine
University of California, Los Angeles
University of California, Riverside
University of California, San Diego
University of California, Santa Barbara
University of California, Santa Cruz
University of San Diego
University of Southern California
University of the Pacific

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COLORADO

Colorado State University
American Cancer Research Center and Hospital

CONNECTICUT

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University of Connecticut
Western Connecticut State College
Yale University

DELAWARE

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University of Delaware

DISTRICT OF COLUMBIA

National Sea Grant College
Program Office
6010 Executive Blvd.
Rockville, Md. 20852
301/443-8923

American Geophysical Union
National Association for Equal
Opportunity in Higher Education
National Fisheries Institute

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Florida Atlantic University
Florida Institute of Technology
Florida International University
Florida Junior College
Florida Keys Community College
Florida State University
Harbor Branch Foundation
Mote Marine Laboratory
Nova University
St. Petersburg Junior College
University of Central Florida
University of Florida
University of Miami
University of North Florida
University of South Florida
University of West Florida

GEORGIA

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Fort Valley State College
Georgia Institute of Technology
Georgia Southern College
Morehouse Medical College
Skidaway Institute of Oceanography
University of Georgia

GUAM

University of Guam

HAWAII

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University of Hawaii at Hilo
University of Hawaii, Honolulu
Community College
University of Hawaii, Kauai
Community College
University of Hawaii, Leeward
Community College

Honolulu, Hawaii 96822
808/948-7031

University of Hawaii, Manoa
University of Hawaii, Maui
Community College
University of Hawaii, Windward
Community College

IDAHO

University of Idaho

ILLINOIS

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INDIANA

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Indiana University
Purdue University

IOWA

Iowa State University

LOUISIANA

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Herbert Law School
Louisiana State University Agricultural
Center
Louisiana State University, Baton
Rouge
Nicholls State University
Northeastern State University
Southern University, Baton Rouge
Terrebonne Parish School Board
University of New Orleans
University of Southwestern Louisiana

MAINE

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Bigelow Laboratory for Ocean
Sciences
College of the Atlantic
Maine Maritime Academy
Southern Maine Vocational Technical
Institute
University of Maine at Machias
University of Southern Maine
Washington County Vocational
Technical Institute

MARYLAND

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Anne Arundel Community College
Baltimore City Public Schools
Citizens Program for Chesapeake Bay
Council for National Cooperation in
Aquatics
Johns Hopkins University
National Aquarium in Baltimore
St. Mary's College in Maryland
St. Mary's County Public Schools
Undersea Medical Society, Inc.
University of Maryland, Baltimore City
University of Maryland, Baltimore
County
University of Maryland, Center for
Environmental and Estuarine
Studies
University of Maryland, College Park
University of Maryland, Eastern Shore

MASSACHUSETTS

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Boston University
Children's Memorial Hospital
Harvard University
Massachusetts Institute of Technology
Massachusetts Maritime Academy
Marine Biological Laboratory
New Bedford Public School System
New England Aquarium
Tabor Academy
University of Massachusetts, Boston
University of Massachusetts, Amherst
Woods Hole Oceanographic
Institution

MICHIGAN

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Eastern Michigan University
Michigan Primary and Secondary
Schools
Michigan State University
Michigan Technology University
Northern Michigan University
Northwestern Michigan College
University of Michigan
Wayne State University

MINNESOTA

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University of Minnesota, Duluth
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MISSISSIPPI

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Biloxi High School
Gulf Coast Research Laboratory
Jackson State University
Mississippi State University
Ocean Springs High School
University of Mississippi
University of Southern Mississippi

MONTANA

Montana State University
University of Montana

NEVADA

University of Nevada
University of Nevada, School of Veterinary Medicine

NEW HAMPSHIRE

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Colby-Sawyer College
Dartmouth College
Franklin Pierce Law Center
New Hampshire Council of
Universities and Colleges
Plymouth State College
University of New Hampshire

NEW JERSEY

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Atlantic Community College
Brookdale Community College
Fairleigh Dickinson University
Kean College of New Jersey
Montclair State College
New Jersey Institute of Technology
New Jersey Marine Sciences
Consortium
New Jersey Medical and Dental
School
Princeton University
Rider College
Rutgers—The State University
Stevens Institute of Technology
Stockton State College

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City University of New York, Graduate
School at University Center
City University of New York, Hunter
College
Clarkson College
Columbia University
Cornell University
Great Neck Public School District
Jefferson County Community College
New York University
New York University Medical Center
Pratt Institute
Rensselaer Polytechnic Institute
Rochester Institute of Technology
Southampton College of Long Island
University
St. John's University
State University of New York,
Agricultural and Technical
College at Farmingdale
State University of New York, College
of Environmental Science and
Forestry

State University of New York at
Albany
State University of New York at
Binghamton
State University of New York, College
at Brockport
State University of New York at
Buffalo
State University of New York, College
of Fredonia
State University of New York at
Oswego
State University of New York at
Potsdam
State University of New York at Stony
Brook
Staten Island Continuum of Education
Society of Naval Architects and
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Syracuse School District
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Campbell University
Cape Fear Technical Institute
College of the Albemarle
Duke University
East Carolina University
Laque Center for Corrosion
Technology, Inc.
North Carolina A&T University
North Carolina Central University
North Carolina State University
University of North Carolina at Chapel
Hill
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Firelands
Case Western Reserve University
Center of Science and Industry
Cleveland Museum of Natural History
Findlay College
Hiram College
Lakeland Community College

Lorain County Community College
Ohio Arts Council
Ohio State University, Columbus
Ohio State University, Mansfield
University of Cincinnati
University of Miami

OKLAHOMA

University of Oklahoma

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Oregon Health Sciences University
Oregon State University
University of Oregon

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Lake Erie Marine Sciences Institute
Lehigh University

