6th National Sea Grant Conference

proceedings

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University of Delaware Sea Grant Program
College of Marine Studies
University of Delaware
Newark, Delaware 19711

DEL-SG-16-74

Sixth National Sea Grant Conference

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Acknowledgements

The sixth annual meeting of the Sea Grant Association, with its theme of "Shaping the Future", provided an impetus for defining the goals and future actions of the Association. In this regard specific topics were discussed and several recommendations were made. Dr. Wayne H. Tody was the recipient of the 1973 Sea Grant Award, a choice very appropriate to the theme of this year's program.

Since 1970 and the formation of the Sea Grant Association, the group has expanded to include 50 members, all dedicated to furthering the optimal development, use and conservation of marine and coastal resources.

The University of Delaware was the host institution for this sixth annual Sea Grant Association meeting. Meetings were held at the Clayton Conference Center on the University of Delaware campus in Newark. Some presentations which were made at the conference are not included in the proceedings because written reports were not available. Recordings were not made of any talks or panel discussions. However, a summary of each panel is included. Only those presentations which were available to the editors have been listed.

The executive committee of the Association and the University of Delaware as host express thanks to the following session chairmen and special workshop chairmen for their help in planning and conducting the conference: William S. Gaither, Erma Upham, Herbert F. Frolander, Tapan Banerjee, John Armstrong, William Q. Wick, Bruce Wilkins, James Sullivan, Ronald Stewart, Robert Stegner and Louie Echols.

Robert A. Ragotzkie
President of the Association
1972-73

The Association of Sea Grant Program Institutions

The Association of Sea Grant Program Institutions was formed on November 19, 1970 in Washington, D.C., as an organization of colleges, universities and other institutions concerned with the broad objectives of the National Sea Grant Program.

The Association's objectives are:

1. 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.

2. To increase the effectiveness of member institutions in their work on marine and coastal resources (including those of the Great Lakes).

3. To stimulate cooperation and unity of effort among members.

Presentation of the 1973 National Sea Grant Award

Dr. Wayne H. Tody, chief of the Fisheries Division of the Michigan Department of Natural Resources, was the recipient of the third National Sea Grant Award, presented by the Association of Sea Grant Program Institutions at their sixth annual meeting in Newark, Delaware, October 8-10, 1973. Following are the introductory remarks regarding Dr. Tody, made by Dr. John M. Armstrong, director of the University of Michigan Sea Grant Program.

Dr. Wayne H. Tody is chief of the Fisheries Division of the Michigan Department of Natural Resources.

Tody was born in Goodrich, Genesee County, Michigan, October 24, 1924. He received his Bachelor of Science degree in Forestry in 1946, and his Master's degree in Fisheries in 1950 from the University of Michigan. In 1964, he received his Doctorate in Fisheries from Michigan State University.

His first position with the Department was with the Institute for Fisheries Research in Ann Arbor in 1947. He worked there until 1950, when he was placed in charge of the Rifle River Experimental Stream Improvement Project. After a year of being primarily responsible for getting the project going (which was the first of its kind in the U.S.), he moved to the Lansing office as supervisor of stream improvement projects. His promotion was rapid. In 1965, he was promoted to supervisor of the Lakes and Stream Improvement Section, and the next year was placed in charge of Species Management. In July of 1966, he was made chief of the Fisheries Division, a position he presently holds.

He played a very important role prior to being chief of his division, in the planning for and stocking of coho salmon in the vast Great Lakes that surrounded Michigan. After becoming chief, he increased his efforts at restoration of a historically depleted Great Lakes fishing resource, and chinook salmon were successfully introduced in the fall of 1966. This initial and innovative program was the turning point for a revolutionary redevelopment of the Great Lakes sport fishery.

Dr. Tody did not rest on the laurels his Fisheries Division had attained. When mature coho returned in the fall of 1967, he pushed ahead with broad plans for expansion. In 1968, with coho and chinook programs well underway in Lakes Michigan and Superior, Tody introduced salmon into the void of Lake Huron, a program just now coming into its own right.

Nor did Wayne stop with coho and chinook. He pushed the State's Hatchery Program into full capacity, providing steelhead, domestic rainbow, and brown trout for the Great Lakes. The program has since shown the foresight and vision with which Wayne is gifted. Steelhead fishing is at an all time high in the state and many excellent rainbow and brown trout fisheries are developing at various locations in the Great Lakes. The millions of new fishermen who are enjoying the results of this program are a testimony to the real benefit of this program.

In addition, Wayne forged ahead with plans for introducing Atlantic Salmon, the aristocrat of the salmon family. After touring and conferring with Canadian, Great Britain, and Swedish officials, Wayne obtained and introduced Atlantic salmon into both Lake Michigan and Lake Huron streams. The recent appearance of Atlantics in the sport catch in Lakes Huron and Michigan give optimism to his dream of a truly great and diverse sports fishery in the Lakes.

The Great Lakes are not the only place Wayne Tody has utilized his skills. Once again he has a program of his old love going in full swing--stream improvement. Along these lines he has also initiated an improvement program which includes the removal of old dams, so common to Michigan streams, to allow development of steelhead runs and the construction of low lamprey weirs to augment federal lamprey control programs.

A new and invigorating project recently introduced by Tody is a Five Point Metropolitan Fishing Program for the greater Detroit area. Through such a program, Tody hopes to bring fisheries to the door of Detroit urban residents. The initial thrust of the program already is being felt with the stocking of salmon and trout in the Detroit River, with the development of a fish-out program, and with the River Rehabilitation Projects well underway.

Tody has traveled extensively throughout North America and Europe studying fisheries management, genetic varieties of sport fishes, environmental administration, and land use. He has been influential in marine fisheries regulation and management and in 1969 was the recipient of the Heddon Hall of Honor Award.

I have had the pleasure of working directly with Wayne in several cooperative projects that our Michigan Sea Grant program is conducting with his department. I can attest to his unique perception of the real problems of resource management in the Great Lakes and his dedication to the goals of maintaining a rich and varied fishery resource.

Wayne's work has been in the finest tradition of attaining the Sea Grant goal: working for better utilization of marine resources and the enhancement of the marine and Great Lakes environment.

Table of Contents

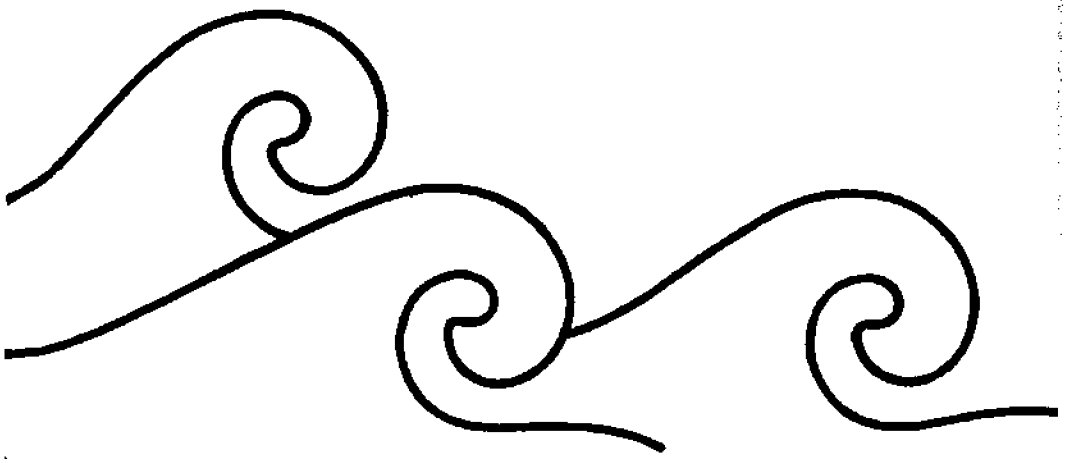
Coastal Zone Management

Energy From the Sea

Special Workshops

Appendix

THE SEA GRANT PROGRAM—AN OVERVIEW



What is the Purpose of the Annual Meeting?

Donald F. Squires
State University of New York

This is the sixth annual meeting of the Association of Sea Grant Institutions. While that sounds as though we have a long and glorious history, I believe that it is important to put this present meeting in some perspective. The first meeting, held in Rhode Island, preceded the formation of the Association, and in fact antedated the National Sea Grant Act of 1966. It was clearly a meeting of people interested in the Sea Grant concept. The second meeting, also held in Rhode Island, immediately followed passage of the Act and had much to do with the development of the Sea Grant concept--but still preceded the concept of an Association. At the third meeting, in Oregon, the Association existed--at least we were voting on the adoption of a constitution and determining what we were all about--but it was still very much a formative session. Then, by the time of the fourth meeting, in Wisconsin, the Association had form and substance and even a purpose. Our fifth meeting, in Houston, was the first in which the major preoccupation of attendees was something other than the business of getting an Association started. Even so, we are still finding our way; in the discussions here at Delaware, you will notice we are seeking to define a role and goals.

What is the purpose of a meeting such as this? Among actually many purposes, the principal one is serving the need for communication between those institutions engaged in carrying out the ideals of Sea Grant. As the Association matures, there will be a shift from organizational and inward-focused activities to outward expressions of what Sea Grant is and what it has accomplished. We are a new organization--in fact, a very new concept in this nation--and can be excused for some groping.

Putting together the framework of a conference like this so that the communication will really happen is quite a process, as

those of you who've done it know. Selecting the host institution and setting a date are formidable tasks. If you look in the back pages of the journal *Science* you will find long listings of meetings being held all over the world. The calendar is crowded. There are those who say that the chief activity of scientists is going to meetings, but I will come back to that point. Because we in Sea Grant were feeling the pinch of national austerity, we were economy-conscious and pressed for a tightly compacted meeting--and that is why we are getting up so early in the morning!

The Program Committee worked most on the theme and the structure of the meeting. The theme "Shaping the Future" pointed us toward technical sessions dealing with those areas of Sea Grant concern having a national impact. We also wanted to design into the program a balance of activities to serve the very broad range of Sea Grant interests--from Advisory Services through many, many research subject areas.

Thus the meeting is structured to provide opportunities for technical exchange, for communication among participants, for exchange of experiences, for developing new working relationships; above all, it is an opportunity to get together at the national level. Dr. Upham in his earlier remarks stated that we need to get together at the local level with industry and local government. But there is also a need for us to share experiences broadly, to learn what others are doing and how we can diversify and improve our own activities. In many areas of Sea Grant, things are moving ahead rapidly, much too rapidly to keep current by traditional means of communication--publications and correspondence.

These are the reasons behind the agenda:

SHAPING THE FUTURE

Mariculture - Aquaculture Energy from the Sea Coastal Zone Management	Technical Sessions: designed interchange
Building the Association The Sea Grant Program-- An Overview	Association: inward focused events
Marine Education Advisory Services Legislation	Special Sessions: designed to meet specific needs
Annual Business Meeting	

It is important to note that the annual meeting of the Association of Sea Grant Institutions is only one of the several meetings going on here at Newark, Delaware. The Executive Committee of the Association will meet several times to conduct business; the Council of Sea Grant Program Directors will meet several times; there will be a meeting of the National Marine Advisory Services Advisory Committee; and numerous committees both of the Association

and other groups will use the opportunity to meet. Above all, in every corner of this building there are rump sessions going on: at dinners and lunches, at cocktails, between and during sessions, groups of individuals are getting together--sometimes for the only time until next year--to exchange information. These are the really significant interchanges and this is where the real business gets done. Countless ideas of new activities will be planted in these conversations.

In brief, the annual meeting's purpose is to be a very fine opportunity for a lot of people interested in Sea Grant to get together to talk about what is going on and how to do it better.

Communication is particularly important in a multifarious program such as Sea Grant, with so many parts: faculty and student researchers, advisory service staff, program managers, interested persons from industry and government, and concerned citizens. Being new we haven't yet fleshed out our Association, nor even the Sea Grant concept, with a body of people who should be vitally involved in Sea Grant but are missing from this meeting: we have lots of researchers and advisory service personnel, and program managers all over the place, but we have very few industry and governmental people there.

The seventh meeting of the Association is taking shape already. It will be in Seattle; the host institution, the University of Washington, has already submitted a proposal of 19-some pages to the Association. At the business meeting tomorrow, the President will appoint a new program committee, and the seventh meeting will be underway. We earnestly hope its planners will work to broaden the base of the meeting and to showcase to a wide audience the results of the Sea Grant Program.

The Sea Grant Program is a unique concept--internationally, nationally, and within the framework of the academic institutions participating in the program. We are doing things in new ways, striving to chart new directions of service to the nation. Because no one has ever done the things we are trying to do, we sometimes seem to move with ponderous slowness or with fits and starts. But we're making headway: the Sea Grant concept is gaining support and attracting attention elsewhere in the world. We are doing things for industry and for people through their governments. We are shaping the future.

A Unique Program: Sea Grant

Sidney Upham
Mississippi-Alabama Sea Grant Consortium

From the time of its conception, the Sea Grant Program has been unique. It all started when Web Chapman, Athelstan Spilhaus, Roger Revelle, Benny Schaefer, Fritz Koczy, and Sumner Pike were discussing the possibility of a marine oriented program and came up with the idea of Sea Grant. I believe it was Spilhaus who conceived the Sea Grant name. We have Land Grant Colleges, why not Sea Grant? So an idea was born which was to be picked up by the Congress of the United States when Senator Pell and his associates wrote the Sea Grant Bill. Again, it was unique. This was not a program to fund universities for research in the sea, it was a program designed to get things done, to solve problems, to put all the expertise of the universities to work in cooperation with industry, state, local and Federal Agencies already interested in or working in marine affairs.

Certainly there was a need for such a program. There was no central thrust of research or work in the marine field. There were some universities who had strong programs in the ocean, there were laboratories, state and Federal, that worked in marine projects but they were more or less alone, divided, each to his own interest. There was a great deal of repetition all over the country, a kind of hit or miss proposition as far as marine work was concerned. And so Sea Grant was born, with its directives to work in the marine area, to solve problems, to teach and to disseminate to the user the results of research. Again it was unique, the right people were on hand to run the program and to put the whole thing together. Certainly, I believe that Sea Grant would never have gotten off the ground without Bob Abel, Hal Goodwin, Bob Wildman and Art Alexiou and others who helped set up this program.

From the first, then, Sea Grant has drawn to itself an exciting group of people. People with ability to get things done, to do good work, people who seem to be inspired, and this is true throughout the whole Sea Grant System. The program has attracted not only

university personnel, but people from industry and from private life. People who have made it their life's work and people who want to help. Lawyers, fishermen, industrialists, legislators, mayors, county officials, and the list goes on. Why? Why did this happen? Why did Sea Grant rapidly become a people program welding the university expertise with people from all walks of life?

There was and is no doubt about it, Sea Grant differs from most national programs. For one thing, it was recognized at an early hour that there could be no national overall program spelled out in detail which would fit all of the coastal states. Guidelines were broad, perhaps sometimes too broad, but the chance to be innovative, to do the thing that was best for your state was definitely there. Yes, there were parameters set, one of the best which was started with Congress and has been growing ever since, get something done that somebody needs and is going to use to solve a problem. We were asked, what are you going to do with the results, who is going to use the results, what is going to be accomplished because you did this work? This wasn't heresy, but it was close to it. Research for the sake of research has been a war cry for a long while. It took a little getting used to and a lot of training in the system to finally arrive at a point where you began to comply with the Sea Grant directives. This does not mean that basic research is not done under Sea Grant. Where gaps in our knowledge exist, which need to be filled before we can go ahead with any development, Sea Grant is willing to fund projects to fill these gaps. The main push however, is to get a job done, educate the public and bring the fruits of research to the user. Finally, in all of this, a control bank of knowledge has been set up. People around the country are much more aware of what other states are doing: Repetition of work has been greatly reduced.

It is my own belief that Sea Grant is a people's program because it offered to many the opportunity to really do something; something for their community, their state, their country and mankind. A chance to really get results, to help certain marine industries, to help stop pollution, to save valuable marine resources from destruction and any number of gratifying accomplishments. Corny, maybe, but I do not doubt for one minute that many of our Sea Grant people are motivated by this opportunity and that it means a great deal to them.

Sea Grant is by no means perfect. Occasionally there is a tendency in the National Sea Grant Office to become bureaucratic. However, that seems to be a check and balance set up. When pressures build up to have everything the same, and in triplicate, and rules become so lengthy and detailed as to be confusing, some very penetrating questions begin to be asked by the rank and file, cries of distress go up from all sides, snide remarks are passed and the word eventually gets back to the office, because the Sea Grant group is a vocal lot and I admit the office usually tries to do something about it. I hope this will continue because the National Sea Grant Policy and Philosophy is of utmost importance to the success of Sea Grant.

It has recently, in the past two years, come to the attention of many of us in Sea Grant that we must have political savvy, mostly to the extent that our political people know and understand what Sea Grant is and what it is doing. We live by political mandate, yet in many cases, especially at the state level, very little recognition has been given to this. In fact, in many cases universities really put a clamp on any political moves and even go so far as to tell you not to even talk to legislators. There is a good reason for this I suppose. More than once some dedicated and perfectly honorable professor who just happened to be in left field has gotten the whole educational system into a bind. We do not want that to happen but neither can we hide our heads in the sand. It is our duty to educate our public officials and to give them all the help possible in recognizing the importance of marine resources, coastal zone management and the like. Not only on a national level, but on a state, county and local level as well. Nothing will keep a Sea Grant program closer to the needs of the people than close cooperation and exchange of knowledge at the local level which happens in, I guess, almost all of the Sea Grant programs. This does not mean that we should become involved in politics, but we must be politically astute. Being in politics is one thing, but helping and educating political people, being aware of political policies, and becoming familiar with the political arena is something else again. Something we must do if we are to succeed.

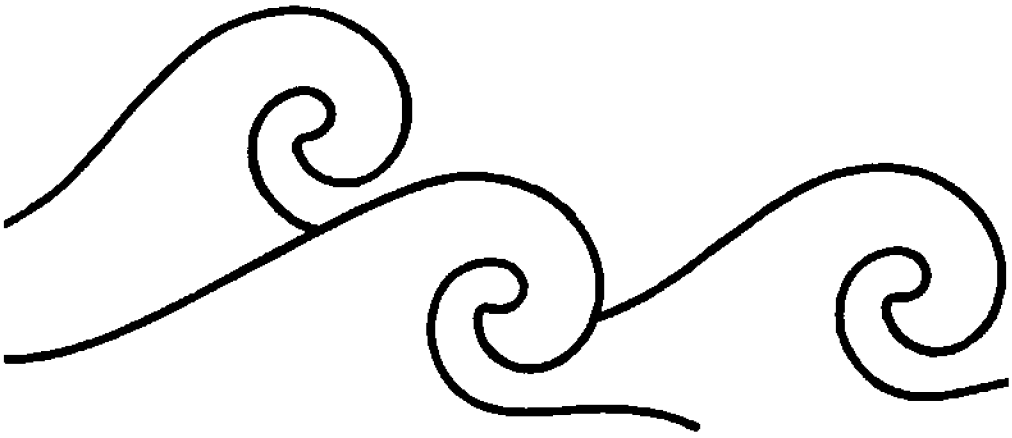
These are some of the reasons why Sea Grant is what it is, why it does what it does, why it has been as successful as it has been. It is an attempt to look behind the scenes, even into people's minds, to find out what makes Sea Grant tick. We come up with three major reasons of success.

The Sea Grant Mission - The need for Sea Grant. The way Sea Grant is supposed to function.

The Sea Grant People - From Administrators to Rank and File people who have become dedicated, loyal and intensely interested in their work--lay people from all walks of life who have become interested in the program.

The Sea Grant Philosophy - Something much harder to define, but potent nonetheless: Strongly tied to the administration but very noticeable in the whole program. The thing that makes Sea Grant a partnership.

BUILDING THE ASSOCIATION



How Sea Grant Looks from the Outside

E.W. Seabrook Hull
Former editor, *Ocean Science News*

Ladies and gentlemen, members of the Association, it is a pleasure to be here...I think.

When I was first asked to participate, I thought of declining, renting a suit of armor or taking out special hazardous duty insurance. However, I was assured that I would suffer no bodily harm. So here I am, once again, to lay into the Association of Sea Grant Program Institutions.

One cannot either praise or criticize much in 15 minutes, and there certainly isn't time for details or considered discussion. So, I leave praise to others and largely ignore specific facts. Instead, I'm going to play the devil's advocate. If I sometimes seem blunt, ascribe it to the shortness of time or to the fact that I simply want to get your attention. My overriding objective is to stimulate thought. Those of you familiar with my editorial approach when I was editor of *Ocean Science News* will appreciate what I mean when I say: Make 'em think even if you have to make them mad to do it. Well, I hope I don't make anyone here mad today, but if I do, well.....

"How Sea Grant Looks from the Outside": I lucked out on that one. I don't need to know what Sea Grant is or is not doing. It frees me from the discipline of facts and gives me license. I need only concern myself with what others -- outsiders -- think of Sea Grant.

It is important to keep this perspective in mind because what you yourselves say and think you are doing does not always coincide with the outsider's view. In some ways this is the key to many of Sea Grant's problems. In many important areas either your introspection is flawed, and you are not in fact doing what you think you are,

or your external communications system -- your public relations -- is malfunctioning, and you don't get the message out where it counts.

In either case your image to outsiders -- and "outsiders" has to include the Office of Management and Budget -- leaves much to be desired. This may be a function of the growing process, for Sea Grant is still very young, or it may be because you are not doing some of the things you could and should be doing, even within current budget constraints. Quite likely it is some of both.

There is one more caveat: There are many "outsiders." Consequently there are many outside viewpoints. In general I am restricting myself to the kinds of outside viewpoints that I feel are working against you in the Federal budget-making processes. I am not speaking for OMB, but I am attempting to relate the kinds of things I know concern OMB to some aspects of the Sea Grant external image.

Once again, remember: This is an *outsider's* view. It may not be fair. It may not be correct. And, it certainly won't be what many of you think of yourselves. But, it is valid, for the impressions are there, and, being there, they are trouble and will remain so for as long as they persist among those who decide, either directly or indirectly, how well Sea Grant is fed. I will now elaborate briefly on some of these outsider's views.

OUTSIDER'S VIEW NUMBER ONE

Sea Grant is an ill-defined Federal spending program with a potential for growth which has no discernable limit.

Want to scare the hell out of OMB? That's a good way to do it.

At a time when national policy is to hold a firm lid on Federal spending and when competition for funds is intense, that impression is anathema to OMB. Yes, I know the Sea Grant Act puts a limit on Sea Grant budgets, but acts can be changed. And, yes I have read the Congressional declaration of purpose. It is a broad statement of general principles. It does not set goals. It does not define specific objectives. It does not define programs. It does not relate Sea Grant to the solution of highly visible, critical national probelms. Probably the Act should not do these things, but someone should.

The whole Sea Grant program needs to be analyzed and specifically related to the critical problems that daily concern the national leadership and affect their decisions -- such things as the balance of payments, inflation, poverty, energy, land and water use, environmental management, *et cetera*.

As it is, Sea Grant is supposed to advance the nation's marine capabilities because Congress has said that the ocean and its resources "constitute a far-reaching and largely untapped asset of immense potential significance to the United States..." Well, such rhetoric falls in the same category as the many odes to flag, God

and motherhood. It hasn't recently and may never again win budget battles.

You need to define your purposes in a more disciplined manner. You need to establish program objectives that relate to specific national needs. Enable outsiders to see clearly how Sea Grant relates. At the same time you need to do something to dispel the lurking fear that Sea Grant is a fiscal amoeba -- growing more as it spends, spending more as it grows and so on without limit, producing nothing all the while except a bigger, hungrier amoeba. To get the budget-makers on your side, you must show them that Sea Grant is a more cost-effective way of meeting critical national needs. Among other things OMB thinks in terms of benefit/cost ratios. How many of you do?

OUTSIDER'S VIEW NUMBER TWO

Sea Grant is an agglomeration of multiple, separate, often-duplicative efforts; it is a collection of individual spending cells that lacks cohesiveness and sense of specific purpose -- and the main product of which is paper...publications.

