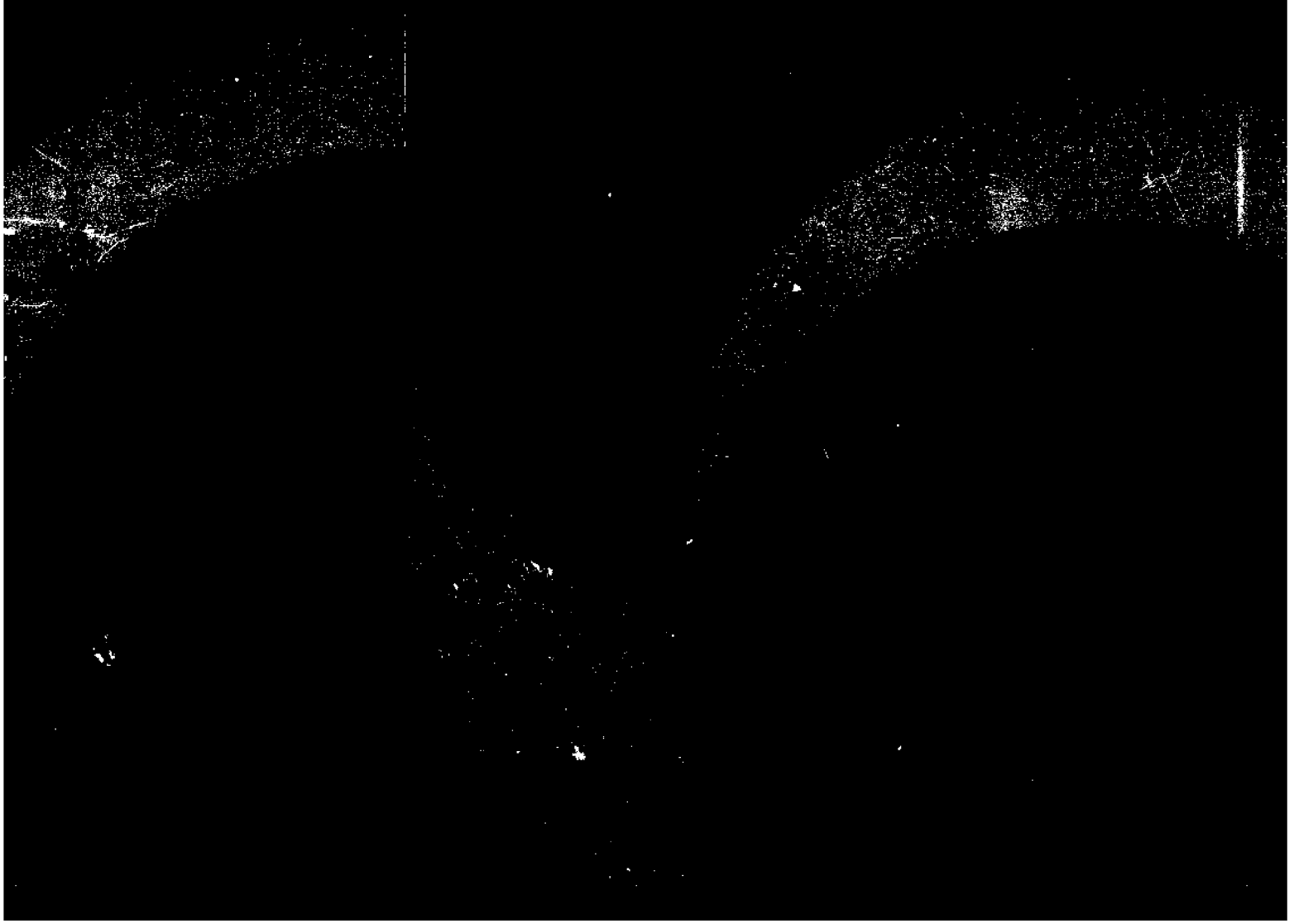
proceedings of the third sea grant conference

sponsored by oregon state university

march 1970



3

proceedings of the third sea grant conference

sponsored by oregon state university

march 1970

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

CONFERENCE COMMITTEE

John R. Donaldson, Chairman	Department of Fisheries and Wildlife
John V. Byrne	Department of Oceanography
Joe Cox	Cooperative Extension Service
Gwil O. Evans	Sea Grant Marine Advisory Programs
Herbert F. Frolander	Sea Grant Programs
William J. McNeil	Department of Fisheries and Wildlife
Daniel A. Panshin	Sea Grant Marine Advisory Programs
William Q. Wick	Sea Grant Marine Advisory Programs
Joan Flynn, Assistant	Department of Oceanography
Judy Lidstrom, Assistant	Sea Grant Programs
Saundra Donaldson	Proceedings Editors
Beverly Knapp	
Martha Ann Norgren	
Dave Hardesty	Cover Art

Copies available:

Sea Grant Administration
Oregon State University
Corvallis, Oregon 97331

Price: $3.00

INTRODUCTION

Herbert F. Frolander, Coordinator,
Sea Grant Programs, Oregon State University

As with previous Sea Grant conferences, the major goal of the Third National Sea Grant Conference was strengthening Sea Grant nationwide by openly discussing and critically evaluating our activities. In such an atmosphere, there are several avenues that help contribute to strong and vigorous programs. An important avenue is the contact that occurs among representatives of participating Sea Grant institutions that offers an opportunity to learn about programs being conducted in other parts of the country. Such exchange of information helps to avoid duplication of effort and enhances existing programs by fostering more rapid diffusion of information about them. Another avenue to program improvement offered by a conference such as this is the opportunity for direct input from the industrial and business sectors that are concerned with the direction Sea Grant takes. Sea Grant institutions learn more quickly the needs of industry; industry, in turn, finds out about progress that may offer opportunities for profit.

Programs on the conference agenda were concerned with food and non-food resources. Participants were drawn from state and federal agencies, industry, universities, and other institutions with an interest in marine sciences. There was a real and successful attempt to get input from the men actively engaged in wresting a living from the sea. For example, active participants were leading fishermen: men who take much of the risk and make major capital expenditures as part of this risk. Much was gained from the give and take that occurred when men who make their living from the sea discussed such questions as the relationship of national policy and the marine industries.

There was an attempt to look at Sea Grant from inside and from outside. Sea Grant was assessed by those actively engaged in the program. It was also assessed by those who share responsibility for economic development of the sea, but who are not directly involved in the research, education, and advisory programs that now make up Sea Grant.

During the course of the discussion, many valid and important comments were made from the floor. Some of those comments have been preserved in these proceedings because the "ground rules" asked that they be submitted in writing after the conference. Unfortunately, just as many excellent commentaries from the floor have not been included, as no written summaries were received.

The nature of the material presented at the conference and reported here is indicative of the cooperative spirit of state and federal efforts to develop the resources of the oceans. A public awareness of the nature and results of these efforts will do much to further the goals of the National Sea Grant Program. Involving all interested groups in a National Sea Grant Conference leads to even better understanding and to a sharpened definition of our goal of the wise, planned use of the resources of the oceans.

Welcome

Roy A. Young
Acting President
Oregon State University

Ladies and gentlemen, I can assure you that it's a pleasure to be here and to welcome you to this Third Sea Grant Conference. Many of us at Oregon State believe the development of the Sea Grant Program is one of the outstanding developments of the past decade. We look at the tremendous potential for marine development and we do a lot of speculating on what will have been accomplished after the first ten years of this program. We certainly have very high expectations, not only at Oregon State, but over the country as a whole.

It is not difficult to visualize increases in quantity of edible food products from the ocean and greatly improved methods of handling seafood. We know also there will be a great deal more information about mineral deposits. We anticipate increased understanding of marine life relationships. I think also that one of the aspects of marine resource development that will be very interesting will be the number of new marine laws that will be enacted or the new interpretations that will be developed to meet some of the problems that will result from research in aquiculture with mineral resources and in other areas.

We feel little doubt that the formula selected for the Sea Grant Program will be a successful one. If you look at what has happened at state universities over the last one hundred years, you will see highly successful agriculture programs where the same formula of education, research and extension programs has been focused on agriculture development. The development of agriculture must be recognized as one of the truly outstanding achievements of the past century. And if we plan now the effective use of our marine resources through programs that bring together advancement of knowledge through research, the education of our young people, and service of the community at large, I'm sure the Sea Grant Program will also contribute to the betterment of many millions of people.

I think you have three very interesting days ahead of you. I'm sure the two days of scheduled presentations will be most interesting as they involve a number of talks by individuals who are outstanding in marine resource areas. Several discussions will give you insight into Federal and State programs related to marine resources. You will hear discussions of some of the active Sea Grant Programs by people who have programs underway at the present time. You will hear also from our Governor and from the Treasurer of the State of Oregon, both of whom have a great deal of interest in marine programs.

We hope you have an interesting and enjoyable time at the meetings and also that you may have a chance, those of you from other areas in particular, to visit Oregon State University and to travel along the coast on the tour that is planned on Saturday.

Luncheon Address — World of Polaris

R. Adm. Patrick J. Hannifin, USN

Commandant, 13th Naval District
Seattle, Washington

I am pleased and honored to be a part of this third Sea Grant Conference. I have followed closely and been much impressed by the discussions and presentations of this morning's session. My talk today is by intent not directly related to the principal objectives of the conference. It is by intent a change of pace from the program sessions. There is, however, one common link to this Sea Grant Conference and that is the sea itself. It has been my vocation and my avocation for the last 29 years.

We are at a time of traumatic change in this nation of ours. A time when all of our traditional institutions are under attack to lesser or greater degree. None have escaped, our churches, our schools, our courts, our free enterprise system and, perhaps most of all, our military system.

I, for one, am concerned about what appears to be a wave of destructive self criticism that seems to be sweeping the country. I am concerned that I see and hear so many people who can point out everything about this country except what is good, and everything about our past except what we have accomplished. It is easy to deplore the way things are, but it is much, much harder to devise better alternatives and to persuade others that our alternatives are indeed better.

There is much controversy now on the proper ordering of our priorities. Should national security be the major object of our effort and resources, or should domestic needs attract our principal attention and efforts? Even the term "domestic" is misleading when applied to priorities, for certainly nothing can be more "domestic" than the survival of our people or the freedom of this nation to choose its way of life. Can one kind of survival be more important than another?

I believe that we must not only maintain the peace by deterring nuclear war, but we must promote a just and healthy society as well. Surely success in one of these goals will not help us survive failure in another.

My purpose today is to give you some insight into one way in which this country can and has deterred nuclear war. Deterrence has long been a basic military policy. In this day and age it has become the dominant military policy. As military power has grown more awesome, it has also turned more abstract, intangible and elusive. Deterrent power, for example, depends on psychological reaction and the psychological criteria is as important as strategic doctrine. What deterrence really means is to keep an opponent from a given course of action by posing to him unacceptable risks. Deterrence then involves what the potential enemy thinks is likely to happen to him. The real measure of deterrent power is the assessment of it by the other side. Credibility is as important as technological success.

I said that power has grown more awesome and also turned more abstract, intangible and elusive. One of the elements of deterrent power is that it is tested negatively by the things that do not happen. Yet it is never possible to demonstrate clearly why something has not occurred. Thus nuclear deterrence is abstract and intangible, yet essential.

Let me shift now from the philosophical "why" of deterrence to the "how" and "what" of Polaris. As you are all aware, for many years our principle deterrent weapon was the manned bomber of the Strategic Air Command, and then the land based missles Titon, Atlas and finally Minuteman. It was apparent to many that if one could put our nuclear deterrent at sea, preferably under the sea, and remove from the continental United States many of the target areas of the Soviet Union, that this could be a large plus in the credibility of our nuclear deterrent system. So the Navy embarked in 1956 on a development program which was ultimately to produce the Polaris Weapon System.

I believe that there has never been a more intensive development program. When development work began in 1956 the only part of the FBM system that was a reality was the nuclear-powered submarine. The rest of the elements of the system were only ideas. This required raw research into areas of technology where very little was known at the time; solid rocket propellants, small inertial guidance systems for the missle itself, advanced ship navigation methods and underwater missile launching techniques. In addition a tremendous amount of research was being conducted by the AEC into the development of a small nuclear warhead. We necessarily enlisted the help of some of America's finest scientists and engineers in universities, government and industry to study these problems, to solve them and to build the thousands of pieces of equipment required. Over 20,000 private contractors and many universities contributed to the Polaris system.

With the help of the computerized management methods and assists from the Soviet Union with the launching of her first ICBM and the orbiting of Sputnik I in 1957, the Navy was able to coordinate the Navy-university-industry team so that in only 4 years, by 1960, sooner than even the most optimistic had hoped, the many parts of the FBM mosaic were integrated into the first Polaris submarine, George Washington.

While improvements in the later submarines and their equipments have been made over the years, the basic composition of the weapon system remains unchanged and consists of six major subsystems. First, the Navigation Subsystem proved to be the most advanced navigation system yet devised and provides continuous data on the ship's position to both the ship and to the missile Fire-Control System for computing missile trajectories. Each submarine has two or three complete inertial navigation systems for cross checking, plus other navigation systems to verify the main inertial system.

An Electronic Watchman or the Missile Test and Readiness Equipment provides a continuous check on the missiles and constitutes the second subsystem. This equipment also has the ability to check its own electronic components to insure they are doing their job properly.

The Fire Control Subsystem computes the missile trajectory to each target. Unlike a land based missile, this trajectory must be computed every few seconds since the missile's position relative to the target is continuously changing. The problem is compounded since each of the 16 missiles could be assigned a separate target. Consequently, the computerized Fire Control system must obtain new trajectories for all 16 missiles with every change in the position of the submarine.

The Launching Complex is the fourth subsystem. Although the art of launching torpedos horizontally from submarines was mastered many years ago, launching a 15-ton missile vertically required some significant changes. The missile in its launch tube is like a piston in an engine. Upon command to launch, a small gas and steam generator, basically a small fixed rocket motor, is ignited. The propellent gas, mixed with water, is directed into the base under the missile forcing the missile upward through the tube. When the missile has cleared the top of the launch tube, seawater replaces the missile. The cover hatch is closed and the water is blown from the tube until the weight of the water equals that of the missile it replaced. The entire launch cycle takes only a few seconds and the submarine's delicate buoyancy is never upset.

The final subsystem, of course, is the Nuclear-Powered Submarine itself, 425 feet long, 33 feet in diameter and over 8,000 tons. With a nuclear fuel core capable of lasting up to ten years and cruising for months at a time, the ship is truly only limited by the needs of the crew.

Oxygen generators and "scrubbers" maintain the ship's atmosphere at a state purer than the outside air in most cities. Air conditioners keep the submarine's interior at a comfortable living room temperature. Fresh water is generated in sufficient quantity to meet all needs of the ship and crew.

A stainless steel galley outfitted with the most modern cooking equipment answers the need nearest and dearest to the hearts of submariners, good food. Four planned meals are served a day, and snacks can be had for the asking around the clock.

A two-month patrol is made more endurable for the crew by recreation and relaxation features. A ship's entertainment system features the latest tunes on a coinless juke box. Different movies are shown each evening and there is a small but well stocked library. "Night" time is simulated by turning off the white flourescent lights in sleeping areas and replacing it with a soft red glow. With this brief description I think it's plain to see that the life of a Polaris sailor today is a far cry from those diesel days of World War II.

Today our FBM force spreads across the north Atlantic, the Mediterranean and the Pacific providing continuous coverage of assigned targets to carry out the mission of deterring nuclear war.

Although no FBM submarines beyond the 41 presently in commission are planned, an extensive retrofit program is presently underway to modify 31 of the 41 submarines to fire the new Poseidon Missile. To date 10 such conversions are underway or authorized, with the first, James S. Madison, scheduled to go to sea in early 1971. Poseidon will be larger than Polaris and will have what is called a Multiple Independently Targetable Re-entry Vehicle Capability, or MIRV. This capability permits the delivery of warheads to many separate targets.

To emphasize the fact that we are not complacent about our presently favorable position we have not outruled the fact that the Soviets may attempt to counter our sea-based deterrent system by mounting an extensive ASW effort against our FBM force. In preparation for such an effort we are examining a longer range submarine launched missile system. This system is being planned for introduction in the late seventies and is called the Undersea Long-Range Missile System, or ULMS.

This then is the world of Polaris. I have tried to describe and discuss the "why" and the "what" and the "how." Will Durant once wrote that "War is one of the constants of history and has not diminished with civilization or democracy. In the last 3,423 years of recorded history only 268 years have seen no war. Peace is unstable equilibrium which can be preserved only by acknowledged supremacy or equal power."

If history teaches us anything, it is surely that weakness invites attack. And that it takes but one aggressor to force the world into war against the desires of peace loving nations. This is particularly so if the aggressor is militarily strong while the peace-loving nations are not.

We can be assured that Polaris is not a sign of weakness. It is a deterrent to nuclear war that is virtually invulnerable, and does pose an unacceptable risk to potential aggressors.

Luncheon Address — The Lonely Sea and the Sky

Robert W. Straub
Treasurer of Oregon

The sea is earth's last frontier and its vast, vital, fragile resource stands in more danger of wanton destruction than face the land or the air. Wherever man has made material progress, the price has been a poor, polluted, second-rate environment as a consequence of that progress. The big difference between what has happened to the land and the air and what has and could happen to the sea lies at the heart of politics.

Pollution of the air and the land and the rivers is visible. Television cameras can take pictures of it, editorial writers can write about it, people can *see* it. In seeing it, they can comprehend it. When a river in the Midwest became so polluted that it burned last summer, this was visible and forceful. When we had a situation in Oregon several years ago where the main stem of the Willamette River and every one of its twelve major tributaries were so polluted that the State Board of Health would not permit swimming in any of them, this was visible and it helped public opinion to take action to change these conditions. But pollution of the ocean is invisible.

I am not here today to talk as a scientist because I am not a scientist. I am not here to talk to you as a specialist because I am not a specialist. I am not here today to recite to you all of the terrible contaminations and threats that exist to our ocean resource. You know this better than I. I am here today to talk to you as a politician, which I am; as a generalist, which I am; and as a citizen concerned about the overall problem of what happens to this universe.

I think we need each other. The role of politics in oceanography is to arouse public opinion about priorities which are important; to provide resources through legislative appropriation; and to provide the shield for public pressure of one kind or another so that scientists can go about doing their work of research, of inventory, of discovery.

The problem that we face in proper management of our ocean resources is the problem of prejudice and ignorance and the competing claims for money for jobs on which we are behind schedule in some of our land areas. The demand for federal and state money to take care of urban blight, transportation problems, highway needs, research needs, welfare, and education are sizeable, critical, visible and immediate.

There is a funny notion about the sea which I find many people have. They believe that it is indestructible. They feel that the ocean goes on forever unchanged, unchallenged, unaltered. You can't hurt it. Man marks the earth with his ruin, but nothing can harm the ocean. Lord Byron, who loved the ocean enough to swim often in the cold North Sea, wrote

> "Roll on, thou deep and dark blue ocean—roll!
> Ten thousand fleets sweep over thee in vain;
> Man marks the earth with ruin—his control
> Stops with the shore."

The other night I had dinner here in Portland with some investment bankers from the East Coast. Among other things we discussed the impending shipment of nerve gas to Oregon. A very intelligent banker from Boston, and a former high ranking naval officer, said that he thought the only solution for nerve gas was the "deep six" treatment. He said, "Put it in containers and drop it into the deep bottom of the ocean and be done with it."

A lot of people think this way. It is incredible that we aren't aware of the fact that even though something is out of sight this doesn't neutralize the persistent, damaging effect of it. A big job of education needs to be done and the most difficult job in politics is to try to make people aware of a problem before it becomes acute, and *before it becomes highly visible.* To understand the nature of the problem, to help arouse public concern and support, to prevent destruction of certain vital resources upon which the ocean's entire make-up depends (such as the estuary areas) to gain time so you scientists can advance the threshold of knowledge that we need to comprehend better what policy decisions to make—we in public office must have your help.

Just the other day, here in the State of Oregon, we had the State Highway Department trying to relocate Highway 101 and to change it by building a fill along the three miles of an estuary at Nehalem Bay. The Highway engineers didn't try to relocate this highway and put it into the bay because of meanness. They did it because they didn't understand that one unique feature that this highway would trample on was an eel grass bed—a vital one and one of the best on the Oregon coast. For 6 months out of the year, 2,000 migratory ducks use the area and feed on the eel grass.

In this bay area, the Oregon Game Commission has a man who is one of the national experts on migratory birds and their habitat requirements. He lives right at Nehalem Bay. He has lived there all his life. He is available every day. The Highway Department never even talked to this man about what damage to the wildlife would result from putting this highway in the estuary.

Another example concerns one of our large estuaries in the Coos Bay area where recently a large company wanted to dredge up a large portion of the mud flats. The proposal was to dredge up 20 acres of estuarine mud flats for a ship channel and turning basin and to fill over 50 additional acres of mud flats. The argument of those supporting this company was that it would add 18 people to the payroll in the Coos Bay area! Luckily, we were able to arouse enough public objection so that the company has now dropped its application for a permit.

For too long we have been playing Russian roulette with our estuaries, doing damage to our ocean resources with no knowledge and very little concern about what impact it has. Dumping deadly nerve gas poisons into the ocean, relocating highways through mudflats, dredging great areas of our estuaries, are examples of the Russian roulette I am referring to.

The stresses on the ocean are constantly intensified. It is time to use all of our brains, all of our courage, all of our resources to act to save the ocean and the rest of this planet. It is time to work at survival.

Dinner Address

Tom McCall
Governor of Oregon

I am delighted to join with you and extend Oregon's greetings to this Third Sea Grant Conference. I am particularly pleased that Oregon can host this Conference, and there may be some significance in the fact that this is the first one held outside of Rhode Island! We do proudly wear the designation of the largest Sea Grant effort of the eight now engaged in this significant area of work.

Where the first conference in 1965 pre-dated the Sea Grant Act itself with its focus upon expected development, the 1968 conference devoted its thrust to the exploration of ideas. This third gathering spotlights attention upon the all-important reporting of work done, accomplishments realized, and avenues opened for additional work and exploration.

In Oregon we have watched with fascination and enthusiasm our own oceanography development and the achieving of Sea Grant status for Oregon State University. In these days of tight money and tighter budgets I can probably best demonstrate our involvement in support of this essential development area by recalling that in 1967 when Oregon had rather severe budget changes and I called a special session to rearrange our finances, the one appropriation that escaped the cleaver of ways and means was the Sea Grant appropriation. I must also confess there was another–(but those who know me, in the likes of Bob Schoning and Hollis Dole were not surprised)–a cherished fish hatchery on the Oregon coast also escaped unscathed and today is a proud accomplishment.

The ocean and the ocean resources are part of our heritage and the lifeblood of our future growth, and so far as I am concerned, Oregon is not about to discard by inattention the values of the priceless resources of the ocean shore. The same concerns we have for protecting and enhancing the livability and environment of the land applies to the ocean and the coastal zone. At least in Oregon we can avoid repeating the mistakes that have left the brands of environmental degradation so visible to scar our land, and we can move ahead to protect and perpetuate the values of the sea.

It is of unusual timeliness that I have an opportunity to discuss very briefly problems of the coastal zone with this group at this time. So extensive is the impact of man's actions upon life chains in our estuaries, and so irreversible is the effect of unknowing actions upon fragile yet essential resources of the ocean shore, that uncoordinated actions produce inevitable conflicts. This is the story not only in Oregon, but the story of every state in the coastal zones, and with all our environment.

In Oregon, our Beach Bill, an issue as explosive as nerve gas, was in the 1967 Legislature. It is now finally resolved by Supreme Court approval of the action which defines the ocean shore and proclaims public use in perpetuity.

A proposal to place the relocated Oregon coast highway on a sandspit at Nestucca, however well intentioned by the Highway Commission for a variety of reasons, was shot down by a barrage of ecological proclaimings from all across the land. Regardless of the position each took in that issue, all of us hoped the moral of the story had been learned–Oregonians simply do not want highways built on the ocean shore any more.

You can imagine the reaction when this week the news media with excruciating clarity showed yet another highway on an ocean shore area of an estuary, making use of fill also within an estuary, with rather appalling disregard for the fragile estuary environment. This prompted my immediate executive order banning construction and construction planning by state agencies, and tighter than ever restrictions by state regulatory agencies concerned with our estuaries and the entire coastal zone.

Oregon will not continue with too-often blind development. We are going to concentrate on resource inventory and land use planning of our estuaries and coastal areas. We cannot wait for federal action, even though we do consider the Coastal Zone Authority proposals of definite merit and ones we support. I would urge other coastal states to give serious consideration to the move that Oregon has taken so that further unplanned development does not cause subsequent loss of estuarine lands and marine life nurseries.

Oregon is not saying we will stop economic development and resource harvest in the coastal zone for all time to come. We are saying that development and change from now on must be part of a considered and justified research effort and plan which points the way to utilization of area and prudent harvest of resources so we give protection to the sensitive environment of the ocean shore and make man's actions compatible with his natural surroundings. It should almost be axiomatic that those responsible for development must also provide the

leadership in responsibility for protection. Our short-term gains too often are long-range losses.

I am pleased with the in-depth look you're giving to the Sea Grant effort and the challenge of developing our marine resources. The challenge of the Sea Grant is in fact a greater challenge than was given land grant, principally because our needs are greater, the rules are radically different in handling resources, and the pressures are mounting that protection is not sufficient, but preservation is.

I have viewed with substantial favor the identification of our ocean management potential in its own cabinet-level Department of Oceanography and Fisheries, and offered this in resolutions to Governors' Conferences.

I do applaud the Coastal Zone Management concepts and urge conferences in all states to discuss this forward-looking idea as we have initiated in Oregon with the gathering of my Oceanography Committee and interested citizens at Oregon State University just a week ago today. Further conferences are on the agenda with our coastal counties, port districts and coast associations so full discussions can be held with a balanced input of ideas and considerations for the coastal zone resources. The development of an Association of Coastal States such as Oregon participated in this past January is another step forward.

I am encouraged with the thrust directed towards establishment of coastal laboratories, and we look forward to the inter-agency council which is engaged in visiting the coastal sections. John Byrne and I have discussed this concept and are in agreement with its purpose—to fill a research and support role to integrated coastal zone management.

I am extremely proud of the Oceanography and Sea Grant efforts and programs we have in Oregon and I would hope the council visits Oregon, looks critically at our efforts and programs and gives consideration to integration of such a laboratory with our own marine sciences.

It occurs to me that our development of techniques to investigate the seas, to reap the benefits of resource harvest, and to coordinate our exploratory research might be approached by a public corporation of industry, government, science and education. Industry may well choose not to go it alone because of the tremendous investment and uncertainty of reward. Social demands upon government are mounting so massively; budgets for new programs in the oceans, as exciting as their promise may be, simply are not realistic. But the combination of effort and investment that made Telstar possible would be a winning combination to make a sea-star project productive.

The mounting wave of concern with all our resources and the total environment has spawned increasing waves of resistance to ever again doing "business as usual." As we continue our efforts to master the seas let us make certain our mastery does not mean wasteful exploitation, but is based upon the most careful stewardship. Man's needs are to be served, but that service should always be compatible with the needs of other living resources. Sea Grant is people oriented and rightfully so. We must ensure that this orientation is not only for today but for generations yet to come.

The challenge of Sea Grant, then, is to point the way; to solve the problems; to identify the best technique to enjoy the bounty of the ocean without harm to its beauty, not pollution of its life chains; to bring men together as we explore and unlock the mysteries of this vast frontier; and to be patient so our efforts can be protective as well as productive. So rapid is our change, so dramatic is our progress that yesterday's dreams are today's procedure and tomorrow's anachronism.

THE CHALLENGE OF DEVELOPING MARINE RESOURCES

International Development

Donald L. McKernan

Special Assistant to the Secretary of State
Office of Fisheries and Wildlife
Washington D. C.

Man's continuing struggle to conquer his environment has now turned to the largest unexplored area on the planet Earth, the sea. If we can characterize the decades of the sixties as the decade of space, then we can predict that the 1970's will be known as the decade of ocean exploration. This period of history stretching before us will be a time when man turns to the sea with the same energy and determination that has characterized his efforts on land and in space. As President Nixon very recently stated in his report on foreign policy for the 1970's, "In an era when man possesses the power both to explore the heavens and desolate the earth, science and technology must be marshalled and shared in the cause of peaceful progress whatever the political differences among nations. In numerous and varied fields – the peaceful use of atomic energy, the exploration and uses of outer space, the development of resources of the ocean and the seabeds, the protection of our environment, the use of satellites, the development of revolutionary transportation systems – we are working with others to channel the production of technological progress to the benefit of mankind."

The United States, since its origin, has been an active maritime nation. The ocean waters off New England were important lifelines that carried the life blood for the birth of our society. In recent years it has become evident throughout the world that greater use of the ocean for a wide variety of the needs of man is essential to a burgeoning world population and a growing world economy. How effectively man uses the ocean for food, for minerals, for communication, for defense and, yes, for every day living will profoundly affect future life on this planet. Can there be any question that, with a doubling of the world population and with this major increase in human population occurring in those areas of the world that even now are unable to adequately feed themselves, it will be essential to increase our knowledge of how to fully develop the resources and to use the environment of the sea for the benefit of mankind. At a time in our history when we are absorbed by the problems of urban life, by the quality of our environment, and by major political unrest throughout the world, we are likely to overlook the question of food and space and recreation for the future. Yet, it has become clear that we cannot ignore an environment which covers virtually three-fourths of the planet, the seas, if we are to sustain life and improve its quality in the future. Therefore, it seems appropriate in beginning the deliberations of the Third Sea Grant College Conference that we look beyond our shores and spend a few moments reflecting upon our national goals in the world ocean. What are the broad interests of this nation in the sea and how can we assemble our resources to accomplish these broad goals?

The Marine Resources and Engineering Act of 1966 declared the policy of the United States to be to develop, encourage and maintain a coordinated comprehensive, long-range national program in marine science for the benefit of mankind, to assist in protection of health and property, enhancement of commerce, transportation and national security, rehabilitation of our commercial fisheries, and to ensure increased utilization of these and other resources.

While our national policy calls attention primarily to our national requirements, there is a strong implication, amounting almost to an explicit declaration that such a policy must serve the needs of and be for the benefit of all mankind. We are not alone in our dedication to increasing man's use of the sea. All maritime nations of the world are allocating greater and greater resources for the purpose of promoting the use of the sea and its resources.

On one hand, nations such as Japan, the Soviet Union, our neighbor to the north, Canada, West Germany, the United Kingdom, and many other maritime nations have concentrated in the post World War II years on developing their fisheries. For the most part, they have been uniquely successful in accomplishing this goal. On the other hand, nations such as the Soviet Union, Japan and many others have also concentrated on their Merchant Marine activities.

For example, the total tonnage of commercial cargo carried in United States ocean-borne foreign trade increased from a figure of 267,000 tons in 1959 to a total of 419,000 tons in 1968, just 10 years later. World shipping has almost doubled during the same period. This tremendous increase of almost 60% in cargo tonnage in ocean-going cargo tonnage in and out of the United States and the doubling of merchant shipping on a world-wide basis is indicative of the increased use of the oceans for the exchange of goods and materials between nations.

Still other nations, including the United States, have looked at the sea as a means for expanding and developing defense mechanisms by which to defend their country. Many nations, our own included, have looked at the shallow continental shelf areas of the ocean adjacent to the great continents of the world as a place to explore and exploit mineral resources.

Coastal nations have become concerned with the coastal zone along our shoreline and in our estuaries. In our case, the long-term use of the coastal zone – port facilities, recreation, fisheries maintenance, pollution control, and land use – is becoming a critical matter to the nation. The same phenomenon is occurring elsewhere in the world and as yet we do not have enough technical information nor do we have adequate organizations to begin to solve this problem.

The highly technologically oriented maritime nations, including the United States and the Soviet Union, have expanded their capability to carry out research and exploration in the deep ocean. Some of this exploration has led to the discovery of high concentrations of manganese nodules on the deep ocean floor and at least one company is seriously considering mining these nodules. Deep submergent vehicles, man in the sea projects, ocean data collection systems, all are becoming part of the developing technology leading towards an increased use of the oceans. But the rest of the world, where the need for food and economic development is the greatest, is also looking to the sea, and these nations are determined that the highly developed nations of the world shall not control and dominate the world ocean to their exclusion. As man's capability to carry out research in and on the ocean increases; as he develops engineering techniques to work in the deep sea, the possibility of conflict and confrontation, not only among the technologically advanced maritime nations, but often between these nations and the less developed nations, increases at an even faster pace. Therefore, it seems to me that we must pursue research and development in the sea in a parallel course with improving the human political instruments by which to minimize conflict and find ways for all mankind in the broadest sense to benefit from man's entrance into the sea.

In the post World War II period there has been a tremendous expansion in almost all ocean activities. The super tankers with their capacity of up to 300,000 tons of oil cross the oceans at incredibly low economic rates and with their awesome capacity for polluting the oceans and destroying its environment are only one manifestation of man's capacity to conquer this inner space. The recent voyage of the Manhattan through the Arctic and the potential for new and as yet untried means of ocean transport beneath the surface of the sea, further prove man's scientific and engineering capability for developing the use of the sea.

The increase in fisheries production from about 20 million tons of fish in 1950 to well over 60 million tons of catch in 1969 with the latest figures from the Food and Agricultural Organization showing an annual rate of increase in fish production from the sea of about 7% further attest to man's scientific and technological advances in his use of the sea. The development of the sophisticated and successful oceanic defense systems, the Polaris submarine and many other such systems now in use by our nation's Navy further attest to our capability and our developing knowledge of the ocean environment and its potential for the defense of our country. Man and the sea projects by private industry as well as government agencies bring us into closer contact with inner space and may well make possible within the decade for man to live and work for long periods, perhaps a lifetime, within the sea.

Storms appear on the horizon, however, storms that threaten to restrict our progress into the sea. The pollution of our estuaries and inshore waters, and the increasing controversy over ownership of marine resources and marine areas attest to man's inability to provide a balance between the note of exploration and exploitation and the rate of development of successful political organizations to peacefully resolve disputes in these unchartered waters and unknown areas of the planet.

With this background of broad purpose, with this brief glimpse of world interest and world need, what can be said about the desired course of action for this nation as it turns to the sea? Perhaps no nation in the world has such a favorable location with respect to its position. With a very large coastline, bordering the Atlantic coast on its eastern seaboard and the vast Pacific ocean to the west, no nation in the world is so favored by environment and by natural harbors, ice and storm free for most of the year. No nation in the world has developed the high degree of scientific and technological skills capable to projecting its energies, financial and political, into the sea as has the United States. There is no area of ocean activity where United States interests are secondary. It is true that our merchant fleet has dwindled and our fisheries have stagnated, but it is equally true that the interests of this nation commit us to improving the prospects for the merchant marine and fish catching capabilities of the nation. Our opportunities for using the sea as a source of food are immensely important in spite of our lag in this area of economic endeavor in the postwar world.

As was mentioned earlier, with the world fish catch doubling every decade at an annual rate of increase of about 7%, the United States catch has stagnated at about 2 to 3 million tons of production a year. The United States market for fishery products is the best market in the world. We have broad continental shelves on some parts of the Pacific as well as the Atlantic coast and we are either within easy striking distance or adjacent to some of the most productive food producing areas of the world ocean. The international waters off our coast have attracted vessels from practically all high seas fishing nations of the world and without question there is a greater catch by foreign

nations in the waters off the coast of the United States than by the fishing vessels of our own country. At this time, when the world fish catch is increasing at a spectacular rate, the contribution of the American fishermen to this catch decreases annually. What a contrast to our record in other basic industries.

Our nation has been willing to strongly support a strong and viable agricultural industry. The Land Grant College system, organized over one hundred years ago, has and still does attract some of our best brains in the science and engineering of agriculture. We directly and indirectly single out the oil industry for special financial support and trade protection. Our private industry, with very strong government support, explores the lands and in recent years the edge of the sea for oil and gas. Yet our policies with regard to American fish production have constantly put this industry into direct competition with competing fish and other protein products from all over the world. The potential fish production off the coast of the United States or in nearby waters is at least 10 to 20 times present United States production and we do little about it.

Some of our strongest segments of the fishing industry fish the high seas off the coasts of Central and South America, the Caribbean and Africa. Our capability for high seas fishing is very great indeed and the opportunities for American fishermen to catch increased quantities of fish of great economic return is almost unlimited. Estimates of the potential world fish catch vary tremendously, but almost without question this catch can increase four to fivefold beyond the present 60 million ton catch without endangering the supply or without enhancing the basic productivity of the sea. Coupled with this potential increase in fish catch, is the probability of farming the edge of the sea for fish of high economic value.

This has already begun in many parts of the world, including relatively minor efforts within the United States. This country has contributed substantially to the science and technology of aquiculture, however, and many of the new techniques have been discovered and developed here in the Pacific Northwest. Such fundamental accomplishments as those of Dr. Lauren Donaldson experimenting with the artificial cultivation of salmon and trout have contributed much to the field. The food studies carried out by scientists of Oregon State University and the Oregon Fish Commission have brought about a fundamental breakthrough in the artificial feeding of salmonoid fisheries. There is little question but that the aquicultural industry in this country will develop into an important economic industry during this coming decade and it is almost certain that it will add to the food and economy of our people in the years to come.

The development of deep sea mining is proceeding perhaps not so rapidly as the development of under sea oil resources. It has been estimated by some that economic mining of manganese nodules from the deep ocean will proceed during this coming decade but what other possibilities for hard minerals are available in the deeper areas of the ocean is yet unknown. Our research and exploration, even most of our tools for developing deep sea mining, are yet to be developed and predictions of economic opportunities in this area are not as certain as are those for other resources in the ocean.

For the past 2 decades our deep sea shipping industry has declined and for the most part one must recognize that it has been the subject of indifference and neglect. Statistics show that during this post-war period our merchant marine fleet has declined to less than 20% its former size, and the share of our exports and imports carried aboard United States flag vessels has shrunk from over 40% to approximately 5%. Ships of other nations now carry 95% of the cargo in and out of our ports. The opportunities in this area for improving the maritime industry are great. I would add that President Nixon has sent legislation to Congress recently with the hopes of developing "a new era in the maritime history of America, an era in which our shipbuilding and ship operating industries take their place once again among the vigorous, competitive industries of this nation."

Within the foreseeable future world commerce will continue to move on merchant ships and the opportunities for the American shipping industry to recapture its share of the merchant transport is one of the great challenges of the coming decade.

The oceans provide an almost unlimited opportunity for improving our national security. Our Navy supports a very strong program in oceanography, ocean engineering, marine research, technology and research exploitation. The exchange of research and engineering knowledge between the civilian oceanographic community and the Navy oceanographic effort has been improving rapidly in recent years. Together they provide a great store of sea power for our nation. It is fair to say that the national defense programs in the ocean are more important to the security of our nation today than ever before in our history.

With this optimistic view of the opportunities for our nation as we turn to the sea, what kind of obstacles do we see before us that prevent our reaching these goals? While the opportunities in the ocean are great, the cost in terms of manpower, equipment and funds is obviously substantial. While admittedly the cost is less than our cost in conquering space, to accomplish our goals in the ocean decade will require a sizeable increase in effort; much larger allocation of resources of funds, equipment and scientific manpower than at present.

Without question, for the next few years domestically, the benefits of allocating a great proportion of this nation's resources in ocean research and development will be weighed very carefully on the scales for the benefits to be gained. It will be necessary for those of us who are anxious for early fulfillment of our national goals in the ocean to provide evidence of economic gain and to measure that gain. We must show that the benefits to be gained in all

areas of human activity in the oceans will so outweigh the costs as to provide clear evidence of the national interest in proceeding rapidly with our ocean development program.