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Inter American University, Arecibo
Inter American University, San
German
University of Puerto Rico, Hamacao
University of Puerto Rico, Mayaguez
University of Puerto Rico, Rio Piedras

RHODE ISLAND

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University of Rhode Island

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College of Charleston
Marine Resources Research Institute
Medical University of South Carolina
South Carolina State College
The Citadel
University of South Carolina,
Columbia
University of South Carolina, Beaufort
University of South Carolina, Coastal
Carolina

TEXAS

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Baylor College of Medicine
Brazosport College
Lamar University
Pan American University
Sam Houston State University
Texas A&M University
Texas A&M University at Galveston
Texas Education Service Center, Waco
Texas Southern University
Texas Southmost College
Texas State Technical Institute,
Harlingen
University of Houston
University of Houston-Clear Lake
University of Texas at Austin
University of Texas at Port Aransas

UTAH

University of Utah

VIRGINIA

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College of William and Mary
George Mason University
Hampton Institute
Norfolk State University
Old Dominion University
Rappahannock Community College
Thomas Nelson Community College
University of Virginia

Virginia Institute of Marine Science
Virginia Polytechnic Institute and State
University
Virginia State University

WASHINGTON

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Bellingham Vocational-Technical
Institute
Clover Park Vocational-Technical
Institute
Grays Harbor College
Highline Community College
Pacific Science Center
Seattle Aquarium
Seattle Central Community College
Shoreline Community College
University of Washington
Washington State University
Western Washington University

WEST VIRGINIA

West Virginia University

WISCONSIN

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Lawrence University
Medical College of Wisconsin
University of Wisconsin, Extension
University of Wisconsin, Green Bay
University of Wisconsin, Madison
University of Wisconsin, Marinette
University of Wisconsin, Milwaukee
University of Wisconsin, Parkside
University of Wisconsin, Stevens Point
University of Wisconsin, Superior

CHRONOLOGY OF SEA GRANT COLLEGES

		<i>Year Status Acquired</i>	
Sea Grant Colleges:	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	
	University of Maryland	1982	
	University of Michigan/ Michigan State University	1982	
	Mississippi/Alabama Sea Grant Consortium	1982	
	Virginia Graduate Marine Science Consortium	1984	
Institutional Programs:	University of Southern California South Carolina Sea Grant Consortium	1972	
	New Jersey Marine Science Consortium	1980	
	Ohio State University	1981	
	University of Puerto Rico	1982	
	University of Connecticut	1982	
	Woods Hole Oceanographic Institution	1985	
	Coherent Area Programs:	University of Illinois/ Purdue University	1984

SEA GRANT PROGRAM: FORMER DIRECTORS/PRINCIPAL INVESTIGATORS

During the past two decades, upwards of 50 distinguished individuals have given their scientific, technical, administrative, and management skills to the sea grant program. Without their support and encouragement the great strides posted by the program would have been impossible.

Sea grant program former directors and principal investigators include:

Alaska

- David M. Hickok

California

(University of California,
San Diego)

- Jeff D. Frautschy
- George G. Shor

(University of California, Santa
Barbara)

- Robert W. Holmes

(Humboldt State University)

- Richard Ridenhour
- Theodore H. Kerstetter

(Moss Landing Marine Laboratory)

- John P. Harville
- Robert Hurley

(San Diego State University)

- Glenn A. Flittner

Connecticut

- Victor Scottron

Delaware

- William Gaither

Florida

(University System)

- Hugh Popenoe

(University of Miami)

- Richard Bader*
- Eugene Man

Hawaii

- Ronald G. Linsky
- Morton Rosenberg

Maine

- David Dean
- Bruce Poulton
- Frederick Hutchinson
- Malvin Gilmartin

Massachusetts

(Massachusetts Institute of
Technology)

- Alfred Keil
- Ira Dyer

- Dean Horn

(Woods Hole Oceanographic
Institution)

- Dean Bumpus

Michigan

- Ross Tocher
- Charles Overberger
- Erwin Siebel

Minnesota

- Lloyd Smith*
- Dale R. Baker

Mississippi/Alabama

- Sidney Upham
- Bruce Mattox

New Hampshire

- Godfrey Savage

New Jersey

- Lionel Walford*
- Robert Ellis

New York

- Donald Squires

North Carolina

- John Lyman*

Oregon

- Herbert Frolander

Rhode Island

- Niels Rorholm

South Carolina

- Edward Josephs
- John Armstrong

Southern California

- Ronald G. Linsky
- Donald L. Keach

Texas

- John Calhoun
- Roy Hann
- Worth Nowlin Jr.

Virginia

(Virginia Institute of Marine Science)

- William J. Hargis
- Maurice P. Lynch

(Virginia Polytechnic Institute and State University)

- Neal E. Boyd

Washington

- Stanley Murphy
- William R. Davis

*deceased

SEA GRANT REVIEW PANEL

The Sea Grant Review Panel was established in compliance with the Sea Grant Improvement Act of 1976 (Public Law 94-461).

The panel consists of 15 members appointed by the U.S. Secretary of Commerce. By law, at least five panel members are individuals by knowledge, experience, or training who are especially qualified in one or more marine science fields. Other members represent education, extension services, state government, industry, economics, planning, or other activities—such as environmental management or conservation—which enhance the understanding, development, assessment, utilization, or conservation of ocean and coastal resources.

In accordance with the provisions of the Sea Grant Improvement Act, the panel advises the Secretary of Commerce, the administrator of the National Oceanographic and Atmospheric Administration, and the director of the National Sea Grant College Program on broad policy with respect to the establishment and operation of a national network of sea grant programs, institutions and regional consortia, as well as research, education, and marine extension services.

The panel reviews and advises on institutional programs, plans, and policies governing the program, and the change of status of institutional programs to sea grant colleges. In addition to addressing these activities at formal meetings, panelists are called upon several times a year to participate in on-site reviews of major college programs and recertification reviews of sea grant colleges.

