

SEA GRANT COLLEGES

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HEARINGS

BEFORE THE

SPECIAL SUBCOMMITTEE ON SEA GRANT COLLEGES

OF THE

COMMITTEE ON LABOR AND PUBLIC WELFARE UNITED STATES SENATE

EIGHTY-NINTH CONGRESS

SECOND SESSION

ON

S. 2439

A BILL TO AMEND THE NATIONAL SCIENCE FOUNDATION ACT OF 1950, AS AMENDED, SO AS TO AUTHORIZE THE ESTABLISHMENT AND OPERATION OF SEA GRANT COLLEGES AND PROGRAMS BY INITIATING AND SUPPORTING PROGRAMS OF EDUCATION, TRAINING, AND RESEARCH IN THE MARINE SCIENCES AND A PROGRAM OF ADVISORY SERVICES RELATING TO ACTIVITIES IN THE MARINE SCIENCES, TO FACILITATE THE USE OF THE SUBMERGED LANDS OF THE OUTER CONTINENTAL SHELF BY PARTICIPANTS CARRYING OUT THESE PROGRAMS, AND FOR OTHER PURPOSES

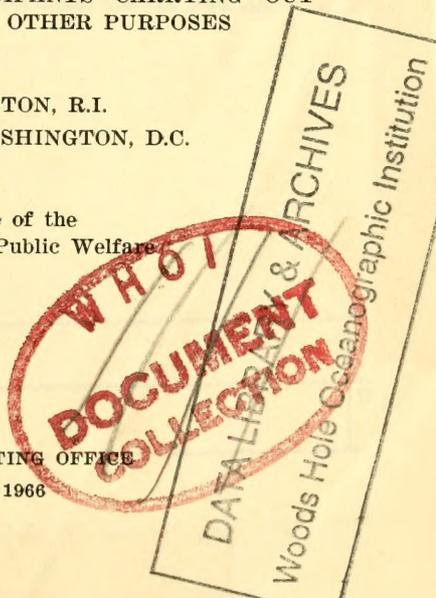
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SEA GRANT COLLEGES

MONDAY, MAY 2, 1966

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SEA GRANT COLLEGES,
COMMITTEE ON LABOR AND PUBLIC WELFARE,
Kingston, R.I.

The special subcommittee met at 10 a.m., pursuant to notice, at the University of Rhode Island, Kingston, R.I., Senator Claiborne Pell (chairman of the subcommittee) presiding.

Present: Senator Pell (presiding), and Fitzhugh Green, special assistant to Senator Pell.

Senator PELL. This morning we begin hearings by the Special Subcommittee of the Senate Committee on Labor and Public Welfare on a bill to establish sea grant colleges and programs.

I think it fitting as we get started to recognize the fact that one of our senior members of our committee died a couple of days ago. I know I express the regret and grief of my colleagues at the death of Senator McNamara whose body is being flown out to his own State today.

The other members of the subcommittee are: Senator Morse of Oregon, Senator Nelson of Wisconsin, Senator Kennedy of Massachusetts, Senator Javits of New York and Senator Murphy of California. All of these Senators are very interested in oceanology and the subject matter to be discussed, either by virtue of being on the Great Lakes, or the Atlantic, or the Pacific Ocean. They have a great interest from their States' point of view and they will be participating in the subcommittee hearings when we are in Washington.

As chairman of this subcommittee, I welcome with pleasure you distinguished witnesses who bring so much expert knowledge to this vital subject today.

I am delighted, too, that we can initiate our study of S. 2439 at the University of Rhode Island which has already established an excellent record of training and research in oceanology. This is a very appropriate spot for planning ocean-oriented programs in the colleges of this nation—programs designed to exploit in a practical sense the rich resources and opportunities of the seas and the knowledge we already have.

(The text of the bill S. 2439 follows:)

1 grant colleges for the education and training of par-
2 ticipants in the marine sciences;

3 (2) initiating and supporting necessary re-
4 search and development programs in the marine sci-
5 ences resulting in the acquisition of knowledge of a
6 direct and practical nature, with preference given to
7 programs that translate the findings of basic research
8 to practices, techniques, and equipment applicable
9 to the marine sciences;

10 (3) encouraging and developing programs con-
11 sisting of instruction, practical demonstrations, pub-
12 lications, and otherwise, with the object of impart-
13 ing useful information to persons currently employed
14 or interested in the marine sciences, to the scientific
15 community, and to the general public;

16 (4) encouraging the development of the ma-
17 rine resources by facilitating the use by participants
18 under this Act of such portions of the submerged
19 lands of the Outer Continental Shelf as may be nec-
20 essary and appropriate to carry out the purposes of
21 clauses (1), (2), and (3); and

22 (5) encouraging and facilitating the expansion.
23 development, or creation, of regional "centers of
24 excellence" in the various fields related to the
25 marine sciences, while retaining the traditional in-

4

1 terests of the existing regional institutions and
2 laboratories.

3 GRANT AND CONTRACTS FOR SEA GRANT

4 COLLEGES AND PROGRAMS

5 SEC. 3. (a) Subsection (a) of section 3 of the National
6 Science Foundation Act of 1950 (42 U.S.C. 1862) is
7 amended by striking out the period at the end of clause
8 (9) and inserting in lieu thereof a semicolon, and by add-
9 ing after clause (9) the following new clause:

10 “(10) to initiate and support programs of education,
11 training, and research in the marine sciences and a program
12 of advisory services relating to activities in the marine
13 sciences.”

14 (b) Subsection (a) of section 17 of the National Sci-
15 ence Foundation Act of 1950 (42 U.S.C. 1875) is amended
16 by adding at the end thereof the following: “Notwithstand-
17 ing the provisions of section 9 of the Outer Continental
18 Shelf Lands Act, 10 per centum of all bonuses, rentals,
19 royalties, and other sums (excluding amounts refunded un-
20 der section 10 of such Act) paid to the Federal Government
21 after June 30, 1965, for leases under such Act shall be de-
22 posited in a special account in the Treasury to be available
23 only for appropriations to the Foundation, which are hereby
24 authorized, to carry out the purposes of section 3 (a) (10).”

25 (c) The National Science Foundation Act of 1950 (42

5

1 U.S.C. 1861 et seq.) is amended by inserting the following
2 new section at the end thereof:

3 "MARINE SCIENCES

4 "SEC. 18. (a) In carrying out the provisions of section
5 3 (a) (10), the Foundation shall consult with scientists and
6 engineers engaged in pursuits in the marine sciences and with
7 agencies of the Government interested in, or affected by,
8 activities in the marine sciences.

9 " (b) The Foundation shall exercise the authority de-
10 rived from section 3 (a) (10) in a manner consistent with
11 the declaration of policy stated in section 2 of the National
12 Sea Grant College and Program Act of 1965.

13 " (c) Programs to carry out the purposes of section
14 3 (a) (10) shall be accomplished through contracts with, or
15 grants to, suitable public or private agencies, public or private
16 institutions of higher learning, museums, foundations, indus-
17 tries, laboratories, corporations, organizations, or groups of
18 individuals, which are engaged in, or concerned with, activ-
19 ities in the marine sciences, for the establishment and opera-
20 tion by them of such programs.

21 " (d) In order to facilitate the carrying out of programs
22 engaged in pursuant to contracts or grants made under the
23 provisions of section 3 (a) (10), the Foundation is author-
24 ized to enter into agreements with the Secretary of the In-
25 terior with respect to the use, jointly or exclusively, by par-

6

1 ticipants in such programs of such areas of the submerged
2 lands of the Outer Continental Shelf as may be appropriate,
3 which will not cover any part of the Outer Continental
4 Shelf needed for national defense or interfere with or en-
5 danger any operations under any lease maintained or granted
6 pursuant to the Outer Continental Shelf Lands Act.

7 “(e) For the purposes of section 3(a)(10) and this
8 section—

9 “(1) The term ‘marine sciences’ means oceanographic
10 and scientific endeavors and disciplines, engineering,
11 and technology in and with relation to the
12 marine environment, including, but not limited to the
13 fields oriented toward the development, conservation, or
14 economic utilization of the physical, chemical, geological,
15 and biological resources of the marine environment; the
16 fields of marine commerce and marine engineering; the
17 fields relating to exploration or research in, the recovery
18 of natural resources from, and the transmission of
19 energy in, the marine environment; and the fields with
20 respect to the study of the economic, legal, medical, or
21 sociological problems arising out of the management, use,
22 development, recovery, and control of the natural re-
23 sources of the marine environment.

24 “(2) The term ‘marine environment’ means the
25 oceans; the Continental Shelf of the United States; the

7

1 Great Lakes; the seabed and subsoil of the submarine
2 areas adjacent to the coasts of the United States to the
3 depth of two hundred meters, or beyond that limit, to
4 where the depths of the superjacent waters admit of the
5 exploitation of the natural resources of the area; the
6 seabed and subsoil of similar submarine areas adjacent
7 to the coasts of islands which comprise United States
8 territory; and the natural resources thereof.

9 “(3) The term ‘sea grant college’ means any suit-
10 able public or private institution of higher learning sup-
11 ported pursuant to the purposes of this Act.”

Senator PELL. First, I wish to extend my sincere appreciation to Senator Lister Hill, chairman of the Senate Committee on Labor and Public Welfare, who constituted this subcommittee.

Judging from the plethora of recent bills introduced in both the Senate and House, volumes of testimony, speeches, articles, and books on oceanology, it is clear that Americans are beginning to think about its practical possibilities. Their interest touches all aspects—defense, industry, science, and recreation. It should be true, as Victor Hugo once remarked, that there is nothing so powerful as an idea whose time has come. But the idea of oceanology still needs a push. For there are many ocean-related ventures in which this Nation is performing poorly.

Our merchant marine competes badly with other commercial fleets of the world. Our fishing industry has slipped from second to fifth place in a decade. Last year, fisheries products' imports equaled more than one-third of our deficit balance of payments.

If these sagging industries don't catch up, what chance will America have in marine industries of the future, such as: mining of marine minerals, drilling for oil, extracting dissolved substances, aquaculture, desalinization, underwater equipment, vehicles and bases of all kinds? We are not adequately preparing the technology for these new or potential industries. Costly gaps can appear overnight. The lesson of sputnik is a painful reminder of weak long-range planning.

So I hope we begin today with a consensus that action is needed to strengthen the marine sciences and industries. To do this will require many more people skilled in various disciplines of oceanology. The sea grant college program will train them in the higher educational system.

I believe this move is important if we are to fashion a new "maritime tradition." We must create an ocean-mindedness, just as we have built a "space-mindedness" among our citizens, particularly the young. In short, we must stimulate students to study in this vital, many-faceted field.

The sea grant college concept parallels the land grant college idea in its intent to guide education toward practical application of knowledge. We should launch this now in the marine environment as we did last century in agriculture.

At present, some 50 colleges from 21 States and the District of Columbia offer courses in the marine sciences. Four of the States are inland, all bordering on the Great Lakes. Most of these institutions offer degrees in the marine sciences. A good base already exists for the sea grant college program. But there are notable lacks.

Only a half dozen colleges now run identifiable courses in ocean engineering or in fisheries training. These are the two areas which might receive immediate attention under a sea grant college program. This is not just one more addition to the existing array of oceanologic and marine programs. It can pull together a number of these and give them a sharper focus.

The program need not be limited to degree-granting institutions. It should include the invaluable resources of staffs, ships, shore laboratories of such excellent private institutions as the Woods Hole Oceanographic Institution, also the in-house laboratories of Federal agencies. All of these can contribute to education and training in the marine sciences and the fields of their application.

In discussing this bill we should explore all possible means for its implementation. I urge the use of the talents, staff, and organizational structures of an existing Federal agency. Also, all agencies whose ongoing programs have any bearing on sea grant college programs should participate in a group advisory basis.

Perhaps a coordinating committee should be established by the agency having primary responsibility to expedite interagency communication and cooperation.

Also to be discussed is the question of where this new program might probably be established. I believe there is merit in starting out this program under the aegis of the Smithsonian Institution, with its tradition of giving temporary haven to various programs and then spinning them off to more permanent sponsors. The important issue here is how best the considerable knowledge we already have may be profitably exploited as opposed to the development of basic research.

Now, we come to the actual hearing and to the witnesses. Those of you in the back room, if you can't hear the witness, I wish you would wave your hand to indicate that you can't hear. I can notice it and I will ask them to talk more directly into the microphone. If you can't hear me, you do the same thing.

Now, for our leadoff witness I will call Dr. Francis H. Horn, president of the University of Rhode Island, where this hearing is being held. Before having him testify, I would like to pay particular tribute to him because of the long connection that the University of Rhode Island and he have had with the field of oceanology. The University of Rhode Island had this long involvement going back to 1937 when a small marine laboratory was established at the mouth of Narragansett Bay. And then, 20 years later, in 1958, Dr. Horn came to the University of Rhode Island and issued a report at that time which shortly proved perfect. He told the board of trustees that some day inner space will become as important as outer space, and in 1961 Dr. Horn was responsible for establishing the graduate school of oceanography presently on the campus. In 1963 Dr. Horn became interested in the sea grant idea and proposed a conference on that. The National Sea Grant Conference was held last year in Newport under the sponsorship of Dr. Horn and the Southern New England Marine Sciences Association.

So, it is with particular pleasure that we welcome Dr. Horn here today because of all that he has done for oceanology and our State. Also, the very fact that this hearing is being held at the university, and not at or in some Federal building is a tribute, as well, to Dr. Horn and to the University of Rhode Island. From my own recollection in the committee this is the first time we have had a hearing not in a Federal building since I have served on it. Will you come forward, Dr. Horn, and present your testimony?

STATEMENT OF DR. FRANCIS H. HORN, PRESIDENT, UNIVERSITY OF RHODE ISLAND

Dr. HORN. Thank you for those kind remarks, Mr. Chairman. As you already know, but I will put it on the record, I am Francis H. Horn, president of the University of Rhode Island, which is one of the three State supported institutions of higher learning in this State.

As you noted previously, this I believe, is the first time a senatorial

hearing has been held at a university. We are proud that the University of Rhode Island has that honor. We are grateful to you, sir, and to the chairman of the full committee, Senator Hill, for holding this hearing on our campus. May I also express my profound regret at the death of your colleague on this committee, Senator McNamara.

Senator PELL. Thank you.

Dr. HORN. It is a pleasure to testify here today because I believe the bill to establish sea grant colleges presents the Nation with a great opportunity and even greater responsibilities. I believe that we stand at an important crossroads in the history of the marine sciences in this country.

After 8 years of intimate involvement with the faculty in what since 1961 has been a graduate school of oceanography and with other people working in the marine sciences in this region, I am convinced that we must provide a more effective educational structure to help solve the problems involved in harvesting the wealth of the oceans.

If we don't seize this opportunity, I'm afraid others will. A Russian scientist summed up the outlook this way: "The nation which first learns to understand the seas will control them, and the nation which controls the seas will control the world." In other words, whether we realize it or not, we are now engaged in a race to see who will control the inner space of the oceans.

While our eyes are focused on the heavens, I hope we don't lose sight of what is happening right off the shores of this and every continent in the world. Many informed observers claim that the Russians are seeking mastery of the seas, not only for the wealth to be realized, but also because this control provides a unique instrument of foreign policy. For instance, Russia's advanced knowledge in fisheries is being used to win them new friends among the underdeveloped nations of the world. Tons of Russian fish are being landed for consumption in Africa and in other parts of the world. Millions of people have benefited from the addition of fish protein to their diet, and Russian prestige has been advanced.

While we struggle in this country to salvage a faltering fishing industry, Russian factory ships and fishing vessels cruise the major ocean highways and establish port and other facilities in strategic locations astride the avenues of ocean commerce.

While we in the United States attempt to coordinate the activities of dozens of Federal agencies concerned with marine activities, we learn that the Russians have recently organized a National Council for the Utilization of the Resources of the Sea. The function of this latter group is to speed up economic and political exploitation of the sea.

If time would permit, I am sure other examples could be developed of how we suffer in comparison to rising Soviet excellence in oceanography and the marine sciences at present. However, I believe it will become evident in the course of these hearings that we need a national oceanographic policy that places major emphasis on the utilization of the brains and talents in our institutions of higher learning.

The partnership between the Federal Government and our colleges and universities has been most successful in the past. I see no reason why we shouldn't adapt it to today's needs.

I emphasize the word "partnership." This is what is being sought in this sea grant college bill.

It is being proposed that the Federal Government and the Nation's colleges and universities enter into an alliance for exploring and harvesting the seas. This effort would be financed with 10 percent of the funds received by the Federal Government from the lease of lands on the Continental Shelf.

An official of the U.S. Interior Department has said that \$17 million a year could be expected as the 10-percent share from leases granted primarily for the extraction of oil, gas, and sulfur from the underwater property. What can the Nation expect by the way of return from the Government's investment in this partnership? There are two ways to answer this question. You can begin by examining partnerships of a similar nature which are already in existence. In looking around for parallel situations, it is inevitable that we focus our attention, at least briefly, on the land grant colleges and universities.

Here we have a vigorous educational system founded on the principles of public service, education for "the industrial classes," and research. In the case of research, a wise balance was struck between projects of an applied nature, where a short-term benefit or economic gain has been the goal, and investigation of a long-range nature, where the object has been to advance man's basic knowledge of life processes.

At the time of their establishment, the land grant colleges represented a sharp break with educational tradition and the prevailing views about classical education imported from Europe. The land grant concept is distinctly American in character. It incorporates the democratic ideals of the frontier and of our pioneer forefathers—the idea that each man should progress in accordance with his abilities, and the idea that almost any problem can be solved, given the proper tools, time, and knowledge. Parenthetically, it is interesting to note that many of today's emerging nations are looking toward the American land-grant system for guidance in framing their own programs of higher education.

If we examine the record, the optimism of Senator Morrill and Jonathan B. Turner was not unfounded.

Today, although the land grant colleges comprise only 5 percent of all the colleges and universities in the United States, they enroll one-fifth of the students and conduct the world's largest off-campus educational programs. Research centers at land grant institutions came up with such scientific achievements as hybrid corn and streptomycin.

The unparalleled efficiencies achieved in agriculture have given this Nation a surplus of food and fiber. But even more important, these efficiencies released a surplus of people from the farm so they could contribute elsewhere to our industrial and economic growth. For instance, it has been estimated that if output per man-hour had remained the same in the last half century, we would need to employ over 29 million persons today in agriculture. Actual employment in the field of agriculture is less than 7 million persons.

This then is the educational pattern followed under the land grant legislation which the National Manpower Council has called the most important single Government step in connection with the training of scientific and professional personnel.

A variation of this formula came into being—more as a matter of necessity than anything else—during and after World War II. The Government mobilized the scientific know-how of the universities, first to help win the war, and secondly to assist in solving the problems of

a relatively peaceful world where science and technology had assumed a new significance. Billions of dollars have been channeled into university laboratories through a complex structure of grants and contracts. In many ways the financial relationships that have evolved have been less satisfying and fruitful than the formula-type allocations upon which an institution may build a solid and reasonably permanent structure. The land grant allocations can be considered a type of endowment, whereas grants and contracts are here today and gone tomorrow. To me this is the essential point to be grasped in considering the sea grant legislation.

The name "sea grant" implies an institution of higher learning offering a broad spectrum of studies relating to the sea. Its mission would be to train the scientists, engineers, economists, political scientists, lawyer, doctors, and hundreds of others who will be needed if we are going to live and work on and under the sea. We also need what Dr. Athelstan Spilhaus has so aptly called the county agent in hip boots to transmit our knowledge of the ocean environment to the people who will apply it.

Formula or institutional grants would be required to support such a system of sea grant colleges. Possibly there should be one such institution in each of the 30 states bordering the Great Lakes and the oceans. In addition, it would be reasonable to allocate about half the available funds on a competitive basis to any college or university which could make a contribution to understanding the sea and its creatures.

Any examination of the sea grant concept would be incomplete, if it did not touch on at least one other area. Admittedly, full-scale exploration of any new frontier, whether it be space or the ocean depths, carries with it an element of romance and adventure. However, the oceans and their depths promise much more. In support of this argument, I would make passing reference to the 50-page report published by the Committee on Oceanography of the National Academy of Sciences-National Research Council entitled "Economic Benefits From Oceanographic Research." I understand some of the authors of this document may be called as witnesses, but a few figures should be mentioned. This report estimated that a continuing national investment of approximately \$165 million a year in fisheries production, undersea mining, marine recreation projects, improvement of sewage disposal methods, reduction of shipping costs, and improvement of weather forecasting techniques could produce savings of nearly \$3 billion a year or increase annual production by nearly that much.

Finally, if for no other reason, we need sea grant colleges as a weapon in the global battle against hunger and disease. Experts have estimated that at least 500 million persons suffer from critical deficiencies of animal protein. Meanwhile, the world's population increases by nearly 200,000 persons each day. At the present rate, the global population of 3.4 billion persons will more than double by the year 2000.

In many countries, such as Japan, there is little possibility of converting any substantial amount of additional land to agricultural use. In other parts of the world, poor weather and lack of adequate moisture make it difficult to cultivate the soil. However, each square mile of ocean contains up to 4,000 tons of vegetation and a majority of all

animal life exists in the sea. With today's technology, we could produce, for less than 20 cents per pound, a fish protein concentrate—also called fish flour—that could help feed the world. Government scientists at the University of Maryland believe the techniques developed there could also be exported to nations such as India.

Even with the methods we have now of hunting fish in the sea, it is estimated we could, with greater effort and present technology, increase the yield of fish approximately four times. But, what if we learned to truly farm the sea? What if we know how to fertilize the sea and stimulate the growth of valuable species? The benefits to be gained are beyond calculation.

There is also reason to believe that the oceans may be an untapped source of the new medicines. Many of today's pharmaceuticals were originally found in tiny organisms living in the soil, but the oceans teem with life. In fact, one of the oceanographers here at the University of Rhode Island was the recipient of the first patent for a marine antibiotic. However, we really have no idea of what other useful substances might be found in the ocean, because only limited research is being conducted in this field.

These are some of the challenges which the oceans offer. I am convinced that Federal funding for sea grant colleges would be one of the most significant educational steps we could take at this time in our history. I therefore urge passage of this legislation. Thank you.

Senator PELL. Thank you, Dr. Horn, and because of your pioneering work and thoughts which have led to the fact that this university here occupies a very leading role in this field on the east coast of the United States.

I have a couple of inquiries here on which I am wondering about your thinking. First: The thought has come up that perhaps the original administration of this bill might best benefit in the hands of the Smithsonian Institution or some other agency on a temporary basis rather than the National Science Foundation. Do you have any thought one way or the other as to this matter?

Dr. HORN. Well, I haven't thought about that, sir, but I should think that whichever agency is most interested in seeing that these funds are adequately distributed where they can be best used should be the one to initially get the program off the ground. One of the difficulties in giving or placing the funds exclusively in the hands of the National Science Foundation revolves around the point that they give their financial support to the individual. There is growing feeling that this has not been always in the best interest of science or the universities. I think it would be wise to find another agency.

Senator PELL. Another question along the same line is whether or not the \$17 million is enough to start with. Do you have any thought as to that? Do you think it is too much? Do you think it is too little? What do you think?

Dr. HORN. Well, any amount, sir, is good. But \$17 million is peanuts when it is compared to the budget for NASA which is \$6 billion, I think. I hope that eventually the importance of exploration of the inner space, as you have called it, versus outer space will become evident to our people and that the results would be rather substantial.

Consequently, I don't think it ought to be tied exclusively to a percentage of income from the reality of offshore exploration.

Senator PELL. Another respect in which we are fortunate in having you, as president of a land grant college, is in connection with the enlargement of the responsibility of a land grant college, because I understand that your extension service does a great deal of work concerning the consumer, or urban living. Would that not be correct?

Dr. HORN. This is correct and particularly in an institution like the University of Rhode Island where we are located in the State with the agricultural part of our economy being reduced more and more. More of our activities of the cooperative extension services, which are housed in the college of agriculture, are moving into the suburban and urban areas. I think you know that we have a very important project working in the South Providence area with underprivileged people. If this sea grant bill is passed, if money is made available to this institution for this sort of thing, we are prepared to move on it and, I think, effectively.

Senator PELL. Actually, in our own State there are only 2,000 people working in the field of agriculture and forestry.

Dr. HORN. I suspect that someone who will be testifying before this committee will point out that the State of Rhode Island has, I think, more shoreline in comparison with the total land mass than any other State of the Union with the exception of Hawaii.

Senator PELL. Maybe we'll have more sea farmers than land farmers.

Dr. HORN. Finally I'd like to say that, as you have pointed out, ever since I came to this university in 1958 I have indicated to my colleagues, and to the board and to the public in this State that we have a unique opportunity here because of our location on the sea, and this major piece of legislation which you propose, we hope is passed by the Congress which will provide additional resources so that we can make a still further contribution, not just to the State of Rhode Island, but to the entire Nation and the world.

Senator PELL. Thank you very much, Dr. Horn, for your testimony and for the hospitality we have been shown here today.

Our next witness will be Mr. Edward Harrington of New Bedford, Mass. Mr. Harrington is the mayor of New Bedford and a neighbor of ours. Mayor Harrington, Senator Kennedy regrets very much that he cannot be with us today. We wanted you to know that.

STATEMENT OF EDWARD HARRINGTON, MAYOR, CITY OF BEDFORD, MASS.

Mayor HARRINGTON. I understand.

Senator PELL. He wanted to hear your testimony and is well aware of your good work and he is very interested in this whole field of fisheries and oceanology and asked that his good wishes be conveyed to you. Also, as a member of Congress it is very good to welcome you here because I understand there is a really good chance that you may be a colleague in a coming Congress. I am delighted to welcome you here, Mayor Harrington, and you may proceed as you wish.

Mayor HARRINGTON. Mr. Chairman, I am grateful for the opportunity to come here this day and address you on a matter which has so much importance to men everywhere throughout the world and to the future hope of a higher standard of living for people wherever they may live. Since I am privileged to serve as mayor of a city

with a great seagoing tradition, and the second most productive fishing port per dollar volume in the United States, I can best give evidence, I believe, as to the practical effects this legislation will have in benefiting those who earn their living from the sea and what effect the programs envisioned by this legislation could have upon our ability to elevate man's economic horizons.

I have always felt that if great national problems and goals were left entirely to the States and those people living in various areas of our Nation, many of these problems would remain unsolved, and goals would not be achieved. We find that over the last few years in the United States, the President and the Congress have accepted this philosophy and our Government is moving forward with great and effective speed to assist in affording citizens everywhere the opportunity of a good education through massive Federal aid. We are making a very concentrated attack upon the economic and social problems everywhere within this Nation and at all levels where standard economic conditions exist. We have also found that in order to afford men their fundamental rights, equal dignity, and justice, it was necessary that the Congress adopt the Civil Rights Act.

The sea is certainly an area which has been given the least attention by scientists, economists, and educators. It is, perhaps, fair to say that we have as much information concerning outer space as we do the waters off our immediate coast. I assume that if the total costs of our space exploration programs were to be compiled, they would range in the billions of dollars. The amount of money being spent annually on exploration, education, training, and research in the marine sciences would amount to only a very small fraction of this amount. Yet, from the sea we have the ability to create a productivity which can provide the natural resources to feed the starving people of the entire earth, and open up new vistas to the light of human knowledge.

Marine scientists have estimated that 200 million tons of fish, at least four times our present harvest, could be taken from the seas each year without endangering future yield. This is an estimate based on exploitation of edible fish species. Is it unreasonable to expect that scientists and those entrusted with our political destinies can make it possible for man to cultivate and harvest crops from that 70 percent of the world's surface which is now inundated by the sea?

Research and the acquisition of knowledge in the gainful use of marine resources are necessary prerequisites for the transformation of this knowledge into practical applications which can benefit mankind.

I have no doubt that other scientists can wrest even greater supplies of nutrition from our seas. If it is true that the oceans contain 4,000 tons of vegetation per square mile, we must know to what extent this vast vegetable crop can be brought into controlled and useful food crops through aquaculture.

Many hundreds of thousands of men and women throughout the United States earn their livelihood from industries allied to the sea. Many more thousands of our young people could be gainfully employed in similar industries were we to reach a point in our marine technology where we could translate the results of creative scientific research into objective, practical application. I can envision the whole sea coast of New England, and yes, the entire United States booming in an orderly expansion brought about through the develop-

ment of new methods of catching, processing, and merchandising fish. We accept the fact that we as Americans have barely commenced to harvest the bounty of the sea. It is essential that we get about this work before those more interested and dedicated than ourselves have advanced far beyond us in a scientific approach to fruitful productivity. At the same time, we must provide for future growth in the fisheries through conservation. We can all envision, I believe, the monumental effect that fish flour or any type of fish concentrate can have upon our internal economy and starving people wherever they exist in the world.

We are living in very accelerated years, years when scientific progress and achievement seem to be outstripping man's ability to understand, in some cases, the rapidity of development. Many years ago when the industrial revolution was taking place in Europe, progress at first moved through very many experimental, mechanical stages. However, in these days, it appears possible that through lateral development starting from the top, with a chartered and fully thought out method of approach, we can accomplish in a few years what would ordinarily take generations.

The universities of America have the ability, if financially assisted, to render to mankind, the mechanism to transfer the brilliance of scientific thought and accomplishment into the practicality of American productive genius. Universities have played an ever-increasing role in the development of our Nation's vital resources both in mind and matter. I can think of no better place to invest some of the fruits of our affluent society than in our great universities for the purpose of returning to Americans, and to mankind, the benefits of their combined abilities.

One of New Bedford's links with the future is Southeastern Massachusetts Technological Institute, our State's newest university, which is now being built not far from our city limits.

This young institute has already made commitments to teaching and research in the fields of marine biology, oceanography, and oceanology.

When the sea grant college concept materializes—as it must if the United States is to provide our young scientists and technologists with the means to explore and develop the resources of the seas—it is essential that the development of the ocean resources be entrusted not only to old and venerable institutions, such as the Marine Biology Laboratories, Woods Hole Oceanographic Institutions, such as our host institution, but also to such new and vigorous seaboard universities as Southeastern Massachusetts Technological Institute. In its few short years of existence, SMTI has demonstrated a commitment to teaching and research in application related enterprises such as fisheries biology, environmental monitoring, and conservation of estuaries.

In other nations, particularly, Russia, Poland, Canada, and Japan, great stress has been given to effectively assisting all stages of marine development both in research and in application. The United States, with its early lead, its tremendous resources, its magnificent universities, and a sense of creativity, has lain back, and permitted others to surpass us.

It is very exciting that we appear now to be moving in the direction of giving our attention to a long neglected area. It seems that

through the establishment and continuance of programs of education, training and research in the marine sciences, we can build for ourselves a dynamic new future, and overcome generations of inaction through the application of modern techniques, and modern scientific achievement. I can think of no piece of legislation at this time that I consider more meaningful to my particular city, to our country, and mankind generally, than S. 2439, which could set into motion a series of programs which could affect the course of history and provide untold benefits for mankind.

I wish to thank you, Senator, for permitting me to come here.

Senator PELL. Thank you very much for coming, Mayor Harrington.

Now, point No. 1, in your testimony where you mentioned that New Bedford was the second most productive fishing port per dollar volume in the United States. Could you enlarge on that? Does that mean you had the largest gross catch landed there or is that in relationship to dollar earnings?

Mayor HARRINGTON. Well, actually the fish landed from all American boats fishing commercially in the port of New Bedford is second only to San Pedro, Calif., and in the last few years we have made tremendous gains and strides and additions to our fishing fleet. We are in the process now of building a \$7½ million pier to accommodate more boats. We hope that within the next 3 years the dollar volume of fish in the port of New Bedford will exceed any other area of the United States. We are also in the process of negotiating a contract with Van Camp's Sea Food Co. which is the largest fisheries company in the entire world to locate a plant in New Bedford, and they are, or have indicated that they will, possibly make New Bedford their world fish headquarters and bring to the city of New Bedford their laboratory and facilities dedicated to marine research.

Senator PELL. I wonder if you could tell us a little something about a fish protein concentrate plant in your city.

Mayor HARRINGTON. There is some conflict in this matter, Senator. There is a professor at the University of Illinois, who, many years ago developed a process of making fish flour, it was called that then, later it was transferred into the terminology now called fish protein concentrate. The professor's name was Levin. Anyway, as Levin discovered a formula for creating and producing fish protein concentrate, he established two plants for commercial production of fish protein concentrate. One in New York and one in New Bedford. Now, he has invested over \$2 million of his own capital in this production. Actually, all we are producing in New Bedford right now is a fish concentrate which can be converted back to fish flour within a relatively short time and rather inexpensively. But, something unusual which developed is that back in 1960, I believe, the Food and Drug Administration refused to permit the fish flour or fish protein concentrate to be sold internally in the United States, Dr. Levin at that point refused to export on the theory that even though he could keep these plants in full production, that was not beneficial to mankind to export a product which the Food and Drug Administration said should not be sold to Americans. He felt that in the Nation's best interests that should not be done.

When I became mayor of New Bedford in 1961, John F. Kennedy was the President of the United States. We had a conference with

him in Washington, and also with Secretary Udall, for the purpose of setting in motion a chain of events which would eventually cause the Food and Drug Administration to reverse their stand with relation to fish protein concentrate. I think we met in the Senate dining room and the meeting was presided over by Senator Saltonstall and Senator Smith, the two Massachusetts Senators. Well, we set in motion a chain of events which we think eventually caused the Food and Drug Administration to reverse their stand with relation to fish protein concentrate. Now, they have devised a formula to produce this fish protein concentrate. We say that the formula of Dr. Levin is superior to theirs, his can produce less expensively and with equal appeal and is equally sanitary. We are hoping that the Bureau of Commercial Fisheries expands their production requirements and permits, frankly, the commercial manufacturing of fish protein concentrate by those who have developed a formula to do it. We hope they don't restrict our ability to use it. They have developed a formula, but we don't think it is superior to the one devised by Dr. Levin.

Senator PELL. I am very sympathetic with your work in this field, Mayor Harrington. It has been said that it is unesthetic to use fish protein concentrate.

Mayor HARRINGTON. We urge the Administration to reverse its position on this. We hope we will get a decision in this direction.

Senator PELL. I know we have had some meals in the Senate Dining Room with Dr. Levin's fish protein concentrate used as the base. It was very good.

Mayor HARRINGTON. We appreciate any support you can give. Senator Douglas, I don't know whether you read his remarks on this, he made a speech in the Senate about the esthetic and cosmetic effect of fish flour. He mentioned that we are marketing a chocolate covered ant commercially at very high prices.

Senator PELL. Are you using a whole fish?

Mayor HARRINGTON. We are using the whole fish, yes.

Senator PELL. All right. Thank you very much, Mayor Harrington. It was very nice of you to come over to Rhode Island.

Our next witness is the dean of the graduate school of oceanography here at the University of Rhode Island. He has certainly developed a first rate department. Dean Knauss, when Dr. Horn persuaded you to come here from the west coast to the east coast, I think that California's loss was a great benefit to us here in Rhode Island. I have enjoyed, I say this publicly, the work we have done together on the various projects which have interested us, and without your help I don't think that my own ideas, or this bill, could have gotten anywhere near as far as this.

You may proceed when you are ready.

STATEMENT OF DR. JOHN A. KNAUSS, DEAN OF THE GRADUATE SCHOOL OF OCEANOGRAPHY, UNIVERSITY OF RHODE ISLAND

Dr. KNAUSS. Thank you for those very kind words, Senator Pell. I am here today not only as dean of the graduate school of oceanography of the University of Rhode Island, but I am also chairman of the Southern New England Marine Sciences Association. As far as I know the idea of a sea-grant college was first suggested publicly

by Athelstan Spilhaus in 1963. The University of Rhode Island and the Southern New England Marine Sciences Association sponsored a 2-day conference on the concept of a sea-grant college in October 1965. This conference was attended by 224 scientists and educators from 30 States. At the conclusion of the conference the following resolution was unanimously adopted:

"We enthusiastically endorse the concept of a 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."

The proceedings of this conference have been published and I commend them to the committee's attention.

Senator PELL. It will be printed in full. You may continue, Dr. Knauss.

Dr. KNAUSS. A national committee was formed among those attending the conference. One of our tasks, as we saw it, was to distill some of the ideas discussed at the conference into a simple statement. As secretary of the group I would like to submit the committee's statement into the record.

Senator PELL. It will be printed in full.
(The material referred to follows:)

PREPARED STATEMENT OF THE NATIONAL COMMITTEE FOR A SEA GRANT COLLEGE

A sea grant college would be an institution of higher education devoted to increasing our Nation's development of the world's marine resources through activities in the areas of education, research, and public service. A sea grant college would specialize in the application of science and technology to the sea, as in underwater prospecting, mining, food resources development, marine pharmacology and medicine, pollution control, shipping and navigation, forecasting weather and climate, and recreational uses. It would relate such application to the underlying natural sciences which underlie social sciences as they are affected by, and in turn affect, the occupation and exploitation of the sea. Thus a sea grant college would bring to bear the wide variety of intellectual resources usually associated with a university on the development of marine resources. We are not suggesting the establishment of new schools, colleges, or universities, but rather the development of this capability in State and private institutions already deeply involved in the study of marine sciences.

The potential contributions of education, research, and public service are many. It is not expected that any single sea grant college would develop all of these possibilities, or that all sea grant colleges would develop in an identical manner.

EDUCATION

If this country is to maintain a position of leadership in the development of marine resources, we must provide the necessary educational base. We must provide engineers, natural and social scientists who are familiar with the problems and the possibilities for the development of marine resources. We must provide education at many levels, from teaching fishermen how to fish to teaching the teachers of the engineers and scientists required by industry. Although all of these various kinds of education need not be done within a single institution, they can be.

RESEARCH

Successful higher education without concurrent research is impossible. This is as true in engineering and applied sciences as it is in the basic sciences. A strong research program is required in a sea-grant college if a strong educational program is to be maintained. In addition, a strong research program in a sea grant college will aid in the development of our marine resources. Much of the work that ought to be undertaken to master the oceans and exploit their resources cannot be afforded by any single segment of private industry. Initially, these

development programs must be undertaken with Federal Government assistance. Many of these development programs require an interdisciplinary approach, which is found in a college or university and is less likely to be found in any single mission-oriented Federal laboratory.

PUBLIC SERVICE

Public service is an important part of the present-day university. The agricultural extension program of a land-grant college has over the years been extremely successful. An analogous program is a sea grant college with the fisheries industry, and other segments of marine industry, could and should be initiated. Large-scale development programs such as MIT's Lincoln Laboratory or Cal Tech's Jet Propulsion Laboratory could be a part of the sea grant college program, but are not envisaged at this time. We see the relationship of the sea grant college to marine industry as being closer to the relationship of the agricultural experiment station to the agricultural industry.

THE IMPORTANCE OF DEVELOPING OUR MARINE RESOURCES

If man can occupy and exploit the oceans, he will. If we in the United States don't offer leadership in this venture, people of other countries will. The history of the development of this country is an excellent example of the axiom that eventual control of the land goes to those people who occupy the land and not to those with the largest army. It is not in the interest of the United States to forfeit our right to the use of 70 percent of the surface of the earth because of our failure to master the oceans. Although our Navy is the most powerful in the world, our traditional marine industries—fisheries and merchant marine—are weak and, on a comparative basis, growing weaker. The 1958 Geneva Convention on the Law of the Sea gives local control to the sea bed and subsoil of the submarine area adjacent to the coast to the depth of 200 meters, or beyond that limit to where the depths of the superjacent waters admit the exploitation of the natural resources of the area. In other words, those countries who can first exploit the depths of the ocean can control them.

In the near future, it will be possible for men to live in depths of 1,000 feet. Oil wells are going to be drilled in water depths greater than 1,000 feet. Deep submergence vessels are now being developed which will operate at any depth in the ocean. We will soon have methods of dredging minerals from deep ocean basins. It is in our national interest that these techniques be exploited; that the United States does, in fact, master the oceans.

The growth of Soviet Russia's naval power is well known. So is the growth of their oceanography program. What is often not recognized is that the U.S.S.R. is becoming a major user of the oceans. In a 30-year period, the Russian fish catch went from 0.5 million tons to 5.6 million tons. During this same period the U.S. catch has oscillated between 2.0 to 2.7 million tons per year. The U.S.S.R. merchant marine, which was almost nonexistent a few years ago, will soon exceed ours in total carrying capacity. There appears to be good reason to believe that the U.S.S.R. has decided to attain mastery of the sea.

The oceans can provide the animal protein resources needed by the world's population. A catch of 60 million tons a year, if properly exploited, could provide the animal protein requirements for 3 billion people. It is estimated that the oceans produce several times this amount of fish a year of a size suitable for exploitation. Techniques of making fish protein concentrate from so-called trash fish have been developed. This material ships well, does not decompose easily, and can be mixed with rice, grain, beans, and other indigenous foods. It is possible that we can provide the means of solving the most difficult part of the world's food problem—the lack of animal protein.

ANALOGY OF SEA GRANT COLLEGES TO LAND GRANT COLLEGES

The sea grant colleges have a special role to play in the mastery of the oceans, and it is here that the analogy with the land-grant colleges is pertinent. We are not suggesting the establishment of separate schools analogous to the early land-grant colleges; nor are we suggesting that the granting of offshore lands to sea grant colleges is a necessary part of the analogy (although such lands might prove useful). What is suggested is the adoption of the system developed by the land-grant college program for turning scientific results to economic use. The land-grant colleges with their agriculture and engineering experiment stations,

their extension service, their departments of pure and applied science have over the years developed one of the smoothest and most efficient operations in history in that very difficult task of bringing the knowledge and the discoveries of science to immediate and practical application. Furthermore, through the extension service and the experiment station they have developed efficient feedback mechanisms whereby the problems of the farmers are brought back to the laboratory for study and solution. It is this aspect of the land grant college movement we wish to emulate.

FUNDING THE SEA GRANT PROGRAM

We believe that at least an important fraction of the sea grant college support should be in the form of institutional grants. We believe that continual, broad-based support, such as that on which the colleges of agriculture were originally based, is important for the success of this program. Not all funds, however, should be awarded on an institutional basis. The remainder could go to special projects, either at existing sea-grant colleges or to other universities elsewhere in the country on a competitive basis.

John A. Knauss, secretary, dean of the graduate school of oceanography, University of Rhode Island.

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.

Wilbert M. Chapman, director, division of resources, Van Camp Seafood Co. Warren J. Hargis, Jr., director, Virginia Institute of Marine Science.

Donald Bevan, associate dean, college of fisheries, University of Washington.

Galen E. Jones, director-elect, estuarine laboratory, University of New Hampshire.

F. G. Walton Smith, director, institute of marine sciences, University of Miami.

Athelstan F. Spilhaus, dean of the institute of technology, University of Minnesota.

Donald E. Wohlschlag, director, institute of marine science, University of Texas.

CHANGES SUGGESTED BY THE NATIONAL SEA GRANT COLLEGE COMMITTEE ON S. 2439

Page 2, line 22 through and including line 24 should be deleted and replaced by: "(d) that the concept of the Sea Grant College: an institution of higher learning devoted to increasing our nation's utilization of the world's marine resources through activities in the area of education, public service, and research; and would relate these activities to the natural sciences which underlie them; to the social sciences, economics, sociology, psychology, political science and law, as they are affected by and, in turn, affect the occupation of the sea, is a concept which could accomplish the goals as set forth in (a), (b), and (c) above; and"

Page 2, line 25 and extending to page 3 and line 1. Replace the words "sea grant colleges" with: qualified institutions.

Page 3, lines 4 and 5 should read: "and development programs in the marine sciences and related fields resulting in the acquisition of knowledge".

Page 3, line 9 should read: "to the development of marine resources;"

Page 3, lines 24 and 25 should read: "excellence" "in the various fields related to the development of marine resources while retaining the traditional in-".

Page 4, line 10 should read: "(10) to initiate and support the sea grant college program and programs of education,"

Page 4, line 12 should read: "of advisory services relating to the development of marine resources".

Page 6, lines 9 and 10 should read: "(1) The term 'development of marine resources' means those scientific endeavors and disciplines, engi-".

Proceedings of the National Conference

THE CONCEPT OF A SEA-GRANT UNIVERSITY

Sponsored by

University of Rhode Island

Southern New England Marine Sciences Association

October 28, 29, 1965

Newport, Rhode Island

URI - SNEMSA Committee on Arrangements:

Win Difford, Phillips Intern in Academic Administration

John Knauss, Dean, Graduate School of Oceanography and
Chairman, SNEMSA

James Leslie, Executive Secretary, SNEMSA

Nelson Marshall, Chairman, Marine Resources Program

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Niels Rorholm, Chairman, Department of Food and Resource
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Editor of Proceedings:

Win Difford

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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 prob-
lems 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 this 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.

WELCOME

Francis H. Horn, Ph. D., Yale University, 1949. He has been President of the University of Rhode Island since July 1958. An authority on higher education, he served as Executive Secretary of the Association for Higher Education in Washington, D.C., from 1951 to 1953 and during 1957-58 he was Distinguished Visiting Professor of Higher Education at Southern Illinois University. The Graduate School of Oceanography at URI was established under his leadership.

I take a great deal of personal pleasure in welcoming all of you to this unique and perhaps historic conference, which will address itself to the proposal that a focus on the marine sciences is as appropriate to our day as was the emphasis on agriculture and the mechanic arts under the Morrill Land-Grant Act just over one hundred years ago. We of the University of Rhode Island, together with the Southern New England Marine Sciences Association, have been tremendously impressed and gratified with the response, both as to number of participants and the high level of the persons in attendance, to this national conference on "The Concept of a Sea-Grant University," and we hope that all of you benefit from the deliberations here in Newport.

I congratulate you, incidentally, upon having made it to Newport. It isn't the easiest place in the United States to get to. Originally we had planned to hold this conference on campus, but the initial response to our preliminary suggestions for these meetings indicated that we could not accommodate the participants while the University was in session so we selected Newport, an historic spot with exceptional associations with the sea, and especially with the United States Navy, which has done so much to bring oceanography to its present state of development in the United States. I am told, incidentally, that Narragansett Bay here, which many of you crossed to get to Newport, can hold all the navies of all the countries in the world. In any case, Newport is a fascinating town with its historic homes, churches, and other colonial buildings; its great mansions, "cottages" as they were called in their heyday; the extensive Navy installations, including the Naval War College; and its recent eminence as the home of the Newport Jazz Festival and the Newport Folk Festival. Before you leave we hope you will have time to see something of these attractions of Newport.

I want to acknowledge now the contributions to this conference of two individuals. One is Dr. Athelstan Spilhaus of the University of Minnesota, who from his location about as far from the sea as it is possible to be in the United States first proposed the idea of a sea-grant university system. The other is our junior United States Senator from Rhode Island, the Honorable Claiborne Pell, who brought the idea to the floor of the United States Congress in the form of legislation to achieve such a system. We are privileged that both men are with us at the conference to give us the benefit of their thinking on the subject and are on this morning's program.

As a university president, I cannot in good conscience let an opportunity pass to beat the drum for our own institution. When I first came to the University over seven years ago, I immediately gave consideration to the status and role of the then Narragansett Marine Laboratory. It was at that time a part of our College of Arts and Sciences. I soon reported to our Board of Trustees, "I am convinced that the most significant graduate program the University can develop is in this area of oceanography and that it can make its greatest contributions to knowledge and human welfare in research in the marine sciences. Though popularly neglected, there is a growing feeling that research into the nature and resources of the sea may hold as great potential for the future as space science."

Two years later, in 1961, the Board approved my recommendation for the establishment of a Graduate School of Oceanography, one of the first graduate programs of its kind in the country. Since that time, our commitment to oceanographic research has been a strong and growing one. The foundation for our program so solidly made in the marine laboratory's days by one of the real fathers of oceanography, Dr. Charles Fish, for whom our present laboratory is named, has been expanded to wider horizons by our resourceful and energetic dean of the graduate school, John Knauss, whom to our great good fortune, we lured here from Scripps. His attention to the coffee cups this morning indicates to you that he has his eye on the nickels as well as on the dollars, and as a university president, I'm grateful for that. Of course, he spends more money on that boat of his than anyone else in the University, but we are happy with the results!

I give you this bit of history to indicate why the national conference with such potential significance to research and to mankind is being held here in Rhode Island. Our own objectives in oceanography--graduate education, basic research in physical, geological, and biological oceanography, and applied resource research on problems of importance to the state and region, parallel in a very substantial way those of the original land-grant effort. One writer has said of the Morrill Act, that it has forced education to fit the changing social and economic patterns of an expanding nation.

Further, it has been said of the land-grant institutions, that through their efforts, higher education came to be regarded not so much as a luxury, as a national necessity. Today, marine science has developed to the point where it is no longer a poor relative in the groves of academic research, but rather a vibrant and vital discipline keyed to national necessity and inevitably to the destiny of much of the world's population.

Man's study of the oceans has come a long way in the past few years. I'm sure that this conference will conclude with new concepts and ideas which will quicken the pace and marshal even greater forces in this unending exploration of the so-called inner space. I wish you all a stimulating and rewarding experience here at Newport. I look forward to participating with you and learning from you during the conference. Thank you.

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, vehicles, 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 on 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 that 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 diving 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 counterparts 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 and 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 spectaculars 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 subsmersibles, 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 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 transplantation 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, under-

water 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 for high-sea fish and residences for in-shore 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 *dynoflagellates* 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 a 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.

THE NATIONAL SEA-GRANT COLLEGE & PROGRAM ACT OF 1965

Senator Claiborne Pell, M.A., Columbia University. A native of 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 aimed 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 effort 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. History combines fittingly in this respect with continuing and improving purpose. 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 deeps, 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 per cent 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 per cent of these revenues in a special account in the Treasury. They would then be available for appropriations on a stable annual 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 per cent of his present food requirements from the salt-water 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 or 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 the 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 glauconite, used as a soil conditioner and water softener and as a source of potash, has been discovered off the east coast of our country.

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.

THE ROLE OF SEA-GRANT COLLEGES IN FISHERY DEVELOPMENT

Wilbert M. Chapman, Ph.D., University of Washington, 1937. He is the Director, Division of Resources, Van Camp Sea Food Company, San Diego, California. He has had a distinguished career in both state and federal government fisheries activities, in education, and in industry.

A little less than twenty years ago I was asked to become Director of the School of Fisheries, University of Washington. It was the period of post-war readjustment, the beginning of the great growth period of the universities bolstered by the federal act giving educational advantages to people who had served in the war. We were promised by the university administration what was to us a palatial new building equipped with research facilities of which we had scarcely dared dream before, and a vessel large enough with which to work Puget Sound. We were given a pretty free hand to reorganize the curriculum in what ways we thought to be best, and funds with which to lay on new professorial staff.

We did all these things. We spent much more time on the design of the new curriculum than we did the new building or ship, as was proper. Most of us were graduates of the school, or the antecedent College of Fisheries, and had been out in the world working at our trade since. None of us was particularly happy about what had been our educational preparation for what we had encountered in the outside world. We were determined that the graduates we sent out into the Brave New World would be better prepared.

The first trouble we had was in estimating what the shape of the market for graduates would be. The school had been in business then for about 25 years, and therefore we had some pattern of success and failure to go on.

For the first ten years the College of Fisheries had been run by Dean John Cobb as primarily a technological school aimed at training persons to go into the fish business. It had been the Northwest fishing industry that had insisted on the college being established at the university and this was what they had wanted, and thought they needed. For the second, and longer, period the School of Fisheries had been run by Dr. Will F. Thompson on an almost diametrically different basis as a scientific educational institution with substantially no technological training offered at all. This was also what the Northwest fishing industry wanted then, and thought it needed, because in the early 1930's it had run into a variety of conservation problems and needed persons adequately trained in fishery science with which the state, federal and international conservation agencies, which had grown up to attend to these urgent problems, could be staffed.

The record of graduate performance coming from these two disparate sorts of training was puzzling. In the first place a quite high percentage of the graduates had stayed in the fishery field (something over three-quarters) and they filled quite high places in this field both in industry and government, and both in the United States and in other countries. From this viewpoint it was hard to tell whether one sort of training had been better than the other, and on a purely pragmatic basis of graduate success both seemed to have done pretty well. In the second place there was not any clear relationship between the type of education the student had had and the type of work at which the graduate was prospering.

Federal, state, and international conservation agencies, and those of several other countries, were staffed with our graduates from the early period of primarily industry-oriented technological training who seemed to be doing about as well as colleagues trained elsewhere and actually were beginning to dominate this field as administrators. Also, some from this period had gone into

the fish business, as they had been trained to do, and were prospering. A few were even university professors. But from the second period, when the training was scientific, and practical preparation had been almost totally ignored, several graduates had gone into industry, and they were prospering at least as well as had their practically trained predecessors. The few female graduates from both periods had mostly married fishery fellows and seemed to be raising families with about equal degrees of felicity and domestic tranquility.

There did not appear to be much rhyme or reason to all of this. One dedicated young fellow who had had no other aspirations than science, and gave every promise of being a good scientist, was in the fresh and frozen fish business making money hand-over fist (and still is). Another, trained as a hatchery biologist and technologist, was then head of the fishery function in the United States government. Another trained as a fresh water fishery biologist, with much emphasis on hatchery techniques, after some successful years at that had joined a large corporation in the salmon industry and was doing very well, with his primary responsibilities being in the labor relations field. Another from the early technology period was on the verge of becoming, as he since has, the director of one of the international fishery commissions having as the core of its work conservation research and regulations requiring the most exquisite and varied science. He had little pretense at scientific training or capabilities. His prime qualification was that he was bright, and he had been before he came to us for training. There are none of the international fisheries commissions that have done their work more satisfactorily than his has done since. Perhaps the most bizarre, almost humorous, case was my own. I was trained as a comparative osteologist specializing in ichthyological systematics, had recently returned from establishing subsistence fisheries on the most practical basis for the troops at advanced bases in the South Pacific, was now director of the school, and was slated to go to the Department of State soon to try and straighten out for the Undersecretary the diplomatic snarls into which our international fisheries had enmeshed us.

The demands upon us from prospective employers were highly varied and each seemed to know precisely what he wanted. There was a flood of students from countries in what is now called the developing world. Many of them were poorly prepared academically for the sophistication of education we were prepared to give. They were coming our way chiefly because the word "fisheries" was in our name, our graduates had made good reputations where they had gone, and their countries wanted their fisheries to be developed.

Hatchery techniques had become more sophisticated and state and federal agencies wanted graduates who could become hatchery superintendents. Fish processing techniques had become more sophisticated and the fishing industry wanted better trained graduates to run their establishments. Conservation science had become ever so much more sophisticated and the conservation agencies wanted graduates with a much broader and more competent scientific training than we had been giving, which to that point had been pretty good for the times.

Each of us faculty members made up a curriculum which students in his persuasion should follow to be reasonably well trained in that field. The net result of the first examination of these curricula suggestions by us all was that a student would require about five years of undergraduate preparation before he was academically equipped to approach the fishery field, and another five years of graduate courses in fisheries and oceanography before he was fit to get out professionally stamped by us as ready for duty, and we were then primarily considered to be an undergraduate department of the university.

All this seemed, of course, a little ridiculous even to us. We did rework the curriculum fully, but not according to the previous ideas of any of us. On the basis of what our graduates had done after graduation we decided to slip back about half way between the technological training of the old College of

Fisheries and the scientific training of the newer School of Fisheries. Almost none of our clients thought this to be wise. We determined to move toward being totally a graduate school, which almost all the students resented. We determined to raise the qualifications that a student was required to have to get into our institution. The university administration did not like this because we were a state institution open to almost all comers. This was probably the most sensible move we made because bright students make bright graduates and successful careers almost no matter what their professors do to them. Lastly, we emphasized seminar-like courses where the students could range over broad cuts of the fishery field with considerable independence but under the critical eye not only of the professor, but of their classmates (a much more critical audience). This was aimed not only at training independence of inquiry and mind, but at causing cross-fertilization of ideas among the broad spectrum of fields for which we were asked to train.

I left for the Department of State about the time this new curriculum, so carefully worked out, began to come into action. Accordingly, I take neither blame, nor credit, for what has happened since.

What has happened in the ensuing seventeen years is that there is still high dissatisfaction with the type of training given by what is now, again, the College of Fisheries of the University of Washington, and all graduates are employed as soon as they emerge. The technology training has now become mostly microbiology as sophisticated as the biological sciences. The biologists tend to take minors or majors in the more hard science oriented Department of Oceanography. Most graduates still stay in the fishery or ocean use field. Those technologically trained end up in the industry, the conservation agencies, or as university professors and do pretty well. Those scientifically trained end up in the industry, the conservation agencies or as university professors, and do pretty well. An occasional female still shows up as a fishery major. They still marry fishery fellows and settle down to raising families about as well as colleagues who have not had the benefit of a fishery education, whatever that is. The faculty of the College of Fisheries is still tussling with the vital problem of how to change the curriculum around so it can produce graduates better equipped to do better with the problems of ocean use.

I think this story has a bearing on the concept of the sea-grant college and that is why I have told it. I will go on to relate a thesis that will seem thoroughly corny to most of you, but that seems to me to be the most important concept involved in this sea-grant college business.

THE SEA-PEOPLE

Forty years of kicking around this business has left me thoroughly convinced of the following thesis: The ocean weeds out from all of the races of mankind that come upon it to make a living a certain type of person. This type of person stays with the ocean and the rest are cast back ashore to deal with the land-people.

I have sat on a nail-keg on the dock at Yaizu, Japan, conversing through an interpreter with Japanese fishing captains who have returned from the far corners of the world ocean, unloaded their catches, and are ready for a cup of tea and a chat with a foreigner while the crew washes down the vessel. The topics, the frames of reference, the attitudes, the background of experience and the gist of the conversations were so identical with those I had had with unschooled Melanesians in the Solomons; deep-water halibut men of Norwegian descent on their vessels in the Northeast Pacific; sophisticated California tuna-clipper men of Portuguese, Italian, and ordinary Anglo-Saxon descent, in San Diego; Russian trawl masters working off West Africa; and Arab sail dhow operators in the Arabian sea, that I felt perfectly at home. In all cases the prime problems were

two: how to wrest a living from the ocean, and how to keep the land-people from stealing it all. I was not a foreigner. For this purpose I was one of the sea-people, and the Japanese captains wanted to know how I and my people dealt with these key problems, as we wanted to know their experiences.

I have sat through two all-nation conferences on the law of the sea when the fishery people of all these countries came rather quickly to an agreement on the wide areas of mutual sea problems they could agree upon, and then absolutely confounded their diplomatic and military delegation leaders by quite refusing to let them agree to things the fish people did not want agreed to. The chanceries and Pentagons of the world still have no clear understanding of what happened to their objectives at the UN Law of the Sea Conferences in 1958 and 1960. Delegation leaders were unable to understand why, at the confusing end of the 1960 conference, fishery and Navy delegation members got together for a roaring drunk to celebrate their magnificent defeat.

Sea-people are different than land-people and I think it is the selective action of the ocean that creates and augments the differentiation. The older ones are worse than the younger ones, but the differentiation sets in pretty early. I think that what we are about, in considering the concept of the sea-grant college, is the education of these sea-people following the general precepts of the land-grant college concept which did such a good job of doing the same thing for the farm and village country people who are, again, much different than the city people but required, during the last century, almost as sophisticated an academic background to deal with their land problems as the city people did to deal with their social problems, and as the sea-people now need to deal with their ocean problems.

Every aspect of human activity or thinking that the ocean touches suffers a sea-change into something rich and strange. Whether this is the gathering of food, the conduct of hostilities, the transportation of things, jurisprudence, the moulding of character and attitudes, the outfall of literature, music and the arts, or whatever, the sea molds the product and producer away from the land mold. A court-musician of central Europe who has not heard a storm in the rigging could never write tempest music as did the Finn, Sibelius. A novelist from the hog-corn belt could never recapture the effect of storm and wave on the moulding of human character and action as did the Polish sailing master in THE NIGER OF THE NARCISSUS. Wheat ranchers and apple knockers do not make very good tuna or halibut skippers, or destroyer squadron fighters, unless you catch them pretty young and let the ocean weed out the ones it wants to train.

For the same reason oceanography, the subject occupying so much public discussion just now, is not a science at all. It is a place where science is done. It is a frame of mind -- a preoccupation, a dealing with the ocean from the viewpoint of science.

This is, in my view, what we are talking about in the concept of the sea-grant college -- a better means of bringing to the sea-people the possibility for them to receive a more sophisticated academic background so that they can deal with ocean dominated problems of all natures in a better way than we have done heretofore.

Since my field is the food harvesting end I wish to talk some about those particular problems. In doing so I do not wish in any degree to imply that the sea-grant college should be dominated by the problems of harvesting food from the ocean. Give us bright graduates who are of the sea-persuasion and well educated in the sciences and humanities, with a sea-slant, and the ocean will help us weed out from among them those who will be the leaders in the next generation of the sea-people.

WHY DEVELOP FISHERIES?

A legitimate first question to examine is why should any particular effort be put into fishery development or any special effort into educating people for that purpose. In 1850, the world catch of fish and shellfish (excluding whales) has been established to be between 1.5 to 2.0 million metric tons. By 1900, it had increased to about 4 million tons; in 1930, to 10 million tons; in 1950, to 20.2 million tons; in 1960, to about 38.2 million tons; and in 1964, a little more than 50 million tons. In the last several years the rate of increase in the ocean fisheries has been at least three times as large as the rate of increase in the world's human population. There is no indication that this is slackening off. Thus fishery development on a world wide basis is moving along reasonably well without the establishment of sea-grant colleges in the United States.

The ashes of World War II had not grown cold before the United States decided to employ a small portion of its gross national product to assist other peoples and their countries to improve their economic and social conditions. Although the Point Four, Marshall Plan, Foreign Aid and other names under which this program has persisted over the years has had consistent and active opposition from the time it was initiated, it has been the firm policy of every President who has taken office, since Truman started it, that this program would be supported in an important manner. This has been as true of Republican as Democratic administrations, and President Johnson appears to be somewhat more dedicated to this principle than most. Humanitarianism, disposal of farm surpluses, building outlets for industrial manufacture, arming allies, and other reasons are brought forward in support (or condemnation) of this principle and program. The basic cause of enlightened self-interest probably hits closer to the mark. If one people are prosperous and others are in serious want it is only a matter of time, historically, until the hungry people take up their swords and come seize from the fat people what they need. In any event the United States is deeply committed to helping the developing world develop economically and socially.

Some years of experience at this sort of thing has taught the United States government that people do not develop economically and socially very rapidly until they are well enough fed to keep in reasonably normal physical and mental health. The major health problem in the world presently turns out to be protein-malnutrition and this appears to be at present a root cause for slowness in social and economic development in about two-thirds of the world. There is no real shortage of calorie or protein food in the world, or its potentials for supporting adequately a human population considerably larger than the present one. The troubles are economic and social barriers to the equable distribution of what is produced, or what can be produced, and one thus comes full circle on the problem, ending up short of both chicken and eggs.

It only requires about 60 million tons of protein per year to fill entirely the needs of 3 billion people if it were distributed equably and in timely fashion. Of this only about 24 million tons would need to be animal protein. The ocean is naturally producing somewhere in the range of 400 million tons of animal protein per year of sizes and forms suitable for harvest and use by man. Of this, about 10 million tons of animal protein per year is actually being harvested and used per year (equating to the 50 million ton harvest now taken in terms of round weight). Even this is a fair part of the 24 million ton per year global need for animal protein if it were distributed in equable and timely fashion.

But it is not distributed in this fashion. Most of the global increase in fish production in recent years has gone into fishmeal for the feeding of poultry and swine in the industrialized countries where the desire for the added protein keeps growing rapidly, but the need is by no means urgent. The world production of fishmeal increased from 590 thousand tons in 1948, to 3,500,000 tone in 1964, which equates with about 20 million tons of round weight fish, or about 40% of total world fish catch in 1964.

Two questions now appear: (a) are there resources close at hand to areas of protein malnutrition where adequate fish can be gotten to where the need exists in a practical manner, and (b) can it be processed and gotten to the bellies that need it in a form they will accept at prices they can, and will, pay? As we go along you will see that the answers to these global questions are not simple and straightforward, and could stand being approached by people somewhat better educated to handle them than those of us in this generation who have been trying to do so.

To pass from the global to the strictly United States fishery scene three sorts of numbers define the fishery development problem pretty well.

The domestic fish catch was 4.5 billion pounds in 1964. This was about average for the range from 4 to 5.5 billion pound catch where domestic fish production has rested for 30 years with no trend up or down.

While we have remained static in fish catch, fish use in the United States has continued to increase at about the world increase rate of three times the rate of population increase. In 1948, the fish use in the United States in terms of round weight was 5,641 million pounds or about 38 pounds per capita. In 1964, it was 12,032 million pounds or about 63 pounds per capita, and the cost of our imported fish and fish products was pretty close to \$600 million. Very preliminary and very rough estimates by the Bureau of Commercial Fisheries indicate that the fish stocks near our coasts are adequate in size to permit a 22 billion pound catch per year on the basis of maximum sustainable yield (or about 5 times our present production from them and twice our present annual use of fish and fish products).

Thus from both the standpoints of the global responsibilities we have assumed (and from the domestic requirements we presently have) there would appear to be some reason for a slightly augmented attention to the solution of problems arising in the field of ocean fishery developments.

Put bluntly, for the United States, 120,000 fishermen caught 4.5 billion pounds of fish last year and we should arrange to catch about 10 billion pounds of fish per year with about 50,000 fishermen-- and then go on to show the rest of the world how to do the same thing.

THE STRATEGIC CONSIDERATION

The power structure among nations is continuously shifting and no problem gives us greater national and international concern than maintaining a national posture adequate to our needs for protecting what we call our open society at home, and for projecting this open society and the human benefits we think derive therefrom as broadly as possible in the rest of the world. Great debate is also heard at home and abroad about this policy but it also has been for a long while solid national policy in the United States and gives every indication of remaining so for the foreseeable future. Control of the ocean lies at the very root of our national posture and there is no hesitation in saying that if control of the ocean is in danger of falling into unfriendly hands we will fight to retain it. We always have and we always will.

Militarily we are in an excellent position to defend control of the ocean against all comers. The difficulty is that for the present time this military power is neutralized for this purpose because our primary competitor in the power struggle has sufficiently close to the same military competence to obliterate large sectors of the human race, and neither of us desires, or dares, to pull the strategic trigger and unleash this awesome military force.

Under these conditions the ability to control the ocean has changed subtly, but in a major manner. With a neutralization of military sea power for this purpose until the final Armageddon, there is the possibility that the occupation through use of the ocean in an almost peaceful world could quickly be shifted to its control in a less peaceful world, or that it could quietly and imperceptibly lead to an alteration of the power balance in the world by peaceful economic means that could become an implement for our slow strangulation under conditions short of major war.

We are reminded through our own history that occupation and use have been perfectly sound methods of getting control in a wide range of human affairs. The whole water law of the arid West grew from occupation and use, and not from the English common law or legislation in force in the humid eastern states. Wherever settlers could survive by use and occupation of the land as they pushed westward, settler's rights won control over native inhabitants and cattle ranchers as well, although the latter ordinarily had the military power, and often the law, on their side.

The two dominant civilian uses of the ocean remain the merchant marine and the fisheries. The Russian merchant marine is new, modern, rapidly growing, and roughly equal to ours in carrying capacity; ours is composed mostly of over-age obsolescent vessels and the industry is chronically in bad economic condition. In 1922, Russia's fish catch was 483 thousand tons of which only 20% came from the ocean; in 1964, its catch was 4,900 thousand tons (over twice the size of ours, which has been static for 30 years) of which 81.6% came from the ocean; their plan calls for a catch of 10 million tons in 1970, and they have been on or slightly ahead of plan goal in accomplishment at sea for several years.

The Russian ability for sea-use in fisheries feeds back into the diplomatic aspects of helping the developing world also. Their sea-fisheries are serving most useful diplomatic objectives in Cuba, Guinea, Senegal, Sierra Leone, Liberia, Ghana, Nigeria, Tanzania, Kenya, Somalia, Sudan, Egypt, Yemen, Pakistan, India and Ceylon, to name a few places.

Accordingly, from the standpoint of purely domestic objectives there are reasons for developing our sea fisheries; from the standpoint of international objectives our reasons for developing global ocean fish production and use, whether through our own activities or those of the international agencies, are major.

THE NATURE OF FISHERY DEVELOPMENT

The first problem in fishery development is to locate aggregations of a kind of fish for which there is a market, that can be caught at a cheap enough price so that the market will accept them while the fishermen make a good living doing so, and that are steady enough in abundance and location to support a regular occupation and industry.

The second problem in fishery development is to develop or adapt gear, vessels, and search and location equipment suitable to catching the fish steadily at a low enough cost per ton of production so that the market will accept them, and to stabilizing the fish so that when they reach the market they will be acceptable for sale or for processing for sale.

The third problem in fishery development arises from the highly perishable nature of fish. Since the market ordinarily lies far from the point of catching, methods of processing must be developed to keep the product in acceptable form until it reaches the consumer and, by so doing, not raise the cost so high that the product will not be accepted by the market.

The fourth problem in fishery development is the distribution and merchandising of the product in such a manner that demand is sufficiently constant to keep costs in the whole system low, and in ways that the cost of distribution does not add so much to cost of end product that producer and processor cannot get enough profit to keep going, or that competitive products will not drive the fish product out of the market, and so that the consumer will repeat his consumption.

The fifth problem is that the resource, for the most part, is common property of all nations until reduced to possession. No person can own such a resource and get the benefits of animal husbandry for himself. Thus management of the resource and its use is a public function for the operation of which there is no satisfactory governmental machinery on the international level, and ordinarily, highly imperfect machinery on the national, state, and local level. This brings all sorts of complicated and vigorous multiple-user problems at all of these levels which are, on a state, national and international level, presently the greatest barriers to ocean fishery development.

In a word, the fishing industry must first fight the ocean for the fish, then fight the rest of humanity steadily to maintain access to the fish, then fight the rest of humanity for continued access to the market; and, in the end, produce a product in a form acceptable to consumers, at a cost they can and will pay, while leaving profit margins at fishing, processing and merchandising levels adequate to keep people employed therein and to attract adequate capital to these purposes.

The first and fifth of these problems are reasonably unique to producing food from the ocean. The second problem also has many ocean-induced aspects, but can draw more on ideas, equipment, and developments in related industry. The third sort of problem has even less differentiating it from other food-processing problems and can draw much from related industrial practices. The fourth sort of problem -- distribution and merchandising -- is not markedly different than the same practices in other consumer-oriented industries, and much the same can be said for general management of the enterprise. A difficulty is that all five sorts of problems must be moved along at about the same rate or nothing develops, and the first and fifth sorts of problems are so different from the ordinary land-induced problems of other industries that a very strong sea-flavor must pervade the whole enterprise or it does not grow and prosper. It is in these areas that the educational apparatus in the United States is most deficient for the sea-people, and where they need assistance from it most.

APPROACHING THE FISH

Fish are affected in their abundance by changes in the environment (which may, and often do, provide changes by an order of magnitude in the incoming year class), and by fishing pressure (the overfishing problem). Disentangling the effects of these two factors on observed changes in abundance calls for the most precise, abstruse, complicated and extensive science. The processes of changes in the environment must be elucidated. The processes of effects of these changes on the biological cycles of the particular resource must be elucidated. The effect of differential fishing pressures on resource forms competitive with the one being studied is only beginning to be understood and studied. All along the line one must be able first to measure that which seems, at first, incapable of measurement. Physical, chemical and biological oceanography of the most sophisticated nature must be done before these problems can even be approached. When this sort of information is in hand the volume of the resource in the opaque ocean must be measured and the effect of density-independent and density-dependent factors on the abundance of the particular resource must be worked out. Then the fishing effort itself must be calibrated and the sophisticated mathematical models, required for relating different fishing pressures to different measured effects on population abundance, must be understood. As

often as not the fishery is working at the same time, or seriatim, or in an auxiliary manner, on a number of different fish populations each of which is reacting in a distinct and different manner to both environmental and fishing effort changes.

When one has the abundance problem in hand one logically would move to the study of the availability problem, which is made up both of abundance of the population and its aggregation in a manner and place which makes it readily and cheaply caught. Events ordinarily do not permit such logical scientific progression. One must almost always work simultaneously on both the abundance and availability problems. In some great fisheries (North Atlantic cod, Peruvian anchovy, tuna everywhere) quite subtle changes in the environment can throw the aggregation of fish some hundreds of miles from where they are expected, or keep them a few feet below the surface where they are undetectable, or promote scattering and prevent aggregation into commercially practical catching bunches.

The objective of all of this is prediction. It becomes more clear as we go forward that our ability to predict environmental changes is a key factor, that they cannot be predicted satisfactorily on the basis of measurements in the area of the fishery, that they are often (if not normally) subject to changes going on over the horizon where we are not watching or measuring, and that they are arising from processes we do not yet understand very well even if we could measure them synoptically. This is a reason why fishery people become more continuously interested in the world ocean as a unit and the study of air-sea interaction processes on a global scale. Involved also are the biological consequences of these gross, and minute, environmental changes, and I could spend the rest of the day illustrating our ignorance of various facets of this aspect of the matter.

The situation is not at all hopeless or impossible. Quite considerable progress is being made in prediction of this nature in several important fisheries. Often this is still empirical but in some cases even the processes are becoming dimly understood.

One must always keep in mind that the fisherman, and the industry associated with him, are making predictions of these sorts on a daily, less than daily, or more than daily basis, on the basis of the best information and understanding available. On a global basis the livelihood of millions of people and the employment of hundreds of millions in capital are risked daily on these fishermen and trade predictions, guesses and decisions. This goes on whether or not there is any science and must do so. If science can improve the predictive ability of fishermen by only one or two per cent, or extend his predictions by one or two days in a direction better than random, the beneficial economic and social consequences on a national and international basis are quite enormous.

THE MULTIPLE-USER PROBLEM

Since the resources used by the industry are, for the most part, the common-property of everyone, the normal instinct of the individual, the group, the nation, or the region is to keep everybody except itself from fishing on the resources. What the individual entity wants is ownership so that it can manage and husband the whole resource and fishery and reap all of the benefits therefrom. This the other individual entities will not permit. Arising out of the same common-property nature of the resources is the attitude of public administrators to their task. If there is any question as to overfishing, the best thing to do (it is often felt by them) is to slow down or stop the fishery until science can ascertain the facts. In consequence laws and regulations of great variety impede the development of the ocean fisheries in all directions, and in many (or even most) instances these laws and regulations, and the local, national, and international interactions that arise from them, have little relation to natural happenings in the ocean or conservation need.

What has grown over the past fifty years is the realization that every living resource of the ocean can be subjected to a fishing pressure that will produce, on the average over the years, a maximum sustainable catch, and that this can be pretty well estimated by independent scientific research capable of independent checking for credibility. Accordingly, the nations in the Law of the Sea Conference at Geneva, in 1958, adopted this as the standard to which they all could, and would, rally. This has disconcerted economists some because the point of maximum economic yield is often (or normally) somewhat short of the point of maximum sustainable yield. But the point of maximum economic yield is importantly affected by socially induced factors as well as factors arising solely out of nature. Different societies created different socially induced factors into the equation. Groups of men are not yet willing to adopt the socially induced factors of other groups of men as their own rules. Thus, the nations could not agree on what was a proper standard for maximum economic yield, but they did agree instead on the standard of nature -- the maximum sustainable yield. This is derived from nature, which each group could measure and evaluate independently.

For our purpose, here, it is only necessary to state that the determination of the point (or area) of maximum sustainable yield is a matter for scientists, and that fishermen, industry people, administrators and statesmen are not able to give much useful input to these determinations.

Neither the nations, or groups within the nations, have yet developed any agreed standards or criteria as to which group or nation will derive the benefit from the conservation contemplated by the adoption of such a standard of maximum sustainable yield; but now that the standard has been created and adopted it does provide the basis for reaching agreements on how to split up the swag -- and this is the proper point upon which fishermen, industry people, administrators and statesmen can effectively bring their talents and aspirations to bear. They have not yet shown much inclination to do so in a satisfactory manner at any level, and in consequence many vigorous artificial barriers to fishery development exist at all levels.

AQUACULTURE

A great deal is heard these days about the raising of resources in the ocean, with aquaculture being equated in these considerations with animal husbandry or land or even agriculture.

Most of this, at this point in history, is nonsense and should not yet be getting the public attention being given to it. The reasons for this are several. One is that we do not yet understand well enough the natural processes of food production in the ocean to be able to intervene in them beneficially in a very meaningful manner. Secondly, mankind never practiced animal husbandry where wild game was always abundant, because there was no need for it. The common pasture of the world ocean is naturally producing about 2 billion tons per year of food in size and form usable by man. At present man is using about 50 million tons of this per year, and the rest is dying and going back into the web of life unused by man. Certainly this wild stock will require being cut into much more deeply before any major activity in artificially raising more is warranted.

The third reason, however, is the most pertinent at this stage of history. No man can afford the expense of raising fine stock if he cannot keep it out of the common pasture where it can be harvested by his neighbors who have not shared the expense of the animal husbandry. Most major fishery resources not only range out into the common pasture of the high sea, but they cannot be practically confined, reared, grown to commercial size, and harvested inside a 3 mile limit or a 12 mile limit. Until the legal and diplomatic problems associated with the common-property nature of these great resources come better into hand no large scale aquaculture in the high seas will be warranted.

There is no question but what Donaldson at the University of Washington has beneficially manipulated the genetic capabilities of chinook salmon, for instance, in such a manner that animal husbandry practices would yield great return, if the legal basis for reaping the reward of the animal husbandry were available. There is good reason to believe that this could be repeated on one aquatic resource after the other. But the legal basis for reaping the reward does not exist on the state, national or international level, and the chinook salmon, because of nature, must range through all three of these levels of management before it reaches harvestable size.

An exception to all of this lies in the aquatic resources of the estuarine and near-coastal area, and particularly to the attached forms--the kels and shell-fishes. Oysters, mussels, and clams in particular are susceptible of economic farming and it looks as if this applies also to some marine algae. While more scientific work is needed at many points the main barriers to present farming of these things are legal and tenure problems, economic costing of methodology, and marketing problems. Pollution problems are also of major concern but these now look to be tractable.

CATCHING THE FISH

If there are fish in abundance where you want them and no legal barriers to getting them, there still remains the problem of catching them and getting them to port at a cost low enough to enter the market and leave adequate margin for profit on labor and capital used.

Should it be a 50 ton boat or a 1,000 ton vessel? Should it have radar, sonar, fish finder, and be supported by air surveillance, or simply use eyeball methods of locating fish? Should it bring in the fish fresh, iced, frozen, or otherwise stabilized? Should it use wood, steel or aluminum in hull and superstructure? In what sort of sea-state will it be required to work? What ratios between speed, length, fuel consumption, carrying capacity, crew comfort, etc., are required to maximize profit? Shall it be a purse seiner, long-liner, trawler, gill-netter, or what (or maybe a combination vessel)? What is the rhythm of sea-state in the area to be fished so that trips can be arranged to take advantage of this?

THE PRESERVATION OF THE FISH

On an average a fish is 80% water which is no more nutritious or tasty than ordinary tap-water. It costs as much to freeze and transport the water as it does the nutritious parts of the fish.

Fish range in oil content from 1% to 20%. Most of the fats are polyunsaturated (unlike most land-animal fats). Upon death they take up oxygen and become rancid. This presents one or more of three sorts of problems. In some fishes (for instance the salmons) the delicate tastes which yield the high prices are carried in the oils. If the oils become rancid the value of the fish depreciates rapidly. Rancid oil in all other fish generally smells badly and makes for an unacceptable product. Thirdly, rancid oils can be unwholesome from the standpoint of human or other animal feeding. Accordingly, the polyunsaturated lipids of fish must be stabilized or extracted rather quickly after death or the product declines in value sharply and quickly.

Fish are about 18% to 24% protein, and this is the principal nutritional element in fish. The proteins have a balance of amino-acids well suited for human or animal diets and the trace mineral content as well as certain vitamins (particularly of the B-complex) are additional plus factors nutritionally. The enzymes of fish are active and keep right on acting after death; accordingly, they must be stabilized quickly if sea quality is to be retained. From a nutritional

standpoint there is not much difference between an anchovy and a bluefin tuna. The amino-acid balance of the proteins is about the same in all fishes and it is possible to take out most of the water and oil, grind the whole business together, and come out with a stable product 85% protein that stores, transports, and handles cheaply and is not much different nutritionally whether you start with anchovy or bluefin.

