UNIVERSITY OF MIAMI

Rosenstiel School of Marine and Atmospheric Science

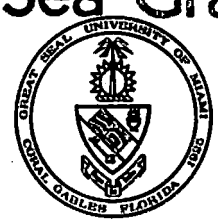
Gulf and Caribbean Fisheries Institute

PROCEEDINGS

OF THE

24th ANNUAL SESSION

MIAMI, FLORIDA . NOVEMBER, 1971



CORAL GABLES, FLORIDA MAY, 1972

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Edited by JAMES B. HIGMAN

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Gulf and Caribbean Fisheries Institute

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Announcement

The Gulf and Caribbean Fisheries Institute was organized in 1949. There are two classes of membership, one for industry and one for scientists. Inflationary costs have compelled the Institute to increase its membership and registration fees this year. Formal action to raise these fees was taken in the annual Executive Committee meeting November 17, 1971. Members of the fishing industry and associated businesses will pay a minimum membership fee of $30.00 per year. Technical members will pay $7.50 per year. In addition, a registration fee of $25.00 will be required for attendance at the Institute.

The membership year of the Gulf and Caribbean Fisheries Institute begins on November 1st and ends October 31st of the following calendar year. Membership cards are issued to this effect. Members are entitled to attend the annual meeting and to receive the published *Proceedings* of the Gulf and Caribbean Fisheries Institute.

Membership and registration fees together with funds from the University of Miami Sea Grant Program (NOAA 2 35147) support the Gulf and Caribbean Fisheries Institute.

Applications for Institute membership are accepted at any time. These should be accompanied by check and mailed to:

EXECUTIVE SECRETARY
GULF AND CARIBBEAN FISHERIES INSTITUTE
10 RICKENBACKER CAUSEWAY
MIAMI,FLORIDA 33149

MONDAY — NOVEMBER 15, 1971

Chairman — L. W. Strasburger, *Strasburger Inspection Service*
Metairie, Louisiana

OPENING ADDRESS

The Organization of NOAA and Its Cooperation With the Oceanographic Community

DAVID H. WALLACE AND HOWARD H. ECKLES
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Rockville, Md. 20852

It has been just a little bit more than a year since the National Oceanic and Atmospheric Administration (NOAA) was organized. A group of separate organizational units and functions from many departments and agencies is making a transition into a cohesive NOAA organization. While it may be a little early to expect significant accomplishments program-wise, it certainly is appropriate for people to ask about NOAA's attitudes and philosophies as it concerns its missions and as it concerns our interface with our broad and varied constituency.

Perhaps it will be useful to briefly outline how we have organized to meet our missions, which can also give you an insight on how we will be interfacing with our constituency.

We have defined the major thrusts of NOAA as outlined in the President's Reorganization Order during subsequent congressional hearings, and in talks with key people throughout the country.

Four basic missions have been identified which will accommodate NOAA's varied tasks and responsibilities: The first of these is the exploration, conservation, development and management of the resources of the sea, including diverse related roles in the coastal zone. The second is the development, operation and maintenance of a national system for observing and predicting the state of the atmosphere, the rivers, the oceans and the solid earth. The third is the exploration of the possibilities and consequences of environmental modification. We are concerned both with arresting the deterioration of the environment caused by pollution and with conscious attempts to modify environmental phenomena for man's benefit. The fourth major focus of activity for NOAA is to foster development of the necessary scientific understanding and technological capabilities the nation must have to achieve the foregoing objectives.

The existing Major Line Components (MLC's) should serve as the fundamental building blocks of the organization. Each service will carry out the applied research and technology development activities for which it is responsible. By going this way, many organizational units have an involvement in each of NOAA's four basic missions. For example, our work in exploring, conserving, developing and managing ocean resources involves the activities of the National Ocean Survey, the National Marine Fisheries Service (NMFS), the Environmental Data Service, the Office of Sea Grant and the Environmental Research Laboratories, with support from the National Weather Service, the National Environmental Satellite Service and our Man Under-the-Sea Technology Program (MUST).

To assure firm policy direction and program guidance, Dr. White has established offices of Associate Administrators for Marine Resources, for Environmental Monitoring and Prediction and for Science and Technology.

David H. Wallace, the Associate Administrator for Marine Resources, has cognizance of NOAA's total marine resource activities as well as its geodesy, mapping and charting programs—except for real-time environmental observation and prediction responsibilities. These responsibilities include living and non-living resources and coastal zone activities of concern to NOAA.

Dr. Richard Hallgren, the Associate Administrator for Environmental Monitoring and Prediction, will maintain cognizance over all efforts in NOAA directed at this objective. He will insure that our meteorological, hydrological and marine monitoring and predictions activities, as well as our data activities, are properly planned, managed, executed and directed to meet national needs. He will carry out the national meteorological and ocean observation and prediction coordination functions that have been assigned to NOAA.

The Associate Administrator for Science and Technology, who has not yet been appointed, will be the policy focus for the research and technology activities throughout NOAA. In addition, he will maintain cognizance over NOAA's programs in environmental modification. To work with this Associate Administrator, we plan to establish NOAA committees for scientific research and technological development.

The Assistant Administrator for Policy and Plans is responsible for integration of our programming activities, the preparation of our annual budget presentations and conduction of policy studies and long-range planning. This office also has responsibility for NOAA's emergency readiness planning activities.

Another important office in NOAA headquarters I should mention is the Office of Ecology and Environmental Conservation headed by Dr. William Aron. This office is the focus for guiding NOAA's response to the provisions of the Environmental Policy Act of 1969, and is our principal interface with many conservation and ecologically oriented groups outside of government.

NOAA's broad national responsibilities, which I mentioned earlier, are not considered exclusive property. They require the participation and action of many state and federal agencies from the academic community and from various segments of industry. There are many on-going programs that reflect this attitude.

We have begun a cooperative program between states and the National Ocean Survey which is concerned with coastal zone mapping with emphasis on the delineation of coastal boundaries. We are already working with Florida in this activity and we are negotiating with several other states to initiate similar programs. This program is in addition to NOAA'S marine mapping and charting missions and other ancillary services, such as tables for tides and tidal currents.

NOAA is one of the nation's key environmental agencies—concerned with proper and effective use of environment for all national purposes: for the protection of life and property against the hazards of nature, and for the conservation and development of our marine resources. A special concern, of course, is our fishery resources. In addition to consolidating our research facilities for this purpose, we have proposed increased studies in marine ecosystems dynamics. We have developed a NOAA plan to provide a concerted effort in key coastal areas, by state and federal agencies and the academic community, to develop information necessary for rational management of the coastal zone which give adequate consideration to our sport and commercial fishery resources. This is a total NOAA effort which is being coordinated in the Office of Marine Resources.

One of NOAA's major concerns is to provide relevant data for policy and decision making in coastal zone management. Through Sea Grant we have supported important programs, conducted mostly by the universities, but of substantial use to the states. Before Sea Grant, no complete studies of legal regimes in the various states had been compiled and analyzed, but a study by the National Council on Marine Resources and Engineering Development made a good start. Now Sea Grant Institutions are conducting studies appropriate to their regions. These include compiling and analyzing legal regimes in terms of scientific validity and conservation and economic impact. Sea Grant has also supported definitive studies of the long-term social and economic values (as opposed to short-range development) as a basic input to management decisions.

We are developing a NOAA-wide extension program and have assigned the Office of Sea Grant the coordinating role. In fisheries, we propose to build upon what has already been accomplished through the universities under Sea Grant and through NMFS Federal Aid Program under P.L. 88-309. Our goal is to supply organization and financial support to enable fishery extension agents to act and interact directly with fishermen, both commercial and sports, and the fishing industry. In mariculture, too, we want to mold the accomplishments in NMFS and Sea Grant with those of the states, universities and industry into a truly national effort.