SEA GRANT REVIEW PANEL MEMBERSHIP LIST

Name	Years Served	Name	Years Served
W. C. Ackermann	1979-85	Otto Klima*	1968-75
Sanford Atwood*	1968-78	Francis Laque	1980-83
Thomas Barrow	1971-74	Bernard LeMehaute	1974-78
Willard Bascom	1979-81	Alton Lennon	1972-79
	1982-84	Harold E. Lokken	1971-78
Werner Baum	1974-78	Arthur E. Maxwell	1982-85
George Benton	1972-79	John A. Mehos	1974-76
Bernard Berman*	1968-70	Charles Mosher	1977-80
Fay R. Biles	1980-83	<i>(deceased)</i>	
John Blair	1979-85	Mary Lou Munts	1978-81
Herman R. Branson	1980-85	Michael J. Pelczar Jr.	1980-83
Randolph W. Bromery	1977-80	David S. Potter*	1968-74
Douglas L. Brooks*	1968-74	Robert H. Roy*	1968-72
Joseph C. Busby	1977-80	Athelstan Spilhaus	1970-76
Lynton K. Caldwell	1977-79	Lyle S. St. Amant	1973-79
Arturo Morales Carrion	1978-81	<i>(deceased)</i>	
John Calhoun*	1968-70	H. Burr Steinbach*	1968-76
Earl Conrad	1982-84	<i>(deceased)</i>	
John D. Costlow	1978-80	Paul D. Triem	1978-81
Lauren R. Donaldson	1980-83	Marjorie Lass Vesley	1977-80
Charles L. Drake	1978-81		1982-85
Jacob Dykstra	1969-76	James H. Wakelin Jr.	1970-76
Phillip Eisenberg	1969-78	Harvey M. Weil	1971-78
<i>(deceased)</i>		Christopher Weld	1979-80
Robert Ellis	1974-76		1982-84
Lloyd N. Ferguson	1978-84	Walker V. Yonker	1978
Osborne Fuller	1971-76	<i>(deceased)</i>	
Roy Gaul	1972-74	Roy A. Young	1978-80
LeVan Griffis*	1968-76		
Leigh H. Hammond	1980-83	<i>*original panel member</i>	
Joseph E. Henderson*	1968-76		
Chalmer G. Kirkbride*	1968-72		

SEA GRANT INTERN PROGRAM

The Sea Grant Intern program was established in 1979 to partially fulfill one of the objectives of the National Sea Grant College Program Act, which states, in part, "The objective of this title is to increase the understanding assessment, development, utilization, and conservation of the nation's ocean and coastal resources by providing assistance to promote a strong educational base . . ."

The Sea Grant Intern program allows outstanding graduate student scientific scholars of the sea grant network to spend one year in Washington,

D.C., learning and honing the skills needed for active leadership and to conduct research in "increasing the understanding, assessment, development, utilization, and conservation of the nation's ocean and coastal resources."

The selection process begins annually in June, with a letter from the Director of the Office of Sea Grant to all university sea grant directors, announcing the program and outlining conditions for candidacy. Individual sea grant directors advertise the positions widely within their programs. Upon receipt and endorsement by candidates' major professors, state sea grant directors select, interview, and after approval and endorsement, forward candidates' names, resumes, and endorsements to Washington, D.C.

In October each year, candidates' resumes, and accompanying paperwork, are subjected to rigid reviews and evaluations by the Office of Sea Grant where they are ranked. After ranking, the top 10 to 15 are notified by the National Oceanographic and Atmospheric Administration that they have been selected as possible candidates. In December, candidates arrive in Washington, D.C., for orientation and placement. Only after a week of orientations and interviews are candidates finally selected as approved interns (subject to grant approval).

Interns work in the legislative branch, learning the legislative process and contributing scientific expertise in development of laws, or work in scientific positions in NOAA.

SEA GRANT INTERNS

Name	University	Year	Name	University	Year
Douglas Lipton	William & Mary	1979	Mike DeLuca	Virginia	1981
Carrol Curtis	Old Dominion	1979	Gail Chmura	Rhode Island	1981
John Kosmark	Rhode Island	1979	Dale Brown	Rhode Island	1981
Frederick Paine	New Hampshire	1979	Cynthia Carlson	Lewis & Clark	1981
Robert Bolus	New Hampshire	1979	Gina DeFarrari	Washington	1981
Christine Dawson	Washington	1979	Onno Husing	Woods Hole Oceanographic Institution	1981
John Kermond	Texas A&M	1979	Thomas Potts	Texas A&M	1981
James Rendall (deceased)	Washington	1979	David Smith	Texas A&M	1981
Allen Stayman	Washington	1979	Paul Vincent	Washington	1981
Arthur Wilson	Delaware	1979	Donald West	Louisiana State	1981
William McClusky	Rhode Island	1980			
Thor Lassen	William & Mary	1980			
Paul Davis	Rhode Island	1980			
Darrell Brown	Washington	1980			
Ann Hochberg	Oregon	1980			
Joanne Peterson	Texas A&M	1980			