The economics of what you want to do with the fish, however, is likely to be controlling. If you are landing the anchovy in Peru for fishmeal production for chicken feeding you can get nearly ten dollars per ton for your catch. If you are landing your anchovy in northern Spain to be marinated and canned for the Italian trade you can get something more than \$100 per ton for your catch. If you are landing your bluefin catch in San Diego for canning for the American trade you can get about \$240 per ton for it. If you are landing it in Tokyo, just before the year-end holidays and it is very fresh, you can expect better than \$2,000 per ton for it in the round as it leaves your vessel, to be eaten raw in the sashimi trade.

This barely indicates some of the great variety of problems susceptible to improved technology which exist in the field of harvesting food from the sea.

EDUCATIONAL REQUIREMENTS FOR AUGMENTING THE USE OF FOOD FROM THE SEA

If you have followed me this far you will have seen that there are broad opportunities for increasing the use of the living resources of the sea by the United States and man generally, that there are some good reasons for doing this, and that there are some difficult scientific, engineering, legal, diplomatic, technological, managerial, economic and social problems in the way of doing this.

In Japan there has been developed during this century a rather complete educational system within the general educational system for the training of people to go into the fishing business at almost all levels. There are grade schools, and high schools that emphasize the sorts of training required for this work. Beyond this level there are fishery colleges which train people for rather more advanced positions in the fish business (vessel captains, administrators, managers, etc.). Finally, there are graduate schools which train fishery oceanographers, fishery biologist, etc., for the scientific aspects of fishery work. These levels of education are integrated into a whole. Some such complete system has been developed in Russia also over the past fifteen years, and is more or less being developed in Poland as well.

I do not necessarily suggest that what is good educationally in Japan, Russia and Poland is either necessary, or necessarily the best, for the United States. I do point out, however, that Japan (next to Peru) is the greatest fishing country in the world and that her fishermen fish the whole world ocean using sophisticated methods of catching, preservation and marketing that we do not employ. At every level of this operation from fishing to management and government agency are found the graduates of this fishery educational system. Russia follows behind Japan in world fish production and her production has grown, diversified, and is growing, and diversifying, even more rapidly. Also at all levels of the Russian operation are found graduates of the Russian fishery education system. Poland's fish production is much smaller, but has increased by a factor of ten in the past eighteen years and is moving up rapidly now. In the United States we give very little attention to fishery education outside our general education system, and the domestic fish production here has stayed level for thirty years. I think there is a relationship between these things.

Where we are failing worst at the present time, in my view, is in translating back from the scientist, who has the information that could be used, to the

fisherman, who is the only person who can make use of the scientific information in fish catching. By this I think I mean that what we now require is something very like the 4-H club, county agent, university extension type system of communication that exists between the land-grant colleges (particularly) and the farmers on a grass-root and all other levels in this country. We now have knowledge and understanding at the scientist and university level that could be usefully employed at the fisherman's level if it could be gotten to him in a form he could use. The machinery does not exist for doing this, and I do not believe that this can be fully done by the Bureau of Commercial Fisheries any more than it can be done in the farming field alone by the Department of Agriculture. On the other hand I believe that the BCF is required to play as full a role in this sea-education system as does the Department of Agriculture in the land-grant college, extension service, county agent system in the farming field.

Beyond this, and supporting it, I believe that we need a few universities (and probably four or five) who give a solid sea-slant to almost the full range of university education. The way things are developing at the University of Rhode Island seems to me to be the direction in which we should move more firmly here and at a few other similar locations. Here there is a Graduate School of Oceanography which is growing rapidly into a center of excellence in the doing of ocean research on a broad basis and the training of ocean scientists on a similarly broad range but high quality level. The sort of training and research done by this school seems to me to be not only satisfactory but excellent for the top educational range of the activity I am talking about. It only requires to be supported somewhat more actively. Similar institutions to build on exist at the University of Miami, University of California at San Diego, Oregon State University, University of Washington, University of Alaska, and University of Hawaii.

At Rhode Island, however, has been added another essential ingredient not yet done so well elsewhere, to my knowledge. Here the Geography Department is slanting its activity toward the geography of the ocean. The agricultural economists are slanting their activity toward marine economics, fishermen's cooperatives, fishermen's education, and the practical things of the sea business. The political science people are paying particular attention to the political science of ocean affairs, in which as a nation we are most deficient. The legal people are having a look at the law of the sea and what that means to ocean development. The Public Health Service is working diligently on problems related to the effects of pollution on the production and utilization of marine foods. To this needs to be added, in my view, a more vigorous input on ocean engineering, the technology of marine food preservation and utilization, and the sociology of marine activities.

I think that what is being initiated at the University of Rhode Island through the vision and energy of the president and his faculty is precisely what we need on a somewhat broader basis here and at several other points in the country. I believe this conforms quite closely to Dean Spilhaus's concept of a sea-grant university, and it certainly leads strongly in the direction I have been talking about -- that what we need is a full fledged University of the Sea where the whole range of man's relationship with the ocean, in the humanities as well as the sciences, can be examined and taught in the same full manner as the Land-Grant College System does for the land-people.

The means by which the support should be derived I leave to others. I do believe, however, that the prime support should come from the federal government and that this should have input from the Department of the Interior and the Department of Commerce, as well as through the Department of Health, Education and Welfare.

I wish I could say that the prime moving agent from the federal side would be the Department of Marine and Atmospheric Affairs, so boldly envisioned by Senator Muskie and his 17 senatorial colleagues in (S. 2251), but apparently this must wait a little yet until the public and the government realize how badly we need such a development in our governmental apparatus.

THE GOVERNMENT LOOKS AT THE SEA-GRANT COLLEGE CONCEPT

Harve J. Carlson, D.P.H., University of Michigan, 1943. Since 1961, he has been the Division Director for Biological and Medical Science, National Science Foundation, Washington, D.C. A former educator and scientist in the Office of Naval Research, he serves as the NSF representative on the Interagency Committee on Oceanography of the Federal Council for Science and Technology.

We have had the pleasure this morning of listening to several speakers describing the advantages to be accrued to the oceanographic community and to our entire nation by the introduction of sea-grant colleges which, in certain respects, may be considered parallel to land-grant colleges established nearly a hundred years ago.

To get a complete picture of the situation, it is first of all mandatory to understand the functions of a land-grant college. In the existing land-grant college system, proceeds from the sale of public lands are paid to the states and are used for establishing and maintaining agricultural and mechanical arts colleges. Most of these colleges have agricultural and engineering experiment stations affiliated with them, thus providing the ideal conditions for a pragmatic education based on research.

Owing largely to the legislative foresight of the Congress, today's land-grant colleges are leaders in the field of applied science education. To better understand some of the other speakers' proposals, we must realize that most, if not all, of the existing land-grant colleges have over the years broadened their horizons to include other disciplines. For instance, in addition to the agricultural and mechanical sciences, other more basic educational fields are included in the curriculum.

Funds for land-grant colleges are budgeted by the Department of Agriculture and are distributed partly by equal allocation and partly according to a formula. The formula consists of a ratio of a given state's rural population to the total population of the state. Most land-grant universities today are, however, autonomous state institutions. Though they receive funds for basic education through the Office of Education and through research grants or contracts sponsored by certain federal agencies, it would be erroneous to imply that the federal government exercises any material degree of control over them.

Until 1935, federal grants for the A & M colleges were distributed equally, with each state receiving about \$90,000 per year. The state-to-federal ratio has now risen to the point where the state contributes about three times as much as the federal government. Although some individuals believe that this rather unusual ratio reflects state fears of increasing federal control over local research, others who view the situation more objectively are convinced that it reflects healthy pressures on state legislators by the urban and rural population through experiment station councils and others. (This we might also note carefully, since the oceanographic community has never been shy about expressing its needs). Both sides, however, are convinced that the existing federal-state relationship is extremely effective. I believe that the oceanographic community of the United States has a great deal to learn from this system, both pro and con.

Whereas the scientific community can and should look at the sea-grant university proposal from a conceptual point of view, the federal government, which would be at least initially saddled with the responsibility for sponsorship, must examine this whole problem in a more pragmatic way to determine the devices available to the federal government for implementing the concept of the sea-grant university.

Here I would like to borrow some thoughts from the book *GOVERNMENT AND SCIENCE* by Don K. Price, formerly Associate Director of the Ford Foundation and presently Dean of the Harvard School of Business Administration. Dr. Price describes five types of relationships which the U. S. Government maintains today with private institutions.

The first relationship concerns a specific contract, such as for the improvement of a certain device, for development of a new one, or for any other specific research project in a university.

The second relationship is built around a so-called "master" contract with several individual institutions. This contract is rather general, merely stating the terms of the relationships, so that new projects can be undertaken by an order without requiring negotiations for new contracts.

The third relationship applies to a "special study" contract consummated for investigating all phases of newly identified major problems. For instance, sometimes the military services identify major problems requiring new approaches which may be based on scientific development, on strategic or tactical thinking, or on a combination of all three aspects. In other countries, such assignments are generally given to military staffs. Dr. Price claims that only in the United States, are studies of such crucial importance to the nation's welfare farmed out to universities.

The fourth type of relationship evolved from those mentioned earlier -- conduct of a scientific enterprise -- sometimes requires not only technical but also managerial competence. Several major universities have been happy to take on such assignments and have separated the contract groups from their normal administrative systems. Of interest to the poverty stricken oceanographer are the facts that the Atomic Energy Commission supported the Argonne Laboratory at the University of Chicago at a level above that of the entire University prior to World War II, and that the Lincoln Laboratories at Massachusetts Institute of Technology (MIT) now spend about \$60 million a year, considerably more than the entire Institute spends yearly on teaching.

Finally, concerning the fifth relationship, we have witnessed in recent years private corporations founded especially for government programs. Examples are the Associated Universities which run the Brookhaven Laboratories on Long Island for the AEC, and the National Solar and Radio Astronomy Observatories for the National Science Foundation; the Rand Corporation which undertakes much of the planning for the Air Force.

Theoretically, of course, our contractual system enables the various federal contracting officers to completely dominate the decisions of the university investigators. In agricultural colleges, however, this simply has not happened.

Dr. Price describes one of the better features of these arrangements -- that of the feedback. For instance, the Applied Physics Laboratory has not merely worked according to military requirements; it has originated ideas on its own that have significantly influenced Navy planners. On the other hand, Dr. Price sees our agricultural aid systems as unique "by comparison either with other government programs in the United States or similar programs in other countries." He criticizes the agricultural programs as being limited in their potential for growth, dealing as they do with specialized subject matter "set aside from the more dynamic elements of industrial development that are rapidly urbanizing the nation and changing its relations with the rest of the world." Because of the very nature of its subject matter, its projects and programs are individual and relatively small.

Dr. Price also notes that even the salaries of scientists who are essentially on the payroll of the state governments, maybe stabilized at a low level because

of the jealous supervision of state legislators. This factor is reducing the competitive ability of these scientists with the world of industrial science. Finally, the programs are scrutinized by Congress which, although it tries to maintain a healthy level of appropriations, is still normally discouraging "bold ambitious national planning."

Dr. Price's analysis is perceptive and at the same time somewhat disturbing in what it portends for the oceanographer at a "sea-grant college." The oceanographic community is traditionally composed of highly individualistic scientists who are imaginative, dynamic, and somewhat vociferous. Accordingly, as promising as the sea-grant college appears in most respects, one can't ignore the infeasible sociological relationships which may result from the federal-state structure.

Now let us examine the purely oceanographic features of the topic. The subject has already been discussed by the Interagency Committee on Oceanography and I should like to pass on to you today an expression of the attitudes of the ICO members and my own personal convictions on the subject.

As you may know, the National Oceanographic Program, encompassing the activities of 22 federal agencies, has been virtually level-funded for the past four years. This implies that if a new project is to be started, somewhere an old project must be curtailed or discontinued. It is evident, therefore, that the first thought of the ICO members is: Will the sea-grant arrangement detract from existing programs, whether sponsored or conducted by the federal agencies?

Interestingly enough, the ICO members are not at all frightened by the possibility. Since several of our agencies have unsuccessfully tried to increase funds for the support of marine science education and training, we really haven't much to lose. Many institutions are now financially undernourished, and it is entirely possible that introduction of the sea-grant arrangement would provide the best stimulus to the development of education and training and, ultimately, the applications of oceanography and ocean engineering toward which we all look forward. Therefore, I would say the ICO members are favorably disposed toward the sea-grant concept.

We often hear the complaint that there is an urgent need for more professional oceanographers and students of oceanography. In fact, this theme may be partly responsible for the emergence of the sea-grant concept. But the ICO does not believe the recruitment and education of oceanographers to be the main problem. There are plenty of scientists available in this country -- good scientists, capable of advancing the state-of-the-art. There are many outstanding biologists and chemists, eager and interested in biological and chemical oceanography. There are exceptionally talented geologists willing to explore the practical and theoretical aspects of submarine geology and to advance to the practical matters of applications in the interests of exploitation. What is lacking is adequate support and encouragement for these scientists.

However, we do have two basic personnel needs: (1) More highly trained, imaginative persons to attack the more advanced theoretical aspects of physical oceanography; and, (2) More outstanding engineers to translate the work of these scientists into practical accomplishments.

In this respect we believe that the introduction of the sea-grant arrangement into the American educational scheme will have a beneficial effect. We can envision applications of sea-grant research in marine conservation, pollution control, agriculture, desalination, recreation, and ocean commerce. We can envision the engineers constructing barriers against disastrous sea storms, recovering the minerals of the deep oceans and the ocean bottom, and building a technology that will stimulate and advance our fishing industry.

One problem which somewhat baffles government agencies concerns practical implementation, that is, the translation of the concept into actuality. The main question is: What devices can the government provide to make a certain idea work?

Here is where we must throw off the crutch provided by the parallelism with the land-grant college system, because essentially that system and all the colleges supported under it depend solely on one government agency -- the Department of Agriculture. What we have to consider is the multiplicity of federal agencies concerned with the ocean.

The ultimate goal of the sea-grant concept is to exploit the ocean in the national interest. Its intermediate goal is to develop the scientists and engineers who are going to do it. The land-grant college system was started with the simple objective of improving agriculture and the mechanical arts, whereas the sea-grant concept, as already mentioned, has many applications, depending on the missions of the various government agencies.

The questions arise: What does this diffusion of purpose lead to in terms of implementation? Which government agency should be assigned the mission of administering a sea-grant college program? If, as has been suggested, the National Science Foundation takes on this task, would this arrangement sooner or later conflict with the activities of the Bureau of Mines, Bureau of Commercial Fisheries, Geological Survey, Navy, Army, Environmental Sciences Service Administration, Public Health Service, and Office of Education?

For answers to some of these questions, we might refer to Dean Spilhaus' remarks. He has suggested curricula devoted to aquaculture and ocean engineering, with harbor agents corresponding to county agents, to quickly relay the findings of new marine engineering to the users. He has proposed relationships with law schools to provide a new look at laws of the sea. He has further proposed contacts with a sea home-economics department, to develop ways of making sea products more appetizing. These ideas could serve as basic hints on how the sea-grant principle would be applied -- but not as a sea-grant college.

Accordingly, I would say the following:

(1) That the suggested source of support -- the realizing of funds from rents, royalties, and bonuses accruing to the federal government from the leasing of lands on the continental shelf -- is excellent.

(2) That rather than to create and maintain new colleges and universities, these funds can be utilized to foster sea-grant programs on institutional bases through carefully planned undergraduate and graduate curricula, leading to the emergence of students trained in all the practical aspects of ocean development mentioned by Dr. Spilhaus.

(3) That courses should be arranged cooperatively in various departments of existing universities which would qualify under the terms of the arrangement: the law school, the sanitation laboratory, the colleges of science and technology, and the schools of engineering.

(4) As an equitable method of determining appropriate support levels, I would favor flexibility over a rigid formula pattern. Certainly, an approximate federal-to-state relationship will have to be reached, but I am opposed to any system which tends to ignore merit. Therefore, I would strongly recommend that this relationship be used merely to set limits within which the granting agencies can operate according to the scientific and engineering merits of the proposed programs.

(5) As for which federal agency should have the authority to administer the sea-grant program, I would have to go along with the National Science Foundation as the closest approach to neutral ground. However, in place of our customary review boards drawn from the scientific community, I would suggest a review council with a seat allocated to each federal agency toward whose mission the sea-grant concept is oriented.

Perhaps in this way we would be uncovering the teams of intellectual and practical giants who would bring about the next series of advances toward our mastery of the ocean. This is, of course, easier said than done. For instance, two years ago Captain Charles Stephan USN (Ret.) was asked by the Florida Atlantic University to design a two-year curriculum leading to a degree in ocean engineering. Immediately, (and naturally), Captain Stephan attempted to be all things to all men. He soon, however, became frustrated by the requirement for turning out a student skilled in chemistry, biology, physics, geology and above all -- engineering, in terms of the relationships of these disciplines with the ocean, within two years. From conversations with Captain Stephan it was learned that he felt ten years would be needed to turn out a student with the proper basic and applied knowledge. Consequently, a compromise had to be found, and today the creation of an ocean engineer involves a curriculum of five trimesters over a two year period, totalling 76 semester hours. The curricula emphasizes engineering subjects, assuming that the student already has two years of basic sciences.

There is one final point I would like to make, and to me this is the most important one. I personally believe that the outstanding feature of this concept and all that it portends is that the discussion is being carried out without the benefit of clergy -- that is, in absence of an already stated national policy. I believe this is all to the good, because now we are provided a most unusual opportunity -- now is the time for the scientists of this country to put their best collective foot forward and formulate on their own initiative a national policy which the government can endorse and develop along conventional legislative and executive lines. I hope that in these two days we can work out the basic elements of the policy and that at least we will have a good start toward the design of a well constructed sea-grant educational curriculum.

Naturally, the members of the ICO are in favor of responsible stimulation of the marine sciences. We feel that there are many applications yet unrealized for the American public. The oceans have limitless advantages to offer the United States, and we are distressed with the slow speed at which we are breaking down nature's forces in the sea.

The sea-grant arrangements suggest part of the formula for speeding up this effort to attain mastery in the oceans. For instance, last year alone the United States Government received in royalties and lease holds from private enterprise on the continental shelves over \$150 million -- more than the aggregate oceanographic programs of all of our 22 agencies. We feel that it would be extremely helpful if some of this money could be invested in ways to improve our technology and advance our ability to work in the ocean, thus increasing even further the royalties and rentals received, and, thereby, accelerating the entire profit-development cycle.

One cloud which lurks on this particular horizon involves a traditional reluctance on the part of the government to earmark funds in advance for any specific program, although exceptions are not rare. The ICO members see no strong reason why another exception should not be made in this case.

Undoubtedly, one of the ocean's most dramatic aspects is the way it cuts across so many fields and disciplines. Many persons who have studied the history of land-grant colleges believe that the principal advantage of the sea-grant concept lies in the multitude of educational effects to which I have already

referred. Some opponents of this concept claim that the sea-grant arrangement would foster the image of a trade school. In reply, I can say that any arrangement which provides training in chemistry, geology, physics, biology, engineering, and mathematics could hardly be described as a trade school, under any system of definitions.

We who have studied the effects of the land-grant college principle have a healthy respect and appreciation for the fact that land-grant colleges now account for 40% of the doctorates turned out in United States educational institutions. They educate 20% of all our undergraduates, and provide one third of all our university and college teachers. The Interagency Committee on Oceanography feels that the emergence of the sea-grant arrangement may add to the already highly respected position of the land-grant colleges and contribute significantly to the objectives of the National Oceanographic Program, if developed in a rational, well-conceived manner.

THE LESSONS OF THE LAND-GRANT MOVEMENT

Harold C. Knoblauch, Ph.D., Rutgers University, 1942. He is the Associate Administrator, Cooperative State Research Service, U. S. Department of Agriculture, which administers the federal-grant payments appropriated annually by Congress for research of state agricultural experiment stations. He is a well known author and authority on the land-grant system.

It is always a special privilege to be invited to return to Rhode Island. My first graduate work was done at the University at Kingston. And it was there that I gained firsthand knowledge of the close association between high quality research and graduate instruction.

Beyond learning more about the basic sciences in relation to agriculture, the location at Kingston gave me the opportunity to observe and contemplate the beauty, the awesome power, and the untold mysteries of the sea. So, let me assure you, it is a genuine pleasure to participate in this National Conference on the Concept of a Sea-Grant University.

Your program committee asked me to present the basic philosophy of federal-state relations in science and education in agriculture. Cooperativeness is essential for the federal and state governments to attain mutual goals and objectives. American agriculture set an historic pattern for scientific growth and its application to benefit society. In this pattern federal cooperation and state cooperation have been and continue to be primary features of the establishment.

In my remarks I shall direct particular attention to relationships between the U. S. Department of Agriculture and the land-grant universities. I shall deal specifically from the background of relations with the state agricultural experiment stations. These were authorized under the Hatch Experiment Station Act of 1887 and became the keystone for federal-state cooperation in agricultural research.

An important part of the development in agricultural research is the associated preparation and training of scientists in areas related to agriculture such as biology, botany, entomology, and many others. In today's paper I plan to put emphasis on the significance of the relationship between research and graduate teaching and, in turn, society to the constantly changing problems of people in our individual states. The graduate-study-through-research principle grew out of the longtime development of the USDA-Land Grant System. It got into subsequent legislation providing for federal support of science. Plans for programs of education, training and research are included in Senator Pell's bill, (S. 2439), and in Section 2 of Congressman McGrath's bill (H.R. 11579), proposing the "Oceanographic Act of 1965." The approach and method of support are different than in the Land Grant or Experiment Station Act.

Reference will also be made to the agricultural research and extension programs as a means for making important science findings available to farmers and consumers. And, some of the significant results growing out of the land-grant college concept will be mentioned briefly. The product of 100 years' cooperative development and application of science to agriculture is indeed a great example of free institutions allowed to operate in an open society. It is worth careful study by those interested in the growth and development of science as it relates to the sea.

The lessons from the land-grant college experience will not provide specific answers on how to organize sea-grant colleges. Instead they provide principles worthy of your serious consideration. For you, their significance lies in

gaining greater understanding of the higher education principles that evolved from the land-grant system. Review of the basic philosophy, and of the federal-state relations that fostered the pattern, should be helpful. If your mission is to strengthen marine science through the development of an effective center or centers for teaching and research in an academic environment, then fundamentals that were developed in the land-grant college system should help you avoid some of the mistakes. The mission that you define is of paramount importance. With a clearly stated mission the organization should be structured so as to accomplish the mission in the most effective manner possible, taking into account associated experiences.

BACKGROUND

First of all, let me summarize briefly how the land-grant philosophy originated and what fostered its development.

The history of 17th and 18th century America reflects a growing consciousness of the need for education and experimentation in agriculture. It grew from the roots of a free democratic society transplanted to a vast virgin land of undeveloped resources. While Europe was experiencing an age of enlightenment, intellectuals on this side of the Atlantic, like Benjamin Franklin, and political leaders like Thomas Jefferson and George Washington, encouraged forming philosophical and agricultural societies. The latter became the forerunners of the structural framework now provided by the federal government and the states for scientific research and education (1, p.2).

From their early beginnings, agricultural research and education were free from any guilt complex about their public nature. This is in contrast to private institutions of higher learning. The latter, proud of their traditional freedom from governmental authority, interpreted the two to be identical. Some resisted incorporation in the belief that this would make them public institutions and subject to government control. The founders of the land-grant colleges were well aware of the problem, namely to create a framework for combining responsibility with authority without destroying academic freedom.

This is revealed clearly in the writings of Jonathan Baldwin Turner of Illinois. He was the professor from down-state Illinois who obtained Abraham Lincoln's pledge to sign the land-grant legislation if he, Lincoln, became President. Lincoln did sign the measure on July 2, 1862. It had been reintroduced following Lincoln's election. Buchanan had vetoed an earlier draft in 1858 (4, p. 8). In each case the author was Senator Justin Smith Morrill of Vermont.

Son of a Vermont blacksmith, Senator Morrill was the product of our early democratic culture in New England. He himself wrote that existing colleges of his youth were "based upon the classic plan of teaching only those destined to pursue the so-called learned professions." His bill offered hope and opportunity to "those at the bottom of the ladder who want to climb up." A man of industry, integrity and dedication, Senator Morrill devoted his congressional career--12 years in the House of Representatives, 32 in the Senate--to creative service for his country. Not only was he the legislative father of the Land-Grant Act, but through his patience, tact and political skill brought about many other national improvements, including, for example, creation of the Library of Congress in Washington (3).

The philosophical changes in higher education, as brought about through passage of the Land-Grant Act, are ably discussed in COLLEGES FOR OUR LAND AND TIME, by Edward Danforth Eddy, Jr. For 200 years the curriculum of higher education was restricted and narrow, consisting chiefly of "philosophy, theology, dead languages, and mathematics." As late as 1850, not a single college had a laboratory or anything like a laboratory in its physical plant (4, p. 4). The Land-

Grant College Act changed all this, for it led to acceptance of the principle that a university should put emphasis on seeking knowledge, as well as teaching it.

Full realization of this principle did not come about until passage of the Hatch Experiment Station Act of 1887. It extended the Land-Grant Act so an agency and needed facilities could be provided whereby the colleges chartered under the Land-Grant Act could engage in scientific research and experimentation.

During the period 1880 to 1910, directors of the agricultural experiment stations, organized as divisions of the land-grant colleges, were confronted by a hard fact. In response to popular demand from farmers, more and more time of scientific personnel went into providing rural demonstrations. The tradition of the American experiment station movement had been that public funds appropriated for research were for scientific investigation and for no other purpose. If the quest for new scientific knowledge was to bring permanent and basic benefit to agriculture, this was the only interpretation to be given. The stations, therefore, threw their full support behind the extension movement, already popular in the states, but until 1914 not supported by the federal government. Passage of the Smith-Lever Act in 1914 provided annual support for agricultural extension work. Under it, programs are developed under which qualified personnel help farmers turn research findings into practice (1, pp. 114-116).

PURPOSE OF MORRILL ACT

The purposes of Senator Morrill's bill are given in greater detail in Dr. Eddy's book. Summarized briefly, they proposed conservation of public lands rapidly disappearing through private speculation. He was greatly concerned about soil deterioration and waste of resources due to haphazard practices. In different states, agriculture was confronted by problems arising from considerable variation in topography, climate, and distances to market. Lack of adequate agricultural education and training to meet this wide variety of conditions blocked progress. The country needed higher education and training of those who could help advance the art of tillage to bring about better farming. Some states were unable to provide it without federal aid. Many benefits had accrued in Europe from agricultural and industrial schools, an idea not yet accepted in this country. As a forward-looking and practical statesman, Morrill saw that technology meant increased production and that increased national production meant world prestige. He wanted our ships laden with grain to continue outward bound (4, pp. 28-30).

MAJOR PROVISIONS OF THE ACT

Under the Act as passed each state became entitled to 30,000 acres for each Senator and Representative in Congress to which each state became entitled by the apportionment under the census of 1860. No known mineral lands were to be selected under this provision. Monies derived from the sale of lands were to be used for the "endowment, support, and maintenance of at least one college. . . to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life" (1, pp. 217-218). The Office of Education, U. S. Department of Health, Education and Welfare has published a 78-page booklet which records the dates when the legislatures of the various states accepted the provisions of the Land-Grant Act (5).

LEGAL FRAMEWORK FOR STATE-FEDERAL COOPERATION

The Land-Grant Act, signed by Lincoln on July 2, 1862, and the Act creating the Department of Agriculture, which he had signed on May 15, 1862, were destined to become the legal framework for state-federal cooperation in agricultural research. In the true sense of the word, however, state-federal cooperation did not come about until 1887, with passage of the Hatch Experiment Station Act of 1887, and the Act of February 9, 1889, raising the United States Department of Agriculture to cabinet rank.

The struggle was a long and earnest one. Many of the young professors who gave support and sponsorship to the land-grant college movement were not satisfied that their end objective had been reached. They wanted the colleges to be scientific institutions where knowledge was sought as well as taught. Soon after the end of the Civil War, there were attempts to establish a national organization of land-grant colleges.

The divergent views of the science and experimentation group on the one hand and the teachers' and college presidents' group on the other are discussed at length in Chapters V and VI of STATE AGRICULTURAL EXPERIMENT STATIONS (1, pp. 55-110). So are the differences of viewpoint between the state institutions and the Department of Agriculture leaders.

In the meantime, there were increasingly glowing reports of the success of scientific research on behalf of agriculture in Europe. Also, agricultural experiment stations were becoming popular in the United States. The first was begun at Middletown, Connecticut, in 1875. It was moved in 1877 to its present home in New Haven. In the next 10 years, state agricultural experiment stations were established in Alabama, California, Kentucky, Louisiana, Maine, Massachusetts, New Jersey, New York, North Carolina, Ohio, Tennessee, Vermont and Wisconsin. In addition, agricultural colleges in Colorado, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, Pennsylvania and South Carolina had also undertaken systematic experimentation (6, p. 133). But until the Hatch Act of 1887 was passed, no federal funds became available.

Numerous annual meetings of Department and land-grant college leaders did not come to a decisive point until 1885, when the new Commissioner of Agriculture, Norman Colman, invited delegates from the agricultural colleges and experiment stations to meet in Washington, D. C. The convention paved the way for organization of the American Association of Agricultural Colleges and Experiment Stations. The latter did not materialize until six months after passage of the Hatch Act. The Hatch Act authorized federal funds for establishing and maintaining agricultural experiment stations in each state.

By the terms of the Act and subsequent legislation, the states are required to provide matching funds on a formula basis; also to furnish physical plant facilities such as buildings, laboratories, and acreage for experimental purposes. Two points need to be kept in mind: (1) That the stations have, since the beginning, been bona fide state institutions--they continue as such; and, (2) although there is a high degree of cooperation between the Department of Agriculture and the state experiment stations, there is no effort on the part of the federal government to exercise direction or control.

"What was the significance of the Hatch Act," asked Dr. Russell Thackrey, Executive Secretary-Treasurer, National Association of State Universities and Land-Grant Colleges, in an address given on the 75th anniversary of the Missouri Agricultural Experiment Station, in April 1963. "Historically, this can be answered in many ways: (1) The usual way is to point to the greatly increased efficiency of American agriculture with the resulting abundance of food and fiber available to a rapidly increasing U. S. population at steadily decreasing costs in

terms of hours of work involved; (2) The establishment of research as a function of the American university, and thus the development-- in America-- of the true university as distinguished from the undergraduate teaching institution-- the transmitter of inherited knowledge, known as the college" (7).

FUNDS FROM THE FIRST MORRILL ACT

Nearly 17-1/2 million acres of land were involved under the Morrill Land Grant. The sum realized for establishing colleges was only \$7.5 million. It is reported that the income realized from the endowment for all states in 1963 was \$3,139,289. The sums appear small by comparison with today's costs. However, the contribution to the establishment of the system of higher education a hundred years ago was of tremendous importance. In 1963, the land-grant colleges received from all federal sources a total of \$771,808,102.

SECOND MORRILL ACT

Before considering the organization and administrative relationships for education, research and extension activities of the land-grant colleges, established under the First Morrill Act, it is important to pay additional tribute to Senator Morrill for his continuing efforts to provide funds for the further endowment of the land-grant colleges. From 1872 to 1890, there were only two years when he did not have before Congress proposals to provide additional support.

His efforts paid off with the approval of the Second Morrill Act in 1890. This legislation granted to existing colleges, or those to be organized under the First Morrill Act, an additional \$15,000 for each state, to be derived from the sale of public lands. The \$15,000 was to be increased by \$1,000 a year until the annual payment was \$25,000. Amounts specified under the Second Morrill Act have since been increased.

All of the states did not use monies received from the sale of land to establish new colleges. In the Midwest and South, 30 states established new agricultural and mechanical colleges. In 18 states, the money was given to existing state universities to establish new mechanical and agricultural departments. Five gave the money to private colleges.

ADMINISTRATION OF THE HATCH EXPERIMENT STATION ACT

The Secretary of Agriculture, under Section 7 of the Hatch Experiment Station Act, is charged with proper administration and is authorized to establish such rules and regulations as are necessary to carry out the provisions of the Act. The Secretary also has the duty to furnish advice and assistance, to take part in planning and coordination of research and to indicate the lines of research that to him seem most important. In addition, the Secretary assists in establishing cooperation among the states and between the states and the U. S. Department of Agriculture.

The Cooperative State Research Service, in representing the Secretary of Agriculture, carries out the following principal administrative functions:

1. Review and approval of all research proposals before Hatch Act funds can be expended.
2. Review annual programs of research giving fund assignments to continuing projects.
3. Review annual reports of research on each Hatch Act project.

4. Periodic review of research progress and associated research expenditures from Hatch fund at the state experiment stations.
5. Consult with experiment station directors and station scientists on research planning, coordination and administration.

ADMINISTRATION OF THE STATION IN THE STATES

Research at the state agricultural experiment stations is under the leadership and administration of an experiment station director. The director is responsible to the head of his institution and to its governing body within the state. He is not a federal employee. The station director is responsible for initiating and guiding the station research program, for maintaining a competent staff, for providing cooperative relationships for a productive research program and for giving satisfactory proof that Hatch fund expenditures have been made in accordance with the approved program of research.

TEACHING AND RESEARCH RELATIONSHIPS

The idea that increase in scientific knowledge could be stimulated through a combination of research and teaching was loudly debated in the formative years of the land-grant movement. In 1850, not a single college in the United States was equipped for laboratory teaching. By 1870, only six colleges taught chemistry and physics by the laboratory method. The breakthrough came with the establishment of agricultural experiment stations as departments of the land-grant colleges. Leadership in this movement was given by chemists on the basis of experiences they had gained studying in European universities. They became prominently identified with the early land-grant colleges. Their dedication to science gained popular support and brought passage of the Hatch Experiment Station Act in 1887 (11, p. 137).

At the Land-Grant Centennial Meeting in November 1961, the late President Elvehjem of the University of Wisconsin said: "It seems clear that the land-grant institutions have been extraordinarily successful in graduate work. Why they have been so is not so obvious. Generally it is conceded that emphasis they have given to research is fundamental to their leadership. For graduate teaching is research, and research was given greater emphasis by the establishment of the agricultural experiment stations, which formalized and recognized research in our institutions for more than three-quarters of a century" (12, p. 190).

STATE EXPERIMENT STATIONS AND THE DEVELOPMENT OF SCIENTISTS

Reference has been made to the close association between research and teaching at the graduate level. Considering only the Hatch research funds, experiment station staff members have 2,300 graduate students currently associated with them in doing research as a part of their graduate training. Based on a total experiment station scientific staff for the nation of about 9,500 scientists engaged in full or part-time research, there are associated with them in conducting research as a part of their graduate training about 8,000 graduate students. The continued development of this supply of scientific manpower, I feel, is one of the major reasons for the success story in agriculture. In addition, because of the basic nature of the training in agricultural sciences, the scientists with advanced degrees find employment in scientific areas other than agriculture and contribute to the total advancement of science.

FEDERAL FUNDS TO ESTABLISH AND SUPPORT
STATES AGRICULTURAL EXPERIMENT STATIONS

The original Hatch Act of 1887 to establish and support agricultural experiment stations in connection with the land-grant colleges provided \$15,000 to each state for this purpose. Congressional acts in 1906 and 1926 increased total federal assistance to each state to \$90,000. Beginning in 1935, federal assistance was allotted on a formula basis, on the proportion of the rural and total population of the state to the total rural and total population of all the states. Also, federal assistance to the individual states required that the federal fund be matched by funds made available for agricultural research by the state.

New legislation in 1946, providing additional support, authorized the use of not more than 25 percent of sums appropriated for any fiscal year to be allotted for cooperative regional research. The legislation of 1946 also required that 20 per cent of new appropriations be used for marketing research.

Members of Congress and experiment station directors actively supported the regional research concept to accomplish improved research planning, coordination and avoid unnecessary duplication in research. Regional research funds can only be used for cooperative regional research recommended by a committee of nine persons, elected by and representing the directors of the state agricultural experiment stations and approved by the Secretary of Agriculture.

Section d(5) of Senator Pell's legislation provides for encouraging and facilitating the expansion, development or creation of regional centers of excellence in various fields related to marine science.

Experience with the cooperative regional research approach in agriculture merits your careful consideration in developing plans for a coordinated approach. The regional approach makes it possible to concentrate funds and facilities at a location that can unite several educational institutions in a common geographic region to contribute to progress on a problem rather than have a program so widely dispersed that it is not possible to provide staff or equipment adequate to accomplish the needed research and desired training for increased competence in marine science.

CONGRESS RESTATES CONCEPT OF EXPERIMENT STATION RESEARCH

Congress responded in 1955 to the requests of the Department of Agriculture and the state experiment stations to consolidate the several acts authorizing federal fund assistance to the experiment stations. A basic objective of consolidated legislation was to improve research administration. The broad concept of agricultural research stated in the amended Hatch Act of 1955 is as follows:

"It shall be the object and duty of the state agricultural experiment stations through the expenditure of the appropriations hereinafter authorized to conduct original and other researches, investigations, and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the United States, including researches basic to the problems of agriculture in its broadest aspects, and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contribution by agriculture to the welfare of the consumer. . ." (1, p. 233).

For the fiscal year 1965 the Hatch Act institutional grants to the experiment stations provided \$36,729,000 in formula funds and \$10,200,000 for

regional research. The experiment stations also receive about 11 million in research contracts from USDA agencies, 24 million in research grants from other federal agencies and about 140 million from state sources, for a total of 222 million dollars.

COMPARATIVE EVALUATION BY UNIVERSITIES OF FEDERAL ADMINISTRATION OF RESEARCH GRANTS AND CONTRACTS

The Select Committee on Government Research of the House of Representatives, 88th Congress, Second Session, in Study Number 1, reported on "Grantees Rate the Grantors." Colleges and universities receiving a questionnaire from the committee were asked to express level of satisfaction for the departments and agencies with which they had contact. The levels were: (1) excellent; (2) reasonable; and, (3) difficult. The universities also were requested to give a grading in the following five areas: (A) administrative red tape; (B) reporting requirements; (C) budget details and negotiations; (D) length of decision making; and, (E) fairness of selection process.

The summary of replies gives cause for some boasting by the agency that I represent. The Cooperative State Research Service system of federal research fund administration received the highest level of satisfaction on the factors indicated above.

IMPACT OF LAND-GRANT COLLEGE PROGRAMS ON NATIONAL ECONOMY

Several publications using somewhat different approaches have been prepared on the returns from agricultural research supported with public funds (8, pp. 40-45). Fortunately, the request of your program committee only suggested that I "touch" on the effect of land-grant programs on the national economy.

Beyond the measures of economic significance, I feel that Dean Spilhaus has captured the broader concept in his statement on "The Idea," in the conference program statement. May I repeat, "Establishment of the land-grant college was one of the best investments this nation ever made." It seems reasonable to assume that Dean Spilhaus had more in mind than measurable return on the dollars invested. Evaluation needs to include the educational system that evolved and the contributions made to the progressive development of our country from all programs of the land-grant system.

ESTIMATE OF CONTRIBUTIONS FROM AGRICULTURAL RESEARCH TO ECONOMIC GROWTH

The release of workers from agriculture, combined with abundant supplies of food and fiber for use at home and for foreign trade, provided the base for the industrial and economic growth in the United States. If output per man-hour in farming had remained the same as in 1920, today's farm output would need a labor input nearly 4-1/2 times that used in 1963 when 6-1/2 million workers were employed in agriculture. Nonagricultural employment increased by over 36 million in this period of time. Even though agricultural employment now comprises about seven percent of total employment, agriculture's contributions to economic growth are significant and will continue to be so in the future.

About one-fifth more total resources would have been required to produce the 1963 farm output if farmers had used the production techniques of only a decade earlier. At cost levels in 1963, these additional resources would be worth about \$8 billion annually. If we also assume technology in the processing and marketing of farm products at the 1953 level, handling the expanded volume

of products in 1963 would have required added resources of around \$5 billion annually. Therefore, the total savings in resources amounted to approximately \$13 billion in 1963. Once achieved, the economic gains from increased efficiency continue to benefit consumers each year. Research-based increases in efficiency of producing, processing, and marketing of farm products, accumulated for the last 10 years, represent savings to the nation of around \$70 billion worth of labor, capital, and other resources. Additional efficiencies arising from new technology will make these savings even greater in future years.

Exports of food and fiber products are of utmost importance to American agriculture and to the American economy. One out of four acres of cropland in this country today is producing for export. Agricultural exports, running to an all-time high this year of \$6.3 billion, account for more than a fourth of the nation's total earnings from the sale of merchandise abroad. This record volume of farm exports has become an important contributor to domestic economic activity as well as an aid in meeting our foreign commitments and foreign policy objectives.

LAND AND SEA

When one considers the low correlation between the location of the world's areas of population concentration and the areas of productive soil a complex problem is presented. In a paper entitled Food from the Sea, presented October 19, 1965 at the annual meeting of the Agricultural Research Institute, National Academy of Sciences, Dr. Chapman considered the great potential of the sea as a source of food. In his paper, Dr. Chapman indicated that much of this food resource is lost at the present time. With adequate knowledge the resource of food from the sea can do much to erase hunger from the earth (9).

The objective of providing an adequate food supply for all of the peoples of the world brings the analogy of the land-grant and the sea-grant college into close association. The research, educational and developmental tasks required will need a crew representing competence in many disciplines.

FEDERAL FUNDS FOR RESEARCH AND GOALS OF HIGHER EDUCATION

The increase in federal funds available for research by universities since the Second World War has received the attention of both educators and government science administrators. The concentration of funds at a limited number of institutions in relation to the possible effects on teaching and research at smaller institutions continues to receive attention.

In hearings before a subcommittee of the House Committee on Government Operations held on June 14, 15 and 17, 1965, "Conflicts Between Federal Research Programs and the Nation's Goals for Higher Education" were reviewed (10, pp. 51-202).

Award of research grants on excellence criteria is discussed in relation to the more adequate use and development of research and teaching talent at smaller institutions. The smaller college without an established reputation in science, or with inadequate scientific equipment is usually at a disadvantage for developing a close relationship between teaching and research.

A federal research funding arrangement (institutional grant) that will give the university greater opportunity for developing desirable teaching and research assignments is considered. It is suggested that if up to 25 per cent of the federal research funds at a university could be institutional grants, the universities would have greater flexibility in more effectively meeting problems of research and teaching assignments.

The record of productive research and high quality graduate training by experiment station scientists gives support to the institutional grant concept. Under the Hatch program, the experiment station director has the responsibility for making the decision on distribution of time between research and teaching. Research assignments are reviewed periodically to determine progress being made.

STRENGTHENING EDUCATIONAL INSTITUTIONS BY WIDER USE OF FEDERAL FUNDS FOR RESEARCH

The hearings referred to above placed special emphasis on the need for federal granting agencies, in accomplishing their missions, to consider strengthening the academic institutions of the nation.

On September 14, 1965, President Johnson issued a new policy statement on the use of federal research funds to aid in strengthening educational institutions while performing research relative to the mission of the agency. The President stated:

"The purpose of the new policy statement I am issuing today is to insure that our programs for federal support of research in colleges and universities contribute more to the long run strengthening of the universities and colleges so that these institutions can best serve the nation in the years ahead."

The President particularly mentioned the concentration of funds in "too few institutions in too few areas of the country" and the need for providing support "under terms which give the university and the investigator wider scope for inquiry, as contrasted with highly specific, narrowly defined projects."

SUMMARY

1. By means of historical review special emphasis has been given to the federal government (USDA) and land-grant college relationships in the administration of research supported by federal funds at the state agricultural experiment stations.

2. Through the cooperative development of administrative procedures the experiment stations have been concerned with problems of conflict in the use of Hatch Act funds, problems of relationships to the parent land-grant institutions and problems of inadequate research program planning and coordination among the states and between the states and the United States Department of Agriculture. Much progress has been made. The experiment station concept provides a pattern of cooperative activity that combines with local individualism and responsibility the benefits of centralized planning. The future offers even a greater potential for more effective programs of agricultural research through greater use by the state stations and the federal government of expanding opportunities for joint planning and cooperation in research.

3. The Hatch Experiment Station (institutional grant) Act has contributed in many ways to the development of research competence through the nation. Federal funds for agricultural research have stimulated the states to provide from state sources nearly \$4 for each federal dollar (based on an average of all the states.)

4. The interrelated discipline approach required in agricultural research has produced scientific strength at the land-grant colleges. The continuing challenge in agricultural science is to seek cooperation that will make it possible to determine the interaction of various sciences for progress on agricultural problems.

5. Hatch Act funds to the state experiment stations and state funds have provided the scientific base that has made it possible for the stations to contribute to federal agency missions. This has been possible through use of special grants that further the mission of the federal agency, when consistent with the goals of the stations.

6. Federal funds to the experiment stations have stimulated an increase in the amount of effort devoted to basic research. At the present time, about 35 percent of the resources available are devoted to basic research.

7. The system of federal administration that has evolved provides checks and balances through research project and program review and reporting in a systematic manner. Emphasis in review of proposed research and research in progress is an improved quality. Nearly a 20 percent annual turnover in Hatch research projects presents opportunity for maintaining a viable program. Currently, efforts are directed to a concentration of research efforts at the state stations to provide more adequate support for research of the highest priority.

8. The experiment station institutional grant under the Hatch Act authorization has been an effective procedure for progress in science and for the development of scientists through participation as graduate students under the supervision of station staff scientists.

9. Agricultural research has contributed to the economic development of the United States. Benefits extend to all the people of this country. In addition, the export of food and agricultural technology is contributing to the development of other nations.

10. The experiment station experience indicates there is a greater opportunity for increased research effectiveness by careful planning and coordination of research effort and attacking problems of regional significance through the joint effort of several states and the federal government at a limited number of locations.

11. Development of knowledge for effective use of the resources of the sea to contribute to the solution of problems of mankind represents a challenge that merits the cooperation of the Government and the universities to develop relationships that will result in greater progress.

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OUR STAKE IN THE SEA - PRESENT AND FUTURE

Milner B. Schaefer, Ph. D., University of Washington, 1950. Since 1962, he has been Professor of Oceanography and Director, Institute of Marine Resources, University of California. He is Chairman, National Academy of Sciences Committee on Oceanography. An educator, and scientist, he has also served the federal government as consultant and expert on areas in oceanography.

The explosive growth of the world's human population is well known. The present rate of growth, with a doubling time of about thirty years, cannot continue indefinitely. However, we may be quite certain that before the human population comes into balance, it will reach levels much above the present three and one-half billion. It is probable that the population will reach ten billion early in the next century. The population of the world, and of the United States, is not only increasing rapidly in numbers but is demanding increased standards of living attainable through the application of science, technology and industry. A population of ten billion people will demand an enormous supply of goods and services if it is to have a healthy and satisfying existence. The present rate of growth of the population and the increase in human welfare is already placing great strains on the resources of the land, and is pushing men everywhere to the sea to satisfy a portion of the needs. The march to the sea is manifested in many ways. All major maritime nations, and a good many others as well, are rapidly increasing their scientific endeavors to understand the sea and its contents, and their technical and engineering efforts to master the sea. The fishing fleets of the world are growing even more rapidly than the world's human population. The world's merchant marine is growing more rapidly than at any time in history, and is also evolving new types of shipping such as the giant super-tankers, automated vassels, and vessels designed for handling both bulk and packaged cargoes in more efficient ways. Unfortunately, the United States is far from being in the vanguard of these developments.

Production of petroleum and natural gas from beneath the sea on the continental shelves is booming; it is believed that perhaps 25% of the total petroleum reserves of the world lie in submarine areas. Other mineral deposits of the shelf-diamonds off South Africa, tin near Malaya, gold off Alaska, not to mention the ubiquitous but highly important sand and gravel for construction materials, are being mined from beneath the sea in increasing quantities. Other deposits, such as phosphorite nodules on the continental shelves and continental borderlands, and ferromanganese nodules which pave a large portion of the deep ocean will certainly come into production within the next decades.

Men are also learning how to live and work under the sea, and will shortly be able to occupy the sea bottom. Already Cousteau's aquanauts in the Mediterranean, and our aquanauts from Sea Lab II off California, have been able to live and work under the ambient pressure to depths of 300 feet, and it is almost certain that this limit will be soon extended to 1000 feet. With deep diving vehicles, and pressure protection for deeper habitations, men will certainly be able to operate, within the next decade, directly anywhere on the bottom of the ocean, and through the overlying waters.

The capability to occupy the ocean, and the growing importance of its resources, brings increasing pressure to bear on the system of legal jurisdiction and property rights which man has historically obtained. Considerable modification of the ancient system of laws was made at Geneva in 1958 through the four Conventions on the Law of the Sea. Two of these, in particular, the Convention on the Continental Shelf (which came into force in June 1964) and the Convention on Fishing and Conservation of the Living Resources of the High Seas (which requires but four more ratifications to come into force) went far beyond simple

codification of the existing law, and established vast new rights and duties. Under the Convention on the Continental Shelf, nations acquired sovereign jurisdiction to the natural resources of the seabed and sub-soil of the submarine areas adjacent to the coast, and outside the limit of the territorial sea, to a depth of 200 meters or beyond, to where the depths of the superjacent waters admits the exploitation of the natural resources of these areas. This Convention also established rules for delineating the boundaries between nations facing the same piece of continental shelf. It is most fortunate that this Convention came into force almost simultaneously with the discovery of submarine hydrocarbon deposits under the North Sea, thereby providing a basis for delineating the jurisdictions of the several nations surrounding it; otherwise, the resulting squabble would have been fearful to behold.

Under this same Convention, the United States has acquired sovereignty over 850,000 square miles of adjacent sea bottom. This wet real estate adds about 25% to our territory. This has further stimulated interest in finding out just what this damp domain is good for -- what is there and how it may be used. It has also raised the question of how far out along the bottom of the deep sea we may consider the exploitable sea bed to be yet "adjacent" to the coast. The matter of the ownership of the sea bottom remote from the shelf was purposely left open at the Geneva Conference, because the needs and capabilities of men as they develop in this region must be the guide to the further progressive development of the law.

The Convention on Fishing and Conservation of the Living Resources of the High Seas establishes an elaborate and useful set of rules for the exploitation of the fisheries, but leaves these resources in the status of common property of all men and all nations. It establishes a satisfactory framework for the use of these common property resources and their maintenance in such condition as to be capable of providing the maximum supply of food and other marine products. It makes no provision, however, for who harvests the fish. This must be resolved in open competition, under the rules of the Convention, and perhaps eventually by some subsidiary agreements among nations.

It is clear that in the major part of the watery realm, covering nearly three quarters of the planet, there will be increasing competition for the use of the resources. It is already abundantly clear that the inshore waters, the marginal sea, along the coast of the United States and elsewhere is becoming crowded. The coastal belt within 50 miles of the ocean is now occupied by 52 million people, 29% of our population, and contains a vast industrial and urban complex. The margin of the sea, its beach and shore, is used for a variety of purposes, including seaside recreation, ports and harbors, industrial sites, power plants, and waste disposal establishments. To accommodate all of these uses we must stretch the beaches, and properly allocate the various uses. Similarly, the adjacent waters are of tremendous importance for recreation, for transportation, for production of petroleum and minerals, as a source of fresh water on arid coasts, for cooling water for power plants, for disposal of domestic and industrial wastes, and for the production of animal protein from the sea. It is only in bays, estuaries, and along the margin of the sea that fish farming is likely to be practicable in the foreseeable future, because it is only here that one can raise sedentary organisms or fence in non-sedentary ones, and can effectively modify the environment at any acceptable cost. This multiplicity of alternative, and sometimes conflicting, uses demands the highest degree of sophistication in the application of science, engineering, economics, sociology, law, politics, and diplomacy, if we are to develop the necessary new institutional arrangements for the fullest and most beneficial use of this region.

SOME IMPORTANT RESOURCES

The resources of the sea include not only what we take out of it, the extractive resources, but all of the ways in which we use the sea. The extractive re-

sources include the living organisms, which support the fisheries, petroleum, minerals, and water. Important nonextractive uses include transportation, recreation, waste disposal, and power. Direct extraction of power from the sea, such as by tidal power or by generation of electricity from thermal differences, is of importance in only a few localities, and is not likely to provide any large share of the total power requirement of the human population, but the use of the sea for cooling water for nuclear power reactors is of rather considerable importance.

It has been pointed out many times that the atmosphere and the upper ocean form a single physical system the operation of which determines the weather and climate. The key to extended weather forecasting lies in the understanding of the actions and interactions of this system. Similarly, through understanding of the system there may be a future possibility for the modification of weather and climate. We may hope to learn how to control hurricanes, or prevent their generation, and to modify the natural distribution of rainfall, for example. Both of these are presently well beyond our capabilities, but their importance to human affairs is so large that we cannot ignore them.

I shall not attempt here to review in detail the extent of the present uses and future potential of all of these various resources of the sea. They have all been examined in some detail by the National Academy of Sciences' Committee on Oceanography in a recent publication on "Economic Benefits from Oceanographic Research." That report considered primarily the direct economic benefits to the United States from the utilization of the resources of the sea. It touched only lightly, however, on the uses of the sea for satisfying the needs of the rest of the world, simply pointing out the ways in which the pursuit of studies of the ocean and its contents could be accelerated to the mutual benefit of the United States and other nations through international cooperation, and the value of international cooperation to the long-term objectives of our nation. It must be noted that some, at least, of the resources of the sea which provide important opportunities to the United States are vital necessities to some other nations. For example, animal protein from the ocean is of importance to the nutrition of people in the United States, but it is a vital necessity to such countries as Norway, Japan, India, or the Philippines, which cannot possibly produce on their land the quantity of animal protein required for the adequate nutrition of their people. We may also note that transportation of heavy and bulky cargoes by sea is indispensable to the industrial development of most nations.

STRATEGIC IMPORTANCE

The more extensive and intensive use of the resources of the world ocean by more and more people presents great new opportunities to the United States, and also must inevitably bring new conflicts, and new dimensions to old conflicts, among the nations. The strategic position of the United States can be profoundly affected by the coming intensive development of this new frontier.

One obvious element of United States strategy is to secure for its people a legitimate share of the resources of the high seas and of the underlying sea bed. I have already noted that the international law is proceeding toward the establishment of property rights of one sort or another in these resources. It may be that it would be of the greatest advantage to the United States and to other nations to vest the ownership of these resources in the United Nations or some other international agency, as has been suggested. It also may be that this solution would be most unwise, and that other arrangements among nations for the allocation of the uses of the resources would be superior. We may, in any case, be sure that the nation which has the most knowledge of the ocean and its resources, and is in the forefront of the actual use thereof, will be in the best position to control its own destiny.

Traditionally, the strategy of the United States with respect to the high seas has been mainly concerned with the freedom of our maritime commerce and the operation of our naval fleets. For purposes of defense the United States must maintain control of vast portions of the sea. It must be able to use this broad highway to other lands, and to interdict hostile craft from those portions of the sea adjacent to the United States or adjacent to other nations for whose defense we carry the responsibility. Because of the importance to our commerce and our defense, the United States has always been willing to maintain the necessary control of the sea by military action if necessary.

This still applies, and will continue to apply. However, in the modern world, the direct application of military force is becoming more and more difficult and less and less fruitful. Control of the sea by other means is of increasingly greater importance. Other than military force, the important element of control of the sea is its use. The main ways in which nations have used the high seas in the past are for marine transportation and for fisheries. The existence of large merchant fleets and distant water fishing fleets flying a nation's flag has been an important element of its sea power. This is still the case. Unfortunately, our merchant fleet dwindles and our fishing fleets are decadent, while the fleets of other nations, including the Soviet, flourish. Merchant vessels and fishing vessels of the Soviet are based near an uncomfortably large share of the strategically important straits and passages connecting the different parts of the World Ocean. It would seem important to reverse this trend. A program of vigorous expansion of our commercial and fishing fleets, which should be capable of accomplishment through the application of our superior technology, seems appropriate. Likewise, the exploitation of other resources of the high seas, and most particularly the minerals of the sea bottom, will be an important element of the use of the sea whereby we maintain a modicum of control. The ultimate element of peaceful control is, of course, occupation. The nation whose people actually live on, and continuously draw their sustenance from, an area of this planet usually winds up controlling or owning this area, while the non-resident exploiter cannot stand up against these people. For example, the Spanish Crown could not hold its New World claims, because they were essentially based on the extraction and export of treasure, rather than full occupation and use. Similarly, the cattlemen could not hold the open range of our Great Plains against the settlers who occupied and farmed it. Who first learns to live in and occupy portions of the sea will have the highest probability of controlling them. We should, therefore, push vigorously toward this capability.

THE NEED FOR THE COLLEGE OF THE SEA

Fulfillment of our destiny in the ocean requires a great deal more than the application of science and technology. This strange and unfamiliar milieu, the sea, presents problems of economics, sociology, law and philosophy to which old solutions and old traditions imperfectly apply. New institutions, and new ways of thought, require development. Our entry into this new realm requires the integration of many disciplines in both the sciences and humanities. We need to have scholars working closely together in the hard sciences such as physics, chemistry, biology, and mathematics; in the soft sciences, such as sociology and economics; in engineering; in law; and others. There is an obvious need for the college of the sea to bring together men of all these disciplines to carry out their scholarly pursuits, research and education in relation to the ocean. The question is, how can this be accomplished? Some attempts are being made to accommodate this need by the establishment of institutes in which faculty and research members of different departments of a large university can work together on the problems of the ocean. For example, my own Institute of Marine Resources of the University of California is a university-wide institute established to be a focal point for the interest and action of men in different departments, and from the various campuses, who are concerned with marine resources, to foster

research and education, and similar functions. Dean Knauss here at Rhode Island is in the process of developing a similar interdisciplinary approach to the ocean. This sort of arrangement has the advantage of drawing on the large potential of existing strong departments in the various disciplines. On the other hand, it lacks the cohesiveness that a separate college devoted to the sea might attain. Whatever way the problem is approached, we must not lose sight of the importance of education, research, and scholarship as an indivisible whole. It is also important, I believe, that at this level of education and research men have a solid foundation in the fundamental disciplines before specializing in their application to the ocean. The college of the sea needs, therefore, like a college of medicine to operate primarily at the graduate level.

OTHER NEEDS

The foregoing concepts of the college of the sea, or of the ocean institute within the university, are possible means of filling the requirements for university level education, research, and scholarship. However, society has additional demands. There need to be trained skilled technicians. There also needs to be provided continuing education, beyond the formal educational period, of both professional people and sub-professional people. Finally, it is extremely important to establish a satisfactory mechanism for transmitting new knowledge and understanding about the ocean to those who actually use the ocean, so that they can employ it productively. This applies to personnel in industries already using the ocean, such as the merchant marine, fisheries, or petroleum industries, and others which will be increasingly using the sea, such as the mining and construction industries. There is a need for aquacultural experiment stations and extension services.

These are important elements in the development of the uses of the ocean. In an earlier day, the satisfaction of similar requirements in relation to uses of the land were important functions of the Colleges of Agriculture and Mechanical Arts, and the agricultural extension services attached thereto. In recent years, however, the faculty of many colleges and universities have come to regard many of these functions as not being appropriate to the modern university. This is, I believe, particularly true of the training of technicians, and extension services. The question arises, therefore, whether these functions can be successfully carried out by the university, and if so, how? If not, what new sorts of institutions do we need? Perhaps, answers to these questions will be provided at this conference.

NEWEST FRONTIER: THE WORLD OCEAN

G. William Miller, L.L.B., University of California, 1952. Joining Textron, Incorporated in 1956, he rose to President in 1960, at the age of 35, of this major diversified manufacturing company operating more than 100 plants in 30 states and several foreign countries. Textron's corporate headquarters are in Providence, Rhode Island.

Twenty years ago, I graduated from the Coast Guard Academy in New London, receiving a degree in marine engineering. At that time we were a nation deeply involved in a great war. We were endeavoring to defend not only our nation but our free societies throughout the world. Almost five centuries ago Columbus made the most important sea voyage of all history. Between that time and the time that I graduated, the world was beset by enormous change. In the time between my graduation and the present there has been just as much change as took place in those five centuries. The characterization of our time indicates we are living in a time of accelerating change. For example, we have expended more for scientific research, since World War II, than was spent between Columbus' voyage and the war, so that the acceleration of effort has been really enormous.

This technological revolution has been going on very rapidly and has been changing our society at an accelerated pace. Now this is about to be supplanted and superimposed with demographic ways that will have tremendous impact. We're on the threshold of a population change that is unprecedented. This combination of technological development and population explosion will certainly have enormous impact over the next one hundred years. There are some people who are rather gloomy about this future. They predict the results are going to be very disastrous and we are going to have vast dislocations. They predict increasing unemployment, and our available resources of food and shelter will be exhausted. It is a very gloomy prospect. The forecasters of this doom are seeing disaster for the whole world.

I don't share their views.

In our dynamic age this challenge is going to be met by the people who have the vision, the imagination and determination to change scientific knowledge into useful effort to overcome the dangers to humanity. The concept of the sea-grant university is an example. Thoughtful people have responded to the needs of our society, trying to plant the seeds that will blossom into real advantage and beneficial use of resources for centuries to come. The world ocean, after all, is our greatest resource. The sea-grant university certainly is a foundation to insure that this resource is developed for the good of everyone. The key to meeting the challenge of technological change and demographic explosion is people. That is the human element of the whole resource equation. The solution is with people of vision, people with knowledge, and the determination to do that which must be done. This describes the people attending this conference.

We have urgent needs in this field, particularly dealing with national defense. We need to be able to see, identify, and locate vehicles in the water, just as precisely as we can locate objects in the air with radar and reconnaissance satellites. We need to have systems that are far more accurate, more powerful and more effective than anything we now have if we're to secure our shores from hostile activity. At the same time, we must not be shortsighted. Our needs, while urgent in the field of national security, are far more important in the longer term needs to develop the wealth of the sea. The explorers that came to the new world, originally, were seeking treasure. The wealth they sought, the windfall of picking up gold from the streets was indeed a very tarnished concept and turned out to be nothing but fool's gold. Their greatest legacy to all of us was

to uncover a haven for the oppressed and that's what America is today. Surrounding oceans have influenced America for many centuries and have allowed this country to be a fertile ground for breeding a free society, for letting it grow to its strength and its maturity. As we think of exploring the great untapped world of water, we should remember that lesson. If we seek to go out and pick up treasures to enrich ourselves then we shall fail the real concept. We can develop the ocean resources only through knowledge. Here is where the whole concept of the sea-grant university is so meaningful, timely and important. It is only with knowledge that we can reduce these resources to useful material, energy, and food, for the people of the world. You know the techniques. You are the scientists who know the equations and know how much more knowledge we need to make them more effective. We need you to give us the criteria for translating scientific knowledge into application. Business can provide the organization for applying this knowledge to the useful development of these resources.

It is rather interesting that the whole modern corporation had its origin in the aspiration of the new world. In the need to combine human resources and capital to develop the new areas of the world that were being found by the explorers, came the company acts, the charters of companies that could have perpetual life. They could live beyond individuals and could accumulate the investments of many, many people. They could organize these corporations to develop the resources and build the colonies that became the real strength of the new world. Out of that new need to organize resources, came the most efficient economic operating unit that exists anywhere in the world--the American private corporation. When the United States is confronted with the need to develop hardware, to develop know-how, to develop techniques for exploring space, it turns to American industry. However, these corporations never will be able to provide what the universities can provide. Universities are the feeding ground of the knowledge and the people who become the basic resource. American industry will be ready to take the knowledge you gain and develop those resources in a highly efficient way. This whole endeavor, will of course, need to be a partnership. The government will certainly play a role because the problem is so large and will require the seed money you are seeking in the sea-grant university concept. It certainly will make the educational institutions do their utmost to provide the highest level of accomplishment, the highest level of excellence in thought and preparation, and it will need American industry to translate these things into a final useful product. It's very encouraging because the world oceans offer far more opportunity than outer space in the next hundred years for developing useful resources to meet the needs of the technological and demographic changes.

I hope from this conference we can do more than talk and compare notes and listen to very learned speakers. I hope we will do something far more concrete. We should go home, each of us, and organize support for the sea-grant university. Here tonight are people who can reach sixty or seventy senators and hundreds of congressmen in their respective states. If you can communicate to them the need, urgency and importance of this concept, then you will have gained from this conference a landmark for a sea-grant university.

In closing, may I remind you that the sea yields to knowledge. When you bring it to yield to you, may you bring it to yield for the good of humanity and for no selfish purpose.

SEA-GRANT UNIVERSITIES: THE POSSIBILITIES
AND COMPLICATIONS FROM THE UNIVERSITY'S
POINT OF VIEW
(A Panel Discussion)

Emery N. Castle, Ph.D., Iowa State University, 1952. He became Dean of Faculty at Oregon State University in 1965, having been a professor in the Department of Agricultural Economics for twelve years. He is a consultant to the U.S. Departments of Agriculture, Interior, and Defense.

In his correspondence with the panel members, Dean Knauss raised a number of provocative questions about the possibilities of sea-grant universities. To do all of his questions justice would require more time than any one panel member should appropriately use. I have chosen to focus directly on a small number of issues. Because my background is largely in economics, water resources, and agriculture, those questions have been chosen which will permit me to draw upon this prior experience.

The Relevance of Existing Institutions

Perhaps it is not surprising that a university representative would conclude that existing universities are adapted to developing work in the marine sciences. Regardless of the internal structure decided upon, all of the resources needed for marine science research and education can be found only in the universities. The disadvantages of attempting to build a new institution would appear to be far greater than the advantages of drawing on existing universities.

The reasons for this can be illustrated by the School of Agriculture at Oregon State University. In this School one finds the usual agricultural production departments. In addition the School has discovered there is much work elsewhere in the University that is of great value in Agriculture. As a consequence, such departments as Botany and Plant Pathology, Microbiology, Zoology, Statistics, and Entomology do a very significant part of the research of the Agricultural Experiment Station to say nothing of the contribution they make in the training of students in the School of Agriculture. Similar kinds of relationships also exist with certain social sciences as well as engineering. The specific organization arrangement to permit this is not so important if this kind of strength is built into the marine sciences program. At Oregon State, the five departments mentioned above are a part of the Agricultural Experiment Station for research purposes but are responsible to the School of Science in instructional work. Several factors will influence the specific organizational plan in a particular institution. Among these will be: (1) tradition; (2) the magnitude of the program in the marine sciences; and, (3) the kind of program underway in the various root disciplines. We have emphasized strong departmental units but we move freely across departmental lines in bringing people together for purposes that do not coincide with departmental boundaries. For example, our Water Resources Research Institute is entirely a coordinating unit; it has no research of its own.

A School, College, or Department of Marine Sciences would be consistent with our experience at Oregon State. We would hope, however, that such a unit would not feel it would have to be completely self-sufficient for all purposes. The mistakes that have been made in Schools of Agriculture and Home Economics have been, in my judgment, mistakes associated with too great an emphasis on

self-sufficiency and too much isolation. I believe this generalization holds not only for Oregon State but for most of the land-grant universities with which I am familiar.

The Pattern of Support

In these days of large grants from NSF, NIH, and Office of Naval Research, it is easy to overlook the pattern of federal financing that has been in existence for a much longer period of time in support of the agricultural experiment stations. To describe the advantages of this program, permit me to use the words of President Eric Walker of Penn State University.¹ He said:

"The land-grant institutions have a wide degree of freedom in the use of these funds, since they are restricted only by the provisions of the Hatch Act of 1955, which pulled together most of the previous legislation relating to agricultural research. Programs supported by these funds are initiated by plans outlined within the institution by the directors of the experiment stations, and these directors are solely responsible for the administration and guidance of the research. The funds may be used for basic research, as in the case of biological science, or for applied research. The directors may--in fact, are encouraged to--pool their resources with other experiment stations in order to attack regional problems, and the funds may be used for research carried out in co-operation with support from 'other appropriate agencies and individuals.' These 'other' sources include not only industrial organizations and private individuals but also state governments. In fact, most of the federal funds must be matched, on a dollar-to-dollar basis, by 'non-federal' funds. The effect of this federal 'seed corn' is seen in the fact that the total expenditures at the agricultural experiment stations were about \$115 million in 1959, or more than three times the amount available through federal funds alone. This flexibility makes it possible for the experiment stations to accept industrial grants for applied research without upsetting the balance of the over-all program."

May I add that the above pattern of financing permits the development of a core group of faculty people with continuous and dependable financing. Such dependable financing could be supplemented with a system of project grants to provide incentive and permit rigorous evaluation of certain projects should this be desired. Reviews are conducted of the administration of Hatch Act funds but ideally these are reviews of programs primarily and projects secondarily.

Such dependable support has also been used for the work in extension or adult education. Time does not permit me to list all the advantages of integrated research and extension programs. These advantages are numerous, however, and similar to the United States Marines, apply to both the land and the sea. In my opinion, it would be a mistake to establish "sea-grant universities" without explicit provision for adult education or extension as a part of the total program.

Does Regionalism Apply?

There are numerous specific questions implicit in the rather large question posed by regionalism. The size of the sea-grant program in the marine

¹Walker, Eric Arthur, "Reorganization for Progress," Proceedings of the American Association of Land-Grant Colleges and State Universities, Nov. 13-16, 1960, Washington, D. C.

sciences, the pattern of financing, and local interest and support are all involved. The problem is too complex to treat adequately but, again, the experience with agricultural experiment stations may be of value.

There are two important factors which pull in opposite directions. First, too many of our agricultural experiment stations try to do too many things. The level of their support is such that their efforts are fragmented and it is not possible for them to have a significant total program. One certainly questions the establishment of a large number of marine science centers with inadequate financing for each. In this connection, the wisdom of the Office of Naval Research in supporting regional oceanography laboratories is appreciated. Given the present and currently anticipated level of support, far more significant work is likely to be done on this basis than if fragmented among 30 or 40 institutions. At the same time, 10 to 15 institutions are a sufficiently large number to preserve competition and to avoid stereotyped approaches to problems.

On the other side of the picture, there is the difficulty of establishing regional centers which can develop adequate local support. It may be difficult for a state which does not have a "sea-grant university" to bring itself to provide (say) matching funds for the use of a regional undertaking. Nevertheless, there are many hopeful examples of regional cooperation in a variety of fields.

Considerable thought should be given to developing arrangements which would permit the efficiencies of size to be captured and at the same time to accommodate the virtues of local participation and contribution. As indicated above, these are questions intimately related to the level of support which is projected and which Senator Pell has recognized.

Paul M. Fye, Ph.D., Columbia University, 1939. He has been Director, Woods Hole Oceanographic Institution since 1958 and President since 1961. He is a former professor, and for ten years was a research scientist and administrator for the U. S. Naval Ordnance Laboratory.

The committee for arrangements for this sea-grant college conference is highly complimented, I am sure, by this large attendance. I think that they are not only pleased, but astonished, by the numbers of us that have turned out to discuss this important subject. It is so large that, as someone mentioned out in the corridor, there must have been some idea that there was some federal money available.

I am reminded of the fact that the Encyclopedia Britannica states that the Land-Grant College Act was very disappointing in its financial return but highly rewarding in its educational return. No one can deny that the Land-Grant College Act did serve as a pump primer not only for the agricultural and mechanical arts, but also for engineering in general. Obviously, it is hoped that the sea-grant college idea might also serve as a trigger for a similar expansion and pump primer in the sciences and technology related to the ocean.

I was fortunate, summer before last, in being a member of a group of about a dozen oceanographers, together with a rather large group of engineers, with the assignment of seeing what could be done today in terms of the real conquest of the ocean. I wish there were time to tell you of some of the concepts and ideas that came out of that study, but this has been published and is available. The point I want to make is that it was apparent to all of us that the time was right not only for such a study, but also for beginning to accomplish some of the ideas which evolved. We looked hard at how one might go about the engineering

of laboratories on the continental shelf where man would be swimming in the waters while subject to ambient pressure, or laboratories in the ocean deeps where it would be necessary to have vehicles protecting them; where you would have work complexes of housing, laboratories, shops, and vehicle garages at any depth in the ocean. It did seem to all of us participating in this study that these things were now technically feasible, and that we had a largely untapped store of scientific and engineering knowledge based on the great variety of technical advances which have been made in so many fields in recent years. Moreover, it seemed to us that the time was right not only from a technical standpoint, but also from a standpoint of economic need and other needs. The sinking of the submarine THRESHER brought home to many of us working in this field some of the weaknesses that exist in our capability for working in the ocean. Our inability to recover any major portion of the THRESHER merely illustrates this.

I must remind you, however, that oceanography is a very young science. As sciences go, it is still in transition from being largely the province of the naturalist--when we went out on the ocean and made discoveries on every cruise and almost anyone could get a seamount named for his ship or an ocean canyon named for himself. It is only within the last decade that we have moved into the sphere of the experimental and theoretical scientist. For this reason it is clear to me that so far as sea-grant colleges are concerned, we must talk about a well integrated program; not one based simply on the advances that must come in engineering and technology, but a compounded program with continuing research and expansion of the things we are now doing in oceanography.

This was illustrated to me this part summer in a dive which I made in our little submarine ALVIN during its test program down in the Tongue of the Ocean. We had just completed an unmanned test dive to 7500 feet and the next dive was planned for testing out the equipment in shallow water to see what was still working after the big squeeze. I didn't expect to see much of anything that would be new or different, but much to my surprise, we saw a few things which to me were completely startling. Earlier this morning we heard about the necessity of fishing being transformed from the state of hunting to farming. If we're going to farm the ocean, we must be able to have fences which the fish will respect, so that when you sow your crop you can also go back and reap it. And the thing that struck me most forcibly about how well we must integrate our research studies with our engineering was that I saw a fence in the ocean on that dive in ALVIN. We didn't expect it--we didn't know about it.

As we went across the coral sandy reef close to New Providence Island, we crossed what might be considered a barren desert in the ocean; no plants, no fish, no animals, almost nothing of any kind. But suddenly at the edge of the coral reef we came into an area with a great profusion of fish, the likes of which I hadn't imagined existing in the ocean. We cruised along this reef for a couple of hours. Looking out the port window of the submarine, one could see fish in a great profusion of species, just as thick a concentration as you can imagine. Yet just across the width of the submarine--the six foot sphere--out the other window, there wasn't a single fish. For two hours, I observed an invisible fence in the ocean that was as sharp as you could possibly draw it. Only three giant angel fish crossed the boundary, and those only for about the extent of one meter.

Why was it there? How did nature create such a fence? Is it one we could reproduce to our own convenience? These questions require a lot of good science and studies of behavioral patterns, in biology and physical oceanography, and it's clear we must have such an understanding if technology is to be based upon it.

I'm happy to be here and do support your idea, Dean Knauss, of the sea-grant college. I believe that it will be necessary that the sea-grant college program be one of broad integration of many disciplines based both on good research programs and on good engineering programs.

William J. Hargis, Jr., Ph.D., Florida State University, 1954. He has been Director, Virginia Institute of Marine Science since 1959; Dean, School of Marine Science and Professor of Marine Science, College of William and Mary since 1961; and Chairman, Department of Marine Science and Professor of Marine Science, University of Virginia since 1963.

Mr. Moderator, ladies and gentlemen, I early registered objections to the sea-grant college-university concept. My objections were primarily directed against: (1) the possible establishment of new systems of colleges; and, (2) the dilution of legislative, executive and public support, and limited funds for oceanography. These objections were partially based upon two surveys, by Dr. L. E. Cronin, my counterpart at Chesapeake Biological Laboratory, Solomons, Maryland, and me, of interest and capability in marine science in the states along the Atlantic Coast, which have a sizeable number of marine research institutions. (I'm sure that like numbers exist on the other coasts). These surveys indicated that a great deal of inadequately supported but potentially strong marine capability exists. As a result, I came to the definite conclusion that what is needed is not more institutions but more support for extant institutions. It is also clear that more integrated large-scale efforts, and more cooperative efforts between basic and applied aspects of marine science are necessary to solve problems of marine resource uses.

It is now apparent that my original objections have been eliminated as the concept of the sea-grant university has evolved. I wish to point out that the concept of sea-grant colleges or universities has changed since first advanced by Dean Spilhaus. It is still changing under the pressures of activities of groups like this one, and through exchanges of opinions in the forum conducted at the ASLO-MTS meeting in Washington (at which time I was stepped on quite vigorously by the moderator). I'm encouraged, of course, that the idea has changed.

As Dean Spilhaus and Senator Pell have been careful to point out here, they are not talking about the establishment of new colleges and universities, but are interested in: (1) utilizing existing programs where possible and encouraging greater interaction between basic and applied aspects of marine science; (2) encouraging more ocean engineering; and, (3) encouraging what is especially important--more money for these aspects of marine science. Personally, I believe, along with them and with Virginia's own Lt. Maury, that marine science should serve society and that marine scientists have a strong obligation to assist the users of the marine environment. To this end, we in our own program at VIMS are attempting such projects as development of a managed estuary in which we hope to bring the tidal Rappahannock under experimental control. We have built a hydraulic model of the tidal James for applied as well as basic studies of the structure and dynamics of that estuary, and we are attempting to establish a demonstration unit, so I'm fully in accord with the applied aspects of this sea-grant college notion with the effort at integrating basic and applied research and marine engineering and marine science. With these things as a background, I must say that I am now a strong supporter of the sea-grant college program. It is a good concept as it has developed and should be strongly supported.

Now I wish to mention several points around which controversy is certain to develop. There are practical problems involved in this program, some of which have been mentioned by Dean Castle and other panelists. One of the problems is going to be the practical matter of selection of those institutions to become part of the sea-grant system. Greater difficulties will be involved in selecting regional centers of excellence from among the sea-grant colleges. It is obvious that all interested institutions cannot become sea-grant colleges or universities. It is also obvious that still fewer can become the regional centers of excellence envisioned by the program. Selection can be simplified and made

more realistic and equitable by establishing certain operational rules. Suggestions are:

1. Institutions that have shown no interest in marine science or in the sea-grant program to date should be eliminated.
2. Implementing legislation should be framed so that competent marine institutions are selected. It should not be inevitable that existing land-grant colleges have an edge merely because they are land-grant institutions. Many land-grant colleges have exhibited no interest or have no special capabilities in marine science. We don't want to set the mechanism so that the land-grant colleges are certain to become the sea-grant colleges regardless of the interests and capabilities of other public marine-oriented institutions.
3. The program should be further limited to institutions with ready access to the sea or the Great Lakes. I realize there are problems and I realize that I may get stepped on before the meeting is over, but I agree with Dr. Fye who pointed out that ready access to the marine environment (or to the Great Lakes, which by legislation have become marine environments) is an important asset that any participating institution should have. From a politically practical point of view, it would appear as though (now I am way out of my field) support for such a program with these limiting features would not be hard to secure because most of the people, and hence political power, in the country are located either in coastal or Great Lakes states, and support of legislators could be obtained by swapping. In other words, I doubt that there will be any serious problems posed by limiting this program to the Great Lakes and coastal states.

It is obvious that the magnitude of the problems of the sea and problems of developing techniques for utilization for marine resources are great. What is needed is more integrated activity between basic and applied science, more marine engineering and more adequate continuous institutional support. The proposed source of financing specified by Senator Pell's bill is good. However, for adequate financing of the program we need money that can be counted on in significant amounts for a long period of time. Is it possible that support from a portion of the federal lease taxes on mineral resources, as proposed by Senator Pell, could be augmented by regular allotment from the duties on fishery product imports? Inasmuch as both are marine resources there is ample justification for utilizing these funds for this purpose. Because of the general importance of marine resources to the nation, support from the regular budget is also justifiable.

To summarize, I wish to reiterate my strong support of the sea-grant college-university program as presented here and urge that all support it.

Francis H. Horn

Dean Knauss, ladies and gentlemen: I take it that everyone here is fully committed to a significant increase in attention to the marine sciences so that the question is how this can best be done. The analogy with the land-grant university is a brilliant one, it seems to me, and Dr. Spilhaus will, I hope, go down in history as one of the great benefactors of mankind for having fathered the idea, along with Senator Pell, as another, for having the judgment and the perspicacity to translate the vision of Dr. Spilhaus into political reality. But the

analogy has one major complication. This was raised on the floor of the meeting this morning and it has been dealt with already on the panel. That is, like the land-grant system, is there to be a sea-grant university in every one of the fifty states?