Remember now: This is the outsider's impression. There is no intention, either implied or implicit, to contend that this is in fact so. But, true or not, it's your problem. If your aquaculture, offshore ports, recreational, whatever programs are indeed coordinated, managed and purged of duplication, you have to make this a lot clearer than you have, and I mean clearer to outsiders, not just to yourselves. Indeeed, I suspect that a really energetic effort of this kind would produce some startling revelations to yourselves. It is one thing to view the operation from within and explain and justify it to each other. It is quite something else to prove your contentions to others. And, "others" in this context does not mean your academic peers but rather politicians, administrators and just plain ordinary John Q. Public.

Evidence of what I mean is seen in the sheer volume of Sea Grant Publications. The rapidity with which these spew forth is at times astounding. Don't get me wrong. Taken as individual documents, many are good, some are excellent, and as specialized publications on specialized subjects they are undoubtedly read and found valuable by other specialists with similar interests. But what about the ultimate *user* of all this intellectual output? Is it useful to the decision-makers, those who must decide finally on the best approach to offshore ports, those who may or may not wish to invest in or legislate about aquaculture? What about those who must consider all aspects of a given problem or option and who simply don't have time to read everything that is written on the subject?

You need to synthesize. I do not say that you should abandon the kind or even the volume of specialized documentation you now produce. This kind of interchange among peers *is* important, but even your fellow academicians don't, simply can't, read all there

is to read on a given subject. You need to organize so as to provide the comprehensive view, the total problem perspective in a given situation. Draw upon *all* the pertinent Sea Grant capabilities among all the Sea Grantees and Sea Grant institutions and produce also *a* document that gives decision-makers the net of Sea Grant's contribution to the solution of critical national problems.

To do this you need a lot more intercourse among yourselves, as well as a more productive, pragmatic awareness of conditions external to Sea Grant. You need more coordination, and you need to direct, to discipline your efforts. You need to minimize duplication of effort, and you need to have a sufficiently strong problem orientation to be able to assure that there are no serious gaps in your efforts. In a sense, you need multi-institutional, multi-disciplinary management.

I don't think the National Sea Grant Office should do this. Perhaps the Council of Sea Grant Directors should take some action. Perhaps this Association should. I really don't know. What I do know is that this Association should certainly try to take the outsider's perspective. It should identify and describe Sea Grant's problems with the outside world and then provide a constructive input to the Council, to Bob Abel and his harried crew, to Congress, to OMB, etc. For example, who among this Association has gone to the ocean-responsible people at OMB and asked: "What is our problem?" Try it. You might not like it, but you might gain from it.

Much of what Sea Grant does fails to realize its full value, or if it does, the word just isn't getting out. Who's done a tally of the national benefit that has derived from Sea Grant expenditures? At the national as well as the local level? If you don't do it, I don't know of anyone else who will.

Much of the work Sea Grant is doing could be the basis for a concise and valid input to national decision-makers. You could develop among them a reflex Sea Grant-dependence syndrome. The magic word is synthesis.

I can see a series of documents designed not to inform your academic peers but to be useful, pragmatic tools. Before now, for example, you should have issued "The First Comprehensive Sea Grant Report on Offshore Ports" -- not the product of *one* investigator or *one* institution, but the product of many, covering legal, social economic, engineering, environmental...all appropriate aspects of the problem.

Perhaps you would have to establish a committee (or several) operating under an editor or director to thrash out differences, weigh alternatives, evaluate pro's and con's, spot and fill gaps and produce value judgements. This would be Sea Grant's best appraisal. It would be a single, discrete treatise on the subject. It would be written and organized for the non-specialist decision-maker. It would be a single document, a contribution designed to help solve a critical national problem -- rather than, as now, a

bundle of documents representing the random intellectual outputs of a miscellany of individuals.

Other titles of this series might be: "First Comprehensive Sea Grant Report on Conflicts and Solutions in Coastal Zone Management"; "First Comprehensive Sea Grant Report on Marine Recreation"; or "First Comprehensive Sea Grant Report on a National Policy for Commercial Fisheries".

If you had that last one out now, you would have made a lot of brownie points, for a "national fisheries policy" is a subject that right now has top NOAA officialdom going 'round and 'round and 'round. It is just one of many national needs that demand fulfillment. With a little more effort, a little more imagination and a lot more internal self-discipline, Sea Grant is uniquely constituted to contribute majorly and obviously to that effort.

OUTSIDER'S VIEW NUMBER THREE

Sea Grant Principal Investigators never get out of the laboratory, the classroom, the conference circuit; they're too removed from the real world.

The impression is that they are too much theoreticians, academicians dealing in concepts, abstracts, etc. What they produce, therefore, does not relate to real problems, real people, real needs, and so forth. Again, this is a generalization. It is unfair, untrue. Be that as it may, it is an impression loose upon the land, and denigrative generalities such as this are just the sort of easy out that people will latch onto in the absence of any convincing alternative, and--justified or not--it, too, is part of Sea Grant's external image.

And, to a degree this reputation may be earned. Let's take commercial fisheries as a case in point. The adverse balance of payments in fish and fish products in 1972 was $1.3 billion--nearly one-third of the nation's total adverse balance of payments for all trade in goods and services. If you want a critical national problem to which Sea Grant can relate, that certainly is one. But, you're not going to solve that problem by computations and dissertations only in terms of maximum sustainable yield, limited entry, economic efficiency and the like.

Most of you Sea Granters and, I'm forced to conclude, most of the Federal Government forget that fish are caught by people--living, individual human beings each subject to his own particular socio-economic conditions. As individuals, they have their own perspectives, problems, hopes, drives, constraints, expectations, etc. I have suggested to the Federal Government, and I suggest to you than an apt fisheries policy goal for the United States would be the elimination of the adverse balance of payments in fish and fish products. We can do this by importing less fish, by catching more of our own needs and by exporting more fish. Admitting that

fish stocks must be available to be caught, we do need either international or unilateral national action to assure that availability.

Beyond that, however, the problem has mainly to do with people--how to motivate and enable them to catch more fish. You've got to identify fisheries capable of further exploitation by American fishermen, and you've got to determine the constraints--both those that are fisheries related and those that are quite external to fisheries--that prevent additional productive effort. Sea Grant is in an excellent position to undertake such an effort, but by and large it hasn't done so. A few Sea Grant marine extension agents have gotten out with and really gotten to know the fishermen and their problems. They are the exception, however. Too many of you still rely overly on the academic, theoretical approach alone. This produces a kind of myopia which blocks discernment of the real problems that need to be solved.

Commercial fisheries should be the subject of a coordinated Sea Grant-wide investigation and analysis. This should be a priorly thought-out, managed program culminating by a specific date in a single report stating the fisheries policy goal, identifying constraints and remedial actions, reducing alternatives and making a series of specific recommendations. It would be a truly multi-institutional, multi-disciplinary program, involving every expertise from economics and anti-trust enforcement to stock assessment, gear research and innovations in marketing.

But, you can't solve a problem until you know what it is, and you're not going to define the fisheries problem until you get out and know fishermen as people, rather than statistics. And, I mean *fishermen* -- not fish buyers, though you had better get to know the kinds of games they play, too, for they share a lot of the blame for the present state of U.S. commercial fisheries.

OUTSIDER'S VIEW NUMBER FOUR

Sea Grant, what's that? Outside of yourselves and a very few others, nobody ever heard of Sea Grant.

As OMB is wont to chide, you don't have a constituency, and one budget-making factor you must not forget is that Federal spending is responsive to voting power -- not only on Capitol Hill but throughout the length and breadth of this great land. This doesn't mean you have to go out and hire a high-rate, hot-shot Madison Avenue flack. You probably can't afford it, and it certainly wouldn't be the best use of either Federal or matching funds under the circumstances.

But, there are things you can do which don't have to cost much but which could have a high pay-off rate, namely getting Sea Grant better known. First let me say, however, don't go running to mother Abel and tugging on those apron strings to get the job done. That's a small, effective, understaffed, overworked shop that does not count a public information officer in its table of organization. No, I'm

talking about things you can do yourselves -- as an Association, as Sea Grant program institutions and as individual Sea Grantees.

For example...

How many of the officially designated Sea Grant Institutions have added these words to the main university sign: "A Sea Grant Institution"? How many of you take every reasonable opportunity to tout this fact -- on official university letterhead, in the logos of their publications, etc.? This is free advertising, and even if the passing motorist doesn't know what a "Sea Grant Institution" is, at least he will know there is such a thing, and he may take the trouble to find out.

I know that the words "Sea Grant" are used profusely in Sea Grant newsletters and the like, but here again, you're talking to yourselves. You're sold; you need to sell outsiders. Even in your project reports, you don't make the most of an opportunity. Usually on the cover and title pages the institution gets top billing; Sea Grant often appears only in the fine print required by law to say where the supporting funds originated. Give Sea Grant at least equal billing with the university.

Those of you with aquaculture projects underway, you lobster breeders, shrimp growers and salmon raisers, those of you with coastal engineering projects, and all of you with more or less separate physical facilities... You're bound to have a sign which says, if nothing else, "Keep Out." And, it probably says more, naming the responsible institution, for example. How many of these signs also say: "A Sea Grant Project"? That much additional stenciling isn't going to flicker a decimal point in your budget, but the words will be there day and night, 24 hours a day, out in public proclaiming that there really is a Sea Grant program and that it is busy doing good work.

The subliminal impact of standard, easily recognizable marks and logos is significant. Perhaps this Association should produce a guide for such standardization so that wherever Sea Grant crops up -- in a report, on a sign, whatever -- it will spark automatic recognition and association.

How many of you engaged in visible, dynamic processes -- aquaculture, for example -- hold open houses and show the general public around? How often? How many of you volunteer to speak at high schools, Rotary Clubs, Ladies' Garden Clubs, etc? Has this Association ever thought of organizing and sponsoring a traveling exhibit? How many exciting, well-produced documentary movies have been produced of Sea Grant activities? How many of these are organized and timed for television features, news featurettes? How many articles do you write for general-circulation magazines, for big-corporation house organs?

How many of you have suggested to your suppliers that they might like to feature their product as used in your project in their

advertising campaign? Has anyone tried to interest Walter Cronkite -- an admitted enthusiastic ocean-freak -- in this oceanic analog of the land grant college system? How many of you notify your Congressman regularly of Sea Grant accomplishments, maybe even giving him the first opportunity to break the story?

There are countless little things you can do. It's mostly a matter of being aware of them and then making sure that someone does something about them. It's your reputation and your budget. It's up to you, therefore, to do as much as you can within existing constraints.

As far as big public relations is concerned, since Sea Grant doesn't have the money, either in Washington or among the institutions, you have to put others to work for you. Perhaps you should give more attention to the potential of joint university-industry projects. There is a dearth of these even though they are urged under Sea Grant. This may be because you don't think big enough, because you don't extend your vision, and because you're not oriented to practice and profit.

As an example of the sort of thing I have in mind, visualize a joint Sea Grant-Pan American-Hilton-Exxon project to construct and operate a 21st Century marine recreation complex, built from the water up and brand new, employing the latest concepts and technologies for both substance and pleasure and seeking in the process to rationalize as many use conflicts as possible. In terms of cost and diversity it would be Disney World in scope, but it would be geared to marine recreation in all aspects--swimming, sunning, boating, diving, underwater touring, underwater camping, participatory research, explorations, seminars and other oceanic educational opportunities, and so forth. It would be designed to make money. It would also be a demonstration project featuring optimal utilization of marine recreation resources with minimum adverse environmental impact, environmental enhancement and simply to prove the methods of minimizing use conflicts.

This wouldn't be penny--ante stuff. We're talking about a $100-to-$200-million project with industry putting up virtually all the money and with the role of Sea Grant being that of senior conceptual and technical consultants. Sea Grant would be funded both by the Federal Government and by industry. Federal funds would come not only from the Sea Grant budget, but also from other agencies with techniques and concepts they desired to test out.

Why an airline, a hotel chain and an oil company? First of all, because they have lots of money, are profit oriented and because such a project fits in with their long-term corporate interests. The airline carries people to the resort. Hotel facilities house them. The oil companies' interests may be a little direct, except that they want yachtsmen to use their products. Anyone familiar with Phillips Petroleum Company's Pier 66 in Fort Lauderdale, Florida, will know what I mean.

Maybe such a recreation complex isn't the right project; maybe there are others just as big, just as challenging, that are more appropriate. The point I'm trying to make is: Don't be afraid to think big. All of you have the prestige, the credentials to approach the highest councils of big industry. A Sea Grant-wide effort could conceive and detail such a project. If you clearly show the profit potential in terms both of dollars and of corporate image-building... if it's valid and well thought out, you can sell it. And in so doing you could realize much latent Sea Grant potential in terms of funding support, coordinated joint effort and public image building. Just think how your constituency would be growing if clearly emblazoned on the Disney World entrance sign were the words:

"A National Sea Grant Project."

What Sea Grant Constituencies Want and Expect

John C. Calhoun, Jr.
Texas A & M University

The first question that probably should be asked is what is meant by Sea Grant's constituencies. I take this to mean the Sea Grant Association's constituency, inasmuch as the general subject being addressed is building the Association. This constituency is, briefly, the members of the Association, i.e., the universities that contribute their funds and resources to maintain the Association and to carry on its work. Every university has constituencies which it serves, including its students, industry, government agencies, and the public at large. However, the Sea Grant Association does not serve these constituencies except as it serves the universities.

The Association is the creature of the universities and it must serve them and their purposes in order to justify its existence. Each of us as a university administrator must be able to justify to our Presidents and Boards the funds that we allocate to the Association and its work, either directly or indirectly. Each of us must be able to satisfy ourselves that supporting the work of the Association is the best possible use we can make of the resources at our disposal. We must be able to show that the product of our Association effort is the advancement of educational programs and the university's fields of service. If we cannot make this determination, then the Association has no reason for being and we have no basis on which to justify its support.

Therefore, as my basic point, I state that in order to build the Association, we must examine whether or not it is of service to those who created it and who sustain it.

Universities belong to many associations and similar groups engaged in common program effort. Why do we have this particular Association? Why is the activity not a part of another association, for example, the National Association of State Universities and Land Grant Colleges or the American Council on Education?

It must be that, as universities, we expect something different from this particular group, something that cannot be done through another group such as the Land Grant Association. It must also be something that we cannot reasonably expect to be done through an existing alternate association channel. There also must be an expectation of a product from the Association's work that cannot be achieved by individual university effort. If the end result could be achieved individually, there would be no reason to band together. What are these unique things? I see three broad purposes and expectations.

The first of these is that we ought to expect a clarification and elucidation of a specific area of concern to the university, a concern that requires separate identification. What is this area of concern? I think it is marine resources. It is not the Sea Grant program, although that is the name we use in the Association. However, as universities, the Sea Grant program is only a channel for funding a part of the program that is of interest. The area to which we direct our attention must be marine resources in the broad sense that parallels agricultural resources. The Association ought to undertake as the first order of business a clarification and discussion of this subject area and what it is all about. What does the subject encompass? Where does it fit into the university community and what resources will be required for carrying on the university's work in the field? Who is doing what?

From this point of view, there are a number of specific things that the universities would like to have guidance on and which they ought to be discussing together. One of these is the organization of subject matter. As I have indicated at other times, there is no academic discipline called marine resources. Subjects of interest to us are found in many areas. Yet, if we are going to advance this field, we somehow have to organize it as subject matter so that we can find our way around it and explain it to others. How will the universities undertake this organization? By and large, we have not addressed ourselves to this subject. We are still thinking in terms of the disciplinary fields that are involved, such as ocean engineering, economics, etc., rather than a total area.

Another result that I think the universities might expect of the Association's work is a discussion of the kinds of curricula that are needed to serve this field. What are the universities doing in this respect? What ought they to be doing? Is it possible to satisfy the needs that are growing in this field through existing curricula or do we have to build new ones? Similarly, what are the career opportunities? After all, we serve the public and students by providing programs of activity that will contribute to certain career objectives. How are we describing these to our students?

Another kind of question on which we need guidance is the organization of these university programs. Do we create new colleges, institutes, or departments, or do we carry on our university activity on an ad hocbasis? Most of the universities that have come into the Sea Grant program with large programs have been facing these organizational problems. Yet, I don't believe I have ever heard a comprehensive discussion of this question at one of

the Association meetings.

Finally, the Association might be expected to make some kind of inventory of what is going on.

In summary, then, I think as a first expectation, the universities would like to think that the Association is spending some time on identifying its overall area of concern and that it is providing guidelines for how this area should fit into a university and how it should be handled organizationally. In doing this, the Association must be aware of and keep informed about sister Associations---i.e., Land Grant and the University Council on Water Resources.

The second thing that I think a university might expect from the Association is an identification of the broad issues relative to educational programs in marine resources and the achievement of collective agreements on the substance of these issues. In making this observation, I do not anticipate that the Association should try to represent the universities in promoting these issues. The Association may or may not play a representative role depending on what the universities want to do after the issues have been identified and fleshed out. I think it is important that the Association play the role of giving the university information about the issues that are identified and an analysis which will allow the university to formulate its own position. The universities can decide whether or not they wish to take a collective position through the association or some other group. It is not necessary that one of the end products of the Association be to take a particular position. Rather, it is necessary to identify the issues and to elucidate them so that the universities can say what they want to do.

There are several areas in which issues may arise: One is interactions with other academic areas and with broad university programs. For example, where does marine resources activity fit in with respect to water resources, energy, food, and many of the other problems with which univerities are dealing? A second area in which issues may be identified and where analysis is needed relates to sources of funding for university support and broad educational advancement of the marine resources program. This issue may involve an analysis of the future of the Sea Grant program. It may also involve alternate sources of funding and recommendations to Federal agencies for starting new programs.

Still another area in which issues may be identified is the need for regional or national programs in selected fields that are a part of the total effort. These national programs might also apply to certain functional things such as advisory services or to the need for oceanographic laboratories. Another very obvious area in which issues may arise has to do with legislation and the relative priorities of universities for supporting government programs at both the state and national level.

Finally, it seems to me that issues may arise out of the general question of how the broad field of marine resources can be

nurtured and developed, how do new universities get into the field, what kind of standards are necessary for high quality programs, and in what sorts of ways a university that is not active in the marine resources field can relate to those that are.

The third broad way in which the Association can offer a product useful to the universities is for the Association to provide a collective representation to the public that supports universities with respect to this total field. In other words, the Association can be a spokesman that relates to students, government, and industry, not for establishing positions in which the universities would necessarily take a collective stand but for explaining to these groups what the subject is all about, what the universities are doing, what the issues are, and how the universities may relate to any of these groups. In other words, the Association could give these publics of the university the best overall analysis of what this thing is all about. This verges on public education and public information functions, but it is a very important task for an Association to undertake. Perhaps it discharges this function in part by stimulating the individual universities to carry on a greater public information effort in the field.

If the Association will develop activities and products along these three lines, it will not have anything to worry about so far as the future is concerned. The Association will build and grow. However, the Association must be positive in its approach rather than negative. It must address itself to the question of developing the total marine resources educational programs needed in the nation and must not become narrowly identified with just the Sea Grant program and its operations. The Association, to achieve these goals, must also avoid a protectionist point of view. It must not get into the position of trying to protect a particular single source of funding or a particular kind of university program.

In this respect, I think one of the most unfortunate things about the Association is the fact that it carries the name of Sea Grant, because this gives the connotation that it is a servant of a particular single government program. In contrast, I know that some of you are familiar with the Universities Council on Water Resources, a similar type of association. Members of UCOWR are many of the universities that are also members of the Sea Grant Association. UCOWR, however, addresses itself very broadly to the question of water resources and its many ramifications within the university community. It also addresses itself to national and regional issues. It has avoided identification with a single funding program. In my opinion, it might be very worthwhile for this Association to change its name to eliminate Sea Grant in favor of Marine Resources. Even though the government has not followed through on the sea grant concept, the universities should not abandon it. I'm not sure now whether the name is a millstone or a blessing, as (E. Seabrook) Hull pointed out.

Finally, the Association should not try to do the jobs that are somebody else's business. It is not the Association's business to develop a national marine policy, to manage the national Sea Grant program, to produce a national fisheries program, or to

develop marine resources. Stick to educational roles. The Association can contribute to these goals by doing the sorts of things I have tried to outline---delineate the program area and its role in education, identify and analyze the issues, and provide a collective representation to the public.

Panel Summary: Building the Association

William S. Gaither
University of Delaware

H. Gary Knight
Louisiana State University

Format

Following the general session on "Building the Association," the panel of speakers and approximately 20 additional persons met to consider possible future directions and activities of the Association. Each participant was requested to identify those actions which he or she felt to be of significance. Following this enumeration, a voting system resulted in the establishment of priorities from among the nominated action areas. These activities were then grouped in four major headings for discussion and consideration.

Before outlining the range of recommendations, it should be noted that many of the proposals are interrelated and in some cases are dependent on prior action in another category. Nonetheless, the list gives some indication of the directions which the panelists and others felt were appropriate for the Association.

Recommendations

The four major areas in which recommendations were made were: (1) Association purposes and function; (2) organizational arrangements within the Association; (3) Association communications efforts; and (4) specific projects.

I. *Association purposes and functions.*

A *clear* priority item was the need for definition of Associatiion functions based on existing financial capability and of its responsibility to member institutions. It was suggested that a group consisting of the Executive Committee plus appropriate non-Association

personnel be directed to develop a proposal recommending Association purposes and implementing activities. Included among the specific suggestions in this category were: (1) the production of an analytical report on the present and future status of the "sea grant" concept; (2) that the Association conduct its activities on a marine resource-wide basis, not limited strictly to Sea Grant proposals and projects; (3) the evaluation of Association programs on a cost/benefit basis prior to implementation; and (4) consideration of the feasibility and desirability of Association inputs to NOAA and other Federal marine-related agencies in order to affect their programs and financial allocation policies.

II. Organization Arrangements

Substantial support was evidenced for the establishment of an Association office in Washington, D.C., staffed by a part- or full-time executive director. It was felt that this would provide necessary exposure for the development of the Association's image and a base for both formal and semi-formal information dissemination efforts. Further organizational issues raised included: (1) that the Association emphasize semi-formal lobbying focused on appropriations; (2) that the Association develop a membership campaign in order to broaden its constituency and raise additional funds for operations; (3) that the Association's name be altered to more accurately reflect its purposes and functions; (4) that all members be accorded co-equal participation in the Association; and (5) that the relationship between the respective functions of the Council of Sea Grant Directors and the Association's Executive Committee be clearly defined.

III. Communications

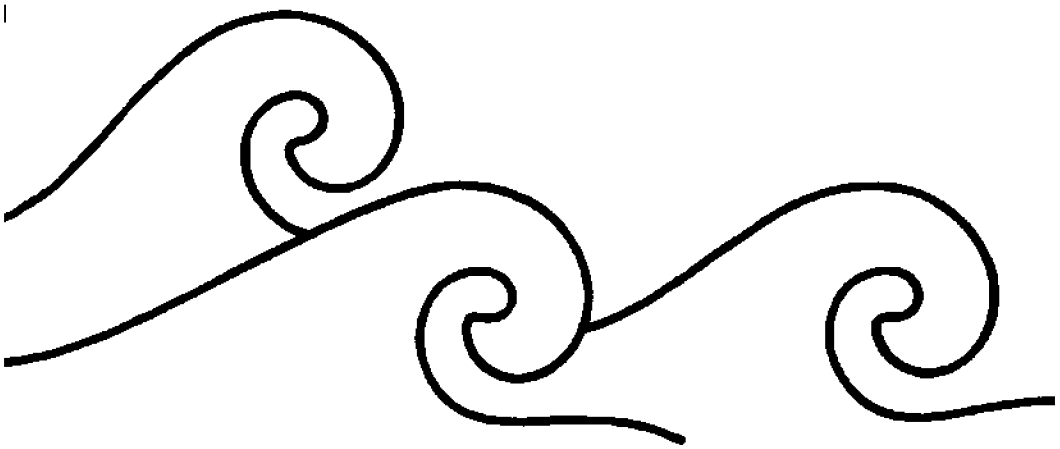
It was felt that the Association needed to engage in a variety of communications activities and that this might best be arranged by establishing a task force to make specific recommendations to the Executive Committee. Among the concepts suggested were: (1) that external contacts and activities be increased in order to secure more beneficial exposure for the Association and its objectives; (2) that careful consideration be given to the structure of future annual meetings of the Association, specifically that a decision be made whether to emphasize substantive professional topics, Association organizational topics, or a blend of each; and (3) that a "public relations documentary package" be developed for quick response to inquiries concerning the Association and its Sea Grant and marine related activities.