Name	University	Year	Name	University	Year
Heather Wicke	Michigan	1982	Thomas Armitage	Virginia Institute of Marine Science	1984
Wim VanTeefelen	West Florida	1982	James Buizer	Washington	1984
Christophe Tufou	Rhode Island	1982	Paul Carothers	Texas A&M	1984
Stephen Risotto	Louisiana State	1982	Candyce Clark	Rhode Island	1984
Dan Jacobs	Maryland	1982	Daniel Farrow	Wisconsin	1984
Glenn DeLaney	William & Mary	1982	Victoria Fabry	California	1984
Brian Burby	Ohio State	1982	Marcus Hepburn	Florida	1984
David Allen	Michigan	1982	Paul Kemp	Louisiana State	1984
Dan Ashe	Washington	1982	Catherine Mills	Mississippi	1984
Michael Brody	Texas	1982	Katherine Minsch	State University of New York	1984
Elizabeth Carnahan	Texas A&M	1982	Mark Monaco	Ohio State	1984
William Horns	Wisconsin	1982	David Pybas	South Carolina	1984
Eric Stromberg	Washington	1982	Nancy Reichley	Rhode Island	1984
Charles Alexander	Louisiana State	1982	Christina Terpak-Malm	Virginia	1984
Andrew Zacherle	William & Mary	1983	Patience Whitten	California	1984
Helen Brohl	Ohio	1983	Mark Aspinwall	Rhode Island	1985
Craig Zamuda	Maryland	1983	Penelope Dalton	Maryland	1985
Edward Richardson	Rhode Island	1983	Jeanne Grasso	University of Southern California	1985
Rebecca Roots	Texas A&M	1983	Donna Johnson	Connecticut	1985
Margaret Overby	Florida	1983	Lisa Knelson	North Carolina	1985
Kimberly Grane	William & Mary	1983	Justin Lancaster	California	1985
Timothy Bartish	Ohio	1983	Vernon Leeworthy	Florida	1985
Robert Deibel	California	1983	Martin Main	Florida	1985
John Lamkin	Texas A&M	1983	Dan Margulies	Maryland	1985
Kevin McManus	Washington	1983	Timothy Osborne	Louisiana State	1985
Carolyn Rumery	Wisconsin	1983	Constance Sathre	Oregon	1985
Monique Trainor	Washington	1983	Lucia Susani	Woods Hole Oceanographic Institution	1985
Susan Wade	Washington	1983	Jill Zucker	University of Southern California	1985
			Deborah Trefts	Washington	1985

THE NATIONAL SEA GRANT DEPOSITORY

The National Sea Grant Depository (NSGD) is an information center dedicated to the collection, storage, documentation, and dissemination of sea grant literature. It offers information on the oceans, and America's Great Lakes and coastal zones.

The NSGD was established at the University of Rhode Island's Pell Marine Science Library in 1970. Through its unique collection it provides current and efficient access to all publications generated by the National Sea Grant Program.

Publications housed in the depository cover subjects, including aquaculture, mineral resources, law and socioeconomics, fisheries, biomedicinals, ocean engineering, coastal-zone management, marine education, marine recreation, and applied oceanography.

The depository includes technical reports, journal reprints, newsletters, marine advisory reports, manuals, guides, directories, bibliographies, annual reports, conference proceedings, and maps, charts, and atlases produced by sea grant-funded researchers.

All depository publications are available for a one-month loan. There is a loan limit of 15 documents. Personal copies are obtainable from the originating sea grant program.

On-line literature searches can be conducted on any marine-related topic, using keywords or authors. Over 22,000 citations are included in the database.

Telephone, mail and interlibrary loan requests are welcome. These services are available.

A new hard copy abstract publication (produced by Woods Hole Database, Inc., in cooperation with the NSGD) lists abstracts of sea grant documents received by the depository on a quarterly basis.

For further information on the National Sea Grant Depository, contact:

National Sea Grant Depository
Pell Library Building
Univ. of Rhode Island—Bay Campus
Narragansett, RI 02882
(401) 792-6114



Four Fathers of Sea Grants. On the eve of the 20th anniversary of sea grant, four authors of the legislation met in the U.S. Capitol to affix their signatures on the statute in a commemorative ceremony. From left to right: Athelstan Spilhaus, John A. Krauss, Senator Claiborne Pell, and Paul Rogers.



SECTION V:

SEA GRANT
ASSOCIATION

THE SEA GRANT ASSOCIATION

The Sea Grant Association is a voluntary organization of marine universities, industries, and agencies committed to furthering the understanding, development, utilization, and conservation of ocean and coastal resources. The association has three purposes:

- To further the optimal development, use, and conservation of marine, coastal, and Great Lakes resources, and to encourage increased accomplishments and initiatives in related areas;
- To increase the effectiveness of member institutions in their work on marine, coastal, and Great Lakes resources; and
- To stimulate cooperation and unity of effort among members.

The Sea Grant Association provides a mechanism through which members can communicate and cooperate to strengthen national ocean goals, thus advancing sea grant involvement in meeting these goals.

The association assists member institutions in maintaining liaison with the Office of Sea Grant in the National Oceanic and Atmospheric Administration; with congressional committees active on marine issues; and with other agencies.

The association provides timely information to keep members abreast of current marine-related federal government activities, such as pending legislation, upcoming hearings, and changes in administration policies. The association also seeks to keep government offices up-to-date on the accomplishments and philosophies of member institutions.

Members gather annually at a meeting to share concerns, discuss new directions, provide opportunities to develop the professional capabilities of sea grant program personnel, and develop innovative ideas for marine-related research.

Active involvement in the Marine Division links the National Association of State Universities and Land-Grant Colleges with the Sea Grant Association to provide a broad focus on marine programs in the nation's universities.

The association's Executive Committee, with representatives elected from member universities, handles the association's business affairs, guides its activities, and represents its philosophy.

Several association professional committees bring together individuals from member institutions to discuss areas of special concern in ocean policy, marine education, communications, and marine advisory services. These committees reflect the various activities of sea grant programs, and provide a forum for interactive discussion on policies and projects useful to sea grant and industries and agencies involved in the nation's marine program.

An Annual Sea Grant Award is presented to an individual personifying the sea grant goal of helping to put the oceans to work.

At its annual meeting, the association pays special tribute to those who will become the next generation of marine professionals by recognizing out-

standing ocean-related research students, who have participated in sea grant projects or in studies supported by other agencies.