Senator Pell suggested, by implication, at least, that were there enough money available to accomplish it, there might well be a sea-grant university in each state. I'm inclined to think that this would not be desirable even if substantially greater funds were to be made available, as we all hope they will be. Conditions are different from what they were one hundred years ago when the Morrill Act was passed. I suspect that if we were establishing the land-grant system today, based primarily upon agriculture, the University of Rhode Island might appropriately be excluded. We haven't enough old-line agriculture left in the state to justify a College of Agriculture in the traditional sense. This is one of the reasons why our College of Agriculture, and I'm proud of its quality and its vision, is working so closely with our Graduate School of Oceanography, and also developing significant programs in the suburban and urban areas of the state, thus putting their expert knowledge and know-how to work for the benefit of all the people of Rhode Island and not just those in rural areas. In terms of the traditional role of colleges of agriculture, I think about one good one is all that the six New England states need.

Now, in place of the old attitude toward what is and what is not necessary in modern universities, we have increasingly worked toward inter-institutional and regional cooperation. Dean Castle has spoken a bit about this, and so has Dr. Hargis. In New England, we have the New England Board of Higher Education, with the Southern Regional Education Board and the Western Interstate Commission on Higher Education, as our predecessors. Let me take just one minute to tell you about a new venture in regional cooperation that we are engaged in. The University of New Hampshire has received a significant grant of over a million and a half dollars from the Kellogg Foundation to establish a regional program at a Regional Center in Continuing Education in cooperation with the other five state universities in New England and with the eventual expectation that private universities in the area which wish to participate will do so. And each of us has committed ourselves to spend a certain amount of money each year to support the program. Each of us will eventually have a building on the Center campus, if you will. We will have staff members there. In turn, people will be working out their projects on our campuses. Each of us has selected one particular area in which we will concentrate. This is the first time that I know of for regional cooperation of this nature, where six institutions agreed that in going after a major foundation grant, they would work together on behalf of one of their sister institutions, which they conceded had a first claim on it. So new things are taking place in terms of regional cooperation.

No one university can any longer aspire to do everything. The smaller ones especially must focus their attention on those areas of man's knowledge and activity for which they have special resources, background and tradition, opportunities, etc. This is why when I came to the University of Rhode Island I became convinced we should put special effort and support into the marine sciences. But I would consider it a mistake, let me suggest, if the federal government were to contemplate establishing or increasing support for colleges of forestry, to locate one in Rhode Island, even though we have quite a bit of woodland.

Consequently, I would have to argue that in establishing sea-grant universities we should not attempt to put one in every state. I doubt, for example, that it would make sense to establish a sea-grant university in South Dakota or New Mexico. I believe, therefore, that a few centers of excellence would be preferable, as Dr. Hargis has indicated. These should, I think, be near the sea or the Great Lakes, where substantial areas of shore property could be assigned to them. However, I would not exclude land-locked universities from participating

in research in the marine science. Grants should be made to them as funds for expansion of the program become available.

My second comment concerns the proposal in Senator Pell's legislation that the money come largely in grants for specific projects and proposals. The great strength of the land-grant movement was financial support of a generally unrestricted nature. Just as Dean Castle has quoted from one of my fellow land-grant presidents, Eric Walker, let me quote from another one, Paul Miller, president of the University of West Virginia, from a speech he made just a month or so ago before the Governors' Conference in Minneapolis, in which he spoke of "the drift in recent years to the agent-client method of providing financial support--a method which exchanges public resources for the performance of specified services. The technique has vastly improved the research experience in the American university and enlarged enormously the intellectual versatility of the country. The national welfare is much the better for it. All in all it is a movement which is gratefully acknowledged by academic men. However, its growth and current extensiveness forewarns us about its chief defect: asking for the return of services almost equal to what it gave initially in resources. Some unrewarding consequences are now identifiable, including the splintering of total effort in ways not always attuned to the aims of the university as a whole, the engendering of a national system of faculty rewards which blunts the historic idea of a community of scholars and the gradual hardening of research practice in a manner that is not always at home with spirited teaching."

So he recommended to the governors, in connection with their support, as well as to the federal government, "rather than the agent-client technique of developing specialized project agreements with individual staff members, a partnership in law [which] has existed between the U. S. Department of Agriculture and the universities." This arrangement, he stated, "has stressed broad institutional objectives for both of them in agricultural and rural life. The results produced by this partnership show as well as any other example how knowledge may be generated and then shared with the common culture when government and universities cooperatively perform their distinctive duties. Importantly, the institutional grant technique employed in the agricultural experience contrasted with direct exchanges of resources for services rendered, lasting pools of strength in the universities. Such is the hope of academic men for the future." And I would say that this is our hope, my hope, in terms of the sea-grant university concept.

One more comment. We at the University of Rhode Island were very gratified at the commendation of our program in the marine sciences by the speakers this morning. Mr. Chapman, in particular, stressed the developing interest of many departments in these areas. Both he and Dr. Spilhaus have also spoken of the necessity of activities comparable to those of the 4-H program, of county and demonstration agents, and so forth, that characterize the work of our cooperative extension services. But on any land-grant university campus, as you all know, there is often considerable opposition to such work by the faculty, especially those in the traditional academic fields. Even the aggie faculty is sometimes regarded by their colleagues rather condescendingly. If the sea-grant universities are established, they will be truly effective only if they are willing to get their hands, or rather their feet, dirty, so to speak, and to operate on the applied level characteristic of our agricultural program. This may well be a serious problem in implementing this concept.

My final comment concerns money. Ten million dollars won't begin to do the job, although I concur in Senator Pell's political astuteness in trying to be practical. After all, the total appropriation for the new Arts and Humanities Foundation, under Senator Pell's recent legislation, is expected to be only \$10,000,000 for the first year. But that's a new program and a new area of federal support. The Navy alone must be spending in the neighborhood of \$10,000,000 annually in support of oceanographic research and activity in the

universities. And well they might when a new aircraft carrier costs over \$400,000,000 and a new polaris submarine over \$100,000,000. As soon as possible, therefore, the per cent proposed by whatever legislation goes in, must be increased beyond Senator Pell's ten per cent. The total federal support of the marine sciences must be expanded substantially. Regardless of whether or not the sea-grant university becomes a reality, the federal government will certainly do this. But the money will, I believe, bring greater over-all benefits to this nation and to society in general if it is expended through the proposed sea-grant university with a deep and a sustained commitment to oceanography.

Athelstan F. Spilhaus

Well, I don't think you need to hear much more from me. I stated my case in my leadoff talk this morning. I think all I can do now is concur with a few remarks that others have made since. Dean Castle said, much better than I could, "let's emulate the land-grant college system but let's not repeat the mistakes we made on land." This is a good generalization. One thing that came out of the discussion is that the federal government and many of us are worried about the organization of oceanography in the government. And I feel that the very necessity of the government paying attention to what Dr. Horn emphasized, the sustained support by institutional grants of these committed sea-grant colleges, will force a better organization in government. I was visited recently by representatives of the committee on appropriations. And while these were excellent and intelligent men, I think that their questions were highly directed. It seemed to me that they wanted me to criticize the past organization of oceanography in government. I do not admit that the Interagency Committee on Oceanography was a failure. In Robert, the ICO had a secretary that was Abel! I think ICO and all the things that are being tried in government organizations are sincere and good efforts and are steps toward better organization in the future. I was visited here by a friend who asked me if I would help him write a paper on the mismanagement of oceanography in the government. I couldn't possibly do this. This would be foreign to my nature. I will say there are things we can improve, but I would state them up positively. How can we improve our management of oceanography? Not by knocking those who are attempting to do it as best we collectively know how, but by searching with them for better ways. I despair of negativity. Let's stick our necks out in the great new social adventure that we are proposing in the sea-grant universities and colleges, and by doing imaginative things a better organization will evolve.

I'm a little bit disturbed that we're worried about the smallness of the sum of money we see as immediately available. I agree with Senator Pell we've got to start small and let the idea grow. Let's not look at the pork barrel before we even get the idea off the ground. I don't think it is important who gets the first little grants that we can afford, and I don't think we should allow it to destroy the birth of the idea and its infancy.

If the idea is good at all, it's good enough for everybody, and as to those states that do not border on the sea or the Great Lakes, they have an equally important water problem--a problem which, incidentally, is funded far better than the proposed funding of the sea-grant colleges--that is the problem of the reuse of our fresh water, of the proper management of our fresh water. If they take this as their job in the water business, we can join with them and give real meaning to the term "fresh-water colleges!" There is no reason why, let us say, a land-locked state like Oklahoma which has its natural inclination toward oil should not participate in certain aspects of the sea-grant concept. It might, for example, focus its attention on the special problems of getting oil from the

sea, extend the state's own existing interest into the sea. I agree completely with President Horn that we must not go into this new concept with funds restricted to a project basis. We must have unrestricted institutional funds so that people can wander around, have an idea and follow it wherever it takes them and not put blinders on them. The best things I've ever gotten out of libraries is when I've gone in knowing exactly what I wanted to look for, but then found on the stacks that the book next door was much more interesting and led me off on a tangent which resulted in a far more fruitful investigation than the one I started on. A certain amount of this kind of randomness is the essential to creativity.

FOLLOWING THESE OPENING STATEMENTS, THERE WAS GENERAL DISCUSSION, INCLUDING QUESTIONS FROM THE FLOOR. WHAT FOLLOWS IS A SUMMARY OF THIS DISCUSSION AND THE CLOSING STATEMENTS OF THE PANEL MEMBERS.

FYE

John, I too have been surprised at the amount of agreement in this large group of oceanographers. But I would like to comment on the problem of how you start, and how you select the colleges, and how many sea-grant colleges you have. I'm not sure about this, but I don't think that this should be restricted to a very small number. Admittedly, starting any new program with limited funds necessarily means that you must start small and with a very few participants. But it seems to me that we're not very far from the time when we need to have a form of marine science and ocean engineering in every decent university. All universities are now teaching something about one form of engineering or mathematics or physics. I think the oceans are such a vital part of human endeavor that their study must be a part of many universities. Maybe they don't all need it, but the concept that all universities should have the availability of intellectual pursuit in this area is a sound one.

HORN

May I start an argument? As a university president, this is the sort of point of view that gives the university president nightmares. This is what he hears all the time. "We can't be a great university unless we have a Ph.D. program in every one of the disciplines, across the board." The fact of the matter is, gentlemen, this concept has got to go out the window for any except universities like California, Minnesota, Michigan, Wisconsin, the really large, extremely well supported institutions. The smaller university simply cannot look forward to this sort of a proposal, and it seems to me that one of the major areas where this goal can be accomplished most easily in terms of preparing for a specialized approach to it, is in oceanography, because, as has been pointed out here, it's a graduate discipline. It's based upon the fundamental sciences and mathematics. This can be done in every university, but one can't afford to establish a graduate program leading to a Ph.D. in every single one of these fifty state institutions plus another twenty-five of the major private ones. Now,

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I'm perfectly willing to concede that maybe at Woods Hole there is an opportunity to create out of an existing educational institution that is not a university a unique sea-grant university, taking only the students who come to them prepared in these other sciences. But I'd also have to point out that it seems to me that it is very difficult if not impossible to develop a serious program leading to the Ph.D. degree in oceanography without some supporting sciences at the graduate level on the same campus.

I've been told that we at URI can't run a decent program in oceanography without a Ph.D. in mathematics, and I think that this is probably correct, at least I've given in to the idea. But I come back to the point which supports Dr. Spilhaus very strongly, concerning any institution that has special competence in a field allied to oceanography. It would be foolish for the University of Rhode Island, for example, to try to develop a program in petroleum simply because it has implication for oceanography. Let's go to the best petroleum place, to Texas or Oklahoma, wherever it may be, and see what it can contribute to the sea-grant program. We should not, moreover, deny to a marine biologist or an ichthyologist on a campus that is not a sea-grant university opportunity for a grant if he wishes to work on a project involving the open ocean. All I'm saying is, we cannot afford anymore to look upon this new concept the way we looked upon the land-grant movement a hundred years ago, that is, to develop a full fledged graduate program, highly developed, and devoted to research, bringing in post doctoral fellows, etc., in every one of the fifty land-grant institutions in every one of the fifty states, plus maybe another twenty-five selected private universities.

HARGIS

In some scientific areas a long time is required from the conception of the project or a program to the eventual yielding of economically measurable results, in others, it is not so great. In marine science, time required is usually fairly short. Scientific results in marine science often quickly find military or civilian application. I think that in general, while there would be exceptions, five years is a minimum time to realize significant economic return from research. Of course, all institutions already have programs in existence which can be improved immediately if additional funds are available. It is also certain that more emphasis can quickly be placed on development and training in ocean engineering, an area which is now lacking; therefore, engineering progress can be realized quickly if adequate funds are available. Administrative resources and facilities are already present to improve existing programs and initiate new engineering projects in most marine institutions, so the return will be relatively rapid.

HORN

I criticized the project-grant business in setting this up. Nevertheless, I did say institutions not designated as sea-grant institutions ought to have project money. I would suggest simply as a practical proposal in this connection, that if this concept goes through, whatever agency, NSF or an Inter-oceanographic Committee, or anyone else who's running the program in Washington, should assign on a continuing non-restrictive basis 50% of whatever money is available to those institutions that are designated sea-grant institutions. Suppose that there are ten or a dozen of them, and let me say parenthetically, that whatever ten or twelve or fifteen are designated in the beginning does not mean that they will necessarily continue to be the sea-grant universities. I don't think I agree

with the speaker this morning that we must only support those universities which are now in the business. There may be some very good universities that have unique opportunities in this field that are not now in oceanography, but ought to be. I don't know what North Carolina's doing, for example, but it ought to be in the business in a big way, I should think. So, take half of the money and assign it to the institutions designated as sea-grant universities, and take half of it for projects available to all universities. Actually, under the land-grant system, there are certain funds in agriculture that are allocated on a project basis, although most of the money is handled regionally. This way would make it possible to continue the individual research of people interested in the marine sciences, no matter where they work, even in a small college. At the same time the program would start out with a modest but very helpful half million dollars a year, perhaps, to ten institutions, and this money would really make the difference between a real center of excellence in oceanography and a mediocre one.

CASTLE

I would like to make just one point relative to the earlier question that was raised about pay-off. This is one reason why I feel it's exceedingly important if you go ahead with the idea of the sea-grant university to incorporate adult education or extension into the program. The period of the pay-off will be much shorter, the closer you get to the industry which you are trying to help. In most of the industries I'm familiar with, there is usually considerable basic knowledge that is not being applied. Now then, if this is true, as someone said about the fisheries industry this morning, there may be information here that can be applied immediately. It may very well be that it won't take five years to get some pay-off in certain areas.

FYE

I'd like to return just a moment to what I thought was an enlightened concept suggested by Wilbert Chapman earlier this morning. The more I think of it, the more I think that he was absolutely correct when he said that sea-going people are different from land people. It is important in our thinking about sea-grant colleges that we plan from the beginning to have a successful conquest of the oceans, to attract to the problems related to the ocean a large number of very intelligent people, and to insure that these sea people are well trained. I don't think that we have done this adequately or very successfully in the past. I think we can do a great deal better, and perhaps that's the answer as to why we really and truly need to implement the sea-grant college idea.

HARGIS

I would say that we have discussed difficulties, perhaps prematurely-- although this is what this forum was called for, of implementing the program. Several of us, and I'm just as guilty as others, have interjected our own selfish ambitions, and ambitions for our own programs, into the discussion; but I wish to say that in the sea-grant concept we have a good vehicle to attract public, legislative, and executive support. The cause is good. Practical results with

economic, military and social pay-off will certainly result, probably much faster than we expect, and so I would suggest that we all get together and push the notion, try to promote the program. It will be worthwhile for the nation and marine science.

HORN

Might I say just one thing. I think Dr. Spilhaus' address this morning was one of the most exciting addresses I have ever heard in my life. In terms of holding up to us the projections for the future of what is possible, I think it probably is a lot better that we talk, not about oceanography, but about ocean engineering, as he did this morning. In this broader concept, in spite of the fact that some of these things sound so fantastic, I'm positive that time is going to prove Dr. Spilhaus correct. Anything we can do to provide individuals with the sort of a creative imagination Dr. Spilhaus has displayed, individuals who want to see if what he has put before us can actually materialize, deserves our widest support. And I hope, therefore, that we can get these people, turn them loose, and see what they'll come up with, see whether or not this massive projection Dr. Spilhaus has made will not in 10, 15, 20, or 25 years actually come to pass. The world will be a much better place if it does.

SPIILHAUS

Thank you. If we cease to dream, we'll wither and die as human beings, and in all this discussion of money and who gets it, I can just say I'm glad that this idea of mine is greater than the money we have to implement it. Otherwise, I would feel intellectually bankrupt.

SEA-GRANT UNIVERSITIES: PROBLEMS OF IMPLEMENTATION (A Panel Discussion)

Robert B. Abel, MEA, George Washington University, 1961. Since 1961, he has been the Executive Secretary, Interagency Committee on Oceanography, and the Assistant Research Coordinator, Office of Naval Research. For five years he was chief scientist aboard two ships of the U. S. Naval Oceanographic Office.

It has been a good five years that our program (ICO) has been in existence. There have been some very significant research accomplishments in all aspects of oceanography, in marine biology, marine meteorology and in the air/sea interaction, submarine geology, geochemistry, the elucidation of current circulation. There's been some very exciting research accomplished. Incidentally, it is hoped that we will be able to document the results of these research projects, and issue them in some kind of compiled report form by early next year to provide a compendium of what has been going on recently in oceanography. Probably equally important, there has been a rather sizeable investment in building up our potential ability to take advantage of new research accomplishments as they occur. This investment is exemplified in ships, laboratories, and (certainly, at least as important as the rest), in student populations in the various universities in the country. So I repeat, it has been a rather good five years, good enough to whet our appetites for considerably more progress in the next five.

One thing that struck me about the proceedings yesterday was the concerted drive to carve up Senator Pell's poor little chicken before it has even emerged from the shell.

I would hope that instead we can concentrate on what it is we're trying to do, what is in this for the people of the United States, how we're going to attain our goals. Hopefully, stemming from this conference, there can emerge some rather substantive ideas. Ideas should be generated within the states, themselves. First of all, we need ideas to strengthen the quality of Senator Pell's bill. After all he did leave us with this request yesterday, that support is needed and needed from many sectors of the scientific spectrum. Secondly, we might consider for awhile what must be at least one of the principal objects of our attention and that is the student, the ocean engineering student. Consider if you will what we plan to do to this student. We're going to immerse him in engineering. We will flavor this immersion with some law, and with some home economics; we will push him part way through a sanitation laboratory, and all the time we are doing this, we are also implementing what someone asked for yesterday -- that the sea-grant college be a sea-going college. So we're going to send this student out. He's going to spend considerable time at sea if he's a worthwhile student, and this will, of course, prolong his stay at school, four, five, six, perhaps seven years. This is the history of oceanography, as you well know. Now, what's he doing all that time? He's certainly prevented from holding down a conventional job ashore. In his shore hours, he cannot normally be an assistant because as you know, there are almost no undergraduate departments in oceanography where he can help students, and so he must have unique sources of income available to him. Now, all this time that he has prolonged his education, he has been raising a family, and this simply adds to his financial discomfort. That is why, you see, this concept of sea-grant support is particularly precious to me. I believe there is going to be a lot of work in it from the point of view of the student.

Finally, there is an international kick to all this. Someone yesterday mentioned the possibility of training foreign students. Possibly some of you are better acquainted with facilities in other countries. I don't know myself of any

foreign programs comparable to that which we have been discussing yesterday and today. But, for instance, at the international desalination symposium last week, Frank DeLuzio, Director of the Office of Saline Water, made the statement that he would like to see literally hundreds of foreign students trained in the arts and techniques of desalination in this country. These are the kind of parallel activities which might conceivably be incorporated into sea-grant universities. So I'd like to leave you with just these thoughts and hope that over the weeks ahead, some ideas will emerge, which we can then tie into Dr. Carlson's specification that the result of all this--the application of funds and support--be tied to meritorious proposals.

John W. Ashton, Ph.D., University of Chicago, 1928. He is Director, Division of Graduate Programs, U. S. Office of Education, on leave from Indiana University, where he was Vice President and Dean, Graduate School, from 1958 to 1965. He is the past Chairman, Council of Graduate Schools in the United States.

I must confess to a little feeling of being like the character that used to appear in, I think it was Abner Dean's cartoons 15 or 20 years ago, of a naked man apparently coming awake in an unusual situation and saying to himself; "What am I doing here?" Because I'm neither an oceanographer or even a scientist I assume that my function is to speak to the practical aspects of a development of marine sciences and related fields in the graduate schools, particularly in the universities.

I begin by reminding you that there's a real difference between the situation when the land-grant colleges were founded a little over 100 years ago and the situation now, in that the land-grant colleges were founded partly because the agricultural and mechanic arts, to use the old phrase, were not really respectable subjects and one of the reasons for the separated state universities in some states is that the then established state universities were not willing to accept these areas as part of their program. Now this is no longer the case, though, of course, there is still a measure of snobbery among various departments in the universities as to the appropriateness of programs in some of the other departments. Certainly the areas that we are concerned with here are now ones of substantial respectability throughout the universities in the country. We speak of marine science, i.e., science in its broadest, in its etymological concept; knowledge, in this case, about the oceans, indeed, about all large bodies of water. I emphasize that the programs that we have been talking about, the interest and the needs that have been discussed in this conference thus far have to be considered in an overall context, much wider than simply engineering or industrial problems in connection with the oceans.

We have to recognize that the breadth and scope of materials that are involved, as Professor Schaefer pointed out just a little while ago, call for a very high degree of a cooperative effort. Not only cooperation between departments of universities (which is not always the easiest thing to attain to), the bringing together of the resources of the various sciences and social sciences to make a program of consistent strength in the areas which the university has chosen as its particular fields of specialization. If the challenges already suggested in this conference are to be met adequately, we need also extensive cooperation among universities. If we think solely in terms of the resources of any one university, no matter how large and how complex (not to say complicated), its structure may be, we will inevitably, I think, limit our effectiveness in the long range development of studies of marine life and its relationship to all the aspects of human life in these days.

That such inter-institutional cooperation is not impossible has been witnessed in recent years by a good many cooperative programs. Perhaps one of the most striking examples is that developed by the Committee on Institutional Cooperation of the so called Big Ten Universities and the University of Chicago. In these midwestern universities cooperative programs in water resources utilization and control, in bioclimatology, in the study of Asiatic languages, and a good many others have been worked out by using the most appropriate resources of each of the universities that is involved in the compact. Only by some such means can we avoid unnecessary duplication of effort, unwise competition among programs, and the spreading thin of scarce resources of money and manpower. Only thus can we make best use of each institution's specialities and provide for a concentration of learning in important fields to avoid that vast spread which Mr. Abel so rightly fears. I would second most heartily and most vigorously Professor Schaefer's comments on the need for conceiving of this area, as not only that of certain highly specialized sciences, but rather as covering a broad range of fields; the biological sciences, engineering, chemistry, and certainly economics, law, and business; indeed, even recreation, which I think has not been mentioned but which is, at least in its economic aspects, an important element in the utilization of water resources. In addition, of course, there are all of the medical sciences.

So what about the needs as far as the universities are concerned? I assume that funds will be needed for facilities, for operation, and for research and student support. There are no new sources. Sea-grant universities will need to depend on state and federal funds in whatever proportion is appropriate--or manageable, on private beneficence, and on support by industry which has a stake in this enterprise. I mention two of the programs of the federal government with which I am involved as examples. To help provide adequate facilities for the development of these programs, in the Division of Graduate Programs of the Office of Education, we already have provision for making one third matching grants for facilities for research and teaching of the kind that is involved here. Indeed, the University of Rhode Island has recently received some assistance toward just such a facility.

The need for research assistance can be of various sorts. This is where people are particularly involved of course, and as Professor Schaefer has pointed out, various kinds are needed. One of the most significant for our purposes in the universities is the special technicians who will be responsible for the less professional aspects of the research and even of the teaching. The training of such people involves new problems for higher education. Our emphasis, however, will continue to be on those who will be carrying on the traditions and developing resources of new knowledge, the kind of students who are supported by fellowships from a variety of sources. There are already some of those sources in existence in the federal government; the National Science Foundation with both its research grants and traineeships; the National Defense Education Act, Title IV, with its fellowships, and others, as well as funds that are provided also from special research grants or the like from industry and government, alike.

These are the real needs, because the universities must provide, as I see it, in this, as in every other field of significance, for the present and on going research and also for the continuation of the searching out of new knowledge and for the training of new people in the field. This can be accomplished only by providing for excellent graduate programs which will produce the kind of people who will be needed as leaders in these areas of research.

Howard H. Eckles, S.B., University of California, 1942. He was appointed in 1962 as Assistant to the Science Advisor, U. S. Department of the Interior. A career employee, he joined the Department in 1948 as a research biologist and has served since then in progressively higher positions. Since 1958, he has been chief of the branch of marine fisheries in the Bureau of Commercial Fisheries.

Thank you, Dr. Schaefer. In thinking over our proceedings, thus far, I have had an opportunity to jot down various steps and subjects which I think will be important for implementation of this new idea of sea-grant colleges. Yesterday, Dr. Carlson pointed out that there was not yet adopted by the government as a whole, either on the executive or the legislative side, an agreed upon policy on what our country wants to do about use of the oceans and its total oceanographic efforts. I would point out that this is something that needs to be done for the welfare of the oceanographic effort as a whole, as well as for implementation of this concept of sea-grant colleges. Dr. Schaefer stated this same point in a slightly different way just a moment ago. We must have a clear understanding as to what we want to do in the whole program.

I have opportunity for rather frequent contact and conversations with members of the Federal Council for Science and Technology or with officials elsewhere in the government. I know that their outlook toward the oceanographic program does not hold the concept that Dr. Spilhaus gave to us yesterday. On the average there is not a feeling of great urgency about the rate we should go ahead to develop the oceans from a resource and use point of view. In some circles oceanography is regarded as a research opportunity that will show promising things to do. Later on we can develop that information which research has shown to be promising. There is a feeling that the present level of effort, which is about 160 to 170 million dollars a year, is adequate for this purpose.

I would like to make a specific recommendation for consideration by this conference. This is that we ask Dr. Spilhaus, if the arrangements can be made, to give his talk or a related one to the President and his Cabinet, perhaps going via the Federal Council as a stepping stone to this. Secondly, suggest that he give this talk to the appropriate Appropriations Committees within the Congress. I emphasize the Appropriations Committees because leaders in Congress on the legislative committees have stressed the importance of oceanography. But opportunities in oceanography may not be known to those controlling the funds in Congress. I think we should take every step to get this concept across. Our effort is to do things with the ocean, to develop it for our use and go beyond the research effort, which it is at the moment. Thus, clarification of national policy is my first point.

On my second point, I think we need to agree upon a responsible agent within the executive department to carry out the program. Senator Pell's bill mentions the National Science Foundation. I do not sense from Dr. Carlson's paper that the National Science Foundation is very enthusiastic about this idea. He stated the National Science Foundation is neutral ground. I state we can't make progress with neutral ground. We must have someone who is enthusiastic, who wants to take the responsibility and who will work closely with all agencies and with the Congress, to bring the program about. I do not think it necessary to point out which agencies might do this, but there are several that are interested. I happen to be in one of them.

I cite as an example, the passing of the Water Resources Research Act of 1964. It resulted from a bill introduced by Senator Anderson of New Mexico. It resulted from a very wide base of support from the academic community. There was a clear responsible agent with an idea to be carried out and a clear demonstration that the nation had to do something about producing more information on the water resources of the country. If we obtain the same parallelism in ocean-

ography with sea-grant colleges, then I think the program will go ahead. My second point is, let's get a horse to ride that will carry this program through.

My third point is that I think I can provide additional information on the funds situation. The income from leases primarily for oil, gas and sulphur extractions, on the outer continental shelf, over the last ten years, brought in about 1.7 billion dollars. This is a little more than was mentioned a number of times yesterday. Ten per cent of this could mean on an average about 17 million dollars a year. Also, no one has mentioned the possibility of developing a program that would involve matching funds. There is considerable precedence for this. On a twenty-five per cent local contribution basis we are then talking about a program something in excess of twenty million a year. This is a substantial proportion of the present oceanographic effort.

We might consider also, something higher than a ten per cent portion of funds from leases. The Saltonstall-Kennedy program, administered by the Bureau of Commercial Fisheries of the Interior Department, receives thirty per cent of the import taxes on imported fishery products. It produces an income for research and development purposes of about five million dollars per year. So there is a precedent for a higher percentage of funds which are of the nature being considered. There are also Dingle-Johnson and Pitman-Robertson funds used for fish and wildlife research, development and management which are based on a tax from the sale of fishing tackle and hunting equipment. This brings a program of about twelve to fifteen million dollars a year to the Department of the Interior, Bureau of Sport Fisheries and Wildlife. The funds are administered through state fish and game agencies. I understand that through legislation a tax was instituted for this purpose. The public and the industry involved pays for research and development. The same thing could be done as a source of funds for the sea-grant colleges.

I would like to make a next point that we consider a broad base of participation by institutions as sea-grant colleges. I think it would be a mistake to restrict participation only to those institutions that have a water front or a sea coast location. Ocean resource development includes a high interest in petroleum and in marine mining. The competence that has been developed at the University of Wyoming or the University of Colorado, on how to break rocks, could well be applied to marine mining problems. I suggest, therefore, that there be a set of criteria developed that an institution would have to follow to qualify as a sea-grant college. If an institution meets the criteria, then it could participate. There would have to be travel to the ocean from inland locations but we do this every day.

I suggest also that we keep our eye on how industry might participate more fully than their members are at the moment. To illustrate this, I state there are now social and legal barriers to attracting industries to work on ocean resources. The present practice on the outer continental shelf is for industry, particularly now the petroleum industry, to do its own exploration. This is mostly by seismic shooting. Once an area is outlined as promising for oil production, the Interior Department is asked to hold a lease sale which is done by bid. Companies will bid on the areas that they want to lease. The sale goes to the highest bidder. It is expensive to do the exploration but not so expensive that oil companies will not do it. If we transfer this same system to ocean mining or possibly to offshore ocean farming for fish, an industry could spend thousands or millions of dollars to define a resource. It could lose the sale to a higher bidder by a few dollars. On this basis industry may not proceed with resource development. We need to develop new kinds of social practices which will allow some kind of proprietary right to industry so that it will spend high risk dollars for developments in the ocean.

I close by rephrasing in a slightly different way what has already been said a number of times. And that is that we have as our goal extension of our

capability for use and operations on land to the environment of the sea. We need to learn how to go out on the sea in mid-water and along the bottom with the same facility as we do now to fly an airplane, drive a tractor or use an automobile. We ought to have as an objective development of an engineering capability that will break the interface between air and the water so that scientists and technicians can operate in the oceans in a familiar way. We will never bring all of the ocean's resources into our domain without this new engineering capability. This I propose as an objective for sea-grant colleges that we might think about.

Thank you.

Claiborne Pell

In my few remarks at this point, I will refer to the word oceanology. I notice in my bill in a Freudian way, I never mentioned the word oceanography which is something of a triumph in a bill on this subject. I had this Freudian difficulty with this word, so I also did a little checking around after yesterday and found that the word ology is perhaps far more applicable for what we're trying to do, which means the study of, instead of graphy, which just means the mapping of. It seems to me the mapping of, the charting of, is only one phase of the work we're doing, so I hope you will bear with me as we rechristen this science oceanology.

In drawing up my bill, I'd like to put in a plug at this time for one of your own community, George Beardsley, who is a graduate student and who did a good deal of the technical research on it. We were in touch with the scientific community in trying to work out a good bill.

I also would like to make it very clear to the whole group here that in our concept we definitely visualize the use of these funds and the application of the sea-grant college concept to colleges not necessarily on the ocean shores, but on the Great Lakes, as well. There are certainly great advantages to the Great Lakes area. Because it's a smaller scale model, they can develop and study some of the phenomena more economically and efficiently than you could in the ocean as a whole. So for those of you who are from that part of the country, I hope you will take an equal interest in this bill. And, because of my belief in the importance of that area participating in this program some months back, I specifically mentioned the Great Lakes area in my bill. Also, another point which came to mind in yesterday's discussion, is that the purpose is not the development so much as the application of knowledge. The Lord knows that there are more areas of ignorance than there are of knowledge in this whole field. But, more important for us is the translation of this knowledge into practical application. As I said yesterday, my job as a politician is the translation of ideas into events and the job that we have here in this field is the translation of the limited knowledge that we already have into actual practical application over and beyond the development of more basic and original knowledge. I would like to complement the inter-governmental committee which under Mr. Abel's sponsorship, and sparking, has done as excellent a job as it can with its very tenuous mandate and without any direct controls. A coordinating committee is what we refer to in government as a dotted line relationship; and those lines are very dotted, indeed. Eventually, there'll have to be a solid, unbroken line relationship.

I thought Mr. Eckles ideas exceptionally good and exceptionally well taken and I would like to comment on a couple of his specific points. I'm not frozen into the idea that the National Science Foundation must administer this Act. It just seemed the logical agency to do it. If the National Science Foundation is

lukewarm about it, other agencies in government are not lukewarm and would be delighted to administer it. Or we might even consider creating a new agency, but I hate to see that done, if it can be avoided.

The purpose of my bill is to provide a take off point that we can discuss for general reactions and, I hope, approval. I realize the final bill that may emerge will be different in many respects from the bill that we have before us today, but this is the best thinking that with Mr. Beardsley's help and other people's help, we put together at that time. We don't have a monopoly on knowledge. But we in the Congress must do our best to decide who could best administer this concept. The thought of matching funds is a good idea. There is no reason why we couldn't put it in the bill in the course of the hearings.

In this connection, I would like to see hearings on my bill which, by happy coincidence, comes before the committee of which I am a member, in January or February. We will hope that at that time the best ideas of this conference could be put forward and might well be adopted. I'm not sold on not having matching funds. I much prefer it, but I'm not sure that the matching funds would always be forthcoming.

The question was raised - why not raise the percentage from 10 per cent to a more generous amount? This again is purely a question of political judgment. It developed out of a luncheon table discussion of six or eight of us, doing our best thinking as to what seems possible at this time in the Congress and that we might get passed. Quite honestly, if we get my bill through the Senate, amended any way this coming session, we would be very lucky, indeed. I would doubt, too, that we would get it through the whole Congress this coming session. But I'm confident that eventually a bill of this sort will get through the Congress. It might take one or two or three Congresses to do it, but with your help, it can eventually be done. I think if we raised the amount to 20 or 30 or 40 per cent of the off shore rents and royalties, we would find very real political obstacles to its passage. If I could be assured that we could get the bill through and make it a 100 per cent of the rents and royalties, I would be glad to do so. But I would have to make a political judgment as to what kind of bills will get through.

Finally, the point of this panel today is not just sea-grant universities, but what I call sea-grant colleges, which I think is perhaps more what I have in mind. Sea-grant universities would apply just to a few great institutions. But I have in mind perhaps a more wide cutting up of our poor little chicken, though not as widely as some of you would like! As sea-grant colleges, there will come many problems of implementation. How do we implement them? Before we start cutting up our little chicken and implementing this bill, we have to get it into being, get the Act into being. That means legislation, the translating of this concept into law. And, quite honestly, I can do just so much as one individual. A great deal of the rest of the load of doing this will have to come from each one of you who are here and come from all around the country and who believe in the concept. I would welcome, too, any of your suggestions as to how we could get this bill through, because even if a bill provides for motherhood, and the flag, we still have to get a certain amount of national support building up for this on any bill.

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SCHAEFER

I might say one of the most encouraging things to me at least is the very great interest Congress is taking in this whole matter of how we utilize the resources of the ocean. Mr. Eckles referred a few moments ago to difficulties of a unified program from the appropriations standpoint. Very recently the Appropriations Committee of the House of Representatives has become sufficiently interested in this whole problem of having pieces of the program going to various subcommittees of the Appropriations Committee, that they have established an investigation of this whole matter on their own. They have a group of seven or eight extremely able investigators that are delving into this whole matter on a full-time basis. I think this is likely to be an extremely useful review by the Congress of problems of implementation of the entire national oceanographic problem.

One point on which I would like to hear some further discussion is this matter of the bringing knowledge to the users for practical development. The Senator referred to this in his remarks, and others touched upon it. I think Mr. Abel and Dr. Ashton were talking very largely about the accumulation of new knowledge. Mr. Ashton said that one of the differences between 1865 and the present is that the land-grant colleges were set up because the kinds of things they wanted to do weren't respectable in the existing large universities. These land-grant colleges have now also become respectable. Whereas the original land-grant colleges worked with the county agents and that sort of thing (and some of them still do), the general attitude of faculties in most universities, even those who started land-grant colleges, is that this really isn't an appropriate function for a university. The university has a part, in educating the people who perform this function, but the actual county agent function bringing this knowledge to the users is not considered "respectable" now. So the question arises, as I stated earlier, can this be handled within the university system, or do we have to think of some ancillary mechanism for taking care of it? I think, although our knowledge is fragmentary and imperfect, we do know a great deal more about these things than many of the users do. For instance, in the area of fisheries, we know a lot more about catching fish, and the information a fisherman can use to catch fish, than the fisherman does. So how do you get this information into his hands?

ASHTON

I'm told by some of my engineering friends, Mr. Chairman, that even the engineering schools now are doing a quite different kind of thing for their baccalaureate degrees from what they were doing 35 or 40 years ago. They recognize this as a very real problem, and are beginning to develop what are sometimes called technical institutes or other types of organized programs, not necessarily of full baccalaureate caliber, which are doing what used to be done for an engineering degree a generation or two ago. It seems to me that this offers a perfectly good parallel to the situation here. My hope, indeed my expectation, is that at least the larger universities and perhaps many of the small ones, can broaden their scope enough so that they see this need for a kind of special technical training which is not of the same sort, exactly, as what we thought of as the usual baccalaureate program; and will open their doors, in effect, to this kind of development, so that it will have the advantages of being associated with a university or college, even though it may be outside the patterns usually associated with the regular degree programs. I speak with prejudice, of course, but I think this is a much better way than the development of separate and isolated trade schools, technical schools of one sort or another,

that have no opportunities to draw upon the very extensive resources of a well established college or university.

ABEL

I would like to suggest one additional approach to this question as to how we get the education to the practitioner, and that is not to wait until he becomes a practitioner; get him while he's young. Get the fisherman before he's even thought of becoming a fisherman. Work a little bit more on the aspect of motivation and to translate Dean Spilhaus' remarks to the lower level, get the idea that there is an ocean around us to children in the lower grades. There are already a few programs of this sort from which some of the states and state schools might well copy. A few high schools have come to us with on-going programs where they even have boats available. They take the children out, give them first hand knowledge of what's going on, and how we find out about it. There are science camps that have proven extremely effective in some areas of the country. There is, for instance, at the University of Rhode Island, whose representatives here today are obviously too shy to mention the subject, an outstanding project being conducted by Dr. Moriarty, to design a curricula to inject oceanography into the public school systems.

ASHTON

We might add this bit of experience, I suppose, from the National Aeronautics and Space Administration which established in several universities throughout the country centers for the dissemination to business and industry, the results of research that has been carried on under NASA. I think that these are generally working out very effectively. They are organized with differences in different universities, but they do provide centers in which businesses and industries in a quite broad area, can participate and can, through various types of information retrieval systems, share in the basic research that has been carried on under NASA's auspices, making whatever applications seem to them to be useful and effective and presumably profitable from that knowledge.

ABEL

Concerning financial assistance to students, as I had described earlier, you have a real problem of helping the students through school. What may not be apparent to the taxpayer is that support for students (and for departments, of course, in which students are enrolled) is furnished by several sectors of the executive branch of the government. Clearly, the National Science Foundation and Office of Naval Research have been traditionally involved in this as integral to their charters. In addition, the Departments of Commerce, Interior and Health, Education and Welfare, have certainly provided very significant support to universities, by grants and contracts, etc., and there has certainly been a most fruitful feedback, as any of these agency representatives can attest.

Another point concerns the matter of pulling industry into the program, and this is certainly a critical point because until you provide a commercial or

industrial base for oceanography, you are at least in part talking about a somewhat artificial program. But, of course, there is an industrial base to several parts of the program such as that provided by the oil industry, etc. The ICO is quite sensitive to this problem. We have held a number of symposia in the past to bring industrial representatives together with federal representatives to trade ideas. Indeed, we had a most profitable session two weeks ago in Washington at the David Taylor Model Basin.

Finally, the matter of what universities or what schools can qualify has been treated rather exhaustively. Personally, I wouldn't care if some psychology professor at South West Cupcake College came in for a grant; if he had a terrific idea and he could demonstrate facilities by which the idea could be processed efficiently and effectively in pursuance of good science or good engineering, he deserves support.

ASHTON

The importance of knowledge of and development of the resources of the oceans has already been made clear in the previous sessions. We should consider here the steps necessary to implement a program.

1. The universities are well qualified to meet this need through their varied resources and the ability to develop interdepartmental and interdivisional programs that bring to bear on the highly complex problems involved biologists, economists, engineers, business administrators and others. By the pooling of their knowledge and skills they can meet effectively many of the present problems and can chart new directions of development.

2. The research capabilities of the universities can in some instances be more thoroughly developed by the organization of such cross-discipline programs with the aid of presently established federal programs, especially National Science Foundation.

3. Assistance in the building of special class-room and research facilities can be obtained from Federal Programs, (University of Rhode Island has already received one grant for a library in this connection).

4. Student support is possible not only through research grants but also, for well-organized programs, from the NDEA fellowships.

5. There is always the possibility of direct Federal action in the form of block grants to particular universities for carrying on programs of teaching and research in this area.

The area needs to be broadened to include the large fresh water lakes and the rivers. Support should not be confined necessarily to institutions on or near the coast.

6. If a program is set up, it should be coordinated with related programs already in existence, particularly the Water Resources Research Act of two years ago.

Just one comment. I sense from the discussion some difference from the concept which Dr. Spilhaus gave to us yesterday. One of the main points that he made was that we are going to take knowledge produced by research and transfer this to do useful things with the ocean. This then requires a new kind of outlook, new kinds of personnel, new kinds of financing, and different ways of working. It would be a mistake, I think, if this conference didn't clearly recognize the difference between what Dr. Spilhaus is proposing and what we have been doing as a national research effort in oceanography. We should not look to sea-grant colleges as a source of funds to do the same kind of basic project research that we have been doing over a number of years. You have sources of funding for this now. There are ways to improve these sources if you think they are not adequate or they are not appropriate. The main thing is to know that we are going to do things with the ocean, not as a research effort, but one of application and of changing the ocean to our benefit.

PELL

I notice on this panel a wish to return to the problem of securing a bill, of implementation; there I hope you will help me to help you. When the hearings on the bill come along, if you have ideas for refinement - improvement, or wish to appear as witnesses, please let me know. That will help our work.

I think our sea-grant college conference here today accepts ideas more quickly and more easily than will be the case in Congress when we seek to pass our bill. I may be wrong in that, and the hearings in Washington will show us the wrinkles. I am thinking of asking for a couple of days of hearings and then letting it settle for a while. Then, a few weeks later have another few days of hearings. Anybody who wants to, comes along and expresses his ideas. Out of this process you usually get a much better bill than that with which you start. If you have a too ambitious bill in the beginning, it may be a long time before you get it through. This bill is realistic in concept and I believe that we really might get it through in the future.

The most important thing is when you return to your own community, if you could give a thoughtful expression of opinion by word of mouth or by letter to your own senators and representatives, it could have more effect than any other single thing in translating all our words here the last two days in a very intelligent way into implementation. Without this being done, there will be absolutely no implementation. So, I really need your help to get this sea-grant college concept enacted into law.

SUPPLEMENTARY STATEMENTS

JAMES D. BARTON, Associate Dean for General Education, Southampton College of Long Island University

It is, disappointing to see that 88% of the delegates at this conference represent graduate schools of oceanography and/or industry. It is the former that have the most significance since, by comparison, the land-grant colleges were designed to provide basic education in the agricultural and mechanical arts for the individual who are residents and husband the land, basically an undergraduate education. If the sea-grant college concept is to be fulfilled we must have the support of the scientists and the educators in the coastal undergraduate institutions. The Interagency Committee's listing of marine science programs gives only 22 undergraduate programs in the entire United States. These include everything from the long established schools of marine architecture to such new programs as the undergraduate major in the marine sciences of Southampton College of Long Island University. The latter has had, from its founding in 1963, a keystone of an undergraduate marine science program.

The development of the character, attitudes and nonscience education of students was not mentioned, except by an industrial representative, W. M. Chapman of the Van Camp Sea Food Company, as an indication of the practicality of a basic program for the future sea oriented individual.

VICTOR BASIUK, Associate Professor of Political Science, Case Institute of Technology, and Research Associate, Institute of War and Peace Studies, Columbia University

There are two aspects of our discussion which I find of some concern. First, is the preoccupation with what oceanography and marine technologies can do for the United States to the virtual exclusion of considering America's position in an international context. Second, is the preoccupation with the subject matter from the point of view of technologies themselves, i.e., technological capabilities, present or future, without adequate consideration of social needs.

We are considering the concept of a sea-grant university, and, for a fully justifiable reason, the idea has evoked a great deal of enthusiasm. It is, however, important to emphasize that the concept of a sea-grant university did not discover the oceans--the oceans have been with us for many, many centuries. Two things are new about the oceans and our present highly increased interest in them: the emergence of new technologies, which enables us to exploit the huge resource potential of the oceans on an increasingly large scale; and the social needs for raw materials and foodstuffs, with their increasing depletion on land, which makes us look towards the oceans to solve our problems.

These days, oceanography and marine technologies can do miracles for us, but unless their fruits are socially and economically justifiable, the exploitation of the potential of the oceans (and by implication, the concept of a sea-grant university) will die stillborn. Social needs and marine technologies have to be considered simultaneously. If the existing social needs can be met more advantageously by means other than marine technologies, then there will be little justification to view the oceans as a new frontier.

There is a very serious need for foodstuffs and raw materials in the world at large, but it is perhaps ironic that while the United States is the most capable

of developing marine technologies to extract these natural resources from the oceans, we need them least. There is room for improvement in our fisheries industry, but in general, we have a surplus of food. Extraction of minerals from the oceans will also find a fairly stubborn competition from alternative sources of supply available to us. Therefore, although in the long run marine technologies will be essential, perhaps vital, to meet our needs as a nation, in the short run the picture is much more blurred. If we rely on domestic needs of our economy alone, the development of our oceanographic knowledge and marine technologies is not likely to be as rapid as many of us wish.

On the other hand, our social needs are not limited to the domestic economic needs as such--they include the requirements of our foreign policy and of our military establishment. We are committed to spend about three billion dollars annually in foreign aid. Oceanic R&D, designed to meet the needs of the underdeveloped or deficient countries, may significantly cut our foreign aid bill without decreasing its effectiveness. In later years, as our population grows and our own resources diminish, we would be able to utilize these technologies with full advantage for our own economy. In a somewhat similar vein, our civilian oceanic R&D can proceed much farther and much faster if the interests of the U. S. Navy are considered and Naval cooperation is obtained. The mining of the ocean bottom can provide our submarines with stations and sources of supply. Non-military U. S. presence in the oceans can provide the Navy with navigational assistance, information, and denial of footholds to the potential enemy. In sum, an effective and rapid exploitation of the potential of the oceans can be brought about if we view the problem not only from the point of view of the domestic needs of our economy at this time, but if we integrate the present and future needs of our economy with the needs of our foreign policy and defense.

In our sea-grant universities, we should not only do research and provide educational facilities in marine sciences. We should provide research to determine what our social needs are in each given period of time and how marine sciences and technologies can satisfy those needs. We need social scientists who understand the implications of oceanography and marine sciences for society as a whole. Conversely, we need oceanographers with a keen appreciation of social requirements so that they can direct their research towards goals most needed by society.

DAVID DEAN, Department of Zoology and Entomology, The University of Connecticut

Certainly no one would question the objectives of scholarship, research, training and dissemination of information proposed in the sea-grant university concept or the benefit our country would reap from the program. However, I question whether it is wise to designate specific institutions as sea-grant universities. Such a labeling might be detrimental to the objectives of the concept in the following ways: (1) In obtaining support in the legislature. While it is incongruous to designate institutions from inland states as sea-grant universities, it is quite conceivable that these same institutions could make significant contributions to the marine sciences. Greater support could be rallied if the inland states were not excluded by the use of a label. (2) Stigmas have been associated with land-grant universities in the past. I'm afraid that similar stigmas, as unwarranted and unfortunate as they maybe, will carry over to the sea-grant university.

While a sea-grant university will focus attention on marine science and oceanology, there are other equally effective ways to focus attention on these areas. I suggest that the sea-grant university label be abolished but that the

same objectives and purposes be retained. These objectives can be successfully attained by the following: (1) The sponsoring governmental agency establishing criteria for institutional grants; (2) Permitting any institution to apply for a grant on a competitive basis; (3) The grant application providing for marine science programs in (a) graduate training, (b) the training of technicians, (c) continuing education, (d) research, and (e) extension; (4) Awarding institutional grants on the basis of merit.

Dr. Knoblauch pointed out quite clearly that it was the unrestricted institutional grants which were largely responsible for the tremendous success of the land-grant movement. Let's profit from history by adopting the institutional grant method. These grants should be unrestricted except that the institutions agree to provide programs in the areas outlined in (3) (a) to (e).

The possibilities of joint ventures should not be overlooked. Inland and coastal universities might join strengths in a cooperative sea-grant program.

MEIR H. DEGANI, State University of New York, Maritime College

It is of great importance to keep in mind, when the implementation stage of the sea-grant college arrives, the strengthening of the several existing undergraduate curricula in oceanography, as well as encouraging the development of more such undergraduate curricula.

The job ahead of us will need the aid of many practitioners of the art, as M. B. Schaefer has suggested, to work side by side, with graduates of other academic levels.

WILLIAM H. DREW, Associate Dean, Graduate School, University of New Hampshire

As a land-grant college located directly on a large marine estuary and in a state that has a limited amount of Atlantic seaboard, the University of New Hampshire is interested in the concept of a sea-grant university. As evidence of more than a passing interest in these matters are the history of a marine laboratory that was located on the Isle of Shoals, well established programs in the biological departments concerned with estuarine and marine matters, emerging programs in ocean engineering, and the building of an estuarine laboratory on Great Bay within the coming year.

The University strongly favors the general concept of a sea-grant university and shares the immense enthusiasm expressed for the idea at this most successful meeting. As with most far-reaching ideas, it will be necessary to establish some parameters. Although we have all agreed upon a goal (that of occupying the sea) and have also agreed upon a general means of achieving said goal, there must be considerable further thought and discussion concerning the specifics of the sea-grant university concept.

As defined in these meetings, oceanography can be interpreted to include many disciplines within the social, biological, and physical sciences. Although one might not disagree with this broad type of definition for general discussion, it does have serious impact when we consider the types of educational programs to be initiated. While it is desirable for the ocean-oriented physicist to know

something about ocean law, biological organisms in the ocean, and the geology of the ocean bottom, he still is and should be first and foremost a physicist. It is very doubtful that the technological breakthroughs that have been envisioned at this meeting could come about through persons who are not well trained in a given academic discipline. Although inter-disciplinary education certainly has advantages up to a limit, we may be envisioning something beyond this limit in terms of training of overall oceanographers. In other areas of endeavor that have been discussed at these meetings, there is an obvious need for a broader type of training program that does not delve to the very depths of any given academic discipline. In the training of technicians and extension agents, a curriculum of this type has merit. It seems necessary, therefore, to have a clearer understanding of the types of training programs we are concerned with and the best means of accomplishing them.

We see a need for a wide variety of approaches to the needs of oceanography. Approaching the problem through technical training, extension work, and applied and basic research seems desirable. The writer has serious doubts as to whether or not this is a type of program that would be compatible with the present operation of the National Science Foundation, which has an enviable record of supporting basic research programs. It would seem that other agencies would better fit the needs for administering a program developed along the lines of the sea-grant concept.

A final remark would only be to repeat once again the objections to the center of excellence idea, which were made during the meetings. For fairly obvious reasons, the idea of developing a very limited number of centers of excellence in oceanography with federal funds is politically unfeasible. We should not be content, however, to allow political implications to dictate educational programs. I would, therefore, object to the centers of excellence concept on the basis of academic advisability. A few centers of excellence might very well be a reasonable means of approaching the needs for specialized basic research in oceanography. If, however, we are to consider also the application of basic research to specific problems and the results of these applications being extended to the industry itself, it is doubtful that a few centers of excellence would accomplish these ends. To have an effective extension service, it must be administered close to home.

In summary, we at the University of New Hampshire are highly enthusiastic about the idea of a sea-grant college and strongly hope that future fruitful discussions of the type held at this meeting will further define the idea to the point where it will be possible very shortly to transform the idea into fact.

FRANKLIN P. EGGERT, Dean of the Graduate School and Director of Research, University of Maine

The concept of the sea-grant university as outlined by Dr. Spilhaus is a valid one and should be heartily endorsed. The exploration, exploitation and occupation of the oceans will become a necessity in the near future as we deplete the resources of our land masses and as population increases. The oceans will belong only to those who have the required knowledge to utilize them. These principles appear undebatable and, consequently must be supported.

The source of funds for support and the agency through which the program might be administered is more obscure than the basic principle. It is my opinion that since the sea-grant concept involves a greater role than any present agency now performs, a new agency such as that proposed by Senator Muskie (S. 2251) might offer better possibilities provided the sea-grant concept is included.

Centers to receive support must be identified on the basis of their capacity to carry out the total concept of the sea-grant university, as well as their being centers of research excellence.

HAROLD H. HASKIN, Professor of Zoology and Oyster Investigations, Rutgers University

Of course no one concerned with the development of our marine resources can be opposed to the primary idea of this conference--that additional financial support be provided for this purpose. It is easily understandable also that we are impressed with the accomplishments of agricultural sciences and therefore are thinking of ways and means to establish similar national support for the marine sciences. I cannot, however, agree with the several speakers at this conference who held that our basic knowledge in marine science is at such a high level that we can de-emphasize basic research and should now concentrate on application of this knowledge, through marine engineering, to the conquest and occupation of the sea. One speaker even stated that the management of the shallow water coastal resources was easy and that we should move at once to the more challenging problems of offshore waters. As one who has worked with estuarine shellfish resources over the past 20 years, I should like to point out that we don't even have the basic knowledge to insure proper management of such relatively well-studied species as the oyster, hard clam and soft clam. These estuarine populations have been placed under severe stress largely through engineering "improvements" in channels, harbors, stream control, water diversions, sewage disposal, etc. This conference should not push for all out engineering advances without frank recognition that we require stronger basic research programs to support such advances.

CLARE P. IDYLL, Institute of Marine Science, University of Miami

It is widely recognized that understanding of the ocean environment is necessary in order to reduce its potential to use. And it is further realized that this understanding can only come through the mechanism of scientific enquiry; that this must then be followed by the development of engineering technology; that, finally, the technology must be demonstrated to the industrial community and adopted by them. Ocean scientists have stated and restated this conviction often enough in recent years that the public and the Congress are dimly perceiving it. But in such cases it often takes an eloquent expression of the idea for it to achieve realization in any reasonable time. Dean Spilhaus' imaginative concept of the sea-grant college and his eloquent exposition of this concept is the kind of spark required to pick the idea out of its tracks and carry it to realization. It is clear that the sea-grant college idea has caught the imagination of the ocean science community, and properly handled by that community it can also capture the imagination of Congress. If Congress adopts the concept and establishes sea-grant colleges the oceanographic community will find itself called upon to increase its activity enormously to keep up with the demand for information and skills at all levels.

But while it seems certain that this widely ranging kind of activity will result from the establishment of sea-grant colleges, it will be fatal to try to create them full-blown by attempting to include all things for all oceanographers. The great danger now is that Dr. Spilhaus' key idea will be ignored and that all of us go baying after our own modified vision of the "sea-grant college" regard-

less of how far this vision might deviate from the original. The Spilhaus concept is to create the engineering and technological machinery and to translate knowledge already gained about the sea into practical use. "Pure science" is seen as an essential companion activity, but application - applied science - is the fundamental base of the concept.

It is to be hoped that wide, active and unified support can be given to Dr. Spilhaus' idea and to Senator Pell's practical expression of it. Support of all facts of oceanographic research and engineering will certainly follow, but we must be willing to allow a certain amount of time for some of them. It took the land-grant colleges 100 years to build their complex structure; it will not take the sea-grant colleges anything like as long if we are energetic and intelligent enough to build on their experience.

One principle which seems necessary to establish is that the functions of practical application of the sea-grant colleges should be based on research and teaching at the graduate level. A common misconception is that oceanography is a science in itself. This is no more true than that there is such a thing as "land science." Oceanography is the application of the basic sciences of biology, geology, physics and chemistry to problems of the sea. This being the case, students of oceanography must be graduates who have mastered the principles of at least some of these sciences and who are then confronted in a graduate school with the kinds of problems created by the unique ocean environment and given opportunity to practice the solution of some of these. Training in marine science should be largely the teaching of attitudes and principles and the intensive participation in research. It is essential, furthermore, that this research be on real problems whose solution is necessary to advance our mastery over the ocean environment, and not artificial problems invented only to provide a student with a thesis. This requires that graduate schools in marine science be given realistic support for research programs. Whether this support is in the form of grants or contracts will depend on circumstances, but however it is given, some control is necessary to ensure that only excellence is supported. Once this kind of safeguard is assured, and review mechanisms established, then some system of continuous and long-term backing is required in order for the schools to attract and hold able faculty and to guarantee long-term programs.

Since the result of basic research is to be applied to practice in the nature of programs envisioned for the sea-grant colleges, and applied research is strongly emphasized, it seems appropriate that the sea-grant college program should be administered by the Bureau of Commercial Fisheries. It is to be hoped that the National Science Foundation and other agencies will continue strong support of basic ocean research. In fact, it will be necessary, as applied research and engineering increase in scope under the sea-grant college impetus, that greatly increased basic research will be essential, inside the sea-grant colleges and in hundreds of other institutions on the coast and inland alike. Technology feeds on pure research, and the base of the latter must be far broader than the technology it supports. Thus the support of NSF and of many other agencies will be increasingly urgent. But for the mission of the sea-grant colleges, the experience and philosophical base of the Bureau of Commercial Fisheries seems to be a more logical administrative agency.

The sea is an unique environment, and if we are to understand it we must study its problems intensively with scientists trained in special techniques. It may be true, as has been stated, that there are enough chemists and biologists and other scientists in the United States to solve the problems of oceanography, but this is highly doubtful. What is certainly not true is that these scientists are engaged now or are likely soon to be engaged in the study of marine science. The only means by which the United States can engage more effectively in oceanographic studies is to direct the efforts of skilled and trained scientists on this research. Many of these have still to be trained. The establishment of sea-grant colleges would be an effective means of promoting this training, as well as providing an enormous stimulus to the essential research.

FRED MANGELSDORF, Administrative Aide, Woods Hole Oceanographic Institution

It seemed fairly obvious to me that the sea-grant college would indeed be oriented to the applied science, or ocean technology. It should be a school that would tell people how to do things in the oceans, but not necessarily what should be done or what questions should be asked; a school that operated long-range experimental programs in the oceans that consistently produced the biggest tuna ever caught, the most abundant yield of nutrients produced, etc.

The old schools known as land-grant colleges are also known as agricultural and mechanical colleges. I think that what we now need is not really the land-grant concept as much as it is the agricultural and mechanical concept. If we substitute "oceans" for "agriculture", and substitute "technology" for "mechanical" (to include electronics, et al) you have ocean technology instead of agricultural and mechanical. I thus see the emphasis shifting from "sea-grant" colleges to "ocean technology" colleges. I think this is really a much more meaningful name for the type of school that I personally had in mind.

WILLIS E. PEQUEGNAT, Acting Head of Department, Texas A&M University

It can be said that a substantial number of persons representing a wide variety of academic pursuits at Texas A&M University subscribe to and are willing to lend support to the development of the concepts embodied in the proposed Sea-Grant College and Program Act of 1965.

It is understandable that we should have an interest in the provisions of this bill and that we can appreciate the many needs that it will satisfy. Being the land-grant college of the State of Texas, Texas A&M has a long tradition of translating the results of research in agriculture and engineering into applications that will benefit public pursuits. The University established a Department of Oceanography in 1950 in response to the needs expressed by persons who derived their livelihood from the Gulf of Mexico. Since that time we have graduated a total of 60 students at the M.S. level and 36 at the Ph.D. level. Many of these former students now occupy positions of leadership in academic, governmental, or corporate institutions. In addition, our regular staff members are called upon to conduct a wide variety of research for both industrial and governmental agencies. Furthermore, we have for some years given special courses in advanced topics to personnel in several agencies of government. Since we are the only department of oceanography situated near the western Gulf of Mexico, it is natural that our staff would be called upon for a wide variety of consultative functions in cooperation with industrial needs.

In order to meet some of the needs of the industrial and technological community, Texas A&M has recently established a cooperative program in Ocean Engineering that is administered by the Department of Civil Engineering and in which selected members of the oceanography staff participate. In short, we are called upon with increasing tempo by a broad spectrum of nonacademic activities to aid them in orienting themselves toward the ocean for economic purposes.

These are only a few of the reasons why we are interested in the sea-grant college bill. In addition, we see in this proposed act an excellent mechanism for redirecting some of the funds derived by the federal government from provisions of the Outer Continental Shelf Lands Act back into those academic and related channels that will increase our effective and more productive use of submerged

lands on the fringe of our continent and of the waters that bathe them. Thoughtful use of these lands will obviously be of benefit to the United States as a whole, and will as time goes on permit the deriving of increasing funds to permit far more sophisticated uses of the sea margins than we may now even envisage. We also see the proposed act as providing a sound basis for the setting aside of selected areas of our continental shelf as reserves that will be protected from haphazard exploitation. These areas which will be preserved as natural laboratories will, with the passage of time, become increasingly valuable to Americans generally, and the act of setting them aside may be hailed by future generations as the most significant part of the Sea-Grant College Act. Although we are blessed with extensive coastlines including those of the Great Lakes, even those of us born in the second decade of the present century are too aware of the impact of unbridled usurpation upon certain regions. We also see in the proposed act the stimulus that will bring together persons of many talents in our search for more intelligent use of the marine environment. When the bill is spelled out more completely, it will make clear to our colleagues in economics, sociology, and the law that we welcome their thoughtful study of the many problems that beset those who wish to make more effective use of the sea as a habitat for man in broader scope than attempted heretofore.

We feel, therefore, that it is incumbent upon those of us who are devoted to the traditional study of the sea to support legislation that will not only in the long run stimulate more basic investigations but will also provide reasonable means for bridging the gap between the act of deriving new knowledge and its application for the more immediate benefit of our citizens.

JOHN H. PHILLIPS, Director, Hopkins Marine Station, Pacific Grove, California

The presentation was stimulating and the discussion rewarding. It left no doubt in my mind of the desirability of supporting Senator Pell's Bill (S.2439).

There were several points, however, with respect to implementation that need early consideration, and many of these points were best revealed in the general discussion. I would like to recommend that while everything possible is done to urge the enactment of this important piece of legislation, discussion and planning of ways for its implementation also proceed.

Several aspects are obviously in need of thought. What are the subject deficiencies of our national program? Marine engineering and technology were mentioned as well as marine law and economics. What deficiencies exist with respect to facilities presently available for training and research in the essential subjects of marine science?

Based upon the answers to these questions, consideration must be given to the best ways of removing the deficiencies and encouraging the improvement of existing programs and facilities. Institutional grants would appear to be the most useful form of funding. They would allow both strengthening of existing programs and initiation of needed additional ones.

President Horn made a very good point in his comments as a panel member. It is unrealistic to anticipate that each institution involved in some particular aspect of marine science will become equally involved in all other aspects. We cannot anticipate the development of faculty and curricula representing all of the needed subjects of marine science in every institution. Some will remain strong in only one or more specialties, e.g. biology, oceanography, engineering, etc. It would be unrealistic to expect these institutions to broaden their offerings to include all subjects in marine science. Perhaps additional institutions

will be needed to provide the kind of offering exemplified by the agricultural college, but I feel it is short sighted to suggest that this latter type of institution is the only kind in need of support. It would deny the value of what we already have. Instead, we should try to improve and augment those already in existence.

While the term "sea-grant university" has an appeal, it does not describe the program as it was proposed at the conference. The term also carries some difficult connotations with respect to distribution of funds. It at least suggests distribution of support, not on a regional basis - but on a national one.

GEORGE A. ROUNSEFELL, Professor of Marine Biology, University of Alabama

The sea-grant university is an interesting concept and especially so in light of the facts that we have slipped from second place to fifth place in world fisheries, and need the mineral resources of the seas. Moreover, it even becomes urgent, when we consider the need of the world for additional protein to buy time for adjustments in human populations.

The sheer enormity of the problems in studying the seas dictates the need for a wide variety of programs among universities. Under the land-grant program some universities specialized in horticulture, some in livestock, and still others in agricultural engineering or entomology. Similarly, intelligent exploitation of the seas calls for work in many areas and disciplines, each in varying degree consistent with both local and national needs. Several universities already possess considerable capabilities in the oceanography of the high seas, for instance, and it would seem unwise for too many universities to attempt to work in this area which requires such enormous outlays in ships, technical personnel, and operating expense. The University of Alabama is attempting to meet its own requirements for any deep sea ventures in conjunction with the Gulf Marine Research Association. This association of universities and marine laboratories, formed recently to aid marine research effort through cooperation in use of facilities, presently has members in Alabama, Mississippi, and Louisiana.

In view of the above, I hope any pending legislation will allow for considerable latitude.

Our specific concerns cover three main points: First, the situation in the Gulf is vastly different than in the Northeast, or in the Pacific. Over 20 per cent of the catch by United States fishermen is taken along a stretch of scarcely 300 miles of the northern Gulf. Over 95 per cent of the species now harvested are dependent on the shallow protected bays and estuaries during all or a part of their lives. The preservation of this rich environment in the face of pollution and engineering projects engendered by burgeoning industrial development is one of our chief concerns.

A second concern is the obsolescence of our fishing fleet which now fishes only the shallow inner portion of our wide continental shelf. We must build new vessels capable of using modern gear and fishing both the deeper waters, and the vast schools of herring-like fishes not now being tapped. The kinds of vessels needed will require operators skilled in electronics, navigation, and mechanical engineering.

A third concern is the rearing of crustaceans, mollusks, and fishes in our extensive estuaries. Although the possibilities are vast, implementation awaits research on the physiology and nutrition of marine fauna.

Despite the lack of any funding similar to that accorded agricultural training and research, the University has maintained growing interest in these problems. For the past 10 years, a course in marine biology has been taught every summer. Since 1963, the University has operated the Alabama Marine Resources Laboratory on Dauphin Island, conducting applied fishery research for the Alabama Department of Conservation. On-campus courses are offered in ichthyology, limnology, and marine fishery science. However praiseworthy, these efforts are puny in relation to the need.

The University of Alabama has shown it is both willing and anxious to aid the state and the nation by expanding its education and research in the marine sciences. If the pending legislation on sea-grant universities has broad enough scope to encompass the needs we have outlined, it will be welcomed and supported by the University.

CARL N. SHUSTER, JR., Director, Northeast Shellfish Sanitation Research Center, U. S. Public Health Service, Narragansett

When I gaze over Dr. Spilhaus' shoulder into his crystal ball portrayal of men working and living under the sea through achievements in ocean engineering -- taking full cognizance of his concept of a sea-grant university and recognizing Dr. Chapman's apt differentiation between the "land" and "sea" people -- I can see the establishment of a college on grant lands of the continental shelf as the ultimate fruition of the concept. I see also an extension of Dr. Spilhaus' remarks on ocean engineering into a research-application area in which the Public Health Service of the U. S. Department of Health, Education, and Welfare has a definite interest. As in the case of Captain Cousteaus' and the U. S. Navy's Sea Lab experiments in underwater living, medical and physiological research will continue to play a vital and significant role in man's invasion of the sea floor. Successful habitation in the underwater city of tomorrow will depend in large measure upon advances in environmental engineering -- including water and air supplies, sanitation, and community health -- beyond those even now envisioned for our terrestrial habitat. It is an exciting future to contemplate; by establishing sea-grant universities on the land today we may be fully able to benefit from the lands at the bottom of the sea tomorrow.

WILLIAM H. TAFT, University of South Florida

Many of the discussions at this conference have been directed towards the problem of financing the sea-grant colleges.

One of the challenging and most inspiring aspects of the possibility of establishing sea-grant colleges is the possibility of augmenting a need by proper planning and implementation rather than being forced by a national crisis, such as produced by Sputnik, to race into the problem of crash-program support for marine science on a national scale.

We have heard comments by various speakers as to how they would finance the proposed sea-grant colleges. These proposals range from Senator Pell's 10% of royalties from leases on the continental shelves to the proposal from Dean Hargis that we should use a portion of the more than \$1,000,000,000 collected in 1964 from import duty imposed on fishing products brought into the United States.

It seems to me that funding should really be the least of our problems. Let me illustrate. Last summer, (1965), a Russian trawler appeared off the west coast of Florida in the vicinity of St. Petersburg. This vessel was collecting fish to be consumed either by Russia or her satellite countries. As a result of this visit, Floridians were "up-in-arms" and were extremely displeased that Russia was "stealing their fish." Nevertheless, the Russians were there principally because they could locate and catch a sufficient number of fish to make their efforts worthwhile.

What will the State of Florida, or the federal government, do if the Russians move onto the expansive continental shelf off the west coast of Florida and withdraw billions of barrels of petroleum? Will it take such a crisis to awaken the American public? When we initiated the space race after Sputnik did we concern ourselves with the problem of finances? I submit that the United States cannot afford not to pursue and accelerate its programs in marine science.

ALLYN VINE, Woods Hole Oceanographic Institute

In discussing some of the international aspects of the oceans, Dr. Chapman has emphasized the future importance of ownership. I would like to emphasize another aspect of ownership, or perhaps non-ownership of the ocean.

For a long time most nations have held dual, and somewhat contradictory attitudes toward the sea and the land. On the wet portion of the earth they have supported the concept of freedom of the seas while on the dry portion of the earth they have been highly nationalistic, possessive and boundary conscious. The contrast between these two cultural and national attitudes is very great and it may well be that the international attitude towards the ocean has been one of the great stabilizing influences in the world. To the degree that this is true, we must be far sighted enough to also consider the reasons for not dividing up the ocean but evolving maritime law, and procedures that will help maintain the most useful aspects of our water frontier. This effort is far more than a technical one and implies that the contributions of a sea-grant college would be philosophical, historical, economic and legal as well as technical. The implied scope of the phrase "sea-grant college" is perhaps the best promise that our educational and national efforts may come to grips with preserving the freedom of the world's ocean in its political and recreative sense as well as trying to bring the ocean down to a workable size in a technical sense.

There have been many comments on how many sea-grant colleges there should be, initially, with good reasons given for having only a few and good reasons for having quite a few. In making these decisions I believe it is important to remember that the ocean is very big and very tough, and the ocean is unlikely to be tamed or developed by using only the sea-going craft and technologies that we have used in the past. For example, both students and company presidents may believe that new kinds of ships, drilling rigs, mining methods and aquaculture techniques must be developed before we can quadruple the ocean's impact on the world economy and the American labor market. Because of the need to educate students and teachers with new and expensive sea-going ships, laboratories and techniques it may be wise to initiate sea-grant colleges on a regional basis to more rapidly develop major facilities and field graduate work in ocean engineering.

For example, the laboratory ships for an electrical engineering department might be a FLIP ship like a 1000 foot long telephone pole that sends power to the bottom while the archeological department might have a pair of exploration submarines. These examples are only to show that by combining efforts during an

initial period we can improve the chances for technical innovation and effective, imaginative approaches to our problems.

We must also remember that while the sea-grant university is an idea of the 20th Century, it is an idea for the 21st Century.

CHARLES G. WILBER, Director, Marine Laboratories, University of Delaware

After careful thought on the matter I am, in principle, in support of the sea-grant college idea. I feel that certain details of the Pell bill may have to be modified as a matter of practical politics. However, I feel that the general concept is sound and should receive the support of the oceanographic community.

To my mind one of the most important aspects of the bill and the concept is the insuring of continuous, dependable, long term support for college efforts in the marine sciences. It is gratifying to realize that leaders in the field are no longer satisfied with the project type of support. I feel that I have had a reasonable amount of experience both as administrator, research worker, and as university teacher to maintain that the project method of supporting our scientific endeavors leaves much to be desired. I would urge that any implementation of the sea-grant college idea insure this type of continuous, dependable, long-term financing. The field of oceanography is so broad that it requires much imagination, daring, and innovations; long term financing of research and education in the field is a must.

To my mind certain aspects of the bill require changing or modification. I am thinking specifically of some way to encourage the formation of regional oceanographic colleges which might be operated by several cooperating states to the benefit of all. I also have misgivings over the present wording of the bill which seems to indicate that support under the sea-grant college legislation could go to private concerns and to individuals. I feel that, if this were left in the bill, I would be forced to do all I could to defeat the legislation. I do not know what private concerns would qualify under the broad education and research aspects of the bill. Certainly I do not know where individuals would qualify or should. It is my view that support under this legislation should be limited to recognized colleges and universities, either private or public. The legislation should not make funds available under the sea-grant concept to private industry or to individuals.

Finally, in our debate and thinking on the sea-grant college concept we must never forget or allow legislators to forget that this is an educational venture. We must urge that the educational aspects of the bill not be lost or snowed under by the research aspects.

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Dr. KNAUSS. Many of my scientist friends have asked me what a sea grant college is. I believe the statement of the committee does much to answer that question. A modern university is dedicated to teaching, research, and public service. The land grant system of research, academic instruction, and extension—getting knowledge into circulation and use—has made American agriculture the most productive in the world. The land grant colleges were probably one of the best investments the Federal Government ever made. The sea grant college concept implies a similar attack on the many problems of marine science and industry within the context of a modern university.

Sea grant colleges, or whatever you would like to call them, are already emerging on college and university campuses from Maine to California. A modern university is committed to serve the people in its region who are faced with scientific, technical, and other problems. The people who are trying to reap a living from the sea have long-neglected problems and they are turning to the universities in increasing numbers for solutions and assistance. In other words, we are going to have sea grant colleges one way or another. However, Federal legislation is most important if you wish to accelerate the process and to establish high initial standards of performance.

In the course of my travels I have had some opportunity to learn what other institutions are doing to develop our ocean resources, but naturally I know more about what is happening in Rhode Island. I'd like to talk about what is happening here in Rhode Island as an example of what one might expect from a sea grant university, because the University of Rhode Island has made some progress in becoming a sea grant institution. In part this is due to a maritime tradition that goes back to colonial times. Now, here in this State you are never very far from the sea. In addition, our university is a relatively young institution where you can experiment, innovate, and initiate programs without too great a concern for tradition.

The graduate school of oceanography trains students at the master's and doctoral level in all aspects of marine science. We operate a major research vessel, *Trident*, which can travel to all parts of the world's oceans. Our faculty and graduate students are working on the frontiers of ocean science and they have been responsible for at least a few of the many important discoveries that are being made regularly in this new and exciting field.

Our graduate school of oceanography, with its total commitment to the sea, serves as a focal point around which many programs have developed. At one time or another we have had 30 departments within the university working on various projects under a coordinating group known as the committee on marine resources. We have been concerned with the marketing problems in the fishing industry, the growth and exploitation of the hard shell clams, beach stabilization and dune rebuilding, the possibilities of obtaining pharmaceutical agents from the ocean, labor efficiency in fish processing and handling—to name but a few areas of investigation.

A year ago we established what I believe is the first university group focusing its attention on law of the sea. The Law of the Sea Institute has or is seeking to promote understanding and solution of the legal and international problems that arise from attempts to exploit the sea. This summer nearly 200 lawyers, scientists, and educa-

tors will gather here for 5 days to discuss offshore boundaries and zones. The chairman of our geography department is directing this effort.

Last spring we formalized a program that has been evolving for some time and announced the establishment of a curriculum in ocean engineering. This program is a joint offering of the college of engineering and the graduate school of oceanography, designed to produce graduates with master's and doctoral degrees who understand the ocean environment and can design and build structures, vehicles, and equipment necessary for its exploration and exploitation. Graduates of this program are in great demand.

We have recently established a marine experiment station. Through the mechanism of this station we expect soon to be able to tackle a wide variety of problems. The initial program which will begin this summer concerns shellfish culture. We believe it possible to develop a completely controlled "closed system" of growing shellfish on a commercial basis. Assuming such a system can be established where we control the environment and the growth from the larval stages on up through maturity and reproduction, we can start on the next stage. We can try to improve the environment; we can develop the optimum food for growth; we can develop a better and faster growing product by selective breeding.

We work almost on a daily basis with local fishermen. We run a 1-day fishermen's forum each spring, introducing them to new techniques to increase their productivity. University bacteriologists also help to solve quality problems in fish processing. In addition, we are working with local fishermen to modify midwater trawl methods and gear so that they can be used on local vessels. We have proposed the establishment of a 2-year fisheries school where fishermen will be trained.

I hope I have given you an idea of where we here at the University of Rhode Island are heading and the type of activity that should be characteristic of sea grant colleges. What is being proposed as I understand it is an assault on the problems of the sea, using all of the various kinds of intellectual resources generally associated with a university. I am convinced, however, that much as we have done to date, it is only the beginning. Much more can be done in terms of the future growth and security of this country. I think much more needs to be done.

I believe a mechanism of some sort which guarantees minimal levels of financial support is necessary. This can be accomplished through passage of legislation establishing sea grant colleges. If such legislation is passed I am certain that within a hundred years or less our children and our children's children will have reason to admire our vision. We will have given them another world far richer than the one we have now. Thank you very much.

Senator PELL. Thank you very much for coming here to testify. I should also like to add how grateful we are to you for lending us one of your graduate students, Bob Fournier, who has contributed so much in the actual drawing up of this legislation. As you know I have quite an intern program of people from Rhode Island, more than 250 in the last few years have worked in my office. We are very grateful to you for lending Bob to us for this period of 6 weeks. We trust,

even if it stretches out a few days more that he may be with us. I am well aware of the "fish forum," I participated in it and I congratulate you on it.

I have a couple of specific questions here that I would like to ask you. We are fortunate to have such a well informed witness as yourself here. What is your view as to where the administration of these funds should be placed, the repository? What agency should administer this bill? Should it be the National Scientific Foundation or should it be the Smithsonian Institution?

Dr. KNAUSS. Well, I have thought about it, Senator, and also the committee for sea grant colleges has thought about it. I think one thing is clear from our discussions that there is no obvious place within the Federal Government where the sea grant college bill should, I mean, the administration of it should rest. One of the things that we have sort of agreed upon among ourselves is that it probably should not be in an agency which has a reasonably narrow mission as regards the sea, such as the Bureau of Commerce or the Department of Defense. Certainly the National Science Foundation and Smithsonian Institution meet the criteria as having missions with a broad or big scope. I can see many good reasons why it should go to Smithsonian. The National Science Foundation was set up some 15 years ago and as a result the National Science Foundation, rightfully so, has moved very slowly in taking on new funds. As a result it has built up a great reservoir of good feeling among scientists. But, at the same time it has not exercised its prerogatives as much as it might have. Whether they are in a position to take on something as applied, say, as the sea grant college program is not for me to decide.

Senator PELL. In connection with the actual bill itself do you have any specific thought as to changes, because this bill that we have already discussed at the Southern New England Marine Scientists Association, and is being discussed here is perfectly open to change and we need some specific suggestions. Do you have any thoughts as to changes?

Dr. KNAUSS. Well, this sea grant college committee has suggested some changes which are appended with our statements.

Senator PELL. I think it is probably a good idea, whether these suggestions are adopted or not, to put them in the record. Accordingly, I will ask that they be made a part of the record at this time.

Now, do you have any view as to this perhaps more general question of the law of the sea? Where do you think our national interest lies? Do you want to follow the very interesting suggestion of Professor Holmsen of your faculty that the limits should extend on the basis of depths, or would our national interest lie more on the basis of the normal 3, or 6, or 12 miles?

Dr. KNAUSS. I think it depends upon whether you are a New England fisherman or a marine skipper as to where your national interest lies. I feel that the real national interest rests and will be met by our gaining mastery of the sea by economic and scientific exploration and exploitation. I said it before, and I think it is worth repeating, history shows that control of the land has gone to those people who occupy the land. Not necessarily that country that is the strongest or has the strongest armies. That country which actually can occupy the sea, exploit the sea, will, in fact, control the sea. And that is even more important than having the best navy in the world.

Senator PELL. Just to return for a moment to your specific suggestions. Would these suggestions all be accepted with equal force by your group or is there one suggestion that is more favorable than another?