More and more, Sea Grant has been able to serve as an effective coordination focal point between state and federal agencies in some states and has stimulated coordination and cooperation between state agencies, academia and industry within certain states. One of NOAA's overriding concerns, and yours too, I believe, deals with the way our fisheries resources are managed. We have begun a program to explore new federal-state cooperative management systems which can effectively deal with the root problems confronting users of living marine resources — both commercial and recreational. In this endeavor, we are relying on the expertise from several universities as well as state conservation agencies to help us develop the types of management systems that can do the job. NOAA's MUST is a new effort within NOAA which should stimulate and contribute to research of university scientists as well as those in government and industry. The program presently is limited and now centers principally upon the use of presently owned submersibles for research. In Florida we have initiated project FLARE (Florida Aquanaut Research Expedition) which will support a series of research dives next winter between January and March 1972. As the undersea program grows, we foresee the deployment of a varied number of undersea laboratories and continued use of submersibles. Federal, university and industrial scientists will play an integral role in the projects utilizing such facilities.

The National Data Buoy and Environmental Satellite programs are two other relatively new major initiatives that have already drawn upon scientists and engineers from industry and academia, and we plan that this effort will continue with their involvement.

I have sketched here a few areas of NOAA interest and initiatives that will be drawing upon the expertise of people outside of NOAA to satisfy specific aspects of our missions. We have, of course, on-going programs, with which you are all familiar, in our Office of Sea Grant and NMFS that provide direct assistance to academic, industry and state conservation agencies to solve local problems and to train scientists and technicians. NOAA will employ many of the scientists and technicians that universities train. We have brought together in the agency some 13,000 scientists, engineers, technicians and others covering a broad spectrum of environmental and marine services. About 90% of the federal civilian-oriented laboratories concerned with various aspects of marine and coastal zone problems are now in NOAA. To further a closer contact with the university community, it has been a long established policy among the elements that have been combined within NOAA to locate their major laboratories either within or adjacent to academic centers. Here in Miami we have the South Atlantic-Gulf Fisheries Research Center and the Atlantic Oceanographic and Meteorological Laboratories. Both of these laboratories were established here in large part because of the marine programs associated with the University of Miami. Similarly, we have complexes of our major facilities in Seattle; Woods Hole; La Jolla, California and Hawaii, close to the University of Washington, the Woods Hole Oceanographic Institution and Marine Biological Laboratory, Scripps Institute of Oceanography and the University of Hawaii, respectively. We believe it is essential that our scientists and those in the universities work in close cooperation. Often these scientists share facilities. NOAA operates a fleet of 38 ships over 60 feet in length. On many occasions they have provided the means for university scientists to conduct research in the deep ocean. In the Gulf and Caribbean region, this has been especially due to the efforts of Harris Stewart, Director of the Atlantic Oceanographic and Meteorological Laboratories. But this spirit of cooperation exists in all of our laboratories and it is a mode of cooperation we should and do foster. The closeness of these relationships is further demonstrated by the individual research grants that laboratories make available to university scientists for special projects, and by the fact that in many of our laboratories we have staff scientists appointed by local universities, as adjunct professors, to play an active role in the academic programs of these universities.

Finally, I would like to summarize some points affecting NOAA – university and extramural relationships.

In FY 1972 — the present fiscal year — NOAA was appropriated $137.1 million for its various ocean programs. Of this amount, $77.3 million is estimated for research and development. Approximately 25% of the research and development funds will be spent directly through colleges and universities. The Sea Grant level is $17.7 million. Support to state agencies (which in turn have some university contracts) is $6.5 million. The relatively new extramural programs on data buoys and manned undersea technology will expend approximately $13.0 million and $1.5 million, respectively.

1. NOAA is very interested in joint-coordinated research with the universities. We are interested in cooperative research, not only in those projects we are funding by grants or contracts, but also in any marine related research.

2. We recognize the benefits of providing grants or contracts to universities. We get the research product — but also we are investing in the future by contributing to the education process.

3. Because of the great deal of federal government (NOAA) and university research that is going on in the marine area, information exchange, coordination and, in some instances, joint planning is desirable. To facilitate this coordination, we favor a greatly expanded personnel exchange program where on a regular basis NOAA professionals might work at a university for six months to a year and faculty from the university might work for NOAA for a year or so. This would give each a better understanding of both the strengths and weaknesses and ideas of how to get the best research results while at the same time retaining academic freedom. This will give the university faculty a better idea of national needs and assist them in developing project proposals that are in their interest but also relevant to the federal mission.

4. Some problems with academic research are: (a) At times, NOAA needs short-term projects with results in a period of a few months. Our experience thus far is that those universities which have the expertise we might like to use for short-term work are frequently fully committed. In such cases, our alternative is to do the work in-house or contract with industry. Thus, if universities are to be in a position to be of greatest assistance to us, in a sense to compete for the research dollar, they must be able to provide some flexibility and adjust their efforts when short-term results are needed. We believe that Sea Grant may be able to help in forming a base for a flexible organization through which universities can then be in a position to accept short-term grants or contracts. (b) We need to improve coordination of research at the regional level as well as at the national level and we feel the universities, especially if they are receiving funds from us, must share in the responsibility and be "aggressive" in maintaining continuing contacts for research coordination.

5. We would like to stress again the need and opportunity for university people to take sabbaticals to work in our laboratories and in our headquarters offices. Such an arrangement is one through which both federal and university institutions will profit.

In conclusion, we in NOAA are enthusiastic about the progress we can make together. It is an optimism based on talks various NOAA people have had with many of you. I expect you have heard Robert White indicate how strongly he intends to support our academic community, the states and industry. We look to organizations like yours to help us, so let us know your views. Let me assure you, on behalf of Dr. White, Dave Wallace and others, that we intend to keep you advised of important issues as they arise so we can have a truly meaningful partnership.

MONDAY — NOVEMBER 15, 1971

Chairman — Robert B. Abel, *Director, National Sea Grant Program, U.S. Department of Commerce, Washington, D.C.*

An Overview of the July–August 1971 Preparatory Session on the Law of the Sea

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Department of State
Washington, D.C. 20520

INTRODUCTION

My task this morning is to provide some perspective on the current stage of international negotiations on the law of the sea. While I recognize that most of you are primarily interested in fisheries or marine science, it is necessary to consider these individual topics in relation to the overall picture because the subject is being dealt with as a whole within the United Nations preparatory committee on the law of the sea.

Many of you are aware that last December (1970) the United Nations General Assembly scheduled a comprehensive law of the sea conference for 1973. Two preparatory sessions have taken place — one in March and the other in July-August 1971. The March session was largely devoted to organizational and procedural matters. The 6-week meeting during July and August was spent in a general debate during which approximately 70 states articulated important substantive positions. For many of these countries, this was the first expression of national positions on the law of the sea. While we cannot say that substantive negotiations have reached much more than a preliminary stage, we can say that remarkable progress has been achieved in the last year, especially when comparison is made with the progress that was made in the prior 3 years when many of these issues first surfaced in the United Nations.

The general debate last summer took place in the Main Committee and three Subcommittees of the whole. As you may recall, Subcommittee I is to prepare draft treaty articles on an international regime for the seabed area beyond the limits of national jurisdiction. Subcommittee II is to compile a comprehensive list of, and draft treaty articles on, subjects and issues relating to traditional law of the sea matters such as the territorial sea, international straits and fisheries. Subcommittee III is to deal with preservation of the marine environment and scientific research. The Main Committee, under Chairman Amerasinghe of Ceylon, will generally coordinate the activities of the Subcommittees and handle unassigned issues appropriate for its attention.

I should now like to concentrate on some of the principal events which

transpired in each of the three Subcommittees during this past July-August session.

Subcommittee I

Almost all states agreed at one time or another during the 23 meetings of Subcommittee I, that international machinery consisting of an Assembly, Executive Body and Secretariat was needed. Most also felt that satisfactory dispute settlement procedures were desirable but varying views were expressed on how they were to be established. Considerable disagreement was expressed over voting procedures in the executive organization. Many developing countries urged a "one state, one vote" system while the Soviet Union advocated a consensus system which was tantamount to a veto. Other states, including the United States, favored a form of weighted voting which would reflect some logical relationship between a state's voting power and its responsibility or interest.