Signifying industry's partnership with the universities in sea grant efforts, the National Ocean Industries Association provided funds, for some years, for these awards.

1984-85 SEA GRANT ASSOCIATION OFFICERS

President

James I. Jones

Mississippi-Alabama Sea Grant Consortium

President-Elect

William L. Rickards

Virginia Sea Grant College Program

Past President

Alfred M. Beeton

University of Michigan

Executive Committee

James C. Cato (1985)*

University of Florida

R. K. Dearborn (1986)*

Maine Sea Grant College Program

Louie Echols (1987)*

University of Washington

Lauriston King (1987)*

Texas A&M University

Donald C. McNaught (1985)*

Minnesota Sea Grant Program

Treasurer

J. Allen Martin

Texas A&M University

**Year in parenthesis indicates end of Executive Committee term.*

SEA GRANT ASSOCIATION PRESIDENTIAL ROSTER

- 1970-71: **John A. Knauss**, University of Rhode Island
1971-72: **Herbert F. Frolander**, Oregon State University
1972-73: **Robert A. Ragotzkie**, University of Wisconsin
1973-74: **William S. Gaither**, University of Delaware
1974-75: **Leatha F. Miloy**, Texas A&M University
1975-76: **Stanley R. Murphy**, University of Washington
1976-77: **Hugh L. Popenoe**, University of Florida
1977-78: **William Q. Wick**, Oregon State University
1978-79: **Bruce T. Wilkins**, Cornell University
1979-80: **Robert W. Corell**, University of New Hampshire
1980-81: **Donald H. Rosenberg**, University of Alaska
1981-82: **Feenan D. Jennings**, Texas A&M University
1982-83: **B. J. Copeland**, University of North Carolina
1983-84: **Al M. Beeton**, University of Michigan
1984-85: **James I. Jones**, Mississippi-Alabama Sea Grant Consortium (SGA Incumbent President)
1985-86: **William L. Rickards**, Virginia Sea Grant College Program (President-Elect)

SEA GRANT ASSOCIATION AWARD WINNERS

Each year, the Sea Grant Association honors an individual for contributions spurring the wise use and conservation of resources from the seas and Great Lakes—contributions benefitting mankind.

Past SGA award recipients are:

- | | |
|---------------------------------|----------------------------------|
| ■ Dr. Wilbert Chapman, 1970 | ■ Dr. John Isaacs, 1978 |
| ■ Dr. Lauren R. Donaldson, 1971 | ■ Dr. Lewis A. Alexander, 1979 |
| ■ Dr. Athelstan Spilhaus, 1972 | ■ Dr. Arthur Hasler, 1980 |
| ■ Dr. Wayne H. Tody, 1973 | ■ Cmdr. Martin J. Nemiroff, 1981 |
| ■ Dr. John A. Knauss, 1974 | ■ Dr. John Craven, 1982 |
| ■ Sen. Claiborne Pell, 1975 | ■ Dr. Harold Goodwin, 1983 |
| ■ Paul E. Atkinson, 1976 | ■ Dr. John Calhoun, 1984 |
| ■ Dr. Robert Abel, 1977 | ■ Hon. Paul Rogers, 1985* |

*As part of the 20th anniversary commemorative, the SGA also honored former Washington State Senator Warren Magnuson.

SEA GRANT ASSOCIATION STUDENT AWARD WINNERS

The Sea Grant Association is committed to fostering future generations of talented professionals—professionals whose careers are likely to expand the frontiers of knowledge, concerning the marine sciences.

Consequently, the association has honored upwards of 100 students for outstanding scholarship in marine-related research. These awards have been earned by undergraduate, master's, and doctorate-level students for work spanning viruses in sea life and economic models of commercial fishing markets to the ecological effects of off-shore oil exploration and enzyme studies in shrimp.

Sea Grant Association Student Award Winners include:

Name	Title	University
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1976

M.S. Category

R. J. Carrick	"Improved Methods for Detecting Enteric Viruses in Oysters"	Department of Environmental Science & Engineering University of North Carolina
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Ph.D. Category

Guy D. Marchesseault	"The Application of Delayed Recruitment Models to Two Commercial Fisheries"	Department of Biological Oceanography University of Rhode Island
Deborah A. Barsotti	"Biological Response of Nonhuman Primate to Low Level Polychlorinated Biphenyl Exposure"	Department of Pathology University of Wisconsin, Madison

1977

M.S. Category

Robert E. Costa, Jr.	"Disposal of Shellfish Waste on Agricultural Land"	Department of Soil Science Oregon State University
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Ph.D. Category

Charles J. Brine	"Renatured Chitin Fibrils, Films, and Filaments"	Department of Chemical Oceanography University of Delaware
Allan T. Scholz	"Imprinting to Chemical Cues: The Basis for Homing in Salmon"	Department of Zoology University of Wisconsin

1978

Undergraduate Category

Lewis G. Feldman	"Effects of the Costs Imposed by the Regulatory Permit Process on California's Coastal Aquaculture Industry"	University of California, Santa Cruz
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M.S. Category

Donald W. Pybas	"Charter Dive Boat Operations on the Texas Coast: A Guide to Determining Feasibility"	Department of Recreation and Parks Texas A&M University
Janet Baker	"Virus Recovery From Contaminated Shellfish"	Department of Microbiology University of Southern Mississippi
Thomas F. Drexhage	"Measurement and Analysis of Historic Bluff Recession Along the Lake Ontario Coast in New York"	Department of Geological Sciences State University of New York at Buffalo

Ph.D. Category

Robert Clark Byrd	"A Laboratory Study of the Fluid-Structure Interaction of Submerged Tanks and Caissons in Earthquakes"	Department of Civil Engineering University of California, Berkeley
Bruno M. Jamart	"Numerical Studies of Tidal Flows in Estuaries"	Department of Oceanography University of Washington
Donald L. Mykles	"The Mechanism of Water Uptake at Ecdysis in the Lobster (<i>Homarus americanus</i> and <i>H. gammarus</i>) and Dungeness Crab (<i>Cancer magister</i>)"	Department of Zoology University of California, Berkeley