Dr. KNAUSS. I think they should all be accepted with equal force, Senator. The question as to where this bill should be administered, where the administration of this bill should be placed, our committee did not feel at that time that we were in a position to make any recommendation as to where the administration of the bill should rest. Whether it should rest with the National Science Foundation or the Smithsonian Institution we felt that, at least at that time, which was in early February, that we were not in a position to make a recommendation on this matter.

Senator PELL. Speaking to you as the dean of the graduate school of oceanography in this field, where do you apply for funds? What Government agency have you been in close touch with and are they negative in your view?

Dr. KNAUSS. We apply for grants from a wide variety of sources, the Atomic Energy Commission, the National Science Foundation, the Bureau of Commercial Fisheries, and the National Institutes of Health. We have had money from all of these places. Usually I get grants on a project basis. It is very difficult to get grants on an individual basis for a 2- or 3-year period which allow you to speculate on the basis that something might turn up and so forth. This is certainly one of the key points, I believe, of sea grant colleges, this bill, that a fair portion of the funds would be distributed where needed.

Senator PELL. This is the same point that President Horn raised in his testimony about the importance of having institutional grants as opposed to individual grants; is that right?

Dr. KNAUSS. That is right, sir.

Senator PELL. Now, you mentioned five or six Government agencies. Do you have someone in your faculty who coordinates these requests or does each man formulate language which will most appeal to that agency particularly?

Dr. KNAUSS. We have no one person that does the coordinating. I would say that it is the agency, itself, that is aware of the problem.

Senator PELL. Another thought here is in connection with fish protein concentrate. As I understand it you, and the Point Judith Fishermen's Cooperative, have been working together to get one of those plants, one of those stations.

Dr. KNAUSS. We are very excited about this. We have talked with them about this and we have made some tentative plans as to what we might do. Yes, we are ready to move on this if we were first to get one of these plants in this area. First the bill has to pass.

Senator PELL. I would also like to congratulate your university on going ahead with that meeting a few months ago when we discussed this idea of the bill for a fish protein concentrate plant, because, as I have said to Mayor Harrington, I believe the time will come when fish protein concentrate will be considered perfectly suitable for human consumption and then there will be a great need to develop this food, right?

Dr. KNAUSS. Yes, I agree. It certainly has its advantages. It stores easily and can be mixed easily with other foods.

Senator PELL. Thank you very much for your testimony.

Our next speaker is Mr. John Horton, vice president of the Greater Providence Chamber of Commerce. We are very glad that you were able to come here today and testify on behalf of the Greater Providence Chamber of Commerce.

STATEMENT OF JOHN HORTON, VICE PRESIDENT, GREATER PROVIDENCE CHAMBER OF COMMERCE, PROVIDENCE, R.I.

Mr. HORTON. Mr. Chairman, I am privileged to be here today on behalf of the Greater Providence Chamber of Commerce.

Since 1636 when Roger Williams founded his settlement at the head of Narragansett Bay, the destiny of Rhode Island and Providence Plantations has been linked firmly with the oceans of the world. In fact, very few Rhode Islanders are acquainted with the fact that Pawtucket was once a shipbuilding center.

Today, on the quiet, sloping streets of our East Side Hill, shaded by ancient elms and lindens, stand the great houses, virtually unchanged since the days of the sea captains and merchants who built them in the 1700's. Today there exists throughout Rhode Island a new awareness, a determined dedication to discover and harvest the vast potential and rich rewards of the ocean.

In January of this year, the chamber's board of directors, speaking for the 2,000 members and 1,000-member firms of the Greater Providence Chamber of Commerce, unanimously voted to support Senator Claiborne Pell's bill, S. 2439, which authorizes the establishment and operation of sea grant colleges and programs of education, training, and research in the marine sciences, and a program of advisory services relating to activities in the marine sciences, to facilitate the use of the submerged lands of the Outer Continental Shelf by participants carrying out these programs.

In backing Senator Pell's bill, the chamber's board stated that "the important potential of the sea as a source of food is reason enough to expand this Nation's interest and activity in the study of the ocean." The needs of the Nation's defense posture, added to this possible solution of the grim prospects of famine that exist in many areas of the world, are cause for action today in the field of oceanography, the potential rewards of which challenge the imagination.

Already there are more than 200 companies in this country with a major interest in oceanography, and more firms are entering this complex field each year. To staff these private organizations with competent oceanographers and technicians will be an invaluable benefit derived from creation of sea grant colleges.

Much progress in oceanography can be seen in Rhode Island and southern New England. Outstanding research facilities exist staffed by expert technicians, and additional facilities are now under construction. The chamber's interest in oceanography helped to create the Southern New England Marine Sciences Association, an areawide organization devoted to the promotion of the marine sciences and the acquisition, storage, retrieval, dissemination of information on oceanography.

New studies are being made in the field of international laws dealing in the exploration of the sea. I note with satisfaction that the first

annual summer conference of the Law of the Sea Institute will be held this June here at the University of Rhode Island to explore in detail the critical subject of "Offshore Boundaries and Zones." A recent study by the department of food and resources economics at this university disclosed that marine-oriented activities account for 21 percent of the aggregate income received by one and a half million persons in a three-State region from New London through Rhode Island to Cape Cod and the offshore islands of Massachusetts. So, the chamber's support of Senator Pell's National Sea Grant College Act is not without substantial economic foundation. Optimistic forecasters have predicted an annual national market of \$5 billion in oceanography within 10 years, or about the current NASA budget.

The greater Providence Chamber of Commerce urges passage of the National Sea Grant College and Program Act of 1965 as the key stimulus to current efforts by Government and industry to establish sound, long-range planning for this country's oceanographic program and activities. Passage of S. 2439 will be a dramatic thrust toward the crucial goal of harnessing our greatest natural resource, the sea. The last earthly frontier is at this very moment lapping at our shorelines. Thank you.

Now, speaking as a native Rhode Islander with a deep-rooted love for the salt water and our many, many miles of shoreline, I hope that by the production of this bill, by education and proper application, the continual decay and pollution of our marshland may be arrested and the irreparable damage will be stopped. I thank you again for permitting me to come here today.

Senator PELL. Going to one point in your testimony as to the three-State region from New London through Rhode Island to Cape Cod and the offshore islands of Massachusetts, where it is said that 21 percent of the aggregate income of the people there is derived from the sea. How far in does that territory go? Is that a strip that would go up the northern border of Connecticut and all of Rhode Island?

Mr. HORTON. To my best information it is the costal area. I don't think it would include the back extremities of Connecticut which would become more agricultural.

Senator PELL. It would consist of the counties along the coast then? It would include all of Rhode Island?

Mr. HORTON. All of Rhode Island, yes.

Senator PELL. Basically it is the area that includes the Southern New England Marine Sciences Association?

Mr. HORTON. Yes, it is that area.

Senator PELL. That is the area that Dr. Horn and Dr. Knauss spoke about?

Mr. HORTON. Yes, sir.

Senator PELL. Another point in your testimony which I would like to touch on is; you mentioned in your testimony a few moments ago the question of pollution of marshland. I have here another bill that I am trying to get advice on. Senator Tydings of Maryland had introduced a bill on pollution, the Federal Water Pollution Contract Act, and he actually mentions Rhode Island in his remarks. In our State we have 4,500 acres of soft marsh and only 400 acres are earmarked for preservation. These same acres act as a nesting ground, as I understand it, for fish and products of the sea.

Mr. HORTON. Yes, indeed. A quick tour along our shoreline will quickly show what has been happening to much of that very important natural area. There are people who are very eager to develop their waterfront property, either for commercial or private enterprise. There are districts that can never be restored.

Senator PELL. Well, I am turning this thing over in my mind as to whether or not I will cosponsor the bill.

Mr. HORTON. I certainly would endorse it, Senator. I advise you to.

Senator PELL. I understand. I will follow your advice and will support it. Thank you very much for your testimony.

Our next witness is a man of great practical experience and commonsense and wisdom. Mr. Jacob J. Dykstra, president of the Point Judith Fishermen's Cooperative Association, and in bringing him here we are lucky because he has a distinguished record of achievement in both the business aspect of fisheries and the practical aspect as well. We could not have a finer representative. Mr. Dykstra, you may proceed.

STATEMENT OF JACOB J. DYKSTRA, PRESIDENT, POINT JUDITH FISHERMEN'S COOPERATIVE ASSOCIATION, POINT JUDITH, R.I.

Mr. DYKSTRA. Thank you for holding these hearings here today. I realize that this bill provides for increased understanding and development of the sea in many areas other than fisheries. However, since there will be many eminently qualified witnesses appearing to present their views, I will confine myself principally to the relationship of fisheries to sea grant colleges.

It has been reported with increasing frequency and by more and more people that the U.S. fishing industry lacks vigor, its equipment is old and obsolete, its fishermen old and tired, and that the situation is steadily worsening, especially when viewed in relation to the fisheries of many other nations. There is some justification for this view, and in my position I see many unhealthy conditions facing the fisheries. Let me mention a few:

THE TECHNOLOGY

We are fishing with vessels that are much older and less sophisticated than those of our competitors. This is not because the newest methods and equipment are not available to us. If our laws allowed it, we could have the most modern trawlers built in a number of countries. We also have excellent engineers and capable yards and manufacturers here at home. Our problem is not lack of know-how but lack of application to fisheries.

THE MARKETS AND PRODUCTION

The trawl fishermen of New England experience widely fluctuating prices for the fish they catch and often when even traditionally desirable species are most available, the ex-vessel price is so low that effort is curtailed or diverted to less available but currently more marketable species.

The processing plant operator geared to handling one or two species is either overwhelmed with fish in times of heavy production and thereby sometimes produces an inferior product, or is shut down or running a fraction of capacity with resultant loss of competent personnel and crushing overhead.

Many species of fish go ignored or underutilized, not because they are unappetizing to the consumer, but because they cannot be economically put into acceptable form with the techniques and equipment currently used by the industry.

The resources are there. It seems that everyone in the world wants to fish off our coasts. Still it is generally agreed that there are many unexploited fishery resources. The markets must also be there. Over half of the fish consumed in the United States are not caught by American fishermen.

THE MEN

Fishing vessel operators and those activities that back up the fleet need young men who are real seamen if more sophisticated methods and equipment are to be utilized. The land oriented, untrained and poorly motivated are presently those generally available.

THE RESEARCH AND EDUCATION

The staffs of our marine oriented universities, colleges, laboratories, and Government agencies, with a few notable exceptions, could appear in nearby fishing ports and go completely unrecognized, frequently by design. Traditionally we have been overrun by biologists studying the fish. Mostly they are dedicated and doing an excellent job, but they have watched the fishing industry go downhill. Valuable assistance has been given in the most obvious trouble spots, but only in narrowly confined areas.

Sea slanted programs at the high school and college levels are almost nonexistent. Young men who ask us how to acquire such training get unsatisfactory answers.

What are the needs of the fishing industry? Obviously there are needs that are not being filled. What are needed are—

1. Trained people, bright young sea-oriented men, not just to be fishermen any more than all men concerned with land resources are dirt farmers, but a broad base of people who are interested in using the sea's resources as well as studying them.
2. Application of presently available and ever increasing new equipment and techniques. We must do a better job of developing and applying new technology to resources and the markets not just in the area but all the way from the ocean to the consumer.

I believe that sea grant colleges can fill this need. Why? Because of past frustrations and more recent brief but extremely promising experiences. Recently the Graduate School of Oceanography and the Department of Food and Resource Economics at the University of Rhode Island joined together in what is to us a new and most heartening approach. They have brought together in projects, for us, biologists, resource economists, home economists, engineers and biochemists from their respective colleges and departments, who, through cooperation on these and other marine problems have become ac-

customed to working as a team. They can bring their talents to bear on all phases of a problem and are anxious to see successful operations develop rather than just make a study each in his own field. The University of Rhode Island is already in a modest way functioning as a sea grant college should. With proper funding and as a part of a national program of similar activities we are sure that this beginning will expand, and be expanded into an increasingly meaningful and continuous relationship. Also, nearing in reality is a 2-year course at the University of Rhode Island for fishermen. This school, I am sure, will provide not only fishing captains for Rhode Island vessels, but also captains for many other fleets and future leaders and technical experts in widely diverse marine activities.

The provisions of this bill which should be retained and emphasized are—

1. Training of people who will be sea people and work on and in the sea to put the tools and knowledge provided by research and development to productive use.

2. Training of people whose duty it shall be to transmit new knowledge and techniques and demonstrate available equipment to industry.

3. Make available to individuals, corporations, and organizations grants and loans to effectively carry out special projects and programs.

It is my belief that sea grant colleges on a national scale will bring to bear upon marine activities the broad range of knowledge and talent at each college or university rather than attempt to duplicate them in self-contained and relatively isolated units. I strongly endorse S. 2439 and desire its enactment into law without undue delay.

Senator PELL. Mr. Dykstra, I think it would be interesting and helpful if you would put on the record your many years of experience which you have spent in fishing and your occupation as of now. Are you a captain of a fishing boat?

Mr. DYKSTRA. I am a crewmember. The boat is out fishing today and I couldn't be here today if I had gone fishing. I go fishing with my brother. I used to have a boat of my own but I gave it up to do this kind of work.

Senator PELL. How many years have you spent fishing?

Mr. DYKSTRA. Well, I was at URI during the war and I went into the Navy from URI and when I got out of the Navy I started fishing. That was in 1946, and I have been fishing since.

Senator PELL. In other words you have spent most of your working life, well, all of your working life on the sea, is that right?

Mr. DYKSTRA. Yes, my father was a fisherman before me and his father before him.

Senator PELL. Thank you, I just wanted to get that on the record because there are very few men with as much practical experience as that. We are lucky to have you here today.

Now, I was struck by one point in your testimony and that is the difficulty you have in getting young men who are willing to accept the hardships of the sea and go to sea and learn the trade. I was curious about that in connection with the fact that we have a room full of young people from high school and the college here. I wonder if any of you young people, boys I think they might be, who are inter-

ested in a life of fishing, would like to be fishermen, would hold up their hand so we could get an idea.

(Whereupon, Senator Pell counted any hands raised as requested.)

Senator PELL. I think that the record should show that out of, maybe 200 young people here from our maritime State, only 3 are interested in going to sea to make a living. That is a rather sad reflection which I hope will be remedied with the passage of this bill or other measures of this sort.

We had a private conversation one time, which I think should be put on the record, as to the problems you face in getting a young man to go to sea with you. As I understand it you do not want to take a young person with you unless there is some indication that he will stick with you for quite a while, is that correct?

Mr. DYKSTRA. That is correct, sir, and it's not only that there has to be some indication that he is going to stick with us, but it is also very difficult to take a young man who has had absolutely no training at sea and take him as part of the crew. Not only has he no training at sea but he has no training in the skills which are necessary aboard a fishing boat at sea. We have young men that go up and down the docks asking fishing captains to take them fishing with them, and at the same time we have a number of vacancies on fishing vessels. Sometime I will try to bring these two together and the vessel captain will say to me, "What sort of experience has he had?" And, "Where has he fished before?" I say, "He is just willing. He has no experience." The captain says, "I have to have someone with experience. If something goes wrong with my net I need someone with experience who can help the rest of the crew." They are just very reluctant to take a young man who has had no experience. The result is that you generally have to have some sort of a connection, such as a relative or friend on a boat who will take this young lad aboard and kind of take him under his wing for a while and teach him, have him there during this training period.

Senator PELL. So, it would be almost impossible for a young man from Woonsocket to go out there with no connection and get a start with a fisherman?

Mr. DYKSTRA. It would be very difficult. I'd say that if he did get aboard a fishing vessel, he would get aboard one of the less productive vessels because that vessel would not be making much money and he would have to take a man of this sort just to get a crew, so that when he gets aboard a vessel he'd learn all the wrong things when he started out.

Senator PELL. Am I correct in stating that you have your fish-meal factory working all the time and you are perfectly willing to take in young people to work for you there, but that you have a hard time getting people?

Mr. DYKSTRA. That is correct.

Senator PELL. So that when they say it is difficult to get employment of any sort, that is not correct, particularly on the night shift there you have openings?

Mr. DYKSTRA. We already have some college people there, in fact, we hope they stay.

Senator PELL. But you could use more?

Mr. DYKSTRA. Yes.

Senator PELL. How many fisherman are there in Rhode Island?

Mr. DYKSTRA. Well, our port at Point Judith has the bulk of the fishermen in Rhode Island. Newport has some. We have fishing out of our port probably 125 to 150 fishermen. I would say that in Newport there would probably be based right there, maybe 25 or 30, and some of the out-of-State boats are laying there, but they are not Rhode Island fishermen. Now, this is trawl fishermen and trawlers. If you asked me, like how many fishermen there are including the trappers, we call them shell fishermen, pot-lobster fishermen, ones who are part time in and out, and so on, why there would probably be more fishermen to be counted, but as far as trawl fishermen go that's about it.

Senator PELL. Would you say there are more than 1,000 people that are fishermen of one sort or another in the State, lobster, shellfish, trawlers, and so on?

Mr. DYKSTRA. If you were to include shell fishermen, yes, there would be.

Senator PELL. And in connection with insurance rates, since your profession is a relatively hazardous one, do you have any problem in getting insurance for your men and the boats? How do you arrange rates?

Mr. DYKSTRA. This is a very great problem in many places. We are very fortunate in our cooperative. We have a complete program based on our experience, and so far we have been successful in keeping the rates well below, for instance, New Bedford. But many ports and vessel operators find this one of the most difficult things that they have to contend with. I am not saying that we couldn't have a great deal of difficulty overnight, and be in the same boat that they are in. We just happen to have a rather unique situation in that regard. Fishing vessel operators throughout the country have that insurance problem.

Senator PELL. Isn't lobster pot fishing even more hazardous than your trawl fishing?

Mr. DYKSTRA. I would say perhaps, yes, but this is a different type of operation. You haven't got the same situation. Most of these are a one-man, or sometime, a two-man operation. Most of the time they fish alone. We wouldn't think of going out to sea without complete insurance coverage.

Senator PELL. Returning to the general purpose of the bill, that is the exploitation of the knowledge we already have. How many fish that you catch would you call "trash fish," that get thrown back into the sea?

Mr. DYKSTRA. Well, of course we do have a plant which utilizes these "trash fish" now.

Senator PELL. So, you would throw nothing back into the sea as of now?

Mr. DYKSTRA. Well, that would be or might be a very bad impression because we are asking other people if they are throwing anything back into the sea. We try to use commonsense as far as conservation goes. In other words we don't just go out and try to catch everything that we possibly can and bring it in. But we do use all species of fish excepting for one or two species.

Senator PELL. Thank you very much, Mr. Dykstra, for giving us this valuable time and your special specific knowledge. Indeed, we are very grateful to you.

Our next witness is Dr. William H. Drew, associate dean of the University of New Hampshire Graduate School. We have tried to give as broad a degree of coverage as possible to this hearing. We have representatives from Massachusetts, from Connecticut, and we have television from Maine. All the States in New England will be represented one way or the other.

STATEMENT OF DR. WILLIAM H. DREW, ASSOCIATE DEAN OF THE GRADUATE SCHOOL, UNIVERSITY OF NEW HAMPSHIRE

Dr. DREW. Senator Pell, I bring you greeting from our 17 miles of shore front in New Hampshire.

Seriously speaking now as recording the testimony already given I want to add that as recorded in the proceedings of the "Conference on the Concept of a Sea Grant University," held at Newport, here in Rhode Island, last fall, we at the University of New Hampshire strongly favor the sea grant college idea as outlined in Senate bill 2439. There is a vast variety and amount of resources in the sea that are available on a first-come, first-served basis. These sources can change the fate of New Hampshire, the United States, and of civilization itself. For our country not to be in the forefront in developing practical means of exploiting these resources is unthinkable. The mere fact that we, at the moment, are not facing starvation without food resources from the sea, is not an adequate reason to allow a lag in developing marine technology. Increasing the marine expertise of the United States will undoubtedly be important to the betterment of mankind and to the economic and technical security of the Nation. There is little doubt that the next generation will see vast improvements in man's ability to survive in and to control the forces at work on the surface and within the depths of the seas. Dean Spilhaus and others have specified the potentials of this new era far better than I could hope to do.

As a product of the land grant college and one who has been closely associated with several colleges of agriculture, I can, however, state my conviction that the land-grant concept is an excellent type of framework within which our scientific manpower can be placed in order to provide the research, the technical application, and the educational and service needs of the country in the marine areas.

The undeniable fact that we lead the world in the human efficiency of our food production units is one kind of evidence that the land grant college system has worked well for American agriculture. The United States is currently producing an abundance of food and fiber with considerably less than 10 percent of our total working force, while the Soviet Union requires over 40 percent of its labor force to produce somewhat limited supplies of food for its population. Although part of this striking difference can be attributed to the political and economic organization of the Russian farm units, it is the efficiency and the technical means available to the American farmer that loom most important. When Mr. Khrushchev came to the United States, it was our farms and farming methods that most excited his interest. One of our biggest current contributions to the underdeveloped nations of the world is that of providing them with technical know-how in agriculture. On the other side of the coin, it is quite evident that the Soviet Union does not covet the American fishery, nor are foreign countries

looking to us for leadership in the marine sciences. This state of affairs should not be allowed to continue.

Because the land grant college system worked so well in the past century in the areas of agriculture and the mechanical arts, I believe that with some modifications it provides the same opportunity today for development in marine areas. It does not seem necessary to duplicate the land-grant college as it existed when first established. This would involve building new campuses, colleges, and experiment stations in many areas of the country. At the time of the emergence of the land-grant college there was not in existence a large number of organizations that would serve as a firm base for the building of new programs. Today this alternative does exist in the form of many institutions which are currently engaged in research and teaching in the marine area. These facilities should be used to their fullest extent.

I would like now to refer to the University of New Hampshire as only one of numerous institutions which already have some of the basic ingredients for a coordinated program in the marine sciences. My purpose is to show that it would be unwise to duplicate these ingredients. Although we would be very interested in cooperating in the sea grant idea, I am not trying to make a particular case for the University of New Hampshire. My reasons for favoring the proposed legislation are much broader than any particular benefit that might accrue to our institution. I use the University of New Hampshire only as the example with which I am most familiar.

As many of you know, the university is located adjacent to one of the largest estuaries on the Atlantic coast, which contains or consists of Great and Little Bays, into which flow seven major rivers. The tide-water area covers about 16,000 acres, containing many productive clam and oyster beds and an abundance of lobsters and salt-water fish. Great Bay provides not only an ideal laboratory for marine biologists, but a ready access to the open sea for scientists interested in the many areas of oceanography.

As early as the 1920's the University of New Hampshire maintained a marine biological station on the Isles of Shoals, located off the coast of New Hampshire. This station, which was discontinued during World War II, will be replaced with a modern laboratory on the shore of Great Bay. This facility will make it possible for us to expand our research program on estuarine studies and provide laboratory facilities for an increased number of students. The mere announcement of the funding of this laboratory has produced a noticeable increase in inquiries from potential graduate students who are interested in working in the area of marine biology. A further indication of increasing interest in the marine science areas is the fact that Cornell University has recently made arrangements to use the facilities as the Isles of Shoals during the summer months. We are currently developing with them a cooperative arrangement in this area.

In the engineering area we have the recently established engineering design and analysis laboratory within our college of technology. This laboratory is a formal partnership of 20 faculty members who have banded together for the purpose of providing themselves and their students with experience in working on actual engineering projects, most of them associated with the exploration and exploitation of the ocean. Our first concern, of course, is that of educating superior

engineers. We believe that this focus on the challenging problems of oceanography provides the necessary ingredients for engineering education and practical research program. Currently this laboratory is working under contract with Government agencies and industry on such problems as precise navigation, the improvement of man's ability to survive in the depths of the sea, the use of satellites to gather oceanographic data, and the tracing of temperature contours in the deep ocean. The students response to this program has been excellent. However, sustaining the program through specific research grants will be a problem. Support on a broader base would be very desirable.

Our resources development center, composed primarily of a group of social scientists, is working on various phases of the development of human and natural resources of the State. Their studies are concerned with developing recreation and commercial fishery enterprises, as well as ocean-oriented industries.

In the process of approaching the problems of the marine sciences through formalized research and education groups, we find that effective programs require the coordination of the total resources of the university. The inter-disciplinary centers and institutes must coordinate, but their effectiveness rests upon the proper use of the total offerings of the university. Therefore, we do not feel that it would be wise to establish new colleges or universities to meet a specific need. It is suggested that a more desirable approach would be to change the orientation of some existing personnel and facilities. While it is necessary for the ocean-oriented physicist to know considerable about the environment of the sea and its special problems, he should be first and foremost a physicist. A few specialized centers may be a reasonable means of approaching some of the basic research needs. If, however, we are also to consider the application of research to specific problems and the extension of the results to industry itself, it is doubtful that such centers would meet the need. To have an effective extension and applied research program, it must be administered close to home.

Programs of the type mentioned above receive great benefit from the proposed legislation, which would also be beneficial to the State of New Hampshire. Our limited amount of sea coast, which provides excellent access to the ocean, accounts for a commercial fishery whose total annual product landed in New Hampshire is valued at above a million dollars, although many of the fish and lobsters caught off our coast are landed in ports in Maine and Massachusetts. We feel that the value of this fishery could be increased considerably with new practical research results. As evidence of this belief, the State of New Hampshire has recently instituted a division of marine fisheries, which is currently conducting an embryonic research program. Since New Hampshire is strongly dependent upon recreation as a source of income to the State, we are extremely interested in preserving and improving our seashore areas. Much of the industry located in our sea coast area is concerned directly or indirectly with the marine sciences.

If it does not seem feasible to build new sea grant colleges in the manner that land-grant colleges were built in the last decade, one might wonder if the whole idea is not out of fashion. Simply because a different method of implementation is indicated does not mean that the idea is no longer valid. The fact that the sea grant concept attacks an important problem on a broad basis is what makes it so appealing.

A mere increase in our efforts in basic research, in applied research, in education, or in service work will not bring about the desired results. These areas must be attacked simultaneously. This very fact was the reason for the overwhelming success of the land-grant college. Commercial fisherman or oil well drillers will not benefit for many years from the results of today's basic research unless an effective extension-type program is in operation. An extension program cannot be successful unless basic and applied research programs are in operation. Furthermore, neither research nor extension programs can function effectively unless our educational institutions are turning out qualified personnel.

It is not easy to develop a plan for initiating a sustained effort along a broad front. I believe, however, that Senator Pell's bill is such a plan and that it is workable. In adhering to the land-grant concept, this bill makes it possible to provide unrestricted funds to agencies interested in and capable of increasing the country's competence in marine matters. I strongly urge that a major portion of the funding under this program should be in the form of institutional grants. Continuing broad-based financial support is essential to the program. Perhaps I could best exemplify my statement by referring again to the University of New Hampshire. Our water resources research center was funded under the Water Resources Research Act of 1964 in a manner similar to that suggested in the proposed legislation we are considering today. Basically, this act, which is concerned with the problems of providing adequate and safe fresh water supplies, provides for institutional grants for research and education programs. Additional moneys are available on a matching fund basis for individual research projects. Prior to the initiation of the center, three of our departments were carrying on good, but uncoordinated, research projects related to water problems. The lack of coordination was not intentional, but existed primarily due to a lack of a common goal. We are now completing the second year of operation of this coordination program, and the results have been quite astounding to me in the following respects:

1. I find that faculty members who previously did not even know each other are now submitting joint research projects.

2. The degree of cooperation with our State agencies has increased manifold.

3. Undergraduate and graduate student interest in this area has been stimulated.

4. Many additional departments in the biological and physical sciences are cooperating on research programs.

5. The economists and sociologists now have research projects concerned with water.

6. In filling vacated and new faculty positions, we are now making a coordinated effort to recruit competence that we have unknowingly lacked in many of the areas crucial to the program.

I see no reason why these same results could not be achieved in the marine area.

To mobilize scientific manpower and facilities toward achieving a given goal is not something that can be done with money alone. It is imperative that the program be conceived in a manner that assures cooperation between scientists and technicians and allows for

the approaching of problems along the broad fronts of research, education, and extension. I believe that the proposed sea grant college program fully meets these criteria. Thank you.

Senator PELL. Thank you, Dr. Drew. To get a little more background for our committee would you state what your specialization is?

Dr. DREW. I am a resource economist.

Senator PELL. What does that mean?

Dr. DREW. One who is trained in the basic field of economics, but specifically trained in research areas allied to agriculture.

Senator PELL. I am still confused as to what the definition of resource economist is.

Dr. DREW. That is an economist who is interested in the practical aspect of developing resources.

Senator PELL. It could be mineral, agricultural, sea, or land resources, right?

Dr. DREW. Practical exploitation, right. The difference between a regular economist and a resource economist is that the latter has more expertise in carrying out a practical resource program.

Senator PELL. So, from your viewpoint, this bill is right up your alley because it seeks to take the theoretical knowledge that we have and make it more available to exploration.

Dr. DREW. That is correct, that would be our area.

Senator PELL. Do you have any thought as to where the administration of this bill should be placed? Should it rest with the National Scientific Foundation or the Smithsonian Institute? Do you have any thought on that?

Dr. DREW. Well, I did prepare a statement for the meeting that was held in Newport, R.I., in which I expressed the idea that I did not think it should be put in the hands of the National Science Foundation which has a very good record in supporting very good research projects in another area. I can't quite envision the National Science Foundation getting into this sort of thing, this sort of operation.

Senator PELL. Do you have any specific suggestions for improving this bill S. 2439?

Dr. DREW. Well, other than what I mentioned as to the fact that I had some real doubt as to the National Science Foundation administering the bill. I have some doubt about the centers of excellence concept. I don't think the centers of excellence can hope to work this type of program because they have to be administered close to home.

Senator PELL. Thank you very much, Dr. Drew. We are particularly lucky to have the testimony of an economist whose field is the utilization and exploration of all the resources that we have. Thank you, Dr. Drew.

Dr. DREW. Thank you, Senator Pell, for allowing me to testify.

Senator PELL. Our final witness is Dr. Richard J. Benoit of Colchester, Conn. Dr. Benoit is a member of the executive board for the Southern New England Marine Sciences Association and he is highly respected for his marine work. Will you proceed, Dr. Benoit?

STATEMENT OF DR. RICHARD J. BENOIT, MEMBER OF EXECUTIVE BOARD, SOUTHERN NEW ENGLAND MARINE SCIENCES ASSOCIATION

Dr. BENOIT. The National Sea Grant College and Program Act of 1965 has been stated to be in the public interest by many fine men who have been before this committee and I hasten to add my endorsement to that statement. The committee is no doubt thoroughly familiar with the proceedings of the recent Sea Grant Colleges Conference at Newport, R.I., cosponsored by the University of Rhode Island and Southern New England Marine Sciences Association. So there is no need for me to review the ideas presented there. Dr. Spilhaus' keynote address at that conference has been read into the Congressional Record, as you know. I would also call or recall your attention to the 1964 National Academy of Sciences-National Research Council report, "Economic Benefits From Oceanographic Research." That document states the case far better than I might with regard to the ways in which the public welfare will be benefited. The sea grant colleges program seems to me to be the proper educational foundation for the Federal program we can all see evolving.

Working in industry I am probably more accustomed to justifying proposed course of action on an economic basis than are my university colleagues. I do not, however, think we are in this instance dealing with a system that can be subjected to economic analysis except by making many cumbersome assumptions, all subject to challenge. I think we must rely confidently on the example afforded by the history of the land-grant college program.

Let me state parenthetically that I feel strongly that the sea grant program would be weakened by any attempt to provide means for full and direct participation by States that are not marine coastal or Great Lakes States. The available resources might be diluted to the extent that any single State's activity would be ineffectual. My own personal suggestion for broadening the geographical basis for participation would be to provide appointments to sea grant institutions by Congressmen from States with no sea grant college, in the same general way as appointments are made to the Federal Service Academies, of which one, the Coast Guard Academy at New London, is a valued landmark of my home State, Connecticut.

In my student days, I worked at the Connecticut Agricultural Experiment Station in New Haven. I found the atmosphere there to be ideal for productive research. The station worked in contact with industry in the development of agricultural chemicals and equipment, with farmers on the application of new knowledge, and with the scientific and academic community at large in the interchange of new knowledge. That partnership assures the prompt application and exploitation of the fruits of research. The sea grant college program can, I am confident, assure the same success in the seas that we now enjoy on the land. The committee should, I feel, consider amendments and establish administrative or policy machinery that will promote the participation of industry in the program.

Senator PELL. I am not sure I would go along with your thought on congressional appointments to those institutes that get grants because, being in that position myself, I see how very difficult it is in

the implementation of the congressional appointment. I'd like to see more boys interested, other young people, where, maybe, they could apply from inland States to institutions that had a grant.

Dr. BENOIT. My suggestion wouldn't necessarily be restricted to a formal appointment plan, but rather to a provision, a method of assuring a 50-State participation worked from a standpoint of students from the States in the inner part of the country. One of the difficulties in planning a fishing industry in this country is due to the fact that we can only draw on the community or communities that are right on the coastline. I am sure that there are many young men, and perhaps young women, from Kansas, Colorado, States of that kind, where, if the specific opportunity were presented to them, they would be glad to turn their attention toward a career in the marine industry, including fisheries.

Senator PELL. Another point in connection with your final statement that we should consider amendments and establish administrative or policy machinery that will promote the participation of industry in the program.

I wonder if you could be more specific. Do you have any amendments in mind?

Dr. BENOIT. I believe that is in your printed statement, the way that industry participates in agricultural operations. It is on an informal basis although several agricultural firms have established grants for research. I have in mind, specifically, a fellowship from an agricultural experiment station doing research on insecticide chemicals. Industry cooperates with the universities in one way by making specific grants for research projects, and also by taking on the university scientists as consultants. This program has been well received and has worked out fine in the field of agriculture. I know it can be worked out in the marine sciences.

Senator PELL. I have a great deal of respect and admiration for your reputation in this field. I was wondering if you would like to leave the record open for a week or so and you can submit for consideration any specific amendments and changes to the language of the bill that would achieve that objective. I am not sure just how we would put this in writing, what you are talking about. I am not sure I fully understand what you are saying.

Dr. BENOIT. Well, I am not sure that I have given the problem enough thought. I am not sure that a week or 2 weeks would be enough time to do that, but I will do the best I can. I will get some of my colleagues together at work and see what we can do in that time.

Senator PELL. Specifically as to the suggestion of the sea grant college program, how it could be set up in order to assure a more direct participation in industry.

Dr. BENOIT. I will do what I can.

Senator PELL. And, for the record, what is your position within your corporation?

Dr. BENOIT. I am chief of marine sciences at the electric boat division of General Dynamics.

Senator PELL. This lends authenticity to the testimony that you gave because your corporation is one of the leading ones in this field, and speaking as a Senator from Rhode Island it is also of great eco-

conomic importance to our State since so many of our people work there. I appreciate very much, Dr. Benoit, your coming here today and being with us. The record will be left open for a period of time. You may submit any thoughts you have relating to this industrial application. I like the idea, I just don't quite know how we should take hold of it.

Now, in closing I would just like to say that I am impressed with the arrangements that have been made by the University of Rhode Island for today's session. We want to thank you, Dr. Horn. Also I would like to say to the students present here today that you have seen the Federal Government in action. I hope that you have enjoyed the hearing. I want to thank all of those people that traveled to Rhode Island today from New Hampshire, Connecticut, and Massachusetts. Rhode Island is a small State, but we appreciated it.

(Whereupon, at 12:30 p.m., the hearing was recessed to reconvene Tuesday, May 3, 1966, in Washington, D.C.)

SEA GRANT COLLEGES

TUESDAY, MAY 3, 1966

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SEA GRANT COLLEGES
OF THE COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met, pursuant to notice, in room 4232, New Senate Office Building, at 10 a.m., Senator Claiborne Pell (Chairman) presiding.

Present: Senators Pell (presiding), Kennedy of Massachusetts, and Murphy.

Committee staff present: Fitzhugh Green, special assistant to Senator Pell; Stewart E. McClure, chief clerk; Roy Millenson, minority clerk.

Senator PELL. The Subcommittee on Sea Grant Colleges, bill S. 2439, will resume its sessions after a day of hearings at the University of Rhode Island yesterday.

As chairman of the subcommittee I made an opening statement yesterday which will appear in the record, and to save the time of the witnesses, there is no particular need to repeat my statement. I think the first witness who was scheduled to be here, a fellow committee member, Senator Kennedy of Massachusetts, is not here yet.

Is Representative Rogers here? He is not here.

Then I think we will move straight ahead with the executive department witnesses, and if you will excuse me, we will put in the legislative witnesses as they come in.

Is Dr. Bates here?

Dr. Bates, will you come forward, please.

Dr. Bates is science adviser to the Department of the Interior and is coming here in behalf of his Department.

STATEMENT OF DR. THOMAS F. BATES, SCIENCE ADVISER, DEPARTMENT OF THE INTERIOR; ACCOMPANIED BY DONALD McKERNAN, DIRECTOR, BUREAU OF COMMERCIAL FISHERIES; AND HOWARD ECKLES

Senator PELL. Would you identify yourself and also the gentleman accompanying you?

Dr. BATES. Yes. I would like to introduce on my right Mr. Don McKernan, who is Director of the Bureau of Commercial Fisheries—

Senator PELL. Speak up a little louder so the people in the back can hear you.

Dr. BATES. Donald McKernan, Director of the Bureau of Fisheries, Department of Interior, and also I have with me in the audience my assistant, Mr. Howard Eckles, who I believe you met at Rhode Island.

Senator PELL. Right. If he would like to sit with you at the table he may do so. Any people in the audience interested in this subject who cannot hear, wave your hand and we will ask the witnesses to speak up or myself to speak up.

Dr. BATES. We also have representatives of the Geological Survey and the Bureau of Mines in the audience in case there are questions you might like to address to them.

With your permission, I would like to read a brief statement.

Senator PELL. As you know, we have asked the witnesses to confine themselves to 10 minutes on their presentation.

Dr. BATES. I think that will be sufficient.

Senator PELL. I think your statement is about 20 minutes.

Dr. BATES. I will be glad to trim it down if it moves that far along.

It is my pleasure to be here today on behalf of the Secretary on the second day of your hearings on S. 2439 and the sea grant college concept.

I have been following Dean Spilhaus' idea with great interest; from the point of view of a university scientist as well as from my position in the Department of the Interior.

I am presently on leave from the Pennsylvania State University which shares the honor with Michigan State of being one of the first two land-grant colleges of the country. Although it is not situated on the sea, nevertheless like many inland institutions, scientists, and engineers in many of the departments at Penn State have outstanding competence in oceanographic research and development. Several of my university colleagues as well as a number of my associates in the Department of the Interior have told me about the success of the Sea Grant College Conference sponsored by the University of Rhode Island last October. Since then I have read the proceedings of the conference and a number of excellent releases about the concept. These have brought forth many striking proposals and ideas for new and better uses of the oceans. The complete record and information which you have already developed on the opportunities which lie ahead through expanded research and engineering approaches to ocean developments leaves little room for an original or new contribution from my Department. I have noted at least 20 imaginative suggestions from Dr. Spilhaus which range all the way from a Lewis and Clarke Expedition across the bottom of the Atlantic and Pacific to a future need for fish veterinarians to take care of fish in sea farms. I also note the emphasis on the importance of engineering in developing the resources of the ocean.

Mr. Spilhaus and others have described the special problems affecting standard materials in the marine environment, such as corrosion, fouling, and destruction by boring organisms. These are some of the ocean engineering problems which man has been fighting for centuries. But there are some new aspects of ocean engineering, however, which we have scarcely recognized. These are the problems of using new materials and new technology, already available for use on land, to develop imaginative new ways of harvesting ocean resources and to create the kinds of oceanic condition which will improve upon the natural productivity of the sea. To do this we must occupy the ocean, not merely probe blindly through the surface or take momentary peeks at its contents from small submersibles. There are rich prizes that lies

unclaimed in this vast unexplored domain, and our Nation must press forward more vigorously toward this new frontier if we are to be competitive with other nations. We need to take much more seriously our responsibility to communicate our present fund of knowledge of the ocean and its resources to the people who can use it. This need will become ever more acute as we begin to apply modern engineering techniques to the problem. A remarkably large amount of scientific knowledge is available, but largely unused, because it is buried in the scientific literature, expressed in terms incomprehensible to the layman even if he knew where to put his hands on it. This communication failure is partly responsible for the primitive condition of our fisheries and also for the state of our ability to mine the ocean waters and bottoms for minerals and fossil organic substances. The universities are the natural media for translation and dissemination of knowledge to the country. One important purpose of this bill is to provide for closer teamwork between the Government and the universities in achieving these objectives.

In our opinion, S. 2439 states two important purposes to be satisfied through a new program of financial support to colleges, universities, and other organizations. The first of these is to carry out the research, development, and applied work necessary to learn how to use the oceans as part of our environment following the same concepts that we have applied to use of the land. Thus we can regard the oceans and sea bed as areas which produce food, minerals, and chemicals, which can provide energy and be used for recreation, but which also can be polluted and spoiled if we do not follow proper conservation practices. The intent here is to seek practical applications, carry out management, and promote industrial advancement. The second intent is to create an expanded capability for training scientists, technicians, engineers, and others needed to accomplish this first objective.

The Department of the Interior firmly believes that more and more emphasis must be placed by the Federal Government, the States, educational institutions, industry, and other public and private organizations and individuals on improving the Nation's capability to obtain and use wisely our marine resources. S. 2439 is designed to supply this emphasis on the national level. Legislation along the lines of the bill is needed to supply the focus that is required in the field of marine science.

The concept of developing skilled personnel, such as engineers and technicians, to exploit our marine resources is sound. We agree that the National Science Foundation should play a major role with respect to basic research and scientific education in this area. We believe, however, that the Department of the Interior must continue to play a major role in programs aimed at exploiting marine resources because of our present expertise in basic marine research and in the management and development of these resources.

In explanation of this position I wish to refer to the declaration of purpose and recommendations for implementation of this bill as stated on pages 2 to 4.

The marine sciences programs of the Department are directly concerned with the research, development, and applied aspects of these purposes. To a lesser extent we are involved in the training and educational aspects. Interior has the major responsibility for the Gov-

ernment to administer and manage the resources of the Outer Continental Shelf. This applies particularly, under the Outer Continental Shelf Act, to the mineral resources, but does not exclude responsibility for research and study of the living and nonliving resources in the sea.

A brief description of present programs will show the strong parallel that exists between Interior's responsibilities in the marine sciences and the intent of S. 2439. The Bureau of Commercial Fisheries has extensive fishery research in coastal and offshore waters with the intent of increasing natural and world protein supplies. The Bureau of Sport Fisheries and Wildlife carries out research for the purpose of improving marine recreational fishing. Funds for fishery oceanographic research in fiscal year 1966 totaled \$17 million and involved \$3 million in direct support to universities and colleges.

Examples of recent accomplishments in research, surveys, and ocean engineering carried out by the Bureau of Commercial Fisheries are:

(1) Use of new understandings of large scale variations in the physical properties of the ocean to make predictions of the availability of a number of commercially important species of fish;

(2) Discovery of large unexploited fishery resources such as hake and anchovy off Washington, Oregon, and California, or shrimp in the Aleutians or off South America;

(3) Engineering development of fishing gear permitting, for the first time, the capture of large quantities of fish in midwater, such as the Pacific coast hake.

Programs in marine geology and marine minerals research and development, while of modest scale at the present time, have been expanding and are beginning to show promising results.

The Geological Survey has mapped and undertaken a comprehensive study of the geology and geophysics of the Atlantic Continental Shelf and slope off the United States.

If any of your are interested, by the way, I have brought a copy of that map with me that we can show you later.

An example of the practical utility of this program was the delineation of a large gravel deposit in shallow water off the New Jersey coast. Private sand and gravel interests have already begun studies of the feasibility of dredging the gravel for use in areas of the east coast having short supplies of concrete aggregate.

A very recent Geological Survey publication reports a vast pavement type deposit of manganese on the Blake Plateau off the northern Florida and Georgia coasts extending throughout an area of about 1,900 square miles. The thickness of the deposit isn't known as yet but some materials that were dredged from the deposit suggest the pavement may be as much as 4 feet thick in places. This deposit is of exceptional interest to industry because it lies in relatively shallow water, is near land and appears to be sufficiently extensive to become an economic resource.

As is well known, the Department has the saline water conversion program which is now reaching stages of practical application in many areas.

As I have mentioned, the Outer Continental Shelf Lands Act involves the leasing of Federal offshore lands for the development of oil, minerals, and chemicals and the management of these resources. The Department has its future policy considerations and responsibilities

in respect to the Outer Continental Shelf under study at the present time. The aim is to provide increased leadership in the development of offshore resources through cooperation with industry, the scientific and engineering community, and the coastal States.

Permits have recently been issued to a private company to shallow-drill exploratory holes on the outer slope of the Continental Shelf in the Gulf of Mexico. This is indicative of the present industrial trend to extend extractive operations seaward from the more shallow water coastal work which has been done in the past.

The extent of industrial activities managed by the Department on the Outer Continental Shelf are shown by the statistics of mineral production from the Federal leases in 1965 which follow:

TABLE 1.—*Mineral production from Federal leases, Outer Continental Shelf, 1965*

Commodity	Production	Value	Royalty to U.S. Government
Sulphur.....	¹ 1, 134, 000	\$21, 560, 000	\$3, 148, 000
Oil (including gas liquids).....	² 142, 500, 000	436, 900, 000	80, 000, 000
Gas.....	³ 630, 000	120, 000, 000	18, 000, 000
Total.....		578, 460, 000	101, 148, 000

¹ Tons.

² Barrels.

³ Thousand cubic feet.

Source: U.S. Department of the Interior.

In addition to research and development through grants and contracts Interior administers other extramural support programs which are concerned with many of the objectives of S. 2439.

The Bureau of Commercial Fisheries sponsors a graduate educational program in the marine biological and physical sciences and in fishery technology. One hundred and thirteen students have received support under this program since 1962. The Commercial Fisheries Research Act of 1964 also administered by the Bureau of Commercial Fisheries is now supporting 46 projects in State agencies for enhancement of marine fishery production and to support the welfare of the U.S. fishing industry. The recently passed Anadromous Fish Act calls for rehabilitation of these fisheries on both coasts with the research, development, and management activities being carried out by States. Many university and college scientists and students receive support through these programs as their institutions perform the R. & D. functions for State agencies.

The Bureau of Commercial Fisheries has an extension service which provides technical advice to shellfish producers. Work of the Bureau of Mines in development to sea mining technology is shared with industry. Operations on the Pacific coast are now proceeding under arrangements with three companies. While this is not an extension service in the true sense contemplated by S. 2439 it is an excellent way to accomplish a rapid transfer of technological developments to industry. Progress has been made in this program in perfecting an air-activated lifting system, and model-scale units have recovered mineralized materials from shallow depths off the coasts of California, Washington, and Oregon.

We are at this time taking steps to obtain broader authority than is now available to the Secretary of the Interior for the support of research and development in colleges, universities, industry, and private and nonprivate research institutions. This will enhance considerably the Department's ability to effect marine geological and mineral resources research and development through extramural programs. A combination of this new authority being sought with that now available will give the Department of the Interior ample administrative mechanisms to use in carrying out the intent and purposes of much of the program provided for by S. 2439.

In summary, Mr. Chairman, we support the purposes of the sea grant college bill. We recognize the desirability of more extensive participation in marine resources developments by colleges and universities. We believe that the National Science Foundation should increase its support of basic research and scientific education in areas of oceanographic activity; and that major responsibility for programs aimed at exploiting marine resources should continue to be vested in the Department of the Interior.

Thank you very much, Mr. Chairman, for this opportunity to present our statement.

Senator PELL. Right. Dr. Bates, I thank you very much. As I would interpret your testimony, you think it is an excellent idea but you think you should administer it. Would you think that would be it, in capsule form?

Dr. BATES. In capsule form, definitely, but not to the exclusion of other agencies like NSF.

Senator PELL. One thought I have had in mind is that this program for the practical exploitation of knowledge we already have might on a temporary basis go to the Smithsonian Institution with the understanding it will be spun off to whatever agency might be set up by the decision of the Council under Senator Magnuson's bill in 2, 3, or 4 years. As you know, this has happened in the past and I was wondering what your reaction would be to this as a thought.

Dr. BATES. It is difficult for me, at short cursory glance, to see the logic of temporary action in this situation. We feel that in Interior we already have programs well under way that involve the three aspects of this bill—education, extension, research, and development. By accentuating and giving the appropriate image that this bill would give to programs that are in existence, we can move directly into this operation and save some time that might otherwise be spent spinning some wheels.

Senator PELL. I believe I am correct in saying that the Bureau of Commercial Fisheries was originally in the Smithsonian and was spun off to your Department, is that correct?

Dr. BATES. Perhaps Mr. McKernan can answer that.

Mr. KERNAN. I don't believe so, Senator. The Bureau of Commercial Fisheries was one time in the Department of Commerce. It was originally a fish commission back in the late 1800's, during its early formation. I don't recall, although I could be incorrect, I don't recall that it was ever with Smithsonian.

Senator PELL. We had better put this off the record.

(Discussion off the record.)

Mr. ECKLES. I think it might have been Spencer F. Baird who was at one time the Director of the Smithsonian Institution and became the first Commissioner of Fisheries.

Senator PELL. I see. But there was an organization.

Mr. ECKLES. The two organizations were not together.

Senator PELL. Thank you.

Another question here is what is the amount of money presently coming in from royalties and rents from the offshore oil lands?

Dr. BATES. I believe it is the figure I have in the statement, this is the 1965 figure, about \$101 million.

Senator PELL. On the average.

Dr. BATES. About \$1.7 billion for the last 10 years, as I recall.

Senator PELL. So we would expect each year roughly to divide that by 10, correct?

Dr. BATES. That is right, if you were to make arrangements to use these funds.

Senator PELL. Right. All right. I would also like to put in the record at this point a letter from the Department of Interior, Assistant Secretary Stanley A. Cain, and he makes the suggestion here that we ought to await action on my bill, our bill here, until action has been taken on Senator Magnuson's bill to establish an Oceanographic Council. Actually, I think the two are perfectly complementary and there is no real reason to wait.

(The departmental report referred to follows:)

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D.C., May 2, 1966.

HON. LISTER HILL,
Chairman, Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.

DEAR SENATOR HILL: There is pending before your committee S. 2439, a bill to amend the National Science Foundation Act of 1950, as amended, so as to authorize the establishment and operation of sea grant colleges and programs by initiating and supporting programs of education, training, and research in the marine sciences and a program of advisory services relating to activities in the marine sciences, to facilitate the use of the submerged lands of the Outer Continental Shelf by participants carrying out these programs, and for other purposes.

This bill amends the National Science Foundation Act of 1950 by authorizing appropriation to NSF of 10 percent of all payments received after June 30, 1965, from leases on the Outer Continental Shelf, to be used for supporting education, training, and research in the marine sciences and advisory services relating to activities in the marine sciences. The Foundation is authorized to enter into agreements with the Secretary of the Interior for joint or exclusive use of appropriate areas of the Outer Continental Shelf by program participants. The Foundation is authorized to carry out the program through grants or contracts with public or private agencies, museums, industries, laboratories, corporations, etc.

The general purpose of the sea grant college program is to improve the Nation's capability to obtain and use the natural resources of the oceans.

The purpose of this bill is to implement a suggestion made several years ago by Dean A. F. Spilhaus, of the University of Minnesota, who at the time was Chairman of the Committee on Oceanography of the National Academy of Sciences-National Research Council. The proposal was discussed at a conference held at Newport, R.I., on October 28 and 29, 1965, at which over 200 individuals concerned with the subject matter of the bill were present. It was generally agreed at the meeting that the objectives of the bill were desirable and that legislation, such as S. 2439, would have a beneficial effect on the development of marine science and ocean engineering in this country.

This Department also firmly believes that more and more emphasis must be placed by the Federal Government, the States, educational institutions, industry, and other public and private organizations and individuals on improving the Nation's capability to obtain and use wisely our marine resources. S. 2439 is designed to supply this emphasis on the national level. Legislation along the

lines of this bill is needed to supply the focus that is needed in the field of marine science. The concept of developing skilled personnel, such as engineers and technicians, to exploit our marine resources is sound. We agree that the National Science Foundation should play a major role with respect to basic research and scientific education in this area. We believe, however, that the Department of the Interior must continue to play a major role in programs aimed at exploiting marine resources because of our present expertise in basic marine research and in the management and development of these resources.

The Department of the Interior now has broad authority to conduct research directly in marine resources and for supporting such authorities in marine science institutions. Some of these authorities are the Fish and Wildlife Act of 1956, as amended (16 U.S.C. 742a), the Commercial Fisheries Research and Development Act of 1964 (16 U.S.C. 779-779f), the Water Resources Research Act of 1964 (42 U.S.C. 1961 et seq.), and the act of October 30, 1965 (79 Stat. 1125). Also, the Department manages the resources of the Outer Continental Shelf under the act of May 20, 1964 (16 U.S.C. 1081-1085) and the Outer Continental Shelf Act (43 U.S.C. 1331 et seq.). In addition, we are requesting Congress to give the Secretary authority to expand our contract research activities in this area and other areas of importance to this Department.

S. 944 which is now awaiting final action covers a number of activities included in this bill. Your committee may wish to await the outcome of S. 944 before taking final action on this bill.

The Bureau of the Budget has advised that there is no objection to the presentation of this report from the standpoint of the administration's program.

Sincerely yours,

STANLEY A. CAIN,
Assistant Secretary of the Interior.

Dr. BATES. I agree. I believe this was put in with the understanding that things were moving very rapidly with that bill and hopefully it would soon come out of the committee and therefore this would not mean any delay.

Senator PELL. Right.

Thank you very much indeed, Dr. Bates. There are some further questions here.

Senator KENNEDY of Massachusetts. Dr. Bates, what is your estimate of the amount of funds which would be necessary to run this program?

Dr. BATES. We have not, in preparing this testimony, gone so far as to make such estimates. I would be glad to proceed to do so and give you a ball park idea.

Senator KENNEDY of Massachusetts. I think that would be helpful. (A memorandum subsequently supplied by Dr. Bates follows:)

MEMORANDUM FROM DR. THOMAS F. BATES, SCIENCE ADVISER, DEPARTMENT OF THE INTERIOR

The Department estimates that after a buildup of 3 to 4 years for organizational purposes, \$30 to \$35 million per year would be required to take full advantage of the capabilities of a number of sea grant centers. This recognizes that operations at sea are more expensive than most types of land-based research and development. It also recognizes that the program should be a highly varied one with colleges specializing in different subjects according to needs and opportunities in each area.

Senator KENNEDY of Massachusetts. Since so much of this program is involved at the university level, it does seem to me that the National Science Foundation is the agency where this should be located.

However, although I know you respect your sister agency, I would be interested if you could draw that distinction somewhat more precisely between the National Science Foundation and the Department of the Interior.

Dr. BATES. I respect them tremendously. Up until last June I have been supported extensively by their efforts.

I would like to simply answer this, Mr. Senator, by saying that I think there is a logical place here for both of these groups. Senator Pell's bill is written, as I read it, with emphasis upon applied science and engineering; actually moving from our basic state of the art to the extraction and use of the resources of the ocean.

Consequently, there are certainly aspects of both the very fundamental oceanographic type of research that must be continued by the National Science Foundation and should be done through the universities, but also the applied engineering research that relates in my opinion more directly to a mission-oriented agency such as the Department of the Interior. My point—

Senator KENNEDY of Massachusetts. It certainly wouldn't preclude the National Science Foundation from making certain arrangements with Interior and I am sure that they would make such arrangements affecting programs along the lines you describe. Yet in the brief experience I have had in Washington, where various programs are decentralized, we set up coordinating agencies and interagency coordinating committees. Therefore it does certainly concern me to see this too much decentralized.

Dr. BATES. I would like to point out that even since I came on deck last June, the image of Interior is changing considerably. As you know, we now have the Office of Water Resources Research which does relate to 50 land-grant institutions plus Puerto Rico. We have the Office of Saline Water which is largely contract-related to the universities. The new atmospheric water program of the Bureau of Reclamation is involving seven western universities at the present time, and Mr. McKernan here can tell you more specifically if you wish, the extent to which his Bureau of Commercial Fisheries has been involved in training programs, research at many places, including the universities. So I think we have not only a long but accelerating experience with regard to the relation of Interior to university programs.

Senator KENNEDY of Massachusetts. If the money being appropriated now for research in oceanography is spread through a dozen different agencies, how does the Interior Department have any opportunities to allocate funds for either this kind of development or any kind of research?

Dr. BATES. Our total funding in the 1966 budget for oceanographic work primarily related to the Bureau of Commercial Fisheries, the Bureau of Sport Fisheries and Wildlife, the Geological Survey, and the Bureau of Mines amounts to \$19 million.

Now except for the Navy which is, of course, well beyond this and the National Science Foundation which is at the level as I recall of about \$43 million, this is the next highest expenditure among the Federal agencies, next highest allocation.

Senator KENNEDY of Massachusetts. Could you submit to the committee just a further breakdown on those funds?

Dr. BATES. We would be very glad to.

(The information referred to follows:)

TABLE 2.—Department of the Interior, oceanography budget, fiscal year 1966

Agency function	Thousands	Agency function	Thousands
Interior—Total	\$19,566	Geological Survey—Total	\$860
Bureau of Commercial Fisheries—Total	17,466	Research	677
Research	13,675	Surveys	15
Surveys	1,654	Instrumentation	138
Ocean engineering	270	Facilities	20
Ship construction	690	Data center	10
Instrumentation	800	Bureau of Sport Fisheries and Wildlife—Total	1,006
Facilities	210	Research	658
Data center	167	Surveys	38
		Instrumentation	—
		Facilities	310
		Bureau of Mines—Total	234
		Facilities	25
		Ocean engineering	209

Senator PELL. Thank you, Senator Kennedy.

I also have a question from the minority that they have asked me to ask, and that is to what degree do you think these sea-grant colleges should be concerned with matters of water pollution in the Great Lakes and the other bodies of water within its jurisdiction?

Dr. BATES. I think this is a very important area. Whether it is the Great Lakes or the oceans I think, as I pointed out in my statement, we must be concerned with using these resources as we now desire to use the lands, with a minimum of despoilation and a maximum control of pollution. Whether in the Great Lakes or the oceans, this program ought to put considerable stress on that aspect.

Senator PELL. Thank you very much, Dr. Bates.

Senator Kennedy, who is a member of this subcommittee considering the bill, and who is most interested in the subject, has a statement of his own which we are very honored to have.

STATEMENT OF HON. EDWARD M. KENNEDY, A U.S. SENATOR FROM THE STATE OF MASSACHUSETTS

Senator KENNEDY of Massachusetts. I know you have some very able and capable witnesses, Mr Chairman, so I won't trespass too long on the time, but I would appreciate the opportunity to appear as a cosponsor and testify in support of S. 2439, a bill to establish national sea grant colleges. I especially want to commend the distinguished Junior Senator from Rhode Island for the outstanding work he has done in bringing this proposal before the Congress and for his deep understanding of the valuable contribution this program could make to our knowledge and use of marine resources.

Although he is not with us here today, special mention and our appreciation must also go to Athelstan F. Spilhaus, the "father" of the "sea grant college" concept. Professor Spilhaus, who teaches at the University of Minnesota, is a recognized expert in the areas of oceanography, aquaculture, and marine engineering. He has probably done as much as any individual to inspire interest in the proposal and to follow up on all the details necessary to translate thought into action.

Until just recently our approach to the sea and its resources had been primarily from the surface. We perfected the ships and facilities which operate from the surface to exploit the marine resources lying slightly below the surface. But there are, in addition, tremendous untapped resources along the ocean floor, in the ocean floor and throughout the expanse of the ocean body to be studied, developed and exploited for the benefit of the entire Nation, and indeed for all mankind.

The incredible quantities of untapped human food resources within the sea stagger the imagination and illustrate the challenge the sea presents to man's technical and scientific ability. Our oceans produce about 400 million tons of animal protein each year—only about 10 million tons of which are being harvested annually. I find it frustrating to contemplate these enormous unutilized food resources lying so close at hand when at the same time more than half of the world's inhabitants are chronically hungry or constantly undernourished.

Not only are we not tapping this unused potential, we are not even maintaining our relative position in the world. For the past 30 years the U.S. fish catch has remained static while fish use has increased. In 1964, we imported fish and fish products valuing nearly \$600 million. In the last decade alone the United States has dropped from second to fifth place in the scale of world fish catch, and that part of our consumption which we import has increased by 25 percent.

In part, this decline can be attributed to the enormous fleet of foreign fishing vessels, principally Japanese and Russian, which are operating off our shores taking fish resources which should be ours. But the blame must be placed as well upon our failure as a nation to take the aggressive and imaginative action necessary to make our fisheries competitive with other nations.

But the statistics of food needs, fish catch and competitive position do not begin to tell the story of the present challenge and opportunity offered by the sea and its resources. The ocean remains our planet's last frontier. We have only just begun to study its physical and biological laws, to seek out its resources and to harness its power for our own needs. It is estimated that man obtains only 1 percent of his food from the sea. While America spends billions annually to probe the limitless and intangible expanse of space, we let three-quarters of our own globe lie fallow and practically unproductive. Yet we know from recent discoveries that vast mineral resources lie below the waters—the Continental Shelf is rich in petroleum and minerals; gold and phosphorite are already being mined off our western coasts; and who can deny that the mountains and valleys along the ocean floor contain the same riches as the mountains and valleys which form our land continent. And now our scientific and technical knowledge has advanced to a degree where we can begin to mine them.

Many of us here in the Senate have worked hard on various pieces of legislation relating to the sea—legislation to develop and process fish protein concentrate, to improve the facilities and equipment of our merchant and fishing fleets, and to guarantee the health of our fishing industry against the encroaching forces of foreign competition. But all of these measures, while necessary and important, do not provide the basic comprehensive approach which we need.

The 1958 Geneva Convention on the Law of the Sea in effect gives to those countries that first explore the depths of the sea the right to

control them. If we are to become the master of the oceans we must develop and implement bold techniques for exploiting ocean resources.

We need an intensive study and overhaul of our entire fishing and marine resource industries. We need a renaissance in oceanography, aquaculture and marine mining which will move us out of the dark ages of old-fashioned techniques, make our marine fleets again the most powerful in the world and establish the United States as the leader in marine and aquatechnology.

Most important of all, however, we need to call dramatic attention to the existence of this last great frontier. Just as sputnik caused a revolution in space technology by concentrating national interest on the conquest of outer space, the same sort of national interest must be stimulated in the conquest of ocean space.

To put it simply, there are just not enough Americans at the present time who know enough about or who are interested enough in the potential of the sea to make possible of the commitment of men and resources necessary to conquer the sea. We need a national program, a program which will stimulate our young people while in college to pursue careers in ocean science and technology, which will support basic research, and which will translate the results of this basic research into practical programs attractive to private industry.

Taken together with Senator Magnuson's bill to create a national council to give policy guidance in the development of our marine resources, the establishment of a national sea grant college program can provide the foundation for this concerted national effort.

There are already many institutions within the United States which are deeply involved in the study of marine science. Sea grant colleges would be developed through these institutions, by providing Federal funds to support and augment programs which are presently in existence and by creating new programs. Through the facilities of a university, science and technology will be applied to such areas as underwater prospecting, pollution control, shipping and navigation, mining, food resources and development, forecasting of weather and climate, marine pharmacology and medicine and recreation.

These sea grant colleges hopefully will do for the sea what land grant colleges did for the land. The land grant college movement caused an agricultural revolution in America. A small investment in agricultural research brought forth great returns in terms of increased production per acre, the release of workers from agriculture, higher output per man-hour, new methods of farming, marketing and conservation, and higher standards of living for the farmer and his family. These colleges are a continuing source of research and experimentation, keeping America's farmers aware of new techniques and knowledge in agricultural sciences and keeping our farmlands among the highest producers in the world.

Similarly, a sea grant college would have a grant of seashore or lakeshore for experimental plots; it would receive Federal assistance for educational programs in the related fields of oceanography, aquaculture and marine mining for research facilities in the practical application of scientific research and techniques and for the creation of extension services to disseminate this information to all fishermen and oceanographers.

We in Massachusetts are particularly well qualified to expand our already considerable efforts in these areas, and to benefit from this program. The Commonwealth of Massachusetts has long been involved in the life of the sea. For centuries, fishing fleets and whaling schooners have sailed from the ports of Gloucester and Rockport, the South Shore and the islands of Nantucket and Martha's Vineyard. Today these same ports are the home base for fleets which farm the Grand Banks and Atlantic waters. And these Massachusetts fleets account for a large portion—10 percent—of the total U.S. commercial fish catch, surpassed only by Alaska and California. However, today, instead of having the 20th century equivalent of the powerful formidable fleets of the 1800's, our fishermen are working with outdated equipment and inefficient facilities.

We have the resources in Massachusetts to change this. Our State is one of the oldest and most respected centers of marine research in the country. In addition to research facilities within academic institutions such as Boston College, Boston University, MIT, Northeastern, and the University of Massachusetts, Massachusetts is proud of its special marine institutes such as the New England Aquarium, the Marine Biological Laboratories, and the Woods Hole Oceanographic Institute.

Mr. Chairman, I would like to offer for the record a copy of an excellent speech presented last week at the New England Aquarium by Dr. Bostwick H. Ketchum, associate director of the famous Woods Hole Oceanographic Institution. I believe this speech illustrates quite well the long-term interest Massachusetts has had in the marine sciences and the extent of the State's oceanographic activities.

(The speech of Dr. Ketchum follows:)

MARINE SCIENCES IN NEW ENGLAND

(By Dr. Bostwick Ketchum, Associate Director, Woods Hole Oceanographic Institution)

New England has a long and distinguished history in conducting research in the marine sciences. One may think of history as looking back upon the past, but several recent activities suggest that the history of marine science in New England has been a stage of growth and preparation for the changes in marine science which may be just around the corner. One of these activities is the formation formally announced just yesterday, of the Massachusetts Association for Marine Sciences which includes as members several of the Massachusetts universities, the New England Aquarium, and both the Marine Biological Laboratory and the Woods Hole Oceanographic Institution in Woods Hole, Mass. Another action which may have a profound effect on the development of marine sciences is the bill submitted in the Senate of the United States by Senator Pell of Rhode Island providing for the establishment of sea grant colleges and universities which could provide, for the exploration and the exploitation of the oceans, the same kind of stimulus that was given to the development of agriculture by the formation of land-grant colleges. Hearings on this bill are scheduled to be held at the University of Rhode Island on next Monday, May 2, 1966. These are merely two examples of the actions, both public and private, which may profoundly influence the future of marine sciences in New England. It may be worthwhile to review briefly the history of the development of marine sciences in order to provide perspective for the future.

One important unique facet of this history has been the development in Woods Hole, Mass., of a group of laboratories which have established a center for marine research which has gained worldwide renown. Three separate and independent laboratories have been established and have flourished in this small village. These are the Biological Laboratory of the Bureau of Commercial Fisheries, the Marine Biological Laboratory, and the Woods Hole Oceano-

graphic Institution. From the very beginning the relationships of these institutions with the universities, not only in New England but throughout the country, have been intimate and cordial. The personnel of these three laboratories encompass nearly every aspect of basic research concerning the oceans and the life that they contain, the seabed below, and the atmosphere above.

The Bureau of Commercial Fisheries Biological Laboratory was the first to be established in Woods Hole. Spencer F. Baird, Assistant Secretary of the Smithsonian Institution was appointed the first U.S. Commissioner of Fisheries by President Ulysses S. Grant in 1871. Baird was well known to the scientific circles in this country and abroad as a naturalist, a student of classification and distribution of mammals and birds. Baird carried on extensive studies of the fisheries of New England before selecting Woods Hole as an ideal location for a permanent laboratory for the Fish Commission. The reasons for the selection are still valid today and explain in part why the other two laboratories also selected Woods Hole. The excellent harbor is suitable for the type of vessel used in oceanography and fisheries research and, since there is little land drainage, the sea water is relatively clean and unpolluted and remains at a nearly constant salinity throughout the year. It is thus an ideal source for the maintenance of living specimens under laboratory conditions. Cape Cod is the location of a summer temperature boundary, as those who swim in the waters both north and south of Cape Cod in the summertime well know. Many northern species of organisms have the southern limit of their distribution on the northern shores of Cape Cod while many southern species have their limit on the southern shores. Thus populations of two quite distinct sorts are available within a short distance of the laboratories. The open sea and the Gulf Stream are less than a day's sail from the docks in Woods Hole and consequently the scientist has a wide variety of marine conditions available and readily accessible. Woods Hole was always intimately associated with maritime affairs from the landing of Bartholomew Gosnold in May of 1602, 18 years before the Pilgrims landed at Provincetown and Plymouth, to the days when New England whaling captains fitted out and took on water at Bar Neck Wharf, the site of the present laboratory buildings. This history of the development of marine sciences in Woods Hole can be dated officially as starting with the establishment of the Biological Laboratories of the Fish Commission in 1875, though the laboratory building was not completed and occupied by the scientists until a decade later.

At about this same time another great naturalist, Professor Agassiz of Harvard University, was anxious to provide his students with the opportunity to study living specimens of the abundant fauna of the marine environment. He established a small laboratory on Penikese Islands in Buzzards Bay, but found that the problems of transportation and access made its continuous use difficult. As an outgrowth of this marine station, however, a group of university professors with very meager financial assets established in March 1888 a new institution under the name of the Marine Biological Laboratory. From a modest shingled building erected during that first year, the MBL has grown to a position of international stature in biological research that is unequaled in the world. Many of the great American biologists of the present century have studied living marine specimens in the courses offered during the summertime or have conducted some of their research at the MBL. From the very beginning the MBL enjoyed the full support and cooperation of the Fish Commission Biological Laboratories and this spirit of cooperation has prevailed throughout the history of Woods Hole. The MBL continues to be primarily a summer laboratory offering space and facilities to university professors to conduct part of their research during the summer and offering courses in various aspects of marine biology to students drawn from colleges and universities throughout the country.

The youngest of the three laboratories is the Woods Hole Oceanographic Institution which was founded in 1930 as the result of a study conducted by a Committee on Oceanography of the National Academy of Sciences. Here again, complete cooperation was offered by the existing laboratories to the fledgling newcomer. The Chairman of the Committee was Frank Lilly who was, at that time, director of the MBL. The secretary of the Committee was Henry B. Bigelow, professor of biology at Harvard University, who became the first Director of the Institution. The Oceanographic was founded and existed for about 10 years primarily as a summer marine station. This was because Dr. Bigelow, the first Director, did not believe that scientists could be content to live in the virtual isolation of a small New England village, a fact which was probably true at that time with the very limited size of the professional community in Woods

Hole. Unlike the MBL, the Oceanographic Institution has changed, however, to a year-round activity with a resident scientific staff of over a hundred. With the rapid and easy transport to Boston it is a beehive of activity throughout the year.

The biggest change in the oceanographic came when Columbus Iselin was director during the years of World War II. The oceanographic had already been carrying on for 10 years, investigations into the structure and the chemistry of the Atlantic Ocean and Iselin recognized the importance of these observations to the operations of the U.S. Navy, primarily in the field of acoustics and undersea warfare. During the war, scientists were willing to forego their ivory tower investigations and to turn their attention to problems which were vital to the survival of the Nation. To meet the demand for information about marine sciences the laboratory rapidly expanded, not only in its study of underwater acoustics, but also in such fields as the biology of the fouling of ships' bottoms and chemical studies of antifouling paints, the meteorological conditions which influence the patterns and development of smokescreens over water, in underwater explosives, and in the factors which control the development and visibility of wakes of ships at sea. Contrary to Bigelow's expectation, the scientists found Woods Hole a desirable location to carry on their research and to live.

These three separate and independent laboratories in Woods Hole are today as vigorous and active as they have been at any time in their history. Daily, one sees the collecting vessels of the MBL set out to obtain marine specimens which are used in college instruction throughout the country and it is not an uncommon sight to see an oceanographic or fisheries vessel return to the docks after several months on a research cruise away from the home port. For the first time last year the newest of these vessels, the *Atlantis II*, returned from a trip around the world in which studies were conducted at such farflung places as the Red Sea and the Indian Ocean, the coasts of Japan, and the Pacific. Thus the history of Woods Hole as a center for marine research has developed over nearly a century from rather modest beginnings to a scientific center of world renown where one can meet scientists from any part of this country or abroad, where the library is one of the best in marine sciences in the world and where young students can swim, sail, and study with their professors and gain an experience which is difficult if not impossible to duplicate in any other place.

This is a brief review of the past and the present, and it augurs well for the future. Inevitably men will penetrate more deeply the marine environment in order to learn its secrets and exploit its resources. While I have emphasized the scientific center at Woods Hole, it is clear that the nearby universities in Boston and the New England Aquarium have already contributed much to marine science. Closer association between the Boston and Woods Hole centers of marine science will afford unexcelled educational engineering and research opportunities to lead the future developments that are impending.

Senator KENNEDY of Massachusetts. A national sea grant college program would give these Massachusetts universities and institutions the additional financial assistance, direction, and encouragement they need to revitalize the fishing and marine industries of New England. Moreover such a program would give much needed support to younger, developing institutions.

For example the Southeastern Massachusetts Technical Institute, a new university in southeastern Massachusetts, has just begun a program of research into aquatic sciences and is working closely with industry and civic leaders in the New England fishing community. SMTI needs the type of assistance envisioned in S. 2439 to strengthen its curriculum and to provide necessary equipment and salaries. And the establishment of a sea grant college within SMTI or other institutions in southeastern Massachusetts should bring to the New Bedford area new marine and aquatic industries anxious to take advantage of the research facilities and technological advances which will flow from this program. I believe developing private industry interest is an important aspect of the sea grant college program. For just as industry

has grown around the excellent research and experimental facilities of Boston, industry should grow in the areas around sea grant colleges wherever they are established.

Leaders within our Commonwealth have already started devising plans to expand research and education in the marine sciences for the benefit of the public. The various Massachusetts universities and institutes involved in aquatic culture have formed the Massachusetts Association for Marine Sciences, where representatives meet regularly to exchange ideas and plan cooperative research. A subcommittee on oceanography has been created in the Governor's science advisory committee and a New England chapter of the Marine Technology Society has been formed. These efforts to marshal the combined resources of our research and education community reflect the great interest in the ocean within our State, and testify to Massachusetts' capacity to make a positive contribution to the success of these programs.

Mr. Chairman, I look forward to these hearings as an opportunity to hear from individuals in this field who will be working and benefiting from the operation of this program, who can comment on ways to make this program better serve the public interest.

In particular, I look forward to comments on both the proposed method and amounts of Federal funding and on the designation of the National Science Foundation to administer the program. The approach taken on these questions in the present version of the bill seems to be eminently sensible, but I think we should keep our minds open to alternative possibilities.

Finally, I hope to learn about the advantages and disadvantages of restricting eligibility of Federal assistance to institutions having access to large bodies of water. Given the limited resources available to support this national program, it may well be desirable to focus maximum support on these institutions which, on their face, are in the best position to make a major contribution to our goal—the conquest of the sea.

Senator PELL. I thank my friend and colleague of the neighboring Commonwealth of Massachusetts for his statement. He brings a great deal of knowledge and experience of the sea and strength to the subcommittee, and like him, I have no preconceived ideas as to what agency could best administer this program. I look forward to learning more from the highly qualified witnesses who will be coming up here in the next few days and they were with us yesterday already.

On behalf of the minority—I thank my colleague very, very much indeed for his constructive testimony.

We will now hear from Senator Inouye, our colleague from Hawaii.

STATEMENT OF HON. DANIEL K. INOUE, A U.S. SENATOR FROM THE STATE OF HAWAII

Senator INOUE. Mr. Chairman, I wish to speak on behalf of S. 2439 which would authorize the establishment and operation of a sea grant colleges program.

This program is of particular interest to the people of Hawaii, because, located in the middle of the Pacific, we see in it a tool for more effectively exploiting the vast potentialities of the ocean frontier that

surrounds us. The proposal would offer the same advantages to any coastal institution of higher learning.

The ocean bottoms and the life about them remain largely uncharted mysteries, yet comprise 70 percent of the earth's surface.

The advantages offered by S. 2439 lie in the impetus it would give to oceanic research. Now, research funds are scattered among many agencies of the Government, each with its particular interest. There is an advantage in such diversion in meeting specific problems as they arise, but to get the maximum return on the research dollar spent for ocean studies, it is often advantageous to have these studies encompass wide areas of interest rather than the narrower scope often prescribed because of limitations on the granting agency. For this reason, designating the National Science Foundation as the central research agency would be beneficial. It would permit a coordination of research which would maximize the effectiveness of research moneys spent in this area.

Secondly, this bill would single out for recognition and emphasis research programs and programs of education in oceanography. Interest in ocean research is a new emergent in the academic world. Further, few industries, save fishing and in a sense, oil, are based on the wealth which lies beneath the surface of the sea. We know that scientific exploration will precede technological exploitation. Yet our intellectual attack has been piecemeal. This measure, I feel, would give focus to our scattered research efforts.

Thirdly, the objective of this bill harmonizes with the efforts and goals of the people of Hawaii as shown in the activities of our State government. Feeling that our greatest future wealth may lie in the ocean surrounding us, our State is investing heavily in ocean science projects. We have organized within the University of Hawaii, the Department of Oceanography, and have staffed it with highly competent men. Department emphasis is both on instruction and on research in biology and physical oceanography.

The State also has established three research centers which function in conjunction with the University of Hawaii: The Hawaii Institute of Geophysics, which has physical facilities on campus and a research vessel operating out of Honolulu; the Hawaii Institute of Marine Biology with a laboratory on Coconut Island, where a new building is nearly completed; and further, upon completion of the building, there is to be a Pacific Biomedical Research Center for research in marine animals, located at Kewalo Basin in Honolulu.

The State's investment in oceanography has been paralleled by private research interests centering in Honolulu. Operating out of Honolulu, the Lockheed-California Corp. has two research vessels chartered from the Scripps Institution of Oceanography, working on a \$2 million contract with the Navy Bureau of Ships. Also owned by Scripps Institution of Oceanography is the *Flip*, an instrument vessel under contract to study sound waves in the Hawaiian area. Equipment for the undersea drilling of Project Mohole is being assembled, and currently U.S.S. *Pathfinder* of the Coast and Geodetic Survey is engaged there in a project for the Environmental Services Administration. Each of these developments indicates a growing awareness of Hawaii as a center for the study of ocean science.

I believe that Hawaii, as well as the other coastal States of this

country, will in the years ahead, find tremendous new sources of wealth from the ocean. Through the pioneering research projects now underway, Hawaii is investing in the search for that wealth. I am confident that they yield from these efforts and others will far exceed the investment placed in them.

Because of this belief, I ask that favorable action be taken on this proposal to integrate and augment programs in ocean research.

Senator PELL. Thank you, Senator Inouye. We now have Senator Fong, the other Senator from Hawaii.

STATEMENT OF HON. HIRAM L. FONG, A U.S. SENATOR FROM THE STATE OF HAWAII

Senator Fong. The proposed National Sea Grant College and Program Act of 1965 is a much-needed measure, and I strongly urge its enactment.

S. 2439 would authorize the establishment and operation of sea grant colleges and programs through education, training, and research in the marine sciences. The objective of the bill is to do in the oceanic field—by putting research to practical use—what has been and is being done so successfully in agriculture under the Morrill land grant program.

The seas around us cover two-thirds of the earth's surface. In the words of the originator of the sea grant college idea, Dr. Athelstan F. Spilhaus, "The oceans will offer us military, recreational, economic, artistic, and intellectual outlets of unlimited scope."

Yet our knowledge and use of the oceans and their potentials are woefully lacking. A nation which prides itself on its successful exploration of outer space has yet to probe deeply into "inner space" and make the most of the vast resources there.

S. 2439 applies to marine science the principles of the land-grant system which gave this Nation the agricultural extension service and the very fruitful Federal-State cooperation in agricultural research which resulted from that system.

S. 2439 would provide for "aquacultural extension service" to be developed in institutions of higher learning. These centers of aquaculture would concentrate primarily on applying scientific research to the sea, such as exploring for minerals underwater, harvesting food resources, and developing military defense. The range of useful areas which such aquacultural centers can explore and exploit is almost unlimited.

Coming from a State which is strategically located to take advantage of oceanographic science and technology, I see in S. 2439 tremendous benefits which can accrue to our island community, to our Nation, and, indeed, to the world community.

A logical center for oceanic research and development is the University of Hawaii, a land-grant college, which enthusiastically endorses the bill.