At the present time, the world has inadequate mechanisms for resolving disputes in the ocean. The resources of the high seas are considered to be owned by everybody *(res communis)* or, on the other hand these high seas marine resources are owned by nobody *(res nullius)*. Until such time as these resources are harvested and taken into possession, their common property nature makes them particularly vulnerable to controversy and conflict among individuals and nations. The four Law of the Sea conventions, the High Seas Convention, the Territorial Seas Convention, the Fisheries Convention, and the Continental Shelf Convention of 1958, all helped to develop and codify international Law of the Sea. Even so, some serious questions remain. The breadth of the territorial sea was left unsettled although a second conference in 1960 was called in an attempt to resolve this issue. The passage of ships through straits and overflight privileges was left vague and unclear in the 1958 conventions. The outer boundary of the continental shelf and a legal regime for the deep seabed are all issues of great concern to the world community at the present time.

International law governing fisheries as well is far from being settled. Confusion and conflict govern these activities in many parts of the world ocean. On one hand, a few nations have unilaterally extended jurisdiction over broad and unprecedented areas of the high seas and several of them attempt to enforce their unilateral claims. On the other hand, many of the high seas fishing nations under the principle of freedom of fishing on the high seas have so decimated coastal fishing resources that the coastal fishermen are hard put to compete under these circumstances. Witness the appearance off the Pacific coast of the United States of large fleets of foreign vessels; recognize that the capacity of these super fleets of large and modern vessels far surpasses the capacity of our vessels. They are not only larger, but they are far more modern than any of our coastal vessels. They usually fish as a fleet and can decimate the limited stocks of some coastal, non-migratory species of fish. One cannot question the concern of the coastal fishermen the world over of this type of fishing. Thus, there is a great need to provide further safeguards against overfishing the limited coastal fisheries lying inshore which may be found partially at least beyond national jurisdiction and in the high seas.

Our Government has indicated that we believe that the time is appropriate for the conclusion of a new international treaty fixing the limit of the territorial sea at 12 miles, and providing for free transit through and over international straits as well as defining more clearly preferential fishing rights for coastal states on the high seas. Concurrent with these efforts, our Government shall seek to reach agreement on the outer boundary of the continental shelf and we shall work within the United Nations framework to establish a fair and reasonable legal regime for the deep seabed. How successful we will be in these efforts in view of the tremendous interest of all nations of the world in protecting their national interest and in seeking in their own terms a solution to these complex problems remains to be seen. International law and treaties dealing with questions of boundaries, ownership and sharing of the resources of the ocean are quite incapable of dealing with current problems arising from the application of science and technology in the sea, let alone those problems that can be foreseen in the decade ahead. It is imperative that this nation give a high priority to appropriate regimes of the ocean that will ensure that this nation and all nations have adequate opportunity to benefit from the use of the sea and its resources. It will be necessary to provide for a reasonable and speedy mechanism for the resolution of disputes among individuals and nations concerning these resources.

Essentially what I have been saying is that the nations of the world are turning to the sea; they anticipate that its resources and its use will be a major benefit for mankind in the future. This nation's interests in the ocean are as broad and comprehensive as are the interests of the world. Our capacity for developing the resources and using the sea are perhaps on balance greater than any other nation in the world, and our capacity for benefiting mankind by our example is evident. It is quite obvious that our actions in developing ocean resources and their use in the next decade will have an important bearing on the future welfare of mankind.

As we turn to the sea, we must increase our efforts to learn about this exotic environment, but, at the same time and with equal energy, we must address ourselves to the development of international institutions that will overcome political conflict among nations over ownership, conservation and allocation of these resources.

The challenge of our nation to resolve the fundamental problems of expanded use of the ocean for the benefit of mankind strikes at the heart of the Sea Grant Program. Your program is designed to develop the support of the educational institutions of our country, to educate and train participants in very broad fields relating to ocean resource, to development as well as initiating research programs in fields of ocean endeavor, and to provide a link between the scientists and engineers and the public who will invest and develop the economic enterprises with their base in the sea.

Perhaps the most attractive feature of the entire Sea Grant Program is the emphasis on broad interdisciplinary programs. As Mr. Robert Abel, the Head of the Office of Sea Grant Programs of the National Science Foundation has recently said, "few persons have realized the subtle strength of the concept and the innovative management tool that it extends to the Presidents of universities to strengthen coordination among departments and among universities. Already schools of law, business and engineering and

departments of all sciences, food technology, psychology, economics and education are collaborating in this program."

Truly, with our nation turning to the sea, it may well be that the success of the scientific and technological problems associated with man's use of the sea may well depend upon the formation of adequate multi-disciplinary institutions to deal with the economic, social and political problems arising from the use of resources which are owned by everybody, yet belong to nobody.

Let us hope that the next 10 years will see us conquering inner space. We can hope our success is equal to that of the USS Constitution on its memorable sailing from Boston Harbor on 23 August 1779 without its logistic problems.

Take the problems of the supply officer on the USS Constitution when she sailed from Boston on 23 August 1779. He had loaded for a mission to harass and destroy shipping in the English channel area. She departed Boston with 475 officers and men, 48,600 gallons of fresh water, 7,400 rounds of cannon shot, 11,600 pounds of black powder and 79,400 gallons of rum aboard.

Making Jamaica on 6 October she took on 826 pounds of flour and 68,300 gallons of rum. Then she headed for the Azores arriving there on 12 November. She provisioned with 550 pounds of beef and 64,300 gallons of Portuguese wine. On 18 November she set sail for England.

In the ensuing days she defeated five British men-of-war and captured and scuttled 12 English merchantmen, salvaging only the rum. By 27 January her powder and shot were exhausted.

Unarmed, she made a raid up the Firth of Clyde. Her landing party captured a whiskey distillery and transferred 40,000 gallons aboard by dawn. Then she headed home.

The Constitution arrived in Boston harbor on 20 February 1780 with no cannon shot, no powder, no food, no rum, no whiskey, but with 48,600 gallons of stagnant water.

Fishing: Margins of Unused Capability

Sigfryed Jaeger
Captain, F/V Seattle
Seattle, Washington

I'm a fisherman whose job is catching and marketing fish and shellfish from the sea. I am becoming aware of competition in the sea from the same and conjoining areas; for extracting of other products such as minerals and for harvesting of the same species, both from abroad as well as domestically, in the pursuit of recreation. I am also aware that I alone am not able to cope with this situation.

Just as we fishermen look upon foreign fishermen as interlopers on our traditional grounds, so do we judge off-shore oil platforms and sport fishermen. But they are here to stay and will prosper because they fulfill an expressed need, whether utilitarian or aesthetic. Direct confrontation or denial is unrealistic. But lacking any yardstick of coherent national policy we are dependent on political and public good will, rather than on substantive merit, for a rational development of the ocean resources.

We would more profitably expend our energies toward understanding each user's respective and specific needs. We should accept these needs by acknowledging the limitations each group imposes on the other in a unified maximizing of each respective resource at a sustainable level. The influences exerted by the respective interests, however, are not equal, and any inequality will be maximized for advantage without necessarily weighing in an impartial manner the relative needs of the conflicting interests. In Sea Grant the potential exists for examining these respective needs, for evaluating them, and for developing the use of the sea's resources with a minimum of friction and with a maximum of awareness for the responsibilities of each user to his own and to adjoining resources. Until the maturing of such understanding many new developments in the use of the sea or sea-bed will be treated as a direct threat, and the expenditure of energy in behalf of and in opposition to these developments of competing uses will be longer remembered for their resonance than for the verity of their arguments.

Some Problems

My immediate preoccupation is with the harvesting segment of the commercial fishing industry which has its own endemic problems rooted in the past. Its future foretells aggravation of these problems and others now developing.

In attacking technical problems we may circumvent or solve some with major breakthroughs in super-sophisticated techniques of detecting and harvesting. But to slight existing problems and bet heavily on a dark and futuristic horse glosses over existing deficiencies which, though individually minor, are numerous. We must live in the meantime.

The problems of greatest immediacy are an accumulation of these minor deficiencies which collectively add up to substantial margins of unused capabilities. Refinements, improvements, and evolvements in existing fishing techniques, in fishing gear, and in related equipment have not been exhausted. These refinements are precedent to the adoption and use of future sophistications in fish harvesting by present and entering generations of fishermen. They can be stimulated by fisheries extension work, by honing fishing skills to a fine edge, by stimulating a receptive attitude now, and by bringing to bear more intensive in-depth studies of the essential nature of the fisheries themselves and of the participants.

The Men

Fishermen, individually and especially collectively, are themselves a resource with margins of unused capabilities. The individual owner-operator is a basic and versatile resource, capable of superior performance in his field. Unfortunately, such individual attainments are not cumulative in time or in depth and much individual superiority is limited or lost for want of communication and through dilution. And this superiority is only occasionally noted.

In a recent Canadian economic study the comment about absentee ownership was that "such vessels do not fish as hard, operate less economically, earn less than a fisherman-owned vessel."[1] This statement reflects the feeling of many of us, but has not to my knowledge been the subject of a specific study. Through financial necessity some fisheries are prosecuted by company-owned vessels, but there is an ever-present problem of a driving incentive for the skipper, comparable to the whip of self-interest endemic to an owner. Individually owned and operated vessels can achieve greater efficiency because of self-interest, but to achieve this on a broad scale we need to accumulate the refinements of this expertise, to stimulate it

[1] Proskie, John, "Costs and Earnings of Selected Fishing Enterprises, Atlantic Provinces, 1964," Primary Industry Studies, No. 1, Vol 14, Dept. of Fisheries, Canada. P.24

further, and to broaden the base by dissemination of these skills.

Various Approaches

The psycho-sociological approach has been used successfully in professions and industry to collect data on successful individuals; their interest clusters, their aptitudes, and their acquired skills. After the material is assembled and evaluated it might become a series of tests which would indicate the potential for success of a prospective entrant. To my knowledge this approach has not been tested in the fishing industry–except that in certain areas the proper old country accent performs some such function now. One of the basic ingredients for the success of hull insurance pools in the Pacific Northwest is that the individual operator is screened; that is, only pool-approved skippers may operate pool-insured vessels.

The perspective which other fields of discipline can bring to the fisheries can be fruitful of new insights and new knowledge. But the investigation and conclusions reached must keep in mind the intrinsic nature of the industry and its people, those traits which have a time-tested value, and those which have color but little concrete value. For example, a common error in the economist's approach to fishing vessel operation lies in the use of the word *diversification*. The fishing boat "ain't no such animal." Diversification is industrial economics, conversion is fishing vessel economics. A vessel can operate most efficiently with only one type of gear at a time, at the present state of the art.

Fixed labor costs are relevant to gross profits, less so to gross income. The lay system–the share–has a long, traditional, and useful history, but it suffers from unrealistic compromises of which I will say more later.

Another approach is the anthropologist's view of fishermen. Such work is presently in progress by a doctoral candidate at the University of Washington, and has been fruitful in analyzing communication patterns among fishermen. Indications are that these patterns are horizontal, based on kinship or between men of comparative skills in the business of fishing. Also, what may already be surmised is that the ecology of the fishery alters communication patterns. These communications do not materially contribute to any widespread increase in fishing ability because such information, when traded at an upper level of proficiency, is redundant or less vital than if it were transmitted in a vertical pattern to the less proficient. Such a vertical pattern would, for the most part, be of unequal value to the participants. Only one would profit by it, and the other would be increasing his competition.

Myths and Realities

The fisherman in pursuing his trade lives in cramped quarters, under close surveillance, on a 24 hour basis. There is little room here for the individualist and his extroversions or for the introvert and his inhibitions. Not all men can or will tolerate such unremitting scrutiny. It is a monastic existence in the main, punctuated only by brief and sometimes bewildering episodes ashore.

Physically, the fisherman is not identifiable as such when seen on the street, in the restaurant, or in the supermarket. But the demands on his nature and his knowledge are diverse and call forth or synthesize specific character traits for maximum use, to the neglect of others. He works within, and is molded by, the resistant medium in which he operates. This kind of special selectivity operates impersonally on all in some quantitative or qualitative way, regardless of profession.

The fisherman's taciturn individualism has been emphasized, reiterated, advertised, oversimplified and romanticized until he appears to be both a sub-species and a super-species, depending on who is doing the talking, to whom and the motives involved. The fisherman has been praised and damned for this typing until he almost believes it himself, except that in some cases he may simultaneously be profiting from a cooperative marketing enterprise and an insurance pool, building an industry pension through a joint deduct from gross income, or participating in conservation practices involving surrender of some expressed rights of unlimited exploitation.

Cooperation

These advantages of cooperation are regional and fragmentary, and at times short-lived. They are but fragments in the total complex of the United States fisheries because there is little significant communication between the different fisheries. There exists no active medium to efficiently and constantly transmit and demonstrate these basic advantages pioneered in one fishery across to another in need of such assistance.

There exists no adequate and deliberate plan to tag and to develop talented and purposeful individuals to sustain mutually advantageous activities such as a co-operative insurance plan or a marketing mode, or an active progressive union or association. The general will is not enough. Without the individual dedicated manager such plans simply flare up and die, leaving behind little or no residue. Most such successful examples which exist today have had the good fortune of having such men, but by sheer chance. We need more of them.

Is it possible that through extension, the fishing industry might cultivate a rich source for such men so that a mutually profitable exchange of talent could be stimulated? Is it specious to offer the old cliche that "the proof of the pudding is in the eating of it?"

An effective extension program cannot be subject to sporadic *ad hoc* policies and consequent budgetary and political whims of a large agency, nor will it be of a substantial value as a regional effort when it is used only for preemption of a fishery or acquisitive thrust of regional rights. Increased fisheries extension activity today signals the growing awareness of a need to be satisfied. Better a little awareness than none.

Writing about fishing technology and talking about it is not effective enough. Bring the man with the know-how—the expert—to the fisherman, to the boat. A new type of gear must involve the man who knows how to use it effectively. We need face-to-face contact, involvement, and commitment. To shy away from this is to protect a position from the test of application.

Modest Proposals

Contact and involvement can begin with such details as record-keeping. All fishermen keep logs or records, some regularly and in detail, others desultorily and without organized pertinence. Such records should be consulted, evaluated and catalogued along with laboratory information to develop insights and perspectives. The more such material is organized into a body of knowledge the less susceptible are we to the well-meaning but misdirected efforts which have handicapped our fisheries in the past.

It is true that such compilations may be what every fisherman knows, just as the Kinsey Report in its time was a compilation of what every man in the street knew. The difference is that no one man knows the extent or breadth of the various facets of the fishing industry until they are brought together as a body of organized knowledge.

In recording and cataloguing there is an important and basic function for extension work. Behavior of fish stocks, noted oddities or inconsistencies, contemporaneous phenomena such as weather, tides, associated feed or bird activity, and direct observations such as these which in the past have been traditional, need to be either substantiated or debunked. The fisherman looks for "signs" with fishing potential. While there may be great variance in the validity of such "signs," he has interpreted and associated them in the light of his own self-taught or inherited background and its limits.

All such information in ready, cross-indexed form should include gear experiments, successful or not, since such experimental data would forestall duplications later. Subsequent information or equipment development may later yield answers needed to solve stalemated problems.

The solution to a specific problem helps to establish the agency's value to the fishery and keeps it in close touch with needs rather than pursuing less immediately pertinent matters of basic research interest. As a consequence, the specific solution to a given practical problem, though complete and effective, will recede in importance, and be displaced by the depth of the relationship being built. The close relationship developed is the really vital residual benefit.

By no means do I mean that pure research should be neglected or taken for granted. I am simply restricting my comments to this one most important aspect, and that is direct application of results, the end product of all the combined quest for knowledge.

There are some small but valuable techniques and information that can be found or developed from within and without the fisheries. For example, some vessels in longlining have perfected a mode of using loran lines-of-position as a guide for setting their gear in perfectly parallel strings at optimum distances apart. Loran lines can be accurate to within 600 feet and such control results in a 15 to 20% increase in volume of fish from the area compared to using dead-reckoning in the same area. Longer strings can be used with a consequent reduction in hauling non-fishing gear such as bags, flags, and buoy line. Parted gear is more quickly and easily recovered because its position along its entire length is accurately known.

Ordinary sailing charts lack sufficient detail for the fisherman and have inaccuracies which remain uncorrected for long periods. We therefore must sometimes make our own charts of the grounds. There are available, however, original hydrographic surveys of offshore area through the U. S. Coast and Geodetic Survey Office in Rockville, Maryland. District offices have microfilms of these. Photostats of the original survey may be ordered at $8.50 each, but the compass rose and loran lines must be added. These charts have a usual scale ratio from 1:5,000 to 1:20,000, as against 1:5,000,000 or more for regular sailing charts. They are highly detailed, however, and despite the age of some, are the best available unless perhaps there exists in naval archives such information which might be useful and can be de-classified. Such charts, consolidated by area and updated could form the basis for use by exploiters of the sea's margins, just as Kingfisher charts are used by European fishermen who, in turn, are a data source for updating these same charts.

It would be most interesting also to have available the detailed knowledge now being collected by Russian and other foreign fishing vessels operating on North American continental shelves. Such information will be priceless in the increasingly competitive struggle for the sea's proteins and other resources.

To build on the foundation of technical excellence for vessel operators a family of refined skills in their every detail needs to be accumulated. These are not self-taught efficiently. Though some such skills have been built over long years, their use is restricted because they have no common industry repository and therefore are not cumulative except in a restricted sense among family members or neighboring operators. This practice contributes to the consequences common to inbreeding.

The Lay System

Though fishing is highly traditionalized in many respects, there are some basic well-rooted usages that have stood the test of time. The lay, or share system is one of these. It can maximize incentive and financial return to the vessel and to the crew, and does so in many cases, but it is not faultless. Over the years this economic system has been altered in details and has evolved somewhat, sometimes for the better, sometimes for the worse. When stocks of fish and prices are reasonably adequate, both parties to the

agreement make some profit and are not always so critical of the details. But variations in formula details can mar the principle of built-in incentives and proportional returns so that under accelerated economic pressures minor flaws are magnified and tend to reduce the competitive flexibility of the fishery.

A test to reveal some flaws in a specific formula is to compare the proportionate income of vessel and crew at various levels of gross income after trip expenses. Expenses are fairly constant from trip to trip. Another constant, however, in a sense, is the ever present fluctuation in gross income from trip to trip, due to the vagaries of price and of quantity of fish. With fixed expenses, and varying gross income, it is apparent that gross profit will vary considerably. It is important, then, that vessel and crew should underwrite these trip expenses on a basis proportionate to their respective share in the profits. In some circumstances, however, the proportionate share of the vessel and the crew in the gross profit does not remain constant because trip expenses are not equitably divided, with a resultant erosion of incentive and restriction of the vessel's ability to compete.

Comparisons on the basis of gross income alone can be misleading and inaccurate; the most valid criterion in a profit-sharing scheme is the proportion of income received from the gross profit (gross income less trip costs), if the lay system is to be a truly profit-sharing system. Specifically, if the burden of operating cost is borne disproportionately the income of either vessel or crew will disappear at a higher level of gross profit than is necessary. When the profit for one disappears, the vessel ceases to operate and both parties to the system are out of business.

These deficiencies can be demonstrated and detected by applying such a prediction as was voiced 2 years ago at the Seattle conference on the Future of the Fishing Industry in the United States: in the next decade product value will increase 20 % accompanied by a rise in costs of 80%. Valid or not, apply the prediction to a given share system and it will readily be apparent who will profit or lose most. Any alteration in a particular share system is difficult to bring about, especially in a fishery of organized labor and owner groups. When changes are made, they are often inadequate and are made as a refinement to an already faulty arrangement. Or the changes are forced by the preponderance of pressure between the groups without due regard for the merits of economic equities. Or the changes are stalemated even in the face of much evidence supporting the need for changes. An example and an exception was the case of the tuna fishing industry in southern California; although the necessary fishing gear for purse seining and its technique for use was known in the beginning years of the 1950's, it was not until the mid-50's that an alteration was successfully made in the share system, which precipitated the changeover, the beneficial results of which are now history.

By contrast, in 1966, 275 American longliners brought in 27,177,000 pounds of halibut, the full American share of the quota that year. Fifty-one vessels, 18.5% of the fleet, brought in 50.7% of this fish. [2] There is some bias here because some efficient fishermen were itinerants who came into the fishery for a few trips and then left for other fisheries before the season ended. Also, all vessels were not of equal size or manpower. Nevertheless, the hard core of the fishery was clearly dependent on a minority of vessels for a majority of the catch.

In 1967 and 1968, hard core notwithstanding, we fell short of the quota. Prices were low, catch per unit effort was low and many crews were unwilling to continue because the existing share system cut deeper into the crew's income than into the vessels' share when prices dropped. From 1966 to 1967 a 35% drop in price resulted in a 47% drop in crew share. Profit did not shrink and disappear simultaneously for both partners.

The significance lies in the fact that shares for the crew disappeared at a higher level of gross profit than that of the vessel. The result was that many boats could no longer operate because the crew was unwilling to continue. Therefore, fishing ceased at a higher level of gross profit than need have occurred, rendering the vessels less competitive.

The True Majority

The need for change does not of itself effect change. There must be an active desire impelled by an informed and competent majority. Again, let me refer to the foregoing statistic, the top-producing segment of 18.5% of halibut vessels. Numerically, the most aggressive and prolific producers are in the minority, whereas the majority of 81.5% brought in somewhat less than 50% of the total production. I believe this is common to many fisheries. While the preponderance may vary, the question posed is clear, "Who is the true majority?" In the case of a regulated fishery, should regulatory recommendations from industry be based on a numerical majority of fishermen or an effective majority by production? Who has the greatest vested interest? At whom do you then aim a program of extension work? Which group will display the greatest gains? Is the goal to be maximization of the number of participants, or maximization of the efficiency of the fishery?

Multi-Purpose Vessels and Specialized Vessels

Thought must be directed to the difference in economic philosophy that exists between the itinerant multi-purpose vessels and that of the specialized vessels. The former has high cost through multiplicity of gear, the latter sacrifices versatility for economic efficiency. If the better way is the latter, this approach may be guided or stimulated through some form of limited participation program so that the potential of the specialized vessel may be more fully realized and, thereby, encourage the growth of a group of vessels committed to the welfare of the fishery in which they specialize.

[2] International Pacific Halibut Commission, 1966 Catch Statistics.

A multi-purpose vessel has an efficiency peculiarly its own, but the total cost of such a vessel and its various fishing gears must be borne in each of the fisheries in which it engages. As a necessary consequence the attitudes and basic interests of the owner-operator are divided between the various fisheries he pursues. He does this at increased cost to himself and, in a regulated fishery, takes a toll on the potential production of vessels primarily engaged in that fishery—the hard core. But the multi-purpose vessel with its own kind of efficiency is here to stay until more of the harvestable fish stocks are regulated in an orderly manner and until catch limits also mean a limited number of participating vessels.

By limited participation I mean restrictive measures which do not compromise fishing efficiency; overall quotas, division of grounds into sub-areas with sequential openings and closings, free entry, a license conditional on participating a major portion of the open season as a qualification for a succeeding year's license. (Some entry flexibility needs to be retained for those vessels which must move out of temporarily depressed fisheries and to allow for entry of vigorous new fishermen.)

Other Considerations

Above all, the cost of conservation measures which restrict efficiency and raise harvesting costs should be spelled out in dollars and cents to the fisherman so that he may be able to better judge the conservation value of a regulation. He should be encouraged to use his latent political strength in behalf of remedial legislation on the regional level from which most such measures originate. High costs and inefficiency, no matter what the source, are fair subjects for scrutiny and amelioration.

Further, unrealistic gear or vessel limitations sometimes force the fisherman into inefficient investments and tend to perpetuate an undesirable condition because the fisherman is forced to resist any change for the better in order to protect his investment.

A wisely regulated family of successful domestic fisheries adds weight to international fisheries negotiations, not only as protection against foreign incursions, but as pilot operations that materially aid conservation objectives in fisheries which are international in scope.

There are other less subtle and unnecessarily high-cost items. Vessel insurance is one. This problem has been solved in part through pooled insurance by owners' groups. Besides reducing such costs by 50% or more, such pooled efforts have upgraded the fleet in maintenance and safety standards and, since such membership is an endorsement by fellow fishermen, does carry weight with loaning institutions when remodeling or converting.

Other cost reduction by refining fishing techniques of existing fisheries are only a beginning and satisfy only immediate needs, but they are a means for moving into advanced fishing modes. Such advances grow out of present states of knowledge and experimentation. The clues for major changes are all about us and each promising clue needs to be investigated and catalogued. The strides made by science are at a pedestrian pace, piling block on block with apparently little progress until finally one block becomes the keystone that drops into place and gives the edifice coherence.

Questions Needing Investigation

There is an assumption that fishing can be more efficient if aggregation of fish schools can be artifically stimulated. This may be so through such known characteristics as phototropism in some species, using or stimulating thermal upwellings or even by chemical seeding. There are some clues that could be investigated.

With halibut, for example, it has been noted that they are often hooked in the belly and that they can be calmed down on the dressing table by rubbing gently in the area of the lateral line. It has been also noted in one place on the grounds that halibut are brought up with several green spots on their ventral side. Copper oxide is green and has an acidic, piquant taste. Is it possible that copper nodules or extrusions exist on this piece of ground and have an attraction for halibut, like a salt lick for cattle? (And, of course, there is the possibility of a copper deposit in this place.)

What is the significance, the useful significance, of such an observation as benthic predators nosing about the bottom in the tracks left by a scallop dredge?

What other clues do we see on the fishing gear, on the fish, on the depth sounder, that we are not yet able to interpret?

To whom can a fisherman bring information of an inferential nature? Will it continue to be by mere chance that such information will fall into the hands of a qualified someone who has other random bits of information and to whom this one more bit may yield another value, namely coherence, to preceding information?

A relevance once discerned stimulates further investigation. An active extension effort, with a planned method of recording and reporting, eliminates a large area of randomness. From such a planned exchange flows something that cannot be taught; a gentle and persistent curiosity sustained by the sense of excitement such an exchange stimulates, caused by the dim, new perception of a state of existence seen many times perhaps, but not understood before. This exhilaration is as real and as solid as a 15% profit. Not understood by the hard-eyed realist always, but nevertheless a spiritually satisfying, creative experience as real and as solid as the profit such developments can bring. This exhilaration, more importantly, generates further efforts.

This then is a potential product of an information exchange and repository, of reducing the area of chance significances escaping us indefinitely and of stimulating their pursuit and further examination.

The Future

For the future where do we look for markets for other underutilized and unutilized species? Just bring them in and sell them? Who likes octopus or shark?

Popularizing a new product is a slow process when eating habits are going to be changed and there seems to be a relationship between income and eating habits. Emulation plays a large role in introducing new foods, especially one destined to be a staple rather than a luxury. It is an evolution rather than a revolution, but it can be accomplished. The development of markets for a new species is a task-force project. Such teamwork does not exist today in most of our fisheries, but it could through Sea Grant. Here is a possible common meeting ground for harvester, processor and distributor.

Until now we have pursued the most easily captured species, the upper level terminal concentrators in the food pyramid of the sea. Though we cannot measure it yet, almost certainly increased fishing pressures have wrought an imbalance in this pyramid which will continue to grow, resulting in a massive wastage of proteins. The easy way is nearly over. The time for planned penetration into new fisheries, into further margins of unused capabilities, is here, with more efficient gear, better detection and planned market development. Unless planned for and stimulated, purposeful penetration will not transpire until we have been successful in exhausting the traditional species and probably the traditional fisherman.

The margins of unused capabilities in all their dimensions must be developed and used fully today, while we still have time.

The Challenge of Engineering

Edward E. Horton

President, Deep Oil Technology, Inc., Long Beach, California

It is a pleasure to have an opportunity to express some of the problems we, as engineers, face in developing the ocean's resources. To introduce the subject, I might relate a very short story about the professor and the flea. It starts with the professor addressing his class, "Students, I want you to observe closely. I have in my hand a flea and I place it on my sleeve and say to the flea, 'Jump'." The flea jumps to the professor's shoulder. Then the professor points back down to his sleeve and says, "Jump." The flea lands back on the sleeve again. After repeating this several times, the professor picks up the flea and carefully pulls off the hind legs and puts the flea back on his shoulder. He again says, "Jump." Nothing happens. "Jump." Still nothing happens. The professor then addresses the class, "Now you see, class, when you pull the hind legs off a flea, he can't hear."

To some extent, I think that we engineers in private industry are like the professor. We are very conscious and responsive to what we think is about to happen in the oceans and we do act accordingly, but sometimes, like the professor, we misinterpret the evidence.

The challenge to the engineer—to me the biggest challenge facing the engineer in private industry as it relates to the ocean—is the economic challenge. How do we make money from the projects that we are proposing to our management? This is a real problem now. I think some of our associated oceanographic companies have been hurt by making the wrong moves. In other words, going into the wrong areas, because these moves sometimes represent major capital commitments. The ocean is not laced with gold.

My company, Deep Oil Technology, is owned by two quite different companies. One is a very large engineering contracting company and the other is a small oceanographic engineering company. I think it will be interesting to tell you of some of the things we, as a group, are doing in the oceans.

Let's take the large company. This company has gone very heavily into the offshore oil contracting business, which entails acquiring a substantial fleet; large drilling barges, pipeline-laying barges, and derrick barges. This is big equipment and it's big money. A drilling vessel usually costs from 8 to 12 million dollars. Derrick and pipeline barges are somewhat less. It takes know-how as well as nerve to be in this business. The derrick barges, for example, can lift from 500 to 700 tons. In about two weeks, we will be launching a pipeline-laying barge. This barge is unique and represents some highly technical advances in pipe-laying methods. The barge we are getting ready to put in service has a reel on it in which the pipe (8-12 in. in diameter) is spooled horizontally. Up to 25,000 feet can be spooled. The reel is as large as the room we are now in. This barge goes out to sea and unwinds the pipe and lays it on the ocean floor.

I think we can say this represents a technical breakthrough. Actually, it is a solution to an engineering problem that has been solved by engineers. It is a new application of some existing engineering principles. The total commitment that our larger company owner is making toward floating construction equipment is in excess of 20 million dollars.

Now let's take the other company – Ocean Science and Engineering, which is a small, aggressive ocean-oriented company. This company recently went into the scallop fishing business. It did this not using methods by which scallops are normally gathered, – but by developing a new method which utilized on-board scallop-shucking machinery. This method enables the scallop boats to stay at sea for longer periods of time and actually shuck the scallop on the ship and bring only the meat back to shore. This scallop venture is beginning to look like a very good bet. It is a small investment in comparison with the large construction equipment, but nevertheless, it is a good investment.

The smaller company is also working on beach sand replenishment using a small submersible dredge. This dredge actually crawls under water. It is built on caterpillar tracks and looks something like a bulldozer with a diving chamber on it. A small cutter head is mounted on the front. This dredge can crawl out from the beach a distance of about 1200 feet and pump water through an underwater pipe which transfers the sand back to the beach.

This is another example of how small oceanographic engineering companies are willing to take economic plunges into technical areas where there is some question as to whether or not the projects will succeed. Private companies have demonstrated a willingness to take such risks if the reward is sufficient.

Another project we are working on is the building of a deep-sea recovery vessel. It is a large ship, over 200 feet in

length, built of aluminum. This is a new application for aluminum, as aluminum ships aren't usually this large. The vessel is specifically designed to work in deep water (5,000-6,000 feet), to search the ocean bottom, and to lift large objects. This undertaking is a major capital investment. We have studied the market and we think we can get our money back on it with some profit.

What I, personally, and my company, Deep Oil Technology, are most interested in is offshore petroleum. It's a timely subject right now, and is representative of the technical problems that this industry faces.

Offshore oil certainly has attracted a lot of attention from the industrialists, the politicians, the conservationists, and, last but not least, the engineers. Offshore oil exploration is active and has been for a number of years—long before Sea Grant was even conceived. However, in the last few years, since Sea Grant, interest has accelerated rapidly. This intensified interest is reflected by the money the oil industry is willing to pay simply for the right to exploit some of the areas on the continental shelves. For example, in the last few years, leases off California and Texas brought in more than a billion dollars not including the additional royalties that are paid on production.

There is no question that oil offshore is a very valuable commodity.

Over the last several years, there has been a great deal of interest in producing oil in increasingly deep water. Not long ago, a couple of hundred feet was considered deep. Now we are drilling for oil in water depths greater than 1300 feet. But I want you to notice that I said, "We are drilling for oil." We're not producing it. Actually, the deepest water from which oil is being produced is something over 300 feet. This lack of production should not be taken as a reflection of our lack of capability to produce in deeper water. Instead it is a reflection of the actual value of oil. There is no reason to go into deeper water if you can get it in shallower water at less cost. It does cost money to go deeper. Ways of doing things are controlled by economics.

Right now I'm absolutely certain that we can produce oil in deep water. We have the technology on paper. We can show the methods are technically possible with good sound engineering calculations. We haven't got the dollar problem solved yet but keep in mind that this capability of moving deeper and deeper offshore to produce oil is available to us.

At the present time, virtually all offshore oil is being produced from fixed platforms. These are big structures that have legs on them. The legs are driven into the sea floor and the equipment is placed on top of the platform. In a sense it is similar to a land operation. The cost for a platform in 600 feet of water will be around 12-15 million dollars. Such depths have not yet been reached. The deepest platform, as I said, is in 300 feet of water, so we are projecting costs. In a thousand feet of water we might be looking at 20 million dollars, if we continue using bigger platforms with heavier and longer legs. These costs refer to the cost of the platform and not the cost of drilling. It costs an additional $500,000 to drill the well once the platform is built.

Now, bearing in mind what it costs to move into deeper water, we might look at the demand for energy. It's been predicted, and these predictions are generally accurate, that our demand for energy will double over the next 15 years. Right now, we're producing about 5 billion barrels a year. As a general rule, we have been keeping about 15 times this amount in reserves. I don't think we are going to be able to maintain this practice. The reserve will probably drop to about 10 times the annual production in the next few years. There is terrific pressure for companies like ours to move offshore and to explore for oil. There is no question that we have to do this if we are going to meet the energy demand.

The way that our company has approached the problem is by means of subsea completions. And we are not alone. We think that we can put the oil wells on the sea floor. Again, I am speaking only for our company. The oil industry is a very mixed group of people but our group, as well as others, is looking very hard at using subsea completions, or at least putting the platforms under water. We think that the technical know-how is here. We're also looking at new designs of platforms—getting away from the idea that a platform has to be fixed on the bottom.

We are looking at floating platforms with new ways of mooring. Now, what does this entail as far as engineering and technical know-how? In the first place, if we want to put an oil well under water we have to consider control systems. Over the last few years there have been some really significant advances in control systems and we're borrowing from some of the space program developments. The wellhead that we have in our shop has control systems that are very similar to the ones used in satellites. We're able to transmit a great deal of information through a digital multiplex system which enables us to monitor and operate the sea floor installation.

At the same time, we are actively investigating new platform designs. We are more aware of the hydrodynamic forces of the ocean on the structure and the elastic behavior of the structure itself. We have better ways of defining these wave forces as well as those on submerged bodies. We're running extensive model tests and we're also using the computer for analyses. In fact, we are now able in some of the designs to predict the actual motion of the platform on a computer and compare these results to the same test in a wave tank. This approach is very effective, and when properly applied to hydrodynamics analyses, it enables us to achieve far better platform designs. It also brings up the need for even further studies in hydrodynamic behavior. We can handle the simple shapes but we don't know quite how to handle some of the interference problems; that is, where you have structural members coming together. These are problems that engineers should be thinking about.

Deep water is not the only challenge facing petroleum engineers working on oil production problems. It's virtually certain now that vast quantities of oil lie in the Arctic, in the Beaufort Sea and in amongst the arctic islands. I don't think that anybody really knows how we are going to produce the oil from these areas. It is a very fertile field for the engineer to be thinking about right now. How do you produce oil under ice? What are the real ice forces? We are learning and the Manhattan project that Humble Oil is carrying out is certainly an example. This project is a test to determine the feasibility of sending oil tankers by way of the Northwest Passage.

How does Sea Grant fit into these problems of offshore petroleum? Well, first and probably most important, they're going to be helpful in supplying the engineers and the technical people, through their engineering programs, to meet these technical challenges. Here I would like to add a few views of my own. I think there is perhaps too much emphasis placed on the uniqueness of the ocean with regard to engineering. I think, from my own experience, I would prefer engineers that are good engineers in their own right and are then able to work on problems specifically oriented toward our needs. I emphasize that the fundamental problems in engineering are most important; I get so tired of people coming in and saying, "I know how to skin dive, therefore I can solve a problem of the dynamics of your structure." This is simply not true. For example, I would rather have a good electrical engineer and train him to dive if I have to. In fact, when I took civil engineering, I was very surprised, in studying earthquakes, that many of the techniques we used to solve building motions were things that electrical engineers used all the time. We need basic knowledge first, then we can apply it to the ocean. That's my own opinion.

Again, I think probably one of the biggest roles that Sea Grant can play as far as a company like ours is concerned, and I'm talking about a company that is interested in developing equipment for the petroleum industry, is to direct their attention toward developing a framework in which we can develop this equipment and still protect the ocean's environment. Last year we had some real environmental problems in the petroleum industry—Santa Barbara is an example. It seems as though every time I turn on the television or the radio, there is another problem that is related to the oil industry. In my opinion, we're not really bad guys. Some things have gone wrong. Weighing these hazards against the benefits that can be realized by developing our resources, is the real problem facing the engineer. Public opinion is a great deterent.

These problems have to be weighed, and I think that certainly there is an opportunity here for engineers to develop what I would call an environmental criterion or analysis much the same way that an engineer is called upon to develop an economic analysis. Weigh these risks, and weigh them in the rational sense that is normally expected of an engineer. To me the true definition of an engineer is a person who can skillfully guide and manage an enterprise. And in this case, I look at the development of the ocean's resources as this enterprise.

The Economic Challenge

F. Ward Paine

President, Oceanographic Fund, Inc., Palo Alto, California

Professor Donaldson asked me to speak of the economics of this game and this I am going to try to do. This has not been a good year to talk of the economics of many things, like the economics of the stock market or the economics of government spending. However, talking of the economics of developing marine resources is not such a bad job. I am also glad to be speaking to this group because there are a lot of believers in the crowd and it is always easier to speak to believers than to non-believers and skeptics. Perhaps this meeting is a sign of better times. It is early March, the time of Aquarius, and it is the Age of Aquarius – Aquarius – the water carrier. Perhaps there is hope for us yet.

When putting together my remarks for today concerning the economic challenge of developing marine resources, I went back to my company's files and dug out a lot of dusty papers that have served as my notes for several speeches I have made over the past few years to various groups such as this. I also dug out of my files copies of public utterances made by several of my peers and contemporaries over the same 8-year period. It was a bit embarrassing to re-read all those fuzzy projections that did not come true and miscalculations of what was to happen in the near term. There is no question that I was wrong about many things I had stated, but those other guys, my peers and contemporaries making public statements beside me during this time, were often at least as wrong and sometimes "much more wronger" than I. I see in the audience and on the program several people whose past comments I just finished re-reading and I would state now that I don't intend to quote them here today – it would be too embarrassing to us all. You can relax now.

So, to jog your memory, let's dig back into the past. What were some of the big promises made in the past concerning the economic development of the resources of the ocean? What happened to them?

Whatever happened to the concept of underwater cities with bubble-topped restaurants and small submarines to shuttle back and forth? The super-sophisticated submarines built with the ultra-sophisticated technology of the aerospace complex in the United States have found hardly any work except perhaps rescuing each other. The smaller so-called sport-type submarines have run into a horrendous and prohibitively expensive battery of certification tests to get by registration by the Coast Guard and similar authorities. I would suspect any underwater habitat (were such built) would require the same expensive certification procedure.