1979

M.S. Category

Douglas C. Hicks	"Physical and Numerical Modeling of a Seawave Powered Desalination Unit"	Department of Ocean Engineering University of Delaware
David Erdahl	"Preservation of Gametes of Freshwater Fish"	Department of Animal Physiology University of Minnesota-St. Paul
Douglas R. Gregory, Jr.	"Reproductive Dynamics of the Spiny Lobster, <i>Panulirus argus</i> (LATREILLE), in South Florida"	School of Forest Resources and Conservation University of Florida

Ph.D. Category

Tim Ahern	"Bromoperoxidases from Marine Organisms"	College of Forest Resources Physical Sciences Division University of Washington
G. Daniel Templeton, III	"Trace Metal-Organic Matter Interactions in Anoxic Marine Sediments During Early Diagenesis"	Department of Chemistry/ Inorganic Chemistry/Earth Sciences University of New Hampshire

1980

Undergraduate Category

Nicholas S. Vachon	"Incidence of <i>Aerococcus viridans</i> (var.) <i>homari</i> in Lobster (<i>Homarus americanus</i>) Populations Caught in Traps in the Gulf of Maine"	University of Maine
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M.S. Category

Edwin H. Pape III	"A Drifter Study of the Residual Currents in Delaware Bay and Adjacent Shelf Waters"	University of Delaware
A. Thomas Leggett, Jr.	"The Development of Blue Crabs, <i>Callinectes sapidus</i> from Kepone-contaminated Eggs	Virginia Institute of Marine Technology
R. Anne Richards	"Behavioral Interactions Between Cancer Crabs and Lobster, <i>Homarus americanus</i> : Effects on Catchability"	Department of Zoology University of Rhode Island

Ph.D. Category

J. R. Winton	"Isolation and Characterization of a new Reovirus From Chum Salmon"	Department of Microbiology Oregon State University
James H. Rittenburg	"Development of a Gaffkemia Vaccine for American Lobsters Held in Captivity"	Department of Microbiology University of Maine
Ronald J. Bobbie	"Characterization of Benthic and Fouling Microbial Community Structure Using Lipid Biochemistry"	Department of Biological Science Florida State University

HONORABLE MENTION

M.S. Category

Paul A. Iazzio	"Evaluation of Human Response to Immersion in 10°C Water"	University of Minnesota
Barbara J. Pollard	"Optimizing the Production of Atlantic Salmon in Water Refuse Systems"	University of Rhode Island
William B. Hoff	"The Design, Construction and Development of a Prototype Spiny Dogfish Shark Processing Machine"	Massachusetts Institute of Technology
Michael S. Denison	"Pesticide Interactions Affecting Residue Accumulation and Elimination in Mosquitofish (<i>Gambusia affinis</i>)"	Mississippi State University

Ph.D. Category

Frank L. Castille, Jr.	"Osmotic Regulation in Shrimp"	University of Houston
Charles W. Landmesser	"Interpretation of Seismic Reflection Data from Western Lake Superior: Recessional Moraines and Their Relation to Regional Deglaciation"	Department of Geology and Geophysics University of Minnesota
Adnan Al. Shqueir	"The Effects of Liquefied Fish Supplementation of Molasses-urea Liquid Supplements on Digestibility of Grass Hay by Sheep"	Department of Animal Science Oregon State University

1981

Undergraduate Category

Paul Bauman	"Trace Metal Pollution and Transport in the Raritan River and Estuary"	Geology Department Princeton University
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M.S. Category

Stephen Kelleher	"A Thermal Treatment for the Extension of Fresh Fish Shelf-life"	Department of Food Science Cornell University
David W. Shinn	"Dynamic Characteristics of Ferromanganese Nodule Sulfation Process"	Department of Chemistry University of Hawaii
Edward B. Siwak	"Sunlight Identified as the Primary Cidal Factor for Enteric Indicator Bacteria in Marine and Fresh Stream Waters"	Department of Microbiology University of Hawaii

Ph.D. Category

Mitsuaki Nishibuchi	"Demonstration of Virulence in Non O-1 <i>V. cholerae</i> and Related Vibrios Isolated from Seawater and Seafood Products"	Department of Microbiology Oregon State University
Sherwood Hall	"The Biological and Chemical Aspects of Paralytic Shellfish Poisoning"	Department of Chemistry University of Alaska
Eric De Carlo	"Separation of Cu, Co, Ni, and Some Toxic Elements From Deep-sea Ferromanganese Nodules by Absorbing Colloid Flotation"	Department of Chemistry University of Hawaii

HONORABLE MENTION

M.S. Category

Bruce J. Barber	"Energy Storage and Utilization in Relation to Gametogenesis in <i>Argopecten irradians concentricus</i> (Say)"	Department of Marine Science University of South Florida
Edward Richardson	"The Effect of a Change in the Size of First Capture in the Rhode Island Inshore Lobster Fishery: A Bioeconomic Analysis"	Department of Resource Economics University of Rhode Island

1982

Undergraduate Category

Anne Susan Little	"A Simple, Rapid Detection Procedure for Graffkemia"	University of Maine
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M.S. Category

Steven F. Edwards	"Econometric and Welfare Analysis of the Atlantic Sea Scallop Markets"	University of Rhode Island
Sandro Lane	"The Implementation and Evaluation of a Genetic Mark in a Hatchery Stock Pink Salmon"	University of Alaska
Peter H. Dahl	"Measurements of Acoustic Backscattering Directivity and Target Strength of Salmonids"	University of Washington