The university has already embarked on a program of significantly expanding and strengthening its capabilities in oceanic endeavors. It has assembled an outstanding faculty in oceanography, composed of prominent scientists doing important research in both biological and physical oceanography. The University of Hawaii has a strong or-

ganization and is building facilities in ocean science and technology through the Hawaii Institute of Geophysics, the Hawaii Institute of Marine Biology, and the Pacific Biomedical Research Center.

S. 2439, if enacted into law, would greatly enhance Hawaii's role in our national oceanic field. It would give financial support to the University of Hawaii in improving and expanding facilities, and make possible a larger staff of scientists and support personnel.

Beyond its immediate and direct impact upon the academic community, S. 2439 would stimulate the industrial and business community to greater efforts in developing the commercial potentials of the oceanic field.

In 1964, the Hawaiian business community, acting through the Hawaiian Electric Co., engaged a nationally known research firm to appraise Hawaii's potential in oceanics, with particular reference to its promise for future economic growth in the islands. According to the survey, oceanics activity in Hawaii can grow in dollar volume from \$4½ million in 1964 to as high as \$25 million by 1970. The projected levels for Hawaiian oceanics activity were based on the then existing, quiescent levels of national planning and support. The report added the significant note that—

When and if oceanics breaks out of this current level, and if Hawaii meanwhile has developed a strong foundation within economically viable bounds, the field could become a major "industry" for the islands, in the \$100 million class. Even if oceanics does not break out, its economically sound development within the State makes sense and will help to enrich the community intellectually, socially, and economically.

The survey concluded that the most promising activities for Hawaii are oceanographic research and development, fishery research, man-in-the-sea and life support programs, Mohole project, Navy tactical and calibration ranges, underwater test facilities, and Hawaiian-based ocean surveys.

These are areas of activities which come within the stated purposes of S. 2439. The National Science Foundation would be directed under S. 2439 to carry out marine science programs through contracts with, and grants to suitable public or private agencies, public or private institutions of higher learning, museums, foundations, industries, laboratories, corporations, organizations, or groups of individuals concerned with activities in the marine sciences.

Financing for the program would be derived from using 10 percent of the annual revenues from rents, royalties, and bonuses from offshore oil properties under Government lease. This would be a logical source of financing for the sea grant college program since the revenues come from the ocean.

The author and sponsor of S. 2439 (Senator Pell) has stated that the proposed sea grant colleges "should be fostered and developed in those areas that have made a beginning and have the capabilities and resources for such an undertaking. Obviously, geography too is an important consideration."

Hawaii fits both descriptions. As pointed out earlier, the University of Hawaii already is embarked on a strong program of oceanographic activities, having attracted scientists of wide renown to its campus and having developed facilities for extensive research and development.

As to geography, Hawaii has the distinction of being the only island State of the Union—an island community completely surrounded by the ocean and enjoying ideal natural advantages for oceanic work. These advantages include Hawaii's central location in the Pacific, close to nearly any sea conditions that might be demanded in almost any investigation; its equable climate; and its underwater visibility.

The sea grant college concept is being proposed at a time when fresh interest is being generated nationally in the oceans. For too long, this Nation has neglected the ocean that promises so many benefits if only its potentials were more clearly understood and appreciated. S. 2439 offers opportunities for this Nation to put to practical use the knowledge we have gained from research of the ocean. Because of what the proposed legislation could mean to my State and to the national interest, I urge this subcommittee to act speedily and favorably on S. 2439.

Senator PELL. Thank you, Senator Fong. The next witness will be Congressman Rogers who I believe is here. He is an authority in this field in the other body and is very good indeed to have taken the time to come here. I know his interest and the work he is doing in getting through the Magnuson bill on this side.

Mr. Rogers.

STATEMENT OF HON. PAUL G. ROGERS, A U.S. REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Mr. ROGERS. Thank you very much, Mr. Chairman and Senator Kennedy. It is a pleasure to be here to appear before your committee and I am pleased to testify in support of S. 2439, and I do want to commend this subcommittee for bringing this legislation to the floor and the distinguished chairman, Senator Pell, for his interest in introducing the bill along with Dr. Athelstan Spilhaus, distinguished dean of the College of Minnesota, that Senator Kennedy mentioned, who also deserves a great deal of credit.

I think it is interesting that the idea for a sea grant college originated not from a coastal State but really from the heart of our country and, of course, all of us I think in this country, once we look at the problem, see the need for this legislation.

If the Chair will permit, I will just file my statement and just make a few comments at this time rather than read the entire statement. Of course, the reason for the sea grant college program is based on the successful concept of land grant colleges, which have contributed so much to the Nation's progress. Sea grant colleges, nurtured by a program set forth through the National Science Foundation, are vitally needed to enable the United States to enter the "wet space age."

I think there is no question about the fact that such a race is on, and unfortunately our principal competitor, Russia, is the same competitor that we have in space and is making great progress in conquering the wet space.

I think just a quick look at some of the things they are doing, and we realize that we can fall behind very quickly if we are not cognizant of this problem and willing to do something about it.

The primary objective of a national sea grant college program concerns the development of marine manpower. Today the Soviet

Union has between 8,000 and 9,000 persons engaged full time in the marine sciences. The Soviets have over 1,500 qualified oceanographers. The United States has less than 1,000 oceanographers, and total marine technology manpower at work full time in this country today numbers less than 3,000 persons.

The Soviet Union is placing high national priority on ocean technology training and application of marine research. The United States by contrast has just begun recognizing the importance of this new field.

The seas represent greater and more immediate economic returns than have yet been found in outer space. The Interior Department, for instance, estimates that this Nation's fish catch could be expanded to five or six times its present level as Senator Kennedy brought out, good news actually for a nation which has slipped, as has been brought before the attention of the committee, to fifth place.

The Soviets, who rank fourth, are increasing their fish catch by 500,000 tons per year and they have made fishing a science, have adopted progressive methods such as fish farming, transplanting millions of salmon eggs and fingerlings from the Far East to the Bering Sea.

I was in the Soviet Union in January and this program was discussed with me. Now the Soviets are also transplanting the king crabs which is a very lucrative field, as you know, in the seafood business.

Each year Americans spend over \$500 million on imported fish products. Over 62 percent of this Nation's fish consumption is from foreign producers. In fact, I think we can say every other fish in the American frying pan is imported.

By developing scientific methods in marine biology and ocean engineering through sea grant colleges, this Nation could reap enormous economic benefits from sales of fish at home as well as to hungry and growing populations abroad.

Further economic returns are to be had for that nation which has the technology to surface precious minerals lying on the ocean floor. Offshore oil drilling by U.S. producers in 1964 brought in 174 million barrels valued at over a half billion dollars. By 1970 it is estimated it should be bringing in about \$1.2 billion, double what it is today.

Manganese ore has been discovered off the U.S. coast, actually in an area just east of the Georgia-Florida State line. This layer has been estimated to be 3 to 4 feet thick and up to 1,900 square miles. Of course, this is vital to the manufacture of steel and related alloys as well as dry cell batteries and is of vital importance to the Soviets as well as the United States which consumes several times as much manganese as it produces.

A sea grant college could be instrumental in developing methods of harvesting this mineral, and a host of other benefits could be realized. My own State of Florida has begun to move in the direction of schooling young minds in the value of the seas. In our State there are four State universities which offer courses in oceanographic and related marine sciences. One private institution, the University of Miami, maintains the Institute of Marine Science, one of the finest in the world. Florida Atlantic University, the newest of our State institutions, is now offering programs in ocean engineering and other applied uses of the seas.

Of course, other progressive States boast of such fine institutions as the University of Rhode Island, Graduate School of Oceanography, the University of Minnesota's Institute of Technology, of course, with which Dean Athelstan Spilhaus is associated.

We must do more to raise the level and numbers of oceanographic students and educators in every State if this Nation is to win the wet space race. And the ranks of America's qualified oceanographers must grow more rapidly than the present 10 percent per year.

Now, it is interesting to note that Russia has already reached the level of producing 15 percent of oceanographers every year which already surpasses us in the number of qualified people they are turning out and they are increasing this rate. So all in all I think it is evident, if one will look at what is being done all over the world in the development of the seas, that we must begin to have more vision in this Nation as to what can and should be done to develop the 70 percent of the earth's surface represented by the seas.

Therefore, I would urge that S. 2439 be approved by this distinguished subcommittee, its parent committee, and both Houses of Congress as well, and I commend the chairman and the subcommittee for devoting the time and effort necessary to bring this legislation to the attention of the Congress.

I thank you, Mr. Chairman.

Senator PELL. Thank you very much, Congressman Rogers, and I understand that you like this idea equally and are helping shepherd the same concept through in the House.

Mr. ROGERS. We hope to do this.

Senator PELL. That would be wonderful. I realize it is still premature but do you have any views as to where the administration of this program should rest? I know we on our side have no fixed views. We look forward to listening to the witnesses and making up our minds in the executive committee session.

Mr. ROGERS. I have no strong views about who should administer it as yet, Senator. I would agree with you. I don't see anything wrong with the way the bill is drawn to let the National Science Foundation begin the program. As you know, we have other legislation that is now moving along rapidly to have a commission study the entire program of efforts of the United States and its development of the seas. If the legislation is passed and approved, as we hope it will be, this would require a study of 18 months.

Now, at the end of that time I would hope that they might make suggestions as to organization of how the Government should carry on its entire program of oceanography, and this could then be considered. In the meantime I think the National Science Foundation would be an appropriate body.

Senator PELL. The legislation that you are considering, to my mind, is excellent because it calls for a self-liquidating council which does not create one more Government organization, and that is a wonderful idea.

Mr. ROGERS. That is right.

Senator PELL. It is an excellent thought. One of the ideas going through my mind is that the Smithsonian Institution, which has a certain tradition of nurturing and spinning off Government groups, organizations, actually, might be suitable to handle it on a temporary

basis and then see where it would go on a more permanent basis. The argument being made that in the National Science Foundation there might be a greater emphasis on pure research and also much more on individual grant assistance, and some of the people in the field think there should be more program assistance, institutional assistance, and also more practical use of the knowledge. This is open for discussion.

Mr. ROGERS. Well, I think that has a great merit. I think the Smithsonian could well do this job. And although I think we should have some recommendations in about 18 months, that is why I said I thought the National Science Foundation could do this for that period of time. However, I can see nothing that would be objectionable. It might be worthy of consideration in letting the Smithsonian do this.

Senator PELL. To consider it basically on a very temporary basis.

Mr. ROGERS. Yes.

Senator PELL. From the testimony of the Department of Interior witnesses, I can see a certain avariciousness on the part of the Government agencies in handling a program that looks to have the potential for growth that this has. I think we must make a very sound decision in the beginning.

Mr. ROGERS. Yes. That is why I think it is very important for us to enact legislation this year to get this study going so we can kind of get everybody together rather than going off on tangents which we have done so often. I am afraid.

Senator PELL. Right. I can't tell you how glad I am, Congressman Rogers, that you take such an interest in the field and work with it as well. It was very nice of you to come over here this morning.

Mr. ROGERS. Thank you very much. We commend your leadership in this area.

(The prepared statement of Mr. Rogers follows:)

PREPARED STATEMENT OF HON. PAUL ROGERS, A REPRESENTATIVE IN CONGRESS FROM
THE STATE OF FLORIDA

Mr. ROGERS. Mr. Chairman and distinguished members of the subcommittee, I am pleased to have this opportunity to appear here this morning to testify to the pressing need for sea grant colleges. The entire subcommittee, and particularly its distinguished chairman, Senator Pell, who represents one of the Nation's foremost oceanographic States, Rhode Island, are to be commended for initiating movement within the Congress toward establishing a program of sea grant colleges.

The question "What is a sea grant college?" can be raised. The answer can be given that sea grant colleges will be to ocean technology what the land grant colleges of 100 years ago have been to not only America's agriculture, but her entire system of higher education.

Similar to the successful concept of land grant colleges which has contributed so much to this Nation's progress, sea grant colleges, nurtured by the program set forth through the National Science Foundation, are vitally needed to enable the United States to enter the "wet space age."

We are in a race to conquer the earth's "wet space." There is no question about it. Our principal competitor is Russia, just as Russia is our principal competitor in the race to conquer outer space.

And right now Russia is in many respects winning the wet space race. It is a matter of national survival that the United States be the first to completely master the oceans. Nearly three-fourths of the earth's surface is water. This fact alone makes U.S. mastery of the seas imperative. Considering the mass of the earth's inner space which the oceans occupy, America's need to penetrate and occupy the greatest depths becomes even more critical.

The primary objective of a national sea grant college program concerns the development of marine manpower. Today the Soviet Union has between 8,000

to 9,000 persons engaged full time in the marine sciences. The Soviets have over 1,500 fully qualified oceanographers. The United States has less than 1,000 oceanographers. Total marine technology manpower at work full time in this country today numbers less than 3,000 persons.

The Soviet Union is placing high national priority on ocean technology training and application of marine research. The United States, by contrast, has just begun recognizing the importance of this new field.

The seas represent greater and more immediate economic returns than have yet been founded in outer space. The Interior Department estimates that this Nation's fish catch could be expanded to five or six times its present level—good news for a nation which has allowed its fisheries to slip to fifth place among world fishing nations. The Soviets, who rank fourth, are increasing their fish catch by 500,000 tons per year. They have made fishing a science, have adopted progressive methods such as "fish farming"—transplanting millions of salmon eggs and fingerlings from the Far East to the Bering Sea.

Each year Americans spend over \$500 million on imported fish products. Every other fish in the American frying pan is imported. By developing scientific methods in marine biology and ocean engineering through sea-grant colleges, this Nation could reach enormous economic benefits from sales of fish at home as well as to hungry and growing populations abroad.

Further economic returns are to be had for that nation which has the technology to surface precious minerals lying on the ocean floor. Offshore oil drilling in 1964 brought in U.S. producers 174 million barrels valued at \$541 million. By 1970, U.S. offshore production will be worth about \$1.2 billion, or about double what it is today. With increased knowledge, that figure could be even higher.

Manganese ore has just been discovered off the U.S. coast near the Florida-Georgia State line. This layer has been estimated at 3 to 4 feet thick, and up to 1,900 square miles of pavement. Vital to the manufacture of steel and related alloys, as well as dry cell batteries, manganese is of vital importance to the Soviets as well as the United States, which consumes several times as much manganese as it produces. A sea grant college could be instrumental in developing methods of harvesting this mineral.

A host of other benefits could come from advancing this Nation's ocean technology. Better weather controls, improved antisubmarine warfare, utilization of sea vegetation, pollution control, conversion of salt water to fresh, and improved surface shipping are just a few returns to be had for an investment in the oceans which is meager compared to our financial stake in outer space probes.

Florida has already begun to move in the direction of schooling young minds in the value of the seas. In our State there are four State universities which offer courses in oceanographic and related sciences. One private institution, the University of Miami, maintains the Institute of Marine Science, one of the finest in the world. Florida Atlantic University, the newest of our State's institutions, offers programs in ocean engineering and other applied uses of the seas.

Other progressive States boast of such fine institutions as the University of Rhode Island's Graduate School of Oceanography, and the University of Minnesota's Institute of Technology, whose noted Dean Athelstan Spilhaus has long advocated the concept of sea grant colleges.

However, more must be done to raise the level and number of oceanographic students and educators in every State if this Nation is to win the wet space race. The ranks of America's qualified oceanographers must grow more rapidly than the present 10 percent per year if we are to outdo Russia's annual expansion of 15 percent. This Nation must discover more undersea technology if our national defense is to be maintained against such submarine military operations as may be launched from Soviet bases in Cuba. Sea grant colleges can be a major factor in turning this tide. I urge that S. 2439 be approved by this distinguished subcommittee, its parent committee, and both Houses of the Congress as well.

Thank you for this opportunity to be heard.

Senator PELL. Thank you very much.

Our next witness is Dr. Randal M. Robertson, Associate Director for Research, National Science Foundation.

STATEMENT OF DR. RANDAL M. ROBERTSON, ASSOCIATE DIRECTOR FOR RESEARCH, NATIONAL SCIENCE FOUNDATION; ACCOMPANIED BY HARVE J. CARLSON, DIVISION DIRECTOR FOR BIOLOGICAL AND MEDICAL SCIENCE, NATIONAL SCIENCE FOUNDATION

Senator PELL. Will you proceed as you will, Dr. Robertson?

Dr. ROBERTSON. Thank you, Senator Pell. I am delighted to have the opportunity to speak to you today. I would like first to introduce my colleague, Dr. Harve Carlson. Dr. Carlson is Division Director for Biological and Medical Sciences in the National Science Foundation, and is the Foundation member of the Interagency Committee on Oceanography of the Federal Council of Science and Technology.

I am a physicist, sir, and spent 12 years with the Office of Naval Research before joining the National Science Foundation in 1958.

I would like to read a very short statement outlining the Foundation's position with regard to S. 2439.

The Foundation is in agreement with three basic premises of S. 2439: first, that the time is now ripe for an aggressive move toward fuller exploitation of the resources of the seas; second, that our universities and colleges must play a key role in this movement; and third, that while ocean science itself is in reasonably good shape, the exploitation of ocean resources needs a new push forward.

Ocean science, both physical and biological, has only just begun to develop an adequate understanding of the complex natural phenomena of the seas. This work must go forward and should be intensified. The Foundation agrees, however, that the time is now at hand to mount a concurrent program of applied research and exploratory development, in which we must take direct aim at optimum utilization for our country of the resources of the oceans. On the basis of experience it can be expected that advances in ocean technology will open up new opportunities and techniques for basic research.

The Foundation believes that no one agency can undertake the entire task. For example, the Navy Department, the Department of Commerce, the Department of the Interior, and the National Science Foundation have essential roles to play. Each one has skills and resources in this very field which can and must be dedicated to our mutual objectives. Therefore, consideration should be given to having any sea grant bill make clear that direct participation of those and other appropriate agencies is contemplated.

The National Science Foundation can well undertake a key role in developing strength in the ocean resources field at our academic institutions. Under its present legislative authority, the National Science Foundation can undertake the support of many programs in the general field of oceanography. However, we would welcome a specific assignment in the area of academic research, basic and applied, and education along the lines envisaged by the provisions of the bill as our part of a continuing governmentwide effort. It is in interaction with the academic institutions of our country that the Foundation has the greatest store of experience and competence. However, the Foundation considers that it should not be assigned responsibility for activities involving the development of practical systems for exploitation of the marine environment.

I will comment very briefly now on two major aspects of the bill. One is how the program should be financed; the other relates to the basic concept of the sea grant institution. First, I cannot see many advantages in financing support under the bill by tying such support to a fraction of the funds derived from offshore leases as proposed in section 3(b) of the bill. The Foundation favors the established procedure of analyzing our needs and opportunities and then providing the necessary funds through the budget process. This would be a more direct procedure for insuring that funding is carefully planned in relation to the required program and that it is adequate to meet the opportunities.

Second, the Foundation would urge that the title "sea grant institution" be reserved for a limited group of carefully selected universities which agree to mount major programs in the ocean resources field rather than being applied merely to any institution receiving support under S. 2439. Institutions qualifying would most likely be in the coastal and Great Lakes areas. Further, I believe that the National Science Foundation should work closely with the State governments in this development, and that a "sea grant institution" should be the fruit of an agreement between the Federal Government and the State, in which the State agrees to commit some of its own resources to the program. To qualify for sea grant status, an institution would have to present a carefully worked out, realistic plan showing how it would proceed to develop a program of education and research, both basic and applied, aimed at training the manpower required and developing the knowledge and techniques necessary for tapping the resources of the oceans. These selected institutions would not in any sense have a monopoly on the field. However, they would be clearly identified as the focal institutions for this enterprise, which is so important to the future of our Nation. This would give a much more significant meaning to the term "sea grant institution" than that presently envisaged by the bill and thereby help stimulate research and education in this field.

I appreciate the opportunity of appearing here today to present the Foundation's position and will be glad to answer any questions.

Senator PELL. Thank you very much, Dr. Robertson, for your succinct, imaginative, and thoughtful testimony with the specific suggestions. I was struck with your point that it might be wiser not to relate the funds to the percentage of the rents and royalties. The Bureau of the Budget may have some views on this matter, too. And there may well prove to be considerable wisdom to your thought that we should just have a straight authorization. Our minds are open on that.

The reason we originally tied it into the rents and royalties was to show that it was a self-feeding operation, that the more money that went into it, the more money would be produced for the public weal.

Secondly, with regard to your point about matching programs with the States and not spreading the program too widely, diverting it, diluting it, I think there is some merit in this thought, too.

Have you thought how the program might be matched, what kind of ratio you are thinking of, 50-50, 90-10, or anything of that sort?

Dr. ROBERTSON. We have not worked it out in detail. I believe there should be a negotiated participation by the State in the program.

Senator PELL. When you say the State, it would either be the State or private educational or business institutions within the State. You don't mind where the money came from as long as it didn't come from the Government.

Dr. ROBERTSON. I had in mind non-Federal funds, but sufficient State participation to insure that the State itself, the State government, is behind the venture.

Senator PELL. I know we are very lucky in my own State of Rhode Island where the university itself and the State—particularly the university with great help from the Federal Government—have really taken considerable initiative in this field. This is what you are driving at, I would imagine, in other States as well, that the initiative should come locally and that the Federal Government would help it.

Dr. ROBERTSON. Yes. I think we should stimulate initiative, however, not simply wait passively for something to happen.

Senator PELL. I think this bill would probably do that. There is nothing that stimulates interest more than the prospect of funds, and it has that effect, I have noticed.

Now, another question with regard to the administration of the bill. I notice that you believe the Foundation should not be assigned responsibility for activity involving the development of systems for exploitation of the marine environment. The purpose of this bill is basically exactly that, not development of new research or the development of new knowledge. It is the practical exploitation from a money-making or health or economic viewpoint of the information and knowledge that we already have. So I would imagine you would not be adverse to it being administered by the agency that might be set up by the self-liquidating council under Senator Magnuson's bill, or on a temporary basis by the Smithsonian Institution. Would that be correct?

Dr. ROBERTSON. I believe that the engineering development of systems for exploitation of the resources of the sea should be done primarily by industry and the Government support should come from whatever agency of the Government has a mission to accomplish, such as the exploitation of mineral resources. I believe that the academic institutions should be involved in applied research and in the exploration of new techniques, and in education which leads people to engage in such activities. I believe that we can support any program which would be appropriate for an academic institution, be it basic or applied.

I simply feel that the management of engineering development programs should not be undertaken by the National Science Foundation but by mission oriented agencies in collaboration with industry.

Senator PELL. But you have no strong view or preference as to where this program should be administered. I think we all agree the program is probably a pretty sound idea and to the national interest. The question is where it should be administered because where it should be administered would give the cachet to the program as it goes along, or the direction, and as I understand your view, your interests are mainly in this area of research and development of knowledge, but the exploitation of knowledge would not necessarily come within your purview or your practices even though it may be in the original mandate from the Congress.

Dr. ROBERTSON. I feel strongly that the bill, insofar as it relates to strengthening our academic institutions in this field, both in the basic and applied areas, should be managed by the National Science Foundation. I believe we are the Government agency best qualified to handle it.

Senator MURPHY. May I ask a question?

Senator PELL. Certainly.

Senator MURPHY. Why wouldn't it come under the ordinary procedures of education?

Dr. ROBERTSON. We support many programs in graduate education in the sciences.

Senator MURPHY. Is it necessary to graduate?

Dr. ROBERTSON. And in the undergraduate area as well. We have a broad mission to support education in the sciences and engineering, and under this we have supported work in the area of oceanography and could support graduate education in marine resources, for example, in engineering schools.

Senator MURPHY. What is your association with the developments of La Jolla, if I may ask? Forgive me for being not knowledgeable on this subject, but there is so much to learn in such a short time.

Dr. ROBERTSON. We support many projects in oceanography at the Scripps Institution of Oceanography.

Senator MURPHY. Individual projects.

Dr. ROBERTSON. Primarily through individual projects and in support of basic research to which we are limited. We cannot under our broad legislative authority support applied research unless specifically authorized to do so by the Congress.

Senator MURPHY. I see. Thank you.

Senator PELL. This brings out the very point I am driving at. The thrust, the purpose of this bill is not to go into research. It is to the application only of research that already has been done and also our concept of it, at least my concept, is not so much individual grants as program grants, somewhat along the lines of land grant colleges, which is the reason we call it sea grant colleges. I am a little confused because as I understand it from your testimony, you believe you should not be assigned responsibility for activities involving the development of systems for exploitation and you have just said, as I understood it, that you believe that your work involved the grants on an individual basis and not for applied research, but more for basic research.

Well, then, it would seem to me that the three viewpoints would indicate that you thought it best not to administer this program.

Dr. ROBERTSON. Well, let me clarify if I can some of these points.

First, under our general authority we can only support basic research.

Senator PELL. Excuse me for interrupting, but that is against the purpose of the bill because we are not seeking to develop basic research.

Dr. ROBERTSON. We would welcome in the case of the sea grants bill authority to extend our support into applied research in the fields relating to marine resources, but it would require this specific bill to authorize it. We would be happy to manage that program.

Senator PELL. Well, then, pressing you on this point, what this bill would do if you were left as administering agency would also be to widen your present congressional mandate.

Dr. ROBERTSON. It would. It would widen our mandate in this particular field just as it was widened when we were assigned responsibility for weather modification where we may support both basic and applied research.

I would also say that I agree with you, sir, that this program requires something beyond the project type of support. It requires in my opinion the same kind of support that we have provided to selected academic institutions through our science development program where we have invited institutions to submit proposals which would permit them to strengthen their science programs across the board. We have made grants up to \$4 million or \$5 million for 3 years to assist these institutions to move to a stronger position in science.

I believe that the objectives of your act would probably best be met if we invited institutions to submit a proposal which would enable them to move strongly into this field across the board in both basic and applied areas, including the education of scientists, and the setting up of new groups. These broad proposals, which would have to be substantial in size, should be judged competitively, and those who can present the best plan should be selected as sea grant institutions and given grants of a broad nature to enable them to move ahead in this broad field.

Senator PELL. What I am concerned with, and I have the greatest respect for your work and the academic community I am, I guess, a frustrated teacher myself, but the problem I foresee in the National Science Foundation is with emphasis upon the development of scientific knowledge, the development of a larger number—I remember the arguments after sputnik—the number of Ph. D's we are getting in the scientific world. It is completely counter to the object of this bill. This bill is supposed to be to help get more fellows going into the fish business. We have a program for 2 years of training of youngsters so they can go on fishing boats. It is to have a greater development of use of the crabs, greater use of trash fish, and I am not sure that your purposes are terribly important for the national interests but are a little bit too high or esoteric, somewhat like asking a portrait painter to be a wall painter.

Dr. ROBERTSON. Well, I believe, sir, that in this broad field the several agencies which have applied missions, such as the Department of Defense in its particular area or the Department of Interior in areas such as commercial fisheries, each should pursue its program aimed at exploiting the resources in the seas around us, and they should do this in every way possible, including contracts with industry, and other methods aimed at developing the kind of systems of exploitation that are needed.

I feel the role that the National Science Foundation can well play in a joint enterprise among several Government agencies is in relation to the universities and to the education and the research, both basic and applied, which those universities will be doing to undergird the total program. We cannot call on our universities to do the final engineering systems development which only industry can do.

Senator MURPHY. Dr. Robertson, forgive me, but you are getting me confused. I thought what we were concerned with was setting up something like the Colorado School of Mines, if I may oversimplify, where young men can go and begin to learn, and after they have

learned the basics, then they arrive under this broad concept of what you are talking about. Is that—

Senator PELL. That is my idea. Less esoteric.

Senator MURPHY. This is the idea of the committee, I am certain, that this is to develop or set up the primary schools which evidently don't exist at the present time.

Senator PELL. Or not set up new schools but develop courses in presently existing schools.

Senator MURPHY. Yes, in presently existing schools.

Dr. ROBERTSON. Well, I think that would be—

Senator MURPHY. I mean, after they graduate, I would see them going into this broad concept of all sorts of particular accomplishments and special projects that you speak of, but these fellows we are talking about that we want to help, they are not qualified, they wouldn't understand what you were talking about any more than I do.

Dr. ROBERTSON. Well, I feel, sir, that the academic institution selected for this purpose would develop courses, both undergraduate and graduate, in all aspects of marine science and technology.

Senator MURPHY. I would think you would start with the undergraduates because you have to begin at the beginning. Before you get to the graduate school, you have to have undergraduates prepared, and apparently there is little opportunity for a young fellow going to school today that wants to become interested in this, where he can get the courses that we think should be provided because of its obvious importance not only now, but in the future.

We are trying to get the first step started, is that right?

Senator PELL. Exactly. For instance, both you, Senator Murphy, and we in Rhode Island have people going to sea. One of the problems of people going to sea is find out how you start. It is a pretty tough life but there are young men who want to do it, but the skippers in the fishing boats would not take a young man now untrained because he would be a nuisance unless he is a relative or has a particular in.

What we are seeking to do to remedy this is to start a program which is not going to turn out bachelors of arts but will turn out fellows at the end of 2 years who want to fish. This is the thrust of the program.

I think what has happened here, and we notice it sometimes from the Hill, no matter what the merits of a program, rarely does a Government agency not wish to administer it. I think it is interesting in the executive branch of the Government, the interest in this program.

I hope that the executive branch will get together, come up with a composite conclusion. Maybe the Bureau of the Budget will be of some help in that matter, but aren't I correct in saying this that, if you did administer this program, as you suggest yourself, it would require an extension of your mandate?

Dr. ROBERTSON. It would insofar as some of the things that we would hope to support would be applied research in areas supporting our exploitation of marine resources. It would not insofar as it relates to our charter to support education at all levels in science and engineering. We could assist in developing the 2-year curriculum for this purpose, on the 4-year curriculum, or the graduate curriculum. There is no question that we have the authority and could

work in this field as we have in many others, to help provide the kind of education that is needed.

I believe that together with these educational activities should go hand in hand a research component at the university in which the faculty and the graduate students would be involved, just as we have in the other fields. I think this is necessary in order to have universities serve as centers for creating new knowledge and new techniques and new ways of doing things in the oceans, and in order that they can better educate people at all levels, both the ones who are in for a 2-year course and those who are going through to the doctor's degree in marine engineering, let us say.

Senator PELL. Well, I thank you.

Senator Murphy, do you have any further questions?

Senator MURPHY. No.

Senator PELL. I just repeat my point, that I never heard of a Government agency not wanting to administer a program, and I guess this is not an exception to it.

Thank you very much, Dr. Robertson.

Senator PELL. The next witness is Dr. Sidney Galler, Assistant Secretary for Science, Smithsonian Institution.

Dr. Galler, I see you have a short statement here. Will you proceed as you will?

Dr. GALLER. Mr. Chairman, the Secretary of the Smithsonian Institution sends his regrets that an out-of-town commitment prevents him from being here, and with your permission, I would like to read this rather short statement from him.

STATEMENT OF HON. S. DILLON RIPLEY, SECRETARY OF THE SMITHSONIAN INSTITUTION, AS PRESENTED BY DR. SIDNEY GALLER, ASSISTANT SECRETARY FOR SCIENCE, SMITHSONIAN INSTITUTION

Dr. GALLER. The idea of injecting scholarship into the marine resources field is a sound one.

The challenges are many to lure students into this unexplored field. They can receive inspiration and become productive through legislation along the lines of this act.

The Smithsonian Institution is deeply involved in studies of the ocean. We are interested in such fundamental problems as the kinds, populations, and distributions of plants and animals in the sea. Thus, this proposed bill is of great interest to us. It could represent a major step forward in learning about the biology of marine forms of life, and utilizing this knowledge for improved management for husbandry of our marine resources.

In 1838-42 the Wilkes Expedition was sent to the southern oceans to study the occurrences and populations of harvestable whales. Captain Wilkes recognized that one could not study whales without knowing much more about the seas in which they live. He collected potential whale foods; he sampled the environment to find out why whales occurred where they did. At the time when Senator Justin Smith Morrill's first Land Grant College Act was passed in 1862, the fledgling Smithsonian Institution had just taken over, in 1858, the Wilkes Expedition collections to study them and to retain them for reference by future generations of scientists and scholars.

It seems appropriate that I and Secretary Dillon Ripley as successor to former Smithsonian Institution Secretaries Joseph Henry and Spencer F. Baird of 100 years ago, again record the Institution's concern with the total environment and the necessity for greatly expanded studies of life in the sea.

The proposed bill, S. 2439, is an important extension of our efforts to learn about the sea. It offers a great opportunity to exploit this 70-percent of the earth which is still, in many ways, a mystery to us.

The proposed act encourages the establishment of research centers of excellence in existing institutions. Whereas the Hatch Act of 1887 was necessary to extend the Morrill Act of 1862 into scientific research and experimentation, the proposed act hopefully will give due emphasis to basic research from the beginning.

As an extension of this historical illustration, I would like to compare the situation at the time of the passage of the Land Grant College Act with that at the present time. In 1862 the United States was an agricultural Nation. The vast majority of its citizens were engaged in farming as a vocation. The passage of the Morrill Act had been preceded 2 months earlier by the creation of a Department of Agriculture. Under these conditions it was highly appropriate and necessary to place great emphasis on the improvement of practical farming techniques and the dissemination of ideas through an extension system.

By contrast, the seas today are almost as poorly known as was the American Continent when the Pilgrims landed in 1620. We do not have a major segment of our population ready to farm the sea. They are not merely awaiting the dissemination of known information. This proposed bill is in some ways more visionary in that regard than its predecessor.

The emphasis in sea grant colleges must be to obtain data of a basic nature needed for the appropriate husbandry and management of our marine resources. They must engage in such familiar agricultural practices as the seeking of brood stocks and experiments on how to improve them. At the same time they must approach with diligence the problem of inventory of the available resources and evaluation of their potentials. We know which varieties of cows should be husbanded for milk production and which for beef. We have no similar information on the sea creatures. We do not even know the complete life histories of one of our most important commercial fisheries, the tunas.

Hybrid vigor is recognized as a most useful factor when applied to the production of corn, chickens, beef, and other agricultural products. Yet today we do not even possess a rudimentary knowledge of the genetics of some of our most important species of fish. Only recently have we succeeded in culturing artificially some of the most common fish species. We will not be ready to move vigorously into the husbandry of marine resources until the fundamental knowledge about the classification, ecology, and genetic characteristics of the life forms of the seas is acquired.

I hope that this bill will focus attention on the need for basic research which must be carried out in order to achieve success in the exploitation of marine resources.

Additional activity stimulated by a bill along the lines as this would assist the Smithsonian Institution in increasing its fundamental investigations of many kinds of marine organisms of the sea by mak-

ing more specimens available to us for study. As the agency responsible for the national collections, we would be called on to identify the unusual sea organisms and to produce better lists, descriptions, and monographs of the organisms to be encountered. The Institution would continue to utilize its research collections to advance the ability of the Nation to exploit its resources.

Colleges have a continuing need for identifications of animals and plants. The Institution has provided for identification of such specimens through making available reference collections, special library facilities, and staff assistance. We provide identifications directly and serve as hosts for scientific staffs for the specialists of the Department of Agriculture and Interior for example. We would hope to be able to extend our scientific and intellectual resources to meet the exciting challenge proposed in S. 2439.

I thank you, Mr. Chairman.

Senator PELL. Thank you, Dr. Galler.

As to be expected from the Smithsonian Institution, I notice that your testimony was deft and muted and brought forth chuckles of appreciation from the audience.

I have great admiration for the work that you do. I was struck particularly by your point about how primitive we are in our fishing today, and how little we know, and actually our fishing—we talk about aquaculture as opposed to agriculture—fishing today is really at the same stage as when my own Indian forebears in this country were picking berries and food as they came across them and then moved on. Ultimately harvesting by this nomadic approach was replaced by establishing fixed farms. In harvesting the seas' resources we have not yet reached the farm stage.

Dr. GALLER. That is correct.

Senator PELL. And you are very right. We are very far behind.

Now, there is one question that I have been asking various witnesses. I would be very interested in your response to it. One of the problems is where this program should be administered and while originally we had thought in interim of the National Science Foundation, the question has come up as to whether that might give too theoretical a cast to it or an approach to it, also too much of the so-called individual grant as opposed to program grant approach, and perhaps not enough emphasis on the types of work which are rather mundane and not necessary even at the college graduate level.

One of the thoughts that I had was that it might well go into the Smithsonian Institution to be spun off at a later date as we see fit or remain, but most likely spun off to whatever agency might be set up under the Magnuson bill to have responsibility for the development of oceanology in our quest. It may be a wet NASA—I would say I hope not—or it may be some other kind of agency. It is extremely unlikely that any Government agency would decline to take on a program, but I just wanted to ascertain your own thoughts in this matter and if you would be willing to take this on and if you wanted to take this on. What are your views?

Dr. GALLER. Mr. Chairman, I can only respond in a circumferential way to this question because it does involve a question of policy which would have to receive the appropriate consideration of our Board of Regents. So with your permission I would like to respond as a per-

sonal opinion without necessarily implying a position on the part of the Board of Regents.

I would like to point out that the Smithsonian Institution has indeed served as the parent body for organizations of scholars and scientists later becoming incorporated into new agencies. For example, harking back to the comment made previously in response to your question, Spencer Baird was indeed a part of the Smithsonian Institution and was in many ways the father of research activities now residing in the Fish and Wildlife Service of the Department of Interior.

Similarly, the Smithsonian Institution has fostered, not by premeditation I might add, basic research research leading to the development of the NACA, the Weather Bureau, and in some ways the National Bureau of Standards.

Senator PELL. Excuse me. I was diverted for a moment. You say that the Bureau of Commercial Fisheries did start in the Smithsonian or did not?

Dr. GALLER. I did not wish to give that impression, Mr. Chairman. Spencer Baird laid the scientific groundwork for what later became the research program now vested in the Department of Interior Fish and Wildlife Service. To be specific, as one of the great marine biologists of our Nation and as a person with considerable foresight, envisioning the exploitation of the sea resulting from basic research, he was instrumental in establishing a fishery commission which was later to become the organization that we call the Bureau of Commercial Fisheries. So that indirectly one of the Secretaries of the Smithsonian Institution was instrumental in introducing the scientific climate which led to the establishment of an independent agency, and as I point out, this was true also for other agencies formed from Smithsonian activities.

Their formation however, was not by premeditation. It was, rather, recognition by the Regents that a body of scholarship had reached a point where it could become not only intellectually self-sustaining but also programmatically self-sufficient.

If we were to take on the organization sponsored in this bill, it would be one of the first premeditated actions of this kind in the history of the Smithsonian Institution. Let me say, also, that the Smithsonian Institution has always attempted to be responsive to the wishes of Congress and the Chief Executive. That is the extent that I would be prepared to speak on that particular question, Mr. Chairman.

Senator PELL. It is a somewhat circumferential reply, but I think I get the message.

I had another question here. Do you think the bill's emphasis on the application of science is correct or wrong?

Dr. GALLER. Mr. Chairman, I think that the emphasis is quite correct, provided it does not close the door to the need for basic knowledge in order to sustain the applications. I would hope sincerely that the bill would not emphasize or accentuate the schism that appears to exist between the scientists who are engaged in the acquisition of fundamental information and those agencies who have large national responsibilities of a mission-oriented character. There is indeed a schism. It is one that is unfortunate, but it is perhaps a natural product of growth of research and development in this country where we have found that agencies responsible for mission oriented research are

naturally inclined to select those fundamental research proposals which appear to be relevant to the fulfillment of the missions of the agencies.

This, however, has created serious gaps in the support of fundamental science, so-called unfashionable science, which nonetheless must provide the informational coherence needed in order to apply the data resulting from other kinds of basic research.

I envision that S. 2439 would provide the transitional or translational mechanism that the Hatch Act provided for the land-grant colleges and actually pull together programs for basic research which could in turn nurture the mission-oriented interests of the several agencies. Also, it would also provide a feedback mechanism, if you please, whereby the agency interests and needs could be conveyed to a center of scholarship and research and provide the broad program frame of reference for fundamental research of primary concern to the scholars and scientists but consistent with the long-range interests of our Nation.

Senator PELL. I find your answers a little confusing. To boil it down, do you feel the emphasis on the application of knowledge, of exploitation of knowledge, is good or poor?

Dr. GALLER. Good. Absolutely necessary. But I would also like to point out, if I may, Mr. Chairman, that application is only as sound as the pool of knowledge upon which it is based and I feel that we have not acquired sufficient knowledge of the sea and the biota in the sea to feel confident that we are ready for a broad, comprehensive, in-depth application without additional basic research.

Senator PELL. The purpose of this bill is not to add to that pool of knowledge. The purpose of this bill is to utilize the knowledge we already have.

Dr. GALLER. Yes, sir. I understand this. It is also my thought, however, that the bill will provide a point of focus for more fundamental research.

Senator PELL. I want to make it very clear that my own personal thinking in proposing this idea was not that development. Obviously you want basic research encouraged, but there is too little money and it would be spread too thin and it is the practical application and the use of it for the fishing industry, the tuna fisheries out in California, the trawlers out of our own part of the country, the mineral people in the South who could better use the knowledge we have.

Dr. GALLER. Yes. May I also take this opportunity to point out that the bill will have a byproduct impact on basic science. It will tend to stimulate scholarship, whether it is the primary intent of the bill or not, and I think this augurs well. For example, I think it could close a gap that has existed between the so-called limnological or fresh water sciences and the marine sciences.

Let me point out, if I may, that many of the leaders in oceanography today are either first or second generation fresh water biologists, fresh water geophysicists, who took their early training in institutions not located on the coast but located in the interior of the country. Limnology, or fresh water science has been and continues to be an important educational resource for the training of scientists in the marine sciences.

Senator PELL. Thank you very much.

Senator Murphy?

Senator MURPHY. No questions. Thank you very much.

Senator PELL. Thank you very much.

Dr. GALLER. Thank you.

Senator PELL. Our final witness today is Rear Admiral Waters, the oceanographer of the Navy, and I would like to thank Admiral Waters particularly for being kind enough to come up here today on short notice as opposed to tomorrow.

Admiral Waters, I hope you will proceed as you will, and let us know your views on this bill and its application to the Navy and your own thinking.

Please proceed.

STATEMENT OF REAR ADM. ODALE D. WATERS, JR., OCEANOGRAPHER OF THE NAVY, U.S. NAVAL OCEANOGRAPHIC OFFICE, WASHINGTON, D.C.

Admiral WATERS. Thank you, Mr. Chairman. Because of my change in schedule, it may be that copies of my statement have not arrived yet.

I have accepted your kind invitation, sir, to appear this morning with a great deal of personal pleasure.

Because of my present assignment in the billet of the Oceanographer of the Navy, I have a continuing interest in the subject matter involved in these hearings. At present I have held this position for a period of only 8 months. Last fall the term "oceanography," I must admit, was somewhat poorly defined in my own mind, although I had been associated with the sea for many years. The overall field appeared to hold interest for both young and old, military and civilian alike. Many highly trained and qualified personnel were drawn into governmental ranks under the terminology of "oceanographer." In the intervening months I have come to realize that by far the greatest numbers of persons working in this field, both within my own office as well as other Government agencies, are not oceanographers in terms of academic background but in terms of on-the-job training in the Office as well as at sea. Recruiting problems are great and the Oceanographic Office has no greater drawing power than any other agency involved with the hiring of qualified personnel in this field. At last count we are still averaging from 50 to 70 persons short of our requirements in this category.

Young people apply for work and then must be trained after acceptance. The end result is a relatively long period of training before we can allow these people to go to sea on surveys. Everyone associated with oceanography today feels the impact of the acute personnel shortages involved. This same holds true for many other fields, but I doubt they can also claim the general lack of university-type training which exists for the young man or woman about to enter this limb of scientific endeavor. These shortages are felt throughout the entire oceanographic world but at present appear to be most acute in the disciplines of physical and chemical oceanography. The governmental, industrial, and academic communities are all clamoring for additional personnel to fill the gap.

The oceanographer of the Navy is the curriculum adviser for all naval officer personnel enrolled in academic oceanographic study

throughout the United States. In addition, the assignment of officer subspecialists in oceanography is coordinated between the Bureau of Naval Personnel and my Office. In this role we are continually striving to reach a fine mix of academic oceanography with those environmental processes which may affect both naval operations and systems. Consequently, as oceanographer, I favor the "sea grant college" concept of training and research, since all output from this type endeavor must, of necessity, eventually assist the Government and Navy.

While the sea grant college program is not designed specifically to produce additional oceanographers per se, it relates to training in many disciplines as they pertain to the sea. In addition, the direction of pure and applied research in study areas associated with the sea cannot help but benefit both military and civilian approaches aimed at the conquest and use of that environment.

Thus, the main purpose of my testimony this morning is to advise you that my Office fully supports the major objectives of this proposal. I have no specific knowledge of or recommendations to make with respect to the various avenues which may be utilized to finance such a proposal or, in fact, the requirements which should be laid upon any college or university seeking grants under this program, if approved. These are problems which fall outside the province of my Office. I can only reiterate that a program along the lines as that discussed in the "Conference on the Concept of the Sea Grant University" held in Newport, R.I., in October 1965 along with the broad guidelines proposed by the National Sea Grant Committee in February of this year, cannot help but advance the state of academic preparation of our young men and women. It is also quite evident that the additional educational programs provided in a sea grant college toward both pure and applied oceanographic research, will be of immense importance to the many fields of endeavor developing in the oceans, whether they be military or civilian, educational or operational, commercial or recreational. A greater output of personnel trained in either basic oceanography or in fields such as engineering, meteorology, mining, food resources, or shipping as they apply to the world ocean, cannot help but give a great boost to the efforts toward more effective utilization of the oceans by our country.

Thank you, sir.

Senator PELL. Admiral Waters, your very title provides me the opportunity to bring up a point that has bothered me a little bit, and that is the term "oceanographer," or "oceanography." I found sometimes the very mouthing of that word a little difficult as opposed to oceanology and to my mind oceanology is a broader term. Oceanography—I have just had it looked up in the dictionary—has more to do with something written on a chart or map, the mapping of, while "ology" means science, a branch of knowledge.

Would not your title perhaps be more correctly that of "oceanologist of the Navy"?

Admiral WATERS. Well, there are many opinions about this, sir.

Senator PELL. What would be your views? I would be very interested.

Admiral WATERS. Well, sir, I suppose my views can best be stated by saying that the title of "Oceanographer of the Navy" was created by Congress. It is pretty well understood throughout the country

and the world, although some of the foreign countries are adopting oceanology. I believe the Soviet institutions use that term. But since it is so well known, so well accepted, and covers such a broad field that a succinct definition is rather difficult to arrive at, I have no quarrel with either term, sir.

Senator PELL. When we speak of oceanography as a general rule, are we not really talking as a rule about oceanology?

Admiral WATERS. Yes, sir; because oceanography, going back to the pure definition of it, is concerned with writings concerning the oceans, whereas oceanology covers the whole field of science.

Senator PELL. It reminds me a little bit of some phases of our foreign policy. We start out with a policy and we just keep the same policy because it is a matter of tradition, and I am wondering if as time goes on—I am seeking to do this in this bill—we might bring in more and more the term “oceanology” which would perhaps, as you point out, be more understandable abroad and by the developing body of oceanological knowledge that would be developed in the world. You would not be adverse to that idea?

Admiral WATERS. No, sir.

Senator PELL. Do you see in the application of this bill any direct relationship of the application of this bill and the U.S. Navy?

Admiral WATERS. Yes, sir.

Senator PELL. In what ways?

Admiral WATERS. Well, as I tried to bring out in my statement, sir, the great impact on this bill on the Navy will be the production of more trained people and trained people are the big bottlenecks today across the country, both in the Federal Government and in industry.

Senator PELL. Now, in trained people, are you speaking of technicians, bachelors with a proficiency in the field, or graduate scientists?

Admiral WATERS. I am speaking of all of them, sir, but I would like to point out that the need for subspecialists or technicians is rising at just as rapid a rate as the need for professionals, not that we do not need professionals, but we also need technicians and because the proportion of technicians that you need has increased with the increase in the complexity and sophistication of our instruments.

In the old days it used to be that you could send a group of professional oceanographers to sea and if they could operate a screw-driver, they could usually keep their instruments going. These days it is not that way. So you have to have a mix of technicians, electronic technicians, electricians, and so forth.

Senator PELL. Reverting to the earlier discussion then, you would welcome the thrust of this legislation which is really to turn out more technicians, and people proficient in the ways of working at the sea, and it is not designed to increase the number of scientists. I realize we need both, but the production of scientists is a responsibility of the institutions of learning, the National Science Foundation, but it is not the end of this bill. Under this bill the man will finish 2 years training, without his college degree, and must come to you for his military service and might prove quite proficient in his work. This program you like, I gather.

Admiral WATERS. Yes, although as a personal opinion I would tend to agree with Dr. Galler's testimony in which I believe he indicated

that he felt that any injection of funds into our educational system for oceanography, regardless of what level they go in on, I do not think it can help but assist the whole program. In other words, It would have its effect whether the bill says so or not on the entire education.

Senator PELL. Beyond the fact that this bill will obviously not be administered by the Navy, do you have any thoughts as to where it might best be administered in the Federal Government?

Admiral WATERS. No, sir.

Senator PELL. Any of the ideas that have been advanced, though, the Office of Education, the National Science Foundation, Smithsonian Institution, they would be in our view of equal merit.

Admiral WATERS. Yes, sir. My reply to that I think would have to be confined to the fact that it does not seem to be within the Navy's purview.

Senator PELL. Right. I thank you. It is always particularly nice as a Senator from Rhode Island to welcome a representative of the Navy because the Navy and Rhode Island are pretty well intertwined and even our coats of arms are the same. We have an anchor and so do you, but the difference is ours is unfouled and the Navy anchor is fouled. [Laughter.]

We are delighted you were here, and the session will now recess until tomorrow morning at 10 o'clock. We are going to wind up tomorrow at noon, so we seek the 10-minute rule, if any of tomorrow's witnesses are here. My colleague and the senior member of this committee, Senator McNamara's funeral service is at 12 tomorrow and we will not be in session during his funeral service.

(Whereupon, at 11:55 a.m., the committee recessed to reconvene at 10 a.m., on Wednesday, May 4, 1966.)

SEA GRANT COLLEGES

WEDNESDAY, MAY 4, 1966

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SEA GRANT COLLEGES
OF THE COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met, pursuant to notice, in room 4232, New Senate Office Building, at 10 a.m., Senator Claiborne Pell (chairman) presiding.

Present: Senator Pell (presiding).

Committee staff present: Fitzhugh Green, special assistant to Senator Pell; Stewart E. McClure, chief clerk; Roy H. Millenson, minority clerk.

Senator PELL. The third session of the Special Subcommittee on Sea Grant Colleges will resume its hearing today. We will be terminating at 12 in deference to the funeral of Senator McNamara. So I trust we can get through the scheduled witnesses this morning.

Are either Representative Clausen or Representative Keith here?

Pending their arrival, we will go on with the executive branch and private witnesses.

The first witness this morning, then, will be Captain Snyder of the Interagency Committee on Oceanography, who is appearing in behalf of Mr. Morse, and Mr. Abel is with him, a fact of which I am glad.

Captain Snyder, will you proceed?

Captain SNYDER. Good morning. Dr. Morse is still on the sick list. He sincerely regrets his inability to appear this morning.

He did write this statement and, with your permission, I will read it as if he were here.

Senator PELL. All right.

STATEMENT OF HON. ROBERT W. MORSE, ASSISTANT SECRETARY OF THE NAVY (RESEARCH AND DEVELOPMENT), AND CHAIRMAN OF THE INTERAGENCY COMMITTEE ON OCEANOGRAPHY, AS PRESENTED BY CAPT. J. EDWARD SNYDER, JR., U.S. NAVY, ACCOMPANIED BY ROBERT B. ABEL

Captain SNYDER. Mr. Chairman, members of the subcommittee—

Senator PELL. Excuse me. If anybody in the back of the room can't hear, raise your hand.

Will you talk more into the microphone, Captain, and raise your voice, and if you can't hear me, let me know, too.

Captain SNYDER. It gives me great pleasure to appear on behalf of the Interagency Committee on Oceanography (ICO) to discuss the

ICO's view of the sea grant college concept, as put forward in Senator Pell's bill, S. 2439.

Since the essential components of this legislation are presented in a very straightforward manner, and because they represent not an entirely new concept in terms of applied research, education, and training—but rather an ingenious twist on an educational approach which has already established itself as a success—I feel that I can be equally direct and precise in expressing those views which are the reason for my being here today.

There is no doubt of the general need for the continuance of Federal assistance in developing and maintaining centers of oceanographic excellence in our universities. The establishment of such centers of excellence necessarily includes the support of means whereby a broad range of skilled manpower can be developed to handle theoretical and practical problems soon to be encountered by the research scientist, the development engineer, and the technician who supports the ocean operators. All of this contemplates progress in instrumentation, resource development, intelligently integrated academic curricula, purposefully defined research goals, improvement in operational techniques, and last but not least—dissemination of the knowledge acquired to those people who daily work will eventually exploit the ocean to the fullest.

I can say without reservation that the Interagency Committee on Oceanography supports the concept of sea grant colleges as outlined in S. 2439. If I might also depart from custom, I might add that my personal views are identical to that of the ICO.

I would like us to look at a problem of administration—and from your vantage point, gentlemen, one of legislation—which I think we will all agree is most difficult—the question of implementation. Or said in other terms: “What is the best way to go about getting this done?” S. 2439 calls for the deposit, in a special account in the Treasury, of 10 percent of all bonuses, rentals, and royalties paid to the Federal Government after June 30, 1965, in accordance with the provisions of the Outer Continental Shelf Lands Act.

The conclusion that the ICO has reached is that no program of this nature should look to funds earmarked from another source for its subsistence. If the principle is worthwhile, which this one is, it should stand on its own merit. Thus the ICO feels that needs and the means to meet them should be analyzed and then funds to support them can and should be provided through the normal budget and appropriation processes. This would insure that funding is planned in relation to the required program and that funding is adequate to meet the challenging opportunities.

I feel certain that State enthusiasm for this program can best be effected by a stipulation in this bill that Federal moneys allocated for the development of these “centers of excellence” be paralleled by funds from individual State legislatures, according to an apportioned formula.

Another aspect of “State participation,” which the ICO feels is deserving of careful attention, is the question of which States should receive the benefits of such a bill were it to become law. I do believe that some means should be devised whereby all of the 50 States, regardless of their location in proximity to the oceans or the Great Lakes,

could qualify. Surely the call to the sea has not in the past been confined to residents of coastal areas nor is that likely to be the case in the future.

But of even more substance are the declarations of purpose in S. 2439 calling for the use of marine resources to provide greater economic opportunities, expanded employment and trade, new sources of food, and new means for the utilization of fresh and salt water. These, we believe, are the most obvious opportunities for true State participation, particularly in the case of our landlocked States. Therefore, we urge that due consideration be given to recovery, conservation, processing and marketing techniques, and to the "home economics of marine products." These subjects should be well within the meaning of "* * * education, training, and research in the marine sciences and a program of advisory services * * *."

Concerning the point of an executive agency to administer the use of allocated sea grant funds, the Interagency Committee on Oceanography concurs with Senator Pell's designation of the National Science Foundation. The ICO feels that the considerable experience of the Foundation in the interaction of the academic community and the Federal Government makes the NSF the best agency to administer the bill. We do feel strongly that members of the ICO—particularly Navy, Commerce, and Interior—have essential roles to play and also should provide advisory services to the Science Foundation in view of the complex ends to be served by S. 2439. The ICO stands ready to assist the Science Foundation in the performance of its administrative duties under the act, thus recognizing these essential roles and insuring direct participation by other agencies in the sea grant college structure.

In closing, the ICO is in full agreement with the three basic premises of S. 2439—first, that the time is ripe for an aggressive move toward fuller exploitation of the resources of the seas; second, that our universities and colleges must pay a key role in this movement; and third, that while ocean science itself is in good shape, the exploitation of ocean resources requires a forward thrust.

Thank you very much, Mr. Chairman. I will be happy to try to attempt to answer any questions.

Senator PELL. Thank you very much, indeed.

Returning to the three points you mentioned, first, the relationship of the amount of money that would be authorized through the revenues from the rents and royalties, the reason for that is to show that this would be a self-generating measure. I realize that there are executive branch reasons why they don't like to create separate trust funds and I am conscious of this fact.

In this connection, have you been in touch with the Bureau of the Budget? Have you any idea what their general viewpoint is in this bill?

Captain SNYDER. Yes, sir. Dr. Morse had this statement which he wrote taken to the staff of the Bureau of the Budget and to the Office of the Secretary of Defense, and this particular statement represents the official position of the Department of Defense, his own personal viewpoint, the position of the Department of the Navy, the concensus of the Interagency Committee on Oceanography, and the Bureau of the Budget had no objection.

Senator PELL. Do you think a letter could be forthcoming from the Bureau of the Budget that if these measures, the suggestions, were

met by the committee, that the bill would be agreeable to the administration, because as you know, from the viewpoint of actual passage, it is very important that there be some specific statement of approval of the Bureau of the Budget.

Captain SNYDER. I think each agency's official submission to you does have in its end paragraph that the Bureau of the Budget has no objection, again, stated, not in the statements, but in the official letters that the heads of each agency write to you in their comments on the bill.

For example, the National Science Foundation's statement says in its final paragraph:

The Bureau of the Budget has advised us that it has no objection to the submission of this report from the standpoint of the administration's program.

So that if the agency, the majority of agencies, are in favor of it and they all contain this statement, as I understand it, that is the Bureau of the Budget's concurrence.

Senator PELL. And, as I understand it, your Interagency Committee is the key executive branch group for coordinating executive branch's opinion and you are authorized, in this connection, then, to speak on behalf of the Bureau of the Budget so that if—and I am not saying that the committee will agree to the various points raised in your statement, but if all the points were accepted, would this bill be agreeable to the Bureau of the Budget?

Captain SNYDER. I think I would have to directly ask them but it is my impression that it would be agreeable, as stated.

Senator PELL. Right. I think it would be of help after we have discussed this, if a letter could be forthcoming from the Bureau of the Budget to this effect and maybe Mr. Green of my staff could be in touch with you in this regard.

Now, another question is, with regard to the matching formula idea, which we had not thought of in the basic bill. It may have merits. Have you thought of the idea of what formula—50-50, 90-10, 75-25?

Captain SNYDER. Speaking for Dr. Morse, Dr. Morse has kicked this around in his own mind and has not come to any firm formula. This is only a suggestion on his part because there are many things that have to be taken into consideration—the exact nature of the program—and it may not be true that the apportioned formula would be the same as rigid guideline.

Senator PELL. What about the viewpoint of the Bureau of the Budget? Do they have any view as to what the formula should be?

Captain SNYDER. No, sir. They have not expressed any view, sir.

Senator PELL. But they do have a view that it would be a good idea, presumably.

Captain SNYDER. They accept that, sir.

Senator PELL. They accept it. I see. But, from the viewpoint of the Government, if it was a 90-10 percent formula, 90 percent Federal, 10 percent State, which would show some sort of State interest or commitment, that would be acceptable to the executive branch of the Government and the Bureau of the Budget, in your view.

Captain SNYDER. That is my understanding. And my understanding is, also, what you just expressed, that the real reason for this is that a person doesn't have a stake unless he has an interest, and the best way to insure interest is actual dollars out-of-pocket.

Senator PELL. This, of course, is not done with other programs administered, if my recollection is correct, by the National Science Foundation in similar programs, is that correct?

Captain SNYDER. That is correct, sir. However, there is no prohibition against this.

Senator PELL. Nor is it a custom in the administration of land-grant colleges.

Captain SNYDER. That is correct.

Senator PELL. In other words, this would be a new concept.

Captain SNYDER. Yes, sir.

Senator PELL. This one might find difficulty in being worked out.

Now, with regard to the administering agency, the thought has gone through my mind as we have discussed, speaking privately, that since the purpose of the bill is more to develop grant assistance to programs and, also, the purpose of the bill is the actual exploitation of the knowledge we already have, not the development of further basic research, that it might be best to put it in some temporary agency. The idea being that it will be spun off eventually to the agency that is set up as a result of the bill presently being discussed in the Congress to administer oceanological studies or oceanological work.

My main thought was that the Smithsonian Institution might be a good agency to take it on a more or less temporary basis, since I feel that if it went to the National Science Foundation, there would be too much emphasis on pure science, and also that the grant aid would generally be to individual projects and not on an institutional basis.

What is your thinking on that?

Captain SNYDER. I would like to speak for what I believe to be Dr. Morse's thoughts on this matter.

No. 1, all of the agencies in the Federal Government who could administer this bill were considered. Each one was looked at with the objective which I believe is the objective of your bill, and that is to deal more in the applied areas, more in the actual exploitation as opposed to the basic research. It is true that the National Science Foundation is oriented toward basic research and that is its principal responsibility. However, I believe that the statement made by Dr. Morse is very explicit on that point and that is, in order to assure the kind of objectives that he feels you are discussing, that at a minimum, the Navy Department, Interior Department, and the Commerce Department should play a key role.

He feels this can be accomplished through the mechanism which already exists in the executive branch, namely, the Interagency Committee on Oceanography. I think most people on the ICO feel very strongly that it is a worthwhile bill. Therefore, there should not be any sort of temporary home, that it should have a permanent home, because if people really are convinced it is temporary, they won't get, necessarily, the best kind of people to administer the program.

Senator PELL. What about the Smithsonian as a permanent home?

Captain SNYDER. Actually, and particularly after having read Mr. Galler's statement yesterday, the Smithsonian seems to be only interested in basic research and pure science.

Senator PELL. My recollection of Mr. Galler's statement was that they fully understood, though, that this bill was for the practical exploitation of scientific knowledge already available. Maybe this came

out in the verbal exchange. I realize the statement he made had this emphasis. I want to refresh my memory on that.

Captain SNYDER. I didn't mean to infer by that, that the Smithsonian wouldn't accept it. I merely meant to infer that my understanding of the Smithsonian's role is that it is a more narrow role than even the National Science Foundation in this field.

Senator PELL. Right. I will revert to that in a moment because I am getting a copy of the statement.

There are several other questions that I would like to ask, not only in behalf of the minority who have offered them, but, they are very sound questions and I share their viewpoint in this, just to get it in the record.

What executive agencies comprise the ICO? Maybe you can submit a list for the record. Fine. Just the 18 different—

Captain SNYDER. Well, there are only eight or nine. Actually, when they refer to 20 or 22, they are referring to subdivisions within, say, the Navy Department and Commerce Department.

Senator PELL. Maybe you can submit for the record, for inclusion at this point, a list of the agencies that compose the ICO and a breakdown of the Government agencies which are presently involved in the administration of oceanological work.

Captain SNYDER. Yes, sir.

(The information subsequently supplied follows:)

INTERAGENCY COMMITTEE ON OCEANOGRAPHY

MEMBERS

Department of Defense: Hon. Robert W. Morse (chairman).
 Atomic Energy Commission: Dr. John N. Wolfe.
 Commerce: Vice Adm. H. Arnold Karo.
 Health, Education, and Welfare: Mr. Harry G. Hanson.
 Interior: Mr. Donald L. McKernan.
 National Science Foundation: Dr. Harve J. Carlson.
 Smithsonian Institution: Dr. I. E. Wallen.
 State: Mr. Herman Pollack.
 Treasury: Rear Adm. William W. Childress.

OBSERVERS

Bureau of the Budget: Mr. E. L. Dillon.
 Council of Economic Advisers: Dr. Guy Black.
 National Academy of Sciences Committee on Oceanography: Dr. Milner B. Schaefer.
 Office of Science and Technology: Dr. H. William Menard.
 ICO Executive Secretary: Mr. Robert B. Abel.

Senator PELL. What do you estimate the cost for each of the first 5 fiscal years of this bill, what do you think would be the cost of this administration? Do you have any thoughts?

Captain SNYDER. I really couldn't answer that without having seen the real specifics of the bill.

Senator PELL. My question here is, Since the Bureau of the Budget would prefer not to tie it into the rents and royalties, what do they think would be fair authorization for the bill, for the first 5 years? Mr. Abel.

Mr. ABEL. If we can go back a couple of statements, Senator, we were originally discussing the application of this bill, talking about the Federal-State relationships as limits, and then, within these

limits, allowing the administering agency to manage the program according to the merits of the proposals received. Traditionally, the Science Foundation reacts to these proposals after they are received, and can better formulate its planning on the basis of the nature of the proposals themselves, in terms of their scientific merit, the capacities, the already recognized facilities of the agency or the institution in question, and the proven work or reputations of the investigators within those institutions.

Senator PELL. You are not thinking that the money authorized in this bill should be just turned over to the National Science Foundation to be allocated between a variety of its programs, are you?

Mr. ABEL. As Captain Snyder stated, the National Science Foundation would also acknowledge roles to be played by Interior, by Commerce, by HEW, Smithsonian, and Navy, and would react, based partly on their influence and advice.

Senator PELL. Right. But my basic question is, What would be the cost to the taxpayer of the enactment of this bill if we do not relate it to the rents and royalties for the first 5 years, in your view?

Captain SNYDER. This is a function of the total numbers of centers of excellence that you would have. You can get a ballpark figure by, for example, what does it cost to run Scripps or Woods Hole, or depending on what you really envision, it costs you approximately a million dollars a year to run an oceanographic vessel, and Scripps and Woods Hole budgets are between \$6 and \$8 million a year. And smaller institutions run between \$2 and \$5 million a year. And your advisory services, much similar probably to the Department of Agriculture in its—

Senator PELL. What I am really driving at here is what sort of figure would fall within the guidelines of acceptability to the administration from the viewpoint of the budget? Do we talk in terms of \$10 million a year, \$25 million a year? Would you hazard a thought? I had tied it in originally, you see, to the rents and royalties which gave the specific amount, probably in the neighborhood of \$15 million a year. I am very interested in your thinking since you are in touch with both the administration, and the Bureau of the Budget, what sort of figure they are thinking about.

Mr. ABEL. Speaking in terms of allocations that the Science Foundation and other sponsoring agencies will give to some of these major institutions and, of course, it is going to vary, and depending on the number of institutions that come in with proposals, I would suggest that a minimum of \$10 or \$15 million would be required to get the program off the ground the first year.

It is a guess on my part, without interviewing the institutes themselves.

Senator PELL. Right. But, then, as one said, if we made an authorization of say, \$15 million, \$20 million a year, for the first 5 fiscal years, that would be acceptable to the administration? Not as a minimum but as an approximate figure.

Mr. ABEL. I would have to defer to a statement from the Bureau of the Budget.

Senator PELL. Right. This is what we need. This is the hard core of trying to promote this bill's passage, because I know how important it is to have the administration's support and approval. Not only

would I like to see no objection, but I want to know if the administration supports the objectives of this bill and believes in it, and if they do, what are they willing to allocate in their budget for its enactment.

Mr. ABEL. We have found, in preparing the national programs in previous years, that it is rather difficult to try to predict what can be allowed by the executive branch of the Government for one agency or a combination of agencies owing to the unforeseeable factors that creep in.

For instance, we could not, ahead of time, predict the Vietnam problem in terms of the money needed for other programs.

Senator PELL. No, but in this particular case, if you want us to leave out the 10 percent of rents and royalties, we are going to have to put in a dollar figure. I am asking your suggestion from the administration's viewpoint, what dollar figure—

Mr. ABEL. I think in this case, Senator, what we could do is ask the Bureau of the Budget for an opinion.

Senator PELL. I would be grateful and, as you know, we plan to close out the record. I think, on May 12, so I would like a figure. My assumption would be a figure equivalent to the rents and royalties if we left the rents and royalties concept, then it would be a figure equivalent to the amount because this is what all the witnesses have been thinking in terms of, 10 percent of that amount, which would be in the neighborhood of \$15 million or \$17 million.

But, finally, how do you believe the funds should be allocated among the different States? You do believe, as you say in your testimony, that the inland States should be included, but should they receive proportionately the same allocations as seaboard or lake States?

Captain SNYDER. This would be a function in addition to an ordinary apportionment, what their program actually was, and what this contribution would be to the national goal of exploiting the ocean.

I don't think you can answer that arbitrarily. If you did, I think you wouldn't have a very good program—

Senator PELL. I must say I agree with you. I don't think it can be decided like the basis for midshipmen for the Academy.

Captain SNYDER. No, sir. I don't think anyone had an intent in that direction. The fact is that the sea is a national resource belong to the whole country. Some method should be found as, for example, the Navy is not limited as to its sailors and officers—they do not come from just the coastal States.

Senator PELL. I think we really must depend, as you say, on the degree of interest and the desirability of the individual States.

Are there any further points that either you, Captain Snyder, or Mr. Abel—and I would like to pay tribute here to the work Mr. Abel has been doing in helping pull together the work of the ICO—would like to submit for the record?

If there are any further thoughts you have, the record will be open to May 12 so they can be inserted.

Mr. ABEL. Thank you, Senator. Not at this time, but we will approach the Bureau of the Budget.

Senator PELL. Yes. My main objective is to get this bill passed, the basic concept passed. I think it will carry itself once it is passed. It is obviously in the national interest, both from a civilian and economic and defense viewpoint. So we will adjust the various portions of the bill in order to secure the passage of the basic concept of it,

but we have to have the specifics of what is acceptable to the administration, so that we can have that little added support.

Thank you very much. And please bring our greetings to Mr. Morse. We are very sorry to hear of his illness.

Senator PELL. Congressman Clausen is now here and will offer his testimony.

Mr. CLAUSEN. I see Mr. Keith has come in, too.

Senator PELL. I realize that but you were here first.

At this time I am going to ask to read this statement from Senator Murphy, who regrets, he says, that he is unable to attend today's hearing. Senator Murphy, along with other Senators from this committee, is in Michigan attending the funeral of our colleague, Senator McNamara. Senator Murphy particularly wanted to be here today to hear the testimony of the outstanding Californians scheduled to speak on S. 2439. Senator Murphy asked me to extend his fellow Californians the warmest greetings and assure them that he will carefully read their testimony.

Congressman Clausen.

STATEMENT OF HON. DON H. CLAUSEN, A U.S. REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. CLAUSEN. I thank you, Senator Pell, for this opportunity to appear before the committee. I am most appreciative of the comments of our distinguished colleague, the Senator from California, Senator Murphy.

At this time, I, too, would like to express my personal regrets on the passing of our beloved Senator McNamara. I had the privilege of sharing with him, in the building of public works projects as I served on the Public Works Committee of the House.

I am here today, of course, to join in support of your S. 2439, Senator Pell, and to compliment you for your leadership in establishing what I think is going to be a very exciting contribution to our education system throughout America.

Certainly, the land grant college program has proved itself to be successful and it would appear that the sea grant college program certainly will open up many new frontiers on an international basis. I am convinced, personally, that it is long overdue.

First, I want to urge, as forcefully as possible, that this legislation be adopted. I am hopeful that we may see this measure become law before we adjourn this session of Congress. I, personally, believe that we cannot do more for our own United States, and for the world as a whole, than to begin now to gather information that will allow our bountiful natural resources to be used advantageously in the future. This bill will do that.

The necessity for this action is obvious to those of us who are concerned with the conservation of our natural resources while at the same time, using them to man's own gain. If we hesitate to begin compiling needed information, as has happened in the past, we will undoubtedly find ourselves haphazardly depleting these valuable resources. I do not want to see this happen, and it is for this reason that I firmly believe in the importance of the legislation we are considering today.

On the other hand, if we start now to accumulate knowledge of our marine resources, we will be ready with the facilities and equipment necessary for development of these resources when they are needed. And we will need them, Mr. Chairman. With the massive population explosion will come the need for more and better food, water and other resources that we know now to be available from the sea. And this need is not a temporary one, instead, it will be a continuing and growing one for which solutions must be found. I feel certain this legislation will lead to the necessary solutions.

I am frank to say, Mr. Chairman, that my second reason for appearing today is to point out the role that several educational institutions in my congressional district could play under this measure.

One of the finest marine research centers in the country is located at Humboldt State College in Arcata, Calif. Under the program established by this bill, Humboldt State could further expand its curriculum in the marine sciences and add greatly to the positive contributions it has already made in this area of study. The knowledge gained by Humboldt State, coupled with the work of other institutions, can provide us with a broad base of knowledge about our nearby marine environment that can help us effectively develop these resources.

I know that this committee will also be concerned with determining whether 2-year colleges should be included in the provisions of this bill. I would like to urge you to approve this possibility. A 2-year college, the College of Marin, located in my district, has a marine biology center at Bolinas, Calif., which has been quite successful in the past and which could be greatly enhanced by the programs of this legislation.

In conclusion, I would merely like to express again my full support for early passage of this bill. I hope you will agree with me that enactment will provide a great service to the future of our Nation.

The oceanography centers in colleges and universities, will make a contribution well beyond what we can anticipate at this time. I believe that those of us who represent coastal, congressional districts, are in a unique position, as you are, representing the great State of Rhode Island on the Atlantic seaboard. Our unique location, contiguous to the Pacific and Atlantic Oceans, quite naturally, places us in a position to recognize the need and the opportunities for establishing oceanography centers in our colleges and universities.

I would also submit, sir, it is vitally necessary that we work with our existing institutions and as suggested in the bill, I am hopeful we will have the cooperation of all the States.

Certainly, however, as we look for a formula for finance, it would seem to me that because of the vast international aspects, the Federal Government must assume a high percentage of the financial obligations.

Just recently, on the coast of California, we had evidence of the overwhelming need for legislation of this type.

Russian trawlers have been invading, shall we say, some of the fishing grounds just off the Pacific coast. I know that the same situation has taken place on the east coast. As we review the international political facts of life, especially in southeast Asia and Vietnam, we must agree that our major battle is really ideological warfare. This particular bill will greatly enhance America's position in the development of an economic offensive designed to compete with our major

ideological adversaries of the world, the Russians and Communist China. I believe it is about time that we organize this type of offensive to apply economic pressures against their political systems. We have not kept pace in oceanography and the development of the fishery and other resources of the sea.

Most of us in America are competitive by nature and, in particular, those of us that might have been athletes in our day, are perfectly willing to accept this challenge. I strongly believe in this sea grant college program that we are attempting to promote. Again, sir, I want to compliment you for your leadership and I stand ready to support you, on the House side, with all of the vigor at my command, because I think the prospects are very exciting. We must recapture our position of leadership in ocean resource exploitation. The challenges and opportunities are unlimited.

Senator PELL. Thank you very much, indeed, Congressman. It was very nice of you to come over today.

Congressman Keith, from the neighboring Commonwealth of Massachusetts, was kind enough to come over today, too.

STATEMENT OF HON. HASTINGS KEITH, A U.S. REPRESENTATIVE IN CONGRESS FROM THE STATE OF MASSACHUSETTS

Mr. KEITH. Mr. Chairman, thank you for giving me this opportunity to speak before your committee in support of the sea grant colleges bill.

The bill, in my view, meets squarely some of the major weaknesses in our national oceanographic program. I have recently returned from a trip behind the Iron Curtain with the purpose of evaluating Soviet progress in oceanography and marine science in general for the Merchant Marine and Fisheries Committee. The Soviets clearly are putting high priority on the ocean sciences. They have perhaps two or three times as many people working in these areas as we do. Moreover each of their ocean scientists has more technicians to back him up than do our scientists. We have approximately 1,000 professional level oceanographers and perhaps 2,000 ocean technicians, while the Russians have about 1,500 scientists with about 7,000 technicians.

One result of this concentration of manpower has been that the Soviets are leading us in the applied areas of oceanography. They are very effective at translating basic research into technology. Although most experts agree that we are still ahead in basic research, we learned in Moscow that the Soviets are putting new efforts into this area. They are upgrading the Institute of Oceanology, their basic research institute, so we may see new competition in this area.

Moreover in the Soviet Union advanced technology is applied to fisheries far more than it is in this country. The Russians fish on large factory ships spread over much of the world's ocean. Some of their techniques that we learned about were explosions to bring the fish briefly to the surface and fish elevators to help spawning fish to go upstream over dams. They appear to have done a great deal with fish farming and other modern techniques. All these are areas to which I do not believe we have been giving adequate attention.

The sea grant college could meet much of this problem because its emphasis is on practical education and applied research. One of our major problems in fishing has been that the ordinary fishermen are

not familiar with the new techniques available. This is perhaps the major reason we have fallen to fifth place among fishing nations of the world and Russia's catch has increased 250 percent in the past 10 years while ours has declined. In fishing, oceanography, and merchant marine as well, the Soviet Union presents a great challenge to this country. Sea grant colleges can be one answer.

The investment in the sea grant college system could pay off in economic terms for this country in a very short time. For example in my area, the nucleus for a regional center of excellence in oceanography such as the bill describes, is already in existence. The energy, motivation, and talent to produce a great spurt of growth in oceanography is already present in southeastern Massachusetts, as I am sure it is in a number of centers across the country.

This area has as a focal point Woods Hole Oceanographic Institution, where much of the advanced work in oceanography is being done today. Also in the area are a number of industries which make oceanographic equipment. These could have a role to play in the sea grant college system. Serious thought is being given to introducing an oceanography curriculum at some of the colleges in the area. Southeastern Massachusetts Technical Institute for example is a young and growing college in an area where interest in oceanography is high. In fact, preliminary plans have just been approved by the trustees for an oceanographic developmental program. The location of SMTI on the outskirts of the fishing port of New Bedford and in close proximity to Woods Hole Oceanographic Institution makes it an ideal place for oceanography studies. The sea grant college system could provide such an institution the encouragement it needs to develop a substantial and important program. It could not only provide courses for scientists and technicians, but it could also operate lectures and demonstrations for fishermen of the area under the extension service plan.

I have on my desk at this moment two interesting proposals. One is for a vocational school to train ocean technicians in the Cape Cod area. This proposal, in detailed and well-thought-out form, has been made by a number of marine scientists and other responsible citizens who believe there is a need for such technicians to back up the scientific work at Woods Hole and the other laboratories in the area. Another proposal which is actually going to be a pilot study is for oceanography teaching in one of the high schools of the area in conjunction with Woods Hole Oceanographic Institution.

I mention these various institutions to give you some indication of the extent of interest in this subject. Many diverse groups can contribute to our national oceanographic program as well as gain from it. A national investment in this field will pay off in the short run as well as the long run. The need is there and the people and plans are ready to go. I urge this committee to report favorably on the sea grant college legislation.

Senator PELL. Thank you.

I have one specific question to ask you and that is your thought as to whether there should be matching-funds provisions in this bill as suggested by the executive branch witnesses, or whether there should not be.

Mr. KEITH. Generally speaking, in the past, I have approved matching funds for most legislation. I did so in the case of anadromous

fish, for example. But it seems to me that the Federal Government has so preempted the tax dollar that it is becoming almost impossible for the States to match the Federal Government's ability in this respect. Inasmuch as this is a national resource which needs exploitation, I would tend to minimize the role of the States in the financing of it. The fact that States are unable to do what might historically have been their share in this respect, is an argument I would tend to use to support Mr. Heller's recent suggestion to revert Federal resources to the States. Thus they could, once again, help in providing facilities which we need at the State level.

But I doubt that I would feel that the States could do as much as the Federal Government can. We are doing all that we can to provide secondary school education at the local level and we still need a lot of Federal help.

Senator PELL. I would be inclined to agree with you.

I would like to revert to Captain Snyder and Mr. Abel, who are still with us, and ask if they think from the executive branch's viewpoint the contribution rendered by the States could be considered to be in kind. The very fact that it will be the existing institutions that are giving the backup, providing the medium through which these programs would be enacted, then I see very real problems if you try to tie it into a 90-10 or some sort of arithmetical formula.

Do you think this would be possible in acceptance to the executive branch?

Captain SNYDER. That was only a suggestion on the part of ICO. That was not a position of the executive branch, condition, or anything of that sort.

Senator PELL. In other words, if we met some of the other suggestions of the executive branch, do you think from the viewpoint of the Bureau of the Budget, that the contribution could be, as I say, in kind, somewhat as under the poverty program, where the contribution is the land and the buildings that the city has, and that it would not require financial contributions from the States?

Captain SNYDER. You certainly have a better feel for this than any of us in the ICO.

Senator PELL. I just see a very real problem if we start enacting the idea of a mathematical formula for the first time in NSF-type operations, and with respect to a matter of national interest of this sort. I was wondering on the strength of your position if you felt this might be an acceptable alternative.

Captain SNYDER. This was just a suggestion. It is not a position, as such.

Senator PELL. Right. Thank you very much.

Thank you very much, Congressman Keith.