Whatever happened to the concept of using the sea to generate the protein to keep up with the exponential growth of the population in the world? Today the population of the world is growing exponentially as anticipated, but the production of fish flour has not gotten off the ground. The FDA and the milk lobby (among other factors) has in effect strangled the concept of protein flour from the sea, which was the only real hope of using the sea to meet some or part of the world's growing hunger. And, no market for the product ever appeared.

What happened to the farming-the-sea concepts, aquiculture using near-shore water bottoms or estuaries? Any promising entrepreneur who hopes to use near shore areas for aquiculture 9 chances out of 10 will run into a fantastic spectra of problems. His major problems will not be technical ones. Unexpectedly, the aquiculture entrepreneur's major problems have turned out to be what is euphemistically called institutional problems. If the aquiculturist can solve his technical problems, which is no mean task, but is being done today, he finds himself in death grips with the Corps of Engineers, the applicable state lands commission, county government, the municipal government, a town government, the port authority, the water quality people, the FDA, and very likely every one of the conservationist groups.

Whatever happened to the world wide oceanographic buoy networks?

Whatever happened to mining of hard minerals offshore?

Whatever happened to manned exploration of the mid-Atlantic Ridge?

Whatever happened to all those dreams?

While I am asking such rhetorical questions, I might also ask – why am I still in the business I am in? Why haven't the shareholders of the various companies I serve lynched me long ago? Why are all of you people here? Well, I make these negative rhetorical questions to illustrate that today is perhaps a more promising time for the ocean science industry than there has ever been in the past. A good many of the early dreamers in our industry have been

shot out of their saddles during the past few years. The people in the business today are far more realistic in their outlook. Certainly there were better industries with more promising futures near term to have been involved with over the past 5 years than the ocean resource development industry. But those of us today who are on our feet in this field are, in my opinion, in damn good shape indeed. I am not here to be pessimistic – I am optimistic.

The oceanographic industry, the economic potential of developing marine resources, got started with a huge blast of hot air 8 years or more ago but, like a feather, it started quickly, slowed very soon thereafter to a standstill, and started to settle. The history of the ocean science industry, the economic of ocean resource development, has been a horror story of ups and downs, boom and bust, for 8 years. The initial rush is now over and best forgotten. I believe today real progress is being made. In a word, things are looking up.

So what's the story today? What's the story today in the economic challenge of developing marine resources? I would like to go back, if I could, to my day-long excursion in our company's filing system that I described in my initial few sentences. As you recollect, I went burrowing back through all the speeches and papers and so on concerning the economic potential of the ocean sciences, and I found a very interesting document dated July 17, 1968, called the *Oil Statistics Bulletin* published by the Oil Statistic Company, Inc. in Babson Park, Massachusetts. It was called "Oceanography, American's new glamour industry" and the title was quite tongue-in-cheek when you read the text. On page two of this bulletin was a very fancy graph entitled "Hypothetical illustration of the seven periods in the life cycle of most products or systems" and an attempt was made to fit the ocean resource industry into this "hypothetical" curve. The curve given was supposedly a universal curve true of all "life cycles" of products, systems, or industries. The curve was given to illustrate what problems the oceanographic industry faces. Taken today, I believe this curve reinforces my optimism about the future of the industry, an optimism I hope you will share after I give you my rationale.

Let's study it. On the vertical axis, we have percentage increases that start out at zero and end up at a 1000 times. It is a log scale. That means in my book for every 10 dollars you invest, you get 10 thousand dollars back once you climb two orders of magnitude. Of course, the horizontal axis is time with number of years which run from zero to 40. This is not a log scale. We have certain periods of years: 0 through 6 years is called "Dream Period"; 6 through 8 years is called "Adventure Period"; 8 through 10 years is called "False Growth Period"; 10 through 13 years is called "Reorganization Period"; 13 through 23 years is called "True Growth Period"; 23 through 30 years is called "Income Period"; and then you get a possible second growth curve or you have a period of obsolence and so on. The author of the article says that the shape of the curve and the scale can all vary widely. There are all sorts of disclaimers in the text, as you might expect. However, it is an interesting curve and I think it applies to the oceanographic industry today. The line itself is called the "Investor's profit possibility line."

So let's talk about the periods on our Life Cycle chart as applied to the oceanographic industry. What was the Dream Period? How far back can we go to find the beginning of the Dream Period in the ocean science industry? Was it the action of the Office of Naval Research and the National Academy of Science in 1956 to appoint a committee to provide advice and guidance on the needs and opportunity of oceanographic research, or was it November, 1957, when the Committee on Oceanography of the National Academy of Sciences first met? Or was it 1958 when the White House President's Science Advisory Committee recommended the establishment of the Federal Council of Science and Technology indicating oceanography as one of the several fields warranting special stimulation? Or maybe it was January 1, 1959, when the long range planning for Navy Oceanography Report, Tenoc (Ten years in Oceanography) was endorsed by Admiral Arleigh Burke, then CNO. Let's say it was sometime in that period.....1956 to 1958 that the Dream Period began.

What about the Adventure Period in oceanography? What was that? Perhaps that began in February, 1961, when the then-President Jack Kennedy, in a special message to Congress on natural resources, emphasized, among other areas, oceanographic research. Executive communication from Jack Kennedy followed in March of 1961, supporting a sharply accelerated program in oceanography through supplemental appropriations. Perhaps it began in May of 1961 when Mohole Project first was thrashed around in Congress. Perhaps the real start of the adventure was President Kennedy's often-stated challenge to the country "to drive back the frontiers of the unknown in the waters which encircle our globe .... knowledge of the oceans is more than a matter of curiosity. Our very survival may hinge on it." That was 1961.

The next section of this graph to rationalize is the False Growth Period. When did that begin? The chart shows that it lasted 2 years. I can't think of a good time to suggest when the False Growth Period began, but I can give you a pretty good indication when the False Growth Period ended and the so-called Reorganization Period began. By my estimation, the Reorganization Period began about 1968 – maybe 1967 – when the operating oceanographic industry was caught in a huge period of disillusionment. Many oceanographic enterprises had begun as adjunct of large corporations or as independent entities. Many of these entities looked toward the federal government for markets, perhaps relating to their past experience working in high technology areas of aerospace. There was a huge line of people all waiting at the church but the groom, the federal government, never came and everybody was jilted. Many companies, the companies that are healthy today, recog-

nized quite early in the game that they were being jilted by the federal government and went out and did other things which were efficient and effective, and they are viable businesses today. Other businesses continued to wait at the church until they faded away to dust or were blown away by a gust of wind. Other companies with larger resources, perhaps, are still waiting at the church and it's still possible that the groom may come.

Where does all this lead us? Where are we today in the oceanographic industry? Well, quite obviously, I picked a graph that would reflect my personal opinion. I think we are at the beginning of a True Growth Period, the period starting about two-thirds of the way down from the all-time high of the curve which has been called "Investor's profit possibility line" and one that goes up past the old top and climbs to twice or three times the height. And, this is a log scale. Quite obviously, I'm optimistic.

Why the optimism? Well, first, let's look at what the federal government has managed to do during the 10-15 years of boom and bust in our industry. If you take all the legislation introduced in the 86th, 87th, 88th, and 89th Congresses, which only runs into 1965, you will find there were a little over 50 bills related to oceanography; of these, one or two actually became law and they involved a bit of reorganization by the Coast and Geodetic Survey and the Coast Guard, nothing earth shaking. I don't have any ready records as to how many bills were introduced in Congress over the last 4 or 5 years. I suspect the number is in excess of 50, probably less than 100, and, once again, the number of bills actually passed into law can probably be counted on one hand. That is, bills that relate to oceanography. A couple of the significant bills were the several that led up to the formation of the Commission on Marine Science, Engineering, and Resources, which resulted in the publication of four volumes, *Our Nation and the Sea*, the so-called Stratton Commission Report with its recommendation for NOAA. That was a real piece of work.

Another of the significant bills passed by Congress which makes sense was the Sea Grant Act. Congress passed the Sea Grant legislation; then got staff into it to give it some life; then put in some money; then more money, until the Sea Grant Program has become the one oceanographic-related program originating in Washington that has real Congressional support, support that is continuing. The support for the Sea Grant Program is probably based on the fact that it's a good idea; that it's exciting; that it is mission oriented; that the legislators can see things being done by the Sea Grant Program itself; and that it has got a good man running it – Bob Abel.

What is the Sea Grant Program attempting to do? What is its job? Sea Grant is attempting to work out models and inventories of what existed in the U.S. ocean and coastal areas; to mix disciplines within universities for greater effectiveness; to take academic and engineering information developed inside universities outside to the public; to attempt to understand the point of view of industry, of conservationists, of municipal governments, and of the federal government; to get all these various groups working together; to stimulate local initiative; and to communicate with the popular press to tell the story.

In spite of my cynicism, I must admit that the Sea Grant Program seems to be doing a lot of these things today and attempting to do most of the others. Miracle of miracles, all this seems to have the blessing and continuing support of Congress which is unprecedented. The Sea Grant Program has in it a true basis for growth of the economic potential of the development of the ocean's resources. It is, I believe, an indicator of the True Growth of this field.

What else is new and encouraging in the oceanographic field? In President Nixon's recent State of the Union Address there was a lot of talk about ecology and pollution. This relates to the oceanography business very definitely. The United States has been gloriously insensitive to the way it has treated its environment since the country first was founded, and the present trend toward environmental sensitivity is long overdue. The new emphasis on ecology can mean big things in the oceanographic industry in dollars and cents. For example, offshore oil slicks from oil wells are just plain unacceptable to the general public (myself included). Santa-Barbara was a particularly awful set of circumstances. There probably was a little bit of sloppiness in the operation out there, and it came at a time when everybody was just waiting for something to happen. What the cry concerning oil spills is going to mean to industry is that offshore oil is going to be forced to operate over water, on water, and under water with far greater safety precautions involving buried pipelines, automated systems, submerged production, etc. All this means business for the marine-related construction industries.

As the country begins to clean up its environment, particularly its urban environment where most people live, ther realization is going to come that part of the city which usually is the crummiest, that part along the wharfs and docks, is, in reality, potentially the most desirable part of the city, particularly when the water gets cleaned up. We are going to see over the next several decades entire renovations of city port facilities and water fronts. The areas where the water meets the city will be made into the most desirable places for people to live and play. Shipping is going to be forced to operate from facilities offshore so that the most valuable parts of the cities, the water front where people like to be, will not be cluttered. The rusty boats and the sulfur piles and rusty railroad tracks and fallen-down wharves will not hold precedence to people any more. They are going to go, and people are going to come in. Once again, this is big business for the construction industry and the survey industry and all the service industries associated with it. This is potentially the biggest play in the oceanography industry over the next decade.

What else is big and new and representative of true growth in the economic development of the ocean's resources? A big area, perhaps one of the biggest total

markets, is the recreational resource of the ocean. Here we are talking about a market that is mixed up with the economic and sociological trends of discretionary spending and leisure time in the United States. It's a market that relates to the demographic trend of people living near the seashore. The data on recreational use is incomplete. However, I think I can make some statements about the market that no one will argue with even though I do not have the statistical evidence to support them. There are very few people who do not think the ocean represents a great place to recreate. It is a place where you can find solitude, if that is what you seek, or crowds of people. It is a place where you can find others who like to do the same kinds of things you like to do. It's a place where you can loaf around and look like a slob and nobody complains about it. It's a place where you can challenge yourself in very active sports such as surfing and diving, but it's also the place where you can relax in an outboard or a fishing boat. It's a place that is away from where most people spend their non-vacation time. People are going to be more oriented toward recreation in the future and they are going to turn more and more often to the sea. This, once again, is a big industrial opportunity. There are the existing markets for boats and motors and all the associated gear that goes with various water sports. New products, such as the surf board, catch on fast. New technologies, like fiberglass boat construction, grab hold quickly. Ocean recreation in these terms is a big industry and will continue to grow.

There are other growing areas of ocean recreation that people sometimes initially overlook. There are marinas and ocean front real estate. In the last 8 years, there have been three major and numerous oceanarium-type exhibit parks built on the West Coast and in Hawaii. These attractions allow the tourists to get a closer look at the sea and its life. The fantastic popularity of the Cousteau TV series is another indicator of the use of the ocean as a recreation resource. What about surfer music, surfer movies, and baggie surfer swim suits?

I would like to sum up the overall theme of my talk today on the economic challenge of developing marine resources. The marine resource industry includes a wide variety of resources all of which must be considered. They include the protein resources, the recreational resources, the petroleum resource, the mineral resource, the transportation resource, the environmental resource, the defense implications, and the water itself. As operating persons who have attempted to set up and do useful work in the sea have found out, the sea represents a harsh environment where it is challenging to earn a living. From the point of view of the investor and entrepreneur over the past 5 years, it's been a wild and woolly game that began with huge expectations that could never be realized and has just finished (in my opinion) with shattering disillusionments. I think today, however, we are on the Real Growth curve, in the True Growth Period. True growth that will result in better economic opportunities than were ever anticipated in the best of times of the past. Most of the euphoria of expectation is gone. I think we are on our way.

A LOOK AT SEA GRANT -- GOOD BAD OR OTHERWISE

Food Resources as Viewed by: West Coast State Fishery Administration

Robert W. Schoning
Director, Fish Commission of Oregon
Portland, Oregon

The potential of the Sea Grant Program is tremendous. It provides an excellent opportunity to accomplish some meaningful and needed research associated with the fisheries resources. However, it will take careful planning to coordinate a great many people and interests.

Progress to Date

The program is really just getting off the ground, at least on the West Coast. I am not familiar with every project that has been started here, but efforts in Oregon look encouraging.

The program has established rapport with fishermen and industry. It is bringing the state and federal fisheries agencies, and the ivory-tower residents, closer to the people in the business. We are talking fishing problems with fishermen. Direct communication was previously lacking and the state organizations were remiss. At least our department, the Oregon Fish Commission, was doing little, and should have been doing much more. Undoubtedly, some of our activities and decisions would have had greater support if communication had been better.

A periodic newsletter to a mailing list of licensed Oregon fishermen and dealers has been developed by a marine extension agent at Oregon State University. It is easy to understand, interesting, useful, well done, and well read. It fills an existing void and makes the people in the business think somebody cares about them, which is true.

Useful research programs with valuable potential have been initiated. They include fishing gear development, oyster hatchery expansion, early saltwater rearing of pink and chum salmon, and coordination of a coast-wide albacore location and catch program. Training programs have been established for teaching maritime law, marine economics, and ocean engineering.

Enough about what has been done in the program so far. What about the needs of the future?

I have some comments, as a state fishery administrator, on things to do, and not to do, in keeping with the authorizing legislation. There should be emphasis in at least three general categories: (1) training people, (2) supporting and conducting research, and (3) disseminating information. There is need for work in all three on the Pacific coast.

Training

More trained people are needed to upgrade the fishing effort, fishing gear, processing and marketing techniques, research and management. Progress is being made in such training, but not enough.

How does that old saying go, "We get too soon old and too late smart?" It's not too late to get smarter. There are a lot of young and old who are willing and anxious to learn to do their jobs better.

I know of nothing the fishermen, industry, management agencies, and universities are doing in the fishery-oriented fields that can't be done better. It is just that no one has yet figured out a way, or if they have, it hasn't been put into use.

More practical training and schooling for the fishermen would be very useful. Many things are done because their fathers did them that way, it is the only way they know and it has worked reasonably well for years. A blending of experience, college training, sense of urgency, money to push a program, and competent leadership can do wonders. If there are going to be professional fishermen, let's see that they get some professional training. Think of the people you consider to be professionals--doctors, lawyers, engineers. All have had extensive education and experience. Why not give fishermen the same, and start out with a practical approach in choosing the curriculum and classroom? The fisherman, processor, and biologist should learn something about the others' problems on a firsthand basis.

The fishermen need help with their daily problems. They are not able to finance studies, yet they are in need of them. Meaningful results from such work could make the difference between success and failure. A start has been made in figuring profit and loss for income tax purposes. Improved vessel insurance and better preservation and sanitation at sea have been investigated. Many other aspects of the business should be covered.

Research

Much can be done in a great variety of research fields, but it must have practical application. The results should be applied toward a current problem while it still is a problem, before the problem disappears along with the resource itself. There are programs other than Sea Grant in which

basic research with some eventual application can be conducted. Let's get immediate answers to immediate problems in this program. If we can't get the answers, let's develop the techniques for getting them, and if not that, then let's train the people who can develop the techniques. There are enough people spending enough money finding out things it is *nice* to know. Let's concentrate on finding out things we *have* to know, and then do something about correcting the situation. Why, some years, do coho salmon disappear off the Oregon coast in August? Can gear modification simplify and facilitate simultaneous capture and sorting of many different species? Can good stock predictors be developed for a variety of pelagic and demersal fish and shellfish? Answers to these and other questions will help us more adequately harvest the stocks off our coasts and successfully compete with foreign fishermen on the same grounds.

Anyone can keep doing things in the existing way. It is not always easy to try something new and different. I would much rather have the program condemned for trying some far-out things than continuing only current practices. That steamboat would never run, but somehow it did. Those heavier-than-air craft would never get off the ground, but many of us have ridden in them. I have done a lot of reading by a bulb that was never supposed to give light.

I have eaten some great fish as well as some crummy products from the sea. In neither case was it entirely the fish's fault. The fish could only do so much, and man took over after that. Between the time that the fish came aboard the boat and was eaten by me, it got the treatment. Processing really helped on one hand; in other cases it was detrimental. I am in the fish business and am a great supporter of it, but some of its products I don't care if I never eat again. Why not handle it all so that the consumer will put it in the "can't do without" category? The potential is there. Let's realize it. Work is being done now, but much more is needed at each stage of the handling.

I acknowledge, and I am sure I will get cries of agreement from many fishermen and industrial representatives, that we can use some new approaches and philosophies in management. Efficiency is penalized in some fisheries. One would think efficiency would be encouraged in almost every line of endeavor, but commercial fishing is different.

There is an increasing need to put greater emphasis on economic aspects managing the fishing resources. After all, there is nothing really wrong with making money. Changing operation to make more profit with the same or less fishing effort, while still properly harvesting the fish, isn't really a bad innovation.

In some of our Pacific coast fisheries there is too much gear for the present harvestable level of the resource to be economical. That doesn't cause enough fishermen to drop out. They stay and keep looking for the big year to make it all back.

What about a limited-entry study on the Dungeness crab fishery or the offshore salmon troll fishery? Thousands of fishermen from California to Alaska harvest up to 30 million pounds or more of each annually. That's important enough to warrant studies. Information could be gained from pioneering studies of this sort in Canada. The knowledge could be developed for state management agency use.

I would like to see some feasibility research on exclusive leasing of ocean bottom tracts and/or the above water column for farming fish and shellfish.

Communications

I am a great believer in telling people where they stand and why. Maybe this attitude is due to my old Marine Corps background and the indoctrination "pass the word." On the other hand, I am speaking for our organization, the Oregon Fish Commission, when I say we don't get around often enough to the fishermen, processors, and interested public. Our intentions are the best, but our actions are not. As a result we do not always end up with the best rapport, or regulations for that matter. The extension agents are helping to reduce this deficiency. They, in a sense, are providing the catalyst for us and others. Much good has already happened and much more will be forthcoming.

Useful information, regardless of the source or developing entity, should be given appropriate distribution on a timely basis. Get it in print for the fishermen and industry, as well as fellow workers, in understandable and usable form. New findings or concise summaries of known information should be readily available. Subject matter might include fishing gear innovations or developments, vessel sanitation, and special handling aboard vessels or at the dock.

The Sea Grant people, in addition to their own research studies, should pick the brains of state agencies for current developments and force publication, or even circulate results themselves. The interested public deserves the information. No good can come of it if it is not used. A classic but justified criticism of many agencies, both state and federal, is that they don't publish enough. Information doesn't have to appear in one of the nation's leading scientific journals, cleared by an eminent editorial board, to be useful. There is a possibility that findings would be even more useful if gotten out a year or two sooner in mimeographed form. Fishermen and even scientists read mimeographed material when it has enough to offer.

The Fish Commission has just completed an attitude survey in an attempt to make our organization more effective. The results are now being analyzed. Our most significant problem appears to be poor communication at all levels. I'm sure this failing is not deliberate. It's like that old saying, "This is a nonprofit organization, but it was not planned that way." I was amazed at the number and type of things that were misunderstood. The reason had to relate to communications.

The Sea Grant program can rise or fall on its ability to communicate. Collectively we have to communicate to identify the problems needing study. We must communicate the answers, even if only partial, so they can be put to use by the interested parties.

Admonitions

There are several potential pitfalls that should be avoided. I will list a few.

Fisheries management is primarily the responsibility of state agencies, except in the case of international commissions. It is not the responsibility of the Sea Grant institutions. As a state agency administrator, I would resent any effort on their part to take over. On the other hand, they can provide tools to make state agencies more effective.

Production hatcheries for salmon and steelhead are responsibilities of state and federal agencies and not Sea Grant universities. However, the latter can train people to run them and develop improved techniques. The agencies will hire the successful students and implement improvements.

When large new programs with substantial federal funding are developed and turned over to the nonfederal entities for operation, there is a human tendency to build an empire. Our agency has done this to some extent and I know we are not alone. My suggestions to the sea grant universities are not to create an empire primarily to keep people busy or simply to attract more graduate students or just to spend all the available money. Look for a need and satisfy it. There are plenty of needs to go around. I suspect that even with careful planning there could well be more pressing needs than available money. A good guideline might be resource interest and not self-interest.

I am pleased to see that the money can't be spent to buy land, docks, vessels, or buildings. I think that is a great idea for this program. Let's get the work done. There will always be a need for studies at sea, but they should be programmed carefully with consideration given to chartering. I am sure you, like I, have heard about some of those magnificent research vessels that were so desperately needed in other programs. Regardless of the real or christened name, by experience they would be more aptly named USS Never Sail. Measure your field success by the results; not the size and number of vessels owned or operated.

Don't look for specific research projects to continue in perpetuity. In my judgment, there is nothing wrong with putting a realistic deadline on the length of a project, regardless of its merits. Get what you think can logically be obtained and then dump it for something better. One of the reasons we quit using square wheels was because someone tried round ones.

It would be a serious mistake, with such a promising start and a great potential, to unnecessarily duplicate or overlap existing programs thus developing conflict and jealousy with other entities. Cooperation is the name of the game.

Don't spread your money too thinly. It is not uncommon, in planning programs from scratch with new money, to try to do all the things you have thought about for years. The result is programs doomed to failure because of inadequate financing. Unnecessary frustration, dissatisfaction, and criticism are fringe benefits. Do a few things and do them right.

Summary

In summary, as an administrator of a Pacific coast state fishery agency, I am not here to outline a great many specific projects to be undertaken. Instead, I am suggesting some general concepts to consider, some ground to cover that our agency and others like it are not covering adequately, but which could logically be handled by the Sea Grant program. I say let's train the people, both those now in the business—whether it be those catching, processing, managing, or teaching—or those who will enter and provide new blood. Let us conduct necessary studies, conventional and far out, as well as in between. Let us disseminate the findings promptly so they can be used while we still have a resource.

I am reminded of an engraving over the door of a Portland grade school. "A child has infinite possibilities. Here he may realize some of them."

The potentials of the Sea Grant program are enormous. Let us start to realize some of them.

The hour is late, the need is great, and the tools have been provided. Let's get on with the job.

Food Resources as Viewed by: Federal Fishery Administration

Dayton Lee Alverson

Associate Regional Director for Fisheries
Bureau of Commercial Fisheries
Seattle, Washington

According to the brochure I am to speak as a fisheries administrator. However, I have been self-purged from an administrative position in Washington several months ago, so will speak from recent past experience as well as from my present position. Looking back, several months ago I couldn't understand how field people could be so misinformed about so many things. Today I sit in a little different position and can appreciate both sides. I will speak today more as a fisheries scientist. Let us set the scene by asking: what is the natural resource base, in terms of living marine organisms, on which man can depend to help meet his protein needs during the next several decades?

The following figures depict and explain the natural resource base that is contiguous to the United States. The divisions on Figure 1 show the major ecological zones along the coast of North America. This is perhaps an over simplification; however, we might say that these are natural geographic boundaries within which data have been collected. Therefore the statistics fall into some rather nice groupings which allow one to make evaluations. Keep these regions in mind as we go around the United States and look at the amount of fish that is now being produced in relationship to the anticipated or suggested potential. The base of the forecasted potential is now quite good. Let us examine the area of the continental shelf and slope (Fig. 2) to get some idea of the living space available to species indigenous to coastal waters. This area yields about 80% of the total fish caught in the world and must be considered as a factor governing fish production. We see that very large continental shelf areas prevail in the Eastern Bering Sea, the Gulf of Alaska, and off the Middle and South Atlantic coasts. A relatively large continental slope area, going down to 300 fathoms, occurs in the South Atlantic.

Figure 3 shows the present concept of potential catch versus current use. You will notice that the North Atlantic is one of the most heavily exploited areas at the present time and, if everything that is now available in types or forms is considered usable in economic terms, we might increase production 2.2 times. This figure is a little outdated because production has continued to grow as a result of foreign developments, so increase potential is probably somewhat less. In the South Atlantic and Gulf of Mexico we anticipate that current production may be increased roughly 17 times. A large part of this potential is in the form of crustaceans and clupoid fishes (herrings and anchovies). Along the California coast, an approximate 8-fold increase is possible, while in the Gulf of Alaska the yield may be increased as much as 12 times. An overall production of about 24 million metric tones is suspected. We usually produce about 2 million metric tons. There is adequate room for expansion in terms of raw material.

Let's take a further (Fig. 4) look, bringing the foreign production into the picture because it changes the production/potential ratio and gives another perspective. This figure shows the same areas, but is redone to show both U.S. and foreign production, so that you get a different look at the potential versus current use. In Alaska you see a large part of that projected 12-fold increase is being utilized by foreign fishing fleets. If the U.S. were to use that "potential" it would mean taking the harvest away from somebody else. The extent of foreign fishing is not quite as large off California. In the South Atlantic and Gulf, minimum foreign fishing activity occurs at the present time. However, a large part of the North Atlantic production is being caught by foreign fishing fleets, so that the unused potential drops substantially below the 2.2 times noted earlier.

In quick summary, I would say that foreign activities are now catching somewhat more fish than U.S. fisheries from the waters over the U.S. continental shelf. We can say there is a big potential, but a large part of that potential today is being used by somebody else. If we are going to use a part of this very large biological potential that exists in terms of real unused material, the South Atlantic, the California-Washington coast, and parts of Alaska are the areas from which we can expect increased U.S. production.

Figure 5 shows the growth curve of anticipated demand for fisheries products over the next several decades. We can expect a very strong growth in use of fisheries products in the United States. I'd like to clear up one misconception, particularly for people who say this is not a fish-eating-using nation. To say it's not a fish-eating nation has some relative truth. But if we look at it in terms of use, the United States is one of the largest users of fisheries products in the world. We currently are using about 85

Figure 1: Major ecological zones along the coast of North America.

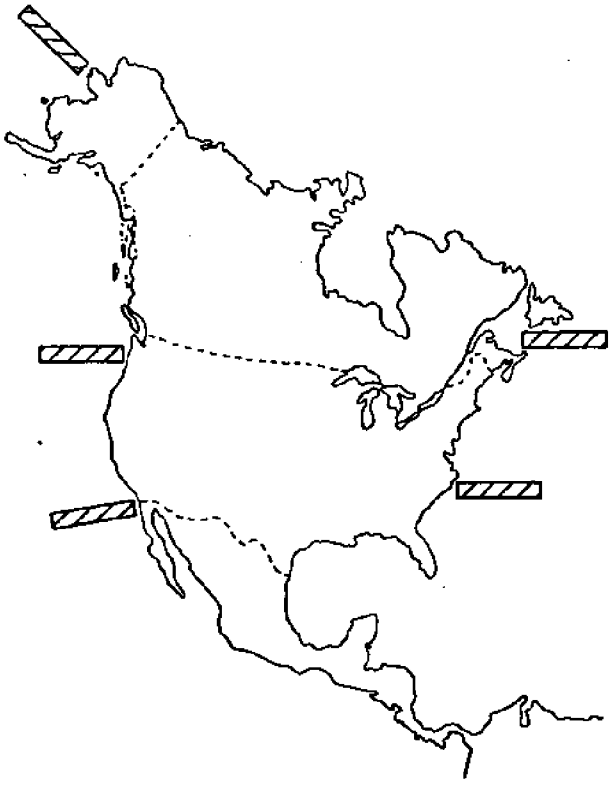


Figure 3: The approximate United States catch of fish during 1968 versus the potential catch for the major regions adjacent to the United States (catch in millions of pounds).

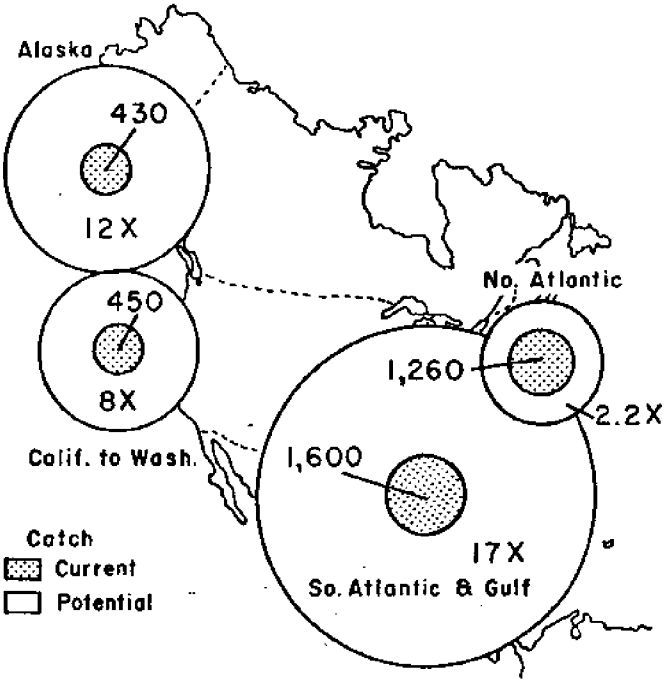
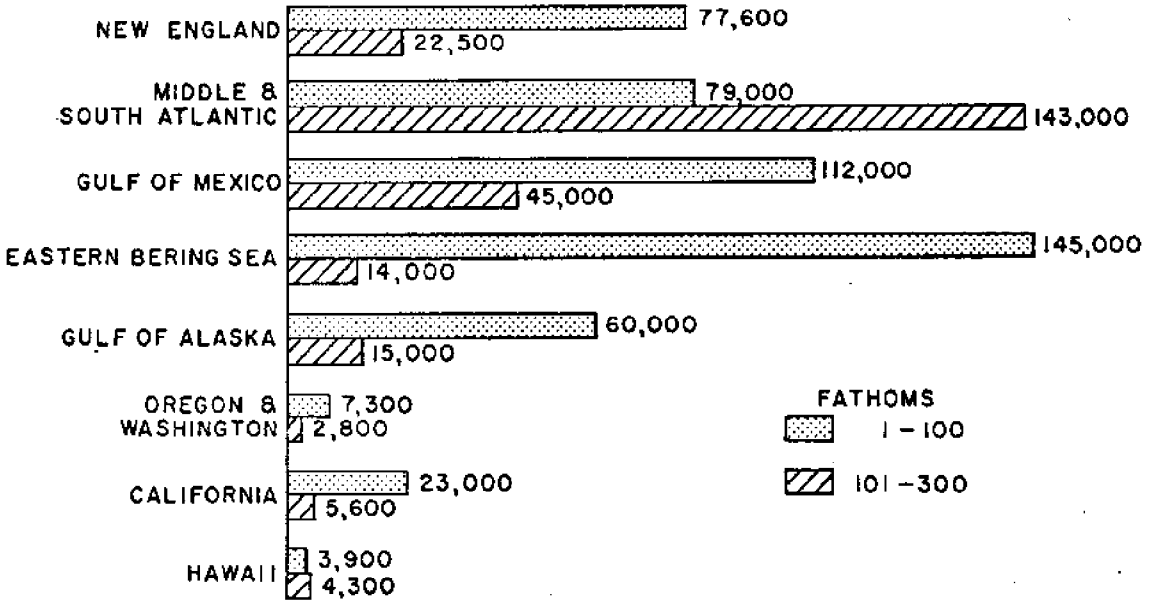


Figure 2: Approximate area of the continental shelf and upper slope in square miles (nautical) by geographic areas.



pounds per capita. Of course, a large part of that is being utilized by other animal forms to reconstruct protein in the form of poultry, hogs, and other livestock. (Fig. 6).

Now let's consider the global picture, because there's been a great deal of confusion about the potentials of the ocean. A lot of conflicting viewpoints have come out, particularly in the last 12 months. Most scientists, working in the field of fisheries and oceanography, feel that the oceans will produce roughly 200 million metric tons of fish of conventional forms. They are now producing roughly 50. So the forecast increase in fish production is about 4-fold. This prediction refers to those types of fishes we now utilize and has a constraint in terms of the types of technology that are employed.

It is rather interesting that an article in *Science* last fall essentially said that fisheries could only expand for another decade and we would be out of business. Therefore, there really isn't much use in looking to the oceans in terms of food. Now what was the reason for this opinion? This particular article was written by a biologist. He made an analysis of the biological potential of the oceans and came up with values similar to those of other scientists. His conclusions, therefore, in terms of biological potential, were no different than those people who said that the oceans might produce 1,000 million metric tons. Quite recently, a Canadian scientist, Dr. Ricker, came out with a figure of about 160 million metric tons. Now why these differences: Is there a biological potential to be achieved in the oceans, or is there not?

If one looks carefully at the conclusions of scientists who have made these studies, the difference is not in terms of biological material produced, but in terms of technology. They have forecast technological inability to retrieve the biological potential of the sea; not for lack of adequate organic production in the ocean, nor for lack of large amounts of protein, but because technology will fail to develop the means to extract it. It is the anticipated capacity to use the potential that accounts for a good share of differing viewpoints on the future of ocean fisheries. The people, myself included, who are trained in the area of biology, have said engineering cannot accomplish the chore because of the density patterns of fish distribution in the water column. Maybe we're too short-sighted in what technology can do, and the conclusion is unwarranted. We are talking today about challenges for Sea Grant, and I say this is your challenge. If we do fail, in terms of biological production from the sea, it will not be because the photosynthetic process, that the trophodynamics of the ocean are such that there isn't a lot of organic materials. We will fail because we were not able to overcome the technological problems that confront production.

Mr. Paine, the previous speaker, set in perspective what a large number of us have known for some time. About a decade ago, when the rhetoric on oceanography was reaching its peak and the potentials of the ocean were being talked about by industry, some of the biggest companies in the United States came to our office enamored with the concept of getting into the oceans to solve the food problem, to work on mineral extraction problems, and so forth. Their eyes were dancing with dollars. I looked at them and thought "Those poor people – without any registered parental heritage. Have they come here knowing their own capabilities, trying to resolve problems that confront effective use of the ocean, or have they come here enamored with the newspaper rhetoric on ocean potential?" I think Mr. Paine gave us an answer, because when the glamour wore off, many of these people and their oceanographic titles, that were created overnight, started to disappear. Those that really understood the problems, those that were really interested in the potentials of the ocean, are still with us and will continue to be.

There is a definite biological potential in terms of food. However, there are some real and difficult problems to be solved before utilization can be achieved. The potentials that I've talked about in terms of biology, that is, the relative portions that man can take, might be considered as an ultimate efficiency factor (Table 1). The challenge to Sea Grant is to make the best use of these natural efficiencies through technological development.

As to the question that Bob Schoning put to the panel members at the opening, "Sea Grant-good, bad or otherwise?" I am not going to fill you with platitudes. In terms of the reasons for which Sea Grant was formulated and the intent of Sea Grant the answer is – good. In terms of evaluation of Sea Grant progress today and the enthusiasm in Sea Grant people, again it is good.

However, if Sea Grant people get bound up in an organizational sense of building groups of people for their own particular self-interest of an establishment, of an institution, and do not look at the goals in terms of what other people are doing, if they do not try to establish capabilities in missions-oriented work, there's going to be a large waste of the U.S. taxpayers' dollar and this is bad. It behooves us in the government agencies, in the state agencies and the Sea Grant system to very carefully look where we are going to see what we are working in concert, and adding one to another rather than taking away from each other and duplicating each other's efforts. If these organization problems are resolved, Sea Grant is going to be a smashing success. Finally, I shall put one other limitation on success of Sea Grant – the same one I put on government in terms of management. Success of application of new information and technology will be good only if it is coupled with a capacity to manage – if there is allied with Sea Grant a management system that allows for timely decisions. Otherwise, your information in terms of intelligently managing animals, of using animals in the sea and the environment, will add to the scientific literature but there will still remain all the problems that face us today.

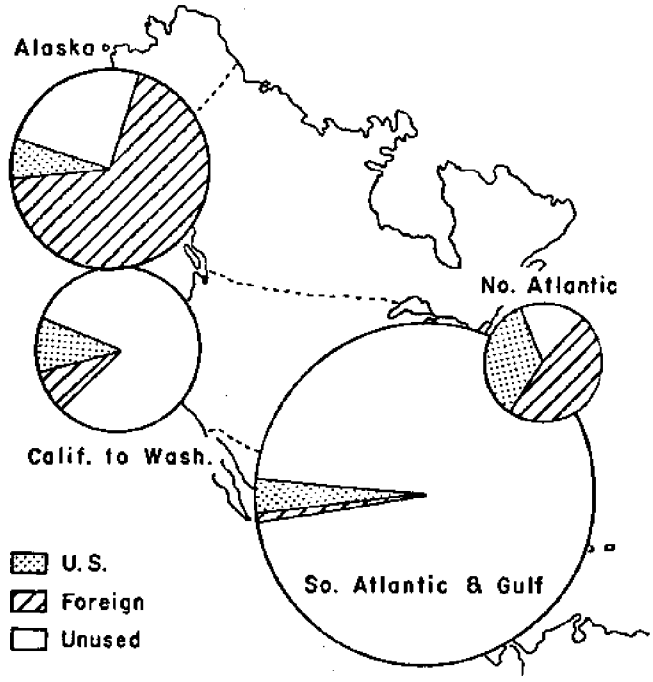
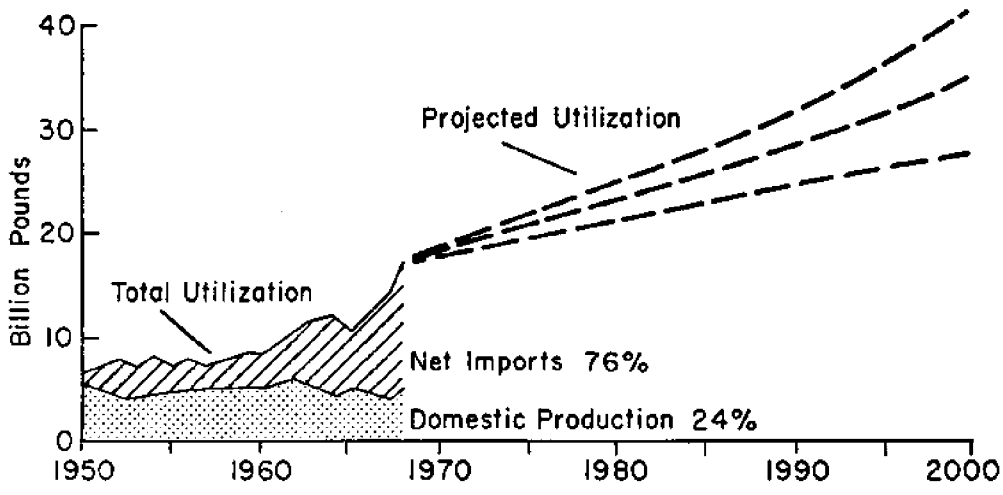


Figure 4: Total potential fish catch by adjacent coastal areas compared with the present United States and foreign fish production.