Ph.D. Category

Kenneth W. Anderson	"Utilization of Chitin to Control Pesticide Mobility"	University of Southern Mississippi
George W. Chamberlain	"Effects of Environmental and Nutritional Variables on Reproduction of Penaeid Shrimp"	Texas A&M University
J. R. Wilson, Jr.	"Changing Natural Resource Endowment, Property Rights, and Their Effects on World Trade"	Oregon State University

HONORABLE MENTION

M.S. Category

Jonathan F. Eaton	"Seasonality and Discrimination in the Feeding Behavior of the Soft-Shell Clam, <i>Mya arenaria</i> "	University of Maine
Jeffrey S. Denny	"Minnesota Bait Leech, <i>Nepheleopsis obscura</i> Culture, Management, and Economic Feasibility"	University of Minnesota
Nancy E. Hadley	"Growth of Seed Clams (<i>Mercenaria mercenaria</i>) at Various Densities in Raceways"	University of South Carolina
David W. Shinn	"Controlling Factors in the High-Temperature Sulfation/ Hydrometallurgical Treatment of Ferromanganese Nodules"	University of Hawaii
Lois A. Crump	"Marine Algae in Production of Fuel/ Chemical Feedstocks and Wastewater Renovation"	Jackson State University

Ph.D. Category

Stanton J. Fountain, Jr.	"Public Rights in Coastal Lands: Three Common Law Theories Affecting Deer Island's Future"	University of Mississippi School of Law
Heidi B. Kaplan	"Persistence and Distribution of Marine Vibrios in the Hardshell Clam, <i>Mercenaria mercenaria</i> "	Cornell University
William W. Smoker	"Quantitative Genetics of Chum Salmon, <i>Oncorhynchus keta</i> "	Oregon State University
Yathirajulu M. Naidu	"Stability Changes in Mechanically Deboned Carp (<i>Cyprinus carpio</i>) During Frozen Storage"	Michigan State University
Stanton J. Fountain, Jr.	"Littoral Rights: Rights of Property Owners Along Mississippi's Tidal Waters"	University of Mississippi School of Law

1983

Undergraduate Category

William B. Coney	"Experimental Evaluation of a Novel Propulsor"	Massachusetts Institute of Technology
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M.S. Category

Anne R. D. Kapuscinski	"On the Density of Chum Salmon (<i>Oncorhynchus keta</i>) Eggs in Shallow Metric Substrate Incubators"	Oregon State University
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Vijay Panchang	"Storm Generated Waves in the Gulf of Maine"	University of Maine at Orono
Walter R. Keithly, Jr.	"Florida Spiny Lobster Fishing: Monthly Allocation of Economic Input With Consideration of Population Parameters and Alternative Fishing Enterprises"	University of Florida
Lance A. Yokochi	"Solid Phase Enzyme-Immunoassay (EIA) for the Direct and Indirect Detection of Ciguatoxin (CTX) in Fish Tissue"	University of Hawaii

Ph.D. Category

John C. Wiltshire	"The Puna Submarine Canyon and Its Potential for the Slurry Disposal of Manganese Nodule Tailings"	University of Hawaii
Alexander Andradi	"The Fly Bioassay for Dinoflagellate Neurotoxin Measurement in Marine Bivalves (Pelecypoda)"	University of Southern California
William S. Lovejoy	"Simulation of Unified and Multi-Purpose Fleets in Multi-Stock Fisheries"	University of Delaware

HONORABLE MENTION

Ph.D. Category

Russell S. Nelson	"Ecological Effects of Oil Exploration on Reef Fish Populations on the East and West Flower Garden Banks in the Northwest Gulf of Mexico"	North Carolina State University
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1984

M.S. Category

Nancy Diamond	"Molting, Mating, and Growth in the Adult Female Dungeness Crab, <i>Cancer magister</i> : An Argument for Senescence"	Department of Fisheries Humboldt State University
Linda Bacon	"Timing of Gamete Release in <i>Ascophyllum nodosum</i> : A Multivariate Approach"	Department of Botany and Plant Pathology University of Maine
Joanna Ruth Leung-Trujillo	"Panaeid Shrimp Maturation/Reproduction: Studies on Sperm Quality in Several Commercially Important Species"	Wildlife and Fisheries Science Texas A&M University
Douglas B. McGuffey	"A Case Study: Fishing Vessel Stability and Loading"	Department of Oceanography and Ocean Engineering Florida Institute of Technology

Ph.D. Category

David B. Josephson	"The Chemistry of Fresh Seafood Volatile Aroma Compounds and Its Application in Preserving Fresh Seafood Quality"	Department of Food Science University of Wisconsin, Madison
Charles A. Wilson	"Age Determination and Reproductive Biology of South Carolina Swordfish"	Department of Biology University of South Carolina

Jonathan R. Pennock	"Regulation of Phytoplankton Carbon and Nitrogen Production in the Delaware Estuary"	College of Marine Studies University of Delaware
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HONORABLE MENTION

Ph.D. Category

R. Anne Richards	"Ecological Competition Between American Lobsters, (<i>Homarus americanus</i>) and Jonah Crabs (<i>Cancer borealis</i>): Implications for Lobster Management"	Department of Zoology University of Rhode Island
Mohammad Yazdandoust	"Bioaccumulation of Paralytic Shellfish Poison by Crab Larvae Fed on <i>Gonyausax cantenella</i> , a Toxic Dinoflagellate"	Department of Biological Sciences University of Southern California
Reynaldo Patino	"Physiology of Coho Salmon Smoltification: Effects of Hatchery Practices"	Department of Fisheries & Wildlife Oregon State University
Pepsi Nunes	"Aspects of the Reproductive and Larval Biology of the Northern Shrimp <i>Pandalus borealis</i> Kroyer, in Relation to Temperature"	Institute of Marine Science University of Alaska
Phillip G. Lee	"Digestive Enzymes of Panaeid Shrimp: A Descriptive and Quantitative Examination of the Relationship of Enzyme Activity With Growth, Age and Diet"	Department of Animal Science Wildlife and Fisheries Science, Texas A&M University