IV. Specific Projects

The following specific projects were recommended, listed here in the order of degree of support from the participants in the panel meeting: (1) that the Association undertake an analysis of the role of education within the sea grant concept, with emphasis on curri-

culum and career analysis; (2) that a group be assigned to examine the organization of marine resources programs in various institutions; (3) that investigation be made of the possibility of having the Association provide (from its member institutions) assistance to Congressional committees and Administrative agencies engaged in the consideration of legislation and regulations, respectively; (4) that a directory of work in progress by member institutions be developed and circulated; (5) that white papers be developed on the theme of proper resource development as an aid to program management for member institutions; (6) that a group undertake a quality evaluation of the competences of member institutions of the Association to undertake various projects; (7) that professional advisory panels be developed to assist upcoming member institutions; (8) that a model be developed to assist members in selecting the most beneficial program to pursue; (9) that regional program possibilities be identified; and (10) that other sources of marine resource project funding be identified.

MARICULTURE—AQUACULTURE



Aquaculture in Perspective

Harold L. Goodwin
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Here and there on the University of Delaware campus are attractive posters on which the principal object is earth as seen from space, and a legend:[1]

> *Man is part of a natural system, the Earth, and is ultimately subject to the limits of that system.*

Implicit in that legend is the fundamental reason for developing the full potential of aquaculture.

The simple fact is that mankind is placing so many demands on the planetary system that some limits of the system already are in sight. Of principal concern in a discussion of aquaculture is the limit on the potential supply of animal protein to feed the growing human population.

In the United States, since colonial days, we have not considered aquatic proteins to be a part of the basic animal protein supply. Instead, with the development of land animal husbandry, we became a society of beef, pork, and poultry eaters. Seafoods are essentially luxury items, eaten for taste and variety, not because we depend on them for proteins.

In mid-1973, we received a rude shock. Beef became relatively scarce and prices soared. That was the most visible manifestation of a trend. But there were others, less noticeable in terms of direct impact on the consumer. People concerned with sea products were aware that the Peruvian anchoveta fishery had declined sharply, and were further aware that the United States has become too dependent on fishmeal from that fishery. As supplies of fishmeal dwindled, prices rose, from $120.00 a ton to more than $700.00 a ton at one point.[2]

The problems of Peruvian fishermen and the vagaries of the Humboldt Current would seem to have little interest to Americans, but the fact is that our high technology system for producing land animals and poultry depends on protein feeds, and Peruvian fishmeal is a major source. When decline of the anchoveta fishery was coupled with both natural disasters and human errors in handling of the vegetable protein crop marketing, production costs for beef and poultry soared. With prices held down, we saw the spectacle of farmers killing chicks and cattle left on the range instead of being moved into feed lots for final fattening.[3]

We also saw an increase of fishery products in the supermarkets. People began eating species to which they were not accustomed. Fish quite suddenly turned from a nice change in diet to a significant alternative source of table protein.

Even assuming that the situation was, to a great extent, the result of a temporary combination of natural and human factors, it demonstrated the complex linkages in the food production system and our dependence on imports from the natural harvest of the seas.

There is another factor in our approach to serious limits. It is usually referred to as the "energy crisis." We think of this in terms of gasoline shortage, heating fuel shortages, and the environmental impact of power plant location, but a salient factor usually escapes us: Our agriculture, the greatest in the world in terms of productivity, is energy-dependent. Agriculture is high technology. The huge productivity depends on strains of plants that could not survive without human nurture; they must be fertilized, irrigated, protected from natural enemies. We nurture our plants with chemical fertilizers and pesticides that it takes enormous amounts of energy to produce. We irrigate by the further expenditure of energy. And, in the process, we provide area runoffs of chemicals that are fine for the plants, but are pollutants in our waters, and so accelerate eutrophication in some places and poisoning in others. All of which helps to reduce natural productivity of fish and shellfish.

Man is part of a closed system--and from the viewpoint of the ecologist, intervention in one part of the system ultimately affects all the other parts.

If we look at the productivity of the oceanic part of the system, we find some interesting numbers. Before he turned to aquaculture, John Ryther of the Woods Hole Oceanographic Institution was a recognized scientific authority on natural productivity. Several years ago, he estimated that the total animal productivity of the oceans was on the order of 240 million metric tons, of which perhaps 100 million metric tons would be available for human harvest.[4]

In February, 1973, the Food and Aquaculture Organization held a conference on fishery management and development, and Minister Jack Davis of Canada reported that Canadian fishery scientists estimated the total world maximum sustainable yield of fishery products at 100 million metric tons—Ryther's figure, arrived at independently and based on fishery statistics. Davis further estimated that maximum sustainable yield might be reached world-

wide by 1980.[5]

One can argue about the numbers, and experts do. But their arguments do not attack the basic concept, that the limits of the planetary system for oceanic harvest are in sight. Time estimates may vary by a decade or two, and the total harvest may be off by a factor of 50 percent--but such refinements do not invalidate the critical premise.

As demand increases, as real incomes rise around the world, the portents become clear. We must have sources other than the natural harvest for aquatic proteins, and this is just as true of the protein-rich United States as it is of nations that have depended primarily on aquatic protein sources.

Don Whitaker of the National Marine Fisheries Service has pointed out in an excellent paper[6] that U. S. imports of fishery products have increased at an essentially constant rate since 1950. We have been the world's principal importer of some species--shrimp, for example. We import about 65% of the shrimp we eat, and our imports are from nearly 60 nations. Until 1972, we had the world market cornered pretty well; there was no real competition. In that year, the Japanese outbid us for the first time. With the kind of aggressive competition Japanese seafood eaters can provide, it's easy to visualize the price of shrimp rising beyond the ability of anyone to pay except the rich.

Shrimp is only the first manifestation of the rising world demand, and hence rising competition, for fishery products. And, to repeat the point, the United States is dangerously dependent on other nations for its seafood consumption.

Other nations, in turn, are dangerously dependent on a resource whose limits are clearly visible.

The trends need not be overstressed to make the point. As stocks of fish level off or decline, there will be less profit incentive for fishermen, less return on public investment for nations that subsidize or operate their own fisheries, less supply with increased demand and greater purchasing power. It's not a hopeful picture . . . .

Unless we develop aquaculture as a viable alternative.

Let us define our subject:

> *Aquaculture: the culture and husbandry of aquatic organisms; the control and management of aquatic plants and animals reared in large numbers in controlled or selected environments for economic or social benefit.*[7]

That is the NOAA Definition, spelled with an "A" for aqua as the rest of the world traditionally spells it.

Because we have been protein-rich, our approach to aquaculture in the United States has been that of a dilettante. We have not really been serious about it, nationally speaking. We have had no focused effort, no national goals, no national priority. We have accomplished quite a great deal in some fields, but almost in spite of ourselves.

It is time for a structured, planned effort, and we believe it is up to NOAA to take the lead.

Too often, as people begin research into aquaculture, it is with a half-assumption that the wheel of aquaculture has not yet been invented, when, in fact, it is turning with ever-increasing velocity. Aquaculture exists. It is a fact of life. We don't need to invent it; we need to improve it, as we improved agriculture. Furthermore, we must improve it with attention to energy limitations.

Fortunately, for culture of many species, the source of energy is the cheapest, least-polluting source of all: sunlight. It is the energy that drives most of present world aquaculture.

At the FAO conference in February, T. V. R. Pillay of the FAO Department of Fisheries estimated total world aquaculture production at more than five million tons. He further cited estimates of a ten-fold potential--50 million metric tons or more.[8]

When we examine Pillay's figures, it becomes clear that the world species cultured most intensively are of little present interest to us in the United States. Carp, milkfish, and mullet lead the list. All are essentially herbivores whose culture is based on the simple economics of using sunlight as the basic energy source. Further, although the culture of carp is centuries old and their life cycle is under control, milkfish and mullet culture are based on collection of wild juveniles.

As we go into the world aquaculture literature, we find the ever-present demand for reliable sources of seed stock, and it is clear that, to improve aquaculture as we have animal husbandry on land, the basic biology of reproduction is a first requirement.

This is also true of the quite different species of aquatic animals we prefer in the United States. We have achieved mass production of relatively few species, with trout and catfish as the leading examples for private commercial operations and salmon in public aquaculture for stocking commercial and sport fisheries.

Apart from species, there are other differences in U.S. aquaculture requirements and those of other nations. World aquaculture, by and large, is labor intensive. With a few regional exceptions, operations that depend on low cost labor are not economically feasible in this country.

The answer, obviously, is high-technology, intensive culture systems suitable to the U.S. economy. But, just as obviously, some of our most prized animals are territorial and aggressive, and not easily put into intensive systems. Further, the aquatic animals we like in the United States, excluding only the mollusks, are either omnivores or carnivores. They need animal protein in their diets--and such diets are expensive.

Except for some ethnic preferences, Americans aren't really fish eaters. We're seafood eaters. We prefer what George Pigott of the University of Washington once referred to as "Tiffany foods." Lobsters and other crustaceans--above all, shrimp; mollusks of several kinds, but not that prize mollusk, the blue mussel; and selected finfish make up our table diet. Generally, we prefer fillets, sticks, or other simple-to-eat forms of fish.

This marketing fact of life has caused American aquaculturists to focus on the marine species generally most difficult to culture. Our commercial successes, for the most part, have been achieved in fresh water.

We begin to see breakthroughs in some marine or partly marine species. Our long experience in salmon hatcheries has led to pen culture of individual portion salmon, and has opened up a whole new prospect of private ocean ranching of salmon. Ability to hatch and culture shrimp has caused a number of companies to leap into commercial activity even though we do not yet have full control of the shrimp's life cycle. We already lead the world in oyster production; now we're in good shape to transfer our ability with oysters to other mollusks.

We will continue to want good table seafoods. The demand will rise, and with it the price. This means a new look at the economics of aquaculture.

The United States is by far the world's leading consumer of energy--and we throw a great deal of it away, in the form of thermal effluents, sewage, and processing wastes. It's time to develop means of using the energy we waste by applying it to aquaculture--and, more specifically, to the aquaculture of low-value animals that can be mass produced both for fishmeal and for human foods. The common factor among the low-value animals is that they are low on the scale of trophic levels. They are herbivores, for the most part, or they feed on the complex of plants and animals that grow in detritus, or algal mats. Nutrients from wastes of all kinds, and thermal effluent to increase temperatures can also increase productivity, but the major energy source for these organisms is sunlight, the process of photosynthesis.

Growing animals for fishmeal might not cause serious difficulties, but lack of public understanding of biological processes would prevent ready adoption of fish cultured in sewage--and would give certain State and Federal agencies a shock so great it might cause cardiac arrest.

This is where the food technologist comes in. The recent developments in food processing have been so dramatic and promising that they show the way to entirely new aquatic food products, changing and reconstituting low-value aquatic animals so drastically that their origin is unrecognizable. A discussion of seafood technology is worth a day in itself, and I can best refer you to the experts in the Sea Grant food science and technology programs, and to the technology laboratories of the National Marine Fisheries Service.[9]

The point I want to make is that our national approach to aquaculture must be holistic. We can no longer afford to focus on a single aspect of aquaculture--the commercial production of high value foods.

Further, we can no longer afford to overstate the case for aquaculture. I think we can demonstrate through economic projections that the need for aquaculture will increase, and that national priority and investment are strongly indicated. But the time frame for realization of the potential of aquaculture must be realistic, and it must be based on a full systematic approach involving not only the biologists, but the engineers, economists, managers, social psychologists, and lawyers.

Since issuance of the Stratton Report in 1969, the promise of aquaculture has been held out with promise of relatively quick return. A lot of us were caught up in enthusiasm which was warranted in terms of the long-range potential, but not realistic in the short range. Every advance was labeled as a major step toward fast results.

The very nature of living organisms means that fast results are seldom achieved. Even if there are no problems of mass production, economics, disease, legal or institutional barriers, nutrition, water quality, or just plain operation of Murphy's Law, it takes time to grow any animal from egg to salable maturity. The time may range from a half year, to four years in the case of ocean-ranched salmon, and this means that the experimenter needs time to go through several cycles and prove out his system. Because all the other factors also come into play, during that time he will have problems of water quality, disease, proper feeds, or mechanical failures, and get damaged or wiped out.

When it comes time to apply what he has learned to the real socio-economic world, he finds laws that need to be changed, and institutional barriers that make a Cretan labyrinth look like a straight path.

Perhaps you've heard of an airplane called the C-5A. Its development, based on the state of the art, began when I was in NASA ten years ago. The C-5A still isn't fully debugged. If we can't go faster than that with inert materials, how fast can we go with sensitive living organisms? The answer is, perhaps that fast, if everything goes well. Perhaps it won't take ten years in some cases, if we build on an existing base. But it's difficult to imagine getting to full scale production in much less than ten

years, even with the full interdisciplinary approach that's needed and enough money to do the job.

This does not suggest that we should relax and take our time, only that we must be realistic in our planning, and in what we say to each other and to people outside the aquaculture circles.

In Sea Grant, and to a large extent in National Marine Fisheries, we're primarily interested in marine and brackish water animals. Some have very handy life cycles. Others are extremely difficult. Fish, particularly, may have very tiny eggs and larvae. Some larval forms take many months to turn into juveniles. Some require different foods at every stage of development. Some are so sensitive that a bumped nose opens them to disease and death. Some frustrate us by turning over and dying for no reason that we can diagnose.

Even if the very difficult, high value animals are successfully cultured to pilot scale, there are a host of problems awaiting. These have been summed up in Harold Webber's excellent paper, "Risks to the Aquaculture Enterprise."[10] I have sent a copy to every Sea Grant Director and I urge that you refer to it for a realistic appraisal by a scientist who really believes in the future of aquaculture but who views it through open eyes.

The lack of overall national goals in aquaculture is being remedied within NOAA, under the direction of David Wallace, our Associate Administrator for Marine Resources. Within a short time, we will have for distribution an initial document which sets forth NOAA's philosophy and objectives, and a NOAA management scheme for meeting those objectives.

A major element is a statement of the need to make maximum use of the resources available to us. It would be naive to think that the development of a program means a substantial flow of new money--although we hope there will be some. The way to make maximum use of what we have, both in Sea Grant and in the National Marine Fisheries Service, is to focus our efforts on results. We haven't been doing this to a sufficient extent, and our problem will be to provide focus without reducing innovation or penalizing imagination.

What it means in Sea Grant terms is a much harder look at aquaculture proposals in terms of what is to be achieved, and what is necessary to reach an objective within a realistic time frame. We will also want to know how the investigators are communicating and cooperating with Federal and State agency personnel who are working toward the same objective. We will ask about the whole picture: the economics, the legal structure, the engineering, the environmental impact, and the quantity and quality of industry interest. We will be interested in recreational applications, if there are any.

It seems probable that quite a few activities that are below critical mass or unnecessarily redundant will fall by the wayside. It also seems probable that we will want to know why an institution is starting low on the learning curve to develop aquaculture talent

in a particular field of endeavor when a fellow Sea Grant institution already has the talent and capability which can be applied to a local or regional situation through cooperative endeavors.

We suggest that Sea Grant institutions get busy now to strengthen communications, and a good place to start is with our colleagues in the National Marine Fisheries Service. We assume that Sea Grant aquaculture investigators already are in good communication with state agencies—and we'll be checking to see if the assumptions are solid or shaky.

If aquaculture is to develop in the United States, and have significant impact on our socio-economic structure, it is essential that an aquaculture constituency be developed--and that means that the aquaculture community must be brought together through communications and common objectives. It also means that confidence in the future of aquaculture must be engendered among people who are not aquaculturists, which in turn means that we had better begin to show results, in terms people can understand: products in the marketplace, employment, a return on investment, a contribution to that ephemeral but real thing we call the quality of life.

But, while we are focusing our efforts, while we are obtaining useful results that will be the base for a greatly expanded national aquaculture venture, we must not develop myopia. For Sea Grant in particular, a long view is essential. We must anticipate both problems and opportunities of the future, a decade and more ahead, and lay a base of solid research for them while we continue to work on the problems and opportunities of the next five years.

In particular, because of the preoccupation of Sea Grant institutions with the whole problem of marine resource utilization, including the Coastal Zone, we can make a special, vital contribution in maintaining perspective, constantly examining aquaculture as one use of the coastal area which must be considered in context with other uses--some of which are antagonistic, others of which are complementary.

A very important facet of a total NOAA Aquaculture Program for the future will be the development of a strong, mutually supporting relationship with the National Marine Fisheries Service, the Bureau of Sports Fisheries and Wildlife, and--to a more specialized degree--with other Federal agencies whose missions relate in some degree to aquaculture. Federal laboratories and university research facilities are different; they are manned by people who are both similar and different--and the differences lie principally in motivation and mission, not in training or even experience. The question we must answer, and to which the answer must evolve and not be imposed, is how can a national aquaculture effort make best use of the strengths, motivations, and resources of each.

Both Sea Grant and NMFS operate under constraints. Availability of funds is a very serious constraint to both of us, but NMFS has a constraint Sea Grant fortunately does not share: our fisheries colleagues must operate under rigid personnel ceilings at a time when

the government is under orders to reduce its size rather than expand. This means that NMFS has a handicap in trying to put together the total teams necessary to cover the whole spectrum of aquaculture-related activities.

One purpose of Sea Grant was to create multi-disciplinary teams able to take on all aspects of a system--in this case, an aquaculture system. Our success has been spotty, to say the least. In most cases, the biologists have continued to dominate aquaculture without sufficient help from engineers, economists, sociologists, lawyers, and other critical specialties. If we stress this total systems approach, particularly in combined efforts with the entire aquaculture community, Sea Grant can make a particularly valuable contribution in providing the kinds of expertise other parts of the community cannot provide for themselves during the research and development phases of aquaculture progress. But contributions are not made in a vacuum--and good communications and a strong desire to cooperate are essential.

It's time to bring the pieces together and develop a solid, total approach to aquaculture. If we do this jointly with the whole aquaculture community, we will have a new and exciting surge in aquaculture development--and we will again prove the principle of synergy by demonstrating that the whole is considerably greater than the sum of its parts.

FOOTNOTES

1. University of Delaware Population Study.

2. Special Emphasis Document, Aquaculture in the National Oceanic and Atmospheric Administration (in press).

3. Time Magazine, September 10, 1973, Farming's Golden Challenge, and Aquaculture in NOAA, op cit.

4. Rhyther, J. H., "Photosynthesis and Fish Production in the Sea," Science 166: 72-77, 1969.

5. Aquaculture in NOAA, op cit.

6. Whitaker, Donald R., "National Supply of Fishery Products; Discussion Paper," Meeting of the NAS Committee on Aquatic Food Resources, Boston, June 8, 1972.

7. Aquaculture in NOAA, op cit.

8. Pillay, T.V.R., "The Role of Aquaculture in Fishery Development and Management," FAO Technical Conference on Fishery Management and Development, Vancouver, February 1973.

9. Dassow, John, and Maynard Steinberg, "The Technological Basis for Development of Aquaculture to Produce Low-Cost Food Fish," October 1972 (revision in press).

10. Webber, Harold H., "Risks to the Aquaculture Enterprise," Fourth Annual Meeting and Workshop of the World Mariculture Society, January 1973.

On Becoming a Mariculturist

John R. Donaldson
Oregon State University

Who and What

I would like a show of hands as to what you consider you do for a living: How many of you are scientists? How many are not? By whom are you employed: academic institutions; governmental agencies; private enterprise? How many make their living as fish farmers?

It appears that roughly 75% of you are scientists while the remaining must be administrators. You appear to be split evenly as to academic and governmental employment with a small scattering in private enterprise. I saw two hands up for fish farmers of the 103 of you that I have counted in the audience.

Since this is a conference called by Sea Grant people for Sea Grant people, I am not surprised by the results of my informal polling. On the program of participants I can find only one name from industry and he is for aerospace. My name on the program is misleading as it has me as an academician. This is only 25% true. The remaining days and nights of the week I am a fish farmer. I have been asked here to this conference to share with you the business of becoming a mariculturist, or more to the point, a fish farmer.

The conference brochure indicates that the challenge of this year's gathering is to shape the future use of the sea through Sea Grant Association action, based on factors that are hopefully going to come forth here in the next few days. It is apparent from the session headings that questions are still being asked as to where is Sea Grant, where is it going and how is it going to get there. This same evaluating process also occupied the group that gathered in Portland, Oregon, in March 1970 for the third Sea Grant Conference—which I remember well as I served as chairman of the organizing committee. At that session we did the usual overviewing;

we looked at ourselves from outside and inside, and were challenged by a variety of individuals.

Evidently this is a continuing process that is necessary to shape future directions. I will, therefore, bear down on the facts of life that I feel are necessary to becoming a fish farmer in hopes that the problems can be excised for solution finding and the present successes be made available for bolstering the "pay-off syndrome" that is a necessary and continuous part of Sea Grant activities.

When I was re-reading the Proceedings of the Third Sea Grant Conference I went first to a presentation titled *The Economic Challenge* by F. Ward Paine, President of Oceanographic Fund, Inc., of Palo Alto, California. I clearly remembered that Ward Paine had indeed delivered a challenging address. I would like to read a paragraph from his paper as it stated the problems of farming the sea which were present then, and, based on my recent experiences, are even more so now.

> *"What happened to the farm-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."*

Where to Begin?

To start a fish farm for some is a dream, for others a whim, and for a few sober folks it is a serious challenge. Only the latter will ever come close to making a go at fish farming. But no matter what the motivation, each must settle a few basic questions before beginning. These questions are where to locate, what to begin to rear and how much to grow. These are not mutually exclusive situations, but in the first analysis they can be considered separately. You certainly would not pick Florida to produce a million pounds of pan-sized Pacific salmon for market.

No matter where you are or what you want to do, the basic ingredients are a piece of land with water flowing over or near it, an indigenous stock of animals or plants, and you are ready to start serious planning. It is not possible here and now to cover all the combinations or potential fish farm situations, and furthermore, if I tried it would only dilute the important issues in developing aquaculture that I hope to convey. I am therefore going

to be autobiographical and use our firm, Oregon Aqua-Foods, Inc., in Newport, Oregon, as a case history.

It started way back in my younger years with a need to produce something tangible for a living. For 20 years it lay while I experienced life in agencies and institutions to the point where the only door that really had a bright light on the other side was going out and actually doing it. Enough thinking and talking had gone on.

January 28, 1972, was the actual beginning date for Oregon Aqua-Foods which is important only as a starting reference for the time required to bring it into being. My wife and I drove to the coast and began looking for estuarine land. We had already designed on paper what I refer to as a completely integrated fish farm. The system would produce fish, mollusks and crustaceans in fresh and saltwater with complete control of broodstock, food supply, production, processing and marketing. I am convinced this independence in all facets is absolutely necessary in order to assure the quantity and quality of your product. Diversification of your products increases efficiency and spreads the risks.

Since it is not feasible to proceed into production on all the possible species simultaneously, it was necessary to choose which one or several would give us the earliest and best cash returns. Thus began the first of many pro forma statements. These become your paper fish farm. Great care must be taken in your feasibility studies. Total honesty is the only way to proceed. In the selection of costs always use the highest ones and then when they are summed add at least 20%. When you select market prices always pick the lowest one. If you do this and the projections are favorable, you have avoided kidding yourself and you even may come out a big winner.

Our early efforts in feasibility analyses told us that salmonids reared in saltwater to pan-size gave by far the best return on dollars invested. Oysters would bring a profit, but not as great as salmon and trout. Crustaceans weren't ready for substantial capital investment in production. This order of profitability should be obvious to you as being directly related to technological advances. Considerable agency and institutional money, mostly tax based, has been spent on salmonid research and thus there is a wealth of technology available. Marketability differences also enter into the cost figures. So the site we selected had to meet the life cycle needs of the salmonid.

Developing the early pro formas and selecting sites was the fun part of the game. When these were completed it was putting them into operation that got sticky beyond belief. Ward Paine's words were all too true.