Figure 5: Utilization of fishery products in the United States during 1950-1968 with projections to year 2000.



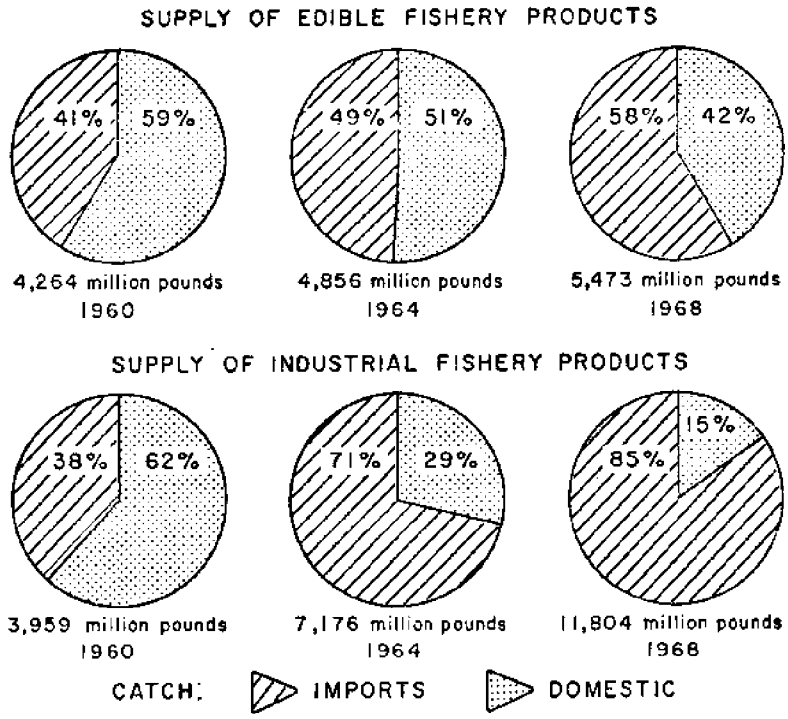


Figure 6: The relationship between imports and domestic fish products in the United States for the years 1960, 1964 and 1968.

Trophic Level	Ecological Efficiency Factor					
	10%		15%		20%	
	Carbon	Total Weight	Carbon	Total Weight	Carbon	Total Weight
(0) Phytoplankton (net particulate production)	1.9×10^{10}		1.9×10^{10}		1.9×10^{10}	
(1) Herbivores	1.9×10^{9}	1.9×10^{10}	2.8×10^{9}	2.8×10^{10}	3.8×10^{9}	3.8×10^{10}
(2) 1st stage carnivores	1.9×10^{8}	1.9×10^{9}	4.2×10^{8}	4.2×10^{9}	7.6×10^{8}	7.6×10^{9}
(3) 2nd stage carnivores	1.9×10^{7}	1.9×10^{8}	6.4×10^{7}	6.4×10^{8}	15.2×10^{7}	15.2×10^{8}
(4) 3rd stage carnivores	1.9×10^{6}	1.9×10^{7}	9.6×10^{6}	9.6×10^{7}	30.4×10^{6}	30.4×10^{7}

Table 1: Estimates of the yearly potential yields at various trophic levels in metric tons.

Food Resources as Viewed by: Commercial Fisheries

George Johansen

Secretary-Treasurer Alaska Fishermen's Union
Seattle, Washington

The last frontier on this planet is the sea which surrounds us. There is a wealth of food and minerals to be derived from the oceans, as yet largely unexplored and unexploited. As our resources on land dwindle, oceanic resources become ever more important. Lack of long-range planning, poor management, overexploitation, and lack of environmental controls have severely depleted natural resources on land. We must not repeat these mistakes with respect to the resources we have in the seas.

Recognition of the potential importance of the seas resulted in the establishment of the Commission on Marine Science, Engineering and Resources. The findings of that Commission are contained in the report entitled *Our Nation and the Seas.* While there is room for differing opinions, on the whole the report serves a useful purpose in stressing the problems and also the benefits connected with oceanography. This same recognition led to enactment of the Sea Grant Act, which is designed to stimulate and improve the development of the latent resources of the ocean through coordinated efforts of government, industry, and educational institutions.

The Sea Grant Act is probably one of the most important instruments forged by Congress to probe the mysteries of the seas. If proper planning and direction are provided, we can look with hope to the future and to the rewards brought by useful exploitation of the ocean's riches.

In establishing priorities, we believe one of the primary objectives must be to provide food for a constantly increasing national and world population. Of all the underwater wealth, perhaps the greatest is food. It is estimated that four-fifths of all life on earth exists in salt water. Another estimate is that present catches could be greatly increased without harming sustained yield, providing we have adequate research as a base on which to conduct our operations.

We are on the threshold of a new era as we begin to explore the last frontier. We must now prepare to make possible an orderly harvesting of the living resources of the sea, and this harvest must be based on sound conservation principles. The question we must ask is: "How can we use the Sea Grant colleges to best serve our interests in deriving food from the oceans?"

I will not attempt to list specific courses of instruction, but a broad outline of existing needs and problems in fisheries may be helpful in arriving at a useful curriculum to prepare students for the task ahead. The subjects to which I refer are as follows:

Training of Fishermen If the fishing industry were to expand its operations to an appreciable degree, we would need an influx of younger fishermen. Even without any significant expansion, new people will be needed. These prospective fishermen will need training in the practical aspects of fisheries, such as, preparing gear, mending nets, and splicing rope and wire. They will also need on-the-job training on board fishing vessels in order to learn the practical aspects of fisheries and seamanship.

Moreover, a certain number of future fishermen will need navigational instruction plus courses in diesel engineering and refrigeration. Existing programs in practical training for fishermen should be evaluated and updated to include the latest techniques.

Economics An understanding of fishery economics is desirable and necessary. This would include cost of vessels and gear, types of vessels best suited to a specific fishery, and vessels to be used in a diversified fishery. Other factors, such as prices paid to fishermen, market prices, and market conditions, must be given due consideration.

Distributing fishery products to the consumer in the freshest possible condition is an all important part of the economic fishery picture.

Aquatic Resources Development and Uses The practical aspects of fisheries demands a stable supply of fish for harvest purposes. Not being in the glamorous position of the space program, fisheries have been sadly neglected and relegated to the rank of a stepchild.

Our fisheries have the capacity of producing vast amounts of protein foods. Unlike farms on land, the seas have not been regularly harvested nor have they received the care and attention needed to provide sustained yields.

While agriculture has been granted billions of federal dollars, the fisheries have had to be content with rather insignificant appropriations. Thus, if we are to significantly

change existing conditions, we must engage in educational programs which will foster a deeper understanding of the tremendous potential for food – even medicines – which are available from the sea. The fact that the supply comes from the ocean rather than land should not segregate this resource from others in our thinking. With the awareness that ocean and land resources must be treated equally, the fisheries will obtain its rightful place in our storehouse of food supplies. We must work for closer cooperation between actual producers, fishery scientists and university faculties dealing with fishery problems.

The scientific society cannot divorce itself from problems facing the ordinary fisherman and still gain the intimate knowledge needed to train and advise the industry toward maximum efficiency. To accomplish this purpose, we must direct our over-all attention toward controlling environmental factors which are detrimental to fishery production. This effort would include controlling the effects of industrial development and population growth on the aquatic environment. In other words, the effect of pollution on the fisheries must not only come under intensive study, but must be followed up by realistic measures which will provide safeguards for aquatic life.

Offshore research is urgently needed to establish size of existing fishery stocks and to determine allowable catches not harmful to sustained yield. Fish farming and other methods which will assist nature in providing additional supplies are of much importance.

In enumerating these various programs, I am not sure to what extent the Sea Grant Act supplements existing programs. It has been my understanding that the Sea Grant office wants to establish whole new projects rather than to supplement existing programs. In my view, supplementing present programs is equally important with establishing new ones. Be that as it may, for the purpose of discussing how the Sea Grant colleges could most benefit the fisheries, I advance the following thoughts for possible consideration.

Consolidation of Existing Agencies There are proposals pending to combine a number of government agencies in the National Oceanic and Atmospheric Agency (NOAA). This consolidation will include the Environmental Science Service Administration (ESSA), U.S. Coast Guard (USCG), Bureau of Commercial Fisheries (BCF), and possibly the Sea Grant program. If each agency is given rightful consideration within such consolidation, this could be a tremendous forward step in oceanic science as it will be possible to pool many otherwise overlapping programs.

Appropriations – which are never plentiful and almost always in much demand – would go further and accomplish more for the general good. Perhaps the chief benefits of a consolidation of these various agencies would be to insure a continuous program in all fields and adequate funding to carry out the purposes of each agency.

We must give careful study to this proposed reorganization. Now that we have gained recognition for a start in oceanography, we must not lose any of the contemplated programs due to lack of cooperation or because of petty differences.

The Sea Grant Programs. While most fishermen, including myself, know little about science, we do know that science can develop knowledge based on reality and facts. We cannot embark upon ocean journeys without a compass and electronic equipment, nor can we revert to sailing-ship days, in view of the technological progress made by our competitors in foreign fisheries.

We need a Sea Grant Program; we need scientific direction to supplement practical management of the fisheries. We need to interest young people in the potentials and opportunities which exist in oceanography and related sciences. Above all, we need food from the sea and proteins from sea food to supplement our supply on land. Hopefully, this conference will serve as a step along the road for a better understanding of the problems and to provide guidelines to help solve these problems.

Food Resources as Viewed by: Gulf Coast State Fishery Administration

Lyle S. St. Amant

Assistant Director
Louisiana Wildlife and Fish Commission
New Orleans, Louisiana

The proper management and protection of the nation's estuaries and coastal areas has become a major issue in recent months. Political and public interest throughout the country has reached such proportions that almost every newscast, magazine and newspaper proclaims the need for environmental management, ecological studies, pollution control, and a return to near virgin conditions. Without question, it is high time that our nation and its individual states take a critical look at the way we are managing our estuaries and coastal areas. Certainly we need to ascertain whether we may be damaging them permanently and, if so, change our course to some form of better management. On the other hand, those of us who have been involved in the practical and administrative end of conservation for the past 10 or 20 years, realize immediately the problems which must be overcome before any new, all-encompassing policies can be applied. Total pollution control and the equitable administration of multiple-use programs will require a great deal of research, precise administrative and enforcement procedures, and cost of a magnitude not clearly understood by the loudest voices making demands for immediate change. Certainly if proper management procedures are to be developed, one important need that must be met is the development of adequate research programs and a better understanding of the problems within the various estuarine types.

Ecological factors controlling maximum and sustained productivity of the estuaries are complex and sound information concerning this part of the environment is scarce. Although new laws are being enacted directing that estuarine management programs be established and granting the necessary authority to proceed, we are in a poor position to do so at the present time.

Perhaps the coastal area of Louisiana, with its vast economically-valuable production of both minerals and seafood, and with some semblance of management already developed – though this has been primarily from hindsight – will serve as a good example of the problems that can develop in multiple-use estuarine programs. Certainly one can see what not to do. Should the opportunity present itself to establish a management program before multiple use has become a reality, many of the pitfalls that developed in Louisiana could be avoided. On the other hand, many problems have been worked out and investigated in this particular coastal type. Here much has been learned about the effect of industrial activities on the basic ecology of an unstable estuarine area.

What I propose to do today is to describe briefly the productivity and problems of the Louisiana coast, the advances made by the Fisheries Commission in coastal management, and the research aid and supplemental information that has been and will be obtained from the Sea Grant and other federal aid programs. Thus far, the Sea Grant Program has been well coordinated with the Marine Research Program of the Louisiana Wild Life and Fisheries Commission; however, there is much that needs to be done and certainly a more complete joint research effort would be advisable at the very earliest opportunity.

The Nature of the Louisiana Coast and its Problems: In many ways Louisiana's vast coastal area, which consists of some 5 million acres of marshland, meandering streams and embayments plus an additional, shallow, offshore area of about 20 million or more acres, has been both a blessing (because of its valuable productivity) and a curse (because of the difficulty in its management and regulation). We find that the area produces renewable natural resources resulting in a commercial fishery valued at more than 125 million dollars annually. Recreation, sport fishing and the tourist industry may have an even greater value. In spite of this tremendous value recreational development is in its infancy and many useful species remain unexploited.

Without question, the full potential of the area remains to be reached. Louisiana now annually produces more than 20 million pounds of edible fish and more than 12 million pounds of oyster meat, 10 million pounds of crabs, and 80 million pounds of shrimp. Nonedible fish, such as menhaden used for crude protein and fish oil, are taken in volumes of between 650 million and one billion pounds annually. Another 27 million pounds of rough fish is processed into cat and mink food. In addition to this commercial fisheries production, tremendous numbers of fish are taken for recreation and sporting purposes. The general area also produces from 3 to 10 million muskrat and nutria pelts annually, and is heavily used by wintering waterfowl populations.

The amazing thing, however, is that one of the greatest oil, gas and sulphur producing areas in the world has been developed in the midst of this rather staggering production of renewable resources. For example, in state-owned waters between the three mile line and the Intracoastal Canal, which lies in the northern edge of the estuary, there are more than 24,000 actively producing oil and gas wells. Offshore, from the three mile limit to the edge of the continental shelf, there are another 14,000 wells. The attendant structures involved in the production of oil and gas includes perhaps more than 100,000 miles of pipelines, numerous tank batteries, separators, storage facilities and similar developments. In view of the present hue and cry concerning the dangers of oil pollution to living creatures and estuarine ecology, one might wonder why and how Louisiana continues to produce great quantities of both oil and fish. I will be the first to say that our continued successful production of both oil and fish is probably the result of pure luck as much as any other single factor. Certainly we were not able to design or undertake proper regulations and management to give maximum protection to fishery production and coastal ecology in the early days of mineral industries development. As problems increased, hindsight, coupled with research and experience, resulted in the development of more strict and efficient regulations. The two industries are apparently able to coexist and maintain near maximum production under present regulations.

I would be remiss, however, if I left you with the impression that oil pollution and the development of the mineral industry has had no effect on the fishing industry or has left no scars on our estuarine area. The most serious problems and conflicts which result from the production of oil and gas, are not those receiving national publicity, such as oil pollution per se, which results from oil slicks, spillage or major accidents. More serious, by far, are the multitude of dredging operations, spoil displacement, silting, changes in hydrographic and ecological parameters, navigational conflicts, underwater obstructions and, in areas of intensive operation, actual competition for space. Oil slicks and spillage – accidental or otherwise – though unsightly, costly to clean up, and totally unacceptable from the esthetic point of view, seem to be one of the least toxic industrial effluents entering our waters. The biggest problem from spilled oil and/or oil-based muds and emulsions is that they cause undesirable odor and taste in oysters and clams. This trouble has resulted in a high percentage of the litigation between the fishing industry and the oil companies in Louisiana. Toxic effects of oil on oysters and other marine forms have not been clearly demonstrated except in cases of extremely heavy pollution. While no one would condone oil pollution, certainly it is easily visible, and it can generally be traced to its source and controlled by effective enforcement of pollution laws. From this standpoint, it is much easier to handle than other types of industrial and pesticide pollution which may be considerably more toxic and dangerous to the fish population and to the ecological balance of an estuary.

In any case, the large fishing industry and extensive oil industry coexisting in an unstable and valuable estuarine nursery has necessitated the development of a significant marine research and management program. This program, started in 1953, has a current budget in excess of one million dollars annually, not including other funds directed solely at pollution control and research.

The Louisiana Program is particularly aimed at studying the estuary and the ecological and hydrographic factors contributing to production within this vast nursery area. In the past we have investigated the effects of dredging, silting, spoil placement and pollution from oil-based muds and oil spillage on the oyster industry. Our studies of shrimp are aimed primarily at population dynamics. These studies indicate the factors controlling shrimp production are to be found in the environmental changes within the nursery ground. These changes may be from cyclic, seasonal conditions or man-made, permanent changes. In addition the program includes: a rather extensive mariculture investigation directed at pond culture of shrimp and fish, a study of factors controlling crab fish production, investigations of the basic productivity of the marshes, the artificial spawing of shrimp, and the production of the clam *Rangia cuneata.*

The Relationship of Existing Sea Grant Program to Louisiana's General Research Program. The Need for Additional Programs. The Sea Grant Program in Louisiana has been well coordinated with the overall research interest of the Louisiana Wild Life and Fisheries Commission since its inception. A group from the Department of Marine Sciences dealing with Sea Grant development, and other interested individuals from Louisiana State University, conferred with us before developing their program. We were able to advise them concerning our program and to indicate those gaps in our studies which could and should be filled by Sea Grant. Since that initial contact between the University and the state agency, we have maintained a coordinated program which has resulted in considerable additional contribution to our knowledge of the estuaries of Louisiana.

Some of the Sea Grant programs have been directly aimed at reinforcing our work on shrimp, particularly with reference to determining the basic factors controlling productivity in good shrimp nursery areas. The Sea Grant group has also become involved in the Mariculture Program and in Food Science projects. One of the most important Sea Grant projects, in my opinion, has been their legal studies dealing with laws and regulations related to estuarine areas and inland waters. Hopefully, this study can both direct the state in the establishment of proper laws aimed at the management and development of the coastal area, and develop the proper legal approach to the introduction of intensive mariculture in coastal areas.

Additional projects at LSU and the University of Southwestern Louisiana deal with systems analysis of shrimp production data and the study of the brackish water clam, *Rangia cuneata*. This latter study complements the one being carried out by the Louisiana Wild Life and Fisheries Commission. It is important to our economy; royalties received from dredging this clam as a source of calcium carbonate are a principal source of funds for our state Marine Program.

Perhaps one of the greatest contributions that can be made by the Sea Grant Program is in the field of marine science instruction. This effort should soon begin to turn out qualified personnel to meet the needs of the expanding research program that will be necessary for proper management of the estuary for multiple use.

At Nichols State College other Sea Grant projects deal primarily with shrimp production in impoundments in the natural nursery grounds of the estuary. This work also complements the state's overall shrimp program and should do much to develop mariculture to its highest level.

Discussion and Conclusions: It is apparent that the coastal area of Louisiana, which has been subjected to intensive multiple-use development, represents conditions that may be expected in other areas of our nation's coast. Although the situation in Louisiana indicates that maximum production of both fish and minerals is being attained, and that some semblance of management has been developed, there is much more that needs to be done and learned. For example, we have seen many detrimental effects of industrial activities upon the basic ecology of our estuary. By and large, we have managed to maintain production, in spite of these effects, by establishing regulations which require that the integrity of the natural drainage be maintained and that spoil deposits and silting be kept to a minimum.

Pollution per se such as oil slicks resulting from spills, catastrophic accidents and/or the use of oil-based muds in industrial operations is carefully controlled by our pollution enforcement section. We have learned much about the effects of oil on oysters and other marine types, and it has been established that no immediate and abrupt toxicity occurs from oil. As yet we have not determined whether long-term chronic oil pollution will have a permanent and damaging effect.

Many of our regulations are actually compromises between the mineral and fishing industries. These compromises work well up to the point where intensive industrialization begins to usurp physical space from the fishing community. Our position now is that we do not know whether further intensification of the multiple-use principle will result in continued maximum production from both industries, or whether we are reaching a point where one or the other of the industries will have to curtail its operation. It is in this area that we need a great deal of additional research and knowledge. Additional studies should be developed under the Sea Grant Program, or other federal and state programs, to produce information in time to make the necessary decisions concerning further multiple use of the Louisiana coast. If we fail in this endeavor, there is always a danger that a valuable coastal area and estuary may be permanently damaged or destroyed.

One other step would be the formation of a coastal advisory council or committee to develop long range planning and management. Such a group can only function properly if it has adequate information and data on the coastal area to be managed. The source of such data can only come from the state's research program and the Sea Grant Program, both of which should be designed to give maximum results.

In final analysis, Louisiana may be approaching a condition of overuse of its coastal area, and it is time we determine if this is the case. This determination will require much more research and must be done, not only because it is important to Louisiana, but also because it can serve as an example to the rest of the nation.

The Louisiana Coast represents a peculiar type of highly unstable estuary. It has been subjected to intensive multiple use and attempts have been made to manage the area. Some successes along these lines have occurred; however, it is questionable whether our program is one that can be depended upon for permanent management. Much research has been done by state agencies, but they have not been able to meet all of the needs for a complete program. The Sea Grant Program has been well designed to complement the state's research program, and we feel that these programs are extremely valuable and should be continued. We strongly recommend that the Sea Grant Program be further expanded along with the state's research program to give a more definitive answer to the needs of managing such a complex ecological zone.

Food Resources as Viewed by: Commercial Fish Processing

Lowell A. Wakefield

President, Wakefield Seafoods, Inc., Port Wakefield, Alaska

One hundred and fifty-three miles due west of my office start the great underwater plains of the Bering Sea. When I began dragging there, 22 years ago, my net was the only piece of gear on the bottom in over 400,000 trawlable square miles.

If I were to trawl there today, my net would travel over bottom that has been repeatedly scoured by Japanese, Russian and Korean fishermen. The Japanese estimate their bottom fish catch in this area for calendar 1969 was two billion pounds. Korea is just starting, but the Soviet effort is substantial. The catches of salmon, crabs, shrimp, herring, halibut and other species by those three countries, plus U.S. and Canadian fishermen, total a gross harvest from Alaska waters far exceeding total domestic fish consumption.

World wide, there has been a 6% average annual growth rate in marine food harvest in the last two decades. Even this increase, however, is not rapid enough to meet the problems of population growth and protein deficiencies: problems which are accelerating not only in the underdeveloped areas of the world but in our own country, from the Alaska bush village to the urban ghetto. Existing technology can perhaps push production to three or four times present levels, but there is no reason to believe that ocean food harvesting will always be bound by present technologies. The oceans are capable of producing perhaps as much as 10 times the present catch, provided, of course, we cease to use them as a dumping ground for everything from garbage to excess munitions, and as a repository for DDT and other pollutants.

Even the current rate of growth appears to be more than can be handled by existing conservation and management structures. Many species are being over-exploited, while others are capable of sustaining much greater harvest. The problems become more severe each season.

A discouraging aspect of this rapidly increasing harvest of sea resources is that it has left the American fishing industry standing at the post. Our landings are about the same as they were before World War II. Most of the fish used in this country is imported; we harvest perhaps 10% or less of the production potential over our own continental shelf. Our equipment, ashore and afloat, is for the most part antiquated. A fisherman with more than a high school education is a rarity. There is little incentive to seek better educational preparation even if available, since the average earnings of Alaska fishermen are only slightly over $3,000 a year (a level which has remained constant for years).

Our Japanese counterparts think that our less well developed fishing industry is just great and that fish harvesting, even along the U.S. coast, should be left to those who are good at it and that we should occupy ourselves with something to which we are more suited. Of course, the Japanese feel that they are the ones best equipped to catch and process seafoods.

I disagree. The American fisherman is not inherently less efficient than his counterpart from other countries. When the first Japanese cannery ship showed up in the eastern Bering Sea, after World War II, my crew outfished and outpacked them man for man, pound for pound, fifteen to one. Similar examples are numerous in our Gulf shrimp fishery and our eastern Pacific tuna seining operations. Our access to ports and markets gives us a tremendous advantage. If we could break the bonds of the Jones act, senselessly restrictive regulations and other artificial deterrents, I think we would be hard to beat.

Despite weaknesses in management, U.S. control and harvest is more likely to preserve fish stocks off our coast for future generations than is Japanese, Russian, Korean or, for that matter, multi-nation joint management. (Ask any of us who has tried to get the salmon abstention line shifted to protect our Bristol Bay red runs.)

In a state such as Alaska, with the highest incidence of unemployment in the country, the stakes are considerable. Even at the present level of marine food harvest, there are 10,000 good jobs available if domestic effort can replace foreign effort on our state's continental shelf.

I hope I do not underestimate the difficulties. Even as simple and non-controversial a course as I suggest would require, among other things, a complete revision of our attitude (and that of other sovereign states) toward who owns the fish in the ocean, as well as a complete overhaul of our U.S. management philosophies and practices.

If such a program is embraced, it is my hope that the Sea Grant program will be able to train the many people needed: people trained somewhat differently from those available now. In 1968 all the colleges in the 50 states graduated 76 persons in the fields of fisheries science and marine food science. The few who wound up in management seem to have been pretty well inculcated in ap-

proaches which have not worked for the past 50 years and do not promise to work in the forseeable future. When a stock shows signs of depletion, they shorten the season, shorten the net, or put on hastily and often arbitrarily contrived quotas. If a piece of gear is efficient, they outlaw it, etc. Perhaps the Sea Grant program should consider trying a modest subversion of the next generation of students by exposing them to some ideas of historians, economists, sociologists, and the business community, concerning profit incentive management, as well as to standard MSY criteria.

I note that the Sea Grant Program is intended to initiate and support applied research. Admirable. As long as I can remember, the various state, federal, and other public supported agencies have been supposed to direct some of their effort to such research. Yet in my own area I see little effort directed at gaining knowledge to solve current management problems. Rather, the effort seems to be directed toward developing new programs which are not completed, towards science for science's sake, and/or toward creating, nurturing, and protecting bureacratic empires and positions.

In the past twenty years the U.S. king crab catch has zoomed from 0 to 160 million pounds and dropped to a quarter of that. Yet, no one knows the population size in our principal fishing areas, or how natural mortality and fishing pressures effect those populations – nor is anyone engaged in a serious effort to find out.

As earnings from king crabs shrink, our fishermen turn in force to tanner crabs. Ten, twenty, or even thirty million pounds of these crabs will be harvested this year (and we don't even know enough about them to call them by their right name).

Additional research and training, supported by Sea Grant funds will certainly be of some benefit, but establishment of new priorities and new approaches to the problems at hand, might be substantially more productive.

Food Resources as Viewed by: Federal Fishery Research Scientist

Robert L. Edwards

Acting Assistant Director Bureau of Commercial Fisheries
Washington, D. C.

These are interesting times. Times when mankind is once again deeply concerned (even scared) about his seeming lack of potential to survive satisfactorily, even into the next century. Previous scares were usually due to fear of the unknown. Would Halley's comet hit the earth and destroy it; would the black plague never stop? Today's fears are hardly related to anything so palpable, but rather to an understanding of the possible consequences of our exploding population. As before, the fears are often illogical and emotionally expressed, but now they seem to be all too real.

Let's look at some interesting statistics. You have all read, many times probably, that the present world's population approximately equals the total number of men who have lived since Adam and Eve. I can't vouch for the accuracy of this estimate, but it is not far off. During its life span, the present population will use up as much in the way of natural resources as has all mankind since Adam and Eve! Now another statistic. About 5×10^{10} tons of dry carbohydrate are produced each year on land and about the same amount is produced in the oceans. If everyone on the face of the earth lived as we live here in the United States (the total world population approximates 3.5 billion people), no less than 5% of all material photosynthesized would be consumed, one way or another, by human beings. Obviously much of what is produced is useless directly to man, considerable is consumed by other creatures, and some is converted into other products. Incidentally I paraphrased this thought from material presented by H. R. Hulett in an article in the February issue of Bio-Science. I commend the entire issue to those of you interested in the general problem of population. In any event, man would appear to be on the verge of, if not already, using resources faster than they are being replaced. Don't forget that coal, oil, and natural gas are also products produced as the result of photosynthesis long ago.

Closer to home now, let's consider our fishery resources. Lee Alverson and I don't differ markedly in our estimates of the potential of ocean resources. We do, however, tend to think and talk about them differently, often quite deliberately, with the hope of stimulating thought and promoting better understanding.

I think that the practical maximum catch of marine fishes is presently something like 70 million metric tons, but no more. In 1961 I said that it was about 55 m.m. tons. Believe it or not, there is no inconsistency here. Present world landings are just short of 50 m.m. tons.

My estimates are qualified in this way: they are based on existing technological capability and obvious new technology on the immediate horizon. None of us in 1961 clearly foresaw the impact of the large, relatively efficient distant water fleets now so painfully obvious. The "practical maximum" estimates are derived in a thoroughly straight forward manner. It is simply a matter of multiplying the average catch per acre on typical fully exploited – but not overexploited – grounds. For the late 1950's this was on the order of 20 to 25 pounds per acre. Today, on these same grounds, it is averaging about 35 pounds per acre, but sadly many stocks of fishes on these same grounds are obviously overfished. The most probable value is around 30 pounds per acre.

It has been estimated, and I was a member of the motley crew involved in the production of the estimate, that the fishery resources (fish and other creatures such as shrimp and molluscs) in the immediate vicinity of American shores is around 20 m.m. tons (40 million pounds).

Not too long ago one of my esteemed administrators asked me why we imported South African hake (*Merluccius capensis)* when we had so many tasty, delicious species of hakes (*Merluccius albidus, bilinearis* and *productus* to name three) swimming right off our own shores. He reminded me that those starry-eyed estimators, Alverson and Edwards, had suggested in various speeches and papers, and unguarded moments, that the sustained yield of these species might be as much as one billion pounds. Judging from the success of our Soviet competitors, that was a solid estimate. The administrator wasn't completely dense and he recognized that the price had something to do with it. He therefore reasoned that good-old American know-how, ingenuity and competitiveness could win out if our estimates were in the ball park. What he did not realize was that it took between 20 and 30 average-sized American hakes to equal one average-sized African hake. Thus, the first point with regard to our sizable American potential, is that many of our

unexploited species are not of much value because of physical characters.

The bulk of our unexploited potential, for the time being anyway, is useful only as raw material for fish meal or flour factories. Ultimately we may be forced to have our fish only in this form, but I sincerely hope not. If the haddock on George's Bank and the halibut and ocean perch off your coast and Florida's red snappers and Alaska's king crab are overexploited, there are not many optional resources to take their places. I remember Gene Odum once saying that he hoped we could always continue to enjoy beef steak and go sport fishing. He didn't wish to see us driven to utilizing all ponds, lakes and puddles for intensive aquiculture at the exclusion of a quiet moment of relaxed recreation, and using all land for intensive agriculture merely to survive. Similarly, I don't wish to forego my occasional halibut steak or lobster or shrimp creole because we failed to manage and were left with only the enormously abundant bony herring and heart urchins.

What is this management problem and what does it have to do with Sea Grant anyway?

The basic management problem can be simply identified as one of institutional barriers. The phrase *institutional barriers* covers a multitude of sins including:

1. Establishment of property rights in a common property resource,
2. Interstate relationships, and divers others.

I will discuss the two institutional barriers mentioned above and suggest some of the ways I think that they present challenges to Sea Grant.

The number of taxicabs in at least one of our larger cities is limited by law. There are times when I have deeply regretted this fact, but it has generally worked to the advantage of all. The licenses are treated as property and may be sold as such. They acquire considerable value. This practice is clearly a form of limited entry. Taxicab riders are an example of a common, renewable natural resource, and the general concept is quite valid for marine fisheries. Quite clearly, if we really wish to encourage the development of our fisheries, we must provide some reasonable guarantee of economic success. The dynamics of the resource must be understood and the amount of harvest carefully controlled. We look to Sea Grant to help provide scientists and to carry out some of the research necessary for management. Since the federal government can't do everything, its efforts must be concentrated where the logistics required exceed the capabilities of Sea Grant and state laboratories. Sea Grant can fill the middle ground between the states and federal government because it need not be restricted to state boundaries. While it is not a perfect illustration of this particular point, what better example is there than Dan Panshin's albacore advisories and temperature charts?

The limited entry concept won't come easily; in fact, it might turn out to be a generally unacceptable mechanism. In any event, it seems to offer a great deal of promise and it will be sold only if we do the proper research and communicate the results effectively. Sea Grant is certainly a bright hope for those of us who consider an "extension" service the missing ingredient in the stew. Management is really successful only when the costs of enforcement are but a tiny fraction of the economic gains. The best speed limit enforcer on the highway is a tangled mass of crumpled sheet metal and broken bodies, although that is a very unhappy way to achieve an understanding of the deadly effects of speed (no pun intended).

The potential multi-state aspects of Sea Grant can be vital in solving some of our troublesome management problems that are largely institutional in nature. There are many species that freely transgress state boundaries and are harvested largely within the territorial sea. There are all too few examples of interstate agreements truly achieving an optimum utilization of these resources. There are far too many examples of internecine struggles and variations in legal restraints that virtually guarantee entirely unsatisfactory utilization of the resources. Here is a man-sized challenge for Sea Grant: first, good research properly evaluated and communicated, and then the resolution of conflicting but valid social pressures. Such a program requires scientists, lawyers, economists, and consumate ocean politicians, many, if not most of whom, will be trained in Sea Grant institutions.

One last thought. When our astronauts finally landed on the moon, no one was really surprised to find that it was not made of green cheese and uninhabited, even by primitive life forms. Good telescopes, logic and common sense long ago established these facts with a high degree of probability. The discovery, however, that Venusian surface temperatures were sufficient to fire pottery, and that Mars was nearly as desolate and forbidding as the moon has had a marked dampening effect on man's aspirations and dreams. A couple of weeks ago I flew from Washington to Honolulu, all during daylight hours with unexcelled visibility. The first 6 hours were somewhat depressing. Man has really taken over—fields, roads, houses, factories—everywhere. Few places remain unutilized in one way or another. The next 3 hours over the Pacific Ocean were nearly as depressing. What a vast expanse of nothing—virtually a desert. And then it hit me. For a short while I was transformed into a Spilhaus, drawing mental pictures of floating agricultural communities and factories, operating in an area many times the area of the land masses. Here, at least, we still have a challenge, obviously not as glamorous as another planet Earth within our reach, but still well beyond our present grasp and well worth it. Here is Sea Grant's real challenge! I dare you!

Non-Food Resources as Viewed by: Federal Mineral Resources Administration

Hollis M. Dole

Assistant Secretary for Mineral Resources, Department of the Interior
Washington D. C.

I was delighted to receive an invitation to speak before the Third Sea Grant Conference for both professional and personal reasons.

In the first place it gives me an opportunity to discuss a topic of immediate concern to me and the Department of the Interior – the mineral resource potential of our continental shelves. Secondly, the invitation provides a welcome occasion to visit my alma mater, where I was an undergraduate and a graduate student in geology. Unfortunately, I was not able to take advantage of Oregon State's outstanding Department of Oceanography because it was not established until 1959. I have always loved the Oregon Coast, however, and as a student I was fascinated by the coastal geology and speculated about what lay offshore. Later, as State Geologist I became aware of the mineral resource potential of this offshore region, and also of the problems that must be resolved in order to use these resources wisely.

The opportunities for mineral development on the continental margin of our nation are great, for this region comprises an area one-third the land area of our country. The geology off each of our coasts is as complex and varied as that onshore.

The problems associated with mineral development are complex also – whether the technological problems of recovering minerals economically, or the related problems of protecting the environment from the effects of mining, drilling, or dredging.

Our panel this afternoon consists of four distinguished speakers, each of whom will discuss a particular aspect of our non-food marine resources. They will present comments and ideas as to how the Sea Grant Program can best stimulate the development of these resources through the coordinated efforts of industry, government, and the educational institutions.

Before I call on the first speaker, I would like to make a few brief comments of my own on the Sea Grant Program. I am greatly encouraged that it has been established with very broad guidelines to cover a wide range of ocean disciplines, including student training, applied research, and extension activities.

I am particularly anxious that this excellent program maintain a broad perspective as it continues to grow. Our tendency is to break down scientific or technical problems and organizations into specialized categories, even though today we all recognize that our principle resource concerns cut across such specialties. For example, our panel today is discussing non-food resources; another panel is considering food resources, especially fisheries. Yet, in offshore minerals development, we must be concerned with the effects mining or dredging operations may have on fisheries, or recreation, or other uses of an area.

It is not enough to propose that mining or dredging or drilling simply be excluded from certain areas. It is imperative that research and technology be developed so that any use of an area, including mining, may be pursued with as little damage as possible to other potential uses. Our industrial economy is built upon the uses of minerals and energy, and the needs for minerals or fuels must be met. More and more as we look ahead 30 or 50 years, we will need to obtain minerals from areas now uneconomic.

The submerged continental margin shows great promise to meet some of these needs, but it is necessary that we undertake this development with concern for possible side effects. These can best be avoided or mitigated if they are understood before the mining or dredging or drilling has started. Biological and ecological studies carried on in association with minerals studies are helpful in achieving this understanding. As a geologist, I should like to point out that an understanding of ecologic conditions in the marine environment is greatly dependent on an understanding of the geologic conditions and processes that are taking place. The same geologic knowledge that is fundamental to discovering where and how the economic minerals are formed and concentrated in deposits, can be used to predict the effects of mining on organisms and on the environment, and to minimize those effects that are detrimental.

I do not suggest here that each project concerned with offshore mining technology should contain geologic or biologic or ecologic components. Rather I would encourage those responsible for the Sea Grant Program to emphasize that development of any resource may have impact on other resources. We must be aware of the possibilities.

Non-Food Resources as Viewed by: Seashore Development

John D. Gray

Chairman of the Board, Omark Industries
Portland, Oregon

My approach will be a little different from what you have been hearing. It will be from a non-technical aspect, more about the coastline and how we can enjoy it – pointing out, from my viewpoint, how it is a non-food asset.

For example, last Saturday I had the pleasure of hiking about 2 miles up the coast and back. It was a cold day, but I enjoyed the change of pace, the relaxation, the privacy. These are things that a great number of people enjoy. I'm certainly not the only person getting away from it all. Throughout our country and the world, there are probably untold millions who enjoy the natural environment of the coast. I think we should be concerned about how, not only the Oregon coast, but every coastline in the world is used.

Think of some other aspects of the seashore that are assets – perhaps non-financial assets. Think of all the poems, plays, stories, songs, and articles that have been written about some impression of the coast. Then, think about the various artists who, through oil paintings, water colors, or other types of graphic expression, convey their impression of the coast. These expressions are important to the quality of our life and should not be overlooked. I'm speaking today primarily from the emphasis of these aesthetic values. I want to direct your thoughts towards the non-economic impact and importance of what happens to the coastline.

I want to stress that the edges of the sea are an extremely important resource that must be properly managed. Obviously when I say "properly managed" in quotes, it means a lot of different things to many different people.

There are two key reasons that we should be concerned. One is the economic impact which comes from tourism and recreation. I see no point in spending time on this aspect, since we're all aware that environmental development does have a major influence on our economy. There are abundant studies and publications, pointing out the various jobs created and the overall dollar value resulting from the tourist trade.

The second reason I think we should be concerned – and this is where the Sea Grant Program comes in – is that certainly as a nation and as a world, we must work to preserve the physical and emotional experiences which are important to all of us. Environmental awareness is one of these aspects which helps us, I think, to improve the quality of our lives.

Speaking from my role as a land developer, I think we are obviously going to see a somewhat increased number, but perhaps not a great number, of ocean projects. Facilities will be created and developed – some privately, some through state and federal agencies. Regardless of who does the developing, we are more likely to notice concern about the preservation of environment and ecology, in general. The land developers, whether private, state, or federal, should all be subject to the same types of constraints. High standards should be established so that all will have to tread very cautiously in the design and execution of a state or county park, a Forest Service camp, or whatever.

I think the public, correctly so, is much more aware that what we are working with on both coasts is a very scarce commodity. In the past, many places have been badly abused by developers. Land developers do not deserve the entire blame. Little towns started up during the depression or in that time when concern about planning was just not known. We have to think back to realize why we have the highly-unzoned, little towns and strip developments along our coasts. In a number of cases we can't be too critical; as we know, cash was tight in those times. However, I think we can be very critical of what happens from now on. We need a great deal of urban renewal along the coast. Cleaning up and rebuilding can happen, but it will take money as does everything else that we are currently concerned with. Improved environment – improved ecology – will not come free!

Tied in with this concern for decent planning and development, is the need to accept planning and zoning on a regional basis. Here again I stress regardless of whether it is governmental, private, or joint development. Without a workable, regional plan, you cannot do a decent job of developing, whether in downtown Portland, Indianapolis, or on any coast. If you are in an unzoned area, you are at the mercy of the next-door property owner; you just cannot create the type of environment which I foresee people will want today, in the year 2000, and beyond.