A controversy arose over the possible economic impact on the prices of land-based sources of raw material as a result of the extraction of these minerals from the seabed. Several Latin American and Middle Eastern countries in particular, felt that cause for concern existed and they supported a general statement by the Secretary General of the United Nations Committee on Trade and Development (UNCTAD) which indicated that adverse consequences were possible. A comprehensive study by the United Nations Secretariat had concluded that no cause for concern existed except for a few, relatively minor instances. Dr. McKelvey of the United States Delegation delivered a well-reasoned, factual statement which reached essentially the same conclusion as the United Nations Secretariat study.

On this issue, the way in which the question is asked can structure the answer. Perhaps a question as pertinent as possible adverse consequences for present land producers is: what are the possibilities for less expensive resources for all states as a result of seabed exploitation. In any case, there was a split between those who thought controls on production were necessary and those who believed that the uninhibited action of world supply and demand would take care of most of the problems. This latter group feared that the proposed cures might be an "overkill" more harmful than the supposed illness.

A number of developing states argued that the international agency should be established with the power itself to exploit seabed resources. France, the United Kingdom and the United States opposed such an international operating agency, mainly because it appeared financially impractical and because it raised many unnecessary political problems.

The degree of practical difference between an operating agency which issues joint service contracts and an international authority which licenses exploitation could be made clearer. There may be as much of a semantic as a real problem on this point. I believe that more precise exposition of the positions of various delegations on this issue might pave the way for a narrowing of differences over what now appear to be largely doctrinal views.

The primary undercurrent in the first Subcommittee was on the question of the outer limits of national jurisdiction over the natural resources of the seabed. Many countries did not take a position on this hotly disputed subject. Among those who did, a goodly number spoke in terms of a 200-mile resource zone — that, of course, would include control over both minerals and fish. Importantly,

however, in the view of almost all, freedom of navigation and overflight would not be affected in such a zone.

A newly formed group of landlocked and shelf-locked states advocated narrow seabed limits by suggesting that the international seabed area begin at either the 200-meter isobath or 40 miles from shore (at the choice of the adjacent coastal state). The landlocked and shelf-locked group also suggested the creation of an intermediate zone. This would consist of an adjacent 40-mile belt denoted as a "coastal state priority zone" wherein coastal state consent would be required for resource exploitation.

The United States, as most of you know, has proposed that a trusteeship zone be established for the seabed between the 200-meter isobath (or 12 miles — whichever is further seaward) and an outer limit which has yet to be determined. In the trusteeship zone there would be a mixture of delegated coastal state rights and international elements. At the July-August meeting, the United States stressed that finding an appropriate, acceptable mixture of rights and duties was our most important objective regarding the seabed, and that we were flexible on the method of determining the outer limits of the trusteeship zone.

Subcommittee II

Territorial Sea and International Straits: The general debate in Subcommittee II was less detailed than in Subcommittee I during July-August, 1971. A large number of states (including the United States in a draft Article I) did support a 12-mile territorial sea. However, certain conditions were attached. For the United States, this meant world-wide acceptance of a provision for free transit through and over international straits. For others, support for a 12-mile limit was tied to recognition of coastal state control over resources in a broad zone adjacent to such a territorial sea breadth. A few states pressed for full maritime sovereignty out to 200 miles but the overwhelming majority of states did not believe national sovereignty should affect navigation or overflight beyond 12 miles.

The problem of unimpeded passage through and over straits used for international navigation received sufficient attention at this session to conclude that much negotiating effort will be required before this question is satisfactorily resolved. The United States believes that since many important straits would be overlapped by territorial seas if 12-miles became the norm, we need more legal assurances to ensure satisfactory maritime communications than is provided under the doctrine of "innocent passage". Under "innocent passage", the coastal state could claim a good deal of discretion about what is "innocent" and what is not. At best, the concept still does not include a right of submerged transit or overflight.

I seriously doubt that states bordering international straits would be well-advised to seek the legal authority to control maritime traffic. Internal and external pressures could be brought to bear for or against allowing passages by particular flag states or types of ships. Confusion and uncertainty could result. Maritime communications are too vital to be left subject to such caprice. In any event, the United States proposed in Article II that "free transit" be provided for movement through and over international straits. The right contemplated by the United States is a narrow one — that of going from one point to another in lanes designated by the coastal state. Spain, bordering the Straits of Gibraltar, argued strenuously for permitting only the mere right of "innocent passage" and

spoke out strongly against "free transit". I think some of her concerns were probably based on misunderstandings about our intentions in Article I, but, in any case, we hope any differences can be resolved.

Indonesia, the Philippines and Fiji discussed the status of their claims based on the archipelago theory. In the past, this concept has been thought to mean the drawing of straight baselines around the outermost fringes of islands and declaring the waters enclosed therein to be "internal". However, Fiji, an observer at the July-August meeting, suggested that the enclosed ocean space should be territorial seas and not internal waters, thereby permitting innocent passage. Perhaps an increased appreciation of the damaging effect of the archipelago theory on international navigational interests was being indicated and the thoughtful Fijian presentation merits close study for clues about possible accommodations of interests.

Fisheries: Resolution of the fisheries issue may well be the keystone to a successful law of the sea conference in 1973. One reason is that almost every state has some interest in fishing either as a producer or consumer, or both.

A large majority of the coastal states were inclined towards an expansion of their national control over fisheries. However, this view was in sharp contrast with the outlook of the major distant water fishing states such as Japan and the USSR. A more middle approach was suggested by some other states which indicated a preference for a fisheries zone with international elements.

For its part, the United States introduced its draft Article III on fisheries which was intended to reflect a practical approach to a problem which has long been a source of friction in the international community. We stated that we welcomed discussion on all aspects of fisheries and, in particular, suggested that negotiations between the coastal and distant-water fishing states most concerned would be appropriate on the question of traditional rights. Article III proposed a "species" approach with a coastal state preference over coastal and anadromous stocks based on a coastal states actual fishing capacity. Fisheries management responsibility was lodged in international (including regional) organizations, or in coastal states in the absence of such organizations. An expert commission would deal with disputes unless the parties agreed to another method of peaceful settlement.

The draft Article on fisheries submitted by the United States received little detailed attention at this session, but it is likely that specific reactions will be forthcoming at the next meeting of the Committee.

I shall not go into the procedural matters, which may still prove to be a stumbling block to progress in the law of the sea negotiations, except to say that a number of states were involved in drafting a "list" or agenda for the 1973 conference. Work on this problem is continuing.

Subcommittee III

Subcommittee III held a dozen meetings in Geneva but there was not a great amount of substantive discussion on the subject of preservation of the marine environment. This was probably due to the on-going work in Intergovernmental Maritime Consultative Organization (IMCO) and the Stockholm Conference on the Human Environment set for 1972. Many Delegations were not eager to duplicate efforts underway in other fora, and most expected the results of these other efforts to be channeled into Subcommittee III.

Canada, consistent with her national legislation, did actively advocate the

right of coastal states unilaterally to establish broad anti-pollution zones adjacent to the territorial sea. This would be done within the framework of a "custodianship" concept and a delegation of powers from the international community to the coastal state. Spain, Australia and others also supported marine pollution control zones in adjacent high seas areas. Japan thought that the maximum achievement at this time would be a new legal instrument for control of oil pollution. Other states favored regional arrangements but most of these were inclined toward basing regional arrangements on internationally agreed principles.

The United States stressed the desirability of internationally agreed standards as well as the important role of the specialized agencies of the United Nations and various inter-governmental groups in coping with marine pollution. We suggested that, taking into account the work done in these entities, Subcommittee III should draft the necessary treaty articles to provide a broad international legal framework which would leave technical details to appropriate specialized bodies.

The question of freedom of scientific research in the oceans was the subject of some differences of opinion. On the one hand were those nations such as the United States which considered freedom of scientific research a basic principle of the high seas which should be subjected to a minimum of restriction. On the other, there were states which expressed the view that scientific research should be regulated.

The varying views were not even close to reconciliation at the July-August session. In my opinion, this is an issue which merits much more attention from academic, industrial and even governmental experts in the United States than it has received in the past.