Senator PELL. Now, we have the father of this whole project, the intellectual father and the actual father, who invented the term "sea grant college" and a man who made the launching speech in Newport, R.I., last fall on this and galvanized the audience, and I am looking forward to being galvanized again by him.

I hope he has just about the same speech as he had then. I hope also he has an opportunity to see some of my colleagues, while he is in Washington, and to sell them on his idea, as well.

It is a great honor and pleasure to have with us Dean Spilhaus of the Institute of Technology of the University of Minnesota.

STATEMENT OF DR. ATHELSTAN SPILHAUS, DEAN OF THE INSTITUTE OF TECHNOLOGY, UNIVERSITY OF MINNESOTA

Dr. SPILHAUS. Senator, it is a particular honor to be invited to give testimony before this important subcommittee on sea grant colleges, a concept which I originally suggested, but I must say your remarks are too gracious. If it were not for Senator Pell's interest, drive, and imagination, none of us would be here today.

In view of the fact that you will have statements from the national committee for a sea grant college, on which I serve, I will attempt not to duplicate the statement of that committee. I will not say all the things that I said at Rhode Island because I believe that they are available in the Congressional Record should anyone want to read them.

The National Academy Committee of the National Academy of Science, over the 10 or so years, contributed much to revitalizing, strengthening, and formulating a national program in oceanography and the marine sciences. We may well be proud of the work in marine science which is going on in the United States today.

But in my opinion we are not doing enough to capitalize on our excellent marine science by utilizing its findings to strengthen the U.S. position in commercial and other nonmilitary uses of the sea. As far as the exploitation of the sea for the benefit of our people is concerned, and in comparison with Japan, U.S.S.R., and even Peru, we are an underdeveloped nation.

It was for this reason, in 1963 I proposed that the United States take steps to make a lasting commitment to the sea through its many excellent universities and colleges. And that we do this by using the analogy of the land-grant colleges that contributed mightily to the present leadership of the United States in the use of our land for abundant food and natural resources and the application of the "mechanic arts" in our enterprising industry that gave people the things they need. I proposed that we arrange to have sea grant colleges with special funds and provisions that would dedicate their efforts to the sea and the use of its natural resources for greater human benefits.

Sea grant colleges with continuing support would provide the focus needed to bring the United States rapidly to a position of leadership in ocean engineering and aquaculture, and keep it there. They would draw out and put our vast scientific knowledge of the sea to use. We have a grand technological goal—a goal no less than the peaceful exploitation, occupation, and colonization of the sea by man.

And for this goal we need, on a long-term basis, not only to develop marine technology, underwater prospecting, mining, fish and sea plant farming, marine pharmacology, shipping and navigation, but we need to relate all of these to social sciences, economics, sociology, psychology, politics, and law because all are affected by an effort to colonize the sea and all, in turn, affect the way we pioneer this new frontier.

There are those who fear that emphasis on technology of the sea will decrease the support of basic science. I believe exactly the reverse is true; history, even the most recent history, shows that science blooms in an atmosphere of application—and so it will be for marine science. In the sea grant colleges the marine focus would also be

associated with the liberal arts, literature, art, and history, which describe man's emerging relationship to the oceans and enhance his appreciation of their potential and value.

In an early talk I said that—

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 submarines and submotels.

I am happy to see that at least in one institution—in Senator Pell's home State—there has already been recently established a marine experiment station parallel in its aims to the agricultural experiment stations which help the farmers on the land.

I also said in this earlier exposition that law is an utterly important adjunct to any widespread exploitation of the sea, and that we need a clarification of the law of the sea as we move toward industrialization of its resources and colonization of its waters. I am pleased to see that already there is being organized an important National Conference on the Law of the Sea, at the University of Rhode Island June 27–July 1, 1966.

While these beginnings are gratifying, we need to consolidate them and insure that this kind of interdisciplinary activity continues at an even greater rate and with a long-term commitment. It is with this in mind that I heartily support the National Sea Grant College and Program Act.

Sea grant colleges could be established in any public or private college or university which is willing to dedicate itself on a continuing basis not only to the science of the sea, but toward using this knowledge to turn the sea increasingly to the benefit of people.

However small we start, I hope ultimately there might be many of these colleges and, as to the matching question, Senator, I think the most important matching thing is some way of insuring the commitment of the college, the intellectual commitment of the college, and whether this is insured by their dedicating existing buildings, shorelands or turning their programs in the direction of exploiting the sea, this is a more important thing to have than matching the funds given to them with other funds.

I certainly think that all the sea grant colleges need not be on the seashore. We are discussing a marine science and technology program at my own university in Minnesota, which is equidistant from the Gulf of Mexico and the Atlantic, the Pacific and Arctic Oceans. We think we have an advantage that none of them are too far away from us.

I don't think all space science is necessarily done next to the launching pads at Cape Kennedy, and I believe that the seashore resources, the seashore facilities that are needed by inland colleges could be in charge of the sea grant college which, themselves, are on the sea. They could have a brother-sister relationship, a symbiotic relationship, with those fortunate enough to be on the sea supplying the facilities for those, their coworkers in land colleges.

I would personally like to see grants offshore seabottom lands and waters to some of the colleges analagous to the land grants made years ago. But this, though desirable, if not feasible at the moment, should not prevent us from moving toward the other important aspects of this bill.

If you will permit me, in closing, to say that an idea such as mine would simply wither and die if it had not been for the support and interest that was afforded me from all over the United States. Particularly, I want to pay my respects to the many Senators and Congressmen, many besides Senator Pell.

Thank you.

Senator PELL. Thank you very much, Dean Spilhaus.

There are a couple of specifics about which I would be interested in your reaction.

First, with regard to the revenue. Do you think that our original thought in the bill of tying it in with rents and royalties could be foregone in exchange for a direct authorization? Do you have any thoughts on that?

Dr. SPILHAUS. Yes, sir. I think that there are many ways, and these are two which have been discussed, to finance the beginnings of this concept, and I believe any way in which we can start the concept would be desirable, and there are others in Government who know best which way is most feasible.

For my money, which it is partly, I would be happy to see either way, because I think the birth and the beginning of the concept is more important than really worrying about the details. We must get the bill sold, the authorization to focus our eyes on the exploitation of the sea, the national commitment, and the commitment of the institutions toward this great goal. Once we have that, I am perfectly sure the money will come.

Senator PELL. I would agree with you.

Now, with regard to this idea of matching funds which was brought up by one of the witnesses yesterday and brought up by the administration today as a suggestion, what is your thought on that? You mentioned it in your testimony already, in your ad libbing statements; I was wondering if you would enlarge on it.

Dr. SPILHAUS. I believe in the idea of matching funds, the basic idea being that if you ask for a matching contribution, it means that the person or State or institution receiving the funds must indicate its need for them by putting up some of its own resources.

On the other hand, matching funds often are not parallel with the commitment. Some wealthy institutions might be able to find the matching funds while some institutions in poorer circumstances, with a far deeper and greater commitment to do the job, might be prevented from receiving the matching funds.

It was for this reason that I thought we ought to keep the concept of matching but put it on a basis of matching by the turning of facilities, the turning of their programs, toward our objectives, the use of their existing funds into which the States have money, rather than to demand a quid pro quo of new funds.

Senator PELL. I would agree with you in that view.

Another question here is with regard to the administering agency. I was developing the thought that because of the National Science Foundation's interest in pure science and basic research, and also its custom of awarding funds on an individual grant basis, that it might be best to put this in the Smithsonian, with the understanding that it would go off to another agency eventually, or stay there, depending on the decision of this self-liquidating council that is to be set up.

However, since advancing this idea, and as was pointed out today, the very witness from the Smithsonian Institution emphasized that their interest was in basic research and the executive department's witnesses seem to prefer the NSF as the administering agency.

I have a very open mind on this subject. I just thought the Smithsonian Institution would be a logical place, but I must say the witness from them, to a certain degree, refuted his own premise, I thought, in his continuous emphasis upon basic research, and also in his verbal testimony, afterwards.

What are your thoughts on that, Dean Spilhaus?

Dr. SPILHAUS. My thoughts are this. I think, leaving apart the discussion of the two agencies in question at the moment, the most important thing is that pending the other excellent complementary legislation that is in Congress today on oceanography, whatever agency we choose, we should choose it as the administering agency for the time being and not commit the other legislation to something.

On this, I would say about the National Science Foundation and the Smithsonian—and with full admiration for the work they do—that both are largely turned toward pure science, whereas our focus is the other way.

But having said this, I would say that there is no reason whatever why, given the charge, their competent people could not turn their sights to the objective of this bill, which is the drawing out of science and the exploitation of the sea.

Senator PELL. If, as the consensus seems to be, the NSF should handle it at this time, what is your thinking with regard to the idea of turning the program over, the administration of it, over to the eventual oceanological agency? As it turns out, maybe it is a wet NASA—we pray not—or some other Parkinsonian structure that will be created that will look toward developments.

Dr. SPILHAUS. It was with that in mind that I said the responsibility should be given to an agency for the time being. I believe as our engineering exploitation of the sea proceeds, there will need to be some kind of what I have called a sea engineering agency, SEA, in Government to which industry can come, a central agency for the peaceful exploitation of the sea.

This engineering agency need not interfere with the present various agencies that support marine research and science. But when you do big engineering, as I envisage we will be doing, I think we will need a central agency in Washington, and the pending legislation, other than your own bill, Senator, is pointed in this direction. So that, therefore, whatever agency we choose, we should have in the back of our minds and they should realize that they will turn it over when this new arrangement in Government comes to fruition.

Senator PELL. What we are talking about here is the very practical kind of project, as we suggested yesterday, to get young fellows when they finish high school to spend a couple of years in technical training and go aboard fishing fleets, to get proper use of seaweed, to help mining underneath the surface of the sea, and to do that, I think we want to get away from pure science because the money we are talking about is but a drop in the bucket when it comes to pure science, but it could help very much in the development of technical training.

A couple of other questions in behalf of the minority. First, Senator Murphy has asked, what do you think of the idea of a floating school

of oceanography—a floating school where the students and professors and the working professional scientists and technical personnel might work and learn at sea?

I must say it is a new concept to me and I hadn't thought of it until I just read the question to you, sir.

Dr. SPILHAUS. It is not an entirely new concept. I think it is very important that students should get their feet wet in the sea. I am not sure that a floating platform is the best podium for professors or teachers of technicians. I think we need both. I think we need shore facilities where we can teach subjects and then sea facilities where we can take the students for the experimental work, their laboratory work, if you like.

I think we need both.

I don't think we should really think that we need to have all our sea instruction done from floating structures on the sea, although such structures will be needed for the laboratory work of the students.

Senator PELL. If we did have such a school, do you have any idea how much it would cost, such a school vessel?

Dr. SPILHAUS. No, sir. I haven't given this much thought but I am quite convinced it would cost a lot more to do the same job that you could do on land, using ships for laboratory purposes.

Senator PELL. I must say I would agree with you. It would be perhaps a little like this Project Hope where the individual cost of the treatment to the people abroad is far greater than if they had hospital units under Medico. It is a little off the subject, but I think the expense analogy is not particularly off the subject.

Another question from the minority is to the following effect, that provision is made in our bill for consultation with scientists and engineers by the National Science Foundation in carrying out the provisions of the bill, but no provision is made in the bill for a statutory advisory group that would also report to the President and the Congress, and as the reports would be in the public domain, do you think such a provision would be advisable? I must add here I am completely openminded.

Dr. SPILHAUS. Senator, this question comes all of a sudden to me. I haven't given it any thought. I don't understand the purpose of this group. Is it to report to the President and the public at large?

Senator PELL. Indirectly, a technique or device that we use sometimes in the Congress to keep the public interested and informed, and also a certain check on the operation.

Dr. SPILHAUS. Well, I am one of those who firmly believes that, and one of the basic—my basic reasons for wanting to exploit the sea for the benefit of people is that I believe that not only does science bloom, pure science blooms best, in an atmosphere of application, but that if you are going to ask the people at large to support science, that they not only—we not only ought to feel it is our duty to draw out the benefits of the science for their use, but we ought to keep them informed about the progress of it, the implications of it for society in the future. So that any device, and if this is one, that keeps people stimulated, excited, and informed about our program of colonizing the sea, I am for. I don't know if this is the best one or not.

Senator PELL. I think this is something we would discuss in the committee and if some of the members of the committee like this idea, it surely would be acceptable to all of us.

You are very, very kind to have come here and taken this time, and without your original creation, we would not be here. I thank you, sir, very much indeed.

Dr. SPILHAUS. Thank you, Senator.

Senator PELL. Our next witness will be Dr. Nierenberg, director of the Scripps Institution of Oceanography at La Jolla, Calif.

STATEMENT OF DR. WILLIAM A. NIERENBERG, DIRECTOR, SCRIPPS INSTITUTION OF OCEANOGRAPHY, LA JOLLA, CALIF.

Dr. NIERENBERG. Mr. Chairman, thank you very much for inviting me here. I am grateful for the invitation to present my views.

Senator PELL. Incidentally, I would like to pass on to you the greetings, as I said earlier, of Senator Murphy, who is very sorry he cannot be with you but he is at the funeral of our colleague.

Dr. NIERENBERG. Thank you very much.

I have put together the consensus of opinions of my colleagues at Scripps and it has turned out to be much too long to be read today.

Senator PELL. I would agree with you. Could it be submitted—it is 26 pages, I think, and a very interesting map here. Let's put the testimony in the record as if read, and if we possibly can, would you like the map inserted in the record, too?

Dr. NIERENBERG. Yes, sir.

Senator PELL. Fine. Depending on the budget of the committee, I guess, and the possibility of it, we will have it inserted in the record. (The map referred to may be found in the files of the subcommittee.)

Dr. NIERENBERG. I would be grateful.

Senator PELL. Maybe you would like to digest your statement.

Dr. NIERENBERG. Yes, sir; and just say a few words about it. I really can't digest it easily but I would like to explain to you, Mr. Chairman, the organization of the report and, perhaps, why it is so long.

It is really in two parts, a very short initial part where we try to draw on the experiences of the Scripps Institution of Oceanography as they are related to the subject of the sea grant college.

We are, as you know, sir, approximately 75 years old and since 1912 we have been part of the University of California, which is a land-grant college, and in a certain sense, in the narrower sense of the proposal, Scripps has been a kind of sea grant college that very early in its history it was given title to the beach at the Scripps property and a thousand feet of ocean, seaward, and this was very fortunate because this title included the Scripps Canyon—which was very important—Scripps and La Jolla Canyons, which are very important for our deep-water—

Senator PELL. What is that?

Dr. NIERENBERG. Scripps Canyon. There are two very deep, narrow canyons that cut the Continental Shelf almost up to the shore. The major one is the La Jolla, and then a piece at right angles to it, called the Scripps Canyon. This is very fortunate for the scientists as it enables them to get rapidly into deep water and study the ocean processes close to shore.

In addition, we have a marshland preserve and we have 1 square mile of ocean preserve that we share with the Navy Electronics Laboratory.

Now, we are an educational and research institution but we are also organized to serve some of the purposes described in the sea grant college bill itself. I would like to briefly list the details of that part of our organization which is so constructed.

We have the Institute of Marine Resources which is housed in Scripps's and headed by Prof. Milner Schaefer.

We have the marine life research group, which is headed by Prof. John Isaacs.

There is the Marine Physical Laboratory, which is housed at Point Loma and headed by Prof. Fred N. Spiess, which was established principally to work in the problems of importance to the U.S. Navy.

We have the Visibility Laboratory at Point Loma headed by Dr. Siebert Duntley. We also house the Tuna Commission. We are hosts to the Bureau of Commercial Fisheries.

One of our divisions, the University of California Division of War Research, no longer exists but has been transmuted into the Marine Physical Laboratory and the Naval Electronics Laboratory.

I put this in the record, Senator Pell, principally to indicate the strong desirability of a sea grant concept and how we have in our own way pragmatically been working in the same direction in that side of our institution which is not organized directly for research and teaching.

Now, I would like to explain the second part of the paper, the longer part, and this part is principally devoted to those areas of research, applied research specifically, and activities that we feel are important for the sea grant college concept as outlined in your bill.

It is too lengthy for me to go into detail and I would just like to make a brief statement about this.

Many needs of man are now supplied by the ocean. A substantial number of these cases are sufficiently well understood that research is mainly only adjunct to specific utilization—affecting the effects of the utilization and dealing with improvements. Such cases can be classified as industrial research and include much of the activity in waste disposal, fish and seaweed harvest, beach construction and erosion control, shallow water petroleum production, marine architecture and transport, harbor engineering, military equipment, nearshore structures, undersea cables, marine instruments, and so on.

In these cases there exists a body of knowledge and a fund of operational know-how and equipment that permits the instruction of and profitable employment of practitioners in ocean technology for both the industrial operations and industrial research.

Construction and research of this type is, of course, essential to man's effective utilization of the ocean environment and can be adequately carried out by technical schools and research institutions. Much of the research is of a specific nature and does not intimately parallel the research of disciplinary oceanography.

But the crux of my remarks is what follows and this is the area of ocean engineering and technology that deals with the generalized problems and opportunities—broad applicability—that ocean science reveals. It is this area directly paralleling and highly compatible with ocean science to which Scripps devotes its attention and study and to which I devote the remainder of my remarks in the full paper. And with your permission, I will just read the titles of areas that are discussed in detail in the report.

The first one is exploration.

The second is appraisal of the overall natural constraints, limits and opportunities of ocean use.

The third heading is the identification of general operational inadequacies and exploration of improved approaches.

The fourth is interdisciplinary ocean technology itself.

The fifth relates to technical learning from nature's solutions to oceanic problems.

The sixth is the application of engineering and technical methodology and knowledge to ocean science.

And the seventh is the problem of the identification of human needs for and human constraints to ocean use.

Now, a very brief summary which just involves two points.

In order for a local marine station, as a sort of wet agricultural and engineering experiment station, to be effective, it must be adjunctive to a broad-scale ocean technology, paralleling, supporting, and mutually drawing from an equally wide program of ocean science.

And second, it must be closely associated with a first-rate university, with departments in geophysics and in the basic sciences and engineering and it will also avoid basic misidentification of needs if it maintains rapport with the humanities and economics departments of the university.

Thank you, Mr. Chairman.

Senator PELL. Thank you very much.

A couple of specific questions. Do you believe that there should be a matching formula or not?

Dr. NIERENBERG. Well, you know, Senator, in my case that is a leading question. As director of the institution I am always desperate for money. I always like to get as much as I can. Drawing on our own history, the State of California supplies 20 percent of the operating funds of the Scripps Institution of Oceanography. I must say that we find this support extremely beneficial in a variety of ways but the most important is one I believe that was expressed by Dean Spilhaus, that in a certain sense guarantees the strong interest and participation of the State of California and the people of the State of California in the operations of the institution. They take a very strong local interest in the operation of the institution.

Senator PELL. Do you have any thought as to what the administering agency for this program should be? Should it be the National Science Foundation or Smithsonian or have you any views on that?

Dr. NIERENBERG. I certainly don't, and I think my colleagues do not have any particular strong viewpoint either, Senator. We can certainly say we have been happy with our operations with respect to the National Science Foundation.

Senator PELL. All right. Thank you very much indeed for coming. I realize it was a very long trip from California here.

(The prepared statement of Dr. Nierenberg follows:)

PREPARED STATEMENT OF DR. WILLIAM A. NIERENBERG DIRECTOR, SCRIPPS
INSTITUTION OF OCEANOGRAPHY, LA JOLLA, CALIF.

Mr. Chairman, I am grateful for the invitation to present my ideas on the subject of the sea grant college. I have obtained a consensus of views from my senior colleagues at Scripps Institution of Oceanography and we have agreed that the special history of the institution as it began before 1900 and from the

time it became a part of the University of California in 1912 put forward in some detail along with some general remarks on ocean technology could provide the subcommittee with the kind of practical information that could be useful in evaluating the sea grant college concept.

The University of California itself began as a land-grant college which developed into the famous institution of today. In many respects the Scripps Institution of Oceanography has paralleled the development of the great institution that absorbed it in 1912. For one, it is devoted to research, with respect to all things that have to do with the oceans—it is also a teaching institution, providing the graduate training for the granting of the Ph. D. in oceanography, marine biology, and earth science. Our first Ph. D. was granted in 1930 and we have to date granted 95 Ph. D.'s. The value of at least one aspect of a sea grant college was early recognized by the State of California in that title to the beach and an area extending 1,000 feet seaward from the institution was granted to the Scripps Institution of Oceanography. This grant is particularly valuable in this instance because of the proximity of the Scripps and La Jolla submarine canyons, which give us the effect of deep water research close to shore. The value of this grant has been increased by a 1 square mile of preserve that is reserved for the joint use of Scripps and NEL.

While we are proud of the fame of our institution with respect to our voyages of exploration and research in the deep oceans around the world, and I would like to present the subcommittee with a chart of the tracks of all our voyages of more than 1 month's duration since the year 1950, I speak today principally in connection with other activities and organizational parts of the Scripps Institution of Oceanography which are also pertinent to the subject of the sea grant college.

There is first our marine life research group which is headed by Prof. John Isaacs. This group is 17 years old and was established for the purposes of translating and extending our scientific results to the better utilization of the fisheries off the coast of California and Baja California. The marine life research group has made those of its contributions that are of a practical nature principally through the Calcofi, that is the California Cooperative Fisheries Investigation, which is a partnership between the University of California, the State of California and the Federal Government with a few other contributing agencies and is coordinated by the marine research committee of the State of California. One of the principal results of this work was the establishment for the first time of a fishery completely on the basis of scientific investigation. This union of university, industry, Federal and State has been, and will continue to be, very fruitful.

The Institute of Marine Resources is a statewide university organization housed in Scripps and headed by Prof. Milner Schaefer. This institute which is now 14 years old, was established to develop and apply the applied science aspects of oceanography throughout the university system of the State of California.

Our marine physical laboratory, housed at Point Loma and headed by Prof. Fred N. Spiess was established principally to work on problems of importance to the U.S. Navy with respect to underwater physics, particularly sound and its transmission.

Our visibility laboratory at Point Loma, headed by Dr. Seibert Duntley, has a variety of missions, but one of the most important is the practical problem of light transmission and visibility.

We also house the tuna commission and we are hosts to the Bureau of Commercial Fisheries with whom we have cooperative programs.

One of our divisions, the University of California Division of War Research no longer exists but has been transmuted into the marine physical laboratory. We can thus see how by steady growth in a space of over 70 years the Scripps Institution of Oceanography, which is now a part of the new campus of the University of California at San Diego, has become in a sense a kind of sea grant college (or perhaps university would be a better description) of the kind somewhat akin to that which is proposed here. We believe we handle successfully on one hand the teaching, basic research in oceanography, a fleet of eight ships, a marshland reserve, our radio station and our various research divisions at the same time that we have been able to set up the organizations for, and effectively serve, the science, the university, the State of California, the United States and international organizations, this later principally through UNESCO.

For the past 10 years the oceanographers at Scripps have carried on continuous study and discussion of the best way to contribute further to the advance

of ocean-related sciences. The first result and the principal one was the establishment of a new campus of the University of California in San Diego. It was agreed that a school of oceanography could not flourish unless it were closely associated with a university that had first-rate departments in the basic sciences and engineering. One of the great results was the growth of our efforts in geophysics through the associated branch of the Institute of Geophysics and Planetary Physics locally headed by Prof. Walter Munk and statewide by Prof. W. Libby. A school of marine science that is isolated from a first-rate campus is a poor concept in this day and age. We at Scripps feel that this development of the Scripps Institution and the University of California has been good and we expect even more dramatic results in the future.

We have proceeded perhaps too cautiously in one area that is of interest to your discussions, and that is the area of formal education in applied ocean science, sometimes called ocean engineering. Our faculty also has discussed the question many times in the last 10 years, and we have reached some tentative conclusions with which we are experimenting right now in some of our courses in oceanography and which we hope to establish on a broad and surer basis in cooperation with our department of engineering, headed by Prof. S. Penner.

In this foregoing introduction to the past and continuing contributions of the Scripps Institution of Oceanography and the University of California to the "practical" use of the oceans, I perhaps have pressed the gist of my remaining discussion, in which I will present some of the abundant evidences that the reduction of the ocean realm to mankind's use encompasses far more than ocean engineering or fisheries as we conventionally think of them. I would like to acknowledge the help of my colleague Prof. John Isaacs in the preparation of this section.

Indeed (and I will presently offer you more examples), in the sea the interaction of the physical motions, waves, and currents; the complex chemicals that the sea contains; its active organisms; and its geographical features and sediments, act and interact in such manifold and complex ways as to preclude most simple single disciplinary approaches to its exploration and use.

When, to these complexities of the sea, we add the cosmic complexities of man, his motivations, economics, laws and need, it is clear why at Scripps we have concerned ourselves only partly with ocean engineering as to its structural, mechanical, or electrical aspects, or fisheries to its problems of acquisition and management.

We thus have been convinced that ocean technology and engineering must be very broadly defined and approached, and we have striven to enlarge its compass to the entire interdisciplinary field of "the purposeful intervention into the ocean for the practical needs of mankind."

In this view ocean technology and engineering fully parallels, derives from, and supports the entire range of the science of oceanography, which deals with the "intellectual needs of mankind" in its fundamental motivation, rather than the practical needs.

Ocean technology and engineering, however, extends farther than oceanography, for it must define and inquire into practical "needs" and concern itself with industrial and defense economics to some considerable degree.

With this compass of ocean technology in mind, I will outline and briefly discuss the scope of the viewpoints to which the definition gives rise.

First I will reiterate the part of the field that is now reduced to practice.

Many needs of man are now supplied by the ocean. A substantial number of these cases are sufficiently well understood that research is mainly only an adjunct to specific utilization—assessing the effects of the utilization and dealing with improvements. Such cases can be classed as "industrial research" and include much of the activity in waste disposal, fish and seaweed harvest, beach construction and erosion control, shallow water petroleum production, marine architecture and transport, harbor engineering, military equipment, near-shore structures, undersea cable, marine instruments, etc.

In these cases there exists a body of knowledge and a fund of operational know-how and equipment that permits the instruction of and profitable employment of "practitioners" in ocean technology for both the industrial operations and the industrial research.

Construction and research of this type is, of course, essential to man's effective utilization of the ocean environment, and can be adequately carried out by technical schools and research institutions. Much of the research is of a specific nature and does not intimately parallel the research of disciplinary oceanography.

We are thus brought to the crux of my remarks—the area of ocean engineering and technology that deals with the generalized problems and opportunities of broad applicability that ocean science reveals. It is this area directly paralleling and highly compatible with ocean science to which Scripps devotes its attention and study and to which I will devote the remainder of my remarks.

These technological aspects of broad implications could be categorized in many ways. I will, however, choose the following somewhat integrated and overlapping divisions for my discussion:

- I. Exploration;
- II. Appraisal of the overall natural constraints, limits, and opportunities of ocean use;
- III. Identification of general operational inadequacies and exploration of improved approaches;
- IV. Interdisciplinary ocean technology;
- V. Technical learning from Nature's solutions to oceanic problems;
- VI. Application of engineering and technical methodology and knowledge to ocean science; and
- VII. Identification of human needs for and human constraints to ocean use.

In my discussion of the categories in this outline I will illustrate them with examples drawn from the general field, with an unavoidable emphasis on the work at La Jolla, and I will also point out some of the deficiencies.

I. EXPLORATION

Basic to man's apprehension of his world is open-eyed, unfettered, inquisitive exploration. As essential to the science of the oceans as it is to its technology, exploration has ever had great and sometimes surprising and unexpected impact on man's utilization of the oceans. It is clear that Mathew Fontain Maury's collation of winds and currents was of great benefit to navigation and transport, but it is surprising to find that the geological exploration of the sea bottom has carried an impact to fisheries. Geological exploration, in finding hitherto undiscovered seamounts, has delineated new fishing grounds that already are in use.

In a similar fashion, broad exploration and delineation of geologic structures, the nature of ocean productivity, the distribution of plankton, currents, the broader understanding of marine meteorology and ocean structure—all are basic to the appraisal of man's practical opportunities in the sea, which I will discuss below. Conspicuous among these, of course, are measurements leading to a knowledge of the propagation of underwater sound in different regions of the sea, nutrient level surveys, and zooplankton collections delineating regions of high oceanic production, but even scientific discoveries of chemical difference in sea water, such as the apparent deficiency of normal cesium in the South Pacific, have important implications to the problems of worldwide fallout and the sea disposal of nuclear waste. Methodological offshoots of scientific explorations have also been important. The development of seismic reflection and refraction methods for marine geological exploration has been vital to offshore petroleum discoveries and even to the utilization of undersea gold and diamond placers around the world.

New scientific tools and methods now exist or are now becoming available that have not yet been applied to broad exploration for the fund of practical knowledge that they are capable of apprehending. Conspicuous among these underemployed tools and methods are the following:

(a) *Unmanned moored instrument platforms.*—Instrument platforms can now be routinely moored on the surface of the deep sea in depths exceeding 3,000 fathoms and survive for the greater part of a year. Broad-scale deployment of such platforms can reveal the nature of the aperiodic alternations of ocean and weather conditions, which so profoundly influence our marine and terrestrial activities.

(b) *Pelagic fish larvae surveys.*—The identification and understanding of pelagic fish larvae has been brought to a high level of development at the Bureau of Commercial Fisheries Laboratory at La Jolla under Dr. Ahlstrom. A worldwide survey of fish larvae has immense possibilities. Immune to the vagaries afflicting exploration for adults, the larval fishes are readily captured and present an opportunity to appraise every major pelagic fish stock in the world both known and as yet undiscovered.

(c) *Fish remains and microfossils in bottom sediments.*—Totally complementary to the two foregoing, is a worldwide survey of fish remains and micro-

fossils in bottom sediments, for this not only extends our knowledge of the distribution of fish beyond their areas of spawning but yields information on the history of peristancy, fluctuations, and competition of fish stocks. Thus at its outset a fishery can proceed with vital knowledge of the history of the fish, and, through a study of the associated microfossils, a knowledge of the organic, oceanic, and meteorological condition under which it has thrived or declined.

Under rather rare conditions along coasts sediments are deposited rapidly and are not subsequently disturbed. Thus the record of fishes, the oceanography and something of the meteorology can be read in calendar pages of a few years or so for several thousand years.

The implications of a broad survey exploiting this entry into the record of the oceans of this world are very great.

(d) *Plankton collections*.—Much is known about the distribution of plankton in rather limited regions of the world oceans. A much broader understanding is essential to the evaluation of the planet's productivity, of potential fisheries, and, of course, to the full significance of research into circulation and the oceanographic changes recorded in the recent past as discussed above.

II. APPRAISAL OF THE OVERALL NATURAL CONSTRAINTS, LIMITS, AND OPPORTUNITIES OF OCEAN USE

Specific projects for utilization of the oceans can be profitably approached on an ad hoc basis. For example, a new fishery, a tidal powerplant, a disposal area for nuclear waste, or etc. can be established on the basis of regional investigations and the resultant understanding.

However, the significance of the oceans to the needs of the world's human population is best comprehended not by a multiplicity of local studies, but rather by an evaluation of the planetary potential, its constraints, its limits, and its opportunities.

Although data for such approaches are in some cases scanty, enough exists for us to set significant limits, adequate for long-term guidance. As further data are available these overall approaches can be perfected.

As examples I can quote the results of studies that show:

(a) Oceanic evaporation and the resultant land precipitation is a sufficient rainfall for the optimum terrestrial agriculture for some 40 times the world's present population.

(b) The total tidal power in the world's oceans is less than 10 percent of the expected human power needs at the onset of the 21st century, with the available tidal power much less than this.

(c) Outside of the nuclear power resources, the greatest single utilizable energy reservoir on this earth is that represented by the temperature gradient of the ocean. This giant low-level reservoir exceeds the total estimated fossil fuel reserves of earth.

(d) The capacity of the oceans to receive nuclear waste is such that a distributed input of about 100 tons of mixed fission products annually would give rise to acceptable levels of radioactivity in marine foods. This input represents about 10 percent of the estimated human electrical power requirements in the year 2100.

(e) The common fisheries of the oceans are ultimately capable of supplying the total protein needs of a world population that is somewhat greater than at present. They are capable of supplying the animal protein requirements for a population of 60 billion people.

A harvest concentrating on the herbivores in the sea could supply an order of magnitude greater yield.

(f) It can be shown that, because of their dilution and microscopic dimensions, the primary food materials of the sea can probably never be profitably harvested by methods involving the input of energy from external sources (such as nuclear or fossil fuel power) for pumping, straining, etc. Thus such primary harvest must use sources of energy contained in the ocean, such as ocean currents, the motion of organisms, or the activity of filter-feeding creatures.

Ocean "farming," as the analog to terrestrial farming, as a consequence will be restricted to special limited regions of the sea such as bays or coral lagoons. The general harvest of the oceans productivity in the ultimate is constrained to methods paralleling terrestrial "ranching" and grazing, where a preferred herbivore is sent to range (if a filter-feeding fish), or cultural on artificial substrata (if it is an attached filter-feeding organism, like a

mussel). The potential of these approaches is immense. Indeed, they are immensely successful in limited areas now.

(g) Certain minerals, such as manganese, are accumulating in the oceans at rates greater than any immediately foreseeable harvest. They, therefore, can be considered to be renewable resources.

I have selected the above as examples of the guidance that can stem from overall evaluation of the planetary resources. It is clear that further research will refine the evaluation of these constraints and permit and reveal others.

III. IDENTIFICATION OF GENERAL OPERATIONAL INADEQUACIES AND EXPLORATION OF IMPROVED APPROACHES

One of the important functions of ocean technology must be to recognize broad deficiencies in our ability to deal with the environmental conditions. If a case is of sufficiently broad applicability should be subjected to a generalized analysis, with the intent of arriving at an analysis applicable to the broadest possible ranges of related problems. Stated somewhat more objectively, there comes a time when problems such as motion control at sea or pressure exclusion are of sufficiently wide importance in manifold circumstances that sophisticated analyses of the most general application are demanded.

Examples resulting from quite general analyses of operational problems of this nature include:

(a) The FLIP platform that has shown itself to be so emancipated from surface motion that a new order of magnitude of measurements can be conducted from it.

(b) *Surface platforms moored in the deep sea.*—General analysis of the problems (and the solution of unanalyzable environmental constraints) have made possible the mooring of instrument platforms in depth as much as 3,000 fathoms for periods of a large part of a year.

(c) *Pressure exclusion.*—Advanced analysis of pressure resistant materials and structures have greatly enlarged our capabilities of operating on or near the bottom of the deep sea.

(d) *Others.*—A rather large inventory of power sources, recall devices, autonomous operators, sound sources, etc., all are of wide applicability and use.

There are still many generalized problems, however, that are so universal and disabling as to demand careful attention and thought.

Conspicuous examples include:

(a) *The handling of masses overside in a seaway.*—We have made very little progress in handling masses over the side of a ship since the time of early navigators. The lowering of a small boat in a seaway is still fraught with serious hazard, even from the greatest vessels of our Navy. Part of the problem of the control of motion, we nevertheless are obliged to operate from rolling ships, and the capability of handling masses over the side should be greatly enhanced.

(b) *Mastery of the ocean air.*—Present investigations and operations at sea are restricted to clumsy surface craft or to brief vicarious overpasses by aircraft or satellite.

The development of a truly marine aircraft would have almost inestimable impact on every phase of oceanographic investigations and ocean operations, civil and military. Present aircraft are barely tolerated by the sea in brief passages. Careful attention should be devoted to the possibilities of a craft designed specifically for pelagic operations. Interim advantages could ensue from developments leading to improved ocean contact by fixed winged aircraft.

IV. INTERDISCIPLINARY OCEAN TECHNOLOGY

One point that I hope to emphasize in these remarks is that the traditional mechanical, structural, electrical, or agricultural technology of man's terrestrial activity, cannot simply be immersed in sea water, and thus brought to bear on the problems of the marine realm. There are many reasons for the inapplicability of this approach, but paramount among these reasons is the strong interaction between the various organic and inorganic entities. The chemicals, organisms, and motions of the sea interact in complex and intimate ways. For example, whereas intervention of native creatures or plants into terrestrial engineering works is a newsworthy event (e.g. squirrels biting cables, or starlings in a jet engine), the absence of such biological intervention in the sea is the unusual event. Thus floats are fouled by attached organisms; fish gather about

any installation, bite, make noise, stir the water; other creatures enter any crevices, excavate and drill.

At the same time other natural events take unfamiliar form in the sea. Landslides become strong density flows, earthquakes result in brief but powerful increases in the hydrostatic pressure, and internal invisible waves confuse experiments and ASW search.

A great list of such interactions could be set down, all emphasizing the fact that the ocean technologist must be very broadly trained and always cognizant and alert to the range of possible compromises of classical engineering approaches. Laboratory tests, for example, cannot duplicate the corrosion of a metal under an unknown organism, or indicate what creature will immobilize a part intended to move undersea.

V. TECHNICAL LEARNING FROM NATURE'S SOLUTION TO OCEANIC PROBLEMS.

It is a platitude to state that the organisms of the sea have solved many of the important problems that face man in his utilization of the sea. Energy supply, light production, echo location, communication, propulsion, navigation, thermal control, oxygen deficiency, osmotic control, and control of the bends are a few of the problems that marine creatures have solved.

Studies of the manners by which these solutions have been achieved have important implications to ocean technology, for, in many of the understood cases, these have been clean basic solutions. It has been stated with considerable truth that man's development of high performance submersibles would have earlier advanced had the fast-swimming fish been studied sooner.

The solutions that creatures have evolved can be considered to be genetic solutions. In most cases we are probably restricted to learning from the organisms. In some cases, however, we may be able to employ the genetic information directly.

For example, there are some 50 or more species of higher plants (halophytes) capable of living in waters even more saline than sea water. These plants possess effective systems for the desalination of sea water, and hence also the genetic information on how this is accomplished.

Since these are flowering plants derived from many families this genetic information should be transferable to our useful crop plants in selective hybridization experiments. Successful breeding of this nature would introduce order of magnitude increases in the salt tolerance of crop plants. Not only might this allow the development of a sea water agriculture but, possibly and more importantly, permit the conduct of an effective terrestrial agriculture in saline soils and with saline waters. Such soils and water are one of the rapidly developing problems of desert agriculture under perpetual irrigation. The larger woody halophytes, such as the mangroves or the Siamese citrus may be useful as salt excluding rootstocks for our useful fruit trees.

Other direct utilization of the genetic know-how of marine organisms are probably not of such far-reaching consequences as the crossbreeding of salt tolerant plants and crop plants.

The direct use of marine creatures to populate inland saline lakes has been spectacularly successful, however; although such introductions have not been widely attempted.

VI. APPLICATION OF ENGINEERING AND TECHNICAL METHODOLOGY AND KNOWLEDGE TO OCEAN SCIENCE

The other half of the interrelation between technology and ocean science has received little attention. It is clear that hydrodynamic analysis, boundary layer theory, dimensional analysis, high-pressure chemistry, investigations on electrolytes, etc., represent powerful methods and have acquired a fund of knowledge applicable to many of the problems of ocean science. Some of the high-pressure engineering work on phase transformation in minerals, and dimensional analysis of organisms has yielded important results. However, much of the potential yield of interaction between the two fields lies unharvested. The two fields have largely neglected this important aspect of their interrelationships. It can undoubtedly be stimulated only in the university milieu.

VII. IDENTIFICATION OF HUMAN NEEDS FOR AND HUMAN CONSTRAINTS TO OCEAN USE

A number of ocean technological programs appear to have suffered from an inadequate appraisal of needs. These inadequate appraisals are of two de-

grees. In some cases the expression of "need" has arisen from enthusiasts and has been undertaken on the basis of this enthusiasm without adequate economic analysis. Desalination programs have suffered from this ill.

In other cases, the significance of the development has been judged from an inadequate, partial, or anachronistic basis.

A few examples will clarify this point:

(a) *Domestic fisheries as operational and technological tests and experience.*—It is clear that many of the domestic fisheries of the United States have suffered from a decline in product and effectiveness. These declines are partly the result of a long period during which the technical development of fisheries has been suppressed as an element of control in management. Additional constraints have been imposed by legislative pressure from conservationists and noncommercial users such as sportfishermen. When economically appraised as simple producers of fishery products, revival of these fisheries appears to be only modestly rewarding. Thus the pressure of recreational users may dominate even where no justification exists. The record of a number of fisheries shows, however, that the greatest rewards have ensued where fishing techniques and product practice, developed in domestic waters have been extended into new waters elsewhere. The tuna and fishmeal industry are important cases in point, where the exported know-how has been spectacularly rewarding to domestic entrepreneurs and investors.

We should thus look at the economics of domestic fisheries in this wider view. Particularly now, when new tools and approaches permit management to be carried on at a much more sophisticated level, this management know-how also becomes an exportable product.

(b) *Noncommercial uses of the ocean.*—Many of the present and continuing domestic conflicts in the uses of the environment stem from our drive toward the recreational and esthetic uses and our cultural inability to set up decision criteria by which these uses can be evaluated in comparison with the conventional practical employment of the environment. This defect in our decision-making process extends, of course, into many areas other than the marine realm. However, with increasing discretionary time on the hands of members of our society, our domestic conflicts are increasing rapidly.

An important point to note here is that conservationists and recreational interests, in the absence of objective criteria for decision, have often been forced to emotionalism and irrational actions and arguments in defense of their interests. A prime example of events of this nature is the attitude of the sports interests in the newly established anchovy fishery off the west coast.

Rather than dwelling on these conflicts, however, it is profitable to consider what opportunities have been obscured by this lack of decision criteria.

Undoubtedly there are many. Immediately at mind, however, are the following that relate to the uses of the marine environment:

(a) *Superstable platforms.*—The implications of the superstable platforms, discussed previously, to marine and military science are obvious. However, their implications to marine sports and recreation are equally great. After all, they fundamentally solve one of the most powerful dissuaders of deep sea recreation—sea sickness. Offshore sports fishing platforms, midocean refuges and supply bases, and, even, midocean hostleries become feasible.

(b) *Small boat harbors.*—Recreational boat harbors, from a harbor engineering standpoint, have been considered to be miniature commercial harbors. However, nature teaches us by example that small boat harbors can possess completely unique characteristics based on their dimensions and nonlinear wave refraction and that these are at once more useful and safer than harbors of conventional design.

(c) *Recreational beaches.*—For 20 years enough has been known of wave refraction to understand, and perhaps duplicate the offshore configuration that gives rise to the famous surfing beaches of the world. Yet this has not been studied. The impact of constructing a great surfing beach near, let us say, Los Angeles, can hardly be estimated.

In these remarks, I have covered quite a range of examples. However, I, of course, have omitted many more examples than I have included. I should have also discussed weather control, bold transportation with icebergs or giant containers, Plowshare harbors, and the Red Sea power proposal.

However, and, in summary, I have intended to demonstrate through these categorized examples, the remarkable parallelism of broad ocean science and ocean technology.

It is my belief, shared by the staff and faculty of Scripps Institution of Oceanography that ocean technology is extremely well fostered and supported by its close association with broad and inclusive ocean science.

Regional technical experimentation in the ocean realm also has an important place in testing and learning of specific regional opportunities that are revealed in the broad picture. The regional experiment attains special importance when it is so alined.

In summary, I wish to make two points:

(1) In order for a local marine station (as a sort of "wet" agricultural and engineering experiment station) to be effective, it must be adjunctive to a broad-scale ocean technology, paralleling, supporting, and mutually drawing from an equally wide program of ocean science; and,

(2) It must be closely associated with a first-rate university, with departments in geophysics and in the basic sciences and engineering. It will also avoid basic misidentification of needs if it maintains rapport with the humanities and economics departments of the university.

Senator PELL. Our next witness is Dr. David Potter, of the General Motors Corp., Sea Operations Division, Santa Barbara, Calif. And I would like also to pass on to you Senator Murphy's greetings and regrets that he can't be with us this morning.

STATEMENT BY DR. DAVID S. POTTER, HEAD OF SEA OPERATIONS DEPARTMENT, GENERAL MOTORS DEFENSE RESEARCH LABORATORIES, SANTA BARBARA, CALIF.

Dr. POTTER. Thank you, Senator Pell. My name is David S. Potter. I am head of the Sea Operations Department, General Motors Defense Research Laboratories, Santa Barbara, Calif. I am also a member of the Governor's Commission on Ocean Resources of the State of California. I would like to limit my comments to a few points which I feel should be stressed and also to comments on the administrative procedures outlined in S. 2439 which seem to be controversial.

Many of us who have been concerned with the exploitation of our ocean resources have felt a sense of urgency which we have failed to transmit to the lay public, and only partially transmitted to those in Government. Probably this is because the case has not always been well documented. As you are well aware, the loss by the United States of a leading position in maritime transport happened many years ago and is dated by some historians at about the time of the Civil War. To change our relative position in this area will be a heroic undertaking. This matter is not the reason for the urgency which I feel.

On the other hand, the decline in our fishing industry relative to world production is more recent and is as yet reversible. The large-scale extraction of nonliving resources from the sea (except petroleum) is still some time in the future, but it is not so far away that this Nation can afford the casualness toward it which we have displayed to date. If we do not move now it is likely that the fishing industry will join the shipping and shipbuilding industries as unsalvageable without massive help or subsidy. If we do not move now, we may not have a free choice in participating in offshore mining in the future.

My second general comment relates to the kind of education needed for ocean exploitation. Some concern has been expressed by my

academic colleagues over the wording of section 2 of S. 2439 which stresses applied research and the training of technical people to serve in an extension capacity similar to the agricultural extension program. Their concern, I believe, is based on the assumption that overemphasis of this facet would be harmful to the basic science programs now being conducted generally in the graduate programs of our universities. I, too, would be opposed to a lack of balance of that kind, but I am far more concerned with the present reverse lack of balance. There is a virtual absence of institutions devoting themselves to the applications side of marine exploitation. Thus in my view, the intent of the bill, as clearly stated in the language of the bill, is directed toward the critical problem area. The authors of S. 2439 are to be congratulated on their explicit wording of this point. It is heartening to find so much support for filling the present application gap.

As a member of the Governor's commission, I have had many discussions with local fishing fleet operators and buyers in California. They are convinced that more and better technical information in the hands of the individual fisherman is a prime requirement for increasing the productivity of the fishing industry. In fact, they rate this requirement second only to hard work as the criterion for success of an individual fisherman. They consider technical knowledge far and away more important than such matters as Federal loans for fishing vessels, new gear, and the like. Thus, I would like to underscore the necessity for giving preference to practical applications and to creating the marine equivalent of the county agent. This will not be a short-term effort. It will take several years before seagoing county agents can be trained and more years before they will be accepted by the individual fishermen. You can appreciate that it will take a long time to gain the confidence and respect of men who have spent 30 years at sea learning their business, and who regard any tricks of the trade which they have picked up as proprietary information within their own family group.

The two administrative points which I would like to raise have to do with the administration of the program by the National Science Foundation, and also the need for funding of institutions as distinct from funding for specific projects. The National Science Foundation seems to be somewhat hesitant to accept the responsibility for administering the sea grant college program, which is certainly understandable. Historically the Foundation has maintained the point of view that they should fund worthwhile projects conducted by men of stature and demonstrated competence, primarily in basic science. As a practical matter the Foundation has preferred to take a passive role in the development of a field by choosing among programs which are presented to it rather than the active role of giving direction by soliciting proposals in particular areas. It is clear that the administration of the proposed sea grant program would require a significant departure from the present National Science Foundation philosophy in order to be successful. A major aid to NSF in administering the program would be the creation of a special advisory group having detailed knowledge of the program objectives.

A second administrative problem which has given rise to controversy, is the kind of institution which is required to carry out the concept of the sea grant college and the nature of the funding to be sup-

plied. We do have centers of excellence in the marine sciences now in this country. We do not have centers of excellence in ocean engineering or ocean technology. Only a few universities, such as the University of Rhode Island and the University of Miami, have made any effort in this latter direction. Further, at least in California, it would be quite difficult to append a paraprofessional or technician training program to those existing institutions which have some competence in ocean matters. Thus it seems to me necessary to provide long-term funding of an institutional nature in order to allow the institution to develop a long-range balanced program. In this way the great need for more applied research and training can best be met.

A superior technology has played a decisive role in allowing the United States to compete successfully in many fields in the world market. The technical superiority which we enjoy has come about largely because of our national commitment to higher education. In order for us to recapture U.S. leadership in world fisheries, and to prepare for the coming market in nonliving resource extraction, it is essential that we provide the education base for an advanced technology. This brings me full circle to the urgency argument which I advanced initially. The establishment of the kind of education program which is visualized in S. 2439 must be regarded as a long leadtime item. It is an essential precursor to any increase in activities by the United States in sea-based markets.

Let me stress that I am wholly in favor of the bill. The administrative details, although important, should not be allowed to jeopardize its early passage. For my own part, I am more concerned that the philosophy of what is required be established, and that we immediately go about the business of providing this long leadtime item.

Senator PELL. Thank you, Dr. Potter. I appreciate your testimony very much. It was sharp and clear.

So that we might have a better idea, what is the interest of General Motors in the sea? I think this would personalize your testimony even more.

Dr. POTTER. I head the sea operations department of our defense research laboratories. Our major activity at Santa Barbara is related to the various Navy programs in undersea instrumentation, acoustic instrumentation, and antisubmarine warfare.

In addition we have interests which are somewhat more broadly based.

Senator PELL. Thank you. I share some of your doubts about the NSF as the administering agency.

What is your reaction to the Smithsonian Institution, or do you have any other suggestions as to an administering agency?

Dr. POTTER. I think from what I have heard—and the idea of the Smithsonian was new to me until I read the testimony this morning—the Smithsonian would have the same three drawbacks that the National Science Foundation would have. I believe that the staff of the Science Foundation if given this responsibility certainly would do their best to discharge it. I feel that the Science Foundation might be a good interim solution. I agree with the other comments that have been heard this morning. I would regard it as an interim solution and that at some point the administration be put in an activity devoted to the ocean.

I think in the end we would all like to see something like the Department of the Ocean in the Federal Government.

Senator PELL. I would agree with you in your thought here because if we put a little program like this into the maw of the NSF, it could get a little lost. So perhaps another way of getting around this is the idea of an advisory group or, as the minority suggested, a group that might report to the Congress once a year, that would keep the personality and the individual purpose of this program separate from the general purpose of the NSF.

Dr. POTTER. I think the major concern that I would have is the necessity for creating a new program or creating within the institutions services that don't now exist. The Science Foundation largely depends upon the fact that the science which they are funding does exist within the institutions. Thus, NSF can accept a passive role.

The sea grant college administration has to pursue an active role to create the program.

Senator PELL. Do you have any thoughts with regard to the matching formula?

Dr. POTTER. Only to echo Dean Spilhaus, that some matching in kind is required to show good faith on the part of the participating institutions. All the arguments that he presented for not having a set dollar formula I think are valid.

Senator PELL. Thank you very much, Dr. Potter. You also had a long trip to come here and I thank you very much indeed. Your testimony was very sharp and very good.

Now our next witness is Dr. Robert A. Ragotzkie of the Department of Meteorology of the University of Wisconsin. And he is coming here at the suggestion of Senator Nelson from Wisconsin who regrets that he, too, could not be with us here this morning and wishes to greet you, and I greet you in his name.

Dr. Ragotzkie, will you proceed as you will.

STATEMENT OF DR. ROBERT A. RAGOTZKIE, DEPARTMENT OF METEOROLOGY, UNIVERSITY OF WISCONSIN, MADISON, WIS.

Dr. RAGOTZKIE. Thank you very much, Senator Pell. I am very honored to be invited to these hearings.

I have submitted a copy of my statement and I will summarize that statement now.

The University of Wisconsin is strongly in favor of the sea grant college program. I speak for the administration of the University of Wisconsin in supporting this bill. We endorse Dean Spilhaus' imaginative idea to advance the frontiers of marine science and to translate the new knowledge into useful information for practical application in the use and preservation of marine resources. We went on record to this effect over a year ago in the March 19, 1965, issue of the AAAS journal, Science. At the Newport conference in October 1965 the concept and many of its aspects were thoroughly discussed by representatives of government, universities, and industry. There is no need to repeat what was so forcefully said at that conference by Dean Spilhaus, Senator Pell, Dr. Carlson of NSF, and others.

Therefore, I have selected three points which I believe need further emphasis.

These are: First, the role of basic research and education; second, the role of the Great Lakes; and third, I would like to mention a few points about the marine sciences program at the University of Wisconsin.

Role of basic research and education: The development of the sea grant colleges as centers of excellence for the study of the oceans and the Great Lakes must be founded on sound educational and basic research programs. Clearly the successful translation of new knowledge into useful information for practical application depends ultimately on a dependable supply of new knowledge. The success of the land grant college program is ample proof of this.

A broadly based education program is also absolutely essential for maintaining effective communication between scientists and the public. This educational program should not be limited to full-time students, but should also provide expanded opportunities for professional and industrial people to learn new skills or revitalize their present skills.

There is a need to increase the numbers of marine scientists at all levels. As pointed out in the American Society of Limnology and Oceanography report on "Education and Recruitment of Oceanographers in the United States":

Recruits have been drawn from two sources:

1. Men trained in the basic sciences and other subjects related to marine sciences; and

2. The graduates of university departments of oceanography.

The report goes on to point out that the first source has provided most of the staff of the Woods Hole Oceanographic Institution and several Government agencies engaged in oceanographic research. The large graduate schools of the midwestern universities have contributed a large share of these. Many Ph. D.'s from the University of Wisconsin in the last few years have gone directly into the marine sciences in both Government agencies and universities.

In order to accomplish the aims of the sea grant college concept there must be an effective working relationship between the natural and social science and engineering groups. This is especially true when water resources are involved. Such a problem as the deterioration of water quality in the Great Lakes or any other multiple use always requires the cooperation of specialists from many fields for its solution. At the University of Wisconsin we have a long tradition of interdisciplinary work on natural waters. As an example, one of our major efforts has been directed toward the problem of artificial eutrophication (overfertilization) of natural waters. Bacteriologists, biochemists, botanists, chemists, geologists, meteorologists, and zoologists have worked together for nearly two decades on this problem to understand the process of natural and artificial eutrophication and its fundamental causes. Our engineers have developed water weed harvesting machines and our sanitary engineers and water chemists have identified and evaluated the sources of nutrients and are developing schemes to eliminate these. Over the years more than 14 university departments have been actively involved in this program alone. Because of this the National Academy of Sciences has selected the University of Wisconsin as the site for an international symposium on eutrophication to be held in July 1967.

Lakes of Wisconsin have served and will continue to serve as sites for conducting experimental oceanography. One can identify problems and develop hypotheses at sea, but it is only in the smaller lakes that one can conduct experiments to test them.

The economic, social, and political aspects of major water problems are becoming increasingly critical. In the oceans and the Great Lakes the development of management techniques and plans for multiple use of water resources is already seriously lagging because of non-scientific problems. In the water resources center at our university we are making a special effort to bring the talents of economists, rural and urban planners and lawyers, as well as sanitary engineers and natural scientists to bear on water problems. This subject should receive special emphasis in a sea grant college.

Sea grant colleges will be expected to assume leadership in developing and applying new techniques for the study of the marine environment. Conventional research ships with improved equipment will continue to be needed in increasing numbers. However, modern techniques of remote sensing from aircraft or satellites have exciting potential for augmenting the ship recorded data and for rapid survey of inaccessible regions such as Hudson Bay or the Antarctic Ocean. These techniques are especially useful for measuring heat exchange and evaporation from the sea surface. These processes are the primary energy sources for our weather.

Automatic buoy systems can also obtain on a continuous basis oceanographic data which can then be transmitted by radio to overflying aircraft or satellites and then relayed to shore stations. These systems, remote sensing and automatic buoys, are already within the state of the art. However, they have not yet been applied to anywhere near their full potential. Furthermore, they will attain their maximum power and usefulness only when they have been married into a single unified system of buoys, ships, and overflying vehicles. To accomplish this combination of subsystems would be a major challenge for the sea grant colleges—one which would require all the talents of several first-class, broadly based universities.

The Great Lakes: The Great Lakes of North America have been called the largest single resource of fresh surface water in the world. Despite their misuse by man their water is still of high quality; no desalting is necessary. They support a fishery which could be further improved by careful management. They are important for commerce and with the opening of the St. Lawrence Seaway they provide a cheap marine highway from the center of our country to anywhere in the world. Valuable mineral resources in their bottoms no doubt exist but have been largely ignored. The Great Lakes represent a recreational asset which has almost certainly been underestimated up to now, but with the high rate of growth in the size and mobility of our population, this asset will surely be tapped heavily in the future.

Yet despite their immense value to man, less is known about some of the Great Lakes, especially Lakes Superior and Huron, than about many areas of the ocean, and Lakes Michigan, Erie, and Ontario are becoming polluted at a frightening rate even before the natural processes in them are understood.

In addition to being well worth studying and developing as a major resource, these inland seas are excellent models of oceanographic and

meteorological processes. Many air-sea interactions can be better studied here than in the sea. Their circulations vary from short-term, wind-driven motions to longer term quasi-permanent circulations; free and inertial oscillations, both surface and internal, and much more easily studied than in the oceans. Since most oceanographic processes occur in these lakes, they represent an ideal training ground for students.

Sea grant colleges in the Midwest could take full advantage of the Great Lakes and could play a major role in the management and preservation of these unique bodies of water. It may be instructive at this point to mention the major research and training institution recently established on Lake Baikal in the Soviet Union. This impressive institution was described in detail last August by Russian scientists at the International Limnology Congress in Warsaw, Poland. This international congress also gave major emphasis to the Great Lakes of the world when it met at the University of Wisconsin in 1963.

Marine sciences at the University of Wisconsin: The marine sciences program of the University of Wisconsin is characterized by numerous separate research projects in various departments such as geology, meteorology, civil engineering, and zoology. These research activities range from the study of the world ocean and the Great Lakes to experiments using smaller lakes as laboratory models of oceanic processes. We have recently established a Ph. D. program in oceanography. We have also set up a center for Great Lakes studies at Milwaukee.

With modern transportation, scientists anywhere in the United States are only hours away from the sea. Hudson Bay is less than 700 miles from the campus of the University of Wisconsin. It is readily accessible by modern research aircraft, and I might mention that we are already taking advantage of its relative proximity to make infrared surveys of its surface temperature. Hurricane research is another of our activities in which we are directly concerned with the sea. Wisconsin scientists have also been active in ship and airborne studies of the Arctic Ocean. Our geophysicists are cooperating in the Mohole project near Hawaii. Marine biologists at the University of Wisconsin now collaborate with marine laboratories at Duke University, the University of Hawaii, the University of Washington, the University of British Columbia, and the Fisheries Research Board of Canada. From these examples it is clear that geography presents few problems to the modern oceanographer.

When viewed as a whole we believe these research and educational activities represent a "critical mass" which could serve as a nucleus for an even broader based marine science program as envisioned by the Sea Grant College and Program Act.

In conclusion I wish to repeat I speak for the University of Wisconsin as a whole in endorsing this bill and recommend that it receive favorable consideration from your committee.

Senator PELL. Thank you very much indeed, Dr. Ragotzkie.

One question here in connection with this matching funds provision. I have been informed I was incorrect in saying the National Science Foundation never did have matching fund programs. It has a 50-50 matching facilities program. Also there is the development program that was matching requirements.

Do you think there should be matching provisions in this legislation or not? What would be your view?

Dr. RAGOTZKIE. I think the institutions should display a tangible commitment to a program in the marine sciences. By a tangible commitment, however, I think one should include intellectual resources in terms of professors who teach courses in marine sciences and who are paid by State funds. Also space, facilities, lands on the coasts, and this sort of thing should be considered a commitment. Furthermore, a statement by the administration of the institution that they are behind a program in the marine sciences should be considered tangible.

I agree fully with Dean Spilhaus' reasoning on the idea of matching dollars. It is sometimes difficult for the individual States, especially those in the center of our country, to defend dollar expenditures for research programs on regions of the world ocean that do not appear to offer any immediate benefits to the people of that State.

Senator PELL. It might be even more difficult for private institutions as opposed to State universities as well in this connection.

Dr. RAGOTZKIE. It certainly would.

Senator PELL. And I must add here that the term "sea grant college" could apply to a private institution. It does not necessarily mean a State institution, which is the meaning and effect in the land-grant college.

Dr. RAGOTZKIE. Yes, sir.

Senator PELL. Thank you very, very, very much indeed, and I am so glad you have come from the Great Lakes area because the action resultant from this bill will have fully as much effect and benefit, I believe, in your part of the country as on the salt water area. Thank you so much.

Dr. RAGOTZKIE. Thank you very much.

Senator PELL. I would like to direct a question if I could to the father of the bill, which I neglected to do before, Dean Spilhaus, and that is on the use of the term "oceanography," and the more I have studied this legislation as a layman, the more I have come to the conclusion that "oceanology" would perhaps be a better term. It is used in more countries abroad now, is being steadily used more, and covers a wider field of knowledge, and I think it comes easier to the tongue of the layman. What do you think?

STATEMENT OF DR. ATHELSTAN SPILHAUS, DEAN OF INSTITUTE OF TECHNOLOGY, UNIVERSITY OF MINNESOTA—Resumed

Dr. SPILHAUS. Well, these are two considerations in semantics which we are discussing now. Oceanography is difficult to pronounce. Oceanology seems to be easier and that is an important consideration to consider when we want to communicate with all people.

Senator PELL. Particularly in this program which is for the practical application.

Dr. SPILHAUS. Right. And certainly oceanography although, of course, the acceptance of the word is an important consideration and oceanography in English-speaking countries has become accepted, basically from the roots of the word it is not a very good word. Supposing we called our living science biography. It is a little confusing. We actually call it biology.

Senator PELL. There is a lot of difference. Biology can produce biography.

Dr. SPILHAUS. Biography really is a true good root for what we understand of biography, the writing up of life. So that in a way, from the root point of view, oceanology is a better word. But I would like to say this, that neither oceanology or oceanography are what we are talking about here nor are we talking about marine science. We are talking about ocean technology, ocean engineering, ocean techniques. We are talking about extracting the science from marine science, oceanology and oceanography, and putting it to work. So that I would prefer in the context of exploiting the seas to talk about ocean engineering or some such term that avoids the confusion with the basic science.

We now have biological engineering and biological engineering is going to be a very important thing in the future. We have biochemical engineering. So we have marine engineering in the new sense and ocean engineering.

Senator PELL. I very much like your analogy to the use of the words "biology" and "biography," and I was quite struck by it.

In this legislation I have somewhat ducked the issue by my bill mentioning neither, adopting the coward's approach, using the words "marine sciences," but I thought in rewriting the bill we might use the word "oceanology." Do you see any objection to that in the professional field?

Dr. SPILHAUS. I see no objection except that it does diminish our goal which is to the practical applications of oceanology. Marine science, too, implies the basic science, whereas our goal is the application of the scientist.

I think that you can duck the issue by saying oceanology and ocean engineering, or oceanology and ocean technology, or marine sciences and ocean engineering. Couple the two as indeed they must be coupled if we are to get anywhere.

Senator PELL. Thank you very much, and forgive me for asking you this question, but I wanted to get it on the record.

We are lucky enough to have with us another witness, Dr. George Rounsefell of the University of Alabama, and in behalf of the chairman of our committee, Senator Hill, who I know would welcome you here if he could, I am so glad you have come and I hope you will proceed as you will.

STATEMENT OF DR. GEORGE A. ROUNSEFELL, PROFESSOR OF MARINE BIOLOGY, UNIVERSITY OF ALABAMA

Dr. ROUNSEFELL. I am very glad to come and testify, Senator Pell.

Senator PELL. I notice you have a fairly lengthy statement. Would you like to read it or digest it or what would be your will?

Dr. ROUNSEFELL. Well, if it is your pleasure, Senator, there are portions of this that are a little long. If you would rather have me summarize it—

Senator PELL. Why don't we put it in the record in full and you might summarize those portions of it that you feel you should.

Dr. ROUNSEFELL. Very happy to.

I want to commend the dedication of yourself and your committee in backing this bill. However, the terms of reference are a little broad and there are some suggestions I would like to make to the committee for some changes that I personally feel are essential.

To begin with, I agree that we do need the extension services as well as the basic and applied research. The idea of having a sea grant university in every State in contact with the fishermen is sadly needed.

Over the last 30 years our fisheries have not advanced. Fisheries in other countries, such as Japan, have made tremendous strides, similar to what has happened in agriculture where they have had their land-grant-college system.

In Japan they have fishery education, research, and extension services at all levels and in all the prefectures. We need a similar type of thing, as you have indicated in this bill. However, the bill as now worded permits this money to be given to groups of individuals, industries, corporations, foundations, museums, and so forth, which somewhat belies the title of the bill, which is a sea grant college bill.

Also I would like to address the attention of the committee to the idea that at least a good part of these funds should be used for institutional support, rather than the project type of support, which I feel greatly weakens the university's participation. I feel that what we need is continuous support, even if it is at a low level, so that the universities can have a hard core of teachers, scientists, and extension service people working continuously.

It is very difficult to carry on any kind of continuous and worthwhile program on fluctuating funds. If a few of these small changes I have indicated could be made in this bill, I would be willing to vigorously support it. As it now stands, I am afraid I would have to oppose it, sir.

Senator PELL. You feel because it doesn't have enough of an emphasis on this practical relationship to the fisherman.

Dr. ROUNSEFELL. Well, no. I agree with the practical relationship to fishermen. I believe we have to have basic science, applied science, and extension all working together as a team.

Senator PELL. Good.

Dr. ROUNSEFELL. I do think that we have enough knowledge to start this exploration of the sea but we also have to continue a certain level of basic science or our information will dry up and in the long run we will suffer. I do believe in the extension service and I think we have got to do it, and it has to be done at the State level, the same as was done with the land-grant colleges. You see, I disagree with the idea that all these funds should be put in a few institutions who are now competent in certain types of oceanographic research, especially deep sea research, which is exceedingly expensive.

At a very small fraction of the cost you can do a fine piece of work in mariculture, in the estuaries. A quarter of all our fish landed comes from between Port Arthur, Tex., and Pensacola, Fla., yet there is no provision to help our fishermen in an area such as this. We are very much in favor of having this bill, sir. But we would hope that it would be so amended that a portion at least of these funds would be put into continuing support of a sea grant college in every State. And I would not oppose having them in inland States because inland States can share seacoast facilities with a seacoast State.

Senator PELL. To draw on your reasoning a little bit in this connection, the thought here is not just to confine it to the few States or institutions that presently have programs. It is to make the program or the concept available to any State that develops an interest in doing so.

For instance, if the State of Utah developed an interest in this kind of program and developed a program to do it, it could become a sea grant college, but I am sure you don't visualize the relatively small amount of the money being divided on a specific population basis or something of that sort among the States.

Dr. ROUNSEFELL. I think any State who wishes to have a sea grant college should be able to have it by the wording of the bill.

Senator PELL. But it is only, say, \$15 or \$10 million and you have got 50 States. That would mean, let us say for the sake of argument, of \$15 million, 50 States, you would see that would amount to maybe \$300,000 a State.

Dr. ROUNSEFELL. Well, \$300,000 on an estuarine program and to develop education and extension in a State would be a very fine start. I also feel that when this program starts you will find a great many other sources of local and State funds that will be funneled into the sea grant university. Thus we will receive enough money to develop a strong program.

I had experience while running laboratories, in trying to hire personnel, and we do not have the trained personnel today because there is not enough education in the marine sciences.

Senator PELL. You believe, then, that it should be available to any State that shows an interest and wants to develop such a program.

Dr. ROUNSEFELL. Yes, sir.

Senator PELL. But it should not just be divided up, as we suggested earlier, like appointments to Annapolis among the States.

Dr. ROUNSEFELL. Well, if a State doesn't want to go ahead with it, then they shouldn't get their share, but if they want to go ahead, they should be able to.

Senator PELL. You don't believe there should be a degree of competition between the States so that if the State of Utah comes up with a good program they could get it. If another State saw a need of just getting some added money, wasn't really interested in it, but saw it as a means of bolstering something they were already doing, they should in my mind not get it.

What would be your view?

Dr. ROUNSEFELL. Well, if a State is not interested in it, it shouldn't have it.

Senator PELL. But if Federal money is available, no matter if it is to teach Siamese or astrology, the States will probably go after it. There has to be a degree of competition to winnow down the degree of interest.

Dr. ROUNSEFELL. Well, I think that we have got to try to establish these programs in as many States as possible if we are going to compete in our fisheries. We are losing out in the race. We have failed in the last 30 years to do anything for our fisheries in spite of all the money spent for oceanography and for fisheries. I think our failure stems from not having proper education at the grassroots level.

Senator PELL. And your thought is, too, the money should be equally

available and used in Montana or Vermont as it would be by the estuarine States.

Dr. ROUNSEFELL. I feel that each sea grant college should develop its own program in the same manner as is done by the land-grant colleges. Some of them went into entomology, some livestock raising, some agricultural engineering. They had a diversified program. I think this was the strength of the program. I don't think they should all do the same thing.

For instance, in Alabama we have no desire at all to compete with deep-sea oceanographic institutions already established, but we do have a great need to work on our estimates.

Senator PELL. I wonder if your thoughts might be somewhat akin to the Arts and Humanities Foundation bill, of which I was the floor manager at the last Congress, where a certain minimum was given to each State provided they had a council and an interest, and then over and beyond that minimum, it was allocated by the Federal Government on the basis of excellence in competition that that particular State offered.

Dr. ROUNSEFELL. I agree, sir, there will have to be some kind of a compromise and I think this is—

Senator PELL. With a provision of that sort you would find the bill acceptable.

Dr. ROUNSEFELL. Yes, sir.

Senator PELL. Now, another question. I am not saying we can do that but I want to get your thinking. Another question here is that you think the Department of Interior should administer the act as opposed to the National Science Foundation. If it is understood, however, that it will be doing it basically on a temporary basis until the agency set up to handle oceanography in the Nation comes into being and helps make a decision on this, would that be equally acceptable to you?

Dr. ROUNSEFELL. I am not strong on this particular point. The Interior Department has desalination, fisheries, minerals, and submerged lands now. They have competent staffs in these fields and they might be able to give the program a little better start than an organization which has been in the granting-of-money business and not in the actual staffing business. Interior has the administrative setup right now.

Senator PELL. What would you think of the Smithsonian Institution as the original agency?

Dr. ROUNSEFELL. Well, I thought from the talk given yesterday that their interest was largely in classification of organisms rather than in administering a bill.

Senator PELL. I think that came out in the testimony of their own witness.

Those are the two main points. Were there any other specific points I failed to catch in the written testimony or what you say today?

Dr. ROUNSEFELL. No. I think this covers it very well.

Senator PELL. Those are the two points basically. If those two points were met, you would find yourself agreeable?

Dr. ROUNSEFELL. Yes, I would.

Senator PELL. As far as the Interior Department administering it, that would not seem to be in the cards, from the bulk of the testimony that has come in so far.

Dr. ROUNSEFELL. This was merely a suggestion, sir.

Senator PELL. Right. Thank you very much. Very kind of you to come here.

(The prepared statement of Dr. Rounsefell follows:)

PREPARED STATEMENT OF DR. GEORGE A. ROUNSEFELL, PROFESSOR OF MARINE BIOLOGY, UNIVERSITY OF ALABAMA

I commend the sincerity and dedication of Senator Claiborne Pell and the scientists who labored with him in drafting this bill (S. 2439). I also thank Senator Pell for his invitation to testify concerning it. The terms of reference in the first draft of this bill are broad. Senator Pell has indicated, however, that this bill perhaps should be modified before enactment. I agree on this point and should like to suggest to this committee some changes which I feel are essential.

Before explaining these needed changes I should like to state that I have been a research scientist, administrator, and educator in fisheries and biological oceanography for over 40 years. I have worked in California, Washington, Alaska, Massachusetts, Maine, Texas, and Alabama, and spent 1 year in Turkey for the Food and Agriculture Organization, besides serving a 4-year term in Washington, D.C. I am familiar with all of your great fisheries and the fishermen who make their living thereby. I have seen oceanology and the marine sciences grow from almost nothing to their present size. I have directed marine science programs and laboratories and appreciate their problems.

Prior to World War II, a number of marine laboratories were already in existence. Some were fostered and backed by universities, some were privately endowed, and several were run by the Bureau of Commercial Fisheries. All were oriented toward the study of living organisms; a few managed to scrape together enough money to buy an old vessel and make excursions from the shore to study the chemistry, physics, and biology of the open sea.

With the advent of World War II, it was suddenly realized that the scientists at these marine laboratories could make important contributions to defense through knowledge of ocean currents, wave heights, and the vagaries of underwater sound. A few of these laboratories were recipients of large defense grants and contracts and so quickly outstripped the other laboratories in physical facilities.

After the war terminated, these laboratories continued to receive generous defense funds. In addition, they and a few more laboratories obtained considerable large-scale support from the National Science Foundation. But existing sources of funds are well-nigh exhausted, or fully obligated.

Dr. Harve Carlson of the National Science Foundation recently stated " * * * the national oceanographic program, encompassing the activities of 22 Federal agencies, has been virtually level-funded for the past 4 years. This implies that if a new project is to be started, somewhere an old project must be curtailed or discontinued * * *". Many institutions are now financially undernourished."

In view of the vast sums already spent on physical oceanography, and the much smaller sums spent specifically on fisheries over the years, the results are pitiful. U.S. fishery production has remained static for the past 30 years; we have slipped from second to a poor fifth place; we import more fishery products than we produce. At the same time, our agricultural production has been advancing in giant strides. Why has our agriculture been so successful while our fishery production has been failing?

I believe the answer lies chiefly in the difference between the manner of financing and operation of marine education and research as contrasted to that in agricultural education and research as carried out by our great land-grant college system. Land-grant programs are devised and administered at the State level, largely unfettered by bureaucracy. A large part of the support has been institutional, thus permitting the development of a core group of faculty with continuous and dependable financing. Marine education and research needs this same type of funding.

The President of the United States last September mentioned the concentration of Federal research and instructional funds in " * * * too few institutions in too few areas of the country" and the need for providing support " * * * under terms which give the university and the investigator wider scope for inquiry, as contrasted with highly specific, narrowly defined projects." Unless amended, S. 2439 will increase the problem which the President has cited, to the detriment of both marine science and our universities.

One other point needs clarification. Throughout most of the discussions on S. 2439 the term "oceanography" has been used without real definition. Oceanography is not a science anymore than you can speak of "land science"; it is merely the application of many basic sciences to problems of the sea. Therefore, you need to know what this bill is intended to finance.

The land-grant colleges did not set out to solve all terrestrial problems. They were mission-oriented to perform specific functions—undergraduate training for future farmers, graduate training for research and teaching, basic and applied research applicable to food production, and extension services at a local level to assure maximum use of research findings. They certainly were not chartered to engage in developing materials and techniques for defense. Some such structure of purpose needs to be given the sea grant colleges.

There has been much discussion of the inadequacy of available funds for the purposes of S. 2439; several have suggested limiting the number of sea grant colleges to those who have already shown competence. What is meant by "competence" is hard to define except in terms of costly research vessels for deep sea work. Whether possession of such a vessel always means competence is open to serious question.

One of the top participants in the symposium on sea grant colleges held in Rhode Island last October and a member of the National Committee for Sea Grant Colleges, in discussing S. 2439, named only seven universities he thought should be sea grant colleges. At least one of these commenced oceanographic work after 1960. Five are in the Pacific, only two are on the Atlantic coast, and none was on the Gulf of Mexico or the Great Lakes. This would mean a sea grant college in all 5 States bordering on the Pacific with only 2 left for the remaining 25 maritime States: What if the land-grant colleges had been so poorly distributed?

Dr. Paul Eye, director of perhaps the world's largest oceanographic laboratory at Woods Hole, Mass., stated at the October symposium, "* * * we're not very far from the time when we need to have a form of marine science and ocean engineering in every decent university." I agree entirely; and S. 2439 should be designed to accomplish this result.

Funds considered inadequate, on the one hand, to embark on a deep sea venture requiring a research vessel and a large corps of scientists to analyze the data gathered may be sufficient, on the other hand, to carry on a very ambitious and equally or even more important program of mariculture, for example. Because one form of research is much more expensive does not guarantee that it is either better, or likely to produce more lasting results. I favor allowing latitude to each sea grant university to develop its own marine program, unhampered by the necessity of conforming. This diversity of program has been the most clearly identifiable source of success for our land grant universities, and for American education in general.

It seems clear from the discussions held at the October 1965 meeting in Rhode Island that many of the participants believe we already have enough basic knowledge to enable us to decrease emphasis on basic research and plunge headlong into marine engineering for the conquest and occupation of the sea. It was even stated that management of shallow coastal resources was easy, and that we should move on at once to the more challenging problems of the deeper waters. These parochial views remind me of the early workers in limnology who worked chiefly on the larger lakes where stable conditions were easier to understand than those in the smaller, but vastly more productive, shoal waters, ponds, and streams. After years of poorly financed work we do not have sufficient knowledge to manage intelligently even our common estuarine species. Yet, the basic research needed could be accomplished at a fraction of the cost of deep sea engineering.

In the foregoing context I should now like to address my remarks to certain provisions of the bill before you. This bill would authorize the making of grants to, or contracts with, not only universities, but also public or private agencies, museums, foundations, industries, laboratories, corporations, organizations, or groups of individuals. In short, the funds could be given to anyone at the pleasure of the Federal administrators of the program.

I cannot in good conscience support such a provision. The strength of the land grant colleges lies in the fact that they provide research, teaching, and service. To grant funds to industrial and nonuniversity groups merely to accomplish a particular piece of research defeats the avowed purpose of the bill. I should like to see this section 3(a) (10) revised to read "Programs to carry out

the purposes of section 3(a) (10) shall be accomplished through grants to 1 fully accredited university in each of the 30 States that border the sea or the Great Lakes. Such university shall be one that is accredited to grant doctorate degrees in the natural and physical sciences."

I should not mind if the wording were such as to permit a sea grant university to be established in any or all of the 20 inland States as well. Many of them have faculty interested in the sea, and each one could arrange to share costs of maintaining any needed seacoast facilities with one of the coastal sea grant universities.

My reasoning is simple. The total funds available under this bill as now worded have been variously estimated as between \$10 and \$17 million per year, with the later figure probably the closer estimate. It is well known and understood that this sum is only a small fraction of the amounts already being spent on oceanography—in fact, less than the annual budgets of only two or three of the existing oceanographic laboratories. Instead, then, of using this money as a supplement to existing projects, or for funding other organizations (as the bill provides), it needs to be used to broaden the base of our competence by providing funds in every maritime State to strengthen academic teaching and research.

The few institutions that have achieved, largely through public funds, the most competence or physical facilities in some field of oceanography seem to feel they alone should participate in the sea grant college program. This is because they are well aware of the great expense of maintaining and operating ocean research vessels. This, however, is a very narrow and selfish view of the problem. There are many phases of marine science, possibly less glamorous, but equally or even more rewarding, that do not require this tremendous outlay in expensive hardware.

Every sea grant college should be free to develop its own program, just as the land grant colleges diversified their attack. The result will not and should not be unhealthy competition, but an urgently needed opportunity to awaken and maintain a widespread attack on all phases of marine science.

I also question the naming of the National Science Foundation to administer the act. The land grant colleges work through the Department of Agriculture. The sea grant college program should be administered through the Department of the Interior, which has jurisdiction regarding submerged lands, minerals, desalination, and fisheries. The National Science Foundation was set up to encourage basic research; it was not set up to administer programs of applied science, teaching, or training. The latter are the most important in development of marine science.

Earlier I mentioned the fact that our fisheries are lagging far behind those of other countries. This failure is continuing despite the enormous sums that have been spent on oceanography. We need not only the diversified approach that can be provided by a number of sea grant colleges, but also the means of translating discoveries in basic and applied research into action programs at the State level. Such work cannot be achieved by a few super universities but must come from local sources working closely with fishery operators.

In the impending year 2000, only 34 years hence, our present population may be doubled. We may or may not need to know more about the Mohole, but we still shall want to eat, and food will likely be a scarce and expensive commodity. If we are to farm our coastal waters and control our pollution, we shall have to start now to accumulate the necessary knowledge.

It was stated at the Newport, R.I., symposium that "At the outset it would seem best to utilize the resources of institutions which have already established a reputation of leadership in oceanography * * *." This concept entirely ignores the proportionately much greater need for support of the smaller marine laboratories already in existence in most coastal States, including Alabama. The funneling of so-called sea grant college funds into a few oceanographic laboratories would result in furthering the existing sad imbalance that is losing us our share of the world's fishery harvest. By our failing to provide sufficient funds at the State level for research, education, and service, our marine sciences program has been marking time.