The Permit Parade

One who, like myself, had been trained and steeped in the agency system, has no comprehension as to how many regulatory hurdles, restrictions and at times almost total impasses are confronted by a new business-especially if one considers using any

portion of the natural environment no matter how prudently you design. Without a doubt, developing a fish farm on an estuary, especially in Oregon, has to be the most closely viewed, scrutinized, investigated, debated and down right spied-upon operation imaginable. The following listing is a generalization of major permit areas with accompanying comments, most of which are appropriate to Oregon, but I'm certain are similar in other areas. As for separate permits, at last count we have 18, and there are more to go.

Fish Use: Most fish resources in their natural habitat are the property of some unit of government. If it is at all legal to possess them privately, one or several permits are needed. In Oregon it requires two formal permits and three letters of approval to obtain eggs and rear salmon or trout. Disease free certifications are also involved.

Recent legislation has greatly liberalized the laws regarding the possession of salmon stocks by private enterprise in Oregon. The new permit system is well designed to protect the state's salmon resources, yet give the entrepreneur the opportunity to proceed with broodstock development from which he can obtain his production stock from the excess eggs.

Land and Water Use: Getting permission to use land and water is by far the most difficult part of becoming a fish farmer. Long gone are the days when you could just help yourself, and rightfully so. However, there needs to be some sanity replaced into the process. Every level of government and several agencies on each level have their say in whether or not you can do business. And on occasions they will be at cross purposes and the applicant is caught in the middle. Have you ever tried to pour a concrete floor in a food processing building? FDA says make it smooth so it can be cleaned. The safety people say make it rough so the workers won't fall down.

My last agency count was two city departments, four county groups, eight state agencies and four federal entities, each with the power to allow or disallow what you had in mind to do. That is 16 unanimous yes votes. It is very much like being voted into a secret fraternity: one blackball and you're out. Paranoia toward agencies is a common ailment in business today and nowhere is it greater than for an aspirant or operating fish farmer.

An added frustration to the imposing list of needed permits is the frequent lack of assistance from the regulating agency in helping you with your problems. They set rigid rules, or in some cases sliding rules that you can't get hold of, and then serve as judge and jury. Frequently there is no place to go for counseling in the system. You are on your own to sink or swim. The newcomer is hopelessly lost.

It has been suggested that I write a book on my permit-getting experiences. If I did, which I never will as it would be only an academic exercise and use up time, it most certainly would range from tragedy to comedy.

The Money Lenders

Here is an area that will curl your hair. Particularly if you're a very recent convert from academia into business. How do you pay for your ideas? First of all, I'm firmly convinced, based on innumerable pro forma exercises, that there is a critical mass necessary in order to make a go at fish farming. Ma and Pa operations will always be just that, and the corner grocery store is testimony to that approach. There are those who have gone to the other extreme and set up grand stock promotion ventures and the money game always received more attention than the fish. They were in trouble from the beginning.

My experiences tell me that between $500,000 and $1,000,000 are necessary in the first year to get an operation underway that has a chance for success. At this level of front money you should be able to see some return in the first 18 to 24 months whereby additional funding through lending institutions would be possible.

Believe me, you cannot walk into a bank and ask for 1/2 to 1 million dollars to start a fish farm. They will be genuinely interested in your ideas, as most everyone is since there is great public interest in fish farming today with some strong exceptions that I will relate later. But unless you have moneyed backers who will sign personal guarantees, you'll just have a nice visit. Bankers take zero risks. Even federally supported loans are difficult. I have played that game with the Small Business Administration and was led down the primrose path for months to the bitter end that huge personal guarantees were again necessary. Even as in our case with people on the Board of Directors with very healthy financial statements, personal guarantees are tough to get. It makes you wonder who personally guarantees the foreign aid money our government gives away by the bushel basketfuls.

The solution is to interest large corporations in your venture. These people are quick to see your scheme and size up its potential and they will act unbelievably fast in their decisions. The business mind is an exciting thing to watch. It is a head full of steel springs that makes things happen now, not 6 to 12 months later. Realize, however, that for their money they want control, which means 51%. So you lose your nice little company that you had such great dreams of personal success and wealth planned for. But your dreams were just that without the financial backing. It is certainly better to have 49% of something than 100% of nothing.

There are a number of large firms that are shopping for fish farms. The Japanese are especially active. You must be most careful, however, in whom you choose. Large firms with the General Motors syndrome can be deadening. Oregon Aqua-Foods, Inc., is most fortunate in being associated with Fisher Companies, Inc.,of Seattle, Washington, which is a family-run operation that has been in flour milling and lumbering for over 100 years. It is important that they understand biological systems. Their people are directly active in our fish farm and they provide additional services in business management and legal counsel that are invaluable.

Management - Not Things

I am firmly convinced, based on viewing numerous state, federal and private fish cultural operations over a number of years, that success is not based solely on technological advances. The primary control is in the management. People, not gadgets or canned programs, make an operation work. This is even more true in the private sector where a profit has to be made or it's all over. Tax supported facilities can have costs get out of hand for some time before anyone notices or cares. The regular profit and loss statement makes considerable difference in how the management functions.

In OreAqua we have a crew of young professionals who have been given the challenge of making a fish farm work. They have been told that when we turn the corner they will have a piece of the profits. Professional pride also motivates each of us as we have had our detractors. Professional doubters and objectors have made themselves known by using the wet blankets of disease, food, genetics, mechanical failures and costs. Sportsmen cry that you will ruin the natural runs and that Californication of Oregon will follow private involvement with salmon runs. Commercial fishermen fear competition.

Summing up the problems of aquaculture development -- it is not technology, but the socio-legal impediments that are of concern. How do you get resource agencies, the planning commission, the sportsmen, environmentalists and commercial fishermen to believe in and possibly support your ideas? How do you get state or federal discharge permits? Add to this the financial worries and you have the problems that really concern a potential or actual fish farmer. And I have found no one to step forward with guidance, let alone answers.

Where Does Help Come From?

Technology: Agencies and institutions in the past have provided the basic hard facts of life and death in the husbandry of both land and aquatic species. Sea Grant is a mechanism through which efforts can continue. And we do have unsolved problems. From my vantage point these are disease control, food sources, effluent control. The rest are less important, but none of the completely unsolved technical problems should hold back a serious fish farmer. Many species can now be reared.

Socio-legal: Whether you are allowed to farm or not is the question. Who is talking sense within the environmental concern spectrum? Certainly not the regulating agencies, that is too much to expect. Industry's voice will most always be suspect as self-serving, which is the only way it can be.

Why can't Sea Grant assume the role of peace maker? How many in Sea Grant administration or research know what the rules and regulations of EPA, FDA, SBA, OSEA or what other agencies in the "alphabet soup" might be? It is with these problems that help is needed.

People Who Can Do Things

Another crying need of the fish farmer is for people who can do things. A thinking man or woman who can build or mend a functioning system is rare. If you find one, pay him well so he won't be hired away. Presently the Community College program has by far the best offerings. Our Oregon State Superintendent of Instruction recently expressed his concern over our information-rich but experience-poor society of today that has replaced the information-poor but experience-rich society of 50 years ago. It must be possible to strike a balance.

The Challenge

Aquaculture must no longer be mauled and pawed over in the laboratories and test facilities of our institutions. Other areas of the world stopped this long ago, if they ever began. The challenge of Sea Grant is to get involved with your local politician, bureacrat, environmentalist and fish farmer and solve the socio-legal problems that impede progress.

When we can freely and pridefully use the term "farmer" to mean one who produces a crop from water, then we are philosophically and physically on our way to economic reality as our land-based counterparts have been for so long.

Who Should Do What in Aquaculture

Robert W. Schoning
National Marine Fisheries Service
National Oceanic and Atmospheric Administration

The title speaks for itself. It implies that some things should be done and there are some entities to do them. I will give you some of my ideas on both.

There are instant experts on many things these days. All you have to do to create one is pour water on its head and watch it transform. In this case, pour a little aqua on its head and culture it into an aquaculture expert. However, I am not an instant expert on aquaculture. I am merely a fisheries administrator with experience at the state and federal levels. But I have seen enough aquaculture activities--good and bad--to have some views. I offer them for what they are worth. Use the ones that are worth something and discard the ones that aren't. I have a desire to see a winner in this field and I have some ideas on how to go about it. We need some early winners to develop and sustain support for a sound long-range program.

It is inappropriate for me to get too specific on technical details. Instead, I will talk about some concepts. I offer four "C's" for guidance. They are CONCEIVE, COORDINATE, CONDUCT, and COMMUNICATE. Who should do all of these things? The major participants are the state agencies, federal agencies, universities, private industry, and other interested parties. Let's see how they fit together.

1. *Conceive.* Conceive what needs to be done; there is much to be done. Consider the needs, requests, and plans of all and evaluate them carefully. Put them together into a master plan. Be careful, for many times an agency has its own cause, often without regard to activities of other agencies. The project may be responsive to a specific problem, but without a relationship

to an overall plan. When large new programs with substantial federal funding are developed, it is a human tendency to want part of the action, and the bigger the part the better. I have seen requests for funds for reasons such as--we need to keep our present staff; we need to increase our staff; we need more graduate students; we should get all the money because we testified for the authorization; or all of our projects are the soundest and most needed. Look for the most pressing needs and satisfy them on a priority basis. A good guideline might be resource interest and not self-interest.

2. *Coordinate.* Coordinate every phase of the plan with appropriate interests. After it is conceived and sent out for comments, the responses should be coordinated and included as appropriate. A realistic procedure must be developed to solicit and incorporate the ideas in an orderly and timely fashion. Final authority for decisions on inclusion or exclusion in the plan must be clearly established and accepted. Circulation of written preliminary draft plans is a good approach as long as it is clearly indicated that they are not set in concrete and others are welcome.

It is a good practice to create a coordinating or advisory committee. Such a group should be involved in the program every step of the way, from the initial planning to the successful completion. When it is a winner, each gets his share of the credit; and when it is not, each shares in the responsibility for the failure--as a member of the team. Backbiting and "I told you so's" are not nearly as appropriate comments from a team member as, "We had a loser in that one, but the next will be a winner."

It is the responsibility of the overall program manager to coordinate. He must impress upon all the importance of it, particularly in a field such as aquaculture in which there are so very many experts in their own right. I have been in situations when it was all--and maybe even a little more than--I could do to coordinate with such competent fellow workers who obviously knew more about the subject than I did, and both of us realized it.

In my judgment, it is absolutely essential that all interested parties become involved in the development of the plan. No single entity I have yet encountered has had a monopoly on brains or good ideas. I have received good ideas--at least much better than mine--on many fisheries matters from such diverse sources as sport fishermen, commercial fishermen, legislators, university faculty, and outdoor writers, to name a few. As I gain experience, I have become less concerned about the source of the suggestion and more concerned about the merits of it. It has been a surprisingly helpful philosophy and I have had more winners as a result.

There is no question that some fisheries interests spawn more good ideas than others. Still, others get a better hatch. But whatever the source, the suggestions merit evaluation. A cursory one may be enough. The originator justifiably feels considered and more a part of the team if his ideas get exposure. If the suggestion is a good one, you have a better program as a result of including it.

I have never seen a program so good that another good idea would not make it better. Just remember your own reaction when someone includes one of your ideas in a plan. This concept of widespread input is particularly applicable in a field like aquaculture that has worldwide interest and experts, and work in it has been going on for centuries.

It has been a longtime belief of mine that if there is anything we need more than fish it is friends. One way to get them is to welcome them as part of the team, and the sooner the better. Let them start at the beginning. Generally speaking, the longer people work together, the better they work together.

3. *Conduct.* Conduct the program in a professional way. Give each person the opportunity to do his thing within the overall plan. Sometimes, this is a neat trick when the team includes such different members as laborers, nutritionists, hatcherymen, pathologists, businessmen, students, professors, biologists, and administrators. The plan must have a time table, deadlines, and objectives and goals which must be realistic, followed, reached, accomplished, or whatever. One of the quickest ways to lose support and maybe funding is to set unrealistic deadlines to impress someone for whatever reason and then fail to meet some of them. There are many things to do with money these days--so many that some probably will go without. One of the least popular is to spend it on poorly planned and conducted programs.

4. *Communicate.* Communicate could well be the most important concept of all. You must know what all the players are doing. A system must be set up to insure communication within the team, as well as from the team to all interested parties. Useful information, regardless of the source or developing entity, should be given appropriate distribution on a timely basis. Get it in print in understandable and usable form for the interested fisherman, businessman, taxpayer, or fellow worker. This could be new findings or a concise summary of known information. Failures, as well as successes, are useful to know.

No good will come of a finding if it is not used. It is a classic but justified criticism of a great many entities--state, federal, and academic types--that they don't publish enough or on a timely basis. It doesn't have to appear in one of the nation's leading scientific journals and be cleared by an eminent editorial board to be useful. There is a chance it could be even more useful if it got out a year or two sooner in relatively simpler form. For example, fishermen, businessmen, administrators, budget specialists, and even scientists will read mimeographed material if it has enough to offer.

We must communicate what the problems are so we can get at the answers. We must communicate the answers, even if only partial, as soon as they can be released, so they can help us attack other problems to which we get answers to release, ad infinitum. There is an old saying, "He that has, gets," or "The rich get richer and the poor get poorer." In our case, he who has answers, gets more, and he who is rich with information gets richer by applying it.

We have talked about some of the general but important things that should be done. Now, let's talk about "The Games People Play" or really, the parts people should play.

Let's talk about the Federal Government first because it is the biggest and usually the most, but not necessarily the best. There are some things it should take the lead in or do entirely. It should provide much of the funding, particularly in the early stages, as well as in the long run, for certain kinds of basic research. The work is needed, but results that can be applied may be many years away. It is not realistic to expect academic institutions or private industry to independently bear this burden. However, there are instances in which State agencies may want to do some such work, and for good reason are the logical ones to do it.

Coordination of the nationwide program logically must rest with the Federal Government. No other entity has the resources to accomplish it effectively. It is a pressing need and must be met. There are a great many Federal agencies directly or indirectly involved in mariculture. It is easier for a "Fed" to talk to another "Fed." I can remember when I was a state agency director, I thought the "Feds" had a language all their own and it was foreign to me, or at least I couldn't get the message.

The NMFS presently conducts large, significant programs in fishery research and resource enhancement. These are essential building blocks in the development of a commercial aquaculture system. The staff is experienced, and the programs are ongoing. This should continue.

Sea Grant also has a major statutory role in advancing aquaculture. It has a substantial budget for supporting practical proposals, innovative research and development, and extension activities in aquaculture, predominantly at the university level.

On the other hand, the Federal Government should drop or reduce certain activities when the results demonstrate the excellent potential for commercial opportunities and there are takers. One of the functions of government is to help, not hinder or compete with, the development of new, sound business ventures.

My personal belief is that, in general, whenever non-federal entities, whether they be state agencies, universities, or private industry, want to conduct a given activity and have some competence to do it, they should be encouraged to go ahead. There are ample things that are needed to be done in aquaculture for which no federal interest or capability exists. However, the Federal Government has a responsibility to evaluate the need if federal funding is requested or already devoted to it, both within and outside the Federal Government.

Dissemination of information is another needed action that can be spearheaded by the Federal Government. There should be a policy of making the useful information available as soon as possible, and if others can't do it, we should.

Biological and engineering research and development, as they apply to aquaculture, should be carried to the demonstration stage. Economics, food science, and marketing research may be carried further under certain circumstances.

State agencies have resource management responsibilities which can be closely related to some aspects of aquaculture. Regulating or controlling the harvest of intermixed naturally and artificially raised fish and shellfish by time, place, method, and amount poses problems and requires information. The states may be best suited to conduct the studies to collect this information.

Many state fisheries agencies have staffs presently working on aquaculture-oriented projects. They should be continued or expanded when they fit into the overall plan. If they don't, but the state feels a need for the work to solve a specific local problem, the work should continue as the state sees fit.

We in the NMFS feel the states should have a bigger share of the action in almost all fisheries programs. That is the thrust of our State-Federal Fisheries Management Program you have heard so much about. We want to be the catalytic partner to help get things done. We aren't offering to give away the family jewels or sell the farm at a bargain price, but we are saying that it is high time there is more mutual trust, respect, and coordination between the state and fereral fisheries agencies. One way to do it is to integrate our aquaculture programs more closely, with the states having a more meaningful say.

On the other hand, they shouldn't have more federal money just because it is nice to have, and they are states. To qualify, they need certain competence or the ability to develop it in appropriate fields, as well as the desire and interest to integrate their efforts into the national plan as needed.

Universities vary greatly in interest, existing programs, funding policies, and receptiveness to integrating university-conducted programs into a national plan. Much can depend on how the package is developed and presented. There is, in my opinion, a large role in the national aquaculture plan for universities. In any partnership there are give and take and the need for compromises, and this one would be no different. Workers of all types for the aquaculture industry must be trained, and universities are experts in that. In the process, much good work can be done on important problems, although usually of a more short term nature, but not necessarily. The results from many Sea Grant-funded and university-conducted projects are conclusive proof of the importance and value of university input.

Universities seldom have any significant amounts of in-house money for the types of studies envisioned in the aquaculture program. They are grant-oriented and effective at it. And, when necessary, they can muster a fine cross-section of needed experts on campus. However, in my opinion, they do not belong in management nor do they belong in commercial production. They teach, train, try new

ideas, develop others, and produce meaningful results to other potential users. That is a lot to do, particularly if it is done right.

The businessman has a very big part of the action. He is the one who will eventually turn it into a success or failure. If we have done it right and have gone far enough, his experience, ingenuity determination and desire to be successful will make it a winner. Then all of us benefit in more ways than I have time to list. Certainly there will be a few who will botch up what appears to be a sure winner, but the American businessman has a good track record. Look at the tremendous strides made in agriculture. Farming the seas and farming the land have many similarities. Let's hope that they are equally successful.

There is an increasing incentive for investing in aquaculture. Food prices are rising. Supplies of many foods, including fish and other protein, are unable to meet the demands. Risk capital is available from many sources for various reasons. Numerous encouraging results have been produced alresdy. The opportunities vary from high risk to virtual certainties. The potential is enormous. As far as I am concerned, the situation is exciting and extremely promising in many respects. Further, I am convinced that much more private capital will go into aquaculture very soon.

Industry can be helpful in identifying problems they see in making a program commercially profitable. They can suggest studies that are needed and even conduct some of them as appropriate. Many large companies have enormous capabilities for, as well as extensive experience in, attacking problems of a type facing aquaculturists. They should be willing to put something in the pot, too. All take and no give makes for a poor partnership.

In summary, I am reminded of an engraving over the door of a Portland, Oregon, grade school which reads, "A child has infinite possibilities; here he may realize some of them." In my opinion, aquaculture, too, has infinite possibilities. Let's begin to realize them.

Enough has been learned to date to prove the concept is sound. Details have to be worked out with some species and under certain approaches. In other cases, much more must be learned, developed, proved, disproved, demonstrated, or implemented. The sooner we get on with solving the problems the better. But I offer four "C's" for guidance. They are CONCEIVE, COORDINATE, CONDUCT, and COMMUNICATE. We must conceive a national plan, coordinate its development and implementation with all interested entities, conduct it in a cooperative, professional manner, and communicate the results as soon as they are available for immediate use.

The Federal Government should be the overall coordinator, primary funding source, and principal catalyst. It should do the needed work not suited to or reasonably capable of completion by others and use its vast personnel, equipment, and facilities potential to the fullest, as appropriate. Needed long-range research and technological programs should be conducted. Most other work

should be completed to the demonstration stage so industry can tell if it is economical to take it from there.

State agencies should take the lead in fisheries management-associated aquaculture programs. They must play a big part in all phases of the program, fully using available staff and other resources.

Universities, primarily with the aid of grants from government and private sources, should teach, train, utilize and develop ideas, and produce useful results in many phases of aquaculture. Short-term research seems most suited to the academic community, but certainly appropriate long-term studies can be successfully conducted there as well. Funding may be more difficult under the latter circumstances.

Private investors have an excellent opportunity to put their money where their mouths are. We just have to be sure their mouths are in the right place. They should point out to us the answers they must have as businessmen to invest their capital. A reasonable balance must be established between what we can and should provide and what they are willing to do to make a profit. I am confident we can reach agreement. Once that is done, it is up to them to make it all worthwhile. There are enough indications already that it will be. It is now just a question of how soon, in what areas, and with what species. More will follow as inevitably as dawn follows darkness. The light is becoming brighter.

We in the National Marine Fisheries Service, with the help of all other interested parties, including you Sea Grant institutions, want to hasten the dawn of aquaculture. We are ready, willing, able and in need of partners. We hope you are in the same frame of mind.

Need for Pilot Demonstration Projects in Aquaculture

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Pilot studies serve as an intermediate between research and production. The need for this intermediate endeavor is obvious and has been described in detail by Woodall (1959). In many instances pilot operations demonstrate the practical value of either basic or applied laboratory research in the transition from small groups of experimental animals to full-fledged production. A procedure demonstrated in the laboratory under carefully controlled experimental conditions may in fact be worthless to the aquaculturist involved in management-production operation. Certainly it would seem that applied research in the various areas of aquaculture could be improved by the creation of active demonstration units or pilot studies. As the authors are both fish pathologists, many of the examples given concern disease control and reflect the area in which our greatest understanding exists.

Large-and small-scale pilot studies have been employed in the development of freshwater fish culture. In the area of infectious diseases pilot programs have proven of value in the perfection of methods for both prevention and treatment of these diseases. For example, prior to 1937, chemotherapy of septicemic bacterial diseases of cultured fishes was virtually unknown, and many hundreds of pounds of fish were lost to such diseases as furunculosis and columnaris. Methods of effectively treating large lots of fishes by free-choice feeding of medicated diets were first developed by Gutsell (1946,1948) and Gutsell and Snieszko (1949 a,b). The developmental or laboratory phase of the drug studies were concerned with efficacy, palatability, toxicity, and tissue levels of each test drug using small numbers of fish. Also most laboratory efficacy studies were performed with artificially infected fish. Pilot studies indicated that effective treatment of production fish could be accomplished with the test drug in diets prepared for use in hatcheries. These studies also

showed effectiveness of the same drugs at hatcheries with a wide range of water chemistry and environmental conditions.

Although treatment of infectious diseases is at times necessary, effective control is usually best accomplished by prevention rather than treatment. With virus diseases of fish such as infectious pancreatic necrosis of salmonids (IPN), avoidance is mandatory for effective control. Several years ago laboratory studies showed that IPN virus could be isolated from peritoneal washings or fecal material from asymptomatic carrier fish. Pilot studies then showed that IPN virus could be detected from five-fish pools of peritoneal washings or fecal material and this became a field technique. Although this procedure has been changed because it was found that visceral homogenates are more reliable for detection of IPN virus, the fact remains that pilot studies were effectively used to develop a procedure for management of IPN.

Proper nutrition of cultured fishes is important not only from the standpoint of efficient growth but also as a means of disease prevention, since anemia and disease syndromes caused by vitamin deficiency are well known. The use of pilot studies has been essential for developing diets for the various cultured species and also the same species cultured under different conditions. Of all the diets developed in recent years, probably few have been more extensively tested and used than the Oregon Moist Pellet (Hublou 1963).

Researchers have for some time concerned themselves with the study of oral immunization of fish. A number of bacterins have been prepared and their effectiveness as immunizing agents investigated (Snieszko, 1970). Of the problems associated with cultivation of fish in salt water, few have been as serious as vibriosis, caused by *Vibrio anguillarum*. Control of vibriosis among populations of fish involved in mariculture is essential; therefore, since 1968 we have extensively studied orally administered bacterins prepared from cells of *V. anguillarum* (Fryer, Nelson, and Garrison, 1972). Results of over 300 experiments have shown that when bacterin was given at the rate of 2-10 mg/g of food for 14-30 days to lots of 200 fish each, effective control of vibriosis was achieved. However, attempts to utilize this information obtained from small groups of fish on a production level have not met with equal success, indicating the need for pilot studies.

The need for demonstration studies is obvious. Such work for many types of aquaculture will fill a necessary void, making for an orderly transition of selected types of research to production conditions. Pilot or demonstration studies where appropriate could be conducted through the Sea Grant Program at participating institutions utilizing available technical capability.