CONCLUSION

A general movement toward certain broad parameters of agreement was seen at this past summer's meeting of the Seabed's Committee. While meaningful negotiations are just beginning, the number and quality of the presentations in Geneva did indicate that systematic progress was being made as articulation of national interests is a necessary first step. However, there are many perplexing problems (which cannot be treated in isolation) which must be resolved before acceptable treaty articles can be drafted at a 1973 Conference on the Law of the Sea.

Acceptability to the Fishing Industry of the Current U.S. Position on Fisheries Article III – Law of the Sea Conference – 1973

WILLIAM R. NEBLETT
Executive Director
National Shrimp Congress, Inc.
Key West, Florida 33040

There is an erroneous concept that because U.S. fisheries are fragmented and far-flung there is difficulty in reaching inter-segment agreement and in speaking with one tongue. Seamen are "wards of the admiralty", but fishermen are the step-children of government. They are simple and wise enough to recognize this fact, so whenever a fisherman opens his mouth to protest, he uses the loudest voice possible, and, on the slightest pretext, consults or advises his congressman and any and all bureaucrats in Washington agencies as to where true justice lies.

Fisheries are far-flung, and in many fisheries there are no really large corporate interests, but only a group of struggling individuals who have wisely learned to form associations and to cling together for their common welfare. For example, we have the inter-state compacts, the Atlantic States Marine Fisheries Commission, the Gulf States Marine Fisheries Commission and the Pacific States Marine Fisheries Commission, covering in total some 21 states. Each segment of fisheries appears to have a trade organization, such as the one I represent, the National Shrimp Congress. There are spokesmen for industry and for labor. The most current effective fishery organization that I know is the National Fisheries Policy Conference which has no home address or officers as such, but only a loose *steering committee* who rouse up necessary meetings when emergencies occur.

I wish to make clear that we are speaking of the men and the vessels who capture the fish under the United States flag. Importers and processors naturally may have different interests in fish and fish products.

I am also happy to report to you that there was a recent meeting in Washington, D.C. of the National Fisheries Policy Conference, well attended by representatives of many fisheries, and the first conclusion reached is as follows (quote):

> **"It was agreed that the U.S. official position, submitted in Geneva in 1971, was not in the best interest of the industry."**

A difficulty arises primarily in attempting to reconcile the interests of four major segments of the U.S. fisheries, namely, pelagic, anadromous, coastal and distant fisheries. The latter involves tuna and shrimp, but even here the interests are diverse, as tuna can be saved through the U.S. position which advocates international regimes, while on the contrary, shrimp become involved with the increasing creeping jurisdiction of coastal states which would greatly hamper U.S. flag shrimp fishing in the Gulf of Mexico, Caribbean and South Atlantic.

There is a similarity in proposals advanced at Geneva by the U.S. (trustee zone) and Mexico (agent for the international community under a "management" concept) which softens the hard "ownership of the coastal zone" concept, by attempting to provide a device to allow some foreign fishing. This

observer believes that while the new international concept of a contiguous fishing zone is not unacceptable to the defense element of our government, still that department must be constrained to view with alarm the inclusion in such contiguous zones of all the principal elements of sovereignty which make up into the definition of *territorial sea.* Defense wants as small a territorial sea as possible, the narrowest now is 12 miles, and defense is willing to trade away any and all fish to gain that objective.

Informed fisheries people say, with what, in my opinion, is correct appraisal, that representatives of fisheries have been at the international game for a very long time, by the very nature of fishing, and that some of the decisions at high government levels do not realistically take into consideration the fisheries reaction that is sure to come from other nations and influence their votes at Geneva for fisheries rather than defense reasons. Fisheries do not seek to make defense decisions, but only to be heard in the inner circles of government, to advise at critical times as to the effect of proposals tabled, both with regard to domestic fisheries and with regard to the reaction of foreign governments. As of this moment, Government has denied fisheries representatives access to this inner council, to which traditionally they have belonged, and fisheries representatives now sit in the balcony at Geneva and know only what is said on the floor of the conference. To assess a situation properly, a representative must have access to all classified position papers and documents.

For many years the representatives of U.S. fisheries have known that a new conference on Law of the Sea was coming. For at least the last 3 years, the group which acts in an advisory capacity to the Department of State has been meeting and discussing the many problems involved. At a recent meeting of all the major fisheries at the University of Rhode Island Law of the Sea Session, in June 1971, most of the major fisheries or areas came forward with concrete proposals, each of which sought to safeguard the interests of the proponent, but at the same time, as sympathetically as possible, offer solutions for the other U.S. fisheries. I have made a comparative table of these various proposals which is attached to this paper as an exhibit. Subsequent to that meeting in Rhode Island in June (1971), representatives of tuna, shrimp and salmon met in Los Angeles, and prepared a joint statement which reflected livable positions for these three giants of the U.S. fisheries, whose total production in dollars represents over 60% of the total U.S. flag production. All of these papers were presented to our Government, so the decisions made in Washington were knowingly made and consciously prevented any proper and viable fishery policy from being made, but rather, as evident from the face of the U.S. proposal at Geneva, tacked on an appendage titled "Article III" to serve as trade goods at the Council table for the gaining of objectives of Articles I and II.

This observer predicts that unless the true significance and importance of a U.S. position on fisheries emerges, the presently planned tactic is foredoomed to fail, as did the package deal offered in 1960 at Geneva. Further, we cannot even muster the percentage of votes which were found in 1960. Peru has not only surpassed us at fishing, they are ahead on diplomacy and international tactics.

What deeply concerns the domestic fisheries goes beyond this coming Law of the Sea Conference. There is a feeling that if we should be so lucky as to win even some minor advantages while bargaining, the later practical application of measures internationally will still not favor U.S. fishermen. This is a type of persecution complex, but the feeling is deep seated and appears rooted in the credibility gap which now exists between fisheries and Government.

In closing, I quote the National Fisheries Policy Conference letter of October 5, 1971, to the President of the United States:

NATIONAL FISHERIES POLICY CONFERENCE

1133 20TH STREET, N.W. WASHINGTON, D.C. 20036 AREA CODE 202/ 338 2610

October 5, 1971

The President
The White House
Washington, D. C.

Mr. President:

This year the commercial fishing industry will commemorate one hundred years of fisheries conservation.

From our point of view, there is little to celebrate.

In fact, if drastic action is not taken before the 1973 United Nations Law of the Sea Conference, there will not be another centennial or a fishing industry left to celebrate it.

In 1973 the U. N. will meet to decide how the resources of the sea are to be managed. If the total lack of concern for the domestic fisheries expressed in the past and at the recent preparatory session in Geneva is any indication, the U. S. position will be based on the mistaken conclusion that certain objectives can be achieved by sacrificing our fisheries. For this reason, the very existence of this basic food industry depends on a change in U. S. policy which recognizes the critical needs of our fisheries.

In connection with any future planning sessions and the Conference itself, fishing industry participation is imperative. Further, we are concerned that decisions which could mean the life or death of our industry are being made with little consideration for their far-reaching consequences.

Clearly there is a need for your re-evaluation of this matter of our representation and its impact on the U. S. position on Law of the Sea. We, therefore, appeal to you for your support in this endeavor to protect the right of American citizens to continue to reap the renewable harvest of a protein-rich sea.