This bill, S. 2439, could be the vehicle for rejuvenating our failing fisheries and developing new sources of marine wealth. Senator Pell should be congratulated for his foresight in introducing it. With suitable modification, such as I have suggested, the bill should be supported vigorously. As it now stands, the bill should be opposed.

Senator PELL. At this time I would like to pay particular tribute to my own intellectual godfather, Dean Knauss, of the University of Rhode Island, who presented his testimony at Rhode Island 2 days ago, and is down here with Mr. Leslie of the university.

Are there any additional points, Dean Knauss, that you think, having heard testimony here, that you would like to offer or supplement your views given in Kingston?

Dr. KNAUSS. No, sir. Not at this time.

Senator PELL. Thank you. I would be most remiss, incidentally, if I did not pay complete tribute to all the help that Dean Knauss has been to me. When I started out on this, very much interested in the field but very ignorant, he guided and helped me a great deal, and it is our own university that has taken up a leading role in this and has also helped inspire an interest in me.

We also have, from the University of Maryland, Dr. Eugene Cronin, whom I understood had a word he wanted to say and will submit a written statement at a later date.

STATEMENT OF DR. L. EUGENE CRONIN, DIRECTOR, CHESAPEAKE BIOLOGICAL LABORATORY, UNIVERSITY OF MARYLAND

Dr. CRONIN. Thank you, Senator Pell. I will make this brief and confine it to several specific points.

I am the director of the university's Chesapeake biological laboratory and of its natural resources institute, and I had the advantage of spending about 15 months in Europe visiting marine laboratories prior to last September. Most of my attention was directed toward marine biology, although I had some opportunity to see activities in other fields.

I did not have an opportunity to visit Russian activities, although I talked with a number of people who did.

I feel a very strong sense of urgency in our competitive position in many of the fields that you have touched on in this bill. I think that the Russians are providing a degree of application, of dedication, of expenditure in marine science that may produce changes, perhaps unexpected changes, as important as they have in other fields in science.

At the moment I would like to comment on two specific aspects of the bill. One is the relation of the proposal to present State activities.

In 1964 I conducted a survey of the oceanographic work being done by States. I have a summary of that information and it shows that at least 25 of the States at that time were directly engaged and investing in oceanographic work. In at least 20 of those States a university or college was designated by the State and was conducting a program in oceanography. I have the details of the activities at this time.

Very briefly, the States were spending about \$7.5 million on oceanographic—

Senator PELL. Excuse me. If you are going to submit a statement at a later date, why don't you merely summarize it now.

Dr. CRONIN. Fine. The States were spending \$7.5 million in research in oceanography. They had about \$20 million worth of facilities and they had a staff of 831 people in related fields. There is a substantial development—not all of it, of course—at universities.

I would like to suggest, Senator, that the bill be considered with two different emphases. One like the present emphasis and one somewhat different.

I would like to suggest that pattern of matching grants to non-Federal contributions to colleges and universities in marine sciences, matching the contribution that is now made in education, in research and in extension and application of science. On the matching end, the non-Federal end, I would like to see included their facilities, their staff and their operating expenses. This draws on the great strength of local participation, supplements it in the national interest, the investment, and would provide a tremendous stimulus for growth at many centers throughout the United States.

Along with this there must be a mechanism of screening for competence. This support should not encourage the development of mediocrity.

As a separate portion of the program I would strongly endorse the concept that seems to be in the present bill, that is, institutional grants to selected colleges and universities which are now outstanding or show promise of distinguished contribution in the development and application of marine science. I would remind you, sir, that the University of Rhode Island not very long ago was not a major contributor to this field. It had a young, relatively modest program, like many others. The spark was struck, tremendous energy went into the system and it has grown to its present degree of promise.

Senator PELL. I would insert here your great tribute to its president, Dr. Horn, and its dean, John Knauss.

Dr. CRONIN. It must always be possible to detect there institutions that show promise for the future and not simply reward those which have already accomplished something in the field. Thank you.

Senator PELL. Thank you indeed. We look forward to your testimony in the future. As would be expected amongst free thinking professors and Americans, there is a considerable diversity of opinion. I notice your views differ about 180 degrees from the previous witness from Alabama. We will do our best to try and bring these various views together and I hope that everybody will give a little in the final support of the bill.

(The prepared statement of Dr. Cronin, subsequently supplied, follows:)

PREPARED STATEMENT OF DR. L. EUGENE CRONIN, DIRECTOR, CHESAPEAKE BIOLOGICAL LABORATORY AND NATURAL RESOURCES INSTITUTE, UNIVERSITY OF MARYLAND

The Sea Grant College and Program Act offers a vigorous and effective approach to problems of national importance. Maryland is reported to be the oldest of the land-grant colleges, and I appreciate this opportunity to enter into the discussion of the potentials of this new concept.

Recently I spent 15 months in Europe for the Office of Naval Research visiting marine laboratories throughout most of the Continent. I did not visit those behind the Iron Curtain except for Yugoslavia, but I had an opportunity to discuss development in the U.S.S.R. with a number of individuals and to review the reports of the members of the exchange committee on oceanography who visited Russia in 1964. I feel a deep and growing concern that the high intensity of Russian application of marine science may surpass us in fisheries and in many other fields of marine application to a point of permanent and irretrievable damage to our economy and our political stature. In fisheries, the Russians may have already mounted an "oceanographic sputnik" in their massive research program throughout the world and their great fleets of trawlers and associated

factory ships and support vessels. For our own internal reasons and for these external reasons, the urgency for effective progress toward achievement of the ideas of Dean Spilhaus and Senator Pell is very great indeed.

Maryland's principal potential within the general field of the bill lies in aquaculture. The Chesapeake Bay has been extremely rich in the past and still contains the potential for very high productivity, but its present yield is far below those potentials. In these inshore waters, there are some of the best opportunities in the world for careful culture of fish and especially of invertebrate animals to achieve high quality, excellent volume, and economic efficiency. In these areas, there is no serious problem of ownership of the yield because the State is the owner of the aquatic area and of its resources and can assign clear title to individuals for efficient exploitation.

Maryland already has an active program in this field, with a marine biological laboratory which is the oldest on the east coast and has been active since 1932. It is conducting extensive research programs in marine fisheries and added studies in basic productivity, estuarine geology, economics of marketing and related fields. In addition, the university has a seafood processing laboratory engaged in developing improved techniques for the handling and distribution of fishery products. At the present time, we are just initiating a new program of research on the resources of the estuaries of the Atlantic coast, to seek new uses for the animals and plants which are now caught and to explore the potentials of entirely new commercial uses for other resources of the region.

It is most pertinent in the review of this bill to recognize that all of the coastal States are already making substantial investment in oceanography and in the application of science to the uses of the sea. These approaches are naturally concentrated on the inshore environment and on fisheries, but these, after all, offer the greatest promise of immediate and visible achievement in improved utilization of the sea.

In 1964, I canvassed all of the States that conduct programs in oceanography and prepared a paper titled "State Programs in Oceanography, 1964." This was a survey of the non-Federal activities operated at that time by 25 coastal States. All of them have substantial and continuing programs in oceanography and it is especially pertinent to note that at least 20 of them involve a college or university in these oceanographic efforts. Complete details are available for anyone with more specific interests, but the summary figures may serve the purposes of this hearing. In 1964, the States were investing about \$7.5 million a year in oceanography. Of this investment, about \$5.6 million was in research, \$1 million in teaching, \$0.4 million in data processing, and \$0.5 million in other activities. The States possessed \$20.3 million worth of capital facilities for oceanographic work, including \$15.3 million in buildings, \$4.1 million in boats, and \$0.9 million in other special facilities.

Eight hundred and thirty-one people were employed by the States in these programs, including 463 trained professionals. Of these trained individuals, 148 held a doctor's degree and 87 held a master of science or its equivalent.

The States were publishing at that time about 368 publications or reports a year on related subjects and they had published nearly 4,000 papers on oceanography.

This strength of activity which already exists suggests a possible pattern for application of Federal funds to achieve rapid and effective improvement in the application of science to marine production. I would like to suggest that the National Sea Grant College and Program Act be amended to provide a dual program of support for college and university work in oceanography.

1. The first portion of the program would provide matching funds for non-Federal investment at colleges and universities in marine sciences. In my opinion, these should include education, research, advisory services, and development. The non-Federal contribution might be in the forms of facilities, staff and operating expenses. I believe that the great and fundamental advantage of local participation would best be gained by a 50-50 matching basis for this program.

It is of utmost importance that a mechanism be created to screen this program for competence. It should never be an open and unrestricted access to large sums of money without demonstration of quality or a potential for achievement of good quality.

2. The second portion of the bill would create a program of long-term institutional grants to selected colleges and universities which are now making distinguished contributions or show promise of making unusual contributions to the effective development and application of marine sciences. This should

permit establishment and development of a limited number of centers of excellence. It should also be open ended and permit new institutions which emerge with fresh ideas, vigor, and reasonable promise of achievement to join those centers. This program should be under constant review so that support can be withdrawn when institutions lose their competence and so that funds can be provided for the centers which will develop in the future but are not yet visible.

Support should, however, be provided for sufficient period to allow stability. I would recommend that at least 5-year commitments be entered into and 10 years would be far stronger. In my opinion, this should not be dependent upon non-Federal participation, although I feel that such participation adds greater strength indeed. It should certainly be encouraged but its absence should not preclude support to an appropriate institution.

Thank you again for the opportunity to comment on this imaginative program. I am deeply convinced that a carefully designed pattern of sea grants to colleges can increase American achievement in utilization of the oceans.

Senator PELL. It is my great pleasure to read into the record at this time a letter from another colleague, Senator Hiram Fong, of Hawaii, where he says:

DEAR MR. CHAIRMAN: In response to my request for comment on S. 2439, the proposed "National Sea Grant College and Program Act of 1965," President Thomas H. Hamilton, of the University of Hawaii, sent me a statement in support of the measure.

I am very pleased that the University of Hawaii wholeheartedly endorses the concept and objectives of the sea grant college proposal.

The university's endorsement of S. 2439 buttresses the arguments advanced in my statement filed separately with your subcommittee and urging speedy and favorable action on the measure.

I respectfully request that Dr. Hamilton's statement and this letter of transmittal be made a part of the hearing record on S. 2439.

With best regards and aloha, I am

Sincerely yours,

HIRAM L. FONG.

(The statement of Dr. Hamilton follows:)

PREPARED STATEMENT OF DR. THOMAS H. HAMILTON, PRESIDENT, UNIVERSITY OF HAWAII

I. INTRODUCTION

Though man has always been interested in the sea, this interest has become sharply intensified in more recent years. The sea is becoming increasingly important as a source of food and minerals. Improved knowledge about it is vital to national defense. As we expand our exploitation of the resources found in the ocean, we encounter a myriad of legal problems requiring study and research. And since 70 percent of the surface of the earth is water, the magnitude and importance of the great variety of scientific and legal problems to be solved is formidable indeed.

The importance of the sea has long been recognized by the Federal Government. Many of its agencies concern themselves with aspects of ocean environment. This is encouraging to scientists and others interested in these matters. However, for those in universities which emphasize instruction and research in oceanography and related disciplines, the scattering of governmental interest among many agencies is often discouraging. The problems to be investigated may cut across jurisdictional lines and, as a result, worthy research may not find adequate support.

Bill S. 2439 provides a much-needed focal point within the Federal Government by designating the National Science Foundation as such. And, by providing for the naming of certain universities as sea grant universities, enables them, in turn, to get the kind of Federal attention and support so necessary to the rapid and successful development of essential training, educational and research programs, and advisory services.

II. BENEFITS TO THE UNIVERSITY OF HAWAII

The University of Hawaii places much emphasis upon instruction and research in oceanography and the marine sciences.

The Department of Oceanography, created as a separate department just 2 years ago, has already assembled a fine staff and plans to enlarge it significantly. Professors in this department are conducting important research in both biological and physical oceanography.

Much of this research is being done in association with the Hawaii Institute of Geophysics and the Hawaii Institute of Marine Biology. The former provides physical facilities on campus and a research vessel berthed at Kewalo Basin. The latter operates a laboratory at Coconut Island—ideally situated for this purpose. A new laboratory building is in the final stages of construction there. Additional facilities will be available at Kewalo Basin upon completion of construction of a laboratory building there. It will be operated by the Pacific Biomedical Research Center for research on marine animals.

Work in ocean engineering has been given added impetus through the establishment of a program for the M.S. degree in that subject and the acquisition of the Look Oceanographic Engineer Laboratory, also located at Kewalo Basin.

Plans for the further development of the Kewalo Basin research complex include continued close cooperation with the Bureau of Commercial Fisheries. It already has an installation at Kewalo.

The university has requested land and pier facilities on Rainbow Island to provide ship handling and technical facilities for a greatly expanded program in physical oceanography. A sizable increase in activity is imminent since scientists at the University of Hawaii will soon be undertaking a vast oceanography survey of the Pacific Ocean.

There is no question that the University of Hawaii will be designated as a sea grant university, should S. 2439 be passed. This would make it eligible to receive funds to increase its research, training, and educational capability in oceanography and marine sciences. Improved and expanded facilities, a larger staff of scientists and support personnel can be anticipated. This would enhance the attractiveness of Hawaii as a base for oceanographic activity. Coupled with the great natural advantage of our marine setting, this would put the University of Hawaii among the world leaders in this field.

III. BENEFITS FOR THE STATE OF HAWAII

Should the University of Hawaii become a sea grant university, the State would derive direct immediate benefit in the form of increased Federal expenditures for research and training in Hawaii. This would result in more jobs directly connected with these programs. However, more important would be the development of a core of research and development personnel as oceanographic work in Hawaii is expanded. For example, instrument technicians, mathematicians, and computer scientists would be attracted to Hawaii. They would help to form the base so absolutely essential to the economic growth of the State. Their presence would make the State attractive as a research center. This would almost inevitably lead to an influx or local creation of businesses directly concerned with research and development in a variety of fields. Needless to say, such events would lead to an expansion of income and job opportunities in industries serving the research and development firms and their employees.

The research findings themselves and the training and education received under the sea grant program could prove to be even more important to the State than the effects noted above. Improved methods of fishing, the discovery of important sources of crucial industrial materials, for example, and the development of processes for getting them from the ocean might well lead to creation of entirely new industries in Hawaii. They could bring about a rate of economic growth far in excess of any imagined possible.

IV. BENEFITS FOR THE UNITED STATES

In addition to participating or sharing in the benefits directly assignable to the State and university, the United States would gain from the growth of its oceanographic research capability and from the acquisition of knowledge crucial to national defense. For example, research encouraged by Federal support through the sea grant program would no doubt add to the fund of information about the acoustical properties and other features of the Pacific Ocean. The more we know about these matters the more secure we can become.

With the population of the world growing at a truly alarming rate, and with relatively limited land areas suitable for producing essential nutrients, the sea remains as a potentially important source of food. Advances in techniques for exploiting even the known resources in the oceans of the world could eliminate the possibility of a worldwide food shortage. The importance to the Nation of obtaining the minerals in and under the sea requires no further emphasis here. Research on these matters is a national necessity. Thus, a rapidly accelerating increase in what we know about the sea and how to obtain what we need from it may be literally essential to the survival of man.

Senator PELL. It is very nice to have support from all over the United States because we have had quite a degree of geographic spread in the testimony offered here in the last couple of days and in Rhode Island on Monday.

Tomorrow is the final day of these hearings. The record will be kept open, as I said earlier, until May 12 for any additional or supplemental statements.

The hearing is now recessed until tomorrow morning in this room at 10 o'clock.

(Whereupon, at 11:55 a.m. the subcommittee recessed to reconvene at 10 a.m., Thursday, May 5, 1966.)

SEA GRANT COLLEGES

THURSDAY, MAY 5, 1966

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SEA GRANT COLLEGES
OF THE COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met, pursuant to notice, in room 4232, New Senate Office Building, at 10 a.m., Senator Claiborne Pell presiding.

Present: Senator Pell.

Also present: Fitzhugh Green, special assistant to Senator Pell; Stewart E. McClure, chief clerk; Roy H. Millenson, minority clerk.

Senator PELL. The fourth and final day of hearings on the sea grant college bill, the special subcommittee set up by Senator Hill, will resume today.

Our first witness is Dr. James Wakelin, Jr., president of the Scientific Engineering Institute of Waltham, Mass., and a gentleman with a great deal of experience in this field in and out of government. Dr. Wakelin.

STATEMENT OF DR. JAMES H. WAKELIN, JR., PRESIDENT, SCIENTIFIC ENGINEERING INSTITUTE OF WALTHAM, MASS.

Senator PELL. I see you have a nice short statement here which is always indeed a delight, and then we will exchange some ideas back and forth. Do you want to read your statement?

Mr. WAKELIN. Yes, sir. Thank you, Mr. Chairman.

My name is James H. Wakelin, Jr. I am president of the Scientific Engineering Institute of Waltham, Mass.

If I may, I would like to read just this one page, Mr. Chairman and expose myself to your questions or discussion.

Since the idea of a sea grant college was advanced by Dean Athelstan Spilhaus 2 years ago, there has been a ground swell of interest to find the proper method to implement this most important concept. S. 2439 clearly states the problem we face in our national oceanographic effort with regard to the training and education of scientists, engineers, and technicians in order that we can man our expanding program in the oceans and Great Lakes. The need for training in this field of many disciplines is critical to our ability to learn more about the oceans, to explore the Continental Shelf and the deep ocean and to make more economical use of the abundant resources of the world ocean. It is significant that S. 2439 provides as well for support of research in the marine sciences and scientific endeavors in technology, engineering, and resource conservation and recovery.

We have long needed a legislative foundation to focus our attention on and to give support for a program of education in the marine sciences and technology for these academic institutions who are prepared to assume this vital task. Such a program is as important to our national defense as it is to our requirements for the material use of the ocean resources for our own economy.

I am wholeheartedly in favor of the stated purposes of Senator Pell's bill entitled "National Sea Grant Colleges and Program Act of 1965." I support the proposed program for education, training, and research in the marine sciences, the advisory services described in the bill, and the method of funding through the National Science Foundation.

Thank you, sir.

Senator PELL. Thank you very much, Dr. Wakelin.

I appreciate very much your statement of support, particularly from a man with as much experience and as knowledgeable as you are in this field.

There are a couple of questions I was interested in your views on. One is the agency that you think might best administer this program.

The ideas advanced include the National Science Foundation, the Smithsonian Institution, the Department of the Interior, and I was wondering if you had any views on this.

Mr. WAKELIN. I think, Mr. Chairman, this comes closer to the stated purposes of the Foundation than to any other departmental or agency of the Government right now.

Senator PELL. Do you think it might get lost there with the emphasis on pure science, research, and once in the maw of the National Science Foundation, it might lose its personality, or do you feel we could preserve the personality of this program?

Mr. WAKELIN. I think this depends upon the leadership in the Foundation for this particular program. I think there is a danger that it might get lost in such a large effort as that of the Foundation.

Senator PELL. Excuse me. Can you hear in the back of the room? Thank you.

Mr. WAKELIN. We have had some training programs also through the Department of Health, Education, and Welfare under which this might possibly come. In my own feeling, I think that if we recast some of the purposes of the Foundation toward the support of training and scientific endeavors in the ocean science area, this program would go very well in the Foundation.

I can think of a few governmental agencies at present that would be proper homes for this kind of support, Mr. Chairman. Certainly the Smithsonian is one. Health, Education, and Welfare is another. The Foundation is another. And also various Departments such as Commerce and Interior. I think the Foundation right now is the best avenue that I can think of.

Senator PELL. As with all programs and all things in life, I gather what you are saying is that it can be no better than the man chosen to run it?

Mr. WAKELIN. That is correct, sir.

Senator PELL. And I wonder if one way, though, of keeping its personality might be to create a little public board to report to the Congress every year or every 2 years.

Mr. WAKELIN. Specific to this program.

Senator PELL. Specifically with regard to this program.

Mr. WAKELIN. Yes. I think this would be a very fine idea and through this mechanism one would have better guidance and a better feeling of responsibility for this particular area in the Foundation.

Senator PELL. This idea emerged in a luncheon some of us had with witnesses yesterday and this thought came up.

Another question is with regard to the cost of the program.

Do you have any idea as to what would seem the appropriate amount for a seed program of this type to get it started for the first and second year?

Mr. WAKELIN. I have looked over the material you sent me, Mr. Chairman and there are various opinions expressed in these documents, particularly in the symposium that was held in the University of Rhode Island on the sea grant college concept. I would say myself that if one were to use the moneys that are accumulated from the lease of offshore lands of the order of a percentage of \$175 million or \$200 million, that certainly a sum of the order of \$15 million to \$20 million, or 10 percent of that figure would be an excellent start for the program.

I would like to have a feeling, probably better than the one I have now, with respect to how many candidate universities throughout the land would be in line for such support. If there were of the order of one per State, it would be a program of the order of \$300,000 per university or per academic institution.

Senator PELL. This brings up another thought that also emerged from some discussions yesterday and that is to work out the balance between a little encouragement to each State and real support at centers of excellence. We adopted this approach in the Arts and Humanities legislation which was also reported out of this committee, and for which I also had the honor of being the chairman of the subcommittee. Our arrangement was that a portion of the funds would be allocated on an equal basis to all 50 States and the other portion would be allocated on the selective basis, on a merit grant basis.

And that would mean maybe \$5 million available for distribution among all of the individual States to get a little program going, and then the other \$10 million to be allocated to a small number of the universities who are doing more in the field.

Does that make sense to you?

Mr. WAKELIN. Yes.

I think also there was another idea that we have been discussing just now and that is the question of interest in the program shown by academic and research institutions by way of what they would offer as an inducement for further funding, such as the matching principle.

Senator PELL. Yes.

Mr. WAKELIN. I would hope, in answer to your first question, that broader support throughout the academic institutions by the Federal Government could be offered on an equal State basis as an incentive to building up departments of excellence in this field, but that also those institutions that are already in being, and that have a research and a technological base already working, would also have a chance to expand their efforts beyond that on a pro rata basis to each State.

But I would also think that in return to engender State interest and become, perhaps, more of a partner in the oceanographic program. in

the United States, in the States, that it might be well to consider also the question of matching funds on some kind of a percentage basis of national funding, Federal funding.

Senator PELL. This is what we are turning over in our minds.

Do you think this matching provision should be in the little bits of seed money that would go to each State, or on a merit grant basis to a few institutions, or to both?

What would be your view from your experience?

Mr. WAKELIN. I am wondering about—in answer to your question—if I can think a bit out loud, Mr. Chairman, I am wondering about those institutions who have at present no capability in this field and perhaps don't have an interest in it right now. What would they do with the money that would be given to them on a pro rata basis?

Senator PELL. They would not receive this money unless they had asked for it, met certain requirements, and showed an intent to develop an interest and a curriculum in oceanology, particularly in the practical aspects of it or marine engineering.

Mr. WAKELIN. I would think the question of matching funds, then, with regard to the two kinds of funding you proposed, would be better on a pro rata basis because I think that you want to engender interest in the universities and build up departments in the universities that are not now strong in this area. And I think on a matching fund basis this is an inducement to them to get into the field.

Now, if you consider matching funds in the special categories of already existing institutions, you are going to those institutions with particular jobs in mind which I think has less of a meaning in the matching principle than it does on a pro rata basis.

For example, if I were going to one institution that we could name in the New England area, I would go there for a particular purpose and I wouldn't want them to feel that I was going there with the idea that they had to match on a pro rata basis what I had given them for specific research or a specific training job.

Senator PELL. So, in your view, the emphasis of the matching provision should be on the money that is evenly divided amongst the States?

Mr. WAKELIN. I think so.

Senator PELL. Would you also want a matching provision in the centers of excellence approach or not?

Mr. WAKELIN. I wouldn't want this as a restriction for the kind of work I believe you would want to put at those institutions of current excellence.

Senator PELL. Right.

One final question, and this, again, concerns the practical aspects of the bill. The thought developed that we might call for the development of the equivalent of the county agricultural agents and call them Marine Extension Agents, and that colleges participating in this program take on a responsibility to have two or three practical horny-handed fellows who would be able to help in the same way that an agricultural agent, a county agent, would.

Does this make sense to you?

Mr. WAKELIN. Yes; it does.

Senator PELL. It did to us.

Mr. WAKELIN. You make provision for that, Mr. Chairman, I think in the bill that is already under consideration.

Senator PELL. That is right, but we thought we might spell it out a little more. The term we thought of using was Marine Extension Agent. Does that seem a good one to you?

Mr. WAKELIN. Yes, sir.

If I might return just to one point for about 30 seconds, with regard to the magnitude of the funding, one doesn't always know in the next 25 years what \$1 is going to buy, and can there be a provision—can you foresee a program growing from \$15 or \$20 million at the current value of the dollar in buying power, to \$45 or \$50 million at some other period in our growth, where \$15 or \$20 million would be an insignificant contribution at that time?

Senator PELL. All figures are completely relative and on the basis of the year or two for which they are provided.

I think if we look 10 years ahead, we are going to have to see how this bill works itself out, what, as you say, the dollar is worth. It may be a great deal more, a great deal less, and what the interest is in the Congress in it, because without an interest here, it would be more difficult to get it through. One just doesn't know how it will develop.

Mr. WAKELIN. I think a percentage of the return to the Federal Government of lease of offshore lands, at least solves part of this program even though you don't earmark that amount of money out of that particular fund.

Senator PELL. It is a fortuitous relationship there.

Mr. WAKELIN. Yes, sir.

Senator PELL. Thank you very much, Dr. Wakelin.

Mr. WAKELIN. Thank you, sir.

Senator PELL. Our next witness is Dr. Victor Basiuk, whom I welcome. At one point when I was taking naval correspondence courses and had pretty well run out of courses, I took one under his direction which I remember was one of the most complicated courses I ever took and successfully passed.

I welcome you here.

STATEMENT OF DR. VICTOR BASIUK, ASSOCIATE PROFESSOR OF POLITICAL SCIENCE, CASE INSTITUTE OF TECHNOLOGY, CLEVELAND, OHIO

Dr. BASIUK. My name is Victor Basiuk. I am an associate professor of political science in the graduate program on science, technology, and public policy, Case Institute of Technology, and a research associate, Institute of War and Peace Studies, Columbia University.

I am also a consultant on the Naval Long-Range Objectives Group, Office of the Chief of Naval Operations, Navy Department. The views expressed in this statement, however, are my own and do not necessarily represent those of the institutions with which I am affiliated.

As my positions indicate, I am a political scientist and not an oceanographer. However, within my field I have had a longstanding interest in the impact of science and technology on national and inter-

national power and in public policy as it relates to science and technology. At present, I am completing a book, entitled "Technological Change and the Balance of Power, 1870." Besides analyzing technological trends as they have affected the distribution of international power in the past, this study attempts to project these trends into the future, and to explore their implications for American policy, both national and international.

Marine sciences and technologies have occupied a prominent place in my professional interest in the impact of science and technology on modern societies. In the late 1950's, I spent 3 years on the faculty of the Naval War College, where, inevitably, the role of seapower—to use the term in a broad sense, which is not confined to its strictly military meaning—was a central consideration in my work. The research on my book and my consultanship to the Navy Department further sharpened my focus on the potential of marine sciences and technologies. In general, I believe that they present the most promising single frontier for the development of America's power and vitality in the future.

Before I address myself specifically to S. 2439, I would like to say a few words on why I consider the oceans and exploitation of their potential through marine sciences and technologies of great importance to this Nation. I hope this will clarify my views on the proposed legislation and will help to explain the amendments which I would like to suggest.

A convenient way of examining the promise of the oceans' potential is to place it in a historical perspective. When viewed in this light, there is nothing novel in the oceans providing a principal means to a nation's power and vitality. During most of the 19th century, Great Britain dominated world politics through seapower—and here again I am using this term in both its military and nonmilitary meaning. In that period, the ship was the only truly effective instrument of mobility. By capitalizing on the development of her navy and merchant marine, Great Britain achieved two things: Militarily, she was capable of projecting her armed forces to any point on the globe and of achieving a local victory before the landpower concerned was capable of mobilizing its own military might to repulse the enemy. Economically, the British possessed a decisive commercial advantage inasmuch as, in those days, the merchant marine was by far the most significant instrument of trade.

The most important single reason for the decline of Britain's predominant position in the world was the development of overland transportation, which deprived Great Britain of her special advantage in mobility. The principal technological instruments in this regard were the steam railroad and, later, the automobile. Armed with new mobility, land powers were now capable of mobilizing their resources and throwing them into the battle within weeks, if not days, and could thus repulse the limited sea-transported forces of Great Britain.

Even more significantly, overland transportation possessed a major economic advantage in developing resources located in hinterland areas hitherto inaccessible to effective exploitation. When a merchant ship sails between London and New York, she exchanges commodities between these two cities and contributes to their and their environs' economic growth. On the other hand, when a train moves between New

York and San Francisco, it not only contributes to the economic development of the two widely separated terminals, but it develops resources and contributes to economic growth of scores of localities along the way. In short, despite of its relative cheapness, sea transportation could not be as effective as overland transport in the development of economic centers, since most recognized natural resources were found on land, while the oceans served principally as transportation routes.

At present, we appear to be on a threshold of a major historical development which endows the oceans with new significance. Because of growing shortages of natural resources on land and because of developing marine sciences and technologies, the oceans are being changed from mere routes of transportation to increasingly significant sources of raw materials and foodstuffs.

Aside from resource benefits, scientific and technological mastery of the oceans carries promise for major advances in activities which will benefit national economies on land. For example, reliable weather forecasting—which involves a study of the interaction between the oceans and the atmosphere—would make advance planning possible and thus effect large savings and increased productivity in both industry and agriculture.

While an ascendancy of seapower comparable to that of Great Britain in the 19th century is no longer a realistic possibility, these developments do open new and vast opportunities to ocean-oriented nations. However, the requisite technologies have not yet been adequately developed and they will require a strong scientific and industrial foundation for their development. The United States possesses such a foundation to a degree unmatched by any other nation and she is also unusually favorably situated with respect to the oceans. By taking farsighted and timely measures with respect to the potential of the oceans, this Nation can assure that its strength and vitality, both national and international, are significantly enhanced for many generations to come.

It is precisely in this light that the value of Senator Pell's bill is to be considered. It addresses itself to a key problem within the area of exploiting the oceans' potential; viz, the education and training of manpower and the promotion of research and development. Without these, our ability to take advantage of the new opportunities will be seriously impaired.

There are two things, however, which, I feel, should receive an explicit recognition in the bill: (1) the need for training personnel and pursuing research in the social implications of marine science and technologies; (2) the necessity of considering the utilization of the potential of the oceans not only from the point of view of the American economy, but from a broader point of view which includes the needs of our foreign policy and defense. I shall elaborate on these points.

As I indicated previously, the present interest in the oceans' potential is, essentially, caused by a combination of two things: the emergence of new technologies which enable us to exploit the vast resources of the oceans, and the social needs, mainly for natural resources and foodstuffs, which induce mankind to look toward the oceans to solve its problems. Unlike the exploration of outer space, whose direct impact on societies has been so far relatively limited—and, on the economic level, it is likely to remain so—the exploitation of the potential of the

oceans will affect societies most directly and on a multiplicity of levels, beginning with the daily lives of average citizens, their food, standard of living, location and type of employment, and ending with such problems as territorial expansion of nations into the oceans, and atmospheric control as a means of international pressure. Social scientists—including students of domestic politics, sociologists, specialists in international relations, military strategists, and economists—will need training in potential implications of marine sciences and technologies. Extensive research will have to be conducted to determine, as precisely as possible, the present and future social needs, including economic, political, and military, and the extent to which marine science and technologies can meet these needs.

Similarly, oceanographers and related scientists will require broader training in social problems so that they can appreciate these problems better and direct their research toward those goals which are socially most meaningful.

The need for this kind of education and research should be specifically recognized in the bill. If we approach the problem of exploiting the potential of the oceans only from the point of view of scientific and technological capabilities and fail to subject them to a careful scrutiny and control from the point of view of social needs and implications, we are likely to open a Pandora's box of waste in resources and efforts, overlapping of institutions and programs, and potential international tension and conflict. A balanced approach which would carefully integrate technological capabilities and social considerations should provide us with a sense of direction and should enable us to control our future as a nation.

My second point—the necessity of considering the exploitation of the oceans' potential not only from the point of view of the American economy, but also from that of our foreign policy and defense—was, in part, discussed in my earlier remarks on the contribution of the oceans to national power and vitality. Here I want to elaborate on some aspects directly relevant to the legislation on hand.

By reaching out for resources from the oceans—and they lie preponderantly outside of the territory of the United States—we automatically move into the area where foreign policy and military considerations prevail. To avoid conflict among the three basic interests involved—the economic, foreign policy, and military—a keen appreciation of the areas of their interdependence and potential mutual support is necessary. Training of personnel and research for this purpose will be needed. Appropriate programs at selected sea grant colleges could and should fulfill this need.

There is one particularly weighty reason why the interests of the American economy with respect to the oceans cannot afford to be dissociated from those of foreign policy and defense. No doubt, there are distinct benefits which the exploitation of the potential of the oceans can provide to the U.S. economy now and in the near future, if proper technologies are developed. However, America's needs for raw materials and other resources from the oceans are by far not as great as those of some other countries, since the United States is reasonably well endowed with natural resources or has access to them. Resources from the oceans will have to meet the competition of alternative sources of supply and, in the case of the United States, that com-

petition will be stiff. For example, one of the most promising resources of the oceans is food, but the United States has a surplus of this commodity. However, we are at present committed to spending about \$3 billion in foreign aid annually, and oceanic R. & D., designed to meet the needs of the underdeveloped countries (particular for food), or of other countries deficient in certain resources, may significantly cut our foreign aid without decreasing its effectiveness. In the years to come, as our population grows and as the availability of competing land-based resources diminishes, we shall be able to utilize these technologies with full advantage to our own economy.

The potential utility of oceanology to our foreign policy is not limited to the problem of underdeveloped countries and foreign aid. Exploitation of the resources of the ocean opens broad opportunities in the area of international cooperation, with a considerable potential for political payoff. Let me emphasize at this point that I do not believe, as some people do, that the rapid growth of science and technology—which does not seem to recognize political frontiers—in itself provides an overpowering reason for worldwide international cooperation. We have seen too many instances of political and strategic considerations override what is frequently claimed to be scientific and technological imperatives for international cooperation. It seems futile to me to expect a millennium of international brotherhood in response to scientific and technological developments. On the other hand, we shall render a disservice to ourselves as a nation if we fail to recognize that, if political and other factors are favorable, scientific and technological cooperation can serve as an effective instrument of foreign policy in achieving a politically desirable degree of international solidarity or cohesiveness.

One example in this respect can be provided by the case of the Western nations bordering on the Atlantic Ocean. The idea of an Atlantic Community is not new; for economic, cultural, and political reasons it is gaining in the number of its adherents. The Western European nations are deficient in a number of natural resources—considerably more so than the United States—and an effective exploitation of the potential of the Atlantic and of its adjacent seas would present them with an attractive opportunity to remedy this deficiency. A cooperative program under American leadership may not only significantly speed up the exploitation of the oceans as an economic proposition, but may also provide just the right kind of cement to make the Atlantic Community a politically viable entity if we decide that this is a desirable goal of our foreign policy.

My next example of using oceanology as an instrument of foreign policy may appear somewhat farfetched, but, if we look far enough into the future, it may well prove to be realistic. I am referring to the possibility of cooperation with the Soviet Union in oceanographic programs. To be sure, at present we are competing with the U.S.S.R. in oceanography as well as in other areas, and our rivalry is likely to continue for some time. However, as the Sino-Soviet rift progresses and the pressure of the rising Red China increases, the Soviet Union may well desire a closer relationship with the United States. While, for ideological and other reasons, an early political cooperation may not be acceptable to the Soviet Union, a joint participation in certain kinds of oceanographic undertakings may prove to be feasible as a

first step—probably more acceptable than a cooperation in outer space, since the latter is more sensitive militarily and provides narrower opportunities for human contact.

On our part, we may be favorably inclined to such cooperation for the same reason as the Soviets, i.e., as a potential counterbalance against Communist China. Also, if properly designed, our cooperation with the U.S.S.R. in oceanography may serve as an additional instrument of what George Kennan called the mellowing of the Soviet society.

In the examples which I suggested, political goals and political pay-offs would play a significant role, and if this is recognized by our policymaking institutions and supported proportionately to the programs' political value, then many of the economic constraints in the development of oceanology will be removed considerably sooner than would be the case otherwise. Similarly, our civilian oceanic R. & D. can proceed much further and much faster if the interests of the U.S. Navy are considered and naval cooperation is obtained. The mining of the ocean bottom can provide our submarines with stations and sources of supply. Nonmilitary presence in the oceans can provide the Navy with navigational assistance, information, and can deny footholds to a potential enemy.

In sum, an effective and rapid exploitation of the potential of the oceans can be brought about if we view the problem not only from the point of view of the domestic needs of our economy at this time, but if we integrate the present and future needs of our economy with the needs of our foreign policy and defense. Again, continuous research and personnel trained in this interdisciplinary function of integrating various interests of our society will be needed, and centers for this purpose should be developed in selected sea grant universities.

In view of these considerations, I would like to suggest the following amendments to S. 2439 :

(1) Section 2, subsection (c), last line: the words "in the world" should be deleted and the following should be inserted: "as the leader of the free world." This would give a hint of policy orientation with respect to foreign affairs.

(2) Section 2, subsection (d), paragraph (1) : at the end of paragraph (1) should be added "and in their social implications, both domestic and international."

(3) Section 3, subsection (a), with respect to the new clause (10) of the NSF Act of 1950, after the words "and research in the marine sciences," I suggest the following insert: "and in their social implications."

I believe that with these modifications, S. 2439 will be better equipped to meet the need of this Nation with respect to the potential of the oceans.

Thank you, Mr. Chairman.

Senator PELL. Thank you very much, Dr. Basiuk.

Actually, the thoughts that you have advanced have great interest. I think they would change the purpose of the bill, though, because this is not in any way a cold war bill or national strategy bill. This is a basic learning bill. And I think if we adopted your suggested amendments, it would change somewhat the cast of the bill. But you may be sure that these amendments will be considered and they are in the record.

I particularly appreciate the way you gave us specific language which is always a great help, and I thank you for your statement.

Dr. BASIUK. Actually, I did not mean to make this bill a cold war bill. It is just a matter of providing for the education and training which would include some considerations of our foreign policy. It doesn't have to be—we do not have to make this a battleground of anything, but, I believe, these considerations have to be included in order to strengthen the effectiveness of the bill.

Senator PELL. I understand, and I fully understand the strength of your views and, as I said earlier, I know of your own background as a professor at the Naval War College and I appreciate what you are saying. The thrust of the bill, though, is more, as I said earlier, to increase our number of fishermen and miners and maybe make seaweed of greater use to the manufacturers and farmers of the country, and things of that sort.

I thank you very much, Dr. Basiuk, for coming, and I wish you well.

Dr. BASIUK. Thank you, Mr. Chairman.

Senator PELL. Our next witness is Dr. Idyll, chairman of the Fisheries Division of the Institute of Marine Science, University of Miami.

Welcome, and proceed as you will.

I have your statement here which I also notice is a certain length but you proceed as you will.

**STATEMENT OF DR. C. P. IDYLL, CHAIRMAN, FISHERIES DIVISION,
INSTITUTE OF MARINE SCIENCE, UNIVERSITY OF MIAMI,
MIAMI, FLA.**

Dr. IDYLL. Thank you, Mr. Chairman.

If you will permit me, I will offer the mimeographed statement for the record, and depart a little from the written statement to emphasize some of the important points.

Senator PELL. I would welcome that approach and I believe also it would serve the interests of the committee best if we get the benefit of the distillate of your wisdom in the paper, and then get the emphasis that you give it verbally.

Your statement will be put in the record.

Dr. IDYLL. In the first place, Mr. Chairman, I find this a most exciting concept. My specialization is in the applied aspects of oceanography. As Chairman of the Fisheries Division of the Institute of Marine Science, my research and that of my staff has been directed toward the application of basic research for the benefit of the community in the way of producing more food and more of the other materials from the sea.

It seems to me that the U.S. science community has failed to derive the benefits from the magnificent research that the pure scientists have produced. I have felt a sense of frustration over many years in attempting to do exactly what your bill proposes and I want to say more about this frustration later because I think it bears very heavily on the problem. The bill is most timely and necessary, in pointing out that this country requires to take the research of the basic oceanographers and make it into something that will benefit this country and, in fact, the whole world.

One of the questions that has been raised several times and is still a point of issue is who should administer this program.

The administration must be with an agency whose ideas are in concordance with you bill. I am a great admirer of the National Science Foundation and I think that the money the United States has put into the National Science Foundation has returned immense benefits. But unless the charter of the National Science Foundation is greatly altered, this is not the place to put the administration of this bill.

Senator PELL. To interrupt, Doctor, the National Science Foundation's point is that if this bill was passed and they were given this responsibility, that in itself would alter their terms of reference.

Dr. IDYLL. Of course. But the frustration I mentioned earlier, one of long standing, is that when institutions like my own put in research projects which are of an applied nature, or in fact if the organism on which it is proposed to work is one of economic importance, the National Science Foundation very properly, under its charter, says that they cannot support it. Unless this is changed—and as you say, in your bill it would be changed—the National Science Foundation cannot handle the sea grant colleges.

Furthermore, however, even though the bill provides for a change in the charter, I think the philosophy of the National Science Foundation must also be changed. In talking to some of the National Science Foundation people I find that they, in fact, do recognize this weakness, and I think that philosophy of the organization could be changed. But under the present terms of their charter, the National Science Foundation is not the place for it.

In my printed testimony, I have suggested the Department of the Interior. I also have tremendous admiration for the people who operate the Department of the Interior. I think they are some of the most dedicated public servants in the Government. I think their philosophy is of the kind that I think is required in this kind of bill.

At the present time I favor putting it in the Department of the Interior because this is their function. Their terms of reference are to translate the research on the ocean into the production of more food and more consumables, more energy, and so on.

However, it is unimportant whether it is put in the Department of the Interior or the National Science Foundation provided the philosophy behind your bill is well recognized by the people who administer the funds. What you said earlier, of course, applies to all human endeavors: It is not the system, it is who runs it; it is a question of background, of philosophy; it is a question of attitude.

The next point that I would like to discuss is how many institutions and what kind of institutions should become sea grant colleges. It would be a great pity if the money were divided evenly among 50 States or even half that many States, because its impact would be completely lost. It will require considerable amounts of money for an effective sea grant college.

This is not to say that there should be no support whatsoever for universities who are not now engaged in this work or are engaged in it in a small way. I think the idea of dividing the money into two parts where there would be some institutions with large grants to implement and expand present oceanographic programs in a useful way would be very helpful. At the same time, if money were to be given to institutions which have a small program, or which would like to have a

small program, I think this would be most useful, too. But it would be disastrous to the program so to weaken the first part of it by the second that we do not have massive programs to support large sea grant colleges. The idea of a critical mass is most important here: There must be a minimum size of institution to produce the kind of practical results that you envision.

Senator PELL. The thought that what we were developing was not exclusive. The thought was that maybe a third of the funds would be allocated on the seed money, matching grant basis, on application and the two-thirds would be on the merit grant basis. There are a variety of reasons why this would be good, one of them being the encouragement of the diversification of interest throughout the country in oceanology amongst the younger people of our Nation, and the other is also from the viewpoint of securing perhaps broader national support for the bill.

Dr. IDYLL. I think this is a very good idea, sir. My prejudice naturally is toward the large oceanographic institutions because I represent one. However, if I worked for a small college and wanted to get into oceanography, I would certainly feel this would be worth while, and as a citizen of the United States, apart from my prejudice, I think this would be a good idea.

Senator PELL. I recognize the extreme merit of your own institution. In fact, we in Rhode Island think on the Atlantic seaboard it is second only to ours. [Laughter.]

Dr. IDYLL. That is very kind of you, sir. We have a slightly different ranking, but we won't pursue that.

The matter of matching funds is most important to us, Mr. Chairman. I represent a private university. If it were required that a certain proportion of matching dollars be put into the program, we would not be able to be a sea grant college.

It seems to me that there are two reasons for suggesting matching funds. In the first place, they would increase the amount of money and therefore the effectiveness of the program. If they doubled the amount of money, they presumably would double the effectiveness. Clearly more money for research is highly desirable.

The other reason for matching funds is to have an institution show its serious intent. If a school is not willing to put up something to make this program go, perhaps it does not deserve to have money from another source.

There is a parallel in our foreign aid program. The foreign aid of the United States would have been much more effective if we had asked for matching funds some way, perhaps not dollar for dollar or even fractions of dollars for dollars, but some kind of commitment.

My view, Mr. Chairman, is that a matching commitment—and let's not call it funds because again the University of Miami has no way of providing matching funds—but a matching commitment seems to me highly desirable so that there is an increase in the effectiveness of research by providing facilities, vessels, laboratories, graduate students and researchers, and that serious intent is shown by providing those things.

Senator PELL. Thank you.

Dr. IDYLL. State universities can provide matching funds. They go to the legislature and they say, "Uncle Sam is going to provide so

much. What you are required to do is provide so and so, and we will get twice as much."

The University of Miami has no way of doing that, but our commitment is deep in oceanography as you are well aware. We would have no reason for quarreling with the idea of matching commitments, and this we can provide.

Next, I think that the money must be provided in a way that supports institutional grants/programs. The money ought not to be provided for individual projects. An institution must show by an application to the administering agency that it has, first, the interest; second, the capability; and third, a program that makes sense in terms of this sea grant college concept. The universities and institutions who get the support for this ought to be able to show all three of these. A program should be developed so that whoever engages in it shows that they have the understanding of the program and are willing to do research which will in fact interpret the basic oceanography into applications in the way of producing food, minerals, and energy, and will solve some of the vexing legal, social, and political problems that face us in the exploitation of the ocean. We are long past the time when we can limit ourselves only to a description of the ocean in biological and physical terms. We are now confronted with legal, social and economic problems that are vexing indeed, and this country is in danger of losing many things of value because the other nations have realized this, and we have not. Institutions that are supported in this program must be those that understand the wide-ranging problem that faces us and can produce programs that make sense and show the capability of solving them. Therefore, support must be for broad programs on the institutional basis. The ideas must come from the institution, the administering agency must have control over what type of program, but it must leave it to the institution itself as to how it carries this out.

Senator PELL. Thank you.

Dr. IDYLL. In conclusion, Mr. Chairman, whether or not your bill goes through, this sort of thing is going to be done. It must be done; it is a basic necessity for the country.

In fact, as you are perfectly well aware, it is being done at the institution in our own State, at our institution, and at others.

If I may be permitted, let me briefly summarize our activities. The University of Miami has been committed to oceanic research since 1943 when the Institute of Marine Science (called the Marine Laboratory at that time) was established. It was understood that the ocean was an area which required research and which had been neglected.

Since 1943 we have grown to a size where our physical plant is worth several million dollars, where we have two major oceanographic vessels and a score of small vessels, where we have between 175 and 200 professional oceanographers on our staff, where we have 109 graduate students at present count, where we have several millions of dollars of on-going oceanographic research.

The weakness in our program is that we have great difficulty in funding applied research. The reason we have is that the philosophy of the Federal Government has been opposed to this. One of the earlier speakers said that a reason for this is that the United States does not need the materials that come from the ocean.

At the present time, this is true to a large extent, but it is not going to be true in the future and unless we realize that some day we are going to need what the sea provides, and start finding out how to get it, we are in trouble.

At the University of Miami, we are committed to other aspects of ocean exploitation in addition to the physical and biological aspects. We have a law school where one of our faculty members is deeply interested in marine law. We have a strong and active ocean engineering program. It is the first ocean engineering training offering master's and Ph. D. degrees.

At Miami we understand that the ocean has to be approached from a multiple point of view. Whether your bill passes or not, we are going to do the things it urges. The advantage of your bill is that it requires the Federal Government to recognize the necessity of doing them and it makes it possible to accelerate this work.

I am very much in favor of your bill and I congratulate you on your foresight in presenting it.

Thank you.

Senator PELL. Thank you very much indeed. I think you have covered in your oral testimony your viewpoints on the different questions that are being exposed for ascertaining the views of our witnesses. I thank you very much coming here.

(The prepared statement of Dr. Idyll follows:)

PREPARED STATEMENT OF CLARENCE P. IDYLL, PROFESSOR OF MARINE BIOLOGY,
INSTITUTE OF MARINE SCIENCE, UNIVERSITY OF MIAMI

I am Clarence P. Idyll, professor of marine biology, Institute of Marine Science, University of Miami. I have been engaged in marine science, with specialization in fishery science for approximately the last 30 years. During the last 18 years I have been engaged in conducting research in marine fisheries and in the training of marine fishery scientists at the University of Miami.

I wholeheartedly support S. 2439, the National Sea Grant College and Program Act of 1965. This bill is extremely timely, and its enactment would fill a void which exists in the scientific program of the United States, one which must be filled if our Nation is to make full use of the enormous potential which exists in the materials and energy which can be derived from the sea, and if it is to escape the military consequences of imperfect knowledge of the processes of the ocean.

The time has come for something new in oceanography, and the implementation of S. 2439 would be an excellent start in achieving this new approach. The new concept is that we must begin to apply the excellent oceanographic research that has been done in the past. There now exists a dangerous gap between pure science in the United States and the application of this for the good of society.

Scientific advances and their eventual application for the benefit of mankind all follow much the same pattern. (1) The sequence starts with the curiosity of some scientist about a particular natural phenomenon. This phenomenon may involve the growth of plants, the number of animals in a particular population, the structure of rocks in the mountain range or any of a million other matters. (2) Whatever it is, the next step is a description of the phenomenon. A generation or two ago nearly all of natural science stopped with the description. (3) Now however, the next phase is much more commonly pursued; namely, the understanding of the processes which underlie the phenomenon. Since these processes are usually a combination of biological, chemical, and physical changes, science has become increasingly interdisciplinary and increasingly complex. In addition, mathematics are usually required to describe the processes which have taken place. Thus, science, which once could be carried on successfully by relatively untrained amateurs, now requires highly trained specialists.

Up to now we have described what is sometimes called pure science, that is, observations and investigations of natural phenomenon which are conducted for no other purpose than to satisfy the curiosity of the scientist involved. No apology needs to be made for this. The intellectual satisfaction of man's divine curiosity is sufficient justification for the lifetime activities of many scientists.

But in a great many cases scientific findings can be put to good use by mankind, to feed or clothe him; to satisfy any of a variety of needs; in general to make his life more pleasant and productive. If this is possible it appears to be highly desirable if not mandatory that science takes the next step in the sequence. This step is to conduct the applied research which translates the findings of pure science into more food, more minerals, more energy, more of all the things that mankind requires. Finally, the results of this applied technology must be demonstrated to the industrial community so that it is adopted by them. This means that the community must be made aware of developments and of their potential.

In the United States the sequence of events in oceanographic research has usually stopped at phase three, an understanding of the natural processes. We should now begin much more actively to advance to stage four, the translation of scientific findings into applications for use by mankind.

Undoubtedly one of the compelling reasons why our country has not usually advanced from theoretical oceanography into applied oceanography is that very little need exists here for additional food or minerals or many of the other things which the sea can provide. But others have felt a sharp need for these resources, and the consequence is that some of the other countries of the world have advanced enormously in applying oceanographic knowledge to the welfare of their nations. For example, some of us think that Russia and Japan have advanced so far in applied oceanography as to pose a serious threat to the United States. And even if we do not need what the sea can provide us, in our condition of relative plenty, this situation will not prevail forever. Someday—and it may be sooner than we think—even the United States will require additional quantities of food and of the other consumables which can be taken from the sea.

If the United States has an excess of food, Japan has a shortage, especially of proteins. The sharp necessity to feed her large population from a land incapable of producing sufficient protein food has driven Japanese fishing fleets to all the oceans of the world. Much of the enormous expansion of the Japanese fisheries has come within the last decade or so. Prior to World War II Japan was a leading fishing nation of the world, but the level of activity was much lower than it is now. Since then competition has become stiff, but the Japanese have kept pace, being surpassed only by the amazing rise of Peru. Japanese fishing boats and factory ships are now seen again in the Bering Sea, where their presence raised storms of protest in the United States before World War II. They are seen in the mid-Pacific, where they are fishing pelagic schools of tunas and billfishes and cashing in on the research of the Americans as well as of their own scientists. They are fishing the whole tropical Atlantic from Brazil to West Africa. Their vessels are among the most active in the new rich fisheries in the bight of Africa. They are fishing tuna in the Indian Ocean. They were the first to explore the shrimp fisheries in the Gulf of Mexico and the coast of Texas. In October of 1962 they appeared in the northwest Atlantic, near Newfoundland.

They are fishing off east Africa and off Antarctica. They are successful because they have done what the United States has not done, which is to translate ocean research into practical methods of increasing the catch of oceanic fish.

Japan was the leading fishing nation of the world before the Second World War so she had a running start in attaining her present eminence. On the other hand Russia was nowhere in sight as a marine fishing nation at that time, getting most of her fish from fresh water lakes and ponds. Now, a little over two decades after the war, Russia has leaped to the position as the third fishing nation in the world, ahead of the United States by two places. She has gained this position because she recognizes the importance of exploitation of the sea and has adopted as a national policy the necessity of translating pure scientific research in oceanography into industrial application, and because she has implemented this policy by widespread applied research and training. Like the Japanese, the Russians are seen in ships over the world oceans. Their boats appear not individually, not in pairs, but in great fleets. Fine new vessels with the latest equipment for the capture and processing of fish are accompanied by factory ships. No species of fish captured is discarded; no part of any fish caught is wasted. The Soviet vessels are seen in the northeast Atlantic where their drifting net still foul the propellers of American and Canadian vessels. Russian oceanographers in exploratory fishing vessels were the first to work off the rich west African coasts. Russian are fishing off South Africa, in the northeast Pacific, in Antarctica. Russia trawlers are fishing alongside Japanese trawlers in the Bering Sea.

It is of great importance to note in our present context that both Japan and Russia have enormous and highly organized systems of university-level training

and research to back up their expanding world fisheries. Several years ago the U.S.S.R. had 137 separate institutions training fishery scientists and technical workers and conducting basic and applied research, and this number is probably badly outdated. Japan is famous for the high level of fishery training and research in its universities.

If Japan and Russia are the most active nations in pursuing oceanographic research for the benefit of their country, they are not the only ones. Peru has become the leading fishing nation of the world by taking advantage of the rich fish stocks off her coasts, and research has greatly aided the development of these stocks. Such nations as Poland, West Germany, and Korea have expanded their oceanic fisheries with strong support from applied research.

Many vexing questions of the rights of competing nations to exploit the fisheries of the high seas are yet unanswered, but it seems certain that those nations which have established an active fishery will have high preference when a decision is made as to who may fish particular offshore stocks. Whether the United States needs to fish for these stocks at the present time or not, we will certainly need them in the future, and we may find that prior claim has been made to them by other nations more aggressive than ourselves in this area. "Traditional rights," obtained through exploitation of stocks and research performed on them, will be forcefully claimed.

At the present time the universities cannot obtain adequate support for applied research in oceanography. The program of the National Science Foundation and of the other granting agencies either is specifically directed toward basic or medically oriented research, or it involves individual short-term grants. A completely new approach is necessary, whereby agencies such as the Bureau of Commercial Fisheries, whose activities are specifically directed to development of the exploitation of the fish resources of the ocean, are provided the authority and the money to support institutional grants. These grants should be made on long-term bases, and be for the support of whole faculties and programs at selected universities.

For the past several years there has been a strong trend for Government agencies to enter vigorously into oceanographic research. Since funds for the support of this work have been limited, the trend has resulted in many cases in the universities being replaced in this activity. It is vitally necessary that the tempo of oceanographic research should be increased, but it must not take place at the expense of university research or the whole structure will come crashing to the ground.

There is no other source of trained oceanographers except the universities, so it is a basic necessity that they should be made as strong as possible, and be actively encouraged to make their training as thorough and effective as possible. Surely this is so obvious that it hardly requires to be stated, let alone belabored. But what does need explanation and urging is the concept that in order to be effective in training oceanographers, the universities must be deeply engaged in research.

It is sometimes forgotten that a university has a dual role instead of a single one. In addition to the responsibility of training students, it must provide the intellectual atmosphere and opportunity for the conduct of research. Historically, the university was the sole center of investigation and scholarly research, and it was to the university campus that scholars and scientists gravitated to take advantage of the collections of books and the presence of other men with whom they could discuss their work. The function of research has been subordinated in recent years in some universities, especially in this country, where some teachers colleges and other institutions have lost sight of the scholarly tradition of universities in their haste to turn out students. The irony of this is that the students are inevitably more poorly prepared for their role through not having exposure to scholars immersed in research in their field, and consequently abreast of the latest developments and philosophies of their profession.

In some areas of scholarship the universities are still the sole centers of research, and if professors did not carry on scientific inquiries, none would be done. In the field of marine science, and especially of fisheries, this is not the case; if no university research were done in fisheries, the country would still be served by Federal and State agencies. It is not fully clear to me why some areas of research endeavor should be dominated by the universities and why other should be pursued vigorously by Government agencies, but one of the reasons relating to the marine sciences surely is the great cost of many phases of this kind of research. Universities have in many cases started this work, but have eventually been faced with such staggering costs of boats and other necessities

that they have been forced to vacate the field in favor of the Government, whose resources alone are able to bear their magnitude of financial burden.

It is a contradiction of terms to say that the universities can and should restrict themselves to the teaching of marine scientists and not engage in research. A university engaged in the training of fishery scientists and oceanographers must give the students not only theoretical training in the classroom, but must allow them to engage in research. And this must not be artificially created problems that have little if any contact with reality, but must be real and vital problems actually being investigated by professional scientists. This means that the university must have its staff engaged in such worthwhile research (which implies that this staff is capable of such work). It also means that we are faced again with the high cost of marine research, and the inability of any university to finance it themselves.

If we are willing to accept this line of argument, it follows that whether the Federal Government looks on the universities as partners in research or only as a source of professionally trained staff for its own and other fishery laboratories, we arrive at the same end: the universities must engage in serious and worthwhile research, and they cannot do this without considerable outside support, probably largely from the Federal Government.

The training of oceanographers and fishery scientists is complex and the application of basic discoveries in oceanography is difficult. This is partly because oceanography is not a science. As a matter of convenience even those of us in the profession tend to speak of the "science of oceanography," knowing full well that it is not a science in the usual sense. This usage is picked up by the public, and it complicates the understanding of the problem of training in oceanography and of research in the field. There is no more a science of oceanography than there is a science of the land. Instead, oceanography is the application of the basic sciences of physics, chemistry, biology, and geology to problems in the ocean. Thus a student of oceanography must have mastered the fundamentals of one or more of these basic sciences before he enters the study of oceanography. This study must therefore be at the graduate level. And it must concentrate heavily on research aspects.

Furthermore oceanography encompasses not only all the basic sciences but other disciplines, such as food technology, engineering, law of the sea, economics, communications. Any institution which hopes to do a useful job of translating pure science into applied science in oceanography must have the capacity to train students in these aspects and to conduct research in them.

It seems to me that Senator Pell's bill, S. 2439 provides an excellent vehicle for achieving the important objectives outlined above. The concepts that we must translate into practical terms the results of pure research and oceanography, and that we must strengthen the training programs for research scientists are most important. It appears that this can best be accomplished by choosing a small number of centers of excellence: universities with a proven interest in marine science, and possessing in addition departments of law, engineering, and the other associated fields where faculty members are interested in ocean problems. Support should be in the form of continuing program grants, made available for either applied or pure research. These grants should be flexible, and the ground rules should permit development of a core of faculty, with continuing support. The emphasis should be on programs and not on projects. The grants should recognize the great variety of needs of students, and permit the university to fill these needs in the most efficient way. The grants must be of a character which will allow students to become seagoing oceanographers, and hence should include provision for research involving vessels.

The special needs of private institutions like my own must be kept in mind in providing these grants. For example, there is no way of our university supplying matching funds, and there are many other schools in the same position.

Finally, it appears to me that one of the major contributions which the United States can make to the welfare of developing countries is in the training of oceanographers from those countries. We have had many foreign students at the University of Miami, and have sent them back to their countries to enter the service of departments developing ocean resources. We would like to do this in much increased scale. Provisions should be made in this act for the expanded support of foreign students who come to the United States to study oceanography.

Mr. Chairman, I greatly appreciate the opportunity to testify in favor of this bill. I believe its passage is most important to the future of the United States.

Senator PELL. We will now proceed to our last witness for this morning, Mr. John Perry, the president of the Perry Submarine Builders, West Palm Beach, Fla. I understand that your submarines are called Cubmarines.

Mr. PERRY. Yes.

Senator PELL. I have your statement here and I will ask you to proceed as you will.

**STATEMENT OF JOHN H. PERRY, JR., PRESIDENT, PERRY
SUBMARINE BUILDERS, INC., WEST PALM BEACH, FLA.**

Mr. PERRY. Thank you, Mr. Chairman.

Since Dean Spilhaus has already very ably pointed out to you the problems and potentials of invading the sea, I feel that my contribution here can come from describing what we have accomplished to date in this endeavor and perhaps point out the parallel of these endeavors to the meaningful purposes of the proposed bill S. 2439.

For the past 10 years I have been building small submarines for the purpose of research and doing useful work in the sea. At the time when I began these endeavors, it seemed there was to be little general interest in this area except from a strictly military viewpoint, and there was little, if any, of what might be referred to as a "state of the art." Today, however, it has become obvious to almost everyone that not only does the area beneath the sea make our country more vulnerable than ever before from a military standpoint, but from an economic viewpoint the invasion of this vast unknown is important and absolutely essential. The question then is no longer shall we enter but how, how fast, and how well. The Navy as well as industry have already found out a good many of the problems and have suggested a good many answers. The problem right now is to arrive at the practical aspect of getting into the sea on a daily, routine, economic basis and, sometime in the next few years, live there on a more or less permanent basis.

Currently, we at the Perry Submarine Builders Co. are building our 10th submersible. One of those to be finished this summer is being built on a joint venture with Mr. Edwin Link who has for many years been the country's leading pioneer in man-in-the-sea projects, among which was the first saturation dive in the world and who, 2 years ago, headed the expedition in which Robert Stenuit and Jon Lindbergh lived for 51 hours at a depth of 427 feet. The vehicle we are now building with Mr. Link is designed to have the capability of delivering a work force to any depth on the Continental Shelf, to send two men out and return them to safety. One of our vehicles was used by Oceans Systems, Inc., and the U.S. Navy in the recent search for the H-bomb off the coast of Spain. Another is at work in Kwajalein in the Pacific Ocean on a classified project of the U.S. Army Materiel Command.

Among other projects, we are currently building an underwater laboratory and classroom which I have donated to the Florida Atlantic University at Boca Raton in Palm Beach County, Fla. One of the purposes in making this donation was essentially to accomplish in my own small way what the concept of Senator Pell's bill for sea grant colleges is designed to do.

We are running into a severe shortage of qualified scientifically oriented personnel to pilot our submarines. Contracts which we had obtained for work from each of the four armed services required a high degree of scientific skill. It became clear to us that in order to obtain the skill to pilot these craft and to do useful work with them, we must call on the resources of a university with an ocean engineering degree. Having a prior interest in the establishment of this facility, it was natural that I should turn to them to help solve this gap in the needs of this new industry.

The Florida Atlantic University next month will have its underwater laboratory and classroom and the industry will thereby have the beginnings of a pool of scientifically experienced personnel to operate undersea craft, to get there and do useful work from a permanent undersea base. It is our hope that this university will be given contracts from Government as well as industry to help further the cause of penetrating this last most important frontier of man.

As you have read recently, Russian scientists are making plans to send multicrewed underwater laboratories into the deep waters along the Soviet Union's Pacific coast for marine studies. They have designed the Tinro-1 for seven-man crews for depths to more than 900 feet and to travel at speeds of $5\frac{1}{2}$ knots for 36 miles.

There is little question of the value to be found in this program. We must have it to survive. The question is how to accomplish it most effectively and efficiently. One point which I would like to make in this connection is the matter of focusing the men and money into the right locations and into the universities already oriented in this direction. As both Paul Fye, of Woods' Hole, and William Harges, of the University of Virginia, and now Dr. Idyll just before me now have ably pointed out in last October's conference on the concept of a sea grant university at Rhode Island, the program should be limited to institutions with ready access to the sea.

I would like to point out the exceptional advantages that the State of Florida has in this respect—not only its 1,200 miles of shorelines, the already existing facilities which it has in the Florida Atlantic University, the Nova University, Brevard Engineering College at Melbourne, and the Institute of Marine Sciences at the University of Miami, but also the enormous technological brain bank at Cape Kennedy.

In addition to the hundreds of thousands of square miles of clean, clear salt water bordering its shores, it has in its interior the largest bodies of canals of fresh water. This makes it the finest natural laboratory in the free world for basic and applied research.

The rising interest in environmental engineering of our Nation as it relates to weather control, beach erosion, air and water pollution, biological engineering, and ocean engineering, makes it an ideal spot to focus the attention of the sea grant university concept.

Furthermore, our Federal Government, in conjunction with the Bahamas Government has jointly begun, in close proximity to the Florida coastline, a several hundred million dollar joint effort which to all intents and purposes will be an underwater engineering mecca. This facility is known as AUTECH—the Atlantic Underwater Test and Evaluation Center.

To illustrate the necessity of spending this money in areas adjacent to the sea, I would like to point out how in my own way this proximity to the ocean has been so important. Recently I moved my own submarine building plant. Formerly, although it was located on the inland waterway, nevertheless it was 12 miles from an adequate inlet. It was time consuming and expensive to get our vehicles into the ocean. The new location is adjacent to a deep sea entrance and large harbor with good proximity to the Gulf Stream. From an operating standpoint, this makes all the world. It is no longer necessary to tow these vehicles to an on-site location. We can get down to work with half the expense we formerly encountered. Now it is economical and we are equipped to invade the sea on a daily routine basis. In fact, this facility will help enable Florida Atlantic University to ferry the student to the underwater classroom on a regular schedule. On this matter I cannot overemphasize the importance of location and nearness to the field of endeavor.

While the state of the art is beginning to reach manifold proportions, there is no question but that the industry is in definite need of the kind of push which Senator Pell's bill would give it.

Any assistance which these universities gain now in the way of funds for equipment will pay off many times in long-range gains. What needs to be realized moreover is that of all the frontiers mankind has broken through, this last one is perhaps the most formidable of all. But when compared to the outer space effort, it would appear to me that conversely it will be much more rewarding. You are all aware of the probability of finding enormous wealth, not only material wealth but great wealth of knowledge.

In view of recent testimony, it would be redundant for me to reiterate the list of potential rewards. Suffice it to point out that the moneys spent on these educational programs (and I might just add that I am in hearty agreement with the Senator on his proposed payment method) will escalate to very substantial proportions, and will, I believe prove themselves very much in the same rewarding manner in which the land grant aid over the last hundred years has helped make this country the best fed in all history.

It could very well be that in the next hundred years the sea grant concept could be instrumental in helping to keep humanity from starving.

In conclusion, I heartily approve of the translation of Dean Spilhaus' idea into the adoption of Senator Pell's proposed bill S. 2439 and recommend its passage into law so that we in industry can further our growth in order to share our profits with mankind.

Thank you.

Senator PELL. Thank you very, very much indeed for your practical businessman's viewpoint and your positive support that you have rendered by coming here. You are a very good spokesman for your own State as well.

Mr. PERRY. I learned that from the Senator in his endorsement of Rhode Island in the hearings last fall.

Senator PELL. But in connection with the allocation of the funds, my own thought is that this allocation could go to the most practical exploitation of the ocean. I gather your thinking and mine is identical in that regard. This is not for the further development of theoretical knowledge but the exploitation of the knowledge we already have.

MR. PERRY. That is correct, but I feel the theories or the arguments advanced for including every State, for instance, are going to cause a scattering of the shot. I think we have a definite problem. I think it ought to be concentrated on those universities which show proximity to the ocean and an already established engineering, ocean engineering, or oceanology facility, and who have the real need for these funds.

I think it is silly to scatter it around because on the same theory we would have given every State a Cape Kennedy, for instance, that seems to me a fairly good example of concentrating our efforts.

SENATOR PELL. Right. There is great merit to what you say, but also what we are trying to do is develop the skills and basic knowledge all over the country. That is why perhaps the lion's share of this funding might go for the institutions, the centers of excellence, but if we could use a portion of it to develop an interest around the country, perhaps on a matching basis, which would do that, it might be more effective.

A good analogy here is the arts and humanities foundation. At this point the performing arts are almost entirely centered in two or three areas—New York, California, maybe Illinois. But the purpose of the act is to generate interest all over the country in the arts, and for that reason we had both concepts in the bill, a basic minimal matching grant for each State as they developed a program or interest in it, and also a competitive grant basis, and that is the thought I had here.

MR. PERRY. I see. I don't agree with that statement at all because I feel you have one problem in the humanities and you have an entirely different problem in the efforts of invading the sea. I think we are going to have to take every penny we can afford in order to lick this problem and I feel that the interest problem will take care of itself if we as a nation do an excellent job of getting into the sea and being ahead of Russia. The interest in the thing is generating itself, and the best way to get the interest is for us to be the best.

SENATOR PELL. I appreciate your views on this and they will be properly weighed and considered, and I thank you, too, for coming here today, very much indeed.

MR. PERRY. Thank you, sir.

SENATOR PELL. I see that Congressman St Germain, a fellow Rhode Islander, is now here and will offer his testimony. Congressman St Germain is shepherding a bill similar to this one in the House. Will you proceed, Congressman?

STATEMENT OF HON. FERNAND ST GERMAIN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF RHODE ISLAND

MR. ST GERMAIN. I thank you Mr, Chairman for this opportunity to appear before the committee.

The matter of oceanography and sea grant college legislation is of extreme interest to me for I believe that it is of utmost importance to the State which I am privileged to represent, to our Nation which we all serve, and to mankind for whom we are all responsible.

The oceans of the world comprise the last frontier of inner space. Herein lies territory as challenging and more promising of economic reward than the regions of outer space. It beholds the promise of an almost inexhaustible supply of minerals, metals and, most important,

as a troubled world is confronted with the population explosion, it holds the promise of a significant increase in the world's food supply. It is here that man can gain almost limitless resources to feed future generations.

Although 70 percent of the earth is covered by ocean—extending itself over 139,400,000 square miles—only a small fraction of our food and other needs are gained from it.

The sea dominates our world. It regulates the weather. It is the ultimate source of all our water. It provides a habitat for plants and animals far greater in area and volume than the life zone of the land. It is believed to have been the birthplace of all terrestrial life. And yet, in spite of all this, we have scarcely begun to learn about our ocean.

It seems to me that anything that we, who are privileged to serve our Nation as legislators, can do to foster the development of marine sciences and associated fields should be done as expeditiously as possible and with a deep feeling of gratitude for having played a role in such significant work.

Let us for the moment confine ourselves to viewing the fishing industry. The worldwide demand for fish is growing rapidly. In 1962, about 33 million metric tons, live weight, of fish were caught for food use. By 1970, the demand may be between 40 and 45 million tons. In addition to this, large quantities of fish are caught for reduction purposes—for example, to be used as feed for farm animals. This also has been growing at an extremely rapid rate. In 1958, the catch of fish for reduction was about 4.3 million metric tons. In only 4 years, this amount had almost tripled, reaching a total of 11.9 million tons. By 1970, it is estimated that the demand for fish for reduction purposes will be between 17 and 27 million tons. Thus, the total world demand for fish for all purposes may be between 52 and 72 million tons in 1970.

Up to 1957, the United States ranked second among nations in total world catch. By 1960, we dropped to fifth place while Peru, increasing its output 140 times since 1948, now has become the world's leader. The Russians, realizing the potential and their own needs, have been increasing their catch at a rate of 6 percent per year and now the only first-rate oceanographic fleet in the world.

The time has come for the United States to realize the importance of the fishing industry, but above this, we must reach out as far as possible to all the marine sciences for the oceans are not a mere hunting ground for fishermen or a highway for our ships.

Before exploitation can begin, basic knowledge must be gained and herein lies the task of sea grant colleges who, working in conjunction with marine industries, can provide us with vital and timely knowledge that will help us to relieve world problems and enable us to realize a better economy. Before we can farm the seas or mine the ocean floor we must equip ourselves with the tools of knowledge; tools which can be provided through sea grant colleges working in conjunction with the marine industries. We have only to look to the land-grant colleges in their joint efforts with the farm industries to realize the significant results to be gained through such a program—results that have proven beneficial to all America.

A program that can provide greater economic opportunities including expanded employment and trade; new sources of food; new means for the utilization of water; exploitation of mineral deposits—these

can be realized by the enactment of the sea grant college bill, S. 2439, introduced by your chairman and my colleague from Rhode Island, the honorable and highly esteemed Senator Pell and my companion bill, H.R. 12337.

I trust that this committee will fully realize the vital nature of this matter and will afford Senator Pell's bill the utmost of consideration.

Senator PELL. I would like to read into the record a telegram from Les Cohen, director of governmental affairs, the California State Colleges. [Reading:]

The California State Colleges wish to express their wholehearted endorsement of your bill, S. 2439, to establish sea grant colleges. The State college system is anxious to fulfill a need in California for the development of marine sciences. Several of our institutions have unique talent and special competence in this area. Your bill is well designed to accomplish these purposes if Federal assistances forthcoming. Detailed letter explaining our support will follow. In behalf of our Chancellor Dumke, I wish to express our pleasure in the measure you have introduced.

LES COHEN,

Director, Government Affairs, the California State Colleges.

We will now hear from Congressman Huot from New Hampshire.

STATEMENT OF HON. J. OLIVA HUOT, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW HAMPSHIRE

Mr. HOUT. Mr. Chairman, I submit this testimony before the members of this committee in support of S. 2439—the National Sea Grant College Program Act of 1965. In fact, I submitted similar legislation in the House on April 19 of this year.

In this present age it has become apparent that the stronger nations of the world are striving to carry out explorations in space, just as in past centuries a similar motivation forced people to explore new continents and new resources.

However, it is now awkwardly evident that the vast areas of ocean which cover the majority of the earth's surface stand relatively untouched. There is no specific policy at hand that says we as a Nation must involve ourselves with the mysteries of the sea, but it stands to reason that if action in this area is not undertaken in the near future, the United States might find itself struggling desperately behind other world powers.

If adopted, the National Sea Grant College and Program Act of 1965 will authorize the institution of certain sea grant colleges and programs whose main objectives will be to offer training, education, and research facilities for the furtherance of knowledge concerning the marine sciences. It will provide for grants of shoreline, specified areas of ocean bottom, and lakesides which could be used by these colleges for purposes of experimentation. This distribution would also aid in the eventual preservation of these areas.

The results of an action of this type would be vast. The United States will stand as a leader in the fields of aquaculture and ocean engineering. However, it is imperative that the engineers of this country receive the proper training for these sciences. The sea engineer in contrast to the land engineer must deal with entirely different standards of pressures, materials, and environment. For this reason, his outlook and scope are entirely different, thus requiring new forms of educational programs.

The goal of the exploration and experimentation carried on by the sea grant colleges would eventually be the construction of a completely self-sufficient submarine city, able to supply its own food, shelter, power, and transportation. At this time, when overpopulation is a worldwide concern, the benefits of such a situation would be countless.

However, it must be understood that to achieve these aims requires a well-based knowledge of the mechanics of submarine soil, the calculated extent to which underwater pressures must be accounted for, means of soil fertilization and upkeep, the possibility of wave movement as a source of power and many other important factors.

It is my belief that the institution of sea grant colleges and programs would create an adequate and successful system for the start of submarine exploration.

Mr. Speaker, I cannot urge this committee too much to look favorably upon this legislation. Experts in oceanography and hydrospace have ascertained that the time is now for the U.S. Government to begin educating our young engineers in this field. The years ahead are important, and our country may find that in the near future complete knowledge of the ocean floor will be a requirement, not a mere curiosity.

Senator PELL. Thank you for your fine testimony.

Our next witness is Congressman Reinecke, of California. You may proceed, Congressman.

STATEMENT OF HON. ED REINECKE, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. REINECKE. Mr. Chairman, thank you for this opportunity to express my support for the sea grant college bill, S. 2439, now under consideration by this special subcommittee. As a member of the House Merchant Marine and Fisheries Committee, and to its Subcommittee on Oceanography, I am very much aware of the importance of the sea around us, and of the need for creative thinking about ways to more fully use this great natural resource for the benefit of this Nation, and of all mankind.

As an engineer myself, I am always most concerned with the problems of practical applications of new knowledge and new discoveries. The land-grant college concept was a creative way to bring to a growing nation the facilities for practical education. It was a means of bringing knowledge to the men who were building our country. And this concept placed the power of the people through their National Government squarely behind the idea of promoting practical education, as well as productive research, at the local and community level.

The U.S. Government operates oceanographic programs from 18 or 20 Federal agencies. And many universities, laboratories, and industries supplement these with research efforts of their own. But, it seems to me, that there is still a need for the application of our new knowledge of the sea. There still is a need for exploring the commercial, engineering, medical, legal, mineral, biological, and food-producing aspects of the ocean. There is a need for further study in the matters of harbor engineering and construction. There is a need for us to realize that the sea around us, which constitutes almost 71 percent of our world's surface, may hold as much potential, and as many rich surprises, as does outer space.

I heartily endorse the idea of the sea grant college. The emphasis of this bill and of this idea is to work with existing educational institutions to make full use of the research facilities already involved in the exploration of the sea. This also brings to bear on ocean problems the combined talents and experience of the scholars from many disciplines within a university. It also uses existing organizations of proven capability.

In my own southern California great steps have been taken to integrate the efforts of local government, industry, and the colleges and universities into a common thrust into the mysteries of the ocean depths. The port of Long Beach, the University of Southern California, the California State College System, the famed Scripps Institute of Oceanography, the Los Angeles Harbor Commission, and my own alma mater, the California Institute of Technology are all involved in various efforts to further our understanding of the ocean and to exploit its riches for the welfare of all human beings.

I am glad to see that the intent of this bill is to solve a real problem without building a large Federal bureaucracy. This bill will put ocean development in the States, where the work is actually going on, and where it belongs. This sea grant concept will involve the American people directly instead of leaving ocean development to a group of Federal researchers removed from the laboratories of practical application.

The urgency of this matter is best illustrated when we compare our progress in ocean development with that of the Soviet Union in recent years. While the United States has maintained a lead in basic scientific research, it has been generally realized that the Soviets have emphasized the applications of research, rather than basic investigations. In certain phases of applied research the United States maintains a lead. The field of oceanographic instruments is one in which this Nation is ahead. Also, the use of computers applied in the assemblage of marine scientific data is an American achievement, though now under study in the Soviet Union today.

Russia claims some 1,500 oceanographers backed up by 7,500 men and women working full time in the field. The status of sea scientists is being upgraded, and the field is being made more appealing to young people. It should be mentioned that the Soviet Institute of Oceanography has been expanded five times from its original size in the past 15 years.

By contrast, it has been estimated that the United States has approximately 700 oceanographers with some 2,000 to 2,500 full-time technicians supporting them. We are increasing our ranks by approximately 10 percent a year. The Soviets may actually be increasing by 15 percent per year.

The United States can also claim a lead in deep sea mining, drilling, and deep sea research vehicles. However, the Soviets are moving up fast in developing vehicles of their own.

The Russians have declared a technological and commercial war on us—on and under the high seas. In shipping, and in fishing, their intent is quite clear. They wish to become masters of the ocean. They have been successful in fisheries because they have applied to the fishing operations the tools learned in marine research. With this success, they are encouraging more oceanographic efforts.

In the United States today there is an emerging awareness on the part of the public, the academic world, the Congress, and the industrial community that the oceans represent a vast untapped resource. This emerging awareness is greeted by an enthusiastic community of scientists and ocean technologists eager to move into a concentrated campaign to promote full utilization of the sea around us.

This Nation stands at the threshold of man's final conquest of his environment. Man in the ocean, or man on the high seas, is as important to our Nation's future as man in space, or man on the moon. The sea grant college is a giant step toward seeing that the first place in ocean technology stays in American hands.

Senator PELL. Thank you, Congressman. At this point, since we are through listening to the witnesses we have invited, I would like to make the announcement that the record will stay open until May 12 for any further testimony or changes that are offered, and after that time it is the intention of the subcommittee to meet in executive session to go over the various amendments that are being offered and see what our combined thinking is in this regard.