REFERENCES

Fryer, J. L., J. S. Nelson, and R. L. Garrison. 1972. Vibriosis in Fish, p. 128-133. In R. W. Moore (ed.), Vol. 5 U. of Washington publication in Fisheries New Series, Seattle.

Gutsell, James. 1946. Sulfa drugs and the treatment of furunculosis in trout. Science 104:85-86.

Gutsell, James. 1948. The value of certain drugs especially sulfa drugs in the treatment of furunculosis in brook trout, *Salvelinus fontinalis*. Trans. Amer. Fish. Soc. 75:196-199.

Gutsell, James, and S. F. Snieszko. 1949 (a). Response of brook, rainbow and brown trout to various dosages of sulfamerazine. Trans. Amer. Fish. Soc. 77:93-101.

Gutsell, James and S. F. Snieszko. 1949 (b). Dosage of sulfamerazine in the treatment of furunculosis in brook trout (*Salvelinus fontinalis*). Trans. Amer. Fish. Soc. 76(1946) 82-96.

Hublou, Wallace F. 1963. Oregon Pellets. The Progressive Fish-Culturist. 25:175-180.

Snieszko, S. F. 1970. Immunization of fishes: a review. J. Wildl. Dis. 6:24-30.

Woodall, A. N. 1959. The Missing Links of Fish Husbandry. The Progressive Fish-Culturist, 21:51-54.

Objectives of Aquaculture: From Profits to Sustenance

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Any planned activity must have an objective or a goal; otherwise it is not possible to make decisions about it. To choose the route you follow in driving to work requires an objective. The shortest route? The most scenic? The one with fewest stops? You can't pick one without having in mind an objective.

It would be folly to suggest that the process of inferring goals by observing actions is an exact one. Also, a given action may be associated with a specific goal because an even better alternative is not known, or because an alternative is not feasible, technologically.

Perhaps this is as good a time as any to say that this presentation also has an objective. It is to remind Sea Grant researchers and advisors about the importance of knowing the likely objectives that prospective users of research results have in mind. Since I am bound to get carried away with this, let me state right now that I realize much useful research or perhaps even most useful research is carried out without knowing the objectives of the user. I also think it frequently leads to a certain waste of time.

Let me discuss, briefly, some different goals that I could visualize for aquaculture, and let me do it in terms of a few very basic economic concepts.

1. Profit Maximization

The assumption that the owner of a business is trying to profit from it as much as he can is often valid and it is, furthermore, one of the cornerstones of traditional economics. We should expect operators following this objective to produce a volume of

output so that incremental cost is equal to incremental revenue (MC = MR), although society in general would be better off if we could get them to produce where MC = Price. This behavior of the aquaculturist should be expected in many developed countries although, in many cases, the fact that aquaculture may not be the dominant product of the firm can significantly alter its behavior. Another variation is that we may be producing for recreational purposes, and minimum cost for a given level of output may take over as an objective. External factors with a potential for limiting success will typically include demand characteristics and, on the production side, managerial skills and "biological technologies," by which I mean those innovations that affect inherent growth or other characteristics of the animals or plants. Ultimately, the field of genetics is heavily involved in this.

2. Maximum production

This could be either of total weight or of protein. In either case, this kind of objective treats resources as if they were free (or had no alternative employment). Experience with agriculture tells us that we should expect to see many aquaculturists (or their managers) mistakenly strive toward this objective even in developed nations where the relationships between product and resource prices would never justify such action. You will see output maximization as legitimate behavior in research situations and in show-case situations where someone, either stockholders or taxpayers, is picking up the tab. This can certainly have its utility as long as scientists and users alike keep firmly in mind that what is being shown is what is possible, not necessarily what is desirable. If you reflect, I think you will find that most of what is universally admired in aquaculture today is associated with such things as "pounds per acre" or "protein per acre." This is surely relevant, but ultimately resource conversion efficiency and economic efficiency become more important.

One would expect to see output maximization as an objective in less developed nations, but it probably does not occur as often as the folklore would have us believe. Typically, some resource becomes critically scarce and tradeoffs with other parts of the economy become necessary.

Limiting factors are typically skilled labor, management, product distribution, social factors and biological as well as physical technologies.

3. Maximum efficiency

This objective, generally achieved at the point of lowest per unit cost, can be a suitable objective for aquaculture in a developing but capital-poor country. Striving toward it would cause the food product to be produced at the lowest possible cost to consumers. Typically, relatively small firms without sophisticated technology would be involved. The presence of large industry or other firms would tend to throw the system off balance. Limiting factors would frequently be skilled labor, biological technologies, capital, and product distribution.

4. *Maximum utilization of some scarce resource*

This is a frequent objective and the solutions typically involve more than one product. Rice and fish culture on limited land is an example. The other product(s) may not be food; some totally unrelated but needed commodity, for instance roads or nuts and bolts, may be involved and the problem may be one of allocating scarce capital among these uses.

Depending upon the extent of industrialization of the country involved, limiting factors could be as in No. 1 or as in No. 3 in cases of less developed economies.

5. *Specific, narrow objectives*

As an example of such an objective, let us take the earning of export credits in order that a country can import from other countries. This is the kind of objective that has to be recognized, although this and other objectives like it frequently will not be offered researchers or technical assistance people on a silver platter. It is possible for technical assistance workers to spend quite a lot of time working on production and on food distribution problems in a country--finally to discover that the real purpose toward which the country is striving is production for exports.

I am also reminded of a technology assessment study a couple of years ago using world-wide aquaculture as an example. At the outset, the assumptions were made that enough capital and enough skilled personnel were available and the study went on from there. Needless to say, the results were not particularly pertinent, for the two most critical factors in all but a highly developed nation had been assumed away. As an example of what technology assessment could do, the study failed for lack of a well-defined objective and realistic resource assessment.

In summary:

a. If the scientist or advisor working close to the adaptation of his work does not know the objectives of the product and the nature of the producer's resources, any value his research or advice may have is largely coincidental.

b. Beware of intra-societal technology transfer without close examination of objectives and the nature of the resources. My guess is that we could no more afford to grow oysters as the Japanese do it than they could afford to grow wheat the way we do it. And even though Taiwan can produce over 1,000 pounds of milk fish per acre and do well at it, this does not mean it would be feasible in the Philippines. There, it might be prohibitively costly to exceed 400-500 pounds per acre.

To increase our understanding of the way objectives and resources affect the application of science and technology, I am afraid I have to give an old answer to an old problem: Preserve disciplinary expertise but tear down the barriers that prevent interdisciplinary cooperation. In short, beg, coerce, force, and bribe scientists to

work together. Working as we do in a Sea Grant context we need to do better in this respect. Our only solcae is that so does nearly everyone else--and that isn't enough.

Concepts in Aquaculture: Intensive vs. Extensive Systems

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"Husbandry of aquatic organisms, though a novelty in much of the world, has been practiced throughout the ages . . . No matter the antiquity of aquaculture, the contribution of the world's waters to man's diet stems largely from the hunting and gathering of fish and shellfish from untended stocks" (Bardach et al., 1972). Obviously, the point at which one distinguishes between hunting and gathering and aquaculture is quite arbitrary; any point of distinction between intensive and extensive aquaculture is also arbitrary. I prefer to conceive of a continuum of activities whereby man obtains food from the sea. At one pole of this continuum are the classical fishing activities, while at the other are totally recirculated culture systems (Figure 1 and Table 1).

The criterion used in positioning an activity on the continuum is the relative dependence upon natural marine phenomena in production of the food. Another way of saying this is that the energy cost to man for the production of food increases with the intensiveness of the culture scheme. It follows that the dollar cost of production will generally be higher in more intensive culture systems. The cost of harvesting the resource would be just the opposite; the dollar cost of harvesting at the less intensive end of the continuum would be considerably higher. A cost-benefit ratio for any activity on the continuum could be developed by comparing the energy or dollar cost of production and harvesting to the energy or dollar value of the crop.

Such a cost-benefit ratio in dollars would not necessarily reflect the true ecological cost of a scheme because virtually all culturing or fishing activities are fossil-fuel dependent. Since the energy from fossil fuels is very highly discounted in monetary units (Odum, H., 1971), the actual energy costs of obtaining food

from the sea are much higher than the dollar costs. Cost-benefit ratios also tend to describe short-term phenomena. Hunting and gathering, for example, is currently the most economical method of harvesting the majority of marine food resources. There are three main reasons for this: 1) the energy of input into production by man is zero; 2) the harvesting is very expensive energetically but is heavily subsidized by the fossil fuel discount; and 3) there is little control of the rate of take--the world fisheries will eventually become predation limited. The ratio of cost to benefit in the world's fisheries will, then, experience a long-term rise.

Transplantation of exotic stock for eventual establishment in new environments is a somewhat more sophisticated form of hunting and gathering. This can be as simple as moving shellfish from seed beds to growing beds a few miles away, or it may involve attempts to introduce an exotic species thousands of miles away from its native habitat. While transplantation affords man the energy advantage of being able to capture a desired prey in a nearby environment, the disruptive effects of the introduction of the exotic species upon the local community structure may be a serious long-term energy disadvantage (Rosenfield, 1971).

Both exotic and indigenous prey species have at times been cultured in hatcheries and subsequently stocked in marine environments (Hidu, 1971). Large inputs of energy are necessary to rear the animals through their early life stages with increased survival of the young of the desired species an energy plus. One individual or group of individuals, e.g., a state, may have absorbed the cost of the hatchery activities, and, of course, this party would hope to reap the benefits of the eventual harvest. This is not always easily achieved as many suitable prey species have considerable locomotory powers. Shrimp which had been hatchery reared by one party might be legally harvested by another if the animals strayed into commonwealth waters.

One obvious solution to this problem is for the owners of the hatchery to gain control of large areas of water or bottom and to exclude others from fishing there. If the cultured species were natatory, the mariculturists would also have to devise ways to keep their stock in the controlled areas. The energetic benefits of harvesting large crops of animals from relatively small proprietary areas are large. The debits are equally imposing. The simple erection and maintenance of an enclosure is expensive. The animals in this type of culture system generally require an ancillary food source. Predators (other than man) and competitors are generally excluded (Anon., 1972). Chemical control is sometimes used here (Loosanoff, 1961; Loosanoff and Nomejke, 1958; Mackenzie, 1970); this could be extremely disruptive ecologically.

There are legal problems in leasing subtidal areas; the idea that subtidal land and the water above it are commonwealth is traditional in Western culture. The leasing of subtidal land will be even more difficult in the future with the rapid increase in the popularity of aquatic sports in the United States. It will be difficult for mariculture to compete for space with recreational interests

until such a time as the United States suffers a severe food shortage.

A further step on the continuum from hunting and gathering to intensive culture is the culture of high densities of organisms in ponds which have been diked off from the natural environment. The energy costs of the construction itself are high, but the advantages in controlling growth and in harvesting the crop are considerable. Most such ponds are built in salt marshes or mangrove swamps (Hora and Pillay, 1962; Lunz, 1957). The construction of many ponds in a marsh would probably be disruptive to the point of destruction of the marsh. Since marshes are well known to be extremely important in the energetics of an estuary (Odum, E., 1971), the total effect of pond aquaculture in marshes may well be an energetic deficit to man.

Another disadvantage of high intensity pond or raceway culture is that large numbers of animals cultured in small areas produce large amounts of metabolites per unit volume of water. The effluents of high intensity pond culture are essentially raw sewage. Such an effluent, if untreated, would constitute a serious problem to the local environment.

The far pole of the aquaculture continuum is the use of self-contained, recirculating systems. While this phase of mariculture is by far the least developed, it is also the most ecologically benign. No physical or chemical alteration of the wetlands or surrounding water is necessary. There need be no competition with recreational interests. Control of the growing conditions could be almost complete, and harvesting the crop could be very efficient indeed. The large debit here is the very high energy cost of operating a closed cycle culture system.

Another problem associated with closed system mariculture is the lack of biological information directly related to the design of the culture systems. In engineering a recirculating culture system, one must have a knowledge of the following:

1) The rate of consumption by the organisms of food, oxygen, and dissolved chemicals;

2) The rate of production of waste products by the organisms; and

3) The tolerance of the organisms to accumulated waste products, and the tolerance of the organisms to depleted chemicals in the water.

My own research group is attempting to culture oysters and clams in a recirculating seawater system. Table 2 is a conservative list of the biological specifications necessary for the design of a closed cycle culture system for oysters along with the state of information of each particular specification. *Crassostrea virginica* is one of the most heavily studied of all marine organisms; similar information for most other suitable culture species is even more sparse.

Efforts in mariculture will undoubtedly expand in the future along the continuum presented in Figure 1. At the present time, the cost-benefit analysis favors those culture schemes toward the hunting-gathering end of the spectrum. Growth of such "close to nature aquaculture" will surely be greatest in non-industrial parts of the world, with expansion of higher intensity aquaculture in countries which most fully exploit fossil-fuel energy. Development of high intensity, closed-cycle culture will take place in Western countries. The largest problems with all but closed-cycle culture are the potentially disastrous ecological effects of such things as introduction of exotic species or marsh degradation, or chemical pest-control or metabolite-laden effluents. The most serious problems in the development of recirculating system culture are the high energy input demands and the lack of relevant biological information concerning the culture species.

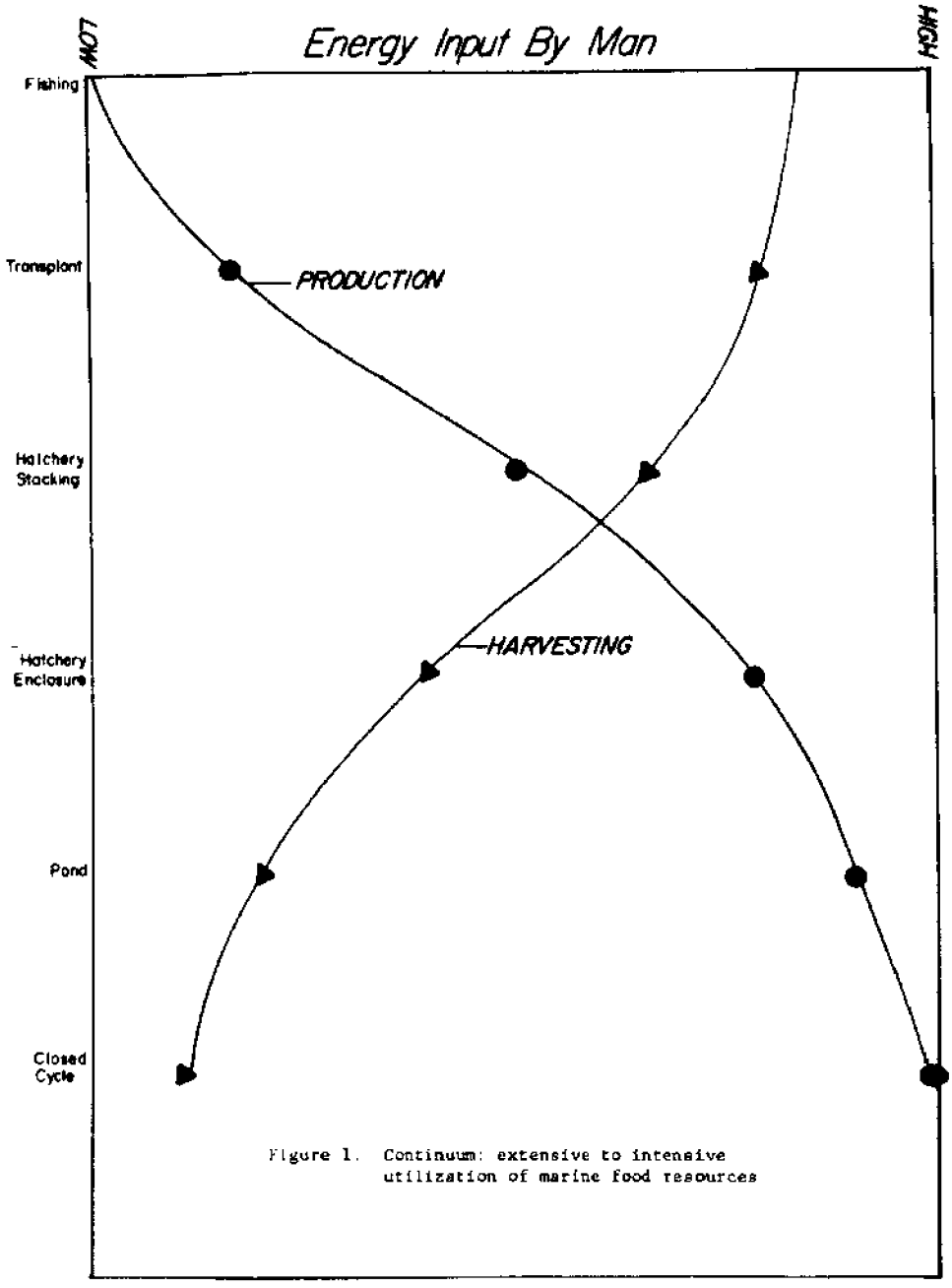


Figure 1. Continuum: extensive to intensive utilization of marine food resources

Table 1

Selected examples of aquacultural yields
arranged by ascending intensity of culture methods

Culture Method	Species	Yield [Kg/(ha)(year)] or economic gain
Transplantation	Plaice (Denmark, 1919-1957)	Cost: benefit of transplantation. 1:1.1-1.3 in best years (other social benefits)
	Pacific salmon (U.S.)	Cost: benefit, based on return of hatchery fish in commercial catch, 1:2.3-5.1
Release of reared young into natural environment	Pacific salmon (Japan)	Cost: benefit 1:14-20, on above basis
	Shrimp, abalone, puffer fish (Japan)	Not assessed; reputed to increase income of fishermen
	Brown trout (Denmark, 1961-1963)	Maximum net profit/100 planted fish: 163%
Retention in enclosures of young or juveniles from wild populations, no fertilization, no feeding	Mullet	150-300
	Eel, miscellaneous fish (Italy)	
	Shrimp (Singapore)	1,250
Stocking and rearing in fertilized enclosures, no feeding	Milkfish (Taiwan)	1,000
	Carp and related spp. (Israel, S.E.Asia)	125-700
	Tilapia (Africa)	400-1,200

Table 1 (continued)

Culture Method	Species	Yield [Kg/(ha) (year)] or economic gain
	Carp (Java, sewage streams) (1/4-1/2 of water area used)	62,500-125, 000
Stocking and rearing with fertilization and feeding	Channel catfish (U.S.)	3,000
	Carp, mullet (Israel	2,100
	Tilapia (Cambodia)	8,000-12,000
	Carp and related spp. (in polyculture) (China, Hong Kong, Malaysia)	3,000- 5,000
	Clarias (Thailand)	97,000
Intensive cultivation in running water; feeding	Rainbow trout (U.S.)	2,000,000 [Kg/(liter) (sec)]
	Carp (Japan)	1,000,000-4,000,000 [about 100 kg/(liter)(sec)]
	Shrimp (Japan)	6,000
Intensive cultivation of sessile organisms, mollusks, and algae	Oysters (Japan, Inland Sea)	20,000
	Oysters (U.S.)	5,000 (best yields)
	Mussels (Spain)	300,000

Table 1 (continued).

Culture Method	Species	Yield [Kg/(ha)(year)] or economic gain
	Porphyra (Japan)	7,500
	Undaria (Japan)	47,500

(From Bardach et al., 1972)

Table 2

Biological Specifications

C. virginica

Variable	Rate of Consumption	Rate of Production	Tolerance Level
Oxygen consumption	3	--	--
Pumping rate	--	3	--
Food	2	--	--
Ammonia production	--	2	3
Urea production	--	2	--
Amino acid production	--	2	--
Unidentified N production	--	2	--
Feces and pseudofeces production	--	1	--
Salinity	--	--	1
Temperature	--	--	1
Nitrate tolerance	--	--	4
Phosphate tolerance	--	--	4
pH tolerance	--	--	2
Other inorganic ion tolerance	--	--	4
Organic tolerance	--	--	4

1 = Well known
2 = Some information
3 = Inferential information taken from studies of other species
4 = Unknown

Bibliography

Anon. 1972. Shrimp harvest at Marifarms. Am. Fish Farmer, 3 (2): 5-7.

Bardach, J. E., J. H. Ryther, and W. O. McLarney. 1972. *Aquaculture, the Farming and Husbandry of Freshwater and Marine Organisms*. Wiley-Interscience, New York. 836 pp.

Hidu, H. 1971. The feasibility of oyster hatcheries in the Delaware-Chesapeake Bay region. *In: Artificial Propagation of Commercially Valuable Shellfish* (D. Maurer and K. Price, eds.). University of Delaware, Newark, Delaware. 212 pp.

Hora, S. L. and T. V. R. Pillay. 1962. Handbook on fish culture in the Indo-Pacific region. FAO Fish. Biol. Technical Report 14. 204 pp.

Loosanoff, V. L. 1961. Biology and methods of controlling the starfish *Asterias forbesi* (Desor). U. S. Bureau Commercial Fish. Fishery Leaflet 520.

_____ and C. A. Nomejke. 1958. Burial as a method for control of the common drill, *Urosalpinx cinerea*, of Long Island Sound. Proc. Nat. Shellf. Assoc., 48.

Lunz, G. R. 1957. Pond cultivation of shrimp in South Carolina. Proc. Gulf and Caribbean Fish. Institute, 10th Ann. Session: 44-48.

Mackenzie, C. L. 1970. Oyster culture modernization in Long Island Sound. Am. Fish Farmer, 1 (6): 7-10.

Odum, E. P. 1971. *Fundamentals of Ecology*, third edition. W. B. Saunders Company, Philadelphia, London, Toronto. 555 pp.

Odum, H. T. 1971. *Environment, Power, and Society*. John Wiley & Sons, Inc., New York. 331 pp.

Rosenfield, A. 1971. Oyster diseases in North America and some methods for their control. *In: Artificial Propagation of Commercially Valuable Shellfish* (D. Maurer and K. Price, eds.). University of Delaware, Newark, Delaware. 212 pp.

Panel Summary: Intensive vs. Extensive Mariculture

Charles E. Epifanio
Gary D. Pruder
University of Delaware

The panel agrees that the point at which one distinguishes between hunting and gathering and aquaculture is quite arbitrary; any point of distinction between intensive and extensive aquaculture is also arbitrary. We prefer to conceive of a continuum of activities whereby man obtains marine food resources. Intensive and extensive culture methods encompass broad and perhaps overlapping ranges on this continuum and are not specific, as well defined points. Decisions to select one method over the other are premature.

Species' characteristics will be a significant factor in the culture method selection. Gains are anticipated by supporting both general approaches, and perhaps the optimum will be a combination of parts of each. All aquaculture is limited by either socio-political forces or underdeveloped technology, or both.

It is recommended that the use of low value energy sources (waste) be explored in both types of aquaculture. It should be recognized that, in addition to a food source, aquaculture may be important in waste recycling, tourist attraction, and improvement in the quality of life. Furthermore, it is recommended that the long-term ecological, energetic, monetary cost and benefits of aquaculture be given high consideration in funding future projects.

Panel Summary: Objectives of Aquaculture

Neils Rorholm
University of Rhode Island
John L. Fryer
Oregon State University
John DuPuy
Virginia Institute of Marine Sciences

There seems to be considerable potential for hatcheries, especially oyster hatcheries for the purpose of producing seed for local leased grounds and perhaps particularly for export.

A quick look at the economics looks very promising but work on demand elasticity in domestic and foreign markets needs to be done to evaluate future potential.