Sincerely,

Robert D Nordstrom

Robert D. Nordstrom, Chairman
for:

Theodore Bugas	Bumble Bee Seafoods
Charles Carry	Tuna Research Foundation
Steele Culbertson	National Fish Meal & Oil Association
Jacob Dykstra	Point Judith Fishermen's Cooperative
August Felando	American Tunaboat Association
Harold Lokken	Fishing Vessel Owners Association
William Neblett	National Shrimp Congress
Anthony Nizetich	Star-Kist Foods, Inc.
Jesse Orme	Fishermen's Marketing Assn. of Wash., Inc.
William Saletic	Seiners Association
George Steele	American Tunaboat Association
William Utz	American Shrimpboat Association
Lowell Wakefield	Wakefield Fisheries
Lee Weddig	National Fisheries Institute
Walter Yonker	Association of Pacific Fisheries

Resume of Recent Fishing Industry Proposals Regarding National Fisheries Policy

Negotiable Issue	Category of Industry Representative				
	National Fisheries Institute	New England (also W. C. Herrington)	Lokken	San Francisco	Menhaden
Coastal state Coastal waters	Vested interest in all fish resources "off its shores", exclusive right to 80% of all coastal species.	Fish and shellfish indigenous to coastal waters property of coastal state. W.C.H. preferential right of harvest.	Fish and shellfish associated with continental shelf and slope except underharvested species. Jurisdiction to outer edge of slope	Dependent on shelf and slope for reproduction and/or survival during major part of life.	Shelf and slope and other waters to 200 miles.
Anadromous species	Exclusive use of 100% of species.	Belong to state of origin. WCH grazing fee to other states where fish graze.	Property coastal state	If harvestable elsewhere, participating states must work out rules and allocate share of catch.	Joint arrangements if found elsewhere at harvestable stage. "Other migratory" to be reserved to coastal state or joint control by adjacent states.
Pelagic fish	Coastal state has right to participate if party to treaties covering species	Control by international body, plus user. If in coastal water include coastal state	"High Seas Species" Multinational control by participants and by coastal state where participation in catch practicable	Multinational control by harvesting countries plus those whose coasts border fish stocks	International agreement by fishing states and coastal state off whose shores stocks are found and harvested.
Under-utilized species	Coastal state duty to develop all fish resources to maximum sustainable yield. Recognize historic rights. Licensing to 8% of value of catch	Provide for harvesting by others... Licensing. WCH regulation by coastal state, phased out in 10 years	Other states may harvest where no interference with other species. Non-discriminatory rules by coastal state. Non-punitive license fees.	Other nations may harvest subject to license and control by coastal state.	Licensing to 8%. Control by coastal state. No interference existing fisheries. Consult participating state regarding conservation.
Territorial sea	Exclusive jurisdiction, twelve miles		Twelve miles		
Arbitration	Must submit scientific findings to arbitration				"Consult other state"

Alternatives to the Current U.S. Position on Fisheries

THOMAS A. CLINGAN, JR.
Professor of Law
University of Miami
Coral Gables, Florida 33124

My task today is to discuss with you alternatives to the current United States proposal for the territorial seas. That position has been articulately explained to you this morning by the first speaker, and, with his permission, my remarks will build upon that excellent statement. The question before us, of course, is not simply, as the title of this panel would seem to suggest, the U.S. position on the territorial seas. It is the broader question of the inter-relation of the breadth of those waters with the fisheries problem. It is this broader question that I wish to address.

Properly viewed, the three-article U.S. draft is an attempt to accommodate a number of highly important and specialized interests. Before I speak of alternatives to that scheme, therefore, I shall attempt to isolate these interests, because the viability of various alternatives depends upon the priority given to one or more special needs of the participants. My list is as follows:

1. The interest of coastal states in exercising competence over a specific resource adjacent to its coast, or to all of the resources located in a particular zone. Claims to extended territorial seas and coastal state preferences reflect this type of interest.

2. The interest of nations in the continued operation of established fishing enterprise, wherever located, into which has been put substantial effort and capital. Claims to historic rights reflect this interest.

3. The interest of all nations to the free exercise of rights of navigation on the high seas, and, to a more limited extent, in territorial seas. This is reflected in traditional claims to freedom of the seas.

4. The interest of certain nations in fishing pelagic species not directly associated with a particular coastal state or groups of states. Claims to freedom of the high seas are applicable here as well, but claims to historical shares may also be encountered.

5. The interest of a coastal state vis-a-vis other nations in anadromous species spawning in that state's waters. Claims to abstention reflect this interest.

6. The general community interest in full utilization of living resources without over-exploitation. Claims to rights to conserve, and rights to fish under-utilized stocks reflect this interest.

In order to attain success in creating a world fisheries plan, one must either accommodate these interests, or, failing that, seek agreement as to which of them is to be given priority in specified areas. In making such decisions, one is guided by the realization that the interests sometimes fall into natural sets. Howard Pollock, Deputy Administrator of the National Oceanic and Atmospheric Administration, recently identified these sets in terms of their potential for conflict: (1) conflicts between the desire to exploit and the desire to conserve; (2) conflicts between the needs of the coastal and distant-water fishing interests and (3) conflicts between fisheries and those seeking free navigation rights and fleet mobility.

The U.S. draft attempts, in Article III, to resolve these potential conflicts by

accommodation. If one were to take another tack, however, and approach the problem by selecting one or more of the various interests to be emphasized, he would undoubtedly come up with another scheme.

For example, if agreement could be attained on the principle that freedom of navigation is to be protected at all costs, then the most desirable scheme would be the limitation of the breadth of the territorial sea to as narrow a belt as possible, reserving no rights (or only carefully circumscribed rights) to the coastal state. The United States has long been an advocate of this position. Our tenacious adherence to the 3-mile limit, our unsuccessful attempts at 6- and -6 proposals in 1958 and 1960, and the presently proposed maximum 12-mile limit stand as evidence of this fact. Thus, alternative one would be the establishment of a narrow jurisdictional limit with little or no preferential rights beyond. I need not comment on this beyond pointing out that the resolution of most fisheries disputes would be left to the market place.

Should we desire, however, to maximize the interest of coastal states in their near-shore fisheries, the result would undoubtedly be a fixed zone in which the coastal state would exercise a high degree of control. As you are aware, some states already claim sovereignty, or near-sovereign rights, over zones extending to a minimum of 200 miles from the baseline from which the breadth of the territorial sea is measured. More recently, some other states have been speaking of less comprehensive, but still substantial, zones for the protection of the economic interests of coastal states. Both such types of claims must lead to a certain amount of apprehension on the part of the U.S. delegation.

Ambassador Pardo, in a speech before the Seabeds Committee last March (1971), made it clear that he believed an alternative of this character might be a real one. He estimated that of the approximately 135 member nations, a total of 35 had the ability to make claims to jurisdiction as far as 300 miles from their coasts, and 65 more could, if they wished, claim as far as 150 miles. This latter group includes more than half of the coastal states, and represents more than two-thirds of the world's population. He was of the opinion that:

> ". . .it is probable that agreement on the outer limits of coastal State jurisdiction in ocean space should be sought somewhere between 150 and 300 miles from the coast.
>
> ". . .my delegation has come to the reluctant conclusion that, to avoid prolonged debate and haggling, it has become necessary to establish a distance of 200 miles from the coast as the outer limit of coastal State jurisdiction in ocean space."

Clearly, adoption of this alternative, if the jurisdiction is to be absolute, would not be acceptable to those whose primary concern is freedom of navigation, though it would well serve the number of nations who draw benefits from coastal fisheries.

It is perfectly clear to me that the United States, for example, would neither join in nor accept this alternative willingly. The Honorable John Stevenson, Legal Advisor to the Department of State (and a highly able one, I might add), made this point quite clear when he said last August:

> ". . .my government would be unable to conceive of a successful law of the sea conference that did not accommodate the objectives of these articles." (Ed. note — the articles include a provision for free transit.)
>
> "We appreciate the fact that many countries attach greater importance to the question of offshore resource management than they do to freedom of navigation. We understand the reasons for this and it gives us hope that a successful law of the sea conference can be achieved through a process of negotiation with mutual respect for each other's interests."

I have an admittedly limited vantage point. And it is not clear to me why many nations would be persuaded to enter into this kind of bargaining, for it seems entirely possible that they are aware that collectively they are in a position to defeat a freedom of transit proposal without giving up or claiming any resource advantage as a consequence.

Now that I have conjured up the extreme alternatives, let me state the obvious by saying that something between the two is required. Such a solution must, it seems to me, have certain basic elements. The first need is for the establishment of a zone of at least limited coastal state jurisdiction that would be enough to enable the state to implement timely and effective fishery management and afford economic protection to coastal state fisheries. Regulations pertinent to such a management scheme necessarily pertain to stocks which do not conform to artificial boundaries, although we must realize that the drawing of such lines may be required for enforcement purposes and for the clear delimitation of economically significant zones. If such lines are drawn, however, they should be constructed on biological rather than geometrical criteria.