I thank the witnesses who have come from long distances, and if there is anybody else in the audience here with a supplemental review to offer, I will be glad to hear it. Otherwise, the meetings of this subcommittee are herewith recessed.

(The following material was subsequently supplied for the record.)

U.S. DEPARTMENT OF THE INTERIOR,
FISH AND WILDLIFE SERVICE,
BUREAU OF COMMERCIAL FISHERIES,
Washington, D.C. May 10, 1966.

HON. CLAIBORNE PELL,
Chairman, Special Subcommittee on Sea Grant Colleges, Committee on Labor and Public Welfare, U.S. Senate, Washington, D.C.

DEAR SENATOR PELL: At the hearing on S. 2439, held May 3, 1966, there was some mention of the origin of the present Bureau of Commercial Fisheries. I have had prepared an organizational chronology which traces the Bureau back to the original act of February 9, 1871, and am enclosing it for the record.

Sincerely yours,

DONALD L. MCKERNAN, *Director.*

ORGANIZATIONAL CHRONOLOGY OF THE BUREAU OF COMMERCIAL FISHERIES

Fish were an extremely important source of food in the early days of the Republic and for that reason the fisheries received early attention from the Congress as a renewable resource. By the act of February 9, 1871, the Congress recognized the national aspect in the conservation of fisheries by authorizing appointment of a Commissioner of Fish and Fisheries to study the decrease of the food fishes of the seacoasts and lakes of the United States, and to suggest remedial measures. The Commissioner was to be appointed by the President, with the advice and consent of the Senate, from among the civil officers or employees of the Government and was to serve without additional salary (16 Stat. 594). The sum of \$5,000 was appropriated to carry out the required study (16 Stat. 503).

The problem of depletion of the fisheries had been called to the attention of the Congress in January 1871 by Mr. Spencer F. Baird, who was then Assistant Secretary of the Smithsonian Institution. The work authorized under the original act was done by personnel of the Smithsonian Institution who served without additional compensation. Thereafter, on January 20, 1888, the original act was amended to authorize a salary of \$5,000 per year for the Commissioner and to require that he not hold any other office or employment (25 Stat. 1).

The Fish Commission and the Office of the Commissioner of Fish and Fisheries functioned as an independent establishment of the Government from February 9, 1871, to July 1, 1903, when, by the act of February 14, 1903 (32 Stat. 827), the

Fish Commission and the Office of the Commissioner of Fish and Fisheries were placed in the Department of Commerce and Labor which was created by the latter act. That same act transferred from the Department of the Treasury to the Department of Commerce and Labor jurisdiction, supervision, and control over the fur seal, salmon, and other fisheries of Alaska (32 Stat. 828). Thereafter, this entity was called the Bureau of Fisheries.

By the act of March 4, 1913 (37 Stat. 736), the Department of Commerce and Labor was divided into two separate departments and the Bureau of Fisheries remained with the Department of Commerce until July 1, 1939, when the 1939 Reorganization Plan No. II (53 Stat. 1433) transferred the Bureau of Fisheries to the Department of the Interior.

The Bureau of Fisheries and the Bureau of Biological Survey, both in the Department of the Interior, were consolidated into one agency to be known as the Fish and Wildlife Service by the 1940 Reorganization Plan No. III (54 Stat. 1232), which became effective June 30, 1940.

By the terms of the Fish and Wildlife Act of 1956, approved August 8, 1956 (70 Stat. 1119), there was established within the Department of the Interior to succeed the then existing Fish and Wildlife Service, the U.S. Fish and Wildlife Service consisting of two separate agencies, each with the status of a Federal bureau, the Bureau of Commercial Fisheries and the Bureau of Sport Fisheries and Wildlife.

NATIONAL ACADEMY OF SCIENCES,
NATIONAL RESEARCH COUNCIL,
COMMITTEE ON OCEANOGRAPHY,
Washington, D.C., May 2, 1966.

HON. CLAIBORNE PELL,
U.S. Senate,
Washington, D.C.

DEAR SIR: Our knowledge and understanding of the oceans and its contents are growing rapidly. With this increasing knowledge, comes the possibility of making fuller use of the ocean's resources. These resources range from oil, minerals, new sources of animal protein, and pharmaceuticals to the uses of the oceans for recreational purposes and the development of cheaper and safer waste disposal systems. New technology has made possible the development of better vehicles for moving through the oceans at all depths; and deep ocean anchored buoys hold promise of better monitoring of the ocean-atmosphere system and of markedly improving our 3-10-day weather forecasts. We believe the United States should continue to play a leading role in these developments.

The analogy of the land-grant concept to the development of our ocean resources as incorporated in S. 2439 is attractive. The agricultural productivity of this Nation is unsurpassed and much of the credit for this fact must go to the development of the land-grant college movement. Land-grant colleges, with their wide range of activities including agricultural experiment stations and extension services, have been singularly successful in bringing the findings of science out of the laboratory and classroom and transferring these ideas into practical application. Land-grant colleges also have provided the services of the laboratory to solve some of the day-to-day problems of the farmer. Most importantly, the land-grant college movement provided the agricultural industry with well-trained men and women capable of utilizing the new ideas of the laboratory and experiment station and of further developing our agricultural resources.

We believe a similarly conceived program for developing our ocean resources could do much to insure the continuing leadership of the United States in this area. We believe such a program could provide the necessary impetus to bring about an expanded effort in the development and exploitation of the oceans' resources.

Thus, we endorse the principle of S. 2439, the National Sea Grant College and Program Act of 1965.

Sincerely yours,

MILNER B. SCHAEFER, *Chairman.*

BOSTON UNIVERSITY,
DEPARTMENT OF BIOLOGY,
Boston, Mass., May 10, 1966.

HON. CLAIBORNE PELL,
Committee on Labor and Public Welfare,
U.S. Senate,
Washington, D.C.

DEAR SENATOR PELL: It is a pleasure to endorse S. 2439, which will be subjected to the Special Subcommittee on the Sea Grant College of the Senate Committee on Labor and Public Welfare. The purposes of this bill are vital to the success of oceanology in this country. Certainly, the land-grant concept has proved to be an extremely important factor in the outstanding performance and knowledge of American agriculture.

We, in the study of the sea, feel that this vast, largely unexplored frontier is open. Other countries such as Russia and Japan are actively engaged in scientific and practical pursuits to obtain knowledge and economic gain from the sea. The United States has devoted relatively little effort toward the development of our knowledge or utilization of the oceans. It seems axiomatic that the self-interest of this country can best be served by occupying and understanding the sea. Our fisheries need modernization and information. Our utilization and understanding of the food chain in the sea needs more detailed investigations. The mineral wealth of the oceans remains largely untapped and unknown. The sea as a source of fresh water needs further investigation.

These are areas to which science and technology can contribute greatly if given the proper tools and personnel. S. 2439 is an important step in returning the seas to American ingenuity. The basic caliber of marine scientists in this country is excellent, but we need to train more of them and devote more attention to practical problem solving without forgetting that basic research is the foundation of science.

Let this country turn to the sea in this century as it turned to the land in the last century and the bounty of the sea will be ours as the bounty of the land is now.

Again, good luck and best wishes on this important legislation.

Sincerely yours,

GALEN E. JONES,
Director-elect, New Hampshire Marine Laboratory.

SCOTTISH MARINE BIOLOGICAL ASSOCIATION,
Marine Station, Millport, Isle of Cumbrae, Scotland, May 3, 1966.

MR. ARTHUR LARSON,
Office of Senator Gaylord Nelson,
Old Senate Building,
Washington, D.C.

NATIONAL SEA GRANT COLLEGE AND PROGRAM ACT OF 1965

STATEMENT SUBMITTED FOR INCLUSION IN THE RECORD OF THE HEARING ON THE
ABOVE SENATE BILL S. 2439

This statement is submitted by the undersigned, Dr. Clifford H. Mortimer, fellow of the Royal Society, director and secretary of the Scottish Marine Biological Association, and director-designate of the recently constituted Center for Great Lakes Studies, University of Wisconsin, Milwaukee, where he will shortly take up appointment with rank of distinguished professor.

Having, in the preceding paragraph, declared his personal interest, the writer seeks to add his support to the scientific case for this bill and for the inclusion of investigations on the Great Lakes under the definition of "marine studies." It is proper that the Great Lakes should be so included, because the techniques and seamanship needed to solve outstanding problems in lake hydrography and biology are oceanographic in nature and scale, and because there is growing evidence that certain basic and universal processes—for instance, air/water interactions, some effect of the earth's rotation on water movements, pollution-induced biological changes in large bodies of water—can often be more conveniently studied in the lakes than elsewhere.

In some senses therefore, the lakes can provide models of oceanic processes—and they could certainly provide effective training grounds for the young oceanographers needed to man expanding programs in other regions—but the writer prefers to emphasize here that the lakes merit study for their own sakes, not only as sources of new knowledge but also because of their far-reaching impacts on human affairs—to mention only a few: the interconnected problems of water pollution and water supply; shipping and international trade; recreation; development and fate of fisheries; local influences on the climate; and the need for enlightened conservation of an incomparable natural resource.

It is a truism that better management of any natural system can only be based on better knowledge of the fundamental principles at work; and it is here that universities and research institutes can play a key role. The force of this argument can, perhaps, be best illustrated by a single example.

At the recent inquiry concerning the city of Chicago's request for authority to divert more water from Lake Michigan, it became evident that much more fundamental knowledge was needed to provide useful predictions of the motion of water masses within the lake and their influence on pollution dispersal and quality of water intakes. Arising from this need for fundamental knowledge, a large-scale program of measurements from anchored buoys was initiated by the Public Health Service, and is still in progress. Much new knowledge has emerged, to the interpretation of which the writer believes that his studies of internal waves in Lake Michigan (carried out while acting as visiting professor at the University of Wisconsin, and as yet largely unpublished) have also made an essential contribution. This is not the place to describe the pattern of these large waves discovered at the summer boundary between warm surface water and cold bottom water—a pattern new to science and associated with remarkable rotating currents—but this provides a good example of the way in which a problem tackled for its intrinsic scientific interest can sometimes provide missing links in the chain of information required for public health engineering or for conservational management.

The universities must continue to uphold the free pursuit of knowledge for its own sake; but they will also not be backward in the application of this knowledge to human needs, and often indeed to local needs. This truism, also, is very relevant to the problems posed by the Great Lakes, the scale of which is large enough to call for collaboration between the midwestern universities. The University of Michigan, with its Great Lakes Research Division, has long been active in this research field. As a more recent entrant, the University of Wisconsin, and in particular the University of Wisconsin, Milwaukee, has declared its hopes and intentions by the establishment at Milwaukee of a Center for Great Lakes Studies, to initiate postgraduate and interfaculty studies which will exploit a promising position near the major port. No doubt the University of Wisconsin has already, through its proper officers, declared itself in favor of the passage of the National Sea Grant College and Program Act; it remains for the undersigned to add his support as director-designate of the Center for Great Lakes Studies at Milwaukee.

(Signed) C. H. MORTIMER, Ph. D., D. Sc., F.R.S.E., F.R.S.

COLLEGE OF NEW ROCHELLE,
New Rochelle, N.Y., April 29, 1966.

HON. CLAIBORNE PELL,
Senate Office Building,
Washington, D.C.

DEAR SENATOR PELL: As president of the College of New Rochelle it is my pleasure and duty to write to you concerning the National Sea Grant College and Program Act of 1965 (S. 2439).

The College of New Rochelle has recently obtained a 1-acre island located in Long Island Sound adjacent to the campus. A two-story block house type structure is located on the island and will be used as a laboratory to extend our growing program in marine biology for undergraduate students.

When the college learned of the possibilities available to us under the bill I was first inclined to request an opportunity to testify before your committee. I am, however, aware of the many demands placed upon the committee's schedule and have decided against such a request.

Senator Pell, please be assured of the enthusiasm of the College of New Rochelle for your program. The college is very much in sympathy with a program that will aid in the development of knowledge of the water that surrounds us and of those individuals who will explore and study that area.

Please feel free to call on me for any further information or comment your committee may require on this matter.

Very sincerely yours,

Mother MARY ROBERT FALLS, O.S.U.,
President.

DUKE UNIVERSITY MARINE LABORATORY,
Beaufort, N.C., April 26, 1966.

Senator CLAIBORNE PELL,
Committee on Labor and Public Welfare,
U.S. Senate,
Washington, D.C.

HON. SENATOR PELL: Kindly add my endorsement to your proposed bill, S. 2439, "National Sea Grant College and Program Act of 1965." My confidence in this bill is strengthened by the decisive role to be played by the National Science Foundation in the administration of the funds.

From the standpoint of marine sciences, I view two aspects of this bill as healthy and significant. First, is the selection of the National Science Foundation as the administrator. This agency already has proven mechanism for the evaluation and support of research and training and would not itself compete for funds. Second, the assurance of continued funding even at a modest level would allow for the establishment of long-term support of marine sciences within the framework of evaluation procedures that are also already established and functioning well.

My personal view of this bill reflects only its present wording and content and as it now stands I favor it with enthusiasm and trust.

Very truly yours,

ROBERT J. MENZIES,
Program Director.

PREPARED STATEMENT OF HAROLD HOWE II, COMMISSIONER OF EDUCATION, U.S.
DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

It is a pleasure to submit to the Special Subcommittee on Sea Grant Colleges a statement concerning the great untapped land and water resource of marine science.

As always, the Federal Government maintains its firm commitment to the development of natural resources.

You may recall the quotation from Daniel Webster which is located directly over the Speaker's rostrum in the House:

"Let us develop the resources of our land, call forth its powers, build up its institutions, promote all its great interests and see whether we also in our day and generation may not perform something worthy to be remembered."

I am pleased to comment on the National Sea Grant College and Program Act of 1965, a bill which is designed to develop the resources of marine sciences through the building up of our institutions of higher education, promoting all our interests.

S. 2439 would amend the National Science Foundation Act of 1950 to authorize the establishment and operation of a program of support for education, training, research, dissemination of research findings, and advisory services in the areas of marine resources.

Clearly this bill has been introduced with the realization that marine resources constitute a great potential asset for the Nation, that it is in our national interest to develop and utilize increasing facilities and increasing student enrollment for these resources, and that aquaculture, like agriculture, can provide unlimited economic benefits to the Nation.

The sea grant college bill would encourage the development of regional centers of excellence, with increased assistance to established institutions with existing and potential facilities. The funding of S. 2439 is proposed to be derived from 10 percent of the bonuses, rentals, royalties, etc., from leases of Outer Continental land, available only for appropriations to the National Science Foundation for programs with marine sciences. Further the Foundation would have the authority to enter into contracts with institutions which seek to participate in the sea grant college programs.

I would submit that the contribution of the sea grant college concept is entirely consistent with the public service goals of higher education, for the last

frontiers of our Nation—the Continental Shelf of the United States, the Great Lakes, the oceans—may hold the answers to such problems as food sources, fresh water, and mineral resources. Indeed, the field of marine science extends far beyond the academic sphere.

The Federal Government has already made some commitments to the field of marine education and oceanography. The George-Barden Act of 1946, with subsequent amendments, provides funds for training students in specific areas of the fishing trades, as well as in agriculture and other trades. Also, the Graduate school of the U.S. Department of Agriculture offers nine courses in oceanography for Federal employees. Such efforts provide a beginning structure to elevate the importance of marine science and to implement the concept of a sea grant college. Further, many bills have been introduced in Congress providing Federal assistance to the field of marine sciences, indicating the concern and interest of many of our legislators.

Within the Federal Government, the study of oceanography has been supported by the Office of Naval Research, the National Science Foundation, the Bureau of Commercial Fisheries, the Geological Survey, the Public Health Service, the Atomic Energy Commission and others.

However, in spite of these Federal programs, there is a need for further development of courses of study and research capabilities in the area of the marine sciences. Federal assistance to colleges desiring to develop programs of study in this area would do much to bring about a wider distribution of research and learning opportunities throughout the country.

Seven years ago the National Academy of Sciences-National Research Council Committee on Oceanography strongly recommended that universities and other institutions take an active part in the recommended programs of expansion of marine science. There are indications that substantial increases in research in this area would be beneficial.

Dean Athelstan Spilhaus first suggested publicly the concept of a sea grant college in 1963, while he was serving as Chairman of the Committee on Oceanography of the National Academy of Sciences-National Research Council. Subsequently this legislation to establish sea grant colleges was introduced. Shortly thereafter, the University of Rhode Island and the Southern New England Marine Science Association sponsored a conference to examine the concept.

Viable grant programs can and should be based upon searching investigation and continuing research. The comprehensive analysis prepared by the Rhode Island conference, which supplements the sea grant college bill, is strikingly indicative of the professional preparation which has always preceded successful programs.

This scholarly conference discovered that to fulfill our commitments to the sea we must have university and college programs of study and research which focus on the sea. These programs must concentrate all of our intellectual disciplines on the mastery, exploration, and preservation of the sea. The National Science Foundation is one of the original members of, and an active participant in, the Interagency Committee on Oceanography. This indicates the continuous and dedicated efforts of the Foundation in this sphere. Further indications are the countless research grants from the Foundation to higher education for oceanographic studies.

In spite of our favorable attitude toward the purpose of this legislation, I would express some reservations concerning the proposal as it now stands.

First, since it is proposed that the program be a continuing one with long-term commitments to and relationships with institutions of higher education, the administering agency should be given a fuller expression of congressional intent. S. 2439, although it does provide enough authority, does not provide much in the way of guidelines as to the specific objectives of the program.

Second, there is no question as to the excellent reputation of the National Science Foundation for contributions to scientific advancement in a great many areas which involve our national interest and our future goals. However, it should be pointed out that the approach of this bill is one of continuing program support in contrast to the primarily research-oriented National Science Foundation projects such as the present support of oceanographic undertakings in some 18 institutions of higher learning.

Third, concerning the proposed funding procedure, we feel that the needs for an educational support program should be assessed in specific dollar terms rather than being tied to a percentage of revenue as proposed in the present bill. There is no indication that the revenues from offshore activities has a fixed relationship with research or educational need.

In conclusion, there remains unexploited opportunities in the development of our marine environment, even though a number of programs are underway and much legislation and many recommendations are still pending. The introduction of a grant program in this area would be a significant step in the direction of the fullest development of the potential assets of that environment.

The modern university with a broad based and balanced educational program would be the ideal place to implement the new concepts in this relatively new scientific area.

It is indeed encouraging to observe the diligent efforts of this committee in critically examining the great potential which the sea grant college concept may offer. We in the Office of Education are vitally concerned with activities which affect and shape this Nation's institutions of higher education. There is certainly no question that this area of concern will increase in importance in future years, and that we must begin to anticipate the problems and to seek solutions now.

PREPARED STATEMENT OF GARDNER A. CAVERLY, EXECUTIVE VICE PRESIDENT, NEW ENGLAND COUNCIL FOR ECONOMIC RESEARCH AND DEVELOPMENT

This statement is written on behalf of the New England Council in support of S. 2439, the proposed "National Sea Grant College and Program Act of 1965" which is presently pending before the Special Subcommittee on Sea Grant Colleges.

As you may know, the New England Council is a private non-profit organization with a broadly representative membership interested in the sound economic development of the New England region. As a consequence, The Council is particularly interested in legislation which would strengthen the marine sciences.

Because of its location on the coast of the Atlantic Ocean, the New England region has long relied on utilization of its marine resources as an important part of its economy. This dependency has by no means been a static process.

The history of fishing industry in New England provides an example of why a program is needed to stimulate the development of the marine sciences generally. New Bedford, Massachusetts, which now is a site for an outstanding whaling museum which attracts tourists and natives alike to view a significant era in the history of the United States and the New England region, symbolizes how time has changed the fishing industry. Today the Port of Bedford takes in over three-quarters of the scallop catch in the United States worth approximately \$7 million. In addition to scallops, New England's fishing industry is principally based upon groundfish, shellfish and "industrial" fish to be used for meal, fertilizer and other non-food uses. Atlantic Coast tunafish, swordfish and off-shore lobster are new areas which hold further promise.

Significant change has taken place not only in what is collected from the seas, but how the products of the sea are handled once they reach port. Fish products are delivered to processors—to freezers—canners, and others, who transform fish into a food of convenience for the consumer. This industry earns New England more than \$20 million a year.

The market for New England's fishing products has been good in recent years. However, there is a problem in relation to the American and New England share of the world market. At present, United States fisheries can only meet a portion of the nation's fish requirements and there is an increasing need to improve the American and New England fishermen's share of the world and the American market. The trends are not altogether optimistic—shortages of certain fish products in great demand plague the industry. In addition, modern technology requires far greater capital expenditures on equipment and techniques to compete successfully than was true in the past. There is a continuing problem of taking effective advantage of modern technology. There is a further problem of manpower needs going unfilled. Not only do we need ways to improve the quality of the equipment and the fleet, but there is a real need to attract interested and competent persons into trades based upon ocean resources. Other countries with superior equipment and manpower are winning this economic race.

The fact is that the United States has not only lagged in developing its fishing industry, but also many other opportunities presented by the oceans. We need to find improved ways to make use of the ocean's vast and virtually untouched resources. The idea of establishing a sea grant college program is a creative

innovation which we believe can make a significant contribution toward developing this aspect of our economy.

We would like to emphasize the great desirability of providing as the bill would do, authority to expand practical education in the marine sciences, bridge the gap between basic research and applied research in the marine sciences, disseminate useful information to those who can best put it to practical use, develop the continental shelf and provide a special method of financing, consisting of 10% of all royalties, rentals and other sums that are paid to the Government for the use of the continental shelf. It should be noted that grants could be given not only to educational institutions, but to any public or private agency including foundations, laboratories, corporations or even groups of individuals which desire to operate a program under the provisions of this bill. This broad involvement of public and private persons in developing our marine resources is essential.

One further aspect of the program should be stressed. As we understand it, regional centers in the marine science field could be encouraged and expanded under the bill. In New England, we attach great importance to opportunities for regional cooperation. The New England region has moved in many areas to create cooperative arrangements to take advantage of new opportunities. Recently there has been authorized an agreement of cooperation for the joint exploration and exploitation of programs in hydrospace by New Hampshire and Maine. In this connection, a Council composed of six members from each State has been established. This is just one sign of the real interest of the region in finding organizational forms and new programs which can assist in utilizing the vast resources of the sea.

S. 2439 should make a significant contribution to a broad national effort to upgrade programs relating to marine sciences.

PREPARED STATEMENT OF J. LAMAR WORZEL, PROFESSOR OF GEOLOGY, COLUMBIA UNIVERSITY, AND ASSOCIATE DIRECTOR, LAMONT GEOLOGICAL OBSERVATORY OF COLUMBIA UNIVERSITY, PALISADES, N.Y.

Mr. Chairman, Members of the subcommittee: I am honored to have the opportunity to comment on S-2439, the Bill proposing the establishment of National Sea Grant Colleges. First of all, I would like to mention that my colleague, Dr. Maurice Ewing, would have liked to testify before the committee but could not do so because he was at that time and is now working at sea on board our research vessel VEMA.

I congratulate Senator Pell and the other members of that committee for their foresight in seeking to stimulate the marine sciences and their exploitation for the good of the people of the United States and the world by means which parallel the establishment of the land grant colleges, which did so much for this country a century ago.

We are still a long way from having a thorough knowledge of the oceans and, in my opinion, it will take many years of further study to take full advantage of the opportunity we have in oceanographic research to unravel the puzzles about how the earth was originally formed and its history since that time. The opportunities to use the oceans efficiently for the production of food and depleted natural resources are self-evident, but no less important for this fact.

The National Science Foundation seems to me to be a very suitable agency through which to channel the funds obtained from rents and royalties paid to the Federal governments for use of the continental shelf to those agencies and institutions concerned with the marine sciences. I would suggest that the Foundation establish some means for deciding on the merit of proposals made for sea grant funds, making use of members of the scientific community and representatives of the Federal agencies to which oceanographic research is vital. Several of these agencies, notably the Office of Naval Research, the Bureau of Ships and the Atomic Energy Commission have had long experience in funding research at non-governmental institutions and I believe that they should continue to play a leading part in allocating Federal funds for oceanographic research.

We welcome the inclusion in the definition of the term "marine sciences" of the broad range of fields which are vitally affected by the marine sciences.

We at Columbia University's Lamont Geological Observatory will continue to follow with interest the progress of the concept of sea grant universities and

we wish to extend our congratulations to those senators who have had the wisdom and imagination to seek practical means by which to allow mankind to make practical uses of the great resources of the oceans.

PREPARED STATEMENT OF EDWIN A. LINK, LINK GROUP, GENERAL PRECISION, INC.,
BINGHAMTON, N.Y.

Thank you, Senator Pell, for your invitation to testify and comment on the pending bill for Sea Grant Colleges.

My experience with the Deep Submergence Review Group of the U.S. Navy and my research work on the Man-in-the-Sea program of deep diving and living at great depths have certainly emphasized the need of having qualified youth understand the problems and environment of the oceans, which at present is lacking particularly in ocean engineering.

I have been working with Florida Atlantic University which is the first university, I believe, to establish an Ocean Engineering course. Also through the Link Foundation, which I established some years ago, we have given them, and others, grants for students in ocean engineering and development of curriculum.

At present I am engaged with the research vessel Sea Diver in developing deep diving systems and have taken on board at my own expense two senior students of Florida Atlantic to give them actual ocean engineering experience, so bad is the need for these trained young men, and because of the almost complete lack of any available training at the present time.

With this background of experience and knowledge of the necessity I hope that Sea Grant Colleges will be established to fill this vacuum.

NEW YORK, N.Y., *May 11, 1966.*

Senator CLAIBORNE PELL,
Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.

DEAR SENATOR PELL: The wide range of activities that may be grouped under the general heading of oceanology includes many areas where pure research may be delayed for lack of the techniques and equipment necessary to carry on such programs. It may well be the case, therefore, that in this emerging science the development of techniques and equipment will have to precede basic research rather than the reverse, which is contrary to the classic relationship. Consequently, it is gratifying to note that the proposed bill S. 2439, the National Sea Grant College and Program Act of 1965 takes cognizance of this fact under section 2(d)(2) which states that the Federal Government should support sea grant colleges and programs by "initiating and supporting necessary research and development programs in the marine sciences resulting in the acquisition of knowledge of a direct and practical nature, with preference given to programs that translate the findings of basic research to practices, techniques, and equipment applicable to the marine sciences."

Similarly, the proposed amendment to the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.) contained in section 3(c) appears to be well advised in proposing that:

"(c) Programs to carry out the purposes of section 3(a)(10) shall be accomplished through contracts with, or grants to, suitable public or private agencies, public or private institutions of higher learning, museums, foundations, industries, laboratories, corporations, organizations, or groups of individuals, which are engaged in, or concerned with, activities in the marine sciences, for the establishment and operation by them of such programs."

I believe that the legislation proposed by S. 2439, and especially those sections cited above, could materially increase the rate of development of oceanology in the United States.

With every good wish for your success, I am,

Sincerely,

PETER R. GIMBEL.

GREAT LAKES COMMISSION,
Ann Arbor, Mich., April 12, 1966.

Hon. CLAIBORNE PELL,
Old Senate Office Building,
Washington, D.C.

DEAR SENATOR PELL: The Great Lakes Commission has authorized me to express the commission's endorsement of Senate bill S. 2439, which would authorize the creation of sea grant colleges, with the provisions that the bill should be amended or include provisions to limit the number of institutions participating to those that have a bona fide interest in the marine environment geographically and historically; that nonduplication of effort in research and training be stressed; and that section 2(d)(5) be emphasized: the regional "centers of excellence."

The Great Lakes Commission is convinced of the great importance of the need for study and development of the marine environment, and believes that much of the future wealth and resources of the globe will accrue from these marine areas.

It is our pleasure to furnish our comments and statement of position. We hope you may see fit to consider them favorably.

Sincerely yours,

LEONARD J. GOODSSELL,
Executive Director.

INSTITUTE OF SCIENCE AND TECHNOLOGY,
THE UNIVERSITY OF MICHIGAN,
Ann Arbor, Mich., April 26, 1966.

Hon. CLAIBORNE PELL,
Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.

DEAR SENATOR PELL: Thank you for your invitation to comment on the bill S. 2439, National Sea Grant College and Program Act of 1965. You are to be commended for foresight in developing plans for effective utilization of the world's marine resources.

There has been a longstanding need for a feasible plan for man's complete utilization of the ocean's tremendous resources. Such a plan should encompass the harvesting and management of all usable products, the understanding of the ocean's characteristics, processes, and phenomena and their potential application to man's welfare, and the ultimate occupancy of the ocean as a place for man to live and enjoy. The plan must necessarily be imaginative, daring, long ranged, and designed to obtain and apply scientific knowledge and technology to all aspects of the marine environment. The concept of the sea grant college could well be the basis for such a plan.

The sea grant college concept should parallel in practice the land-grant college concept only in principle, not in detail. Sea grant colleges should be established first in educational institutions with established records of accomplishment in the marine sciences and have the potential for a strong program in ocean engineering. A sea grant college should have a program involving the totality of the sea, encompassing education and training, research, and resources exploitation. It should involve the natural and social sciences, the arts, law, planning, and engineering. As the program progresses, institutions may be established to meet special needs, but the educational institution should always remain the core of the program.

The role of the Great Lakes in the development and promotion of the sea grant college concept is an important one:

1. These mesoscale water bodies, possessing both oceanic and lacustrine characteristics, are uniquely suited as models or laboratory-sized oceans for the study of a great variety of scientific and engineering problems of interest to marine scientists. Evident examples are studies of air-water interaction phenomena and developmental aspects of the "man in sea" project.

2. Absence of salinity, of heavy biological fouling, and of wood-boring organisms makes the Great Lakes excellent test sites in which the operating principles of new instrumentation can be tested without the necessity for expensive protection against corrosion, electrolysis, fouling, or borers.

3. Within the Great Lakes basin is a unique complex of institutions of higher education, possessing a large reservoir of scientists and engineers, and the capa-

bilities of directing their vast educational, scientific and technological competence to the solution of regional and national problems. Many of these institutions have strong programs in the aquatic sciences, and several are pursuing active research and student training programs on the Great Lakes and the oceans.

I wish you success in the enactment of this bill and greatly appreciate the opportunity to express my views.

Sincerely,

DAVID C. CHANDLER,
Director, Great Lakes Research Division.

WEST COVINA, CALIF.,
May 11, 1966.

HON. CLAIBORNE PELL,
Senator from Rhode Island,
325 Old Senate Office Building, Washington, D.C.
Re Bill S. 2439.

DEAR SIR: I was delighted to answer Senator Murphy's inquiry of April 22, asking for an evaluation of your bill, S. 2439, and to discuss with him its merits. The United States urgently needs a legislative foundation to focus attention on and give support to the three programs you identified when you introduced the referenced bill. These are:

Program 1: Make funds "available to colleges and universities for the purpose of expanding practical education in the marine sciences." (I interpret "marine sciences" to include the "field of oceanics.")

Program 2: Make funds available for the "purpose of supporting research that will lead to a direct and practical nature in the marine sciences."

Program 3: Make funds available for the purpose of establishing a "system of extension services to bring the latest developments in the marine sciences to the attention of workers in the field, scientists, and the interested public."

Several times you asked witnesses if the Smithsonian Institution would be an appropriate administrator for the effort described in bill S. 2439.

Because of the importance of all three oceanic programs of this legislation, and because of the statements made during the hearings of May 5, 6, and 7, 1966, I believe that the Smithsonian is by far the best selection as administrators and that an amendment to the bill is appropriate.

The Smithsonian, under the first Secretary, was the parent of the U.S. Weather Bureau. Under the second Secretary it was the parent of the Fish Commission. It was also the parent of the National Advisory Committee for Aeronautics. The Smithsonian is "an establishment for the increase and diffusion of knowledge among men." It has the experience from its Editorial and Publications Division to disseminate a steady flow of knowledge resulting from research.

Another reason for selecting the Smithsonian is their Board of Regents composed of the Vice President of the United States, the Chief Justice, three Senators, three Representatives, and six private citizens. It seems necessary that a major oceanic grant such as a national sea grant college should be approved by the highly qualified "proposal approval board." The Smithsonian Institution's Board of Regents is exactly such a body.

I discussed briefly with Dr. I. E. Wallen, Smithsonian's representative to the Interagency Committee of Oceanography, the feasibility of creating an Oceanics Bureau within the Smithsonian to: administer bill S. 2439; prepare and administration plan for the effort; and establish an oceanic data bank to collect and disseminate oceanic-type data generated by the recipients of the grants. He stated, as did Dr. Galler to you on May 3, that it is necessary for the Smithsonian Board of Regents to approve such an undertaking, but that it was certainly within the scope and philosophy to perform this task. Dr. S. Dillon Ripley's statement delivered by Dr. Galler specifies the keen interest the Smithsonian has in oceanian items and the importance it places on your bill.

Finally, I believe you should require that an administrative plan should be prepared and approved prior to any institute or agency starting administration of the effort identified in your bill.

Very truly yours,

WILLIAM A. LOBBAN.

THE MARINE DIGEST,
Seattle, Wash., April 28, 1966.

Senator CLAIBORNE PELL,
Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.

DEAR SENATOR PELL: For the hearing record, may we express our complete support and endorsement of the general purposes of the legislation proposed by you in your bill to establish sea grant colleges.

The demands for trained people to serve in oceanography, the development of which is a vital U.S. need, almost dictates the necessity for passage of the sea grant educational concept.

Sincerely yours,

JOHN M. HAYDON,
Vice-Chairman, Puget Sound Oceanography Study Committee.

MARINE TECHNOLOGY SOCIETY,
Washington, D.C., April 26, 1966.

HON. CLAIBORNE PELL,
U.S. Senate,
Committee on Labor and Public Welfare,
Washington, D.C.

MY DEAR SENATOR PELL: Thank you for your letter of April 22, and the opportunity to comment on S. 2439, which you kindly enclosed.

I believe S. 2439 is a positive step toward the development of a strong national capability to understand the oceans, including the Great Lakes, and lay the foundation of knowledge for their intelligent utilization for the benefit of all mankind.

In the last century our forefathers' creation of land grant colleges laid the foundation for U.S. leadership in development of agricultural sciences. The agricultural achievements that have taken place in the United States during the past 100 years have proven to be a blessing not only to our own country but to the entire world.

At this time, when the world's need for food and other raw material is exploding, man must look to the sea for solutions of tomorrow's as well as today's problems. It is encouraging to see U.S. leadership again assert itself in positive steps envisioned in S. 2439 to encourage the growth of understanding necessary for wise and efficient utilization of the oceans.

S. 2439 recognizes the extent to which the funds to support ocean development are already flowing into the National Treasury as a result of offshore leases. The self-supporting provisions set forth in section 3 of S. 2439 are sound and most encouraging.

I believe S. 2439 will become one of the foundation stones upon which the United States will build a strong national ocean program which will benefit this generation and those to come. I hope the Congress will enact S. 2439 into law during this session.

Thank you again Senator Pell for the opportunity to comment on S. 2439 and for the splendid leadership you are giving to the development of a strong national ocean program.

Sincerely,

E. C. STEPHAN,
Rear Admiral, U.S.N. (Retired), President.

NATIONAL CANNERS ASSOCIATION,
Washington, D.C., May 9, 1966.

HON. CLAIBORNE PELL,
Chairman, Special Subcommittee on Sea Grant Colleges, Committee on Labor and Public Welfare, U.S. Senate, Washington, D.C.

DEAR SENATOR PELL: We would like to express, for the record, our support for the objectives of S. 2439, the National Sea Grant College Act. We commend your efforts and the recent hearings of the Special Subcommittee on Sea Grant Colleges, for focusing congressional and public attention on the vital need for a broad program of marine science education in our colleges and universities.

The commercial fishing industry in this country has long been aware of the practical benefits, in terms of increased harvest and more effective conservation of fishery resources, which could result from increased knowledge of the oceans and their living resources. The United States has been unfortunately slow to recognize the true significance of the world's ocean resources and the importance of basic research and educational programs in the marine sciences.

We have been pleased to note increased congressional awareness of the importance of the marine sciences, as evidenced by the introduction of a number of bills and the extensive House and Senate hearings on this subject during the last session of Congress, culminating in passage of S. 944, "The Marine Resources and Engineering Development Act," which is currently in conference.

We strongly believe that if the United States is ever to regain her traditional place of eminence among the world's fishing nations, the marine sciences must be as integral a part of our educational system as the agricultural and space sciences. The establishment of a sea grant college program would seem a logical and necessary step in this direction.

Sincerely yours,

RONALD W. DE LUCIEN,
Director, Fishery Products Program.

NATIONAL EDUCATION ASSOCIATION,
Washington, D.C., May 6, 1966.

HON. CLAIBORNE PELL,
*Old Senate Office Building,
Washington, D.C.*

DEAR SENATOR PELL: Dr. William G. Carr, executive secretary of the National Education Association, has requested that I reply to your letter requesting comments on S. 2439, the "National Sea Grant College and Program Act of 1965."

In general, we would support such a proposal as S. 2439, and commend you for your farsightedness in introducing such a bill. The statements in section 2, "Declaration of Purpose" express our views very well, and we concur with them completely.

Section 3(b) causes us some concern. We are in support of the proposal, first advanced by Senator Lister Hill in the 1940's, for earmarking Federal income from bonuses, royalties, and leases on offshore lands for education. More recently, Senator Paul Douglas has proposed that such income be earmarked for payment of the national debt. We note that S. 2439 proposes setting aside 10 percent of such income for the purposes of this bill. Insofar as your proposal does not conflict with the objectives of the others, we would support it. If such earmarking is to be made, we suggest rewording the last three lines of section 3(b) (lines 22-24) to read "* * * in a special account in the Treasury to be available (only) for appropriations to the Foundation, which are hereby authorized, to carry out only the purposes of section 3(a) (10)."

We also strongly urge that the new section 18(c) be amended to insert the word "nonprofit" in line 15 after the word "private" in both instances to read "grants to suitable public or private nonprofit institutions, etc." Similarly, on page 7, subsection (3), line 10, the definition of "sea grant college" should include the word "nonprofit" after the word "private."

The education community is becoming increasingly concerned with the weakening of the proper educational functions of public and other nonprofit institutions by the invasion of private profitmaking interests into the field of Government tax-supported research and education.

Since the proposal for sea grant colleges is a new one, we feel strongly that the opportunity provided in this bill should be confined to the public and private nonprofit institutions. If, after a reasonable length of time, they prove to be unequal to the task—and we do not feel this will be the case—then subsequent amendments could be considered. However, the establishment of sea grant colleges can potentially be as great a step forward as the establishment of land-grant colleges a century ago. We believe that such a resource, if developed as you propose from public funds, should be protected from the special interests of profitmaking agencies.

With these reservations in mind, we, in general, support the proposal to establish sea grant colleges and commend you for your creative idea.

I will be happy to discuss our views with you further if you wish.

Sincerely,

JOHN M. LUMLEY,
Director, Division of Federal Relations.

OCEAN SCIENCE & ENGINEERING, INC.,
Washington, D.C., May 7, 1966.

Senator CLAIBORNE PELL,
U.S. Senate, Washington, D.C.

DEAR SENATOR PELL: This is in answer to your request of April 22 for my views on S. 2439. I am sorry that I have not had time to think through the implications of your bill which may be far reaching and important in the development of ocean science. Therefore, I will discuss only a few points rather than the broad issues.

Generally it is believed that oceanic work will develop rapidly in the next few years and it is entirely proper that the Federal Government should support programs intended to develop new knowledge and to train people. I think that no one will disagree with that idea; although arguments will arise as to exactly how this should be done. On page 3, line 7, it is suggested that the Federal Government, presumably through the National Science Foundation, "give preference to programs that translate the findings of basic research into practice." In that phrase, you have run head on into the aims and objectives of this company. It is entirely proper that the Federal Government do the basic research and perhaps do some things which might be termed practical research. However, the translation of these into commercial practices and useable tools is a function which can better be performed by companies such as ours.

I am a little uneasy at the idea that much of this program will be carried out under the National Science Foundation. From Government-organizational point of view, I suppose that is the proper agency to do the job. However, the past record of the National Science Foundation in dealing with engineering at sea and ship operations has not been good and has been notably subject to political pressures. In carrying through with this work, I think it would be well if you and other senior legislators would try to find time to review the actual operations under the law to see that they conform to the objectives which the Congress has in mind.

Yours truly,

WILLARD BASCOM,
President.

OREGON STATE UNIVERSITY,
SCHOOL OF AGRICULTURE AND AGRICULTURAL EXPERIMENT STATION,
Corvallis, Ore., April 26, 1966.

HON. WAYNE MORSE,
U.S. Senate,
Senate Office Building,
Washington, D.C.

DEAR SENATOR MORSE: In view of your demonstrated interest in Oregon's fisheries, I am providing you with the enclosed statement on the National Sea Grant College and Program Act of 1965 (S. 2439, 89th Cong.). This was prepared by a group of biologists at Oregon State University, who are named on the last page of the statement.

There is a critical need for financial support for marine biological research. To my mind, this need is brought into sharp relief by the presence of the Russian fleet presently exploiting the fishery resource off the Oregon coast. For, as a consequence of inadequate funds to support basic research on fishes of the sea, we are not prepared to engage in effective discussion with foreign powers for the purpose of establishing a sound treaty to conserve our marine fishery. The Russians may know more about some segments of our fishery resource than we know ourselves.

We are concerned about whether the National Science Foundation is the best choice of agencies for administration of the National Sea Grant College and Program Act of 1965, because it has a well-established policy of nonsupport to research with any visible applied values. This policy would be in direct conflict with the intent of the proposed sea grant colleges and programs.

Oregon State University, with its new marine science center, would be well situated for initiating and developing the basic research and extension programs envisioned by the act.

Respectfully yours,

THOMAS G. SCOTT,
Head, Department of Fisheries and Wildlife.

A STATEMENT ON THE NATIONAL SEA GRANT COLLEGE AND PROGRAM ACT OF 1965
(S. 2439, 89TH CONG.)

This is an expression of views supporting the biological sciences aspects of the sea grant colleges and programs as proposed in the National Sea Grant College and Program Act of 1965:

1. WHY SHOULD SEA GRANT COLLEGES AND PROGRAMS BE ESTABLISHED?

A. The orderly development and exploitation of marine resources is essential to the world's resource demands of the future. The value of the materials and commodities presently obtained from marine sources can be used only as a very conservative index of the potential value of the resource. The problem is not a lack of resources but a need to identify and locate the stocks of useful items and to develop techniques for their harvest. It is well established that there are large untapped fisheries off the coast of the United States. The U.S. catch in 1963 was approximately 4.8 billion pounds of all species of fish, while a recent conservative estimate places the potential catch in the vicinity of 20 billion pounds (McKernan, D. L., 1965, "The Fish Boat." H. L. Peace Publishers, New Orleans, pp. 14-15).

B. Development of aquaculture will benefit the United States as well as other countries and enhance the position of the United States as a producer of food for worldwide consumption. Decline of the ability of the United States to compete in harvesting the marine fishery has resulted in a drop from second to fifth place in world production between 1948 and 1963. During this interval America's contribution to the world catch decreased from 12.4 to 5.8 percent. From 1949 to 1963 our imports rose from 20 to 59 percent of the U.S. market for fish (anonymous), 1965, "The Fish Boat," H. L. Peace Publishers, New Orleans, pp. 29-52). From these data, it may be inferred that the United States has entered the world market in competition with countries less able to produce their own supplies of scarce protein.

C. The gap between basic and applied marine research must be narrowed. Any discussion of this topic must include recognition of the substantial deficiencies which exist in our store of basic information on biological, marine resources. Equally critical is the need for application of existing knowledge. Secretary Stewart L. Udall, U.S. Department of the Interior, has summed up the problem: "Clearly what is missing is application of the results of our research scientists to the technological problems of our fishing industry. The problem is to bridge, on a continuing basis, the gap between the basic and the applied. The fisherman requires more widespread application of advanced location devices and the development of new ones. He needs strategic information, the kind that can be derived from analysis and dissemination of the latest available information on ocean currents and water temperatures so that he can proceed with a minimum of delay to the ocean areas most likely to yield an abundance of fish of the kind he is seeking. He likewise needs the most economical means of preserving the catch against deterioration between the sea and the consumer" (Udall, 1965, Fishing Gazette, Fishing Gazette Publishing Co., New York, p. 10). The commercial fisherman needs to be continually informed on matters that will make it possible for him to become a more efficient fisherman, and thereby improve the economic status of the fishing industry as well as his own standard of living. The industry engaged in processing fishery resources also needs to be responsive to advances in food technology. In a sense, a gap also exists between basic knowledge and its application when a renewable marine resource goes to waste for lack of markets.

D. It is imperative to the well-being of the United States that knowledge of the marine resources off our shores be expanded and refined. How can we hold intelligent discussions with foreign powers aimed at the signing of treaties for the conservation of fishery resources if we do not have information on the species present and on their populations, rates of production, and requirements? It would not be surprising to learn that some foreign countries—Russia, for example—might be better informed on some of our fishery resources than we are.

2. WHAT WILL HAPPEN IN THE ABSENCE OF ORDERLY DEVELOPMENT AND INTELLIGENT MANAGEMENT OF MARINE RESOURCES

A. Many potentially valuable marine resources will remain unrecognized and, therefore, unexploited.

B. Human activities such as pollution, excessive exploitation, and destruction of productive areas by activities unrelated to exploitation may endanger the continued well-being of these resources, possibly even without our being sufficiently informed to know what is happening.

C. Unplanned and uncontrolled exploitation of marine resources will result in ineffective exploitation, including damage to or loss of the resources.

D. The United States will become increasingly dependent on outside sources of supply for marine products which are potentially available to us off our own shores.

E. Failure to develop economically feasible methods of exploiting fishery resources off our own coasts will cause the United States to import fishery products for which less fortunate nations may have a critical need.

F. Incomplete and faulty information on fishery resources off our coasts will leave us in an untenable position in discussions with foreign powers exploiting fishery resources off our shores.

3. WHAT THE BILL MUST PROVIDE

Adequate financial support to initiate and develop basic and applied research programs and training programs in the marine sciences, and initiation and development of programs of education to make the results of research available to those engaged in harvesting these marine resources.

4. EXAMPLES OF RESEARCH WHICH SHOULD BE SUPPORTED BY THE BILL

Preparation for rational exploitation of the natural resources of the sea must be based on a sound understanding of the resources. Basic to management programs is knowledge in the following areas:

A. Inventory:

(1) *Survey*.—What is there?

(2) *Distribution*.—Where are these marine resources in both time and space?

(3) *Standing crop*.—What is the magnitude of the resource?

(4) *Rate of renewal*.—How heavily can the resource be exploited through aquaculture?

B. Requirements for Management:

(1) Determination of conditions necessary for optimal production and yield.

(2) Manipulation of resources to obtain optimal yield.

(3) Experimentation with artificial measures for augmenting the natural production through aquaculture.

(4) Evaluation of the effects of human activities on the well-being of the resource.

5. RESULTS TO BE EXPECTED FROM THE NATIONAL SEA GRANT COLLEGE AND PROGRAM ACT OF 1965

A. Development of adequate information for judging the total potential of marine resources. The scientific community can, at present, provide only a very imperfect inventory of the kinds and numbers of organisms (plants and animals) to be found in marine waters and of their distribution.

B. Provision of information concerning the natural interrelationships of organisms composing the marine communities.

C. Establishment of requirements for the protection of the resources located in the intertidal and upper sublittoral areas surrounding oceanic basins that are most vulnerable to damage by human activities by improper exploitation because of their accessibility. These areas also are biologically the most productive of all marine environments.

D. Translating the basic information into a program of training operations for the business of harvesting the resources in a responsible fashion.

6. WHAT ACADEMIC INSTITUTIONS ARE BEST SUITED TO DEVELOP A COMPLETE PROGRAM?

A. Land-grant colleges and universities have a framework in their schools of agriculture, engineering, science, and in their extension services for initiating and developing basic research programs, applied research programs relating to management and harvesting practices, and programs of scientific training and public education.

B. Some of these institutions already have excellent facilities for research, training, and educational programs in the marine sciences, which, with additional financial support could serve the purpose for which this bill is intended.

Thomas G. Scott, Ph. D., head, Department of Fisheries and Wildlife; Carl E. Bond, Ph. D., professor, Department of Fisheries and Wildlife; Peter Dondoroff, Ph. D., professor, Department of Fisheries and Wildlife; Howard Horton, Ph. D., associate professor, Department of Fisheries and Wildlife; Raymond E. Millemann, Ph. D., associate professor, Department of Fisheries and Wildlife; Harry Phinney, Ph. D., professor, Department of Botany; and Charles E. Warren, Ph. D., professor, Department of Fisheries and Wildlife.

RAYTHEON Co.,
SUBMARINE SIGNAL DIVISION,
Newport, R.I., May 3, 1966.

HON. CLAIBORNE PELL,
U.S. Senate,
Washington, D.C.

DEAR SENATOR: I would like to offer my full support for early passage of the national sea grant college and program bill (S. 2439) which you have sponsored and is now under consideration by your subcommittee.

There is no field for scientific progress and engineering development more critical than oceanology to the future of industry represented in this division of Raytheon Co. Vastly greater knowledge of ocean phenomena and more reliable means for their exploitation are requirements which daily command our attention in efforts to meet the needs of defense and commerce as well as those for scientific exploration itself. It is equally apparent that progress commensurate with the need and the intellectual potential of this country is not being made.

It is continually more difficult to obtain scientific and engineering personnel with skills disciplined to handle problems peculiar to the ocean environment. More importantly, the fund of knowledge available to them in the scientific and technical community at large is not adequate to the size or complexity of their tasks. Government and private investment in the material means to achieve progress will become increasingly restricted in proper application, if the sources of trained manpower are not expanded.

I believe that the proposed legislation for sea grant colleges is the most rational approach to give early and continuing relief to the problem. It will build upon a well-established educational foundation to preserve the interrelationships which should exist among the many disciplines needed for ocean science and engineering and to expand experimental facilities for timely application of research findings. Not only will the products of these institutions add to the vitality of our industry, but, as has been the experience of this division, industry can bring to their facilities new concepts for instruments and processes which require experimental verification and adaptation.

Sincerely yours,

W. ROGERS HAMEL,
Vice President and General Manager, Submarine Signal Division.

NEW YORK, N.Y., May 2, 1966.

HON. CLAIBORNE PELL,
U.S. Senate,
Washington, D.C.

DEAR SENATOR PELL: Thank you for extending me the opportunity to comment on S. 2439, the National Sea Grant College and Program Act of 1965.

While I am not well informed enough in this field to make a constructive contribution by commenting in depth, I do applaud the general purposes of this legislation. It is clear we need to know much more about the sea around us, and I welcome your efforts to extend Federal participation in this field.

With all best wishes,

Sincerely,

LAURANCE S. ROCKEFELLER.

TEXAS A. & M. UNIVERSITY,
College Station, Tex., May 11, 1966.

HON. CLAIBORNE PELL,
Committee on Labor and Public Welfare,
U.S. Senate,
Washington, D.C.

DEAR SENATOR PELL: Your invitation to comment on the proposed sea grant college program is greatly appreciated.

As one of the few educational institutions in the country with a large ocean-going oceanographic program, Texas A. & M. University endorses the objectives of S. 2439, the National Sea Grant College and Program Act of 1965. Increased Federal support of research and education in marine sciences and technology is in the national interest for it is the key to mastery of the ocean environment and to development of ocean resources.

We do wish to suggest, however, that the bill might be strengthened by providing for a distinction between sea grant colleges, a title that might be reserved to those institutions where the full range of education, research, and services pertinent to the occupation and exploitation of the oceans would be developed, and sea grant projects and programs, which might be initiated at any institution with the requisite competence.

Full implementation of the aims of the bill would seem to require pursuit of the land-grant college analogy at least to the establishment of marine research stations and aquacultural educational services to the public as operating arms of sea grant colleges. In our view, such research-education-service systems would need more assurance of long-term funding than is implied in the bill. The support of such sea grant college systems would not preclude, but should be coupled with, support of sea grant projects and programs at other institutions.

I hope these comments will prove useful to you.

Sincerely yours,

EARL RUDDER, *President.*

TEXAS INSTRUMENTS, INC.,
SCIENCE SERVICES DIVISION,
Dallas, Tex., May 10, 1966.

Senator CLAIBORNE PELL,
U.S. Senate,
Senate Office Building,
Washington, D.C.

DEAR SENATOR PELL: I am delighted to have this opportunity to comment on S. 2439, the National Sea Grant College and Program Act of 1965.

Unfortunately, I was unable to attend the national conference on the concept of a sea grant university, sponsored by the University of Rhode Island in October 1965; however, I have carefully read the proceedings of the conference and have discussed this program with a number of my colleagues. All those whom I have approached have been intrigued and have liked the concept. As for myself, I am strongly in favor of such a program. I believe that passage of S. 2439 will provide the necessary foundation and catalyst for the long-term development of our natural resources in the sea.

The bill, as presented, is completely acceptable to me.

Sincerely yours,

KENNETH H. DRUMMOND,
Washington Representative.

UST/UNDERSEA TECHNOLOGY,
COMPASS PUBLICATIONS, INC.,
Arlington, Va., May 9, 1966.

Senator CLAIBORNE PELL,
U.S. Senate,
325 Old Senate Office Building,
Washington, D.C.

DEAR SENATOR PELL: Thank you very much for your letter of April 22, 1966, soliciting our comments related to S. 2439. As the Nation's first and foremost specialized business magazine within the oceanographic community, UnderSea Technology welcomes this opportunity to express its views.

May we commend you on your bill S. 2439. We share your view that education is a key factor to the beneficial harvesting of the seas.

Oceanography is important business—a Government, industry, and academic community constituted by both big business and small business; an exploding new market on a new economic frontier assuring benefits for this great Nation of ours.

Believing no other frontier offers greater economic return for effort and dollar invested, we have urged constructive deliberation on matters related to oceanography, suggesting this will lead to meaningful and purposeful legislation such as S. 2439.

We are encouraged by the expected enactment of Senator Magnuson's bill S. 944 believing this legislation to be an extremely important and significant recognition of the opportunities for action in what remains this last frontier for these United States.

S. 2439 is a much needed companion. Enjoying historical precedence, the sea grant college like its predecessor the land grant college serves two basic and inescapable needs—the assured and increasing return on our ocean investment and a practical and equitable solution to the young men and women of our Nation who with increasing numbers wish to pursue a career in oceanography. As this new community of interest captures the imagination of our young folk, those youngsters in the primary grades, etc., such as Buck Rogers of yesteryear, what more logical step, what more practical solution exists than providing the means whereby the extension of this interest and imagination can be converted into application and working knowledge of a specialized nature. Our Nation will be the richer.

The following is in part a message we forwarded to the President several months ago.

“May we now, Mr. President, solicit your aid in achieving ‘opportunities for action’ in what remains the last frontier for these United States? Your outstanding achievements as a legislator in the early days of aerospace, your profound regard for the well-being and defense of your countrymen, your keen foresight and imagination in regard to the future of our great Nation and your deep concern for the peoples of the world prompts this request for action, for increased attention to the seas around us, the inherent values contained therein and the benefits due us all.

“Expanded exploration, exploitation, such as desalination and increasing uses of the ocean environment have already begun. We are on the threshold of a new and powerful industrial, scientific, and academic era dedicated to this environment. Wider and wider attention is rightfully being given the oceanographic community. Employment opportunities of the first magnitude—the result of new and expanding business and manufacturing enterprise—are here. A new generation of oceanographers, oceanologists and aquanauts is emerging. Many of the courageous domestic policies and opportunities initiated by your administration can be enhanced by benefits derived from and with the oceanographic community. We submit that no other single field of endeavor can offer such opportunities for a greater return in exchange for practical, economical, and world political considerations.”

Consistent with our remarks, we urge favorable consideration for your bill S. 2439 and we offer our wholehearted support.

You may be interested to know that the editors of *UnderSea Technology*, Mr. Larry L. Booda and Mr. Charles W. Covey, received just recently the Jesse H. Neal Editorial Achievement Award. It was presented in recognition of the most outstanding series of editorials among the Nation's business magazines. The subject matter of the editorials related to our messages to the industry we represent and the Government.

The forthcoming May issue will contain several references to your bill as well as an article entitled “Sea Grant Colleges” authored by Dr. John A. Knaus, dean, Graduate School of Oceanography, University of Rhode Island.

We look to you and your colleagues for serious consideration in this current “opportunity for action” so important to oceanography as thoughtful consideration to the Nation's ocean exploration program is being rendered.

Sincerely,

CHARLES H. BUSSMANN, *Publisher.*

UNITED AIRCRAFT,
May 10, 1966.

Senator CLAIBORNE PELL,
U.S. Senate,
Washington, D.C.

DEAR SENATOR PELL: Thank you for sending me a copy of your bill S. 2439 and your invitation to comment. I am sorry that my work has kept me away from the office so much that my reply has been delayed.

I feel that the objective of your bill is excellent. In the interest of our national posture in the world community, we need urgently to develop the skilled manpower, including scientists, engineers, and technicians, and the facilities and equipment necessary for the exploitation of these resources.

I feel that the land-grant college program is largely responsible for our pre-eminent position in agriculture today, and it would be desirable if we could utilize a similar technique to educate ocean engineers and develop capabilities that can be passed on to those who will exploit the ocean. The program should be heavily oriented toward applications, and there is some doubt in my mind that the National Science Foundation is best suited for administration of the Federal portion of the program. I confess to being at a loss to suggest a better place from among the present Government organizations.

Perhaps, if the opportunities still exist, you might consider a slight modification so that administration by the National Science Foundation is regarded as temporary, pending the establishment of a more appropriate oceanographic agency with the Federal Government. I would be happy to discuss this in greater detail if you desire.

Thank you again for giving me the opportunity to comment. I will be happy to assist you with the sea grant idea in any way I can.

Sincerely,

H. A. ARNOLD,
Assistant to the Chief Scientist.

UNIVERSITY OF MIAMI,
Coral Gables, Fla., May 11, 1966.

HON. CLAIBORNE PELL,
Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.

DEAR SENATOR PELL: I greatly appreciate your courtesy in allowing Dr. C. P. Idyll, the chairman of the fisheries division of the Institute of Marine Science, to testify in favor of your bill S. 2439, the National Sea Grant College and Program Act of 1965. You are well aware, of course, of the interest of our institution in oceanographic and fisheries research, and of our deep commitment to the kinds of activities your bill would encourage and support. We look on it as an intelligent and effective method of supporting programs vital to the United States.

I am informed that one unresolved point concerning the administration of the sea grant college program is whether and how matching funds should be required from institutions which become recipients of program support. I am aware of the advantages of some such provision, but I am concerned whether it might eliminate from the program a private institution, such as ours, which has already contributed private funds (not State) to establishing buildings and a faculty, and which would be penalized if required to shoulder a yet greater financial burden to support the purposes of the Government.

I would assume that the objective of requiring matching funds to be supplied by sea grant colleges would be to increase the amount of money available for the work on the one hand, and to provide evidence of serious commitment to the program on the other. If the report of your subcommittee includes a recommendation that some kind of contribution should be required from institutions participating in the sea grant program, I would respectfully request that it stress the reasons for such a requirement. Further, I am anxious that the report should recognize that some institutions, like my own, have existing programs and records that show clearly that they have the necessary serious commitment to the concepts of the program and have already committed private funds to the general purpose. They may be unable to provide further matching funds in dollars, but this should not eliminate them from the program. Could not the report specify that the administering agency should have the authority to accept the existence of laboratory buildings, research vessels, equipment, faculty, and other assets as equivalent matching commitments? Is it not also pertinent that

the Bureau of the Budget, in its directives regarding matching funds, has clearly exempted programs of national importance from these requirements?

I would be most grateful if you could incorporate these ideas into the subcommittee report. Meanwhile, please be assured of my enthusiastic support for your bill.

Sincerely yours,

HENRY KING STANFORD, *President.*

PREPARED STATEMENT OF A. F. CHESTNUT, DIRECTOR, UNIVERSITY OF NORTH CAROLINA INSTITUTE OF FISHERIES RESEARCH

I have been engaged in estuarine research for 25 years in North Carolina, Virginia, and New Jersey and have had close contact with many scientists, laboratories, and programs along the Atlantic and gulf coasts. New laboratories, many programs and a large increase in number of scientists has taken place. A degree of coordination and further stimulus in the area of marine sciences is still needed and can be provided through a national program. Considerable evidence has been presented before the subcommittee to show the need for expanded effort and support of research, education, and services to develop our marine resources in their overall scope.

I would like to direct attention to the fact that many States through a university complex and other agencies are active in programs of marine science. As an example, the program in North Carolina may be cited. The State of North Carolina will spend in the next 2 years, from its own sources, over \$1 million for new facilities, including a research laboratory, an exploratory vessel, an administrative building and associated items for fisheries development and research in marine sciences. A new coastal studies institute has been established with initial studies centered on beach erosion problems. The board of conservation and development has proposed an expanded extension program in the area of commercial fisheries and an interagency committee within the State has been active in formulating a program.

We believe in North Carolina, that a broad program has evolved covering the wide spectrum of basic research, applied research, technological studies, engineering, processing, marketing, and promotion of utilization of resources from the sea. Supplemental activities of such institutions as Duke University Marine Laboratory expand the area of studies from the inshore sounds and bays to the open ocean.

The funds currently being spent within one State, North Carolina, amount to one-tenth of the funding anticipated under the proposed bill for a national program. Other states expend far greater amounts, and budgets of some individual oceanographic laboratories further exceed these sums. These facts point to the need for a serious consideration of a proper balance in funding the proposed program.

I would like to center attention on another point, that of the mechanism of providing grants. Vast sums are being spent in physical oceanography. Other funds have been available from various Federal agencies for project research and individual grants. There is a definite need for grants to institutions allowing freedom for development of specific areas within the concept of the program. This would allow necessary diversification and offer encouragement of balanced programs.

This bill, S. 2439, can be an important factor in providing the necessary stimulus to expand and promote a vital area of our Nation's economy and well-being, and with some revision this can be accomplished.

PORT ARANSAS, TEX., May 2, 1966.

Senator CLAIBORNE PELL,
Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.

DEAR SENATOR PELL: In support of the National Sea Grant College and Program Act of 1965, S. 2439, I should like to submit a few comments for consideration by the Special Subcommittee on Sea Grant Colleges of the Senate Committee on Labor and Public Welfare.

My interest in this act stems from my involvement first, as a member of a 10-man national committee on the sea grant college set up in October 1965 by Dean John Knauss of the University of Rhode Island and second, as a matter of direct personal concern as director and professor of zoology at the University of Texas Institute of Marine Science, where a large amount of research and teaching is oriented toward coastal shelf problems in marine science and engineering.

Generally speaking, it should be most obvious that the educational systems of the United States are not sea-oriented in terms of education, research, and public service. As a consequence, we have no nationally strong basis for any but a haphazard development of technologies for the long-term exploitation of marine resources. The sound development and application of any technology in the modern world demands a sound and comprehensive educational system, not only in the natural sciences and engineering, but in the social sciences in their broadest sense as well.

To the statement presented to your subcommittee by the National Committee for a Sea Grant College, I should like to add my hearty endorsement and to add below some comments on the great potentialities of our educational and research organizations in our major universities.

Many of these universities already have strong academic programs in the research and teaching fields of marine sciences that are directly involved with marine resources. Some of these universities already have rapidly developing engineering programs in water resources, often with considerable reference to coastal marine areas. In addition many of these same universities already have programs in such fields as law, business, and economics. What is still badly needed at the university level is a source of funding that will enable universities to develop integrated programs of instruction and research in all possible sea-oriented departments that now seek funding from many agencies, most of which are not particularly set up to lend large-scale or exclusive support to sea-oriented programs. Because quite a few universities already have a nucleus of departments that can offer an assortment of sea-oriented training and research programs, there is a tremendous potential for such universities to develop broader and more completely integrated programs, if funding is available.

In recent years many other kinds of integrated university programs have been developed in the arts, humanities, sciences, and engineering by means of large interdisciplinary grants like the proposed sea grants. There is every reason to believe that sea grants could likewise have the same catalytic and supportive effects. These effects are notably the production of a new breed of sea-oriented specialists trained to meet the requirements of an increasingly complex society with increasingly complex technologies.

Today there is little lag between the development of new interdisciplinary sciences and the development of technologies based on these sciences. (Perhaps the best contemporary example is the development of the complex electronics industries almost immediately on the heels of theoretical research developments—likewise the development of strong educational electronics programs in junior colleges and even high schools almost immediately on the heels of industrial electronics development.) Today it is commonplace to find university researchers working both in cooperation with government or industries and in cooperation with high schools and colleges in developing their curriculums in addition to supplying trained manpower. It should be presumed that this type of cooperation would normally exist in sea grant programs. With more than 20 U.S. governmental agencies and a large number of State agencies engaged in marine science development programs or in routine operational activities, there is also a tremendous need for highly trained manpower in these agencies. Certainly the sea grant college programs would aid immeasurably in supplying trained personnel for these developmental and operational programs, and for industrial and educational establishments as well.

With the development of sea grant supported training programs, there would normally be expected a greatly enhanced interchange of personnel and ideas from marine industries to the universities and colleges. (Even the most humble and unlettered fisherman often may be expected to know much more about some aspects of a given fishery than his counterpart in a university.) At the present time the interchange of personnel and ideas among the various academic, developmental, educational and technological aspects of marine science is much less organized than in other lines of endeavor, e.g., agriculture. Furthermore, in

many aspects of marine science and technology, the United States lags rather badly behind other nations largely because there is a lack of numbers and organization of highly qualified people with a truly sea-oriented outlook on marine problems. The sea grant college concept, if implemented, would, in my considered opinion, have a profound effect on producing the kind of sea-oriented people that will desperately be needed to develop marine resources, not only in the United States but throughout the world.

Respectfully,

DONALD E. WOHLSCHLAG,
Professor of Zoology and Director, the University of Texas, Institute of Marine Science.

UNIVERSITY OF WASHINGTON,
COLLEGE OF FISHERIES,
Seattle, Wash., May 11, 1966.

HON. CLAIBORNE PELL,
U.S. Senate Committee on Labor and Public Welfare,
Washington, D.C.

DEAR SENATOR PELL: I am very sorry that I was not able to attend the hearings of the Special Subcommittee on Sea Grant College on May 2-5. It is a pleasure to have this opportunity to submit comments on S. 2439—the National Sea Grant College and Program Act of 1965. I am very much in favor of the purposes of the bill and I should like to reaffirm my support of the statement of the National Committee for a Sea Grant College, of which I am a member. Increased support is important for the marine sciences, as they should have an expanded role in the overall national scientific effort.

I do feel however, that the purposes of the bill can be strengthened if its scope is somewhat narrowed. There is a danger that a new program may be looked upon as a complication in the funding of marine science. As you know, our Senator, the Honorable Warren G. Magnuson has suggested many times that marine science programs need better coordination. He has proposed legislation to consolidate the many activities of ocean studies. I suggest that a new program should have a definite focus and that this be done by directing S. 2439 to the development of marine resources. I would define a sea grant university as an institution of higher learning devoted to increasing our Nation's utilization of the world's marine resources through activities in the areas of training, public service and research. There is much sympathy with the idea that an important fraction of support for a sea grant program should be in the form of institutional grants. Such funding would provide an amount of flexibility in programs of individual institutions. Surely with the broad ocean problems needing attention and the wide diversity in university capabilities we should not commit ourselves to rigid programs. On the other hand, there is much to be said in favor of the National Science Foundation's approach to funding research on a competitive merit basis. Perhaps local matching funds could be used for the support of research projects. The National Science Foundation, as it now exists, could administer a sea grant program devoted to the development and utilization of marine resources which will assure support for marine sciences to institutions which are the most capable and which propose to do work that will come under review at the national level.

Sincerely,

DONALD E. BEVAN, *Associate Dean.*

UNIVERSITY OF WASHINGTON,
DEPARTMENT OF OCEANOGRAPHY,
Seattle, Wash., May 11, 1966.

HON. CLAIBORNE PELL,
U.S. Senate,
Committee on Labor and Public Welfare,
Washington, D.C.

DEAR SENATOR PELL: In response to your letter of April 22, 1966, I wish to take this opportunity to submit comments relating to S. 2439 the National Sea Grant College and Program Act of 1965.

I am heartily in favor with the purposes of the act. For over 35 years I have been involved in oceanography and it is heartening to see legislative interest in a broad program to develop our national capabilities to occupy the oceans and to exploit their resources.

For the past 15 years I have been a professor and chairman of the Department of Oceanography at the University of Washington. During this period we have developed both undergraduate and graduate curriculums in all of the major aspects of oceanography. Administratively, the department is in the College of Arts and Sciences and our 250 undergraduate majors must satisfy all the academic requirements of the college. On the other hand, even larger numbers of nonmajors take one or more courses in oceanography. At the present time nearly 1,800 students per year are receiving at least 5 credits of instruction in our department. Experience has convinced us of the importance of studying the ocean at all levels from elementary school through postgraduate years. To partially meet the nonuniversity needs we have, for 6 years, offered summer institutes for secondary school teachers. These intensive programs are sponsored by the National Science Foundation. By the end of the coming summer, 180 teachers will have received special instruction for 1 summer and 40 of them will have returned for a second summer of advanced training. For the 1966 institute, as in previous years, nearly 700 applications were received for the 30 available positions.

To broaden the opportunities for the training of elementary and secondary school teachers we have also offered 12-month programs for faculty members from junior colleges and 4-year colleges. Two such academic year institutes sponsored by the National Science Foundation have been completed and the third will start during the summer of 1966. So far 14 instructors have been trained with 8 more in the program for next year.

Several faculty members have also contributed time and effort to the preparation of secondary school textbooks and related teaching materials as part of the earth science curriculum project (funded by NSF). I have just coauthored a textbook, teachers guide, and laboratory manual on earth science for use in the secondary schools. I mention these items to emphasize the necessity for broad interpretation of the educational needs in the marine sciences. The purposes of the act will best be served if the educational needs are viewed in terms of the total requirements. The scope of educational efforts must not be limited to the preparation of research scientists, engineers and those involved in ocean industries.

It takes many years to develop the facilities and faculty to offer undergraduate and graduate programs in oceanography. The expanding interest in the marine sciences among young people is reflected by the fact that the number of undergraduate students majoring in our department has grown at about 40 percent per year for the last 6 years. We are serving a national need as is shown by the unusually high percentage of out-of-State students. About 80 percent of our graduate students are not native Washingtonians and nearly 50 percent of the undergraduates are from out of State. For the university as a whole the corresponding values are 42 percent and 9 percent respectively. During 1964-65, 33 States and 6 foreign countries were represented. Although we are meeting a national need, the major burden of instructional costs is borne by State-appropriated funds. The expanded demands for competent teachers and college faculty members that will be required to support the national effort is obvious. In the years to come it would be disastrous if only the "direct and practical" aspects of the marine sciences received support.

It is possible to argue at great length about the nature of oceanography, to debate whether it should be "oceanology," and to discuss the definition of "ocean engineering." I have no desire to enter these semantic battles. Regardless of the names that are used it must be admitted that in any area of scholarly enterprise there are broad spectra of topics that range from basic and fundamental aspects to commercial technologies. In between the two extremes it is always possible to identify certain topics as applied research, development, and engineering. Universities have a dual responsibility, to educate the young to prepare them to meet the problems of the future and by conducting research to advance the frontiers of knowledge. In a rapidly changing world, that is experiencing a "knowledge explosion," it is virtually impossible to predict the tasks that today's students will be called upon to solve during their professional careers that will extend into the 21st century. It is clear that in departments such as ours, the students must be given the best possible instruction with particular emphasis on the basic scientific principles (that will not go out-of-date)

and that research should be directed toward similar basic and long-range scientific goals. These objectives would not be satisfied if the program was limited to practical and short-term projects.

The purposes of the act are most laudable but it would be unfortunate if in the haste to develop man's capability to occupy and exploit the oceans the academic educational and research aspects were inadequately supported. Either these must receive recognition within the act itself or provision should be insured through other means.

Sincerely yours,

RICHARD H. FLEMING,
Professor and Chairman.

COMMONWEALTH OF VIRGINIA,
VIRGINIA INSTITUTE OF MARINE SCIENCE,
Gloucester Point, Va., May 9, 1966.

HON. CLATBORNE PELL,
Senate of the United States,
Washington, D.C.

DEAR SENATOR PELL: This letter refers to the sea grant college and university program as proposed in the bill sponsored by you and other farsighted patrons and may be introduced into the official hearing records.

Though I intended to attend the hearings just now being conducted, institute business has prevented me from doing so. This letter will convey my opinions and convictions to you and the other members of the committee. My intention to send such a letter was communicated to Mr. Green, of your office, by phone on Thursday the 6th of May.

Early in the debate concerning this program, I was in opposition. This opposition, based on the strong conviction that additional marine research and training institutions are not justified or even needed in the United States was eliminated when it became apparent that neither Dr. Spilhaus nor you intended for the program to be used as a vehicle for establishing new marine laboratories.

As the concept of the sea grant college and university program has evolved in recent months, it has become apparent to me that it will be a valuable addition to the overall marine resource research and development activity of the United States. Hence, I wish to express my strong support. It will benefit all marine resource users (e.g., sport and commercial fishing industries, recreationalists, shippers, mining interests and most others), all marine States, and be extremely valuable to the entire United States and deserves the support of all of the States, maritime or not.

There is great need for increased activity in the various fields of oceanic engineering and in other marine resource development and use areas. As I have expressed several times during the sea grant college meetings, the Commonwealth of Virginia has been especially active in developing its own program of applied, as well as fundamental, marine science at the Virginia Institute of Marine Science, one of the largest State-supported marine science programs in the East. Though not called by that name, many of VIMS' activities can be considered to be oceanic engineering. VIMS' biological, chemical, geological, and physical oceanographers have contributed in solution of many marine resource engineering problems for local, State, and Federal agencies and industry.

Virginia, with her vast and valuable marine resources, marine industries, and marine-oriented Federal activities, is a major maritime State and can benefit greatly from the sea grant college and university program whether or not she actively participates. If her strong program in marine research and training at VIMS (affiliated with both the College of William and Mary and the University of Virginia) can participate, Virginia and the Nation will benefit to an even greater extent.

I am opposed to the use of this program to develop new and competing institutions. The list of institutions with proven capability and interest in marine-oriented research and education is large. Most have administrative units, research and teaching facilities, shore-based and floating facilities which can be occupied or used much more efficiently if adequate, continuing funds are available. Addition of new institutions at this stage seems unjustified and, in my view, will increase competition for limited funds, facilities, and personnel, and slow the overall marine resource development program considerably.

I cannot offer significant help with the solution to the problem of which Federal agency should administer the program at this time. Perhaps the National

Academy of Sciences could assist in the selection of institutions to be sea grant colleges or universities. Of the two agencies seriously proposed thus far (as far as I am aware) National Science Foundation seems most suitable by virtue of experience. I am sure that NSF can administer the program, if asked to do so, despite its obviously applied nature.

If I can assist further in these deliberations, please let me know.

Sincerely yours,

WILLIAM J. HARGIS, JR., Ph. D.,

Institute Director and Dean, School of Marine Science, College of William and Mary, and Chairman, Department of Marine Science, University of Virginia.

PREPARED STATEMENT OF JOHN H. CLOTWORTHY, VICE PRESIDENT, WESTINGHOUSE DEFENSE AND SPACE CENTER, UNDERSEAS DIVISION

It is a function of government to make technologies responsive to the requirements of society. This is especially true of new technologies which tend to be random in their early stages of development. Ocean technology is in this position today. It requires the establishment of a national program to give it direction.

One of the ways in which government can create the responsiveness required is through the support of educational programs. Because of the significance of our national efforts to explore and exploit the world ocean environment, it is necessary that we provide encouragement to the task of educating scientists and technologists to perform the difficult work that lies ahead and to the added responsibility for educating persons in related social skills to perform the national and industrial planning functions associated with ocean technology.

There are two aspects of this educational problem: the question of organizing the university community to supply the requisite skills; and the question of developing quality standards of education in the face of a limited supply of teachers who must turn out a large number of generalists and specialists. An education bill for ocean sciences and technology must address itself directly to the first of these problems while assuring the quality standards required. Further, such Federal supports as are provided by legislation must be the product of an unified concept of future requirements. The success of the purpose of educational legislation rests on the completeness and wisdom of this concept.

This means that the educational activities supported by the Government for ocean activities are a phase of a national ocean program in the broadest sense, and that the definition of that program must precede the determination of precise educational requirements. Handled in this way, the establishment of sea grant programs through the reapplication of revenues received under the Outer Continental Shelf Land Act would perform a major service. There is also an ironic justice in the method.

The comprehensiveness of legislation dealing with education for this developing technology is quite important, lest we train only for the most obvious of requirements. For this reason, it is heartening to note that the authors of the legislation envision the establishment of programs in economics, sociology, law, and other social studies. Were this not the case, we would be developing an operational capability without providing for the requisite social guidance.

I believe S. 2439 is worthy of enactment as a part of a comprehensive national ocean program.

PREPARED STATEMENT OF GORDON GUNTER, PH. D., DIRECTOR, GULF COAST RESEARCH LABORATORY, OCEAN SPRINGS, MISS.

I do not wish to waste your time and that of your Committee with a long statement upon my background and qualifications to comment on this bill, and instead I am appending a short biographic statement. It does not cover the consultant work I have done in the marine waters of all Gulf states, and in Maryland, North Carolina, South Carolina and the State of Washington. Although for a year each I was Senior Marine Biologist at the Scripps Institution of Oceanography and Professor of Zoology at the Marine Laboratory for the University of Miami in Florida, my experience has been primarily on the Gulf of Mexico. I have worked in the Gulf states for a period of thirty-six years. I have been the head of three marine laboratories, that of the Texas Game, Fish and Oyster Commission, the Institute of Marine Science of the University of Texas, and the Gulf Coast Research Laboratory, which all grew from small size to respectable institutions during my tenure. (I mention these facts be-

cause I have considerable experience—and not all together pleasant experience with financing struggling marine institutions).

As things now stand the powerful oceanographic and marine institutions are related to the wealth of the adjacent hinterland and not necessarily to the wealth or importance of the marine area around them. The area from Pascagoula, Mississippi to Port Arthur, Texas produces annually twenty to twenty-two per cent of all the fishery products in the United States. I have called it the Fertile Fishery Crescent and it should be noted further that the United States coast of the Gulf of Mexico produces Forty per cent of all the fishery products of the United States. The continental shelf of this same region produces vast quantities of oil, gas and sulphur. Yet the monies spent on oceanographic research in this area by the Federal government is probably in inverse proportion to the marine wealth which it produces now every year. There are a large number of economic factors behind this situation and it would take me several pages to expound upon them.

The expenditures of money by the Federal government must, in the terms of a popular song, "go where the action is" and the action does not necessarily lie in the neighborhood of the big institutions, which are sometimes not interested in the distant areas and seldom travel there. The Gulf of Mexico is one of the most important marine areas in North America and it is our only international sea. It has been neglected and I am sorry to say that your bill, as it presently stands, will not take care of this inequity.

In part your bill merely adds money to the present granting agencies, which means that more and more, larger percentages of money will go to the large institutions which have a staff, the business offices and the wealth with which to go after these grants. Thus, the rich will grow richer, etc. and inevitably areas of great importance will be neglected.

I would suggest that the Sea Grant University Bill be divorced from the granting agencies completely and that a sum of money be set up by appropriation or some other device which will go to each state and to selected institutions of the given states which will carry on the work in their own area. The Idaho potato would never have been developed in Texas and the studies which made for the elimination of the Texas cattle fever would never have occurred in Maine. Nor would they have been made by people in Maine traveling to Texas or those from Texas going to Idaho, etc. Yet all of these things developed through the land grant colleges and they developed because the land grant colleges took care of things in their own areas.

Your Sea Grant University idea is one of the most important ones that has been advanced in eradicating the lopsided regional studies of our ocean shores, if it is properly written and properly applied. I should say that to be effective you must have it set up in such a way that each state with a marine border must take care of its own problems through its own institutions. I have no specific suggestions concerning financing except to say that it might be on some sort of a matching basis. Even so some of the poorer states are going to have difficulty in meeting their obligations on this basis.

In short I agree with the statement of Dr. George A. Rounsefell, distinguished fisheries biologist of the University of Alabama, which is presented at this hearing.

(Whereupon, at 11 a.m., the hearing was adjourned, subject to call of the Chair.)