The idea of zoning and planning is, in many ways, unpopular. The idea of property ownership is a very holy one, has been for a long time. Unless we are willing to

subject ourselves to this form of constraint, we're not going to get the other great plusses that come from good planning.

Now if I might talk a moment about Salishan – primarily how it came about. Some other investors and I had the opportunity to purchase, over a period of time, about 550 acres. We had at least a mile of highway and about 2 miles of beachfront within that area – enough land to do a decent job of planning. It had not been ruined to start with, so we had some things going for us. The challenge was to prove that people will respond to good environmental control and the preservation of nature. Our record, since 1961 when we started, shows that not only do people come, but that they return, and they enjoy doing so. Because of our concern for nature –a different standard of development – our natural landscaping has created a different environment which people can enjoy. We need a great many more of these projects. I'm hopeful we have encouraged others to go the same route; that a by-product of this project will be to upgrade existing facilities elsewhere. Again I come back to quality of life, in this case, on the coast – a much different concern from what happens in the water. I'm concerned with what happens outside the water – to ocean-front and adjacent land.

Just about a month ago the natural resources committee of the State of Washington approved a seacoast management bill which provided for study of land up to 1,000 feet behind the high-water line. If enacted, the bill would give local authorities the right to implement zoning regulations most of the time, but the state would have the authority to step in under certain conditions. Starting in one state, at least, only sensible ocean-front development is going to be tolerated by our citizens.

My plea is for concern about zoning as it affects the coastline, or anyplace, for that matter. I would like Sea Grant, in one way or another, to be involved in increasing people's concern about zoning and planning. In that way, I believe we will attain the best possible development of our coastal resource. Careful planning will pay off with psychological and emotional value.

Non-Food Resources as Viewed by: Federal Oceanographic Research

Harris B. Stewart, Jr.

Director, ESSA Atlantic Oceanographic and Meteorological Laboratories
Miami, Florida

I will recall the NASCO meeting a number of years ago when, during a long discussion on marine science education and training, Athelstan Spilhaus delivered a lengthy – and pithy – diatribe on the growing gap between "ivory tower ocean research" and the needs of the poor guys trying to make a buck out of the ocean or get something done at sea. He wound up with an – at the time – outlandish suggestion that what we should have are Sea Grant Colleges, a marine counterpart of the Land Grant Colleges that have worked so well. We have come a long way since then, along the route of hearings, draft legislation, more hearings, a bill, passage of the Sea Grant Act, appropriations, proposals and more proposals, and now we are well along the road of implementation. I believe the program has worked well to date; it has been money well spent.

One of the things that I particularly like about the Sea Grant concept is the involvement of capabilities other than marine science, and of people other than oceanographers. Oceanographers are interested primarily in finding out how that great, boiling, bubbling confusion, called the ocean, really works. Other views will broaden the scope of investigations. You will notice that I avoid the word "interdisciplinary." That term has become one of the most overworked words and underworked concepts in science today, and I have come to loathe it. We tend to use the word as a crutch and forget the concept that the word supposedly embodies. Sea Grant has tried to correct this neglect by bringing many capabilities to bear on oceanic problems. I like the approach.

However, I feel that we have, as a country, done an extremely poor job in our approach to the increased utilization of marine resources. First, we have done a poor job in our public relations. We have for years shouted about "feeding the world's starving millions from the ocean" and "utilizing the untapped treasure troves" of our continental shelves. We tried to use these slogans as justification for an increased federal program in marine sciences. Obviously this approach did not work on those in control, for the federal program in marine science and technology has been essentially level-funded for the past several years. The President's budget submitted to Congress for fiscal year 1971 showed an increase of about $23 million over 1970 for a total of some $537 million for marine science and technology. It is interesting to note that this is the first year in some time that the non-military oceanography budget is more than half of the total amount. So perhaps we have started. I was pleased to note that $3.4 million of the increase was for Sea Grant and about $15 million for the IDOE (International Decade of Ocean Exploration).

If our PR approach has been wrong, how do we correct it? The time has come for our public utterances to be realistic and factual. The solution to the problem of our present inadequate utilization of marine resources is not solely a scientific one, as many would have us believe. It is in large part dependent on the economics of the situation (can we get it cheaper from a land source?), in part dependent on modernizing the legal framework of resource development, and in part dependent on improved technology. Marine science can and will contribute, but the idea that marine science alone will solve the problems of increased resource utilization is mere dreaming. Our public relations, therefore, must be based on cold hard facts, not the flowery phrases and glowing generalities of the past 10 years, which implied that oceanography alone could provide the panacea for all our resource ills.

In addition to a poor public relations job, we have made, what I consider, a gross blunder in pushing for exploitation of marine resources without also pushing for the exploration that must precede it. We talk glibly of the importance of the sea for food, for mineral resources, for transportation, for improved weather forecasts, for national defense, and many other uses. The truth is, that the sea is so little explored and its magnificently complex processes so poorly understood, that we have been unable to utilize the sea for much of anything other than the same uses to which it has historically been put – and with relatively little improvement in these. For example, less than 5% of the seafloor is adequately mapped for nautical charting purposes, and we have yet to know enough about the distribution of wave conditions on a global scale to provide good ship-routing services. We still know so little of the interrelationship between the marine environment and the edible resources living there that "feeding the world's starving millions from the wealth of the sea" is a veritable pipe dream today. We are still so unaware of the extent of the "untapped mineral resources" we talk so glibly about, that we do not know where they are, how extensive they

are, or even what they are. We know that the sea influences the weather and *vice versa*, but our ability to forecast the weather has improved little over the past 20 years, and marked improvements cannot be expected until we have been able to explore, untangle, and understand the complex interrelationship between sea and atmosphere. Our military knows so little of the marine environment that they still cannot find submarines, and new weapons systems that work in theory often do not work at sea. The Navy uses the term "environmentally limited" when referring to some of their marine equipment or systems. Actually, this is just a euphemism that means we still know so little about the environment of the sea that we are unable to build things that will work there.

Too long the United States has talked of the resources and the utilization of the sea without considering the fundamental initial steps of exploring, describing, and understanding. The recovery of food and minerals, the improvement of marine transportation, better national defense, improved forecasts, and all the other ways in which the sea will be utilized cannot be effectively realized until the basic exploration, description, and understanding have been accomplished. This fact is so simple and so basic that it has been almost completely overlooked in the rush to glamorize the benefits eventually accruing from the sea. Exploring, describing, and understanding are perhaps less exciting economically and politically than commerce, weather, food, minerals, and defense, but they are the *sine qua non* of all man's efforts to reap the harvest of the seas.

Man speaks of invading the sea and even now has several habitats in operation on the seafloor, but he knows practically nothing of the environmental constraints of the realm he is attempting to invade. One hears a lot of talk today about marine ecology – the study of the interrelationship of marine organisms and their environment. We know a good deal about the organisms, their life cycles, their eating habits, even the number of vertebrae in their backbones, but we know very little about the environmental variations to which they are subjected. Take for example a study of lobsters from a seafloor habitat – and just such a study is planned for TEKTITE II and was started in TEKTITE I last year. You can tag them. You can follow their travels with tricky electronics. You can watch their movements. You can watch when they eat and what they eat. You can count the numbers that are around a given "rock pile" each day. You can detail their comings and goings with great precision, but to know "why" you must know what changes are taking place in the world they live in. How does the visibility vary; how does the temperature of the water vary? What sort of current regime is in the area and how does it vary? Does the dissolved oxygen, salinity, or nutrient material vary with time, and, if so, how do they react to these changes? My point here is that we talk glibly about "ecology" and tend to neglect the environmental half.

Pollution and pollution control are fast becoming the watchwords for the seventies. Already many in political office, or those aspiring to one, have latched onto pollution control or pollution abatement as their personal standard. To those who are serious and dedicated, I say "more power to you." But for those who are using this merely as a lever for their own political adornment, I have coined the term "polluticians." We will hear from many "polluticians" in the years ahead. Let us plan now to use them and educate them so their "pollutical" speeches make sense and will help the cause. Man eyes the sea as a convenient place to get rid of the wastes he creates on land. He thinks of the estuaries as convenient toilets that flush themselves in a half-hearted way a couple of times a day. In fact, it may be that one of the great resources of the sea is that they are just this – a big flushing hole in the ground and a great place to get rid of our wastes. You could spit in the Columbia River out here, and it wouldn't "pollute" it. Two people or even two hundred people could spit in the river, and it would not be polluted. So it is not a question of dumping or not dumping, but rather a question of how much of what can be dumped for how long before the other uses of the river are imperiled. To answer such questions for the Columbia River, for the nation's estuaries, and for our extensive nearshore areas, we must first undertake to explore, describe, and understand these dynamic systems. Once we know how they work, this information must be conveyed to the decision makers, so that valid judgments can be made on the basis of fact rather than on emotionalism, financial pressure, political influence, and the other grounds on which decisions are so often made in the absence of facts.

We want to protect our beaches and improve our harbors. We want to dispose of the cooling waters from our coastal power plants. We want to fish and play in the nearshore waters. We want to harvest fish commercially in our offshore waters and our rivers and estuaries. We want to launch our pleasure boats, to build our marinas, to develop our coastal lands for living and for industry. We want to build causeways to our offshore islands. We want to set aside coastal preserves and maintain our navigable waters. But, to do these things intelligently, we must first explore, describe, and understand the entire nearshore and estuarine regime.

My point, then, is to stop kidding ourselves that we can just go to sea and harvest its resources. It is absolutely essential that our approach to utilizing marine resources be comparable to that for harvesting our resources on land. First we must map, describe, and understand, or the attempts at harvesting will continue to be in the hit-or-miss, catch-as-catch-can approach we have been using with just the poor results one would expect.

I am not advocating the termination of all resource-oriented activities at sea. I am, however, pleading for an appropriate amount of our effort, of the Sea Grant effort, being directed towards providing the basic environmental understanding on which intelligent utilization of our marine resources must depend.

Non-Food Resources as Viewed by: Petroleum Industry

John E. Sherbourne

Associate Director of Research, Union Oil of California
Brea, California

It is a pleasure to have this opportunity to represent the petroleum industry on this panel today. At the same time, I must advise you that the remarks I have to make are made solely as my own responsibility and do not necessarily reflect the collective views of the industry nor of the company for which I work.

In some ways the petroleum industry differs from other industries which are expected to benefit from the Sea Grant Program. It is desirable to discuss some of these differences in considering how the Sea Grant Program can best help the industry. First, however, I should like to set the stage by outlining why it is so important to the United States public that the petroleum industry continue to be successful in its offshore operations.

U.S. Petroleum Requirement The U.S. is what it is today primarily because of its abundant and effective use of energy. At present, the annual energy demand is equivalent to a little over 50 barrels of crude oil per person. According to Department of Interior forecasts, this equivalent energy demand will rise by 1980 to 69 barrels per person. Coupling this increase in per unit demand with our population increase leads to only one conclusion – a rapidly growing demand for energy.

Three-quarters of the present U.S. energy demands are supplied by petroleum. It fuels 100% of our transportation system, supplies 80% of our industrial energy needs, provides 92% of our residential needs, is primary energy for 27% of our electricity and is the raw material for about 50% of our chemical industry. Although other sources of energy will increase in importance with time, it is expected that the share of the total energy requirement to be supplied by petroleum will decline only very slowly. Thus, the demand for petroleum is expected to rise substantially. Again according to Department of Interior figures, U. S. demand for crude oil is expected to rise from the present daily consumption of about 13 million barrels to about 18 million by 1980 – not very far away. To supply these anticipated needs and maintain the present reserve-to-production ratio will require that the industry find and produce in this period some 80 billion barrels of crude oil.

Offshore Petroleum It is with reference to these large future needs that the importance of offshore petroleum becomes apparent. For some time now the ability of our lower 48 states to yield new oil has been declining. Most of the large oil fields have been found, and in spite of outstanding technological advancements in oil recovery techniques, it is getting more difficult every day to find the smaller fields and produce economically from them.

Thus, the industry has moved offshore in search of big fields which can be economically operated in spite of the watery overburden. This move offshore is not just a recent thing. It may surprise some of you to learn that at present 13% of domestic petroleum is derived offshore. It is expected that this will approach 30% by 1980 in spite of an increase in imports and the potential of Alaskan oil.

It may also come as a surprise that the first offshore wells in the U. S. were drilled about 1900 in the Summerland field just south of Santa Barbara. These produced until a few years ago when they were abandoned because commercial amounts of oil could no longer be obtained from them. It was not until 1946 that the industry made an intensive move offshore, however. Since then, though, over 13,000 wells have been drilled on the continental shelves of the United States, and current production is being obtained from water depths as great as 340 feet. At present, the industry has the technological capability to work in much deeper water, but not the economic incentive.

Present Status So much for history. What is the present status and what are some of the industry's needs?

In terms of wealth generated, the offshore petroleum industry is presently the largest offshore, non-living-resource industry. According to the recent report entitled "An Oceanic Quest," the annual product value in dollars is: petroleum, $3,900 million; sand and gravel, $150 million; sulfur, $37 million; and tin, $24 million.

Now, I mentioned that petroleum differs from other offshore ventures. Other resources presently being recovered are obtained from the surface of the seabed. Petroleum and sulfur, just as on land, are found in the sedimentary formations at considerable depth beneath the surface. Hence, and this is important in determining the industry's manpower and technical needs, operations at sea are very similar to those on land except that one works in the hydrosphere as well as the atmosphere. Our oil fields do not know whether they are beneath the air or the water. As

a consequence, the impact of the ocean affects only the activities we normally carry on in the air, at the land's surface.

Here, then arises the primary change that is brought about in our manpower and technological needs. To better understand how the ocean affects us let us briefly discuss the finding and recovery of petroleum.

Petroleum is found in the pore spaces of sedimentary formations at locations where folding, faulting or facies changes provide traps into which commercial quantities of petroleum migrate and accumulate. Hydrocarbons are ubiquitous and traces of them are to be found in all sediments, but the places where conditions are favorable for the occurrence of commercial accumulations are, relatively speaking, quite rare and hard to find. Thus, large parts of the continental shelf are relatively unfavorable for recovery of oil in commercial quantities. A major problem, and one which can benefit from Sea Grant research, is improving the probability that a well will find a commercial deposit. Since it is a matter of providing its own "bread and butter" so to speak, the oil industry itself has been quite progressive in developing its major indirect oil-finding tools — the magnetometer, the gravimeter, and the seismometer. Indeed, oceanography has benefited from the industry's research and development effort in this field. In fact, the petroleum industry has been a very progressive industry on all research fronts. At present the industry spends in excess of $500 million per year on research. Research success is reflected in the maintenance of very reasonable costs to the consumer for petroleum products.

So far, none of the preliminary oil-finding tools can do more than indicate where the more favorable geological conditions are located. Drilling is still necessary to determine if a significant accumulation of oil is present. Only about 7% of offshore wildcat wells – exploratory wells as contrasted with wells in known fields – find new fields. Only a small number of those which might be called successful find large fields.

Once a commercially significant accumulation has been discovered, it is necessary to drill enough wells into it to recover the petroleum at the optimum rate. We don't have time here to describe production operations in detail, but presently, production at sea is far more difficult than exploration. Moreover, the production operations must be carried on for the productive life of the field which may extend into decades.

It appears to me that exploration will continue to be carried on primarily from floating vessels, particularly as we move into deeper waters. Production operations, at least for the near future, will continue to be undertaken in water depths of 300 feet or less from platforms which rise to the surface of the sea. Possibly some platforms will be used in 600 feet of water – maybe even 1,000 feet. As I see it, continued research and development will be done to perfect sea-bottom and underwater equipment. These devices will certainly be used in deep water when the industry moves farther to sea and may well be used in shallow water as costs decrease. Regardless of the direction taken, above or below water, the goal will be one of efficiently performing the necessary operations with maximum safety and a minimum chance of pollution.

The stage has now been set for a discussion of research which will fit the Sea Grant Program criteria and be of benefit to the petroleum industry as well. Such research possibilities are numerous, and fortunately much of it is of interest to others concerned with offshore investigation.

I, personally, would be inclined to discourage the spending of Sea Grant money on the development of apparatus and equipment to solve resource-industry technological problems. However, I can say with assurance that industry will be quick to take advantage of technological improvements and innovations which are developed to satisfy oceanographic research needs. Improvements in seismometers, gravimeters, magnetometers, and the like which result from oceanographic research will certainly be adopted by the industry. Remote sensing and control devices will also be of great interest. Such improvements are definitely useful, but it is the results of longer-range, more fundamental research that will benefit the industry and our country the most in the long run.

I have mentioned studies to improve the probability of finding petroleum and thereby decrease the substantial loss in the drilling of non-productive wells. Broad reconnaissance of the continental shelves to better delineate the geological provinces most favorable for oil accumulation come to mind. What is the nature and the attitudes of the sediments which compose the shelves, slopes, and rises off our shores? We are interested in obtaining far more comprehensive data on water movement, its relationship to prevailing and transient air movements, and the long term and transient relationships between ocean currents and sediment transport. Where does wind control sediment transport and where does water, and what are the mechanism involved? Much more needs to be learned about gravity flow and turbid flow of sediments, the conditions which favor one against the other, the distinguishing characteristics of each, the changes that take place with time, the effect of bathymetry upon them, and so forth. We are interested, naturally, in the sediment transport by long shore currents and the effects of large river discharges. The work being carried on at the University of Washington and Oregon State University, in cooperation with others, comes to mind. Our interest in some of these investigations is multiple, for such phenomena not only affect our day-to-day operations, but also our understanding of the processes which provide conditions for oil genesis and accumulation.

Although we have a general knowledge of the steps involved in the formation and accumulation of petroleum, there is an excellent chance that more detailed knowledge will lead to the finding of more oil. Hence, we are interested in research proposed by others which may have

bearing on this matter. We know that the marine biologists are anxious to learn more about the biologically lush areas of the sea and contrast them with what might be called deserts of the sea. They want to study areas where the upwelling brings abundant nutrients to the surface. At such places the control on population is often oxygen sufficiency. Where life is abundant, death also is prevalent. Are such places regions in which the sediments have greater petrogenic activity? What is the fate of all these organisms? How does the organic chemistry, the inorganic chemistry, and the ecology of the sediments and superjacent water in lush areas relate to the same factors in the so-called desert areas? Such studies require a well thought out, integrated approach if they are to satisfy the knowledge needs of the numerous interested parties. The results can have very significant applied utility in several fields.

Far more needs to be known of the general chemistry of the oceans and its chemical sinks and sources. Such information, again, is of interest to the petroleum industry. Diagenesis of sediments is a matter of great concern about which very little is as yet understood. What changes take place in sediment make-up and interstitial waters as flow takes place through the sediments, for example? What are the distinguishing features of sediments deposited in fresh, brackish, and saline conditions? What are the rates of change involved? Why, for example, do the data so far available – and I'll admit they are scanty – show that the lead content of surface water on the Pacific Coast of the U.S. is about five times as high as that off the Atlantic Coast when the prevailing winds are predominantly from the west?

The industry has a strong interest in physical oceanography. Wind and wave interaction can materially affect our efficiency and safety. Ability to predict the effect of a storm upon our operations while it is still a great distance away, is of considerable value, as is any improvement in day-to-day weather predictability.

As a last example, but not the least, I might cite the importance of learning a great deal more about the properties and behavior of sea ice. I could continue to name many other areas of research of interest to the industry. I have chosen these for two reasons. First, they show that we have a wide range of interests in oceanic research. Second, much of the research which interests us is also of interest to many others concerned with the ocean. Much of it, too, is of a type which lends itself to the integrated approach sought by the Sea Grant Program.

Finally, I might say that the industry feels it must operate extensively offshore if our country's vast petroleum needs are to be adequately met. We have a strong interest in research and can be counted upon to do our part in helping to promote and foster worthwhile oceanographic investigation.

Research: Fisheries and Aquiculture

William J. McNeil

Marine Science Center, Oregon State University
Newport, Oregon

Lauren R. Donaldson

College of Fisheries, University of Washington
Seattle, Washington

FISHERIES

Many nations have turned to the oceans to supplement limited supplies of animal protein. Modern fishing fleets now operate in waters remote from their home ports and process their catches at sea. Factory stern trawlers which gained popularity in the 1960's are already being joined by a new generation of larger factory ships capable of carrying their own flotillas of catcher boats. The most striking example to date is Russia's 43,000 ton factory ship which carries 14 trawlers piggyback.

There is much speculation about how long the wild stocks can sustain the increasing fishing pressure which has seen a six-fold increase in world landings over the past 40 years. Many important stocks already exhibit symptoms of overexploitation, and it appears that man will exploit most remaining major stocks by 1980. The allocation of the total harvest will become an increasingly important issue among nations in the years ahead.

The world's largest consumer of fishery products is the United States, yet our nation enters this decade of severe competition for limited oceanic food resources with a domestic fishery which has failed to exhibit overall growth in nearly 40 years. The total landings today are about the same as they were in 1930. We now import more than 75% of the fishery products used by the American public.

The Sea Grant Act is the most recent national legislation designed to potentially stimulate our domestic fisheries which face increased competition from abroad and severe problems at home. Some impediments to the growth of our fisheries relate to a general lack of biological knowledge on the stocks of food fish and shellfish. Others relate to complex political, social, and economic attitudes on the part of the public, government, and industry.

A successful Sea Grant Program will focus the broad interests of the university community on problems important to the development of marine resources. We should spare no effort to insure that our research will be relevant and will become an effective catalyst for innovative change. It is essential that Sea Grant fisheries research focus on "key" problems which will stimulate and complement the activities of industry and government. Duplication of effort and unwarranted competition among institutions and laboratories must be avoided. Where the potential for profit is high, industry should be encouraged to seek solutions to problems.

Some educational institutions have been involved in Sea Grant for two years; others have had a briefer association with the program. Even though Sea Grant is in its infancy, it is timely for those of us who have participated in its development to share our thoughts through informal discussions. We need to evaluate candidly our past experiences, our failures, and our successes, with the expectation that they will contribute to an improved program for the future.

William J. McNeil

AQUICULTURE

The signing of Public Law 89-688, the National Sea Grant College and Program Act, by President Johnson on October 15, 1966, was an exciting event to those of us interested in marine resource development. Now we would have an opportunity — and a challenge — to develop aquiculture on a plane comparable to agriculture.

The outstanding contributions of the Land Grant Program during the hundred years since the signing of the Morrill Act by President Lincoln were summed up by former Secretary of Agriculture Orville Freeman in 1962 in these words:

"In the last 10 years alone, the population of the nation has grown by 19%; but the farm production increased 23% – and this with 27% fewer farm workers and 41 million fewer cropland acres.

"Today your costs of food are actually lower in terms of real wages. Compared to 1929, for example, the American factory worker can trade 1 hour of work for 83% more round steak; 128% more milk; 131% more oranges; 146% more bacon.

"In 1940 it took 12 pounds of feed and from 12 to 15 weeks to raise a three-pound chicken. Today it takes only 7 pounds of feed and 8 to 10 weeks. No wonder that chicken, once a special Sunday meal, is now a commonplace, everyday food.

"Today, 1 hour of farm labor produces four and one-half times as much as in 1910. In other words, the American farmer is now 450% as efficient as he was 50 years ago."

Farming the waters, like farming the land, dates back in history. J. H. Slack, in his book *Practical Trout Culture*, published in 1872, writes "that in the works of Fo-hi, who flourished, according to the computation of the best authorities, 2100 B.C., mention is made of laws regulating the time at which fish spawn should be taken." The spawn was sold to merchants who, in turn, sold it to the farmers for stocking their ponds.

The American Fisheries Society was organized in 1870 "to promote the cause of fish culture; to gather and diffuse information of a scientific character; and to unite and encourage those interested in fish culture and fisheries problems." The founding of the Society, which will celebrate its 100th anniversary this year, really marked the expansion of effort in the culture of fishes.

Although the number of people engaged in fish culture and the expenditure of funds have increased greatly in the past hundred years, little real progress was recorded until the last quarter of the century. Since the Second World War, applied research in breeding, disease control, and nutritional requirements has made marked changes in the efficiency of the fish cultural operations. In 1945 it required 3 to 7 pounds of food to produce a pound of poorly-nourished trout or salmon fingerlings. The yearly output per man was a few hundred pounds. During the last 6 months of 1969, the federal stations rearing trout and salmon in the western states (Region 1) required only 1.8 pounds of food to produce a pound of fish. The output per man-year is now 18,000 to 20,000 pounds in a number of states.

We who have worked so many years in the field of aquiculture (I have completed my 44th year as a "fish farmer"), are proud of the accomplishments but, by the same token, are the first to recognize the many shortcomings of our present practices and procedures.

We sincerely hope that Sea Grant can provide the impetus, the leadership – and some financial help – so that meetings such as this can broaden the communications base. Ideas and concepts need to be sorted and weighed, and the good ones applied. Then we "fish farmers" can take a proud place on the rolls of those who "can do."

Lauren R. Donaldson

REMARKS

The following comments cover two projects supported by Sea Grant funds and administered through the Department of Fisheries and Wildlife at Oregon State University. The first project, "Development of Methodology for the Cryo-preservation of Viable Fish Sperm," has the following objectives:

1. To develop fish sperm extenders and protectors that will yield greater than 90% fertilization of fresh eggs inseminated with cryo-preserved gametes.
2. To conduct tests to determine the feasibility of cryo-preservation of the newly fertilized egg of salmonids.
3. To conduct tests to measure the comparative swimming performance of progeny produced from fresh and from cryo-preserved fish sperm.
4. To conduct exploratory experiments to determine the feasibility of cryo-preservation of gametes of economic invertebrates.

The achievement of the objectives of this research would provide a methodology for the live preservation of fish sperm which could broadly be applied in the fields of fish culture, genetics, and disease control. In the culture of Pacific salmon, the storage of viable sperm would eliminate the need for holding male brood fish. Space formerly used to hold male brood stock would be available for additional females without increasing the cost of hatchery operations. For the first time, it would be possible to cross fish species that do not spawn at the same time or locations. Sperm pools could be established which would facilitate the international exchange of semen.

Research into the genetic improvement of Pacific salmon would be enhanced by using sperm from a superior male to fertilize the eggs of many females. The techniques developed would make possible genetic research to study the inheritance of certain anatomical, physiological and fitness characteristics that could be used to improve stocks of Pacific salmon.

In disease control, males from a distant but disease-resistant stock could be crossed with local, disease-

susceptible females in order to increase the disease resistance of the indigenous species. In some studies it would be possible to reduce the variability of laboratory specimens by using the sperm from a single male to fertilize the eggs of many females. These test animals should exhibit less variation in response to environmental changes.

Demonstration of the practicality of cryo-preservation of viable gametes of economic invertebrates would provide a useful technique for advancing studies in culture, genetics, and disease control of invertebrates parallel to those described for fishes.

Our progress to date can be summarized by the following general conclusions: (1) Undiluted spring Chinook salmon sperm was held at 4°C for as long as 11 days and produced 92% fertilization of fresh eggs. (2) Spring Chinook salmon sperm collected early in the spawning season and stored at 4°C remained viable longer than samples collected at a later date. (3) Seminal plasma was not a suitable extending medium for spring Chinook salmon sperm. (4) Mammalian semen dilutents were unsatifactory extenders for coho salmon sperm. (5) Two extenders were developed; Ext 141 was used with coho and spring Chinook salmon and Ext 164 with steelhead trout. The two extenders differ in the concentration of two chemical components; mannitol at 100 mg/100 ml in Ext 141 and 250 mg/100 ml in Ext 164, and sodium bicarbonate at 500 mg/100 ml in Ext 141 and 750 mg/100 ml in Ext 164. (6) The best method of freezing sperm cells was in liquid nitrogen vapor. (7) The best life protector tested was dimethyl sulfoxide at a concentration of 8% for coho salmon and 12% for steelhead trout. (8) Maximum fertilization of fresh eggs achieved with sperm frozen in liquid nitrogen (-196°C) was 38% with spring Chinook salmon, 89% with steelhead trout, and 79% with coho salmon. (9) Frozen and thawed sperm of Pacific oysters was viable and resulted in 79-89% fertilization of fresh ova. (10) The frozen and thawed ova of Pacific oysters could not be fertilized.

The second study concerns the "Early Life History and Potential Yield of the Basket Cockle in Netarts Bay, Oregon." The investigation has the following objectives:

1. To study the reproductive habits of the basket cockle as they relate to age, size class distribution, and survival of the population.
2. To determine the potential yield to man of the basket cockle in Netarts Bay through studies of production.
3. To attempt to identify and evaluate those environmental factors important in determining the distribution and abundance of the basket cockle in the study area.

Achievement of the objectives of this research would enable us to develop models from which potential yield could be estimated and from which information pertinent to future harvest regulations could be obtained. Knowledge of environmental relationships will further the understanding of factors which control the distribution and abundance of cockles in their natural habitat. Because young cockles are apparently more responsive than older individuals to variations in environmental conditions, seasonal, and short-term changes in growth and mortality rates may serve to indicate characteristics of good and poor habitats.

To achieve these objectives, sediment samples were collected in Netarts Bay from early spring through September, 1969. These samples are now being processed for enumeration and description of bivalve larvae and post-larvae. Samples of mature cockle clams were collected during the same period of investigation to determine condition and time of gametogenesis. A vertically integrating plankton pump was constructed and perfected for collecting pelagic bivalve larvae at designated stations.

Howard F. Horton

In Alaska we have many latent and potential invertebrate and fish populations of commercial value that are still unexploited. We also have communities that are almost entirely dependent on fishing for their existence. Since these valuable species will certainly be utilized in the future, we have unique opportunities to develop and manage fisheries more efficiently than in the past.

The University of Alaska does not have a Sea Grant Program yet, but we have high hopes. One phase of our proposal deals with research on and development of marine resources in a certain underdeveloped area. Along with development, we must encourage better management, and here I am thinking in economic as well as biological terms. There is little point in development if it is to follow the "boom-and-bust" pattern of king crab and many other fisheries.

Our first step will be to inventory marine resources in the area, and then to formulate bio-economic models for optimization of benefits. Hopefully, we will have a small model system of what could be done on a larger scale. Concurrently, we want to work with the local fishermen and fishing industry, and the state fisheries agency in an attempt to convince them that there are alternate management methods which could provide a better livelihood and a higher economic return thus avoiding the "tragedy of the commons."

We must also seek acceptable solutions to the basic problem of unlimited entry if we are to compete with foreign fishermen and other protein-producing industries – it is a matter of survival to the U.S. fishing industry.

Jack M. Van Hyning

For the past several years statements have been made by knowledgeable and highly respected individuals in fishery science and administrations that there should be a limited entry in fisheries where it is felt the effort is too great for the allowable harvest. Because this subject was also referred to in the Sea Grant Conference, we feel we should express our opinion on it as there are many legal and political questions involved.

The arguments we have previously heard favoring limitation of licenses were based on economics rather than conservation. It is claimed that too many fishermen trying to make a living in a limited fishery is not good economics and only leads to reduced earnings for all participants. If licenses were restricted, at least those obtaining a license would make a good living for their fishing efforts.

Limited entry has been directed chiefly toward the salmon fishery and, perhaps specifically, toward certain areas where the supply has not been adequate for the number of registered fishermen.

We do not share this view, nor do we believe there should be any limitations based on economics before further investigations have been made. We are not at all convinced that theories – however well-meaning – advanced by scholars and scientists, not directly dependent upon the fisheries for their daily bread and butter, will furnish the best solution to solve the fisheries problems. Limited entry on a declining resource – be it salmon or some other species of fish – if applied equally to all fishermen in order to conserve, maintain, and rebuild the resource, is not only desirable but necessary.

Limited entry to protect the economy of some fishermen while excluding others seems to us a reversal of the free enterprise system under which we have lived and worked throughout the history of the United States.

We have always maintained there can be no ownership of any fish until the fish are actually caught, at which time the catcher becomes the owner. Limitations on licenses would, in effect, confer ownership to those who are licensed, because non-licensed citizens could not participate in the harvest. Therefore, limitations based on economics seem to us to raise serious legal questions, not to mention the possibility of political repercussions.

To safeguard the economy of some fishermen in the manner proposed by license limitations, is an exceedingly narrow procedure and one which cannot significantly provide meaningful solutions to the over-all problem – that of providing a stable fishery economy and a dependable supply of fishery foods.

We have to recognize that not all fishermen can participate in the harvest of a specific resource. There must be a diversified fishery, in which fishermen finding it unprofitable to make a living in one area can transfer to another area and fish on another resource. Part of our planning for the future must be to provide such opportunities, thus relieving pressures in areas where there is a need to impose limitations. We must point out that such opportunities will not be available to our American fishermen unless we can safeguard our coastal fishery resources more adequately than we have been able to do so far.

Salmon is an anadromous fish – one which after leaving coastal waters, heads for the open ocean to feed and grow until its return to its coastal spawning area. Thus, the salmon are not only subject to fishery pressures in the inside waters, but are even more susceptible to pressure from foreign fishermen outside our territorial limits.

We believe in limited entry, but under present circumstances the limited entry principle should be applied to foreign fishermen fishing off our coast rather than to American fishermen who have sacrificed considerably in trying to maintain the necessary spawning requirements. The same argument holds true for other species of coastal stocks of fish which can be destroyed by foreign fishing outside of our territorial waters. We have struggled with this problem for several years and have been able to place limitations to some extent on some stocks of salmon. An example is the North Pacific area where the United States, Canada, and Japan entered into a treaty which placed a line of abstention of 175 degrees W longitude. The Japanese have been restricted from doing any salmon fishing east of the line; consequently, over the life of the treaty, they have been limited to a considerable extent in their take of North American salmon. While their take of Bristol Bay salmon has been in the neighborhood of from 25% to 28% of the allowable catch, were it not for the treaty, their take would have been much larger and could have threatened the life of the resource itself.

During the Law-of-the-Sea Conference held in Geneva, Switzerland, in 1958, there was a strong recognition on the part of most of the world's nations that a coastal state should have the right to impose conservation rules in its offshore waters to protect stocks of fish. While this convention (the Convention dealing with Conservation of the Living Resources of the High Seas) has been adopted by the necessary number of nations, unfortunately, Japan and Russia, which are presently putting the heaviest pressure on our fisheries resources, have not as yet agreed to ratify the convention. Thus, we have no legal way to compel these two nations to agree with us on specific conservation regulations, which would have placed some restrictions on them. It is true we have been able to agree on certain measures, not by treaty, but by executive agreements. Unfortunately, these unilateral understandings have not been satisfactory. For example, some years ago the Russians overfished the Pacific perch stocks in the Newport, Oregon area, and while they agreed to abstain from fishing in this area for the time being. It is going to take many years before the stocks are back to normal. This type of conservation is not in the interests of the American fisherman, who has no guarantee that after abstaining and rebuilding the stock, it will not again be harvested by foreign fishery fleets.

It appears to us that as 12-mile limit cannot protect our fishery stocks and, in the case of salmon, there should actually be a complete ban on high seas fishing. In dealing with the question of coastal fish stocks, we believe that to provide adequate conservation, we must have management control. We cannot have management control without having jurisdiction. In our opinion, meaningful jurisdiction would include extending our present fishery limits to the edge of the continental shelf or to a point where our coastal stocks extend out into the ocean. The continental shelf in its present form provides for absolute ownership of sedentary species, but does not include free-swimming fish above the shelf.

We realize there are many difficulties to be solved before obtaining such jurisdiction as we have proposed herein. It would not be our idea to completely exclude foreign fishery fleets from fishing on stocks of fish which we ourselves may not utilize to an appreciable extent at this time. Rather, our thinking would be that having the jurisdiction, we can license foreign fisheries. Should a violation of conservation principles occur, the license could then be revoked; thus, we would have the management control we need to maintain the stocks on a sustained yield basis.

We cannot afford to live in a dream world, thinking we are going to be able to safeguard our coastal stocks under present agreements and regulations. The reports we receive indicate that between Russia and Japan, billions of pounds of fish are taken annually in the waters off Alaska and the Pacific Coast states. These totals are increasing year by year. We are not naive enough to believe there will be a significant slowdown by either Russia or Japan, unless such is forced upon them by actions of the United States.

Arguments have been raised on the rights of a coastal state to limit fishing in so-called international waters. The Geneva Conference on the Law-of-the-Sea recognized the right of all nations to fish in international waters, but with the limitation that such fishing must comply with conservation principles. Otherwise, the right to fish would be a right to destroy. It was with this in mind that the convention dealing with Conservation of the Living Resources on the High Seas was adopted. Therefore, we do have recognition that a coastal state should regulate its coastal fishery, and if this cannot be done under the convention as we had anticipated, it must be done by extending our fishery jurisdiction.

We cannot protect salmon, anadromous fish, by a narrow strip of jurisdiction along our coast. Salmon should not be fished on the open ocean under any circumstances. We consider the high seas fishery, now conducted by Japan, as exceedingly wasteful. They are taking immature salmon which would more than double in weight upon reaching coastal waters. Also, there can be no segregation of races on the high seas; consequently, while the take of a specific number of salmon may not hurt the over-all resource, it could seriously deplete or destroy a single river run. Moreover, many of the salmon caught in the gillnets on the high seas wash out and are lost to either processing or spawning. Others go through the nets and, in doing so, are more or less descaled – which eventually incurs additional fatalities. Nets are also torn loose and drift around in the ocean, continuously fishing and destroying salmon. Rather than continue this practice, we believe the countries most interested – namely, United States, Canada, Russia, and Japan – should agree to halt high seas fishing for salmon, with suitable arrangements worked out to take care of each country's interests.

The problems dealing with our fisheries are many and complex. We do not claim to be right in every instance, but we felt that we should air our ideas on this subject so the Sea Grant Conference will know where we stand. We also believe our ideas reflect the opinion of most of the fishermen on the Pacific Coast.

Limited entry should be applied to foreign fisheries now depleting our coastal stocks.

George Johansen

Research: Engineering and Mineral Resources

John B. Herbich
Department of Civil Engineering, Texas A and M University
College Station, Texas
J. Robert Moore
Marine Studies Center, University of Wisconsin
Madison, Wisconsin

ENGINEERING RESOURCES

The following introductory remarks are brought forward to suggest areas of research which could be partially supported by the Sea Grant Program to foster development of marine resources.

The Oceans cover the greater part of the globe; they afford a wealth of food and chemicals; we spend many millions every year improving our use of them; we prospect for the minerals they have deposited; they are an important part of a machine which controls climate and rainfall, and it is no exaggeration to say that our dependence on them increases with the growing world population and standard of living.

Activities and interests in the Oceans are continuing to grow rapidly within both the United States and the international community. The President's Commission on Marine Science, Engineering, and Resources, formed in January, 1967, has undertaken the tasks of examining the Nation's stake in the marine environment; assessing the adequacy of scientific activities in meeting national ocean goals; formulating a long-term national program for marine sciences; and recommending a plan of governmental organization.

The commission's older sister, the National Council on Marine Resources and Engineering Development, is composed of five cabinet officers and three department agency heads having significant maritime-related activities, and is chaired by the Vice-President.

Although their areas of interest often overlap, the Commission and the Council (at least according to government spokesmen), bring different approaches to the problem, and have different responsibilities. The Council is directly concerned with current matters and has major responsibility for co-ordinating federal marine programs and for initiating new federal activities. The Commission is free from operating responsibilities and provides an independent assessment of the national effort in marine affairs. So much for the government planning and activities (with the exception of NSF involvement in the Sea Grant Program).

The oceans exchange energy with the air above in many subtle and interesting ways. In receiving energy from the sun, the evaporation of sea water and its later condensation into rain, reradiation to the atmosphere and transport by atmospheric and oceanic circulations constitute a heat engine which determines geographic climate and weather on our planet. As we learn more about it, we should be able to harness their vast potential for our own uses. We are expending the non-renewable resources of the land at an ever-increasing rate. The biological and chemical resources of the ocean, on the other hand, renew themselves naturally.