A proposal for effective management should also permit the coastal state to maximize its sustainable returns, reserving the remaining catch, if any, to other nations. Distant-water fisheries would suffer to some extent under this proposal, and thus their votes may be lost.

The management of high seas zones should not be placed under the control of large, slow-moving regulatory bodies subject to procedural delays and vetoes. The massive mobile fleets placing strains on certain coastal stocks do not usually leave much time for lengthy deliberation. It needed, more responsive, and smaller, groups of nations having realistic interests in the regulated stocks should be formed, and care should be taken in the manner by which the participating nations are identified. Finally, the scheme must have some effective mechanism for settlement of disputes.

You must have noted by this time the degree of similarity between what I have just outlined and some of the provisions of Article III of the U.S. draft. Indeed, I agree with much of that proposal. I support the general principles of coastal state preference and encouragement of conservation with full utilization. I also believe in the rejection of fixed and arbitrary fishing zones. I fear, however, that the draft attempts to accomplish too much. And even more I am afraid that the seeming intransigence with regard to freedom of transit, if it perseveres, will leave scant hope for acceptance of the U.S. proposal.

Howard Pollock has asked:

> "Well, what really is the outlook for fisheries? At the risk of stating the very obvious, I would say that the outlook for fisheries, that is the possibility of a successful fisheries convention, emerging from a final LOS conference, is simply and directly in proportion to the ability of states to reconcile their competing interests. . . .and to accommodate our navigational interests. And I simply won't predict, at this juncture, that they will do this."

And Jake Dykstra, of the Point Judith Fisherman's Cooperative, has recently expressed serious doubts that the 1973 conference will succeed because there are too many interests to be catered to.

If there is total failure, then what? Failure to agree is, after all, the final alternative. Without being privy to any special information, it would be my guess that failure to agree would stimulate a period of unrestricted unilateral claims to

increased coastal state competence. But this solution is inherently self-destructive, and the time will come when depletion of the resources will force the coastal states to realize that the biological and economic unity of the oceans call for more than a unilateral solution, and we will then see a return to the bilateral and multilateral agreement as a basic tool of fishery management.

Foreign Fishing Off the Southeastern United States Under the Currently Accepted Contiguous Sea Limitation

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Southeast Region
National Marine Fisheries Service
St. Petersburg, Florida 33701

INTRODUCTION

Under existing international law, foreign vessels can legally fish off the coasts of the United States beyond 12 nautical miles offshore. Federal laws grant U.S. nationals exclusive fishing rights in U.S. territorial waters, which extend offshore for 3 nautical miles, and in the 9 nautical mile U.S. contiguous fishery zone, which extends from the outer limits of the territorial sea to a distance of 12 nautical miles offshore. Only under certain international agreements are foreign fishing vessels allowed to operate within our contiguous zone. The control of foreign fishing beyond the 12 mile fishery zone can only be regulated by bilateral or multilateral international fishery agreements.

The rapid expansion of foreign fishing off the U.S. coasts during the last decade is well documented. We are all familiar with the extensive Soviet and Japanese fishing fleets that now operate in international waters adjacent to our coasts and the numerous conflicts between U.S. and foreign fishermen that have resulted from invasions of our historic fishing grounds off New England and the Pacific Northwest. Much less is known, however, about foreign fishing in the Gulf of Mexico and off the southern Atlantic states.

The Southeast Region of the National Marine Fisheries Service initiated a preliminary study in August 1970 to determine the extent of foreign fishing in that area. We reviewed all available data on foreign fishing operations and initiated an active surveillance program in cooperation with the U.S. Coast Guard and the various state conservation agencies. In a short time the need for a permanent foreign fishing surveillance program was demonstrated. As a result, an Enforcement and Surveillance Division was established in the Southeast Region in September of this year (1971).

This report summarizes foreign fishing off the southeastern U.S. between October 1970 and October 1971. The area covered includes the Atlantic coastal waters south of 37° north latitude (mouth of Chesapeake Bay) and Gulf coastal waters from Florida to the Mexican border.

METHODS OF SURVEILLANCE

Surveillance flights are scheduled through the Seventh and Eighth Coast Guard District Headquarters in Miami and New Orleans. Patrols are flown from air stations at Miami and St. Petersburg, Florida; Mobile, Alabama and Corpus Christi, Texas. Surveillance of foreign fishing off the southern mid-Atlantic area is conducted by our Northeast Region through the Fifth Coast Guard District Headquarters in Portsmouth, Virginia, with flights from the air station at Elizabeth City, North Carolina. The mainstay of our surveillance program is the

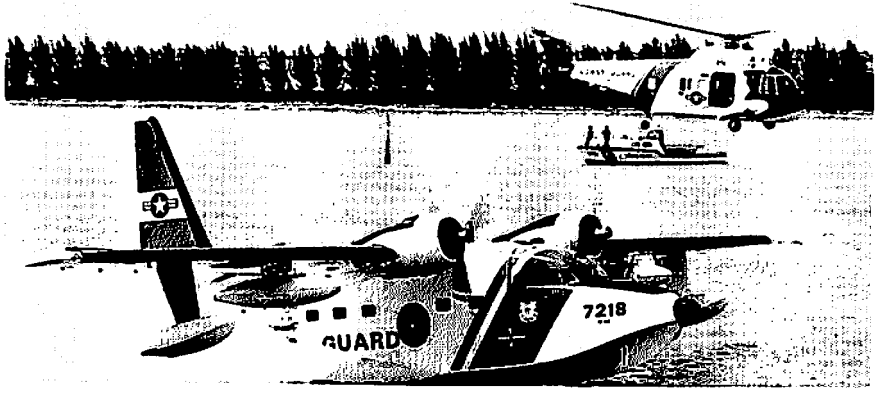

Fig. 1. Coast Guard HU-16E (Albatros) Grumman amphibian and HH-52A helicopter used in fishery surveillance patrols (official U.S. Coast Guard photograph).

Coast Guard HU-16E (Albatros) Grumman amphibian (Fig. 1). Helicopters are also used to patrol nearshore areas from shore stations or cutters.

A National Marine Fisheries Service observer accompanies the flights and records the nationality, position and type of fishing gear, and description or class of all foreign vessels sighted. He also attempts to determine the catch and estimates the volume of catches. When possible, photographs or motion pictures are made of the vessels. The accuracy of our surveillance varies in different areas because of weather conditions, type, number and activity of foreign vessels present, methods of fishing, the size of the area and the extent of patrol coverage.

We also receive sighting reports from Coast Guard fishery patrols and units engaged in other duties. Random sightings thus obtained are a valuable adjunct to our surveillance program and assist us in planning patrol requirements.

Additional sighting reports are obtained from state conservation agencies, commercial and sports fishermen and U.S. merchant vessels. Supplemental sighting reports are used to gauge the accuracy of our surveillance program.

OBSERVATIONS AND ESTIMATES OF FOREIGN FISHING

We observed 386 individual foreign fishing vessels from the Soviet Union, Cuba, Mexico, Japan, East Germany, Bulgaria, Poland and Spain fishing off the southeastern United States between October 1970 and October 1971. Of this total, 241 individual vessels were sighted fishing in the Atlantic and 145 in the Gulf of Mexico (Table 1). Fishing was concentrated in four areas: (1) the southern mid-Atlantic area off southern Virginia and North Carolina for sea herring, Atlantic mackerel and albacore tuna; (2) the Tortugas-east Gulf area off southwest and west-central Florida for snappers, groupers and shrimp; (3) the north-central Gulf area off Louisiana for yellowfin tuna and (4) the western Gulf area off lower Texas for shrimp (Fig. 2).