Management problems are numerous, some of which are:

1. Availability of trained personnel.

2. Lack of proper interactions between engineers and biologists.

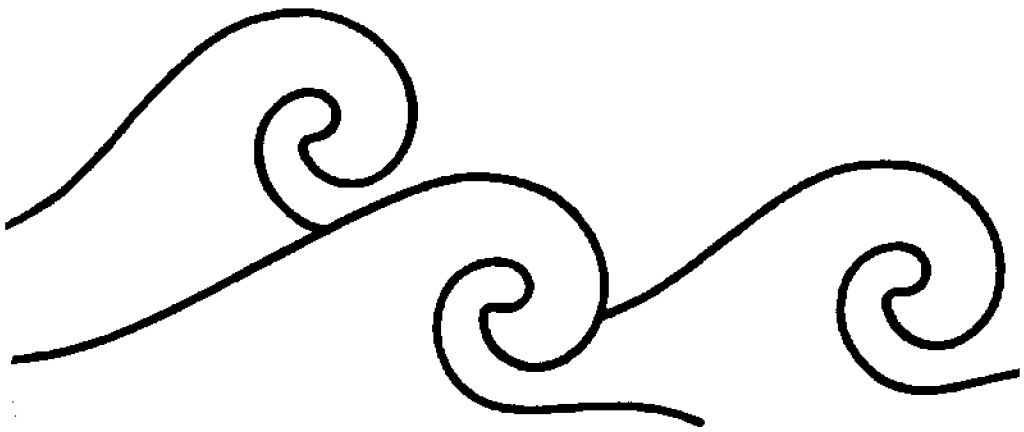
3. Difficulty in obtaining permits for operation of hatcheries with unreasonable regulations set by the regulatory agencies.

4. Problems of communication between the biologist and industry, i.e., the inability of the private sector to follow precisely the advice of the expert to the letter in cases where the procedures are very explicit.

5. Problems of the private sector's expectation that large sums of money can be made on very little investment. The private sector must realize that hatcheries require a total investment of $200,000 or over to design, build and operate such a system for the first 18 months, when there are expectations of making a *real* profit.

6. Availability of land in the chosen locations where there are optimal environmental parameters which make the difference between success and catastrophe.

COASTAL ZONE MANAGEMENT



An Overview of Sea Grant and Coastal Zone Management

Joel M. Goodman
University of Delaware

Good Afternoon, on behalf of John and all of our speakers, I'd like to welcome you to what I hope will be a controversial but stimulating session.

The question of how to provide research support by Sea Grant for coastal zone management and planning has so many facets that it seemed advantageous to set the stage for today's presentations by reviewing a little history, reporting the results of a brief survey, and then postulating a question or two which may or may not have ready answers.

First to the matter of history: three meetings and two years ago in Wisconsin, a topic discussed before the Sea Grant Association was "The Sea Grant Coastal Zone Program." Various suggestions were offered on how the University could support state and federal coastal zone management objectives and after lengthy deliberations the following points, paraphrased for brevity, were noted:

1. It is necessary to maintain a clear distinction between management, a function of government, and research, a service function available from a number of sources, including universities.

2. A close relationship between researchers and decision makers will maximize benefits for both.

3. Two problems appear to exist for Sea Grant programs:

   State and regional management agencies do not understand what support can be provided by the Sea Grant program. University Sea Grant programs are not fully focused on *significant* (emphasis mine) state and regional programs.

4. Coastal Zone Laboratories (the concept) were emerging in several forms in several of the states.

It was concluded that the Sea Grant program was not sufficiently broad, flexible, or well funded to meet the coastal zone research needs of the state. It was recommended that the association establish three ad hoc committees to seek means for improving the situation:

- One to define clearly how to meet coastal zone research needs, comprised of program directors and state managers.
- One to review land grant experience for guidance.

One to define what research activities were appropriate to support regional and national level coastal zone planning efforts.

A great deal of water has gone over the dam since that meeting, amid much coastal zone planning and management activity on the part of the states and Feds. Ideas and methods are slowly evolving for filling capability and knowledge gaps that have appeared while planning or executing management programs. This takes us to the second item. The role of Sea Grant in this context was the subject of a nine-state survey conducted by a disinterested spectator. Those queried were the state-designated points of contact with the Office of Coastal Environment. The states selected encompassed a range of Sea Grant participation ranging from *"None"* to *"College"* status. The degree of centralization of administration and research planning within the states was also widely variable--ranging from highly integrated *Central Committee* planning to *Benevolent Dictatorship*.

The results of the survey revealed an interesting spread of expectations regarding *what Sea Grant has to offer* in satisfying research needs. Clearly, expectations bear some relationship to program status--but which is leading is indeterminate at this stage.

Over the range of program types, reactions varied in roughly the following way:

1. Those with *no program* in the state commented to three major points:
   - A conflict situation between state and academic perception of needs.
   - Competition for funds.
   - Lack of a relevant Sea Grant focus, i.e., Marine Biology vs. Land Orientation.
2. Those with *coherent* or *institutional* programs were fre-

quently ambivalent. They simultaneously had great (but as yet unrealized) expectations while finding current results unresponsive to, or out of phase with, needs. Sea Grant funds were alluded to in the context of a pooled resource, part of which might be effectively employed by direct solicitation.

3. The college/state relationship, while not guaranteeing relevance in the eyes of the state, appeared to be based upon greater confidence of mutually satisfactory negotiation.

In every case academic personnel were identified as resources for satisfying research needs, so it would appear that the problem with relevance must lie somewhere in the definition of need or the project selection process.

If you recall the opening historical comments, you might conclude that not much has been learned in the past few years. You might also conclude, however, that more basic inconsistencies or incompatibilities of other types might exist that require more detailed examination.

In a state with a marine tradition, for example, what unique quality should an advisory service function have so that the Sea Grant assignment is not merely substitutional head count? If a state recognizes the value of such a function, why shouldn't the function be transferred?

Looking next at research, there are generally two types recognized--fire-fighting and planned. Designation and acceptance of responsibility for one or the other is frequently complicated by factors such as

- Competition for Funds
- Conflicts of Interest

  Such as--*Satisfaction of State Needs* (Such as schedule, responsiveness, and expediency) vs. *Satisfaction of Academic Needs* (such as publishable value, problem quality, and reputation enhancement).

What should be the *unique* responsibility which makes it worthwhile to support funds for the academic unit in the name of Sea Grant? Is it the ability to maintain a delicate balance of *independence* with *relevance*? Is it the ability to derive benefits from both directed effort and incidental spin off?

I have premised uniqueness as a criterion for selection, but this itself may not be sufficient to qualify for a supportive role. Our four speakers will offer four other perspectives on the supportive role of Sea Grant research from both user and doer viewpoints.

Potential Sea Grant Contributions to Coastal Zone Management: A State Perspective

Joseph C. Moseley
Texas Coastal and Marine Council

Thank you for inviting me to come here and speak to the state perspective. I'm not sure about the best way to approach this, so I decided to begin by posing some related questions and attempting to reflect on them.

What does state government want/need in the way of technical assistance from Sea Grant?

Unfortunately, we don't usually know. The first thing that comes to my mind is the saying: "It is much easier to answer the wrong question than to answer the right one." This is definitely applicable to coastal zone management. The university community can provide the states with valuable assistance in articulating the right questions. Fighting day-to-day brushfires often occupies most of the time and energies of mission-oriented agencies, and, regrettably, this often precludes their having time to really *think* about the underlying questions. Also, such conditions tend to make one grab for the short-term, quick solution.

Thus, the university community may find itself forced to wear two hats: (a) first, to help ask the right questions, and (b) secondly, seek answers to these questions--after the questions have been tempered by the views and knowledge of those involved in day-to-day management. This is a good position for Sea Grant to find itself in; however, it is necessary to avoid one tempting situation. One must be careful to ask unbiased questions--and not slant those questions toward ready-made answers that he already has available.

What criteria/considerations are states apt to seek in research results?

I believe there are four principal criteria that states must

find in results if they are to be valuable in the ultimate development and implementation of viable coastal zone management programs. They are credibility, utility, timeliness, and objective-oriented.

Credibility - All findings must be credible, both on a technical basis, and from a conflict of interest standpoint. Shoddy scientific work in which errors can be found will usually be a liability, and once-burned, a public official is apt to be most cautious. Poor science is "bad," but conflict of interest is a "disaster." Nothing will destroy the credibility of work faster than a strong charge--and note I say charge, not conviction--of conflict of interest. We all know of situations where such accusations have occurred, and let's avoid any specific cases. Once accusations are made, and even a fair doubt of credibility is established, most public officials will avoid the researcher--and the results--like the plague. This may not be because he doubts the findings, but rather he probably already has his hands full without becoming embroiled in any more flops.

Utility - The results must be usable, and this means that they must be (a) technically valid, (b) workable, and (c) sellable. The point of technical validity should be obvious. The results/procedure must be workable, in that a reasonable amount of energy will result in a usable answer. Lots of grandiose schemes have been devised, but any attempt to apply them in the real world produced frustration, and little else. As much as some purists hate it, research results must be sold to a wide variety of skeptics if such results are ever to be applied. And, after all, if the results are not applied, what was the real reason for doing the research in the first place?

Timeliness - There is an old saying that goes, "he that gets there firstest with the mostest will win..." This is true in coastal zone management. Unfortunately no one knows the optimal trade-off point between being "first" and being the "best equipped." I believe the emphasis should be placed on timing. Let's get moving with anything, as long as it's valid and credible, however meager, and get entrenched. If we wait until we know it all, or until we have all the information, we'll never get anything done. This sort of thinking must be respected by researchers if they want to develop meaningful relationships with state coastal management entities. It's not hard to get an extension of a report deadline on a research project--but have you ever tried to get an extension before a legislature comes to town, or a major hearing is to be held?

Objective-Oriented - Sometimes exploratory research may be the order of the day. However, frequently an agreement will be arrived at between a state agency and a campus-based research outfit to produce a very specific product.

When this occurs, the investigators must go after the stated objective, and not wander off onto tangents, that while they may be interesting and even valuable, don't produce what the contracting agency needs.

To what degree do university groups want to become involved in coastal resources management?

At the risk of raising a few hackles, I'd like to state that most don't really want to get as directly involved as they may think they do from time to time. Let me clarify this. First, I believe researchers must get involved to the extent of knowing what the real issues are. Ultimately, however, coastal zone management means taking some controversial actions, and then seeing who will ultimately have the political muscle to win. This will get bloody, and there will be losers. The indirect involvement--providing advice, doing mission-oriented research, etc.-will be hot enough without being "credited" with making the decisions. Public and government opinion (and funding) priorities swing like pendulums and you as a scientist must survive over time. Besides, if one wants to get directly involved in the type of decision-making that will be ultimately required in coastal management, then he had better be prepared to take the heat and eventaully pay the price of being "gotten." You know, it's much, much easier to find a "Professor Emeritus" than it is an "Elder Statesman."

I certainly don't consider such action as an abdication of responsibility. On the contrary, it would be an abdication if you let temptation/emotion get the upper hand and you jumped into the middle of a fray. You might help "win a battle," but this would be apt to hamper your effectiveness in the long run. It's true that you shouldn't get in the kitchen if you can't stand the heat--but this doesn't mean you should stick your head in the oven.

What kind of a "support picture" should Sea Grant activities related to coastal management expect from states?

That's one I certainly can't answer even for my own state--much less the others. However, there are several general points worth mentioning.

The general fund cutback now plainly visible at the federal level will have some spin-off at the state level. Funds will unquestionably be tighter and the competition tougher. I think several points can be made about state funding: (a) There will be much less interest in basic research; (b) Most activities must result in a specific product; (c) There will be a greater tendency to try to do things "in-house" (whether the capability exists or not) than to contract; (d) RFP's will be rare--most grants will be specific packages; (e) There will be a strong resentment against competing programs, and this will force a degree of cooperation between institutions not now normally practiced. Congress might have supported competitive programs, but state legislatures won't do so. Lastly, be it good or bad, states will not,

in the name of a management effort (such as coastal zone) support the development and pursuit of academic goals without practical benefits. You will find more than a few legislators who will ask, "Why isn't he back where he belongs on campus and teaching like he is being paid to do in the first place; and why should he have any more freedom than any other public employee?" Don't get me wrong, I don't subscribe to these views; I'm just speculating out loud on what I think you should expect.

States are more likely to support programs than projects. This may be biased, wishful thinking on my part, but the types of problems the states will be facing can't be resolved with one-shot projects. Broad, mission-oriented programs will be required.

Now that some general matters have been discussed, what about relating them to a specific situation?

O. K. Let's look at some "Dos" and some "Don'ts" concerning a specific venture in which we are all familiar, namely "Superports."

The "Dos" first:

Do get involved in the socio-economic evaluation of the need.

Do examine and evaluate the environmental impact.

Do study alternative institutional and financial arrangements.

Do evaluate specific sites, including the development of performance criteria for each.

Now for some "Don'ts":

Don't take sides over specific legislative proposals--be willing to present and substantiate the findings of your institutional/financial studies, but don't be for "this bill" and against "that bill."

Don't be a vocal proponent of one site over another.

Again, be willing to present results, but don't be a principal advocate.

Don't make the development of such a project a major cause--you should support certain premises, but being a leading advocate is not a job for a university researcher,

Don't be afraid to "let go." This may be the hardest of all these "don'ts" to avoid. Research has a function, but there comes a point in time on issues like this when the background providers and researchers have finished their role. Then they must back off and leave it to the politicians, promoters, etc.

More dos 'and don'ts 'could be presented, but this should provide some idea of the type of points alluded to in the preceding sections.

As a closing question, what is the single most valuable service/product that campuses can provide to state agencies for use in solving coastal zone management problems?

That's easy—well educated, thoughtful graduates who have a solid academic background and who also possess a knowledge of how the real world works. This is where I believe Sea Grant can play a particularly valuable on-campus service—as contrasted to its off-campus services to government, industry, etc., that get most of the glory. After all, the most basic function of the university is to teach; unfortunately, such teaching often doesn't prepare one to cope with the real world, and thus it often falls to a graduate's first employer to train him. Sea Grant offers an ideal mechanism to achieve this transition from academia to the real world through employment of graduate students on projects, internships, seminars, etc. Making this more ideal is the fact that if Sea Grant programs are involved with state programs, then graduates can often come out capable of fitting in and contributing valuable services and ideas.

I sincerely hope the preceding does not sound overly critical of the "campus"—it certainly is not meant that way. I simply wanted to point out some of the strengths and weaknesses of such operations relative to coastal management. Speaking of strengths, I'd like to point out several things that are of key importance to my state. The state of Texas has certainly made major strides forward in coastal management during the early 1970's. But, the state was largely able to make such advances in the 70's because of the solid programs and innovative research and development undertaken on campus during the 60's. One good example is the broad work of A&M Sea Grant. Another is the coastal atlas done by the U.T. Bureau of Economic Geology. Without such background work and education, the state would not have had the basic building blocks to act upon during recent years.

Granted, there is not always a one to one correspondence between developmental research and implementation, but both are absolutely necessary in the long run. In the above text I tried to point out rather vividly that there are some politically volatile issues that the campus does not want to become embroiled in, yet there are plenty of relevant issues that need exploring and investigating.

Potential Sea Grant Contributions to Coastal Zone Management: A Local Perspective

Edward C. Stephan
Nassau-Suffolk Marine Resources Council

I appreciate the opportunity to speak to the National Meeting of Sea Grant Institutions. I hope I can persuade you collectively and individually to devote some of Sea Grant's resources and talents to the meeting of what I consider to be the great, great environmental management need at the local level.

On the local level there exists a relatively small group of elected and appointed officials who are responsible for policy planning, decision and action not only in the environmental area but also across the wide range of social, economic and political problems that confront our cities, counties and states.

Generally, these local officials are well versed in the political, social and economic aspects of the problems and the range of alternatives that could be employed to solve the problems. But in such highly scientific and technical problems as those relating to our environment, the local officials simply do not have a good grip on the hard science - physics, chemistry, biology, meteorology, ecology and geology and the associated technology and engineering required to give cause-effect understanding of various actions and to give them guidance in lay rather than scientific or academic terms.

This situation coincides with great national and local determination to maintain a healthy environment. This gives Sea Grant a tremendous and unique opportunity. You can work with local officials to provide "science for the solution of problems" that will bring great thanks to Sea Grant and the very strongest type of support for Sea Grant programs.

To be more specific, let us concentrate on one typical area of major environmental concern throughout the coastal zone - wetlands management.

The local official needs guidance in administrative terms that is based on the best available science to make decisions which will result in the preservation of adequate and healthy wetlands.

Sea Grant should undertake first to assemble and distill all available knowledge relative to wetland science, technology, and engineering, and second to present the implications of this knowledge in administrative terms for the guidance of elected and appointed officials and the general public.

This is a difficult task and certainly a tedious one. It would involve a study of existing textbooks, scientific journals and papers and close perusal of symposia transcripts. It would also involve continuing consultation with ongoing and past research and with the related engineering and technology. It would require strong contact with federal agencies such as NOAA, EPA, Interior, Corps of Engineers and others to make maximum use of their know-how and experience. It would require familiarity with the research effort of individual states and localities.

Gradually, Sea Grant would assemble the knowledge base. In the process, they would systematically develop the important knowledge gaps that require priority research. Conflicts would develop as to the veracity of the knowledge itself and certainly as to its administrative implications. But Sea Grant, in spite of knowledge gaps and implication conflicts, could in fact develop for the local policy planning and decision officials far better guidance than is today available for actions that are being taken with respect to the wetlands.

Out of Sea Grant assembly and translation of the entire body of wetlands knowledge would come guidance on such locally pressing questions as these:

a. How much wetland area is needed?

b. How much wetland productivity is required?

c. How critical is the location and productivity of an individual wetland?

d. Can wetlands be fertilized to increase their productivity?

e. Can damaged wetlands be restored?

f. Can new wetlands be created?

g. Can wetlands be used to absorb waste water or solid wastes?

Answers to these questions would obviously help in making wetlands decisions.

Procedurally, with respect to wetlands and other coastal zone and environmental problems, it appears to my administrative rather than academic or scientific mind that the following steps are involved:

a. Analysis of problems to determine knowledge and data requirements;

b. Inventory of existing knowledge and data and development of vital knowledge gaps;

c. Analysis of existing knowledge and data to develop best administrative guidance possible at this time; and

d. Constant utilization of new knowledge to update and improve administrative guidelines.

I believe the assembly of the knowledge base is a job which can only be done by the federal government. Within federal government I believe Sea Grant is most capable of performing this task.

Sea Grant guidance to local officials will in effect say, "If you take this or that action there will be this or that environmental result." The local official's expertise in his area's social, economic and political options will have to govern which action he takes. There may be federally prescribed minimum environmental preservation actions required.

If Sea Grant can establish the close rapport with elected and appointed officials that would result from the type of Sea Grant services which I have described, I am sure Sea Grant's praises would be shouted from the house-tops by officials and the public. Strong Sea Grant support in the federal, executive and congressional branches would be the continuing result.

I hope I have made clear what I believe is the greatest need for Sea Grant and its remarkable opportunity for service. I hope you will give serious consideration to a Sea Grant effort toward assembling the knowledge base and translating it into administrative guidance in a number of coastal environmental areas such as wetlands, beach protection, dredging and waste water treatment and disposal. Let me emphasize once again that hard science guidance is desired from Sea Grant. Political, social and economic guidance locally is neither needed nor desired from Sea Grant.

Coastal Zone Management: An Institutional and Social Sciences Perspective

Judith T. Kildow
Massachusetts Institute of Technology

The University is an educational institution, a place where people go to learn and do research. We should not forget that. Therefore, we must be careful not to force the university into a narrow role where it must handle small local problems in a parochial way, particularly at the expense of other things. Rather, the university can make its greatest contribution first by training experts who can bring their skills to bear on coastal zone problems of a more immediate nature after they leave the university; second by turning its research talents to problems in coastal zone management which require a broad perspective and which have long-term implications. If these problems happen to have application to local problems, and certainly we would all agree that would be helpful, then all the better. However, the university should not be used in a manner it has neither capability nor mandate to carry out. Above all, the university at the least should share responsibility for assuring that research results are funneled to sources who can use them and in the forms in which they can be used!

Perspectives on structure and philosophy of Sea Grant

The state structure and the philosophy for local commitment now appear to have been unsuited for carrying out a coordinated national program. It is apparent to all of us now, that problems of resource management cross state and regional boundaries, but there appear to have been no mechanisms to assure such coordination--nor are other similar programs so structured at this time. Since the national program in the first place was not set up as a management program, the national Sea Grant program does not really have the kind of authority to carry out the kind of national program that we all know is necessary.

It might be helpful to look at some of the elements that make up the political component of the Sea Grant Program. The current funding level is inadequate to carry out a coordinated national program. This low funding level has not been without its good points. Without the money to hire large numbers of strong full-time people, the program instead has attracted many capable scientists and engineers, particularly, on a part-time basis, thereby generating a broad base of interest. At the same time, the products of their work fall short of what might be expected from full-time researchers. This low-level funding has also kept projects small, resulting often in fragmented efforts. This has had another effect. Small, poorly-funded programs get little attention with both some positive and some negative results. On the positive side, these low visibility efforts have attracted little local pressure - and on the negative side, have attracted little support for larger budgets.

One might expect that low funding would encourage pooling of resources between states. This regionalization has not come about yet to any significant degree. The reason seems clear. With a state-oriented structure, there is no strong encouragement for regionalization. State structure seems to encourage geographic instead of functional attacks on problems. This is wasteful in terms of cost-effectiveness, at least. It would seem to support redundant programs. Perhaps, most significantly, it inhibits the pooling of political influence.

These conditions create a burden for the university, the operational arm of Sea Grant, due to the gap which seems to exist between expectations and capability.

The Special Qualities the University has to Offer

The university seems to be a logical focal point for a national Sea Grant effort, because of its strong capabilities for teaching and research. These two are essential ingredients in the long-term planning process. In the short term some universities, particularly the major engineering schools, have demonstrated an ability to understand short-range problems, through close association with industrial partners.

However, the university's most valuable asset is its students. They are the brightest young minds in the country, and can solve the problems Sea Grant is addressing, if properly challenged and motivated within the confines of the university. This should be the university's principal function.

While the university certainly has the responsibility to be sensitive to the problems of its local community, it should always be seeking the best solution, and if that means subordinating local interests to the national good, then it should be free to do so. However, the university should strive to make its resources available to the local communities, and by so doing, help them to help themselves.

Impediments in the University System

Universities are structured along rigid disciplinary lines, resulting in a sort of dichotomy for looking at the oceans. On the one hand, there are ocean engineering, mechanical engineering, civil engineering, electrical engineering, etc., and on the other hand, there are political science, law, economics, management, urban planning, etc. For one thing, this system inhibits cross-fertilization of ideas between fields, particularly between engineering and humanities.

A second major impediment in the university system, in my opinion, is a hierarchical tenure system, which demands classical theoretical work, often subordinating practical work and at times suppressing it, particularly on the humanities side. This creates a dilemma for the social scientist wanting to work in practical areas. While the university has been the scene of many brilliant innovations and discoveries, traditionally academicians have stayed within the university walls, studying classical problems and theory and resisting the temptation to deal with practical societal concerns. Funding sources also contribute toward insulating the university from practical problems. Funds often carry constraints.

The Sea Grant Program was placed under the control of engineers and scientists within the university, who, not surprisingly, saw Sea Grant problems as scientific and engineering problems, and organized programs accordingly. For example, California, widely praised for progressive programs in Coastal Zone Management, had in its ten-campus program but one social scientist - an economist - during its formative years. Even several years later, under pressures from the National Sea Grant Office, no proposals were received from social scientists to participate in the program. Why? It is my opinion that social scientists failed to respond because of an inadequate communications system.

It might be helpful to recall the climate when Sea Grant began. Research monies were tight. Therefore, it seemed logical that scientists and engineers who were given control of large sums of money would naturally look within the boundaries of their own departments for projects to fund.

Lack of communication, lack of money, and lack of desire on the part of many social scientists due to their traditional training and isolation have made the university's task more difficult.

However, the picture is not all gloomy. Recent pressures for mission-oriented research, while anathema to some, have reverberated with interesting results on the university campus.

Changes in the University

As the university climbs down from its ivory tower, we see these results:

Efforts to broaden the education base

Changes in curriculum

Different mixes of faculty within departments

Changing student attitudes and perspectives

Increased cooperation between disciplines

Examples of these changes can be found across the nation. Many of you represent universities which reflect these changes.

A major new impetus for change, an enlightened attitude on the part of major funding sources. For example, the Ford Foundation has sponsored several marine programs around the country, with special emphasis on interdisciplinary work. Other large foundations are funding broadened educational efforts. Federal programs like Sea Grant are encouraging the breakdown of disciplinary barriers. While the gap between needs and capabilities still exists, already the gap is narrower, and we can begin to see how the university can become a potent force in resolving the nation's coastal zone problems.