At this point, one may ask a question: What is coastal and ocean engineering? My own definition for coastal engineering involves all those engineering activities along the shore, in the estuaries, and offshore to the limits of the continental shelf, say to the depth of 600 feet in the case of the Gulf of Mexico (or extending between 55 miles out from the shore at Port Isabel to some 100 miles offshore from Galveston). Ocean engineering involves all activities in deep water outside the continental shelf.

Why do we observe such feverish activity in coastal and ocean engineering today? The oceanographers have been patiently collecting data about the oceans for many years. Why, all of a sudden, such interest? Why do engineers suddenly find themselves working in the oceans? Until recently, we were satisfied with the meager data from the ocean, principally because we did not have to design any structures or other works in the ocean. The civil engineers, of course, have long been designing sea walls and breakwaters along the coast.

Let us look at some of the engineering activities in the ocean. The activities were spurred by the search for oil offshore, with oil companies going into deeper and deeper water. The structures were built sometimes without suf-

ficient data and without adequate knowledge because there were no engineers available who had experience to design such structures. The exploration for and exploitation of oil mushroomed in recent years. The oil companies were designing structures for 600 feet of water and have already built structures to 300 feet.

It is estimated that considerable quantities of minerals, such as shells, iron sands, tin, diamonds, gold, silver, platinum, manganese, titanium, sulphur, etc., are present at the bottom of the ocean waiting to be recovered. It is generally agreed that the only economical way of recovering minerals from the ocean floor is by means of suction dredging. It is anticipated that we will start mineral recovery first from the continental shelves and then, as our methods are perfected, we will be able to dredge from greater depths. However, one should realize that dredging from a 15,000-foot depth may be compared with suspending drinking straws in a single line from the Empire State Building and applying sufficient vacuum or pressure to pull the water from a pond at the foot of the building. I believe that we now have the engineering know-how to dredge minerals from the 15,000-foot depth; however, it may not be very economical to do so at present. Several large corporations have been conducting feasibility studies, but the results of these studies have not been released.

One other activity involving dredging equipment which will perform efficiently at greater depths is the need for deeper harbors. The Japanese are now constructing vessels which have drafts of over 75 feet. Most of the large harbors in this country have channels maintained at 36-to 40-foot depth. One may say: Well, why unload those big tankers in a harbor? Why not provide an offshore unloading platform constructred in 80- to 100-foot depth. I can foresee this as a distinct and economical possibility. In Europe, the sand and gravel industry is being forced to move to the deep sea to find sufficient deposits.

Increase in leisure time, greater mobility of people, all contribute to expanding demands for recreational areas. Beaches provide a very desired type of recreational activity. Beach replenishment, particularly on the east coast of the United States as well as in other parts of the world, presently demands low-cost, deep sea dredging for sand to rebuild the eroded beaches. Recently, an experiment was conducted by the Corps of Engineers off the New Jersey Coast where a sea-going dredge removed material from a depth of about 30 feet and discharged it directly on the beach. Other experiments may be conducted to dredge from a 55-foot depth and discharge at, say 10-foot depth, permitting the waves to carry the material to shore. Recently an underwater dredge mounted on a tractor has been undergoing sea trials off the coast of Florida.

Other new developments involve the construction of two-man submarines and underwater crawlers for a variety of uses, such as tracking ocean bottom cables, conducting research on underwater acoustics, collecting mineral samples, dredging a trench in preparation for laying of a pipeline, etc.

The Navy is engaged in a variety of ocean engineering activities. Due to lack of time, I will not elaborate on these, but only mention the following activities:

a) Undersea vehicles – an effort is made to provide the operating forces with undersea search, rescue, and salvage capabilities. Undersea vehicles, manned and unmanned, are being considered for use in underwater construction. Deep submergence rescue vehicles are being developed which will carry men to depths to 20,000 feet. Such a vehicle will have a rescue capability of up to 24 men at a time.

(b) Undersea installations – prototype underwater manned installations are planned to develop construction techniques, equipment, and methods. The most promising shape for a manned underwater station has a toroid hull.

(c) Sub-bottom stations consist of a series of rooms, excavated within the bedrock beneath the sea floor with access to land surface and with access to the ocean through an air-water lock system, or a lock system which would permit temporary mating of the submersible to the installation.

(d) Construction tools must be developed for deep ocean operation.

(e) Structural materials must be developed for deep submersibles and for underwater habitats. The most promising materials for depths greater than 15,000 feet are glass-reinforced plastics having compressive strength of over 200,000 psi.

Now, let's look briefly at manpower. Engineers from many disciplines are desperately needed to become ocean engineers. Since very few ocean engineers have graduated from the universities to date, civil, mechanical, electrical, electronics, materials, and industrial engineers are gradually, through training-on-the-job, becoming ocean engineers. It is an exciting field, a rapidly developing field, and almost any graduate engineer can become involved in it.

I would like to end this part of the presentation with a quote from the Report of the President's Council on Marine Resources and Engineering Development: "The major challenges which lie ahead of this Nation do not terminate at the water's edge. Neither do the solutions."

"The time is ripe to apply our knowledge of the sea. To be sure, there is much that we still do not know – this will always be true – but we know more of the sea than our actions towards exploitation might suggest. The technology is ready – new structural materials, miniaturized electronics, computers, nuclear power, and underwater vehicles are available. These tools await utilization."

Research Needs

A large segment of our population and industries are encompassed in the coastal area of our nation. The greater bulk of our foreign commerce and a large part of our

interstate commerce is carried by the ships using these waters, and provisions of safe and adequate channels are necessary for this shipping and much of this industry. Also the protection of the area from ocean storm surges and tsunamis is a widespread need. The preservation of the shore against destructive erosion, provision of adequate beach areas and for small-craft recreation are also problems associated with this area.

The great increase in the draft of vessels since World War II has created problems in the establishment and maintenance of the channels. Channels with natural depth in the order of 10 or 15 feet are being dredged and maintained at 40 to 55 feet; the resulting rate of channel shoaling may be excessive unless the project is carefully designed. Also the larger depths permit the saline ocean waters to intrude farther into the tidewater zone; this intrusion may be disastrous to fish and wildlife in the area and may pollute the fresh water supplies for the industries and communities in the area.

In a similar fashion, since World War II there has been a rapid development of shore line for homes and recreation. Shore erosion and storm tides which attracted little attention a decade or more ago are now in the nature of national disasters. Offshore work has been increasing rapidly, mainly for recovery of oil and gas. Accidental oil spills at sea produced disastrous results in several cases.

More precise engineering knowledge is needed to meet these new and increasingly more complex problems. Solutions presently being worked out are the best that can be done with existing knowledge and techniques. However, there is little doubt that the solutions could be improved through research and the costs of research saved many times over.

The overall program in ocean engineering can be divided into studies in fourteen basic categories, each category bearing in varying degrees on the general elements of navigation, shore protection, offshore, and deep ocean problems. These fourteen categories are as follows:

Wave Action in the Coastal Zone
Generation of waves in coastal waters
Transformation of waves by bottom effects
Transformation of waves by coastal currents
Development, installation, and operation of improved ocean wave recording equipment for statistical purposes
Compilation and spectrum analysis of ocean wave records
Determination of design waves and their frequency of occurrence
Wave kinematics in the surf zone
Origin and effects of long-period wind waves
Magnitude of wave-generated shore currents

Shore Processes
Quantitative relationship of wave characteristics and alongshore wave transport
Quantitative relationship of wave characteristics and onshore-offshore sand transport
Detailed study of effect of storm wave action on inshore hydrography
Basic mechanics of sand transport by wave action
Sand transport and dune formation by wind action
Interrelation of factors shaping a natural beach
Cause and probable future of major coastal features
Growth and stabilization of dunes

Tides and Surges
Storm surge generation, travel, and dissipation
Tsunami generation, travel, and dissipation
Effect of shore configuration on tide and surge ranges
Mechanics of tidal flow in inlets
Mechanics of tidal flow in estuaries
Mechanics of edge waves and pressure-coupled waves

Inlet Studies
Inlet hydrography as affected by tidal flow, freshwater flow, and littoral drift
Effect of short storms and prolonged storms on inlet hydrography
Normal migration of inlets, including bar channels
Basic study of characteristics of salinity currents and of their effects on inlet hydrography
Salinity intrusion as related to bar cross-section and depth
Evaluation of factors affecting rate of shoaling of bar channels
Study of tidal currents in inlets and their relation to tidal heights and times and to inlet hydrography
Inlet bars as a repository for littoral drift
Inlet channel maintenance by removal of inner bar

Estuary Studies
Estuary hydrography as affected by tidal flow, freshwater flow, and sediment characteristics
Effects of changes in basic freshwater flow on estuary regime
Effect of entrance cross-section and depth on salinity intrusion
Effect of floods and prolonged low-water flows on salinity intrusion and flushing
Effect of salinity on shoaling of estuary channels
Relation of channel depth to rate of channel shoaling
Study of the current distribution throughout an estuary
Recirculation and flushing of pollutants

Structure Design in the Coastal Area
Wave forces
Shock pressures
Wave run-up and overtopping
Uplift pressures
Mooring stresses

Underwater foundations and bearing
Effect of waves and currents on submerged pipelines
Structure life
Structure stability
Design of filter layers

Effects of Actions by Man
Effectiveness of permeable, impermeable, and adjustable groins
Effectiveness of various types of seawalls and bulkheads
Effects of piers on adjacent hydrography
Effects of jetties on coastal hydrography and channel maintenance
Effects of breakwaters on coastal hydrography and wave action
Effectiveness of various projects for transferring sand past inlets
Effectiveness of various beach sand replenishment projects
Shoaling and maintenance of existing jetty channels
Wave forces on shore structures
Wave run-up and overtopping of shore structures
Improvements in dredging methods

Submerged Structures, Underwater Habitats, Underwater Pipelines
Wave forces on submerged oil tanks
Wave forces on underwater habitats
Foundations for submerged rest-on-bottom structures
Attachment of structures to the bottom
Forces on submerged pipelines
Scour around submerged pipelines
The design of underwater structures

Perfecting of Improvement Methods
The design of fixed coastal protection structures
The design of jetties and jetty channels
The design of breakwaters and harbors in the coastal zone
The design of channels and channel training works in tidal estuaries and inlets
The design of sand by-passing plants including measurements of rate of transfer
Wave forces on shore structures
Wave run-up and overtopping of shore structures
Design of improved maintenance equipment, including dredges

Oil Spill Containment and Recovery of Oil
Mechanical barriers
Pneumatic barriers
Chemical methods
Design of barriers

Knowledge About the Interaction of Humans with the Ocean Environment
"Saturation" diving
Biomedical systems to provide life support, health maintenance, and environmental control
Human factors and performance

Knowledge About the Transfer and Communication Characteristics of the Ocean
Principles of underwater acoustics
Electroacoustic technology
Acoustics of submerged structures

Knowledge About Operational, Instrumentation, and Other Hardware Capabilities Within the Ocean
Capabilities of research submersibles
Undersea installation
Salvage (diving and lifting systems)
Performance characteristics of measuring devices (transducers, operation amplifiers for measurement and control manipulation, transmission and recording of data)
Timing and digital counting systems
Data processing techniques

Knowledge About the Behavior of Materials Within Ocean Environment
Properties of materials (metallic and non-metallic solid, laminated, and composite)
Corrosion of materials (chemical, electrolytical, and biological)
Suitability of materials for static structures
Suitability of materials for submersible vehicles

The following breakdown lists the specific information and data needed to advance on the ocean engineering problems set forth.

A. Information and Data Contributing to Shore Protection and Beach Restoration Activities
   1. Forces Attacking the Shore
      Quantitative data on and understanding of natural forces causing shore erosion
      a. Meteorology
         Quantitative synoptic wind data over seas surrounding U.S. as basis of wave prediction
      b. Wave Action
         Synoptic data on wave action around U.S. coast plus ability to predict critical characteristics
      c. Tide Action
         Knowledge of tides and tidal currents as they effect movement of coastal sediments

d. Wind Action

Synoptic wind data as related to wave and current generation, and sand dune formation

e. Wave Dynamics

Turbulence and forces associated with waves breaking on shore and impinging on shore structures

2. Reaction of Shore

To understand and predict the change in the coastal zone due to natural forces of the sea

a. Alongshore Drift

To equate the quantity of alongshore littoral drift of sand to the characteristics of the impinging waves

b. Onshore-Offshore Drift

To establish the relation between sand characteristics, wave characteristics, and the onshore-offshore cycles of sand movement

c. Shore Irregularities

To determine cause and quantitative significance of irregular shore formations such as bars, cusps, tombolos

d. Inlets and Estuaries

Reliable means of determining interrelation of sand movement pattern at inlets and estuaries and the erosion and accretion of adjacent beaches

e. Dunes

Establishment of relation between dune formation and deterioration and the local wind pattern. Also data on dune stabilization by vegetation

f. Beach Profiles

Ability to predict short-term changes in beach profiles as a result of changes in incident wave pattern

g. Shoreline Changes

Complete coverage of U.S. coast to show long-term changes (5 to 100 years) in position of shoreline

3. Improvement Methods

Most effective design of improvement projects with understanding of their benefits and adverse effects

a. Groins

Reliable guides for selection of proper groin sites, spacing, length profiles

b. Seawalls and Bulkheads

Reliable guides for selection of location, crown elevation, surface shape, and foundation requirements

c. Breakwaters

Reliable guides for selection of location, crown elevation, surface shape, and construction features

d. Beach Restoration

Reliable guides to set the berm height, berm width, surface slope, and sand-size composition

e. Beach Nourishment

Reliable guides for predicting the future nourishment requirements of beaches and the most effective scheduling of such work

f. Sand By-Passing at Inlets

Selection of most economically efficient type of by- passing arrangement whether fixed or floating plant

B. Information and Data Contributing to Protection From Flooding by Storm Surges and Tsunamis

1. Storm Surge Dimensions

Reliable, accurate estimates of height, duration, and frequency of occurrence of storm surge

a. Meteorology

Definition of the storm wind patterns characteristic of a given area together with their frequency of occurrence

b. Dynamics of Generation

Accurate routing of surge to shore from deepwater by defining effect of shallow water in increasing surge height

c. Transmission to Shore

Accurate routing of surge to shore from deepwater by defining effect of shallow water in increasing surge height

2. Storm Surge Action at Shoreline

The surge dimensions to be used in designing protective structure or developing evacuation plan

a. Surge Run-Up

Setting of crown elevation of seawalls and dikes to protect shore area

b. Surge Overtopping

Reliable estimation of surge water flooding over protective structures of insufficient height

c. Surge Propagation
Calculation of movement of surges through inlets and into bays and estuaries and of resulting heights in these waters

d. Diffusion
Accurate estimates of effect of surge blocking constrictions on flushing characteristics of protected bays or estuaries as related to pollution and fish life

3. Tsunami Dimensions
Reliable estimates of tsunami heights to be expected in deep water in various ocean basins

a. Dynamics of Generation
Establish relation of tsunami characteristics and magnitude to earthquake type and magnitude

b. Earthquake Characteristics
To determine the types and magnitude of earthquakes associated with the various ocean basins

c. Transmission to Shore
A quantitative understanding of the alterations of tsunami heights and characteristics from shore to shore

4. Tsunami Action at Shoreline
The tsunami dimensions to be used in designing protective structures or developing evacuation plans

a. Tsunami Run-Up
Determination of height of run-up of tsunami on shore or on protective structures

b. Tsunami Overtopping
Accurate estimates of quantity of surge water, which will overtop protective structures of insufficient height

5. Design of Improvements
Development of reliable guides for selection of design criteria for protective work

a. Storm Rainfall
Estimation of floods entering bays and estuaries coincided with storm surge as guide to selection of ponding and pumping capacities

b. Tides, Waves, Surges
Accurate estimation of probability of concurrence of high tide, peak of surf, and peak of wave action

c. Wave and Current Forces
Reliable calculation of structural requirements to resist wave and current forces accompanying surges

C. Information and Data Contributing to Navigation Channel Development in Estuaries and Inlets

1. Channel Location
To select most economical site and alignment consistent with ship safety and required depth

a. Wave Action
Statistical coverage of U.S. coast to define wave heights, periods, and directions

b. Tide Action
Knowledge of tidal currents as they effect channel shoaling and ship handling

c. Sediment Movement
Definition of movement of fine and coarse sediments by tides and currents

2. Channel Dimensions
To provide safe channel depths for shipping with minimum adverse side effects

a. Salinity Intrusion
Understanding of relation of channel depth and width to intrusion and saline waters into inlets and estuaries

b. Flushing
Information on effect of inlet channel enlargement or restriction on flushing cycles for pollutants in bays and estuariies

c. Inlet Hydraulics
Definition of relationships between tidal flow, jetty spacing, and stable depths at inlets

d. Tidal Propagation
Reliable prediction of effects of altered tidal prism on shoaling and mean sea level elevation in coastal channels

3. Shoaling Processes
Prediction of shoaling rates that will result from establishment of new channels or modification of existing channels

a. Sand Movement
To determine the laws relating sand movement to current velocity in the coastal area, particularly in the zone of wave action

b. Floculation
Prediction of floculating rates as affected by sea water mixing with silt-laden fresh water

c. Silt Movement
To relate movement of silty bottom materials to currents and surface waves

d. Sources of Shoaling
Reliable estimates of movement of shoal material into the coastal zone from inland or offshore

4. Improvement Works
Improvement in the effectiveness and durability of control work such as breakwaters and jetties

a. Chemistry of Seawater
Determination of chemical and electrolylic actions which cause deterioration of materials of construction

b. Physical Forces
Evaluation of wave pressures, current forces, and wind forces impinging on coastal words

c. Biological Effects
Adaptation of findings on marine borers to more effective use of wood and concrete in marine waters

d. Siting
More effective siting of control works as to location and dimensions, including dredging and spoiling locations

D. Information and Data Contributing to Design of Offshore Structures

1. Dynamic Forces
Development of reliable guides for selection of design criteria

a. Wave Action
Accurate estimation of forces due to surface waves and their probability of occurrence

b. Current Action
Estimation of forces due to current at a given location and depth

c. Tide Action
Estimation of forces due to tidal action

d. Wind Action
Estimation of forces due to wind

2. Fixed-on-Bottom Structures
Development of reliable and economical design criteria

a. Dynamic Response
Development of mathematical models to predict dynamic response

b. Foundation
Quantitative data on soils. Understanding of soil foundation characteristics

c. Structural Design
Development of computer-aided designs

3. Submerged Structures
Development of reliable and economical design criteria

a. Buoyancy
Information on buoyant behavior of large submerged oil tanks

b. Attachment to Foundation
Information on pull-out forces and soil foundation

c. Structural Design
Development of computer-aided designs

4. Floating Structures
Development of reliable guides for selection of design criteria

a. Floating Stability
Calculation of floating stability under design wave, current, and wind conditions

b. Mooring Forces
Accurate estimation of mooring forces

c. Structural Design
Development of computer-aided designs

5. Materials
Development of corrosion-resistant materials for offshore structures

a. Metallic
Information on effect of saline water, temperature, ice, and marine organisms on various metals

b. Non-Metallic
Information on effect of saline water, temperature, ice, and marine organisms on various non-metallic materials

E. Information and Data Contributing to Oil Spill Containment Devices

1. Wave and Current Characteristics Development of reliable information on design waves, wind, and current conditions

a. Waves
Reliable information on wave characteristics at a given location and at a given time

b. Wind-Generated Currents
Estimation on wind-generated currents at a given location and at a given time

c. Tide-Generated Currents
Reliable information on tide-generated currents at a given location and at a given time

2. Oil Set-Up by Wind
Development of accurate information for different oils

a. Magnitude and Shape of Oil Set-Up
Information on magnitude and shape of oil set-up as a function of wind velocity and oil characteristics

b. Effect of Current
Knowledge of effect of current on oil set-up

c. Effect of Waves
Knowledge of effect of waves on oil set-up

3. Oil Set-Up by Current
Development of accurate information for oils of different specific gravities and viscosities

a. Head Region
Information on oil water interface

b. Intermediate Region
Estimation on shape of oil-water interface

c. Set-Up Against a Mechanical Barrier
Accurate information on oil set-up and draining action at a barrier

4. Mechanical Barriers
Development of an effective mechanical barrier to contain oil at sea

a. Mechanism
Accurate estimates of forces on floating barriers

b. Towing or Mooring
Estimation of towing or mooring forces required at sea

c. Oil Skimmers
Development of effective oil skimmers for use at sea

d. Deployment Methods
Development of efficient deployment methods

5. Pneumatic Barriers
To develop a most economical and effective pneumatic barrier to contain oil at sea

a. Behavior of Pneumatic Barrier at Sea
To determine the effectiveness of pneumatic behavior at sea

b. Effect of Current
To evaluate effect of current on performance

c. Effect of Waves
To evaluate effect of waves on performance

d. Design Characteristics
To develop such design information as orifice size, pipe size, number of orifices per foot, depth of submergence, etc.

e. Power Requirements
To determine the air discharge and power requirements

6. Chemical Dispersants
To develop effective chemical dispersants not harmful to marine life

a. Mechanism
To evaluate the mechanism of dispersion of oil and its final disposal

b. Effectiveness
To estimate oil removal characteristics

c. Ecological Consideration
To evaluate the level of toxicity of chemicals to marine life in shallow and deep water

d. Application Methods
To develop efficient methods for applying chemicals under wave, current and wind conditions at sea and nearshore

Improved instruments are needed to make measurements such as the following:

1. Wave heights in ocean waters

2. Wave direction in ocean waters

3. Wave forces on structures
(a) shore
(b) offshore
(c) submerged

4. Sand transport by waves

5. Sand transport by wind

6. Current velocity and direction in estuaries

7. Salinity and pollution factors in estuaries

8. Oil spill containment in estuaries and at sea

In the equipment and instrument development phases of the program, it is important that advantage be taken of the new materials and techniques as they become available from such as the aerospace programs.

Acknowledgement

This summary was based on a talk given by J. B. Herbich to the Texas Society of Professional Engineers on May 8, 1968, and on a draft of an ASCE Waterways and Harbors Division Research Committee prepared in 1964.

J. B. Herbich

MINERAL RESOURCES

In regard to mineral resources, we have interpreted the statements and implications put forth by the Sea Grant Act to mean that each Sea Grant institution would explore for new mineral resources in regional areas of interest where the research was geographically oriented. Topical mineral problems may be pursued by the institution on the basis of its own research staff interests and special facilities. From our talks with a very few of the Sea Grant mineral resources investigators elsewhere, this framework of investigation seems to be generally agreed upon. Beyond this point, each institution appears to have its own ideas, dictated by local needs and industry response, as to what particular mineral problems it will pursue, and precisely how it will go about researching them. Such "institutional individuality" seems to us, at least, a desirable quality in Sea Grant mineral research, and I suspect that such is also encouraged from the Sea Grant Office in Washington.

Unlike certain other program and project fields under Sea Grant, e.g., fisheries, water quality, and social problem areas – where the Sea Grant response is much more obvious – the initial efforts in developing mineral resources research had to receive significant direction through expressions of need from the minerals industry community. At Wisconsin, we made it an early matter of business to establish direct liaison with a host of companies. These include some mining in the Great Lakes region, some engaged in petroleum exploration elsewhere in sovereign or shelf waters, and some who have world-wide operations in both hard and soft minerals. In many of the early conversations with industry personnel, we received candid observations as to how Sea Grant could help, appropriate disciplines to be included, and very frank statements regarding proprietary areas where the company should take the initiative. Fortunately, our ideas and the industry ideas on our respective areas of effort are much the same. I did receive many compliments on the Sea Grant Program, its purpose, and its goals from management officers, as well as from industry scientists with whom we would work in any cooperative ventures.

Problems in Sea Grant Mineral Research

Unquestionably, we in mineral resources research under Sea Grant sponsorship have many of the same day-to-day problems that our colleagues in other programs have, e.g., securing trained personnel, availability of research assistants, shipboard operations, adequate funding, and keeping research centered on the dollar targets. We also have several problems peculiar to mineral resources exploration, or at least highly critical to such work. Inasmuch as our own program at Wisconsin has encountered several of these special problems in our manganese work, it occurred to me that these problems could well form the basis for part of our discussion today. I present these as a series of 10 questions which we may wish to consider for the benefit of all attendees. They are as follows:

1) Do Sea Grant sponsored exploration teams compete, in an economic sense, with exploration teams fielded by industry? (This question was asked of me by at least four key management personnel.)

2) What legal safeguards would Sea Grant provide for industry and/or government to ensure that any mineral discoveries made by a university team would not be used to a personal advantage?

3) Some states require that a legal Offshore Prospecting Permit be issued to engage in an offshore minerals search. Is such a permit required also of Sea Grant sponsored "academic" searches?

4) What is the best way to disclose economically important information to the public, particularly the minerals industry, when Sea Grant research turns up clues to mineral deposits?

5) Some states and certain governmental agencies require an industrial team to submit their exploration plans in advance. (This is frequently done to avoid harmful methods, such as preventing explosives used in geophysical profiling from killing fish, etc.) Although not a commercial venture, but still a minerals search effort, must a Sea Grant sponsored team be required to meet the same demands as industry?

6) At what point in the discovery of a possible mineral resource, and in the initial stages of its development, does the academic program stop and industry take over?

7) Is the *finding* of potentially valuable mineral deposits the objective, or should Sea Grant engineers and economists add their part by recommending new techniques for mining a particular deposit, and new commercial and business approaches?

8) In light of the traditional proprietary attitude taken by mineral companies, is it possible to effect true cooperative projects between Sea Grant and industry?

9) How should the Sea Grant minerals researcher bring his observations, findings, and opinions to those preparing legislation governing exploitation of offshore resources?

10) Is a conflict developing between those who search for mineral deposits beneath the sea and beneath the Great Lakes – the "multiple use of environment" group – and that group concerned with pollution control and conservation? Such a conflict must surely involve any Sea Grant mineral project just as it does any commercial exploration.

These questions are real ones. They are brought to this discussion session with the hope that some answers, some suggestions, and some fruitful approaches may be brought forward by our several Sea Grant enthusiasts here today.

J. Robert Moore

Research: Food Science and Biomedicinals

George M. Pigott

College of Fisheries, University of Washington
Seattle, Washington

Heber W. Youngken, Jr.

College of Pharmacy, University of Rhode Island
Kingston, Rhode Island

FOOD SCIENCE

We are all completing our second year of participation in the Sea Grant program. The original intent of the Sea Grant Program was to emphasize technology as well as the extension and advisory phases of the marine industry. Many of us feel that the distribution of funds under the program has not been in keeping with this original intent. It is the purpose of our panel today to review the program of food science research and to stimulate ideas on improving the future of our phase of the Sea Grant Program.

I personally feel that the entire Sea Grant Program has lost much of its effectiveness through two factors, namely: 1) late allocation of funds and 2) dilution of available funding in trying to please the myriad of organizations that desire participation. A poorly funded research program is little better than no program at all. I hope that during this session we not only review progress to date, but take a good look at where the money is being spent. We should ask ourselves whether fewer programs of major impact would not be better than numerous programs of either minor importance or so poorly funded that significant progress is impossible.

At the University of Washington I have been involved in a pet project that we call the TUC program (Total Utilization Concept). Whereas the original funding allowed for necessary equipment, supplies, and an adequate research staff, the actual funds made available (usually well into the year) are hardly more than enough to support a graduate student in a minimal research effort. In order to make the progress that has been noted in this program, we have been forced to encroach on personnel time and facilities normally allocated to non-Sea Grant programs. I would like to know if others are having this same type of trouble in their food science research. If so, let's use this conference as a means of formulating strong recommendations for future funding of the technological programs so clearly given preference in the original Sea Grant Act.

George M. Pigott

BIOMEDICINALS

It is popular to refer to "biomedical aspects of the oceans" in more specific terms as "drugs from the sea." The search for new drugs from marine sources is an important objective in the many goals of the National Sea Grant Program.

Man's interest in sources for new medicines dates back to antiquity. Although a large drug armentarium has accrued over the ages, the search for better chemotherapeutic agents continues. This quest will continue as long as disease prevails and people react unfavorably to environments.

The life of the oceans and, indeed, sea water too, has been a source for therapeutic agents since the beginning of mankind. Although relatively few life-saving drugs from marine sources are used today, there is definitely a rejuvenation of interest in exploring ocean resources for new medicinals.

It is also popular to speculate on how well man will master the formidable ocean environment in his future search for potentially useful biomedicinals. Terrestrial organisms and the synthetic hydrocarbons of the test tube can be procured for drug studies with relative ease. An abundance of difficult problems in ocean hunting remain to be solved before sufficient amounts of materials are ready for study at the research bench.

The topics for discussion today could very well deal with countless problems related to the development of marine pharmaceuticals. Our task, however, is to discuss the role of the National Sea Grant Program in this research. Both applied and basic marine research are involved since

achievement of any success will depend upon interaction.

In order to better understand the significance of Sea Grant participation and its impact on the development of marine biomedicinals, we should know the purpose of the program and the criteria for participating in it. We must be familiar with its goals and its limitations. Finally, it would be helpful to know what affect the program has had to date on the progress of the search, although this national program is still very much in its infancy.

The Purpose: It was the obvious purpose of the original Pell-Rogers Act of 1965 (PL.89-688), which established the National Sea Grant Program, to promote a better use of the resources of the oceans; to catalyze more scientific and technological study and the training of personnel for the development of ocean resources; and to work out the problems of oceanography that are of mutual interest to the United States and other nations of the world. Like the Morrill Act of 1862, which established the Land Grant College programs in the several state universities for development of agricultural resources, the Pell-Rogers Act established a Sea Grant College program for developing sea resources. It began under the administrative guidance of the National Science Foundation as a very broad, almost open-ended, program. It has thus far encouraged several universities and certain of their faculties to establish their own priorities in marine research and development. The Sea Grant Program was also set up to encourage industrial research and development in collaboration with university and institutional marine endeavours. The basic objective is the promotion of applied research in this field so that mankind will derive a greater understanding of and more benefits from all ocean resources.

Criteria for biomedical programs under Sea Grant: A number of recent papers and reviews on the general subject "drugs from the sea," or marine pharmacology, can be found in the literature. Dr. Morris Baslow's new book *Marine Pharmacology* (M. H. Baslow, 1969, The Williams and Wilkins Company, Baltimore, Maryland, pp. 286) is referred to by the author as a "...short text prepared (for the subject) with utility in mind." For an old subject which has suddenly become new again, Baslow's text summarizes the literature well and attempts to assess the pharmacological potential of several marine natural products. One impression gained by reading this short text is the diversity of biological backgrounds represented by investigators whose research is described. The fact is that most would be regarded as ecologists, bacteriologists, biochemists, phytochemists, phycologists, or pathologists rather than pharmacologists in the strict sense of the word.

If one could bring more of these people from the basic biological disciplines together with pharmacologists, and vice versa, to attack the problems, I believe we could achieve much greater success. Furthermore, marine food technology, fisheries, marine resource economics, coastal zone and estuarine studies, aquiculture, ocean engineering, and a host of other marine research projects have aspects related to health problems. The understanding of certain basic and applied concepts in each will determine how successful man will be in developing sea resources. Collaboration of many persons in marine research was certainly an objective of the Sea Grant Act.

It seems to me that a major criterion in organizing a successful biomedical program under Sea Grant, is to integrate as much as possible with other marine areas. It should not be an isolated area of specialization holed up on a university campus without the opportunity for good interchange of ideas. The subject requires a good understanding of basic research as well as applied research.

By the same token, a biomedical program requires collaboration with other medical scientists and with clinicians, even though there has not yet been much need to call upon the clinicians. It should be organized to utilize expertise of other institutional laboratories, both governmental and industrial, for the most effective evaluation of marine compounds with potential biomedical use. One of the important goals of the university effort should be to get industry, especially the pharmaceutical industry, more active in marine biomedical research. It must be a team effort from the start of marine harvest through the period of clinical trial.

Another important criterion is opportunity for training. If the research program is well organized with staff and facilities, there should be provision for graduate study. Masters and Ph.D. programs in pharmaceutical science disciplines have long been established on many university campuses. Pharmacology, Pharmacognosy, and Pharmaceutical Chemistry specialties constitute natural areas for marine biomedical studies. The Sea Grant Program in these studies is one of the major concerns of the College of Pharmacy at the University of Rhode Island. The potential for a similar graduate program in pharmaceutical sciences is equally great at Oregon State and other universities with pharmacy schools and oceanography interests. Pharmacology departments of medical schools should also become more involved in marine research and training under Sea Grant Programs. There is already a solid academic framework in many of these schools, including college, departmental, and interdepartmental course offerings and research pertinent to the field which can be developed further for marine-related biomedical training. The author, in collaboration with two colleagues at other institutions, recently co-authored a paper on the subject of "An outline for a new course in marine pharmacognosy," (DerMarderosian, A.H., Youngken, H.W., Jr., and Halstead, B.W., 1968, Amer. J. Pharm. Ed.32: 219-245) as an effort to focus student interest in marine pharmacognosy and pharmacology.

The graduate program must, however, be interdepartmental, and it should draw upon several other related courses – marine ecology, biology, chemistry, oceanography, resource development, and the like. The trainee will

benefit greatly when he achieves familiarity with related aspects of the marine field. Pharmacology and the other medical and pharmaceutical sciences are not enough *per se* to equip the future marine biomedical scientist with the depth of knowledge necessary for his research. Indeed, it would be extremely desirable for those acquiring knowledge in the field of marine toxicology to also become thoroughly familiar with the problems of marine foods and nutrition. It is increasingly evident that food-drug interactions, which include marine foods, are important health problems. The Department of Food and Nutrition in the College of Home Economics, for example, is also a part of the University of Rhode Island's Sea Grant effort.

One cannot overstate the need for an effective training program in the entire Sea Grant effort. Without it the program will become sterile.

Results to date: Finally, I must mention the general results to date of the biomedical program supported by Sea Grant. The program is about 3 years old. If Dr. Robert Abel's statistics are correct as he described the situtation in his paper, "Drug Pushing in the Ocean," presented to the Food'n Drugs from the Sea Conference at URI, August 25, 1969, there is as yet little action by the research community. Despite the fact that we have all of the "ingredients" for rapid success, including relatively good sponsorship from government, there has been much more talk than action. Only about a dozen scientists seem to be publishing a substantial amount of work in this field. According to Dr. Abel, during the first 2-1/2 years of Sea Grant activity, the NSF office received "a grand total of three proposals" apart from an institutional grant (URI) to investigate drugs from the sea.

This lack of action is puzzling to many of us in view of the potential expressed by so many. It certainly can't be due to lack of publicity by the National Sea Grant Program or a dearth of review papers on the subject. At least 10 review papers have appeared in the literature since 1960, and each one expounds the potential of developing marine pharmaceuticals as though the seas were the salvation of man's search for new drugs. Even prestigious journals with market analyses draw attention to the potential of an increased research effort in marine pharmaceuticals.

In addition to the promotional efforts of the Sea Grant office, several members of Congress are supporting still another national marine pharmacology effort. This is the bill which originated in the Senate in 1969 as S.-1588, the Magnuson-Pell-Fong Bill, to establish a National Institute for Marine Medicine And Pharmacology as a component institute of the NIH. A companion bill has also been introduced by Representative Paul Rogers in the House. It is rather unfortunate that work at the reserch bench in this field is not keeping pace with those who are lobbying for the cause. There might be reasons, as yet unclear, for this situation. Part of the problem probably lies with the newness of the support program, and perhaps another rests with the cautious attitude of industry to become more involved.

The URI Marine Pharmacology-Pharmacognosy programs are closely associated with several other departments of the University's Sea Grant Program. Much of its success thus far is due to the "commonality" or interdepartmental activity in the URI Sea Grant effort. Six faculty members of the College of Pharmacy participate, two full time. There are currently three graduate students in the program and one technician. At least four industries are also collaborating with the procurement of marine materials for the study, and three institutes (NCI, the PHS Water Hygiene Lab, and the Worcester Foundation) participate in the biological testing program. To date, two compounds, with particular antiviral activity in mouse and chick embryos have been obtained from seaweeds, and their structures are being elucidated. A number of other extractives, including those of marine fishes and shellfishes, are being tested. The work is tedious and slow.

A part of the Pharmacology program deals with the physiological-drug responses of the Narragansett Bay clam in an attempt to study its muscle-nerve functions associated with depuration. The pharmacology of several biotoxins are also being studied, and the program will shortly include a toxicology study of certain marine pollutants. This program is in its second full year.

The URI Marine Pharmacy interest began before 1967. Several of its faculty joined with the Marine Biology Committee of MTS in co-sponsoring the first national Drugs from the Sea Conference which was held at Kingston, Rhode Island, in August of that year. At least 200 scientists and representatives from universities, government, and industry attended that meeting. The transactions were edited by Freudenthal and published by the MTS Journal of Ocean Technology in 1968 under the title *Drugs from the Sea*.

A second conference, international in scope, known as the Good-Drugs from the Sea Conference was organized in collaboration with MTS as part of our Sea Grant effort and held at URI in August 1969. Again more than 200 persons attended. Considerable interaction was developed between the problems of marine food research and drug research. The proceedings of that conference, edited by Youngken, are in press. Approximately 35 papers will be published and this report will soon be available from the Marine Technology Society, Washington, D.C.

A third conference is being planned for the summer of 1971 in order to continue the dialogue begun in 1967. It is hoped that by 1971 a greater number of research papers will be forthcoming. The time has arrived for tangible evidence of successful productivity. Without it, it is conceivable that many will believe the efforts of Sea Grant in marine pharmacology have been in vain.

Questions for discussion at this time are numerous, and it is conceivable that not all the answers will be forthcoming. We are here to review both the specific and general points of the Sea Grant Program as it relates to biomedical aspects.

Heber W. Youngken,Jr.

Emery N. Castle

Department of Agricultural Economics, Oregon State University
Corvallis, Oregon

Jon L. Jacobson

School of Law, University of Oregon
Eugene, Oregon

ECONOMICS

The potential of the ocean as a source of food has captured the imagination of many. Several recent events have undoubtedly contributed. Man's success in solving certain physical and biological problems has broadened his concept of what is possible to accomplish. The prospect of mastering "outer space" has resulted in the realization that much is not known about "inner space."

Although Americans are generally well fed, we are aware that much of the world population is not. We probably also recognize that our welfare cannot be separated from the welfare of those who do without. Lord C. P. Snow believes local famines will begin in the 1975-80 period and, unless corrective steps are taken soon, these famines will spread throughout much of the world by the end of this century. Others, of course, disagree and believe recent developments, such as those in wheat and rice breeding, together with human birth control, could prevent such catastrophes.

Some of us may see the opportunity presented by the ocean in a different context. We visualize an opportunity for the investment of our time and capital. We may believe that the application of scientific knowledge and the power of the profit motive will make a major contribution to the large, terrible problem posed by Lord Snow. We may believe the economic prosperity of Oregon is related both directly and indirectly to the solution of the major problem of this planet. Such potential prosperity may, in turn, be related to our place in the world power structure; many may believe control of the rights to the seas will be important in this respect.

It would be presumptuous, of course, for an economist to suggest that his discipline holds the key to the answering of these questions. It is not presumptuous for him to suggest that his field can help put the problem in perspective. Nor is it presumptuous for him to suggest that he may be able to identify the kinds of information man must have to solve the problem. Nor is it inappropriate for him to say to the biologists, the oceanographer, and the engineer, "There is much for all of us to learn, both in our own fields and from one another." Until we all learn more than we have about certain fundamental problems, we will do well to be somewhat humble in attempting to answer the many questions people are asking about the oceans.