TABLE 1
Individual Foreign Vessels Observed Fishing Off the Southeastern United States
October 1970 - October 1971

Nationality	Atlantic	Gulf	Total
Soviet	201	1	202
Cuban	-	77	77
Mexican	-	58	58
Japanese	11	9	20
East German	17	-	17
Bulgarian	7	-	7
Polish	4	-	4
Spanish	1	-	1
Total	241	145	386

Monthly sighting records and estimates of vessels actually fishing indicate that surveillance patrols observed about 57% of the foreign vessels operating off the southeastern U.S. We estimate 100% coverage of Japanese tuna vessels fishing in the southern mid-Atlantic and north-central Gulf areas because of their size, weather conditions during the fishing periods, the limited area of fishing during a given day and sighting reports from sports fishermen and merchant vessels. We also believe that all Cuban shrimp trawlers fishing off Texas were identified. Eighty percent coverage is estimated for the Soviet Bloc vessels fishing in the

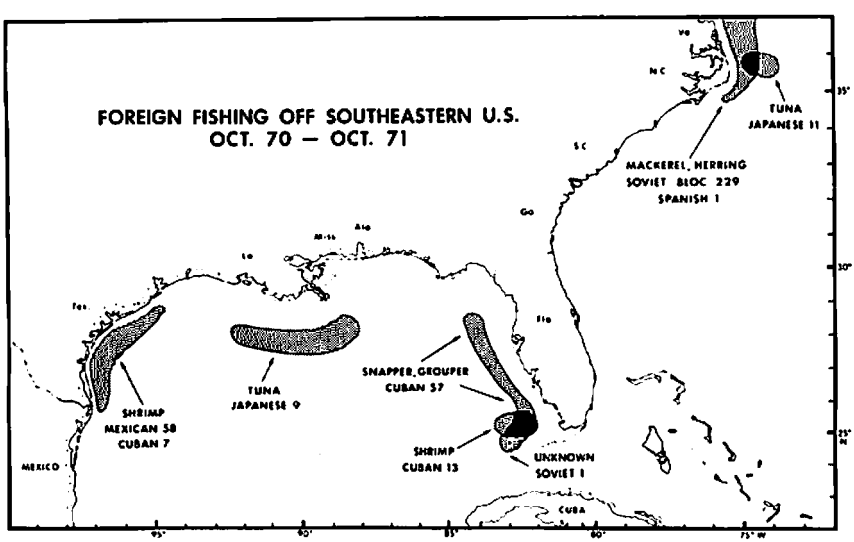

Fig. 2. Foreign fishing areas off the southeastern U.S. showing nationality of vessels and the principal catch in each area.

mid-Atlantic area because of adverse weather conditions during surveillance patrols, the extensive number of vessels fishing on a given day and past experience gained during the surveillance of large Soviet fleets operating off New England.[1] We also estimate 80% coverage of Cuban vessels operating in the Tortugas-east Gulf area because of the large size of the area, limited patrol coverage and sighting reports from commercial fishermen and merchant vessels. Coverage of Mexican shrimp vessels operating off Texas during the summer is estimated at 10 to 28%, based on extrapolations from the proportion of U.S. to Mexican trawlers sighted during each patrol and figured from the estimated total number of U.S. vessels fishing off the Texas coast, limited areas of patrol coverage and sighting reports from commercial fishermen. Estimates of total fishing effort are necessary for catch estimates when foreign catch statistics are not available (Table 2).

Foreign vessels caught an estimated 100 million pounds of fish and shrimp with an estimated ex-vessel value of $7 million between October 1970 and October 1971. The Atlantic catch is estimated at 91.6 million pounds valued at $3.8 million and the Gulf catch at 8.7 million pounds with a value of $3.2 million (Table 3). The species taken by foreign vessels in the Gulf (shrimp, snapper and tuna) are of much greater value than the principal southern mid-Atlantic catch of mackerel and herring. Catch estimates for the individual fishing areas were made from (1) reported foreign catch statistics; (2) estimated number of foreign vessels fishing, time on the grounds and catch capacity of the vessels; (3) catches by U.S. vessels in areas of foreign fishing; (4) interviews with foreign fishermen or (5) combinations of the above. The ex-vessel value of the catch was figured from values published in *Current Fishery Statistics, 1970.* Methods of estimating the catch in each fishing area are discussed in the following sections.

Southern Mid-Atlantic

The Soviet Bloc sea herring and Atlantic mackerel trawl fishery south of Chesapeake Bay has existed since 1964. This fishery is an extension of the current Soviet Bloc herring and mackerel fishery that began off New England in 1961 (Jensen, 1971) and is conducted largely within the terms of U.S. bilateral fishery agreements with Poland and the Soviet Union. The area considered here (south of 37° north latitude to Cape Fear, North Carolina) corresponds to Subdivision C, Statistical Subarea 6, of the U.S.-U.S.S.R., U.S.-Polish Middle Atlantic Agreement Area. The U.S. exerts some control over Soviet and Polish vessels fishing in this area through the two bilateral agreements which contain restrictions covering fishing for sea bass, menhaden, river herring, hake, scup and flounder but do not yet apply to sea herring or Atlantic mackerel.

Fishing occurs in the southern mid-Atlantic area primarily in January, February and March. During the period of this report, 201 individual Soviet; 17 East German; 7 Bulgarian and 4 Polish vessels were identified (Table 1). Cumulative monthly sighting records show that 433 Soviet; 27 East German and 8 Bulgarian vessels were observed fishing during the various patrols (Table 2). In addition, 1 Spanish trawler was sighted operating in this area.

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[1] Estimates of surveillance coverage in the southern mid-Atlantic area obtained from Mr. Charles Philbrook, Enforcement and Surveillance Division, National Marine Fisheries Service, Gloucester, Massachusetts, 01930.

TABLE 2

MONTHLY SIGHTINGS AND ESTIMATES OF FOREIGN FISHING VESSELS

Area	Estimated Percent Coverage	Nationality	Monthly Sightings and Estimates (in parentheses) of Vessels Fishing													Cumulative Totals 1/
			Oct.(70)	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.(71)	
Southern Mid-Atlantic	80%	Soviet	-	5(6)	7(9)	132(165)	118(148)	109(136)	60(75)	1	1	-	-	-	-	433(539)
		East German	-	-	-	3(4)	9(11)	15(19)	-	-	-	-	-	-	-	27(34)
		Bulgarian	-	-	-	2	2	3(4)	1	-	-	-	-	-	-	8(4)
		Polish	-	-	-	-	4(5)	-	-	-	-	-	-	-	-	4(5)
		Spanish	-	-	-	-	-	-	1	-	-	-	-	-	-	1
	100%	Japanese	-	-	-	-	-	-	-	-	-	-	-	-	11	11
Tortugas - East Gulf	80%	Cuban (Handline)	2	5(6)	11(14)	7(9)	4(5)	22(27)	2	22(27)	11(14)	19(25)	1	-	-	106(127)
		Cuban (Shrimp trawlers)	-	5(6)	13(16)	8(11)	5(6)	-	-	-	-	-	-	-	-	31(39)
		Soviet	-	-	-	-	1	-	-	1	1	-	-	-	-	3
North-Central Gulf	100%	Japanese	-	-	-	-	-	-	-	-	-	-	9	-	-	9
Western Gulf	10-28%	Mexican	-	-	-	-	-	-	-	-	13(128)	49(345)	3(11)	-	-	65(484)
	100%	Cuban	-	-	-	-	-	-	-	-	-	-	-	7	-	7
Average - All Areas	57%	TOTALS	2	15(18)	31(39)	152(189)	143(175)	149(186)	64(75)	24(27)	26(142)	68(370)	13(:1)	7	11	705(1232)

1/ The cumulative number of vessels sighted during the year usually exceeds the number of individual vessels identified because of repetitive sightings and vessels recognized as foreign types but unidentified by name or number. Conversely, the number of vessels on the grounds at any one time is usually less than the number identified during the year because of vessels entering and leaving the area.