1985

Undergraduate Category

Robert D. Howerton	"Determination of Optimal Doses of the Hormones Triiodothyronine (T3) and Testosterone Used as Growth Promoters in the Aquaculture of Tilapia (<i>Oreochromis mossambicus</i>)"	Hawaii Institute of Marine Biology
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M.S. Category

Daniel F. Gleason	"Resource Utilization in Postlarval Brown Shrimp: The Potential Importance of Herbivory"	Marine Science Program University of Houston
Steven M. Bogdanowicz	"Differentiation of Mitochondrial DNA in Atlantic Herring"	Department of Zoology University of Maine at Orono
Peter F. Straub	"The Response of Respiration Rate, TTC Reduction, and Regrowth of <i>Sporobolus virginicus</i> (L.) Kunth Robust Form, in Tissue Culture and from Rhizome Sections, to Low Temperature Exposure"	Marine Biology and Biochemistry University of Delaware
Debbie Montgomery Swift	"Analysis and Function of Organic Matrix From Sea Urchin Tests"	Department of Biology University of South Alabama

Ph.D. Category

John Emmanul Kokarakis	"Design Analysis of Marine Risers Based on Their Static and Dynamic Nonlinear Behavior"	Department of Naval Architecture and Marine Engineering University of Michigan
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Cheryl A. Baxa	"Cyanobacterin—A Potent Inhibitor of Photosynthesis in the Eucaryotic Alga <i>Euglena gracilis</i> Z."	Microbiology Gray Freshwater Biological Institute
Jay W. Gooch	"Investigation of the Chemistry and Toxicology of Chlorinated Bornane (Toxaphene) Residues in Great Lakes Trout"	Pesticide Research Center Michigan State University
Rudolf J. Hsieh	"Lipoxygenase-Catalyzed Lipid Oxidation in Fish Skin Tissue"	Department of Food Science Cornell University

HONORABLE MENTION

M.S. Category

Wade H. Jeffrey	"The Physiologic Activity of Marine Microfouling Communities"	Department of Marine Science University of South Florida at St. Petersburg
Paula L. Cooper	"Sulfites on Shrimp: Ion Chromatographic Methodology for Detection"	Department of Food Science and Human Nutrition University of Florida
Steve Berntsen	"Development of Restructured Squid Patties"	Department of Food Science and Technology Oregon State University

Ph.D. Category

Scott Rice Milliman	"The Economics of Resource Rehabilitation: An Empirical Application of Capital Theory to Fishery Management"	Economics University of Wisconsin- Madison
Joy E. Swanson	"Modification of Rodent Organ Lipid Fatty Acid Composition by Dietary Menhaden Oil"	Department of Food Science Cornell University



SECTION VI:

THE FUTURE

THE FUTURE

The first two decades of sea grant—pioneering decades—have given the United States the capability to respond to a new array of social, scientific, economic, and other needs by building institutions and developing new technologies that are meeting the stiff challenges of exploration, conservation, research and development of the world's oceans.

Interdisciplinary teams of researchers—working directly with industry and through efficient advisory services—are addressing current national needs in the marine and coastal sectors. In the future, this burgeoning capability will grow more responsive and effective in helping to improve the quality of life for all peoples.

The future holds the probability of developing wider and more effective partnerships between industry and universities to tackle critical human problems. Interaction and cooperation with other agencies will broaden sea grant's effectiveness and enable better use of a unique national capability.

Emerging national priorities will engage the attention of sea grant universities as this nation moves forward in its use of advanced technology and improved utilization of America's precious natural resources.

New sea grant initiatives will be needed if the nation is to come to grips with these exciting national priorities:

- **Marine Biotechnology**—Sea grant research is likely to lead to major breakthroughs in the use of "high tech" in an increasing array of ocean-based industries.

- **Fisheries Oceanography**—The coupling of fisheries research with oceanography and satellite technology will lead to more effective forecasting and management of fisheries' stocks.

- **Estuarine Habitats**—As the nation's population concentrates closer to the ocean and Great Lakes, recreational and commercial pressures will intensify on fragile habitats. Focused research is needed, if these important resources are to be preserved—research in which sea grant universities will play pivotal roles.

- **Fisheries Development and Trade**—Increasing demands for fisheries products has led to a large export deficit that can be ameliorated through research leading to the development of underutilized fish stocks and better marketing techniques.

- **Water Quality**—Toxins, nutrients, and organics entering U.S. waters require the attention of more sophisticated, fundamental research, leading to a better understanding of the nature of these contaminants and improved economic means of removing them. This is especially critical along the Great Lakes and estuaries in heavily urbanized areas.

- **Seafood Technology and Quality**—Research into the fundamental characteristics leading to new sea food products, improved quality, and health-related issues is needed.

■ **Aquaculture**—A major means of easing the trade imbalance involving fisheries' products can be U.S. development of aquaculture. High-value products will result from basic sea grant research in aquaculture.

■ **Exclusive Economic Zone**—As the U.S. pushes its shores further into the ocean and begins to realize the added bounty, research will be the key to unlocking a treasure trove of resources—resources that can be developed without environmental damage. But a new generation of technology must be developed to make this goal a reality.

■ **Coastal Carrying Capacity**—The ability of the coastal environment to accommodate more people is closely tied to placing new demands on water resources, waste-disposal facilities, transportation, and other related infrastructure and environmental issues. Consequently, interdisciplinary research and better management are needed to maximize returns on investments.

It is likely that in the next two decades at least as many scientific and technological milestones will be posted as has been the case during the past 20 years. The sea grant network remains committed to playing an exciting and meaningful role in guiding this change.