The Supply Side

The biological process by which the oceans produce human food is indeed remarkable. Most marine fish produce very large numbers of eggs. While total yield can be depressed by continually heavy harvest, the resource is a renewable one. Management can influence yield and can return harvest to higher levels after heavy harvest has reduced yields. Furthermore, the prospects for biologists to improve upon nature had already been demonstrated on both the land and the sea. Even so, a 1967 FAO report entitled "The State of Food and Agriculture" has the following to say: "Despite the vast expanse of the open ocean in relation to the area at present exploited, the number of unexploited, but probably exploitable, stocks of fish is not believed to be large. Unless there is a technical breakthrough which would make the harvesting of new types of resources economically feasible...., the present rate of expansion of world fish production cannot be maintained indefinitely, possibly for not more than 10 or 15 years." (*The State of Food and Agriculture*. Food and Agriculture Organization, Rome, Italy, 1967.)

As the economist views this state of affairs, there are two principal factors affecting supply that come to his attention. One is the nature of the biological production function itself, i.e., the determinants of the quantities of various species available for fishing. The other is the cost of fishing, i.e., the quantity of human and non-human resources needed to secure a seafood product to be processed for consumption.

Prospects for increasing control of the ocean fishery lie in the following:

1. Improved harvesting techniques. Better boats, "herding" devices, seines, nets, and fishing tackle, and location of fish all provide examples.

2. Influence on the reproduction of the ocean fishery. Past influence has been limited to restrictions on harvest. Limitation is a very crude type of management for those species where parents produce many young. Hatchery operations and the control of competitive types of activities, such as pollution, are examples of types of management control that will result in a greater output from the ocean fishery. The biologist must understand the organism from a genetic, physiologic, and nutritional standpoint to extend this type of control.

3. Aquiculture. The ultimate type of control, of course, is aquiculture. The production of catfish in confinement provides the prototype, although broiler production anticipated this type of development by many years.

Without question, we will make improvements on all fronts. How rapidly we will proceed will be determined in large part by the success of the type of biological research being supported by the Sea Grant Program. Such research, to be successful, will have to meet biological, as well as economic feasibility criteria, if it is to be adopted.

The Demand Side

The potential demand for food of all kinds is limitless. As indicated earlier, C. P. Snow believes abundant food supply to be the ultimate need. The actual demand, however, must result from purchasing power being combined with desire and need.

The demand for fish products is quite broad. People at all income levels consume fish. In some instances they consume fish because it is the lowest cost form of some nutrient, such as protein. In other instances they consume fish because it better suits their taste. Increased consumption of fish products may come from putting a lower-priced product on the market at any given quality level. At almost any level of demand there are prospects for increases, but increases will come only as the requirements of the food industry are understood.

When one views in a systematic fashion the requirements of the modern food industry in the United States, it is somewhat surprising that the fishing industry has fared as well as it has. It has faced competition from the most productive land-based agriculture ever witnessed by man. In order to improve in the future, it must penetrate a food distribution industry that is geared to a mass consumption society.

Some requirements of the domestic food industry are as follows: 1. Uniform quality. The food distribution industry places a high premium on uniform quality. The retailer has a relatively impersonal relationship with the customer. Dissatisfaction with a particular product may mean either a loss of a customer or an adjustment cost that is quite high in an operation based on an impersonal self-service concept. The average quality must be high, with minimum variance in the quality of that product. Labels that attempt to fix a quality image in the consumer's mind are much in evidence. 2. Large quantity. Large food chains, a characteristic of our times, have come into existence because of the advantages of centralized decision-making. Mass buying is one of the obvious advantages of centralized decision-making. 3. Reduced variability and seasonality of supply. A dominant trend has been general reduction of seasonality and availability of supply. One form of competition is to have a wide variety of foods available at all seasons.

In view of the above, increased penetration of mass markets will occur only if some of the principal characteristics of the fishing industry are changed. If the quality market is to be expanded, it will probably not be in canned goods. Fresh and frozen fish will then have to have a more uniform quality, be available in large quantities, and on a dependable basis. Substantial pay-off is possible from research on improving the shelf-life, and the creation of new products, such as fish sticks. While seasonality probably never will be completely eliminated for some species, it undoubtedly can be significantly reduced for many. The requirements of the modern food industry can serve as a guide to our researchers as they attempt to discover the secrets of the nature that will permit a greater control by man.

Summary

In conclusion, there are prospects that the potential of the ocean as a source of food for man will be increasingly realized. This realization is not likely to be automatic or easy. Much remains to be learned about the biological and physical world that will permit man to better control aquatic resources. The seafood industry has a long way to go if it is to better integrate with the food distribution industry. It must become better integrated, if it is to compete with a highly efficient, productive, land-based agriculture. The dominant fact of American agriculture over the past two decades has been, without question, the integration of the production and marketing of food products.

Emery N. Castle

My initial assignment as chairman of this session is, I have been told, "to open the discussion with a short statement aimed at stimulating an exchange of ideas." It seems to me that a very stimulating discussion could result from a summary by each "Sea Grant lawyer" of his own Sea Grant program.

At any rate, I will use this opportunity to summarize the plans we, at the Oregon Law School, are pursuing under Sea Grant. If any of you would like to follow suit or present a statement on the subject of marine law, please feel free to do so.

The Ocean Resources Law Program at the law school is proceeding on three basic fronts: (1) *education* of students in the problems and practice of ocean resources law; (2) *research* on the legal problems created by expanding ocean technology; and (3) *information and advice* on ocean resources law to members of the legal profession, government officials, industry, the academic and scientific community, and the public in general. I am involved as one of the principal investigators pursuing these objectives, along with Professor and Associate Dean Chapin Clark and Professor Frank Barry.

Thus far, the main thrust of the Sea Grant work at the law school has been aimed at the *education* and *research* objectives. Last year, for the first time in the history of the school, the curriculum included an offering devoted exclusively to the legal problems of marine resources. Ten upperclass law students enrolled in the 3-hour seminar, Ocean Resources Law, which I taught during spring term (1969). Some of the specific problem areas enthusiastically attacked by this first group of Ocean Resources Law students are as follows: (1) Submerged land leases; (2) Effect of coastal shift on ocean boundaries; (3) Legal implications of man-made islands in ocean zones; (4) Changing concept of the territorial sea; (5) Administration of Federal jurisdiction in the territorial sea; (6) Liability of ocean polluters to the tourist industry; (7) Hard mineral mining off the Oregon Coast; and (8) High seas fisheries.

The principal investigators and some of the students continue to carry out research on these topics with a view toward publication of results in both a specialized legal periodical devoted to ocean resources law (to be published by the *Oregon Law Review*) and in other journals.

Future plans for our Ocean Resources Law Program – and our movement into the community information and advice phase of that program – revolve, to a large degree, around the new Legal Center, now under construction on the Eugene campus. The law school plans to move to the Center this summer. The new structure is designed, in part, to enable the law school to expand its functions beyond teaching and teaching-related research (important as these are) to encompass the broader roles of a true Legal Center: service to the law and the community through teaching, independent research, and study; continuing legal education for lawyers; providing a center for law-related institutes and conferences. The capacity of the law school to contribute to the Sea Grant Program will, by this move into new quarters, be greatly increased. For example, we plan to institute a Law-Science-Industry Program in Ocean Resources Law. The basic aim of this program will be to provide an organized means by which there can be an exchange of information, problems, ideas, and inspiration among the major groups now involved in the ocean resources venture. The special function of persons trained in ocean law would be, in part, to spot legal obstacles confronting industry and service programs in order to advise methods of operation or to suggest and even promote legislative proposals.

Future projects scheduled for the Ocean Resources Law Program, to be carried out with the assistance of a limited number of "trainees" in ocean resources law, include: "*Property* rights in artificially-developed varieties of migratory fishes," and "The law of oceanographic exploration." Another project which we are just beginning, in conjunction with OSU's Marine Advisory Program, is *The Oregon Commercial Fisherman's Legal Guide.* This study will include the gathering of data from commercial fishermen on their day-to-day operations and, hopefully, result in a law guide – in the form of a layman's manual – on everything from licensing requirements to international treaties.

In sum, our aim is to become a marine law research and information center for the ocean-oriented community of Oregon and the Pacific Northwest.

Jon L. Jacobson

Education and Training

Thomas G. Scott

Department of Fisheries and Wildlife, Oregon State University
Corvallis, Oregon

John C. Sainsbury

Department of Fisheries and Marine Technology, University of Rhode Island
Kingston, Rhode Island

EDUCATION

This discussion session is concerned with Sea Grant education and training – education and training designed to provide skilled leadership in our quest for increased understanding of the marine environment and in our efforts at better management of marine resources. The Sea Grant Act and the hearings leading to it make it abundantly clear that this education and training has the objective of equipping students to contribute directly to humanity and directly to the economy of the nation. And an international responsibility is implied.

Inasmuch as we are dealing with education and training, there may be some confusion as to the distinction between the two subjects. Legislation attending and establishing Sea Grant activities suggests that education and training are distinct. The Marine Resources and Engineering Development Act of 1966 declares that the marine science activities of the United States must contribute to the advancement of education and training in marine science. In the National Sea Grant Colleges and Programs Act of 1966, we have a mandate from Congress stating that it is the intent of the Act to establish a program of Sea Grant Colleges to stimulate education and training in the fields of marine sciences, engineering, and related disciplines.

It is my belief that Sea Grant education is a broadly based course of learning leading to the Bachelor's, Master's, or Doctor's degrees. By contrast, training is that part of the program designed to produce and aid technicians through two-year programs of specialized training at the college level, short courses, or on-the-job training. In one sense, Sea Grant education, being more broadly based, would permit ready adaptation of graduates to several kinds of work, whereas training might be so specialized that a change of jobs would require graduates to undergo some retraining.

I shall address my introductory remarks to education, and Dr. J. C. Sainsbury will deal with training.

The Field of Education Concerned

To consider education in the marine environment, we must attempt to delineate the field of knowledge under consideration. The first report of the National Council on Marine Resources and Engineering Development (1967:13) states that marine science is a term employed to designate scientific research, engineering, and technological development related to the marine environment and that the "marine environment is considered to include the oceans, the continental shelf of the United States and its territories, the Great Lakes, and their resources." This report also reminds us that marine science cannot be considered in isolation, for programs dealing with the marine environment must be related to activities on the land. "Marine science goals, policies, programs, and activities must, therefore, be examined in two ways: as they relate to the unity they derive from the marine environment, and as they contribute to major goals of society and the Nation." Spilhaus (1966:32) has expressed the belief that the field of marine science comprises "the work of any scientist in any discipline who chooses to use the sea as a focus for his intellectual endeavors." Thus, we are addressing ourselves to a wide array of knowledge.

Where Are We Now?

Now, after two years of Sea Grant activity, our discussion centers on the question of where we are now with Sea Grant education.

Above all, we must acknowledge the tremendous boost which the Sea Grant Colleges and Programs Act of 1966 has given education on the marine environment. This injection of life has been especially impressive to those of us who have witnessed education and research on marine resources, an asset of immense national significance, languish in many universities for lack of substantial, continuing financial support. Many early programs were fragmentary and shallow or even nonexistent in the absence of reliable, recurring financial support. This has been particularly frustrating when confronted with today's pressing demands for knowledge on marine resources and their development. The Sea Grant Act has made it possible to overcome a certain amount of the early institutional inertia.

But, how effectively are we employing this new power? Are we using it to build castles on the hill, or are we truly directing our efforts toward a new era in the development of marine resources? For purposes of evaluating our position, let us review some of the principle areas of concern in education.

Educational Institutions

A consensus of the views expressed during the hearings attending Sea Grant legislation held that the program of education should be developed primarily through the support of the extant educational institutions. The many fine educational institutions participating in the basic training required for the development of marine resources constitute a source of great strength. Thus, any institution offering courses in basic and applied science in related disciplines adds potential educational strength to the Sea Grant Program. In exercising the authority given to the National Science Foundation by the Sea Grant Act, the Foundation is obviously making use of this great strength.

Facilities

Educational programs require special laboratories, research vessels, and all manner of adjunct supporting equipment and facilities. There is merit in making use of suitable existing facilities, but they must be expanded and operated at a stepped-up rate to accommodate the new thrust on education and research on the marine environment as generated by the Sea Grant Program. Thus, in general, facilities to support the educational program need to be expanded and operated more intensively than in the past, and funds for providing for this are not always readily available. What are our needs and what can be done to satisfy them? Perhaps some of our operations are spread too thin, and the available funds should be concentrated on payoff projects.

Levels of Education

The levels of Sea Grant education to which we appear to be addressing ourselves in advanced education lead to Bachelor's, Master's, and Doctor's degrees. One of the questions we must face is that of direction of the student with respect to level of education. To what extent should the terminal degree be at the Bachelor's level? Some colleges offer suitable undergraduate training for immediate employment with marine resources, but education at the graduate and even at the post-doctoral level appears to be growing. Employment records indicate that the probability of finding a job increases with each higher degree earned. Should greater emphasis be given to graduate and post-doctoral work? The Committee on Oceanography of the National Research Council (1967:151), for example, reported that "the major contribution to ocean engineering will probably come from those of the engineering profession who have done most of their special training in ocean engineering at the graduate level." The Committee recommended "the development of upper-division and graduate curricula in ocean engineering...." and "specialized ocean engineering courses for practicing engineers." Schaefer (1966:79), has expressed the belief that the "College of the Sea needs, ... to operate primarily at the graduate level."

Curricula

Education is a dynamic process, responding to changing needs. Curricula must be constantly upgraded. Knowledge of how to handle great volumes of data is needed more than ever before. It seems increasingly apparent that students of the future must be exposed to combinations of courses, the so-called hard sciences (physiology, physics, biochemistry, organic and inorganic chemistry) and must be associated with socio-economic studies. This raises some concern for higher education because perhaps only the larger universities can provide the broad spectrum of courses needed. Senator Claiborne Pell (1966:42) has expressed the belief "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."

In commenting on the need for a College of the Sea, Schaefer (1966:78) observed that "this new realm requires the integration of many disciplines in both the sciences and humanities. We need ... scholars working closely together in the hard 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 ... The question is, how can this be accomplished."

This education must cope with a broad spectrum of problem areas: mineral exploitation, deep-sea engineering, fishery resources, medicine, international law, pollution, defense, food processing – as well as understanding their interrelationships.

Perhaps there is a need for an introductory or orientation course in marine science which is provided by team teaching, with representatives from all the fields involved. Such a course should be open to majors and non-majors. This would help produce an informed public and education for better understanding of the environment and its resources is unassailable.

Integration of Research and Education

One of the truly great contributions of the Sea Grant program is that it recognizes and facilitates the complementary relationship which exists between research and education. The effect of this relationship runs in two directions. The faculty member engaged in a reasonable amount of research is a better instructor, and the researcher engaged in some instruction is the better for it. Although

important at the undergraduate level, this interaction is essential at the graduate level. Are we pursuing this potential benefit to the fullest advantage?

Large research grants for limited problem areas may produce a skewing away from the main thrust of educational programs. This, in my opinion, has been the basic cause for student concern that research and instruction are incompatible.

Manpower Needs

An expanded program and appropriate budgets for the development of marine resources is futile if there is little or no opportunity for employment in the field. What is the need for educated manpower? What are the priorities?

A recent item in *Biomedical News* (February 1970:5), reports that oceanographic jobs, particularly biological oceanography, will increase from today's 5,800 to 100,000 by 1980. Are such estimates realistic? Responsible people with the National Council on Marine Resources and Engineering Development are concerned about excessively optimistic expressions on increasing job opportunities in the marine area (Personal communication, W. Long, February 5, 1970).

Summary

The educator participating in the Sea Grant program bears a heavy responsibility to the welfare of the nation and faces educational problems as complex as those of any profession. Let us direct our attention to this responsibility and to these problems. We shall not find all the solutions, but perhaps as a result of our discussion some views and techniques can be changed or refined to better cope with the need for the best possible education of our students.

Literature Cited

Committee on Oceanography, National Research Council 1967. Oceanography 1966, Achievements and Opportunities. Publication 1492. National Academy of Sciences, Washington D.C. 183p.

National Council on Marine Resources and Engineering Development. 1967. Marine Science Affairs – A year of Transition. U.S. Government Printing Office, Washington D.C. 157p

Pell, C. 1966. The National Sea Grant College and Program Act of 1965. pp. 39-43. *In*: 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. U.S. Government Printing Office, Washington D.C. 285p.

Schaefer, M. B. 1966. Our Stake in the Sea – Present and Future. pp. 75-79. *In*: 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. U.S. Government Printing Office, Washington D.C. 285p.

Spilhaus, A. 1966. The Concept of a Sea Grant University. pp. 31-38. *In*: 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. U.S. Government Printing Office, Washington D.C. 285p.

Thomas G. Scott

TRAINING

Now that oceanography has become a "popular" science with the accompanying increase in funding and spreading of interest, education programs in Marine Sciences are multiplying rapidly. At the same time technician training is growing in importance and numbers.

Do these programs meet the needs of industry, government, universities, and other employing agencies?

Most, if not all, of the Marine Science curricula presently available appear to have evolved along classical lines; sometimes doing little more than paying lip service to the marine field by throwing a course or two into their regular science programs at the baccalaureate and graduate levels. Undergraduate programs in most instances appear to be designed purely as a lead-in to graduate studies.

New curricula which are developing to include such areas as law and economics are being organized in a similar fashion.

Such programs are surely welcome, but must be watched closely to ensure that they contribute to development rather than become "self perpetuating" in the academic field, as seems to be the case with some of the more classical areas.

Within the often discussed technician field, considerable difference of opinion appears on the definition of a technician. The term is used to describe welders, people who collect samples, and those who analyze data, as well as skipper of a tuna seiner whose business ability is certainly as important as his technical and managerial attributes.

There would appear to be a considerable gap between the scientist-engineer level and the technician level. Whether or not such a "between level" exists in practice, the type of person working there must be brought out by industry and other employers.

If such a gap does not appear to exist at first sight, then comparison may be made with industry, education, and training programs in other countries. Indeed, there is growing realization in this country that a vacuum generally exists between the engineer-scientist level and the technician area, which tends to suck in practical men from above and able technicians from below to fill the void.

Technical institutes with 4-year baccalaureate status in technology, together with Maritime Academies and similar institutions, would appear to come closest to providing adequately educated and trained manpower, but these are as yet only scratching the surface.

The difference in emphasis between the situation in this country and that in other areas of the world may be illustrated, perhaps, by two examples:

In the United Kingdom, Norway, Sweden, and Germany – to list but a few countries – technical universities go beyond the baccalaureate to the master's or doctorate level in technology.

In Japan and the USSR, fishing vessel captains usually have the equivalent of a bachelor's degree and often a master's degree.

The existing state of development of education and training in the marine areas makes the present an ideal time to take a very close look at the needs of the whole range of marine activities.

The Sea Grant Program is an ideal home for such a study, with its coupling of industry, government, research, public service, and the academic world, all of which must have a considerable part to play.

A concerted effort at this stage can bring about a balanced program of education and training to suit all levels and aspects of the country's needs for the sensible, safe, and efficient development of marine resources.

John C. Sainsbury

REMARKS

We feel that Marine Technician Training should not focus only on the specific shipboard handling of equipment, especially if the program is leading to an associate degree in Applied Science. A technician, in addition to acquiring "know-how," should learn to communicate with other members in the team, be able to comprehend and present the data he is collecting, and have some knowledge of the theories and principles involved in equipment that he is using. To qualify as a good Marine Technician, a student should be required to have 50% of his course work in college physics, chemistry, mathematics, English, and sociology.

From our experience we have found that at least 30% of our graduates intend to proceed to higher education some time during their career. By offering such programs as mentioned earlier, we will have the door open for these students.

We also feel that there should be more 4-year schools in the maritime states of this country offering degrees in Oceanography. Many industries have shown an interest in hiring 2-year or 4-year graduates in place of Ph.D.'s who demand higher salaries.

We agree with the idea of an "in-service training program," for short periods in the technical institutes, leading to a diploma or certificate. This program would emphasize the basic course work of the industries' needs.

To summarize – the Marine Technician Program of study includes:

1) 1-year diploma or certificate course,

2) 2-year associate degree program,

3) 4-year degree program.

Tapan Banerjee

The training of marine technicians has gathered much momentum in the last 2 years. Despite difficulties in defining the occupational field, colleges from coast to coast have developed a wide variety of programs. By way of review, in the American Association of Junior Colleges 1968 national publication on "The Education and Training of Marine Technicians," I defined the marine technician: 'Under the broadest definition, a marine technician is one whose education and experience qualify him to work in the area of marine technology employing the technical knowledge, methods, and skills . . . ." ". . . In the final analysis, the employer will determine whether an individual is classified as a marine technician or as an electronic technician."(1)

As of September 1, 1969, the National Science Foundation Sea Grant Programs had funded 11 institutions of higher education to develop curricula to train an estimated 400 marine technicians. These schools are:

University of Washington
Oregon State University
Texas A & M University

College of Marin
University of Miami
Santa Barbara City College
Cape Fear Technical Institute
Southern Maine Vocational Technical Institute
Del Mar College
Smithsonian Institution
Washington Technical Institute

To gather a clearer picture of marine technology, many of these colleges sent out questionnaires and conducted interviews with employers to determine job classifications and demand in the field. I have found that these surveys, although valuable for their purposes, omitted many viable questions which needed answering. These answers can only come from the individuals themselves, the marine technicians and students enrolled in a marine technology program. This report may properly be classified as a personnel inventory survey.

Scope and Method of Study

The purpose of the personnel inventory was to determine the characteristics of individuals in the marine technology field so that schools and employers with current programs might treat the needs of their students or employees in a precise and understanding manner. A questionnaire was developed in 1969 to sample the personal characteristics of employed marine technicians and student trainees in marine technology programs.

Survey forms were sent to 14 large organizations which were reported to employ marine technicians; 10 firms replied, providing data on 111 individuals. Seventy-one were governmental employees and 40 were employed by private industry.

Thirteen schools training marine technicians received questionnaires. Eight schools replied, providing data on 154 individuals.

Since there was a high percentage of returns from all organizations, the data provided in this report properly reflects a good sample of the proportion of the nation's individuals who work as marine technicians or as students moving through a trainee program. There was much additional information gathered in the survey which is not reported in this paper. The selection of presented data was based on those questions which I felt were most important in aiding schools and employers in the understanding of marine technicians. Not all the questions were answered by each of the respondents.

Selected Results

A. Marine Technicians Working in the Field of Marine Technology

Number	*Organizations*	*No. of Marine Technicians*
3	Governmental	71
7	Private	40
10	Totals	111

1. Personal History	*Category*	*No. of Persons*	*%*
a. *Age Levels*	29 years or younger	25	27
	30-39 years	31	34
	40-49 years	24	26
	50 years or older	12	13
b. *Sex*	Male	87	95
	Female	5	5
c. *Marital Status*	Single	12	13
	Married	75	84
	Divorced	3	3
d. *Ethnic Group*	Caucasian	103	97
	Black	3	3
e. *Present Address*	32 were employed on the west coast		
	79 were employed on the east coast		

f.	*Birthplace*	12	New York	3	No. Carolina
		11	Connecticut	2	Canada
		7	Pennsylvania	2	Maine
		6	California	2	Missouri
		6	Illinois	2	Texas
		5	Massachusetts	1	Georgia, Indiana, Kansas, Maryland, Michigan, No. Dakota, Oklahoma, Oregon, So. Carolina, So. Dakota, Washington, D.C., Wisconsin, and Phillipines
		4	Ohio		
		4	Virginia		

g. *Military Service*

Seventy-one percent had served in the Armed Forces; 29% had not

No.	*%*	*Branch*	*Major Military Service Specialties*		
			No.	*%*	
39	51	Navy	24	33	Electronics
19	25	Army	23	33	Radar/Radio, Sonar, Communications
11	14	Air Force	8	9	Machinists, Mechanics
4	5	Marines	5	7	Ordnance
2	2½	Coast Guard			
2	2½	Maritime Service			

2. *Socioeconomic Status*

a. *Marital Status of Parents*

Parents are still married, 87%

b. *Number of Brothers and Sisters*

Zero to 5 brothers and sisters, 62%
Six to 10 brothers and sisters, 31%
At least 15 brothers and sisters, three individuals

c. *Occupation of Father*

Father is or was a blue collar worker, 56%
Father is or was a white collar worker, 16%
Father's annual income occurs in the $5,000-$10,000 range, 34%
Father's annual income occurs in the $11,000-$15,000 range, 46%

d. *Education of Parents*	*Fathers*	*Mothers*
Less than high school	42%	22%
High school degree	47%	63%
College degree	14%	7%

3. *Employment Status*

a. *Marine Technician Classification*

Eighty-five percent classified themselves as marine technicians, 15% did not.
About 55% had spent less than 5 years on their present job, while 20% had spent 20 years or more on their present job.

b. *Specific Job Title*

35 electronic engineers
11 marine service engineers
9 engineering technicians/aides
7 survey technicians
7 research helpers or lab technicians
7 mechanical engineers
5 field service technicians
4 physical science technicians
21 miscellaneous technicians and helpers – electronics, drafting, oceanographic, chemical, cartographic, etc.

c. *Annual Salary*

Annual Salary Range	*Number of Individuals*	
	Starting	*Present*
$2,500- 5,500	42	3
5,500- 7,500	24	17
7,500- 9,500	17	29
9,500-11,500	6	25
11,500-up	1	20
median	$6,000	$9,500

d. *Past Marine Related Work*

Six indicated they had no previous experience in marine work and 83 stated they had marine work experience in research, electronics communications, etc. Of the 83, 12 had seaman experience.

e. *Other Statements Regarding Employment*

(1) About 33% stated they are satisfied with their present marine technology jobs, while the same percentage desired more ocean research jobs.

(2) Concerning the amount of desirable work time at sea:
2% desired 75% or more work time at sea
17% desired 50%+ time at sea
31% desired 30 to 40% time at sea
50% desired 25% or less work time at sea

4. *Education*

a. *Amount of Education*

(1) Of the working marine technician, 95% had completed high school. Their average high school grade was about a B-. Of the total who answered, most high school graduates took life science courses (biology), physics, chemistry, and general science. Algebra was the most common math course completed and a large percentage had at least one course in a foreign language. About 40 of the group had vocational-shop courses and most said these were relevant to their jobs.

(2) Of the 74 who went on to a college or a technical institute, 24 (or 32%) earned some form of degree:
10 earned junior college degrees
12 earned **B.A., B.S.** degrees
2 earned **MA., M.S.** degrees
Of those who had earned degrees, 70% expressed a desire to go on for higher degrees. Of those who did not complete college education, 75% desired to return for a B.A. degree. The average grade for those who attended college was about a B.

b. *College majors*
The majority indicated that they majored in engineering and electronics. Many of these desired more electronics and physical sciences and math education to enhance their present work.

c. *College courses*
(1) Math was considered the most important college course. The next most important were physics and electronics.
(2) The least important college courses, in their opinion, were the foreign languages, literature, and sociology.

5. *Marine Interest Statement*
Nineteen percent of the marine workers indicated that the public media on marine science was a factor in their choice of marine technology as a career. The Navy, school teachers, counselors, friends, and self interest were other prime factors for motivating their choice of a marine career.

B. *Students Studying Marine Technology*

Number of Schools
13 requested survey forms
8 returned survey forms from 154 students

1. *Personal History*	*Category*	*No. of Persons*	*%*
a. *Age Levels*	20 years or younger	97	65
	21 to 29 years	42	28
	30 to 39 years	10	7
b. *Sex*	Male	148	96
	Female	6	4
c. *Marital Status*	Single	116	81
	Married	24	17
	Divorced or Widowed	3	2
d. *Ethnic Group*	Caucasian	152	100

e. *Present Address*
64 West coast students
90 East coast students

f. *Birthplace*

38	Maine	6	Oregon
18	New York	4	Florida
12	Washington	4	Idaho
10	California	n	other states with small numbers
8	Massachusetts		

g. *Military Service*

43% served in the Armed Forces; 57% did not.

No.	*%*	*Branch*
12	29	Army
10	24	Navy
9	22	Marines
8	20	Air Force
2	5	Coast Guard

2. *Socioeconomic status*

a. *Marital Status of Parents*
Parents are still married, 84%.

b. *Number of Brothers and Sisters*
Three or fewer brothers and sisters, 80%.
Four-Six brothers and sisters, 18%.
Seven or eight; none had more than 8, 2 %.

c. *Occupation of Father*
Father is or was a blue collar worker, 61%.
Father is or was a white collar worker, 39%.
Father's annual income occurs in the $5,000 to 10,000 range, 57%.
Father's annual income occurs in the $11,000 to 15,000 range, 43%.

d. *Education of Parents*

	Fathers	*Mothers*
Less than high school	13%	2%
High School diploma	77%	91%
College degree	9%	10%

3. *Employment Status*
Students are generally employed in part-time work which required little previous experience: e.g., restaurant work, custodial work, store clerks, etc.
Seven % classified their jobs (mostly part-time) as marine technicians while 93% did not consider their jobs to be marine technician work.
Only 7% of the working students classified their work as full time. These students are probably night school students. Those who classified their work as marine technician reported these positions: marine machinist, worker in a SCUBA shop, fishermen, and marine technician laboratory aide. All other job titles were unrelated to the marine field. Most of the student jobs were summer jobs with varied salaries.
Of the students who had past marine-related work experiences, these were the ones reported:

No. of Students	*Type of marine experience*
13	SCUBA diving
14	Fishing, commercial fishing
6	Seaman
n	Others: ship building, lab technician, oceanographic ship research, aquaria work, etc.

Students expecting to be employed as marine technicians, were hopefull of starting annual salaries ranging from $5,500 to $7,500. The majority desired jobs in oceanographic research, especially east coast students. West coast students desired more diving work than east coast students.

Concerning the desirable amount of job time spent at sea:
27% desired 75% or more job time at sea
40% desired 50%+ time at sea
21% desired 30 to 40% time at sea
12% desired 25% or less time at sea

4. *Education*

a. *High School Education*
One-hundred % of the students had completed high school. Their average high school grade is about a C+. As in most high schools, science, foreign languages, and math played an important course role. Algebra was most often checked as an important course. Marine biology-oceanography courses appeared in their high school curricula.

b. *College Education*

Eighty-two % expressed a desire to go on for higher degrees, while 18% stated they do not plan to go further than their present status of junior college degree. Their current grade average appears to be about a C+.

While these students were classified by the school as marine technology students, the students listed themselves with the following majors:

No. of Students	*Most Important College Courses Major*	*Least Important College Courses*	
40	Marine Technology	19	English, Communications, Literature
16	Oceanography	18	Physical Education, Health Ed
7	Biology	7	Math
6	Marine Biology	6	Sociology
5	Ocean Engineering		
2	Chemistry		

5. *Marine Interest Statements*

Sixty-four % of the students stated that the public media influenced their choice of marine technology as a career.

Interpretations

10 organizations, employing marine technicians	=	111 technicians
8 schools, training marine technicians	=	154 students
18 totals		265 questionnaires returned

A. *Personal History*

1. *Age Levels*

Working marine technicians were grouped in the middle age levels, between 30 to 49 years old. The majority, 65%, of the students were 20 years or younger.

2. *Sex*

In both groups, technicians and students, 95% were males. From my previous surveys on the demand for marine technicians, employers have stated that women are needed, but few are qualified. (1) Many employers are puzzled as to why more women are not involved in marine technical training, especially for lab-type positions.

3. *Marital Status*

The statistics reveal the difference between workers and students. about 84% of the workers were married; 81% of the students were single and most will probably evolve towards the marriage status.

4. *Ethnic Group*

The overwhelming majority of marine technicians were white. No orientals, Mexican-Americans, nor Indians were listed, with only three blacks among 265 questionnaires. A sociological and psychological study should be instigated to determine the reason for this white-dominated occupation. However, there is a current attempt to train the "hard-core unemployed," which included a large proportion of blacks in Washington, D.C., aboard the deactivated hydrographic vessel, the "Explorer." An evaluation study of this program is needed to supply information to all institutions involved in marine technology programs.

5. *Birthplace and Area of Longest Residence*

About 67% of working marine technicians and 62% of the students were born in coastal states. For areas of longest residence, 83% of the workers and 90% of the students lived 10 to 25 years in coastal states. Thus, individuals involved in marine programs generally come from coastal states.

6. *Military Service*

The predominance of marine technician workers have had military service (71%). The majority, 51%, served in the Navy and this training influenced many to choose marine technology as a career. On the other hand, students showed a closer balance between services. Thirty-three % had electronic and communication training in the armed forces, which tended to support their marine technology positions.

B. *Socioeconomic Background*

1. *Marital Status of Parents*

For the worker group, 87% of the parents are still married as compared to 84% for the student group. The majority of those who were divorced have remarried. Does the stability of the home life affect the longevity of students completing their education and being dependable workers? Some sociologists believe there is an effect when family life has been disrupted. My personal view is that there is little evidence of effect for the group as a whole for such a small percentage of divorced parents. For the individual student, however, there may be some effect.

2. *Occupation of Father*

Generally, technical students come from homes where the father holds a blue collar job (56% of the workers and 61% of the students). The annual incomes of the workers' fathers showed a higher percentage, 46%, in the $11,000-$15,000 range than in the $5,000 to $10,000 range. The reverse was true for the students who reported a higher percentage, 57% of the fathers' incomes in the $5,000 to $10,000 level. Generally this trend illustrates a time factor; the longer the father has worked, the higher the income. In general, the average income of the fathers seems to be adequate for the average family maintenance.

What was not measured, and probably a very influential factor in the success of marine technology workers, are the parental attitudes toward college. Cross (3) reported that parental attitude towards college has a strong relationship to the student's persistence in college.

3. *Education of Parents*

In accordance with the trend of blue collar workers and middle income wages, the expected formal education of the parents should be lower than that of the white collar families. Fathers with less than high school education numbered 42% for the worker group as contrasted with only 13% for the student group. For the worker group, 47% of the fathers held a high school diploma; however, for the student group, 77% of the fathers had completed high school educations. There appears to be a trend to more and more blue collar workers with high school certificates. Perhaps in time, the percentage of blue collar workers who have completed college education will be higher, thus illustrating the increased educational trend of the general populace. A noteworthy statistic is the higher percentage of mothers than fathers with high school diplomas for both the worker and student groups. Cross (3) reports that in general, the more schooling the parents have had, the more likely the students will receive parental encouragement towards persisting in college.

C. *Employment Status of Marine Technology Worker and Student*

1. *Specific Job Title*

About 85% of the working technicians classified themselves and their jobs as "marine technicians." However, if we were to look at their job titles, only two were classified as oceanographic aides. All others had other job titles, with 33% called electronic engineers. These data support the fact that there is no large movement towards establishing a specific job title as "marine technician;" instead, technicians working in the marine field are classifying themselves as such. Likewise, employers using technicians in the marine field are also calling them "marine technicians," but with a variety of job titles.

Although the specific job title is not an established category, the efforts of schools throughout the country that train marine technicians will not be fruitless. These schools are training technicians who will eventually work in the marine environment and who will form the cadre or a large body that will one day be called marine technicians, many with a host of sub-specialties, e.g., electronics, diving, mechanical, biological, geological, etc.

Students training to be marine technicians generally are unaware of the complexity of job titles. About 7% felt that their jobs, while going to school, are encapsuled by the title, "marine technician."

2. *Starting Salary*

The median starting salary for marine technology workers was $6,000 per year and the median present salary was $9,500 per year.

The students in marine technology, 53%, generally expected a starting salary between $5,500 to $7,500 per year.

3. *Past Marine Experience*

A large majority, about 74%, of the working marine technicians reported they had past marine work experience. Approximately 14% of these had seaman experience. Most claimed experience in marine electronics.

In contrast, about 32% of the students claimed some form of marine experience, the majority having experience as SCUBA divers or in some form of fishing. Very few of the marine technology workers listed SCUBA as a marine experience. The SCUBA trend is one of recent maturity.

4. *Desirable Time at Sea*

A very interesting contrast over the desirable amount of job time spent at sea occurred between the workers and the students. Only 2% of the workers desired 75% or more time at sea; 50% desired less than one-quarter of their time at sea. For the students, with only a few having had sea experience, 27% desired 75% or more time at sea and only 12% desired less than one-quarter of their time at sea. In time, this student interest in working in the sea will probably diminish to a more realistic percentage.

D. *Education*

1. In both groups, workers and students, 95 to 100% completed high school. Of the 111 workers, 74 went on to college or technical institute, with 24 (32%) of them earning some form of college degree.

Likewise, a high percentage want to continue education towards higher degrees; 75% of the workers and 82% of the students expressed strong desires to go for B.A. or higher degrees. This desire of technical students to go on towards higher degrees is a well-recognized fact among educators, yet I have always wondered why these educators continually try to stifle these drives by setting up "terminal" technical curricula. Even when the student goes to work as a technician in private industry, it has been my experience that these employers set up advance pay scales to motivate these technicians to return to college for more schooling.

2. *Important and Least Important College Courses*

The marine technician workers declared that math and physical sciences (physics, chemistry) are extremely important college courses. The students, with very little concept of the nature of marine technology work, listed oceanography, math, marine biology, and biology as high choices. From my 1967 survey of marine technology employers (2), they listed electronics, chemistry, math, in that order of importance. Such declarations by marine technician workers and employers should be wise advice for marine technology curricula developers.

Least important courses for both groups were generally humanities courses. However, the choice to decide what is most important is much easier than the discretion to express what is least important. The decision of describing least important courses may be clouded with bad experiences in grades, teachers, subject content, etc., and this is true for the other extreme. Nevertheless, the judgment of good or bad is always a difficult choice for educators.

3. *Marine Motivation by Public Media*

The final contrast between marine technician workers and students is seen in the percentage that were motivated towards a marine career by public media, e.g., the Jacques Cousteau television specials:

The workers = 19%

The students= 64%

The contrast in the above percentages may give the reader a clue as to many of the aforementioned differences between the two groups. If motivation is too superficial, the persistence in working in the rugged environment will not be lasting.

Conclusion

The data presented in this report show that the current marine technology workers and students come from families of solid middle-class groups. Their average grades are in the C to B categories, and the overwhelming majority have a strong desire to go on for higher academic degrees. Furthermore, my surveys indicate that success as a marine technician requires an adequate background in math, the physical sciences, and electronics.

With the above information, I have revised some basic thinking in my mind about technical education at the junior or community college level. In the first place, I strongly support the technical-vocational training programs and their role in our economic system. However, the dilemma arises when reports come from around the country that there is a high dropout rate of students in marine technology college programs. A Pacific Northwest college and a Southern California college each started with about 70 students and graduated less than 10 in their marine technology programs. Such attrition rates may be true for all colleges with marine technology curricula. What is the reason? I conclude the following:

1. Many marine technology programs, following traditional technical-vocational course designs, are geared for students of low socio-economic status who generally do not have the background to succeed in college. These curricula are attended by middle-class students with strong drives for academic degrees. When enlightened by the fact that many of these courses are non-transferable (terminal), they quit the program.
2. The majority of marine technology programs have courses in math and science which are either too difficult for, or unappealing to, the many liberal arts students who sign up for the major. Thus, the attrition rate accelerates because of the poor background training of students. These college courses are not designed to teach the basic subject matter.

My recommendations are really suggestions. The time is not too late to revise the system. I suggest two concepts:

1. A seamanship-type of technology could be taught at the secondary or technical school level. I strongly support the post-secondary-technical school concept. At this level there is no confusion about academic degrees. The Los Angeles Trade Technical College, in my opinion, is a fine example of a well-directed educational institution. Such centers should be widespread to provide success to the unskilled students.
2. Junior or community colleges have evolved so deeply into the "transfer" academic curricula that the original technical-vocational concept may never regain its importance. This latter concept is to teach technical-vocational courses that are simple and easily grasped by the non-academic students. There is nothing wrong with this concept. The problem arises when the two incongruous careers of the academic-based courses (e.g., marine technology) and the trade career courses (e.g., cosmetology) are lumped together into one single funding category. Under the single "vocational-technical" classification, both of the above mentioned programs must have courses that are non-transferable. From my studies, I definitely feel that the marine technology curricula must be free to develop into four-year degree programs. The restriction stems from federal and state vocational-technical funding requirements which force all such technical programs under the single "non-transferable" classification. If viable technical programs are to survive and benefit the interested students, such financial bonds must be made more flexible.