The true contribution of the university is its ability to step back and take a broad, long-term view of major problems and bring both the wisdom of its classical professors as well as the new fresh ideas of its younger faculty and its students to bear on society's problems. Formation of a Coastal Zone Laboratory at the university could be, if formed properly, a major contribution to Sea Grant educational systems to meet practical coastal zone problems.

If its principal function is one of education, and if it teaches well, it follows that society's problems will be addressed properly in both public and private sectors. Innovations occurring today will not be felt strongly until the next generation. However, the foundations are there now.

Panel Summary: Coastal Zone Management

John Armstrong
University of Michigan

After lengthy deliberations the following points, paraphrased for brevity, were noted:

Point 1 - It is necessary to maintain a clear distinction between management, a function of Government, and research, a service function available from a number of sources, including universities.

Point 2 - A close relationship between researchers and decision makers will maximize benefits for both.

Point 3 - Two problems appear to exist for Sea Grant Programs:
- State and regional management agencies do not understand what support can be provided by the Sea Grant Program.
- University Sea Grant Programs are not fully focused on Significant (emphasis mine) State and Regional programs.

Point 4 - Coastal Zone Laboratories (the concept) were emerging in several forms in several of the states.

It was concluded that the Sea Grant Program was not sufficiently broad, flexible or well funded to meet the Coastal Zone research needs of the state.

It was recommended that the Association establish three ad hoc committees to seek means for improving the situation.

- ...ime to define clearly how to meet Coastal Zone research needs - ...comprised of program directors and state managers.

- One to review land grant experience for guidance.

- One to define what research activities were appropriate to support regional and national level Coastal Zone Planning efforts.

I. Proper role of research in the university

- Should raise controversial issues

- Should look at all sides

- Should *not* get into advocacy positions in the midst of government policy-making.

- Respond to problems in professional way: avoid political flops, flops they aren't trained to cope with. Otherwise -- may undermine credibility of research.

Emphasis or distinction between raising policy issues and making policy decisions.

How do lawyers avoid advocacy positions when asked to draft model legislation.

- Offering alternatives to leave decision to agency or face political facts of life.
(part of a larger team of researchers)

How does a state avoid advocacy -- when academia are often called upon to wear several hats in the decision process.
- both from policy impact and output requests.

II. Need for research on techniques, but use of problems as test for them is both necessary and useful -- both for local and broader problems.

Stress assuring properly wide application of research results -- geographically and functionally

- How to *transfer techniques* is a good question -- how have Sea Grant Programs addressed this problem?

III. CZM in the university is a synthesis process. Looking at many variables and putting them together

- Must look *process as well as substance*

IV. While CZM has several phases -

Planning, implementation and management. We are currently in its planning stage -- states are also in the management business, handling day to day licensing and permits and other decisions.

V. Land and Resource Management are really major societal reorientations.

VI. Can Sea Grant answer local agency needs?

Problem of turn-around time can't be met by university.

VII. Advisory services necessary as liaison between university and government

- Function as a translator

- Function as an information agent

VIII. Private industry has large role and is welcome in Sea Grant. However, essential that formative plans be carried out cautiously - be sure expectations don't vary from capability.

Must be careful not to oversell Sea Grant

Currently over 100 industries associated with Sea Grant

—The University has yet to resolve the question-issue of the classical promotion tenure system as it relates to and influences the participation of university faculty in Sea Grant type research. This issue continues to be a basic source of difficulty in meeting coastal management objectives.

Not only must the Universities seek to more clearly resolve their issue but the OSC and the site review team must press for their resolution.

--The influence of scientists and engineers appears to be out of Galavine with respect to the kinds of issues that the Sea Grant program should and could be addressing. The role of the social scientist has been submerged and the issues regarding the input of social science research have not been addressed to the extent they might have. Their inbalance of influence is also reflected in the makeup of the OSC staff and the Sea Grant Panel.

The national office should broaden the types of disciplinary on its staff and encourage Universities to provide broader opportunities for social individuals to participate in Sea Grant and coastal zone management activities.

Advocacy

How can Sea Grant researchers avoid assuming advocacy positions implied by their involvement in controversial research or by being involved in legal operation where testimony implies advocacy.

The University should serve the local and other needs in those areas in which it has capabilities. Currently university personnel are accustomed to long-term research and many local needs require short term times. If the university intends to address these latter problems, they should make sure they do it right - hire different kinds of personnel, residence or whatever is necessary. However, this decision should belong to the university. The university risks the credibility of its research by addressing problems it isn't capable of handling.

Researchers should raise controversial issues, dig into them, and lay out alternatives. If alternatives appear to favor a position, so be it, if the reasons are substantial by evidence. After the report is issued, we would recommend that the researchers let the political process take it from there. It becomes a dangerous game for a researcher to get involved in political flags he is not trained to handle. There is danger in rushing the credibility of the research by undermining it with political bias.

Advisory Services

Should state government take part of the operational responsibility for the Advisory Services functions. Perhaps states could have their own agent specifically assigned to a Sea Grant Advisory role (a two way one).

State Perspective

--States need help in defining and formulating the question that needs to be addressed in a given issue.

--State agencies are oriented and often too busy fighting fire to worry about the future and related long term research projects.

--State agencies have several considerations and criteria in viewing Univerasity research work credibility technically and from an interest "viewpoint".

.utility - must be usable

.valid - workable and sellable

.timely- 1 year is a long time for management decision.

1 year is a long time for execution completion of research-considerably less than 1 year for "applied" research.

Don't

Forget that state government has its own problems with legislature, local units, interest groups, etc.

Forget that Sea Grant programs provide technical support - let the other guy (state agency) put his neck in the noose.

Expect the same treatment from state management agencies that you are used to from Federal funding agencies. Their staff needs and constraints are completely different.

Universities can best do the following:

I. Take inventories of physical, biological, etc. resources in CZ.

Take inventories of laws and procedures available to state for required purposes.

II. Analytical Studies

- of various operations open to state considering CZ Development

- development and application of the technology to properly enlist the social, economic, and environmental consequences of various courses of action open to the state.

III. Informed Public Discussion of various kinds of CZ futures through interaction with the public.

Reserved for State

I. Implementation of Programs

- Setting up procedures

- Reorganization

- Bond issues, etc.

II. Decisions by Policy Makers

Sea Grant Program

Advisory Committee Role:

- Should include a balance of interest from the state.

- Sea Grant institution should make sure it maintains control over its funds.

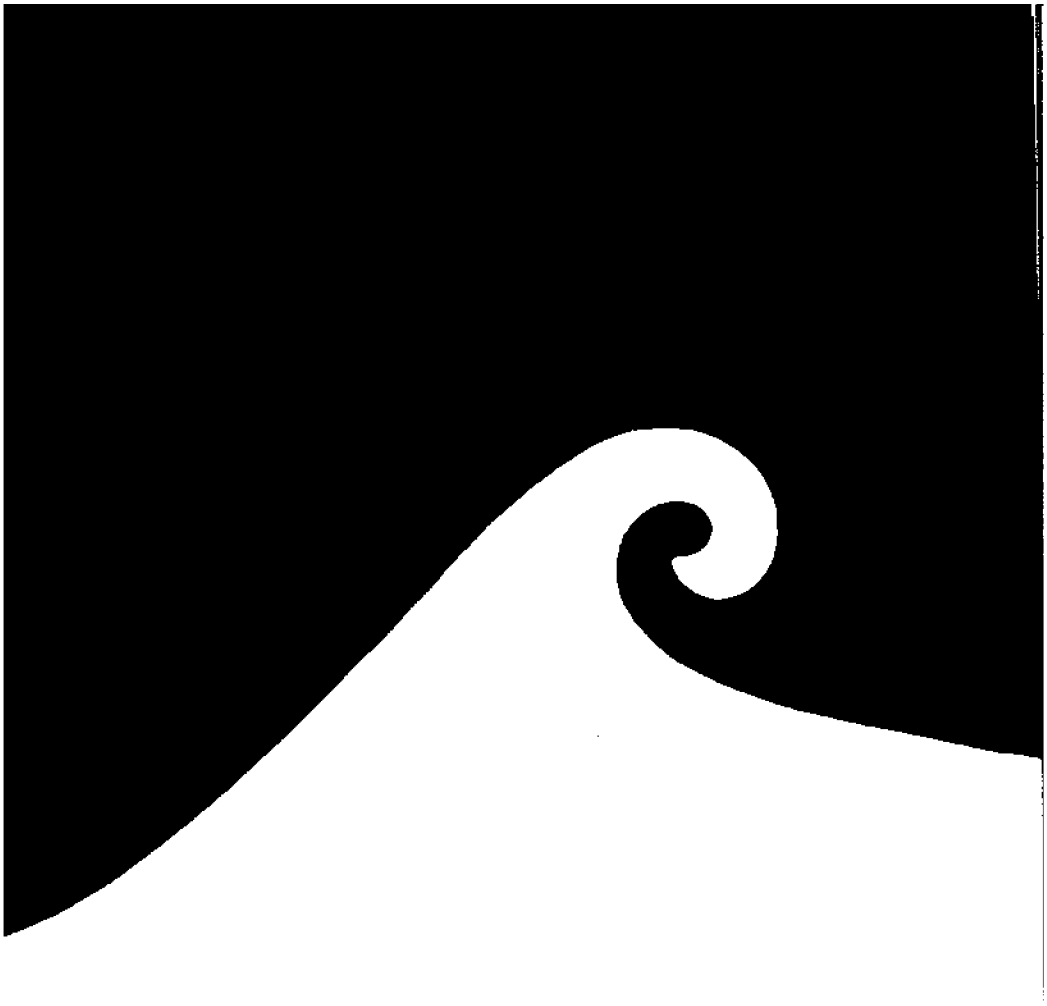
At issue from local perspective the need -- hard science support for the solution to local problems

BUT

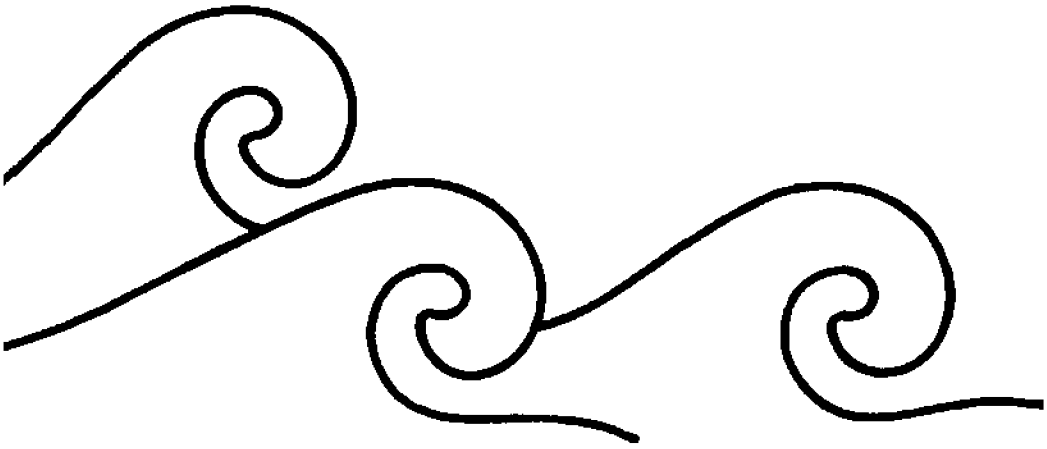
Hard scientist should stick to science -- leave political social, and economic aspects to local officials who are held accountable through the political system.

From the Federal Level

- OCZM will establish close ties with National Sea Grant office.
- Will hopefully review CZM part of Sea Grant proposals and encourage state agencies to get involved with CZ research.
- Will seek to participate in Sea Grant site visits and encourage state agencies to participate - Sea Grant - CZ research.
- OCZM will work in direction of serving as CZM clearing for information.



ENERGY FROM THE SEA



Biophotolysis of Water

Lester O. Krampitz
Case Western Reserve University

During the past few months our laboratory has been investigating the possibility of bringing about the biophotolysis of water to hydrogen and oxygen by coupling the reducing power created by the photosynthetic apparatus found in green plants and marine algae with the activity of the enzyme, hydrogenase, found in many bacteria.

Figure 1 diagrammatically illustrates what has been discovered concerning the events which occur during the photosynthetic act. The ordinate represents the oxidation-reduction potentials developed by the photosynthetic apparatus. The values are expressed at pH 7.0.

Two photochemical systems are involved, Photosystem I (PS I) and Photosystem II (PS II). Chlorophyll a_2 and accessory pigments in PS II capture a quantum of visible light and place an excited electron at a level of about 0.0 volts by reducing a cytochrome component termed C_{550}. The excited pigment system is returned to ground state by accepting an electron from water by means of an enzymatic system involving manganous ion liberating oxygen. A general equation may be written thus:

$$H_2O \xrightarrow{h\nu} 1/2\ O_2 = 2H^+ + 2e$$

Following this photochemical activity of PS II a quantum is captured by a chlorophyll component, P700, of PSI. The excited electron is accepted by a poorly-defined component at an oxidation-reduction level of about -0.7 volts. The chlorophyll component P700 is returned to ground state by accepting the electron placed at the 0.0 volt level in cytochrome 550 (C_{550}) by PS II. During the course of these two photochemical events, the electrons from the water/oxygen couple at +0.8 volts have been placed at a level of about -0.7 volts.

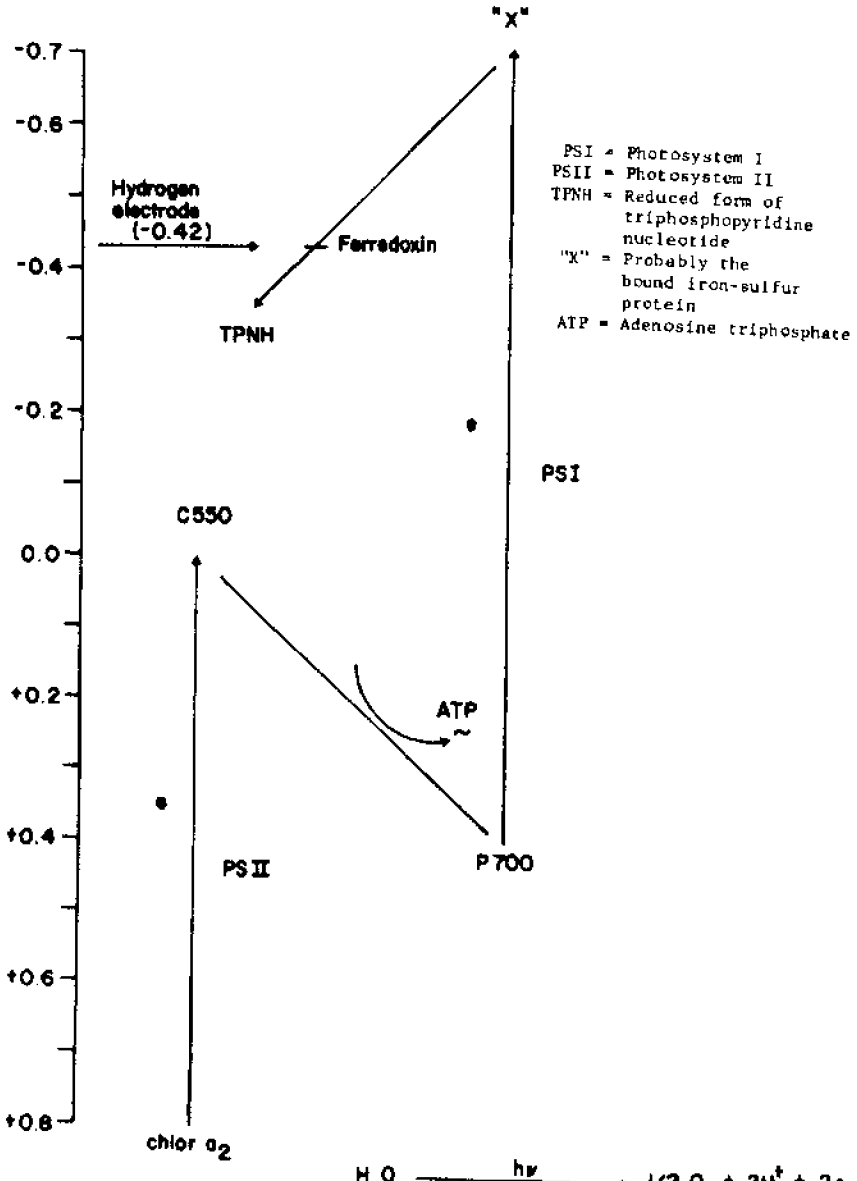

"X"
-0.7
-0.6
-0.4
-0.2
0.0
+0.2
+0.4
+0.6
+0.8
Hydrogen electrode (-0.42)
Ferredoxin
TPNH
PSI = Photosystem I
PSII = Photosystem II
TPNH = Reduced form of triphosphopyridine nucleotide
"X" = Probably the bound iron-sulfur protein
ATP = Adenosine triphosphate
PSI
C550
ATP
P700
PSII
chlor a_2
$H_2O \xrightarrow{h\nu} 1/2\ O_2 + 2H^+ + 2e$

FIGURE I

Two quanta have been required to place each electron at this level of reduction. Therefore, 8 quanta are required to evolve 1 mole of oxygen from water and four electrons are placed at -0.7 volts. Normally the plant uses these electrons to reduce carbon dioxide to foodstuffs, first reducing triphosphopyridine nucleotide (TPN^+) to TPNH by way of an iron and sulfur containing protein called ferredoxin. At pH 7.0 the oxidation-reduction potential of the hydrogen electrode is-0.421. Therefore, it is thermodynamically feasible to obtain hydrogen from electrons which have been placed photosynthetically at-0.7 volts.

There are many species of bacteria which can form hydrogen from appropriately reduced substances by the action of an enzyme termed hydrogenase. Those bacteria which can form hydrogen do so by hydrogenase activity on a reduced ferredoxin. The latter is very similar to the ferredoxin found in the photosynthetic apparatus described above.

The hydrogenase reaction:

Reduced substrate + oxidized ferredoxin $\longrightarrow$

Oxidized substrate + reduced ferredoxin

Reduced ferredoxin + $2H^+$ $\underset{\longleftarrow}{\overset{\text{hydrogenase}}{\longrightarrow}}$ oxidized ferredoxin + H_2

To illustrate the magnitude of a bacterial hydrogenase activity the following protocol is presented. One of the assays for hydrogenase activity involves the evolution of hydrogen from a reduce dye methyl viologen. This dye has an oxidation-reduction potential of -0.42V and can donate electrons to protons to form hydrogen when the reaction is catalyzed by hydrogenase. Dithionite is used to reduce the dye.

It can be observed that under the conditions stated in the protocol 27.6 µmoles of hydrogen were evolved in 30 minutes.

Protocol	*Hydrogen evolved/ 30 min.*
15.0 µmoles methyl viologen	620 µl
30.0 µmoles sodium dithionite	or
25.0 µmoles phosphate buffer pH 6.5	
1.2 mg crude hydrogenase enzyme	27.6 µmoles
1.0 ml total volume	

Under these conditions 27.6 µmoles of hydrogen were evolved in one hour. 30.0 µmoles of hydrogen is the maximum that could be expected.

The hydrogenase preparation employed in this experiment was obtained from the anaerobic bacterium, *Clostridium kluyveri*. This organism will grow anaerobically with ethanol, acetate and bicarbonate

as its sole source of carbon. During growth copious amounts of hydrogen are formed. Recently it has been found that one mechanism of hydrogen formation involves the reduction of triphosphopyridine nucleotide (TPN^+) to TPNH by metabolic reactions occurring during the metabolism of ethanol and acetate by the organism. Under defined conditions the TPNH can enzymatically reduce oxidized ferredoxin at a relatively rapid rate with the formation of hydrogen.

With lyophilized cells the blue-green alga, *Anacystis nidulans*, we have reduced TPN^+ photosynthetically by employing photosystems I and II. The electrons were derived from the biophotolysis of water. The TPNH was then subjected to the hydrogenase preparation obtained from *C. kluyveri* referred to above. From 5 μmoles of TPNH formed photosynthetically by *Anacystis nidulans*, 4.5 μmoles of hydrogen were observed from the action of the hydrogenase preparation.

The photosynthetic apparatus can also reduce methyl viologen if the photosynthetically evolved oxygen is removed to prevent the reoxidation of the reduced methyl viologen. With *Anacystis nidulans* in the presence of an oxygen scavenger we obtained 9.3 μmoles of reduced methyl viologen when the system was exposed to white light illumination. Addition of the hydrogenase preparation to the reduced methyl viologen under anaerobic conditions formed 3.8 μmoles of hydrogen.

The formation of hydrogen by both of these systems was inhibited by 3-(3, 4-dichlorophenyl)-1-1-dimethyl urea (DCMU) which is an inhibitor of Photosystem II. This inhibition clearly indicates that the source of electrons for the formation of hydrogen originated from water.

The Use of Solar Energy in Oceanic Environments

Karl W. Boer
University of Delaware

Solar energy is the source of the major powers acting on oceanic surfaces. These major powers include wind and temperature gradients which cause waves and ocean currents, and provide sunlight for photochemical reactions which in turn, supply the main input for algae growth.

Wind is the most ancient solar source for mankind to provide energy necessary for traveling over water surfaces. The interface relation between water and air provides a means of traveling essentially independent of the direction of the wind and using this form of energy to a larger extent.

Only recently has the wind itself, as well as the waves produced by the wind, been the topic of very serious evaluation -- evaluations on whether to use these forces for conversion into electrical energy which may be used at the site (for instance near research vessels or oil drilling platforms), or perhaps may be conducted in cables to the shore and interfaced there with the power utility grid.

Other evaluations deal with ocean temperature gradients using warm surface waters to boil a low boiling point liquid and power turbines with the produced vapor, consequently condensing the vapor through heat exchangers cooled with lower temperature water coming from deeper layers in the ocean. Other concepts deal with generators anchored in sufficiently rapid ocean currents and driven by large propellers.

Still other projects suggest utilization of algae as feed-stock for fishes or otherwise, and increasing its productivity by optimizing growth conditions.

)

A means to convert sunlight directly into electricity has become quite attractive through the development of photovoltaic cells which have been used first in outer space to power the electric equipment of satellites. The use of such solar cells in navigational buoys and lighthouses to recharge batteries is already in progress in several experimental installations in Japan and the United States. Offshore platforms and other installations may be elecrtically powered by such means, as demonstrated in some first experimental installations in the Gulf of Mexico. The use of photovoltaic cells along the shoreline provides additional possibilities for generating electric power and for interfacing this power with the electric power utility network.

Finally, the combination of reject heat near industry or conventional electric power plants with solar energy by means of photochemical reactions and photosynthesis, or the utilization of the temperature gradient to power turbines cooled by water from lower ocean layers could provide substantial additional means to harvest useful energy.

Oceanic Energy Processes

William E. Heronemus
University of Massachusetts

I would like to itemize a number of oceanic and estuarine processes which our studies in the University of Massachusetts (Amherst) have suggested to be worthy of investigation as future renewable energy sources for continental United States and the oceanic territory and states thereof.

In the first instance, it appears that we should reexamine the possibility of obtaining power from the tides at Passamaquoddy in Maine and at Cook Inlet in Alaska. The Passamoquaddy proposal is recognized as very old. It has been suggested that the total capability of a tidal power plant there might be 1200mW of firm power rating. By today's standards that is a relatively small power plant: about the size of two Maine Yankee Power Plants. But, those 1200 mW could go a long way toward satisfying electricity demands of Maine for a long time. When that concept had been studied in the past, one of the uneconomic features identified was the high cost of transmitting that electricity to customers who needed it. The march of time has brought an expanding market within reasonable transmitting distance. But even if Passamaquoddy were to be used to supply the Boston area with electricity, another recent concept, that of using hydrogen by electrolysis as a storable and pipe-line energy transmitting medium, would firm up the cyclic nature of the power from the tidal cycle and should also permit rather inexpensive energy transmission via hydrogen-in-pipeline. One could without doubt improve the economics of this system using the hydrogen storable even if the electricity were consumed in Maine. The cyclic nature of the tidal resource could be matched against customer created load demand curve in a rather efficient way. Pressure-balanced storage of hydrogen in the deeps of the Gulf of Maine would also fit well into this concept.

These last two ideas associated with the hydrogen link could also open up a whole new approach to the economics of power generation from the tidal resource in Cook Inlet tied by hydrogen pipeline all the way down the Pacific coastline to the more expensive California electricity markets. We must all accept the idea, now, that such long pipelines are not only practical but very desirable!

Kinetic Energy

There are sizeable amounts of kinetic energy available in the Gulf Stream, in at least one of the Aleutian passages and in a number of tidal rivers along the Maine coast. The largest of these sources without a doubt is the Gulf Stream resource. In our 1971 research proposal to the National Science Foundation we used current data produced by Richardson and Schmitz in their ONR sponsored "Project Strait Jacket" work and made a correlation of the maximum momentum exchange possible from the moving particles of the Gulf Stream and proposed a number of momentum exchange machines. We recognized that the seasonal variation in that resource would have to be accommodated: there is a significant waxing and waning of the current with which one must cope. Again the generation of hydrogen as a storable and as an energy transmission fluid could enter into this concept. We made preliminary design arrangements for two rather large diameter free stream propellers (underwater windmills). The first machine was a single disc which we thought could extract 7.5 mW in a seven foot per second current; the second machine is a 4-stage machine rated at 24mW in a seven foot per second current. We also looked at a large version of a Savonius rotor type machine and presented one rated at 14mW in a seven foot per second current. The work of the last three years in high lift, low drag, low Reynolds numbers foils could be applied to these concepts and should yield more attractive results when compared against our preliminary designs. It is perhaps pertinent to suggest that if either of the tidal power projects mentioned above were investigated making use of the hydrogen link, that kinetic energy machines sited in Maine rivers, augmenting Passamaquoddy or kinetic energy machines sited in Unimak Pass, augmenting Cook Inlet might be appropriate.

Ocean Thermal Differences

Our sponsored research at the University of Massachusetts at this time covers the investigation of economics and technology feasibility of the ocean thermal difference processes. Here we have restricted ourselves to two scenes, the Gulf of Mexico and a swath along the axis of the Gulf Stream, Key Sombrero to Charleston, South Carolina. Our actual work has concentrated on the Gulf Stream system. Most of our effort has been expended on cycles of the closed Rankine type using an intermediate working fluid. Three working fluid candidates are still being considered: a) ammonia, b) propane, and c) a halocarbon refrigerant, probably R121. We have also made a preliminary study of the open cycle on a large scale, the cycle which flashes the sea water itself into steam, steam which is expanded through very large diameter low pressure turbines.

The overall system concept which we are using to integrate our individual efforts is called the "Mark I". It is a submerged twin hull submarine power plant of 400 mW electrical net output. We sized the individual turbine to best facilitate the very high turbine efficiency that we require if this concept is to be practical. We thus have 16 turbines each of about 37 1/2 gross mW output. From that gross we can subtract out our total (Significant!) pumping and parasitic power losses and still deliver 400 mW net from sixteen units. This approach means that we have 16 separate condensers. In the Mark I each condenser is encased in a pressure proof "hull" beneath its turbine. An inlet and outlet valve allows us to isolate each condenser either for maintenance or as a casualty control procedure. The resultant arrangement is very open and spacious insofar as the power plant on the upper levels is concerned and the enclosing pressure hulls appear to have vast amounts of waste space in them. Much more effort will be expended in attempt to tighten up this concept while still maintaining the basic idea of pressure proof integration and isolation.

The major problems associated with this concept can be identified as:

a) *Heat exchanger design and fabrication:* it is quite clear that the power plant cost will be determined by heat exchanger cost. We must look at several different metals as well as several plastics (modified to provide improved heat transfer characteristics). Because of the very low overall efficiency of this cycle, vast torrents of both hot and cold water must be put through large heat exchangers, and at reasonable pumping power costs.

b) *The supply of cold water:* this is a problem both from a hydrodynamic point of view and from a structural point of view. Our initial studies indicate that the Gulf Stream does move large amounts of cold water across the seabed in the region in which we are interested; but we must make certain that cold water can be withdrawn in the quantity required without upsetting the natural thermal stratification. The structural problem is associated with the very large cold water inlet pipe which must be provided to permit the pumping of the required large amounts of cold water without unacceptable pumping power loss. The approach here is to recognize that the cold water inlet pipe must be very similar to a large long ship's hull, open at bow and stern, whose interior serves as the cold water passage. Present thinking places this cold water inlet pipe in the mooring system as a long, axially loaded member. A streamlined cross section is thought to be necessary to avoid unacceptable transverse vibration of the pipe.

c) *The turbine:* we want a turbine efficiency of 90% or better and are convinced this can be had provided we size the turbine first, permitting it to operate under the best possible set of initial conditions and dimensions. All else, within reason, will then be required to match this high efficiency turbine. Work to date suggests that this is not an unreasonable approach.

d) *The anchor and mooring system:* the anchor and mooring system required to hold a 400 mWe plant in the Gulf Stream is an ocean system of significant challenge. We are confronted with a mooring line tension as high as 22×10^6 lbs. A gravity anchor constructed from concrete, configured so that it can be moved to

site as a surface ship and then dived into precise location as a submarine, would do the job nicely and would be quite economic. We are also looking at anchors which would be emplaced in the seabed with a multiplicity of piles. The scenario of the entire evolution of moving one of these large power plants to the operating site, emplanting the anchor, connecting up the energy collecting cables and pipes, then connecting the power plant to the anchor resembles very much the sequence of events followed in the construction of the BART Tunnel, but perhaps even more demanding.

e) *The overall system arrangement and containing hull:* we want a semisubmerged configuration that can live in the Gulf Stream with minimal movement even during hurricane season. The horizontal axis cylinder of rather large diameter made from reinforced concrete appears to be well suited. The power plant so far takes the general configuration of a catamarran submarine lying suspended from rather small diameter access trunks, much like a fleet-boat could be suspended from her periscope. The free body diagram of this system matches the weight and displacement of the submarine hulls against the tension created in the mooring line by drag and lift caused by the Gulf Stream flowing around the system. This is a problem in statics with the requirement that adjustments for very small daily or larger seasonal changes in current be possible. The typical submarine variable Ballast System will be used to meet those requirements. The concept has the entire system swinging freely at the end of mooring, which will result in almost continual but slow movement along an arc in the general east-west direction, as the current responds to tidal influence.

It is thought that ocean thermal differences power plants of the rather large size described above, placed in the Gulf Stream off our southeast coast as described above, sending their energy back to shore as electricity in cables or as hydrogen gas in pipelines, is the best way for solar energy to impact the U.S. energy market. Further study may show that a larger number of smaller power plants could be better. The work done so far suggests that power plants comprising anywhere from one to twenty, each of 15-25 mW net output units, can be synthesized along the same general arrangement concept.

Energy From Oceanic Winds

About 1.5% of the solar energy which reaches the outer layer of the earth's atmosphere is finally converted into kinetic energy in moving particles of air, the winds. Almost all coastal regions and essentially all island regimes experience persistent prevailing winds. Winds over the open sea, particularly in the path of the prevailing westerlies of the trades are quite steady and at reasonable height above surface are quite useful in momentum interchange windpower machines. Renewed interest in windpower and the studies associated therewith during the last 2 years suggests that there is really no island regime where energy production by windpower would not be competitive in this decade with energy produced by combustion or by fission processes. For example, it is quite clear that Puerto Rico should have been investing in windpower plants all

this time instead of investing in fossil fuel plants and while flirting with nuclear power. Similarly, one of the largest island energy demands in the west today, that of Oahu, could be satisfied easily and economically by wind driven generators perpetually shrouded from view by the mists hanging over the Koolau Range. In 1938, when Sverre Petterssen was helping organize the Smith-Putnam windmill project, he prepared an analysis showing the specific power to be expected from a standard wind generator whose axis height above surface was 150', anywhere on the globe. (Specific power is the number of kwh of energy that would be produced by a 1 kilowatt generator during a year of 8760 hours.) Petterssen's results were disappointing to the rather landlocked Smith Putnam team because they showed the most productive windpower areas would be at sea. This is of course, no surprise to the sailor man. If one could contrive floating wind generator plants, for example, tethered on the continental shelf all around Iceland, one would have a power plant of huge capacity, and whose energy production would be very inexpensive. In fact, electricity produced that way, then expended to distill fresh water from sea water, then to electrolyze that pure water to produce hydrogen, then to liquify that hydrogen and load it into liquid hydrogen tank ships, could prepare a renewable energy fuel at a total cost which would bring a handsome profit when sold in the northern European market. It could well be a maritime industry of far greater value to Iceland than is all her fishing!

A study has been made and published describing another type of windpower system conceived for New England. This first system is again a 100% hydrogen system. A rather large penalty must be paid when all electricity is used to generate hydrogen followed by reconversion of that hydrogen to electricity. More recent work has been directed toward two other versions of the concept:

a) a system which delivers as much energy from off-shore to the customer in the form of electricity in cables as possible, generating and storing only enough hydrogen so that the demand can be satisfied when the winds do not blow strongly enough;

b) a predominantly hydrogen system, but one which sells pipeline hydrogen as a direct use fuel rather than first converting it back to electricity.

The original studies for the off-shore windpower system used rather large diameter (200') 2,000 kW generators. Such large generators have a cut-in speed as high as 15 mph. Smaller wind generators can start to generate useful work at wind speeds as low as 10 mph. It may be that larger numbers of smaller generators will comprise a windpower system requiring less expensive storage systems, and that they may therefore be more economical. It would certainly appear that almost any region blessed with moderate to strong coastal or off-shore winds could harvest a large portion of their energy requirement and could do it economically. This kind of oceanic energy resource, the oceanic winds, should not continue to be wasted.

Energy From Wind Waves

Of the 1.5% of incoming solar energy that manifests itself in kinetic energy of the winds, a sizeable portion is again dissipated by the creation of wind waves. There are places, many places on the earth, and again primarily in island regimes, where wind waves against a beach or coast are almost continuously present. There have been many attempts made in the past and many patents have been issued for devices that could extract energy from wind waves. In the very recent past Issacs of Scripps has demonstrated a concept that uses momentum in the rising and falling wave forms to do pumping work. The water raised by pumping to an elevated postion can then be allowed to fall down to sea level again through a water turbine thus generating electricity. Anyone who has observed the surf at Bellows Field, Oahu, for instance, must have a feel for the vast amount of energy which is available there in the waves, and in many similar sites on the earth, energy which now is dissipated as friction generated heat. It has been suggested by many for many years that a very excellent way to protect breakwaters and/or sea walls would be a method which extracted the energy of those incoming waves in such a way that you could kill two birds with one stone, that is, reduce the destructive loadings on your sea walls by first extracting that energy in a way useful to you. Coastal towns like Hull, Massachusetts have a continual sea wall renewal problem and also pay premium rates for electricity. A combined system would be of great value to the residents.

Combination Cycles Far Out in the Oceans

There are vast expanses of tropical sea in the Pacific where the surface is nearly millpond flat almost all year round. Such sites, whose available area can be measured in the tens of thousands of sq. miles have been suggested for location of large scale solar energy extraction or conversion plants. William J. D. Escher and Joe Hanson have touched upon this idea in Escher's "Helios-Poseidon" system and Hanson's "Floating City - Project Phoenix" concept. In such regions the direct rays of the sun can be captured via photo thermal collectors, huge collectors, supported over the sea. Heat energy between tropical surface waters and underlying cold water mass can be harvested via the ocean thermal differences process. In some instances wind might also be used, but the more desirable of these sites will have relatively low speed winds blowing over them. Solar energy via several processes would be used to prepare hydrogen gas which would be transported as a cryogenic to its terrestrial customers. Economics look very attractive. It is not known whether or not the Japanese have any work under way along this line as yet; it is thought that they should be among those most interested. From large expanses of tropical Pacific about 1000 miles south of Honshu they could extract all the energy fuel they will ever need from renewable solar energy driven processes and could give up their dependence upon petroleum hauled all the way from the Mid East. It has been suggested to several colleagues in Great Britain that British and other Europeans invest in afloat solar driven energy factories located as far away as the Gulf of

Guinea, factories capable of producing hydrogen fuel from constantly renewed solar created hot and cold resources. Such energy factories built to use renewable resourc would be better investments than those now being planned for the development of off-shore petroleum deposits whose finite resource life is well understood.

Conclusions

The oceans do contain significant fossil fuel resources in their seabeds. It is in that context that most people look upon the oceans as a future source of energy. It is suggested, however, that that is indeed a very narrow view of the energy potential of the oceans. In fact, it is suggested that as time moves along, an increasing number of intelligent men will realize that the burning of any petroleum product brought up from the seabeds is nothing other than a crime against earth and man. Each drop of those precious fluids should be conserved as the feed stock for the petrochemical industry that will support future generations. The ocean, in the role of heat reservoir and cold sink for the ocean thermal differences process, in the role of creator of winds and wind waves, and in the role of creator of tidal potential energy should be understood as the largest source of renewable energy that man could with imagination convert to his needs. None of the processes mentioned in this paper is capable of polluting, all have been practiced to some extent in the past. We should be well advised, particularly those of us who profess to be the most practical and simplest of the ocean engineers, to get back to some of the fundamentals which we have ignored in the last 50 years. Before we complete the job of overheating our planet, we should redirect our efforts toward using the only real income provided to earth as a member of the solar system, solar energy. It is in, on, and over the oceans where our efforts should be directed. There is essentially no support of research and development in this field at this time. Sea Grant would be well advised to consider stepping in here and doing something that would indeed be for the very long term benefit of all mankind.

Panel Summary:
Energy from the Sea

THE PANEL RECOMMENDS:

1. That Sea Grant encourage research and development on oceanic processes which have signified potential for producing energy with minimal environmental degradation. In particular, we encourage efforts in studies of :

   a. Extraction of kinetic energy using oceanic currents

   b. Extraction of solar energy using the ocean thermal differences process

   c. Extraction of energy from wind waves

   d. New approaches to tidal energy

   e. Oceanic wind power systems

2. That Sea Grant encourage education in the possibilities of pollution-free energy sources with particular emphasis on oceanic processes.

3. That Sea Grant encourage studies of the global energy system to identify regimes in which energy from oceanic processes can be coupled economically with existing or projected energy markets.

4. That the Sea Grant Program organize a systems study toward a combination of distillation, solar energy and wind being coupled in a demonstration plant, i.e., an island, self-sufficient. Sea Grant could be the seed-funding agency.

5 Development of a materials corrosion capability for specific energy related materials.

6. Provision for a mapping of solar energy and wind correlation functions designed to aid in choosing the best locations for electrical energy production.

7. Research directed toward reducing the cost of harvesting biological carbon sources.

8. Development of non-autoxidizable viologen as electron acceptors, basic to biological production of hydrogen.

9. Investigation of genetic manipulation of blue green algae (such as Anacystis) for production of formic acid vital to closed cycle production of hydrogen fuel.

10. Comparison of biological solar collecting devices with CdS and silicon cells as to cost and efficiency.

11. Future development of synthetic chloroplast which would produce a stable reduced product to serve as a precusor of hydrogen.

SPECIAL WORKSHOPS

Special Workshop – Marine Education

Tapan Banerjee
Southern Maine Vocational Technical Institute

1. Summary of report of special committee appointed by Dr. Robert A. Ragotzkie

   A. That a survey be made of educational needs.

   B. That "standards" be coordinated with the requirements of industry.

   C. That the academic community consider both of the above.

   D. That a survey be made of non-conventional programs as well.

   E. That relationships be established with other organizations - e.g. M.T.S.

   F. That a "job bank" be established within the Sea Grant Association.

   G. That a workshop be held at the October meeting of the Association.

2. The Panel/a summary of opinions and suggestions.

   A. Allmendinger, E. Eugene/Academia

      1. Presented a diagram of a "Marine Oriented Educational Delivery System." (a flow chart).

         a. Orientation could begin as early as the 8th grade.

         b. Many subsequent "tracks" are available in the post

high school years, leading to various degrees of expertise, taking from 4 to 12 years in preparation.

c. Undergraduate academic preparation should be interdisciplinary.

d. Career minded students should have the benefit of practical experience whenever possible.

B. Anderson, Roger, D./Academia

1. Career guidance personnel are generally oriented toward the more publicized positions which are limited in number.

2. Too little attention is paid to the many marine-related blue collar positions which, despite a poor public image, offer a variety of career opportunities as yet untapped.

3. Students are tired of cliches and are generally better informed on careers than their predecessors.

C. Westneat, Arthur S./Industry

1. Asked, "Is there an ocean industry?"

2. Only a minimal number of industrial employees involved in marine work have actually been to sea.

3. Industry can find personnel with prior marine experience to supplement the efforts of the academically trained employees.

4. Many well trained personnel in industry are underused.

5. University trained employees sometimes find the adjustment to industry difficult.

6. Standardization of training would be undesirable.

D. Abel, Robert B./Government

1. Statistics, as of 1972, indicate that the number of federal employees receiving additional educational training has decreased slightly as compared to previous years, but the cost of training has increased.

2. "In-House" training is generally favored.

3. Training to preserve the environment has tended to emphasize land and air.

4. Programs for upward mobility and the training of minority groups have increased in number.

5. Expectations of continuing education for employees and the support provided vary from agency to agency.

E. Vine, Allyn D./ Academia

1. A main educational objective should be to make the study of the ocean part of the "real world".

2. Ocean Engineering is a good minor but a bad major!

3. Versatility is the key to our effort - we are weak here!

4. The aggressive student of today makes the jobs of the future.

3. Comments

A. Our educational programs differ somewhat from other countries where government, academia and industry cooperate more closely.

B. Titles frequently establish the status of "blue collar" jobs.

C. Continuing education is very important at all levels.

D. Ocean science may suffer from the overenthusiasm of environmentalists.

Evening Session

1. We are poorly endowed with proper definitions for the various categories of marine related skills. However, there is some question as to the desirability of having skills precisely defined.

2. Should marine technicians be certified?

3. What form should marine education take for the general public? Should such education start as early as grade 1?

4. The aquatic environment can be used as a laboratory given the proper bias and support.

5. Interest in the marine environment can be action oriented if promoted by highly motivated and well trained advocates.

6. Should the Association of Sea Grant Program Institutions:

a. Publish a position paper on marine education?

b. Encourage a special meeting of all groups interested in marine education?

c. Compile an inventory of all extant programs?

d. Invest a greater proportion of its income for educational purposes?

Special Workshop – Marine Affairs

James J. Sullivan
Scripps Institution of Oceanography

The marine affairs workshop received a preview report of the study entitled, "Marine Affairs and Higher Education" prepared by Gerard J. Mangone and John L. Pedrick, Jr. With this report as background, the participants discussed marine affairs as a discipline and the current education and research efforts in the discipline.

Two major areas that need further work on the educational aspects of the discipline are:

1. A study of the market for persons holding Masters of Marine Affairs degrees.

2. A study to determine more effective ways of ensuring that MAA candidates become conversant with the traditional marine disciplines.

In discussing the research needed in this area the participants were unanimous in their opinion that Office of Sea Grant appears to be less sensitive to the need for socio-economic baseline studies than the magnitude of the problem seems to require. The participants attribute this perceived insensitivity to the absence of a social scientist from the OSG staff and strongly recommend that one be recruited, immediately.

The participants further recommend that OSG consider moving more so into the social science area to further the development and wise use of marine resources. It was felt that social, economic, legal, and cultural constraints may hinder the application or transfer of existing or new technologies to marine related opportunities. Examples of such problem areas are the establishment of commercial

aquaculture facilities, the study of inland alternatives to coastal site usage, consideration of alternative coastal uses within a framework useful to local or regional as well as national resource managers, and the evaluation of the socioeconomic implications of existing or proposed regulations or standards affecting the use of marine resources. It was agreed by those present that the magnitude of these problems differ regionally and therefore more attention should be paid to regional needs in reviewing proposed Sea Grant projects.

Special Workshop – Congressional Affairs

Louie Echols, III
University of Wisconsin

Marc J. Hershman
Louisiana State University

The Legislation Workshop was conducted by Marc J. Hershman replacing Louie Echols who took ill at the last moment and could not attend the conference. The title of the workshop was changed to "Congressional Affairs" since this was the main theme Mr. Echols wanted to develop during the workshop. About twenty people attended.

Mr. Echols, through Mr. Hershman, presented the following scenario: Sea Grant lacks visibility at the Federal level. This lack of visibility creates serious problems when budget matters are before the appropriate committees. Also, if Sea Grant's position in the future is to be secure, Sea Grant must play an active part in following and promoting developments in the entire national marine program. If the national marine program (especially NOAA) is secure and grows, then Sea Grant can expect to be secure financially. What is needed, therefore, is *continual* presence and visibility on the part of Sea Grant Institutions with their respective congressional delegations. This can be developed through the following techniques. First, each institution should have an internal capability to be aware of congressional developments at all times. This might be done by putting one researcher on a quarter time basis to follow congressional developments and keep congressional delegations informed of state level developments and needs. Second, although the Sea Grant Association could provide valuable services at the federal level, each institution within a state must maintain its contacts as well. Both efforts are needed and one cannot rely upon the other. Third, advisory service efforts at the state level should spend more time keeping congressional delegations informed of efforts of Sea Grant Programs. Too much attention may be given to state-level people and not enough to federal-level people. Fourth, more reliance should be placed upon the Washington representatives from universities where Sea Grant institutions are located.

These Washington representatives do not have sufficient knowledge of Sea Grant and are not giving it adequate attention in their work in Washington. Fifth, all associations dealing with marine resources and oceanography, such as MTS, AOO, CSO, Sea Grant, NOIA, etc., should develop some sort of federation so that a united front on marine and oceanographic matters can be presented to Congress. The impression of staff members to key congressmen and senators is that the "constituency" for marine and oceanographic affairs is fragmented. Their job would be made much easier if a united front could be presented.

After this general scenario was presented by Mr. Hershman, a variety of comments were received and discussed by the group. No official conclusion or consensus of the workshop was reached but all felt that it was a beneficial and informative discussion.

APPENDIX

Business Meeting

Dr. William S. Gaither of the University of Delaware assumed the presidency of the Sea Grant Association for 1973-74, succeeding Dr. Robert A. Ragotzkie of the University of Wisconsin. Leatha F. Miloy of Texas A&M University was selected as president-elect for the 1974-75 year.

Two new executive committee members were elected to two-year terms to succeed Dr. William J. Hargis, Jr., of the Virginia Institute of Marine Science and Dr. Stanley R. Murphy of the University of Washington. The newly elected members were Dr. Edward Chin of the University of Georgia and Dr. Ronald Linsky of the University of Southern California. Their terms will expire in 1975. Continuing as present members with terms expiring at the Annual Meeting in 1974 are Dr. Peter Dehlinger of the University of Connecticut, Dr. Donald F. Squires of the State University of New York, and Dr. Jack R. Van Lopik of Louisiana State University.

The financial report, given by Stuart Hale of the University of Rhode Island was read and approved. The Association's secretariat was continued at the University of Rhode Island, with Dr. John A. Knauss as secretary.

A resolution introduced by the executive committee was adopted instructing the new president to work toward establishment of an office in Washington, D. C.

Dr. Gaither announced that he will appoint approximately six special committees during the year to support the officers and executive committee, among them committees on education, coastal zone, advisory services and external communications.

In other action at the business meeting:

-- The executive committee received a detailed report on planning for the Seattle Conference from Dr. Stanley Murphy and John Dermody. Taken under advisement were informal offers from the University of Hawaii and the University of Michigan to host the 1975 conference. An alternative for 1975 or later was also discussed; the need for a substantial national meeting to refocus interest on marine science and marine affairs involving not only Sea Grant but other elements in the marine affairs community.

-- The president was authorized to investigate and sign an agreement if he so desires, with University Xerox Microfilm Service to reproduce and sell conference proceedings, with a royalty accruing to the Association. The Association newsletter was discussed and the Washington report by Richard Rigby was commended as a readable and useful service to members. The newsletter will continue for a minimum of 10 issues a year. It will continue to be edited and published by the secretary's staff at the University of Rhode Island.

-- A resolution was adopted thanking Dr. Gaither and his staff for their work in arranging and conducting the 1973 conference in Delaware.

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