Therefore, my surveys, information, and conclusions are directed towards educators and employers who will hopefully rekindle the thought processes about all "technical" students. There is so much politics, money, prestige, and red tape tied up in vocational-technical programs, and my compassion goes out to the students struggling through this maze. Out of it all, I hope the field of marine technology survives.

References

1. Chan, Gordon L., *The Education and Training of Marine Technicians,* Washington, D.C., American Association of Junior Colleges, 1968, p.5.

2. Chan, Gordon L., *The California Report on the Education and Training of Marine Technicians* Kentfield, California, College of Marin Press, 1968.

3. Cross, K. Patricia, *The Junior College Student: A Research Description,* New Jersey, Educational Testing Service, Princeton, 1968. p. 17,18.

Gordon L. Chan

Marine Advisory Programs

William Q. Wick

Sea Grant Marine Advisory Program, Oregon State University
Corvallis, Oregon

John P. Doyle

Fisheries Extension, University of Alaska
College, Alaska

MARINE ADVISORY PROGRAM

When the Sea Grant fathers envisioned "county agents in hip boots to take findings of marine scientists – to accomplish the true use of the sea for and by people," I'm sure they realized that the Marine Advisory effort would not shift into high gear by the next low tide. I'm also confident that they did not expect to find many of us 3 years later still trying to define the extension function and arguing that the concepts differed from the half-century of county agent experience with land people and resources.

To be positive, however, Marine Advisory Programs are slowly coming of age. Examples of successful marine extension educational programs can be found on all coasts. Some actual results can be documented. As the action group of marine extension educators, we are building a base of acquaintance with the sea people. We are learning that the sea people may not be as independent as legend once claimed, but, more importantly, that few more intelligent groups can be found.

I hope that we have learned that extension education is not public relations; that it is not charming an audience to legitimize existing research; that it is not being willing to be helpful; and that it is not holding flashy seminars or publishing slick conference reports – although it could be all of these if the target audience is ready and has participated in developing our programs.

Have we learned that Marine Advisory Programs do not just happen? Do we know that to be successful we had better develop an honest (let's not worry about who gets the credit) working partnership among industry, government, and education? As Marine Advisors we must act toward needs expressed by marine resource users. This approach contrasts with our discipline training. We tend to view resources as the problem and falsely assume that if the resources are healthy, and technology is present, informed utilization will automatically follow.

Are we taking the Marine Advisory Program seriously – as an equal plank in the three-pronged Sea Grant effort? To me, Marine Advisory Programs can be likened to a partnership wheel – a circle, which, if properly balanced and oriented, will turn ever onward to higher levels of technological or educational understanding and use. The wheel concept is important for it provides constant evaluation of the program. Further, to be successful, it requires meaningful involvement of the sea people and a genuine "people-oriented" commitment by the Marine Advisory Program staff toward solutions to the problems of the user.

In essence, our discussion today should include emphasis on where we are going and how we intend to get there. We, as the educational "sales" outlet for the Sea Grant concept, must function successfully if development and utilization of our ocean resources are to be improved.

William Q. Wick

I don't know if I really belong here, for the simple reason that the University of Alaska is not yet a Sea Grant institution. Our fisheries extension program has been supported, since its inception, as a state line budget item within the University. We have some problems. The statement was made that we come up with more problems than we do answers. I think that is one of the reasons we have and need a marine extension effort. I will define what I mean by extension. To me, extension includes advisory services, information programs, and demonstrations.

The question we must ask ourselves – one that has been touched on in this conference – is, "Are we relevant? Are we, as extension or advisory people in the broadest sense, relevant to our audience?" I feel that we have sometimes lost our sense of relevancy. During this conference we heard the remark, "Identify the problem, and

then identify the audience." To me this is backwards. We identify our audience – be it the general public or a group of salmon trollers – go to them, and they help us identify the problems. We don't shove the problem down their throats. We can help people cope with problems, but they're the ones who must identify the problems.

Next I think it is up to us, as extension people, to ask, "Is our institution relevant?" We should work towards bringing the institutions into a state of relevancy with the problems at hand. Quite often this gets down to the question: Is our research relevant? Is the research within the Sea Grant Program really pertinent to the problems of the users of the marine environment? I think we owe it to ourselves as individuals, even more to the public for whom we're working, to make sure that Sea Grant effort is directed where it is most urgently needed. We must use our influence to see that the research projects are essential to the industry with which we are working. The need for a common sense approach is a must because interfering too much with the freedom of research can jeopardize interagency cooperation and will not win friends.

I've heard the question asked: "Are we ready for a marine extension effort?" Members of the research community put it like this: "It's going to take time and a good deal of research to develop material for you people to put out to the public." We wouldn't need extension agents if we waited that long! We must be concerned about that backlog of information, accumulated over the last half century, still sitting in the archives, that has not been distributed in a form which the public can utilize. I feel that if the researcher has finished his job, we in extension wouldn't be necessary because the material would have gotten to the public. However, this material often stops in the highest-class academic publication available. The most important source of material that I use with my audience, I identify as industrial intelligence. People that are in the business of producing ideas and materials for the public are quite quick to get them to the potential user. Our function is not only getting information to the user, but weighing its importance very carefully. We've gotten into some significant work in Alaska in this manner. Often, types of equipment or material that were not at all applicable were being pushed and utilized to the detriment of the fishing industry.

I also utilize the State Regional Laboratories as a source of information because they are much closer to the problems at hand. Frankly, academic research is the least productive area as far as the needs of my audience are concerned.

I view marine extension somewhat differently from the educator or research worker. I look on it as the center of the Sea Grant structure. This may be an egocentric view of the importance of extension, I admit, but it follows something that Captain Jaeger succinctly pointed out. Information transfer is a two-way street. He frequently identifies problems that are of some magnitude. People working in the marine industry commonly identify problems that should and could be solved by communication through extension or advisory individuals to the research community. If this system works the way it should it could be a beautiful structure. Unfortunately, right now I think we have a bottleneck structure. There are just too few of us to carry the information in both directions, We're probably acting more as a bottleneck than a relief valve. I feel that anybody interested in marine extension or advisory service and Sea Grant should consider this limitation very carefully.

John P. Doyle

REMARKS

A number of people attending this conference appear to have a limited understanding of Extension or advisory services. My understanding and knowledge of some aspects of Sea Grant activities is also limited.

The advisory aspect of the Sea Grant Program must function in the most effective and efficient manner, if we are to provide training and information to marine audiences. We must somehow strengthen the working relations between institutions and agencies so that "the delivery system" will achieve the greatest efficiency and effectiveness. Utilizing the capabilities of existing agencies, institutions, and groups may mean working closely with, or perhaps through, the State Cooperative Extension Services, as is done in Oregon. In some instances, other agencies possessing good delivery capabilities may be utilized or developed. Regardless of who takes the lead, it is vital that all groups have the opportunity to contribute toward delivering the best possible information and training services to the target audiences.

For those who are interested in learning more about the capabilities of the Extension Service, I refer you to a recent report entitled, "A People and a Spirit" (a report of a Joint USDA-NASULGC Extension Study Committee, November 1968). I would be happy to share additional information concerning Extension's present involvement in educational activities relating to fish and wildlife.

My prime interest is to assist in providing the needed educational and training services to marine audiences. The demand for such information and service was eloquently pointed out by Captain Sigfryed Jaeger and others who have commented here today.

J. David Almand

Several times now we've heard the question "Why can't someone figure out a way of getting a good quality fish on the market?" I think this points out something that we, at OSU, have considered vital to our Sea Grant program. If we want to do anything really constructive for our fishing industry, it has to be done with a true interdisciplinary teamwork effort.

We food technologists, by ourselves, are completely helpless in trying to "get a good quality fish on the market." To do an effective job one has to consider such things as fishing, financing, processing, transportation, retailing, advertising, government regulation, consumer acceptance, and people, to name just a few. If we want to "pick up" this industry we have to work on it's entire structure.

What I'm saying is that only an interdisciplinary team of specialists can hope to really accomplish anything. If we try it alone, we are sure to fail. This philosophy prevails at Oregon State University, and I think it is the real intent of the National Sea Grant Act for all marine programs."

Ken Hilderbrand

A recommendation was made at the Second Sea Grant Conference to establish an organization that would tie together the institutions involved in Sea Grant programs. Dr. John Knauss, University of Rhode Island, was asked to serve as chairman *pro tem* of a group that was assigned to look into this matter. A special committee was appointed to work out the organizational format. The organizational committee, chaired by Dr. Nelson Marshall, was allowed time at this Third Sea Grant Conference to report on their findings and entertain comments from conference attendees desiring to become involved in such an organization. A provisionary copy of articles of incorporation was circulated to stimulate and guide comments. Subsequent to the Third Sea Grant Conference, the organizational committee prepared and submitted final copies of the articles of organization to all conference attendees. These same articles are included in this proceedings as a record of this committee's functioning.

ARTICLES OF ORGANIZATION

OF THE

ASSOCIATION OF SEA GRANT PROGRAM INSTITUTIONS

NAME. The name of this association shall be the Association of Sea Grant Program Institutions ("Association" herein).

PURPOSES. The purposes of the Association shall be:

A. To further the optimal development, use, and conservation of marine and coastal resources (including those of the Great Lakes), and to encourage increased accomplishment and initiative in related areas.

B. To increase the effectiveness of member institutions in their work on marine and coastal resources (including those of the Great Lakes).

C. To stimulate cooperation and unity of effort among members.

MEMBERSHIP.

A. *Eligibility.* The Association shall be composed of two classes of members: (1) Regular Members, and (2) Associate Members.

1. *Regular Members.* The following shall be eligible for Regular Membership:

a. Organizations receiving Sea Grant institutional or coherent project support; and

b. All chartered degree-granting institutions interested in the Sea Grant Program concept.

2. *Associate Members.* Upon approval by the National Council, other organizations and agencies interested in continuing an active association with these institutions in furthering the Sea Grant Program concept shall be eligible for Associate Membership.

B. *Delegates.*

1. *Eligibility and Appointment.* The President of chief executive officer of each Regular and Associate Member in good standing shall represent his institution as a delegate in the affairs of the Association, or he may appoint an individual employed by his institution as the delegate in his place. Any such appointment shall be made in writing to the president of the Association.

2. *Participation by Non-Delegates.* Individuals, other than delegates, who are regularly employed by Regular or Associate Members may participate in the activities of the Association. By appointment or election they may serve on committees or other supporting bodies of the Association, other than the National Council and the Executive Committee.

3. *Termination of Employment Status.* If any Regular or Associate Member shall terminate the employment status of any individual serving as an officer, Council member, committee member, or in any other supporting capacity, then the position held by such individual shall be declared vacant as of the date of such termination and the vacancy shall be filled according to provisions of these Articles that relate to the particular position concerned.

C. *Annual Meeting.* The Association shall hold at least one meeting in every calendar year, to be designated as the Annual Meeting of the Association. Notice of the time and place of the Annual Meeting shall be given to all members by the Executive Committee at least ninety (90) days prior to the meeting.

OFFICERS. The officers of the Association shall be a President and a President-Elect. The President and President-Elect shall be employees of Regular Members.

A. *President.*

1. *Election.* The President-Elect of the Association shall assume the office of President of the Association at the close of the Annual Meeting following election of his successor as President-Elect.

2. *Term of Office.* The President shall serve for one (1) year.

3. *Duties.* The duties of the President shall be:
   a. To preside at meetings of the Association, the National Council, and the Executive Committee;
   b. To serve as a member and chairman of the Executive Committee;
   c. To exert leadership in effecting the purposes of the Association and in fulfilling directives from the National Council or the Executive Committee;
   d. To present a president's report at each Annual Meeting covering activities of the Association during his term of office; and
   e. To ensure such meetings by States and territories as are necessary to provide for election of representatives to the National Council.

B. *President-Elect.*

1. *Election.* Candidates for the office of President-Elect shall be nominated by the nominating committee. Notice of such nominations shall be given by the nominating committee to all members of the National Council at least ninety (90) days prior to the Annual Meeting. Additional candidates for the office of President-Elect may be nominated by members of the National Council. Notice of such additional nominations shall be given to all other members of the National Council at least sixty (60) days prior to the Annual Meeting. The President-Elect shall be selected from among the nominees by majority vote of the National Council during the Annual Meeting of the Association. The President-Elect shall assume office at the close of the Annual Meeting during which he was elected.

2. *Term of Office.* The President-Elect shall serve for one (1) year.

3. *Duties.* The duties of the President-Elect shall be:
   a. To serve as a member of the Executive Committee;
   b. To familiarize himself with the work of the Association in order to render his ensuing service as President of the Association more effective;
   c. To present to the Executive Committee for its advice and approval a list of nominees for membership on the Associations's standing and special committees at least thirty (30) days prior to the Annual Meeting following his election as President-Elect; and
   d. To announce to the Annual Meeting immediately following which he assumes the office of President the membership of the Association's standing and special committees.

NATIONAL COUNCIL. The National Council shall be the principal deliberative, policy-making, and legislative body of the Association. No organ of the Association other than the National Council is authorized to take policy or legislative action in the name of the Association, except on the express direction of the National Council. Meetings of the National Council shall be open to participation, without vote, to delegates not members of the National Council.

A. *Election.* The National Council shall consist of the following members:

1. One delegate from each member having Sea Grant institutional support.

2. One delegate from each State or Territory of the United States to be selected in the following manner:
   a. At the Annual Meeting of the Association the delegates from each State and Territory shall nominate, from the roster of delegates from Regular Members, other than those receiving institutional support, three persons for election to the National Council. The number of such nominees shall not exceed the number of such members in such State or Territory;
   b. One of the nominees from each such State or Territory shall be elected by a majority vote of the Regular and Associate Members of the Association from such State or Territory.

3. The President and President-Elect of the Association if they are not otherwise members of the National Council.

B. *Alternate Delegates.* Member institutions with a delegate on the National Council may appoint an alternate delegate with proxy voting rights if the regular delegate cannot attend a council meeting.

C. *Term of Office.* Members of the National Council shall serve for one (1) year.

D. *Meetings.*

1. *Regular Meetings.* The National Council shall meet concurrently with the Annual Meeting.

2. *Special Meetings.* Special meetings of the National Council may be held from time to time upon call of the Executive Committee. At least thirty (30) days notice of the time and place of such special meeting shall be given in writing to each Regular and Associate Member. The purpose of any such special meeting shall be specified in the notice.

3. *Quorum.* A majority of the total membership of the National Council shall constitute a quorum.

COMMITTEES.

A. *Executive Committee.*

1. *Composition.* The Executive Committee of the Association shall consist of:
   a. The President of the Association, who shall be chairman of the Executive Committee;
   b. The President-Elect of the Association who shall be vice-chairman of the Executive Committee; and
   c. Five additional members, at least three (3) of whom must be delegates from organizations

receiving Sea Grant institutional support, to be elected by the National Council at its meeting concurrent with the Annual Meeting.

2. *Term of Office.* Members of the Executive Committee, other than the President and President-Elect, shall serve for two (2) years. Terms shall be staggered so that the five additional members are elected in groups of two and three in alternate years. Two members of the first Executive Committee shall be elected for terms of one (1) year only.

3. *Duties.* The duties of the Executive Committee shall be:

a. To determine the time and place of the Annual Meeting and other meetings of the Association and to give notice thereof;

b. To act for the Association between Annual Meetings in all matters of business except matters of policy;

c. To act for the Association between Annual Meetings in matters of policy upon specific request by the National Council;

d. To undertake general arrangements for and conduct of all Annual and Special meetings of the Association, and all meetings of the National Council, including the preparation of agenda for such meetings;

e. To prepare a report of its interim activities and to submit the same to each Regular and Associate Member within thirty (30) days after each Executive Committee meeting;

f. To promptly elect a President or President-Elect of the Association should these offices become vacant in the interim between Annual Meetings; and

g. To fill vacancies in the Executive Committee.

4. *Meetings.*

a. *Regular Meetings.* The Executive Committee shall meet at least once each year prior to the Annual Meeting of the Association.

b. *Special Meetings.* Special meetings of the Executive Committee may be held from time to time upon call of the chairman, or by written request of a majority of the members of the Executive Committee. At least fifteen (15) days notice of the time and place of such special meeting shall be given in writing to each member of the Executive Committee. The purpose of any such special meeting shall be specified in the notice.

c. *Quorum.* A majority of the total membership of the Executive Committee shall constitute a quorum.

B. *Standing Committees.* Standing committees, including a nominating committee and others as directed by the National Council or Association with the advice and approval of the Executive Committee.

C. *Special Committees.* Special committees may be appointed by the President of the Association in his executive capacity or by direction from the National Council or the Executive Committee. The President shall promptly notify the Executive Committee of any such appointment.

D. *Joint Committees.* Joint committees with other organizations, as directed by the National Council or the Executive Committee, shall be appointed by the President of the Association with the advice and approval of the Executive Committee.

E. *Vacancies.* Vacancies occurring in any Association committees, other than the Executive Committee, shall be filled by the President with the advice and approval of the Executive Committee.

FINANCIAL.

A. The dues for the various membership categories within the Association shall be fixed by the Executive Committee subject to approval by the National Council.

B. At each Annual Meeting the Executive Committee shall prepare and submit to the National Council for approval a budget for the ensuing fiscal year.

C. Funds on deposit at the end of any fiscal year shall be carried forward into the following fiscal budget.

D. No institution shall be entitled to representation or participation in the benefits of the Association unless such institution shall have paid the membership fee for the year prior to that for which such question of privilege shall arise, or shall have had said payment remitted by vote of the National Council.

E. An independent audit of the books of the Association shall be conducted at least annually by a reputable firm of certified public accountants selected by the Executive Committee.

PARLIAMENTARY AUTHORITY. The latest edition of *Sturgis Standard Code of Parliamentary Procedure* shall govern this Association and all of its organs in all cases to which they are applicable and in which they are not inconsistent with the provisions of these Articles.

AMENDMENT. These Articles of Organization may be amended at any Annual Meeting of the Association by a two-thirds (2/3) vote of the National Council. Notice of any proposed amendment, together with the full text thereof and the name and address of the proponent, shall be given to all members of the Association at least ninety (90) days prior to the Annual Meeting.

DISSOLUTION. This Association may be dissolved as provided by law or by vote of three-fourths (3/4) of the National Council at any Annual Meeting.

In the event of dissolution, whether by operation of law or by vote of the National Council, all debts of the

Association shall first be paid and any remaining balance shall be distributed to the then members of the Association in proportion to their membership fee contributions for the fiscal year immediately preceding the dissolution.

ENTRY INTO FORCE OF THESE ARTICLES. This Association shall come into existence upon receipt by the President pro-tem of twenty (20) written acceptances of these Articles by entities eligible for Regular Membership in the Association including at least five (5) acceptances from organizations receiving Sea Grant institutional support.

Within one hundred and twenty (120) days following receipt of the required written acceptances, the President pro-tem shall call the first Annual Meeting of the Association. The notice shall be sent to all entities accepting these Articles, to all entities sending representatives to the Third Annual Sea Grant Conference held in Portland, Oregon, on March 5-6, 1970, and to all other such entities as the President pro-tem may select. The notice shall (1) specify the receipt of the twenty acceptances, (2) specify the names of the institutions so accepting, and (3) give ninety (90) days notice of the time and place of such first Annual Meeting.

ABBOTT, Robert R.
University of Washington
Fisheries Research Institute
Seattle, Washington 98105

ABEL, Robert
Director, Sea Grant Programs
National Science Foundation
1800 G Street N.W.
Washington, D.C. 20550

ALLEN, George G.
Humboldt State College
Arcata, California 95521

ALMAND, J. David
U.S. Department of Agriculture
Federal Extension Service
Washington, D.C. 20250

ALVERSON, Dayton Lee
U.S. Department of Interior
Bureau of Commercial Fisheries
Washington, D.C. 20240

ARNOLD, Victor
University of Wisconsin
Marine Studies Center
Madison, Wisconsin 53715

BABBITT, J.K.
Oregon State University
Department of Food Science & Technology
Corvallis, Oregon 97331

BANERJEE, Tapan
Southern Maine Vocational
Technical Institute
Ford Road
South Portland, Maine 04106

BECKER, Peter
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

BEER, Charles
U.S. Department of Agriculture
14th & Independence Ave., S.W.
Washington, D.C. 20250

BERGERON, Jim
Clatsop Community College
Marine Technology Department
Astoria, Oregon 97103

BERTRAND, Jerry
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

BISH, Robert L.
University of Washington
Graduate School of Public Affairs
Seattle, Washington 98105

BLOCK, John H.
Oregon State University
Department of Pharmacy
Corvallis, Oregon 97331

BLUMENFELD, Irving
University of Washington
Information Services
Seattle, Washington 98105

BOND, Carl
Oregon State University
Department of Fisheries and Wildlife
Corvallis, Oregon 97331

BOULANGER, Leo W.
University of Maine
6 Winslow Hall
Orona, Maine 04473

BOWMAN, Kenneth
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

BRETSCHNEIDER, Charles L.
University of Hawaii
2565 The Mall
Honolulu, Hawaii 96822

BUGUS, Ted
Bumble Bee Seafoods
P.O. Box 60
Astoria, Oregon 97103

BURGESS, Fred
Oregon State University
Head, Department of Civil Engineering
Corvallis, Oregon 97331

BURRELL, V.G., Jr.
Virginia Institute of Marine Sciences
Gloucester Point, Virginia 23062

BUSBY, Joe N.
University of Florida
1038 McCarty Hall
Gainesville, Florida 32601

BUTLER, Jerry A.
Oregon State University
Department of Fisheries & Wildlife
Corvallis, Oregon 97331

BYRNE, John V.
Oregon State University
Chairman, Department of Oceanography
Corvallis, Oregon 97331

CALDWELL, Richard
Oregon State University
Department of Fisheries & Wildlife
Corvallis, Oregon 97331

CANNON, Kessler
Office of the Governor
Salem, Oregon 97310

CAPLAN, Ron
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

CASTLE, Emery N.
Oregon State University
Head, Department of Agricultural Economics
Corvallis, Oregon 97331

CHAN, Gordon L.
College of Marin
Marine Technology
Kentfield, California 94904

CHAPMAN, Duane
Highline College
Midway, Washington 98031

CHATLAND, H.
Sylvania
Box 188
Mt. View, California 94022

CHOATE, Thomas V.
The Sippican Corporation
Barnabas Road
Marion, Massachusetts

CLARK, Willis H.
Texas A & M University
Office of Sea Grant Programs
College Station, Texas 77843

CONSTANTINE, G. H., Jr.
Oregon State University
School of Pharmacy
Corvallis, Oregon 97331

CONTE, Frank P.
Oregon State University
Department of Zoology
Corvallis, Oregon 97331

COUCH, Richard
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

COX, Joe
Oregon State University
Extension Services
Corvallis, Oregon 97331

CRAWFORD, David L.
Program Director
Seafoods Laboratory
250 25th Street
Astoria, Oregon 97103

CRONIN, Eugene
University of Maryland
12 Mayo Avenue, Bay Ridge
Annapolis, Maryland 21403

CUMMINGS, Maynard W.
University of California
Department of Zoology
Davis, California 95616

CUTSHALL, Norman
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

DAIBER, Franklin C.
University of Delaware
Marine Laboratories
Newark, Delaware 19711

DEAN, David
University of Maine
Darling Center
Walpole, Maine 04573

DEHLINGER, Peter
University of Connecticut
Groton, Connecticut 06340

DILLE, J.M.
University of Washington
School of Medicine
Seattle, Washington 98105

DOLE, Hollis
Assistant Secretary of Interior
for Mineral Resources
6654 Interior Building
Washington, D.C. 20040

DONALDSON, John R.
Oregon State University
Department of Fisheries & Wildlife
Corvallis, Oregon 97331

DONALDSON, Lauren R.
University of Washington
College of Fisheries
Seattle, Washington 98105

DOYLE, Jack
University of Alaska
College, Alaska 99701

DWORSKY, Leonard B.
Cornell University
468 Hollister Hall
Ithaca, New York 14850

ECHOLS, Louie
University of Wisconsin
1762 Van Hise Hall
Madison, Wisconsin 53706

EDWARDS, Robert
Assistant Director
Bureau of Commercial Fisheries
Washington, D.C. 20240

ELLIKER, Paul R.
Oregon State University
Department of Microbiology
Corvallis, Oregon 97331

ELSBREE, Captain J.S.
Clatsop Community College
Coordinator, Marine Technology
Astoria, Oregon 97103

ENGESSER, Bill
Oregon State University
Department of Industrial Engineering
Corvallis, Oregon 97331

EVANS, Gwil O.
Oregon State University
Sea Grant Information
Corvallis, Oregon 97331

FARRIS, David A.
San Diego State College
Department of Biology
San Diego, California 92115

FISHER, R. Barry
Marine Science Center
Newport, Oregon 97365

FLITTNER, Glenn A.
San Diego State College
Director, Bureau of Marine Sciences
San Diego, California 92115

FLYNN, Joan
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

FORSS, Carl A.
Walla Walla College
Department of Biology
College Place, Washington 99324

FOWLER, Jerry
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

FROLANDER, Herbert F.
Oregon State University
Coordinator, Sea Grant Programs
Corvallis, Oregon 97331

GILES, Don
Marine Science Center
Newport, Oregon 97365

GORTER, Wytze
University of Hawaii
2540 Maile Way
Honolulu, Hawaii 96822

GRAY, John
Omark Industries, Inc.
9701 S.E. McLoughlin Boulevard
Milwaukie, Oregon 97222

GRAY, Walter J.
University of Rhode Island
Narragansett Bay Campus
Narragansett, Rhode Island 02882

GREEN, James H.
New England Institute for
Medical Research
Ridgefield, Connecticut 06877

GUNTHER, Fred
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

HALE, Stuart O.
University of Rhode Island
Graduate School of Oceanography
Kingston, Rhode Island 02881

HALL, James D.
Oregon State University
Department of Fisheries & Wildlife
Corvallis, Oregon 97331

HAMILTON, Stanley
Division of State Lands
20 Agriculture Building
Salem, Oregon 97310

HANNIFIN, Patrick J.
Rear Admiral
Commandant, 13th Naval District
Seattle, Washington 98115

HANSEN, George H.
Washington Water Pollution Control
Committee
Olympia, Washington 98501

HARRIMAN, Donald M.
Marine Sea & Shore Fisheries Department
Newagen, Maine 04552

HARRIS, Alva
Nicholls State College
Department of Biological Science
Thibodau, Louisiana 70301

HARRIS, Robert E.
University of Washington
Division of Marine Resources
Seattle, Washington 98105

HASKIN, Harold H.
Rutgers University
Department of Zoology
New Brunswick, New Jersey 08902

HEDDEN, Gregory D.
University of Wisconsin
432 N. Lake Street
Madison, Wisconsin 53711

HEIKKILA, Paul
Coos County Extension Office
Courthouse
Coquille, Oregon 97423

HENRY, Robert F.
University of Washington
Seattle, Washington 98105

HERBICH, John B.
Texas A & M University
Department of Civil Engineering
College Station, Texas 77843

HESS, Harold D.
U.S. Bureau of Mines
P.O. Box 36012
San Francisco, California 94102

HIGMAN, James
University of Miami
Institute of Marine Sciences
Miami, Florida 33149

HILDERBRAND, Ken
Marine Science Center
Newport, Oregon 97365

HOLMES, Robert W.
University of California
Marine Science Institute
Santa Barbara, California 93106

HOOD, Donald W.
University of Alaska
Institute of Marine Science
College, Alaska 99701

HOOPER, Frank F.
University of Michigan
Department of Wildlife and Fisheries
Ann Arbor, Michigan 48104

HORTON, Edward E.
President, Deep Oil Technology, Inc.
1607 West Water Street
Long Beach, California 90802

HORTON, Howard F.
Oregon State University
Department of Fisheries and Wildlife
Corvallis, Oregon 97331

INSINGER, F. Robert
Western Fishboat Owners Association
4904 North Harbor Drive
San Diego, California 92106

JACOBSON, Bob
Marine Science Center
Newport, Oregon 97365

JACOBSON, Jon L.
School of Law
University of Oregon
Eugene, Oregon 97403

JAEGER, Sigfryed
S/V "Seattle" & owners
12519 Corliss Avenue, North
Seattle, Washington 98133

JAMES, Bill
Clatsop Community College
Astoria, Oregon 97103

JAMISON, David W.
Washington State Department
of Natural Resources
P.O. Box 168
Olympia, Washington 98501

JENSEN, Leland
Oregon State University
Department of Electrical Engineering
Corvallis, Oregon 97331

JOHANSEN, George
Alaska Fishermen's Union
2505 First Ave., Room 3
Seattle, Washington 98121

JOHNSON, Vernon G.
Oregon State University
Corvallis, Oregon 97331

JOHNSTON, Richard S.
Oregon State University
Department of Agricultural Economics
Corvallis, Oregon 97331

JOSEPH, Edwin B.
Virginia Institute of Marine Science
Gloucester Point, Virginia 23602

JUNTUNEN, Erland T.
Oregon State University
Department of Fisheries & Wildlife
Corvallis, Oregon 97331

KATZEL, Jeanine
University of Wisconsin
Marine Studies Center
Madison, Wisconsin 53706

KERNS, O.E., Jr.
Bumble Bee Seafoods
Box 30, University Station
Seattle, Washington 98105

KNAUSS, John
University of Rhode Island
Graduate School of Oceanography
Kingston, Rhode Island 02881

KNIGHT, Gary
Louisiana State University
Law Center
Baton Rouge, Louisiana 70803

KOLAR, Michael
Oregon State University
Department of Engineering
Corvallis, Oregon 97331

KRILL, Karl E.
University of Wisconsin
Dean, Graduate School
Milwaukee, Wisconsin 53201

KULM, Vern
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

LANGMO, Don
Oregon State University
Department of Agricultural Economics
Corvallis, Oregon 97331

LEE, Donald
Oregon State University
Department of Food Science & Technology
Corvallis, Oregon 97331

LEE, Jong S.
Oregon State University
Department of Food Science & Technology
Corvallis, Oregon 97331

LEWIS, Billy G.
Shoreline Community College
160101 Greenwood Ave.
Seattle, Washington 98133

LINS, Wesley
Lamar State College of Technology
Beaumont, Texas 77700

LONG, Bill L.
National Council on Marine Resources
& Engineering Development
Executive Office
Washington, D.C. 20550

LYMAN, John
University of North Carolina
School of Public Health
Chapel Hill, North Carolina 27514

MALOUF, Robert E.
Oregon State University
Department of Fisheries & Wildlife
Corvallis, Oregon 97331

MARGULES, Trudy
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

MARSHALL, Nelson
University of Rhode Island
Graduate School of Oceanography
Kingston, Rhode Island 02881

MASON, John
Pacific Northwest Bell
421 Oak
Portland, Oregon 97200

MATHIESON, A.C.
University of New Hampshire
Department of Botany
Durham, New Hampshire 03814

MATTHEWS, James W.
University of Alaska
College, Alaska 99701

MATTOX, Bruce W.
Oregon State University
Department of Agricultural Economics
Corvallis, Oregon 97331

MAYO, Ronald D.
Kramer, Chin & Mayo
Consulting Engineers
1917 First Ave.
Seattle, Washington 98101

McCALL, Governor Thomas
State Capitol
Salem, Oregon 97310

McCAULEY, James
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

McFADDEN, James T.
University of Michigan
Water Resources and Marine Sciences
Program
Department of Wildlife and Fisheries
Ann Arbor, Michigan 48104

McINTYRE, John D.
Oregon State University
Department of Fisheries and Wildlife
Corvallis, Oregon 97331

McKERNAN, Donald
Special Assistant to Secretary State
Department of State
Office of Fisheries and Wildlife
Washington, D.C. 20520

McNABB, C.D.
Michigan State University
Department of Fisheries and Wildlife
East Lansing, Michigan 48823

McNEIL, William J.
Head, Pacific Fisheries Laboratory
Marine Science Center
Newport, Oregon 97365

MERCHANT, Howard C.
University of Washington
Department of Mechanical Engineering
Seattle, Washington 98105

MILLEMAN, Raymond E.
Oregon State University
Department of Fisheries & Wildlife
Corvallis, Oregon 97331

MILOY, Leatha
Texas A & M University
Sea Grant Program Office
College Station, Texas 77843

MONKMEYER, Peter
University of Wisconsin
Marine Studies Center
Madison, Wisconsin 53706

MOORE, D.K.
Naval Material Command Suite 402
732 N. Washington Street
Alexandria, Virginia 22314

MOORE, Harvey L.
Bureau of Commercial Fisheries
6116 Arcade Building
Seattle, Washington 98101

MOORE, J.R.
University of Wisconsin
Marine Studies Center
Madison, Wisconsin 53706

MORSE, R.M., Commander, U.S. Coast Guard
Chief, Oceanography Branch
Marine Sciences Division
Department of Transportation
U.S. Coast Guard
Washington, D.C. 20591

MULLEN, Lt. JG James N
Aide to the Commandant
13th Naval District
Seattle, Washington 98115

MURPHY, Stanley R.
University of Washington
Division of Marine Resources
Seattle, Washington 98105

NELLOR, John E.
Michigan State University
238 Administration Building
East Lansing, Michigan 48823

OLSON, Robert E.
Oregon State University
Department of Zoology
Corvallis, Oregon 97331

OTT, Alvin
Oregon State University
Department of Fisheries and Wildlife
Corvallis, Oregon 97331

PADAN, John W.
U.S. Bureau of Mines
Marine Minerals Technology Center
Tiburon, California 97920

PAINE, F. Ward
459 Hamilton Avenue
Palo Alto, California 94301

PAINE, Roland, D., Jr,
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

PANSHIN, Daniel A.
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

PEARCY, William
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

PEREYRA, Walter T.
Bureau of Commercial Fisheries
2725 Montlake Boulevard, East
Seattle, Washington 98102

PFANNSTIEL, Daniel C
Texas A & M University
1204 Glade Street
College Station, Texas 77840

PIGOTT, George M.
University of Washington
Institute for Food Science & Technology
College of Fisheries
Seattle, Washington 98105

POPENOE, Hugh
University of Florida
2001 McCarty Hall
Gainesville, Florida 32601

POSNER, Gerald S.
City University of New York
Convent Avenue & 138th Street
New York, New York 10031

PRATT, Ivan
Oregon State University
Department of Zoology
Corvallis, Oregon 97331

PRICE, Robert J.
Oregon State University
Department of Food Science & Technology
Corvallis, Oregon 97331

QUICK, Gordon L.
Clover Park Education Center
Vocational-Technical Division
4500 Steilacoom Boulevard, S.W.
Lakewood Center, Washington 98499

RAE, K.M.
University of Alaska
College, Alaska 99701

RAGOTZKIE, Robert A.
University of Wisconsin
Marine Studies Center
Madison, Wisconsin 53706

RETTIG, Bruce R.
Oregon State University
Department of Agricultural Economics
Corvallis, Oregon 97331

RIDENHOUR, Richard
Humboldt State College
Arcata, California 95521

RIPPEY, John N.
University of Rhode Island
16 Woodward Hall
Kingston, Rhode Island 02281

ROBARE, David W.
Seattle Community College
1718 Broadway
Seattle, Washington 98122

ROTTLER, J.C.
Northwest Instrument Company
5245 Shilshole Avenue, N.W.
Seattle, Washington 98107

ROYCE, William F.
University of Washington
College of Fisheries
Seattle, Washington 98105

RULLAND, T.J.
University of Wisconsin
Marine Studies Center
Madison, Wisconsin 53706

SAINSBURY, John C.
University of Rhode Island
Kingston, Rhode Island 02881

SANDERSON, Albert E., Jr.
Maryland Department of Water Resources
State Office Building
Annapolis, Maryland 21032

SCHONING, Robert W.
Director
Fish Commission of Oregon
1400 S.W. Fifth Avenue
Portland, Oregon 97201

SCOTT, Robert
Oregon State University
Department of Fisheries and Wildlife
Corvallis, Oregon 97331

SCOTT, Thomas G.
Oregon State University
Head, Department of Fisheries and Wildlife
Corvallis, Oregon 97331

SERWOLD, John C.
Shoreline Community College
16101 Greenwood Avenue, North
Seattle, Washington 98133

SHEHADEH, Ziad H.
The Makapuu Oceanic Center
Waimanalo, Hawaii 96795

SHERBOURNE, John E.
Associate Director of Research
Union Oil Company of California
Brea, California 92621

SHOR, George G., Jr.
University of California
Scripps Institution of Oceanography
LaJolla, California 92037

SINNHUBER, Russel O.
Oregon State University
Department of Food Science & Technology
Corvallis, Oregon 97331

SMALL, Lawrence F.
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331

SMITH, Fred
Oregon State University
Department of Agricultural Economics
Corvallis, Oregon 97331

SQUIRES, Donald F.
State University of New York
Marine Sciences Research Center
Stony Brook, New York 11790

ST. AMANT, Lyle S.
Assistant Director
Louisiana Wildlife and Fisheries
Commission
400 Royal Street
New Orleans, Louisiana 70130

STEEL, Ronald
Oregon State University
Department of Food Science & Technology
Corvallis, Oregon 97331

STEVENS, Joe B.
Oregon State University
Department of Agricultural Economics
Corvallis, Oregon 97331

STEWART, Harris B., Jr.
ESSA - Atlantic Oceanographic &
Meteorological Labs
901 South Miami Avenue
Miami, Florida 33130

STIFFLER, L.E.
University of Delaware
Director, Civil Engineering
Newark, Delaware 19711

STRAUB, Robert W.
Treasurer, State of Oregon
State Capitol
Salem, Oregon 97310

TAUB, Freida B.
University of Washington
College of Fisheries
Seattle, Washington 98105

TIBBY, Richard B.
University of Southern California
Director, Catalina Marine Science Center
University Park
Los Angeles, California 90007

VAN HYNING, Jack M.
University of Alaska
College of Biological Sciences
College, Alaska 99701

VAN LOPIK, Jack R.
Louisiana State University
Office of Sea Grant Development
Coastal Studies Building
Baton Rouge, Louisiana 70803

VERHOEVEN, Leon A.
Pacific Marine Fisheries Commission
1400 S.W. Fifth Avenue
Portland, Oregon 97201

VERNBERG, F. John
University of South Carolina
Director Belle W. Baruch Institute
for Estuarine & Littoral Science
Columbia, South Carolina 29208

WAKEFIELD, Lowell
Wakefield Seafoods, Inc.
Port Wakefield, Alaska 99605

WICK, William Q.
Program Leader
Marine Advisory Program
Marine Science Center
Newport, Oregon 97365

WILDMAN, Robert D.
Sea Grant Program Office
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

WILSON, Charles
Oregon State University
Dean, School of Pharmacy
Corvallis, Oregon 97331

YAGLE, Raymond A.
University of Michigan
Department of Naval Architecture
and Marine Engineering
Ann Arbor, Michigan 48104

YOUNG, Roy A.
Oregon State University
Acting President
Corvallis, Oregon 97331

YOUNGKEN, Herber W.
University of Rhode Island
College of Pharmacy
Kingston, Rhode Island 02881

YU, T.C.
Oregon State University
Department of Food Science & Technology
Corvallis, Oregon 97331

ZIMMERMAN, Steve
Oregon State University
Department of Oceanography
Corvallis, Oregon 97331