TABLE 3

ESTIMATES OF FOREIGN FISHING EFFORTS, CATCHES, AND VALUES

Area	Bordering States	Principal Species Exploited	Nationality of Fishing Vessels	Principal Fishing Months	Estimated Number of Vessels	Estimated Fishing Days Per Vessel	Estimated Number of Vessel Days	Estimated Catch Per Vessel Day (Pounds)	Estimated Total Catch (Pounds)	Estimated Value of Total Catch (Dollars)
Southern Mid-Atlantic	Southern Virginia North Carolina	Herring and Mackerel	Soviet	January	165	1-30	165-4950	-	Total Catch Estimated From 1970 Soviet-Polish Statistics	
				February	148	1-30	148-4440	-		
				March	136	1-30	136-4080	-		
				April	65	1-30	65-1950	-		
			East German	February	11	1-30	11-330	-		
				March	19	1-30	19-570	-		
			Bulgarian	Jan.-April	Avg. 2/Month	1-30	8-240	-		
			Polish	February	4	1-30	4-120	-		
			Spanish	April	1	1-30	1-30	-	91,130,400	3,616,000
		Albacore Tuna	Japanese	October	11	10	110	4200	462,000	143,600
Tortugas-East Gulf	Florida	Snapper and Grouper	Cuban	Nov.-July	Avg. 15/Month (132 total)	25	3300	1600	5,280,000	1,689,600
		Shrimp	Cuban	November	6	16	96	320		
				December	16	16	256	275		
				January	10	16	160	215		
				February	6	16	96	240	158,400	74,400
		Exploratory Fishing	Soviet	Feb-May-June	1	-	-	-	-	-
North-Central Gulf	Louisiana	Yellowfin Tuna	Japanese	August	5 + 4 Catcher Boats = Six Vessels	15	90	4940	444,600	111,000
Western Gulf	Texas	Shrimp	Mexican	June	128	16	2048	195		
				July	345	16	5520	418		
				August	11	16	172	435	783,300	1,294,200
			Cuban	September	7	2	14	-	-	-
TOTALS									100,258,700	6,928,800

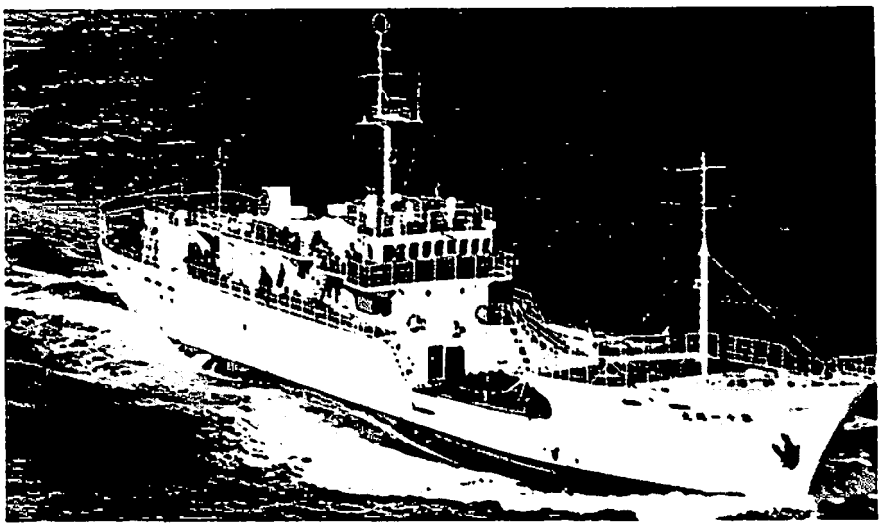

Fig. 3. A typical Japanese longliner used in the tuna fisheries off the U.S. Atlantic and Gulf coasts.

The Soviet Bloc vessels vary in size from the 125-foot SRT (medium side trawler) to the 278-foot BMRT (large freezer stern trawler)[2]. Other Bloc nations employ both side and stern trawlers in the same general size range. The fishing fleets are supported by factory ships, supply ships, refrigerated transports, tankers, base ships and seagoing tugs. Soviet vessels were described in detail by Hitz (1968).

The estimated herring, mackerel and incidental fish catch in the southern mid-Atlantic area was 91.1 million pounds valued at about $3.6 million. These figures are derived from catches reported by the Soviet Union and Poland in 1970 (Table 3). About 85% of the catch was sea herring and mackerel and about 10% river herring. Incidental species taken include hake, flounder, scup, shark and other miscellaneous fish. During the 1971 season there was some replacement of Soviet and Polish vessels by East German and Bulgarian vessels, but the general effort appeared to be approximately the same as in the 1970 season. Catch statistics for 1971 are not yet available.

Eleven Japanese longliners were observed fishing principally for albacore tuna off the North Carolina coast in October 1971 (Table 2 and Fig. 3). The vessels remained in the area for about 10 days and fished from 21 to 85 nautical miles offshore.

The albacore tuna, bluefin tuna and incidental billfish catch in the southern mid-Atlantic area for this period was estimated at about 462,000 pounds valued at about $143,600. The catch was based on an estimate of 70 fish taken each day by each longliner figured at 46 pounds for individual albacore, 220 pounds for bluefin tuna and 125 pounds for marlin;[3] giving an estimated daily catch of

[2] Trawlers and factory ships mentioned here are illustrated in "Soviet fisheries and fisheries research off the east coast of the United States," Proceedings of the 23rd Annual Session, Gulf and Caribbean Fisheries Institute (1971).

[3] Daily catch estimates obtained from Mr. John P. Wise, Southeast Fishery Center, National Marine Fisheries Service, Miami, Florida 33149.

4,200 pounds. Each of the 11 longliners was credited with 10 days of fishing, giving a total of 110 vessel days (11 x 10 = 110 vessel days) and an estimated total catch of 462,000 pounds (110 x 4200 = total catch) (Table 3). The marlin catch was estimated to be about 10 to 20% of the total catch. The value of the catch was figured at $0.26 a pound for albacore, $0.20 a pound for bluefin tuna, and $0.50 a pound for marlin. Marlin have no commercial value in the U.S. but they are of considerable value to sports fishermen. The monetary value of $0.50 a pound to sports fishermen was selected arbitrarily.

Some degree of control over Japanese longliners operating off our coast exists because of an informal understanding between an American sport fishing organization and the Japanese fishing companies involved which was achieved at the Rio Conference on Tuna and Tuna-Like Fishes in 1966. Under the terms of that agreement, the Japanese agree to remain a circumspect distance from areas of interest to U.S. sports fishermen.

Dry Tortugas - East Gulf

Cuban handline vessels have historically fished this area of the Gulf of Mexico for snappers and groupers on a limited scale. In recent years, with the advent of fishery expansion in Cuba facilitated by assistance from the Soviet Union, Cuban fishing efforts in the eastern Gulf have increased.

During the last year 57 individual Lambda and Sondero class vessels (47 Lambda, 10 Sondero) fishing in the Tortugas-east Gulf area were identified (Fig. 4). One hundred and six cumulative monthly sightings were recorded giving a total estimate of 132 monthly occurrences based on 80% surveillance coverage (Table 2). These vessels primarily fish for snappers and groupers using the so-called "creole longline" fished from motor dories (Young, 1971) (Fig. 5). Lambda boats operate 6 to 8 dories with a crew of 16 to 20 and Sondero boats usually fish 4 dories with a crew of 12 to 14.

The snapper and grouper catch in this area was estimated at 5.3 million pounds valued at about $1.7 million (Table 3). Catch estimates are based on the 1970 landings of 8,000 metric tons reported by the Cuban Gulf flotilla (Young, 1971) which primarily fishes the Tortugas and Campeche grounds, the capacity of Lambda class vessels (60,000 pounds), interviews with Cuban fishermen arrested for illegal fishing and the estimated number of vessels fishing each month. These vessels (average 15 per month for 9 months) were credited with a 25 day trip giving an estimated 3,300 vessel days of total fishing effort. Based on interviews with Cuban fishermen, we estimated the average catch per vessel day at 1,600 pounds, giving a total catch of 5,280,000 pounds by Cuban handline vessels (Table 3).

The value of the catch was estimated from the current average ex-vessel value of the various species probably included in the catch and figured at $0.32 per pound. Except for September and October 1971, fishing was observed in the area throughout the year. It peaked in March, May and July.

Cuban shrimp trawlers began to appear on the Tortugas grounds in 1968. These vessels were built in Spain (Fig. 6) and France (Fig. 7) and operated by the Cuban Caribbean (shrimp) flotilla. Five trawlers were sighted in November, 13 in December, 8 in January and 5 in February. We did not identify all of the vessels, but we know at least 13 individual trawlers (December sightings) were active in the area (Table 2).

The Cuban shrimp catch on the Tortugas grounds was estimated at 158,000

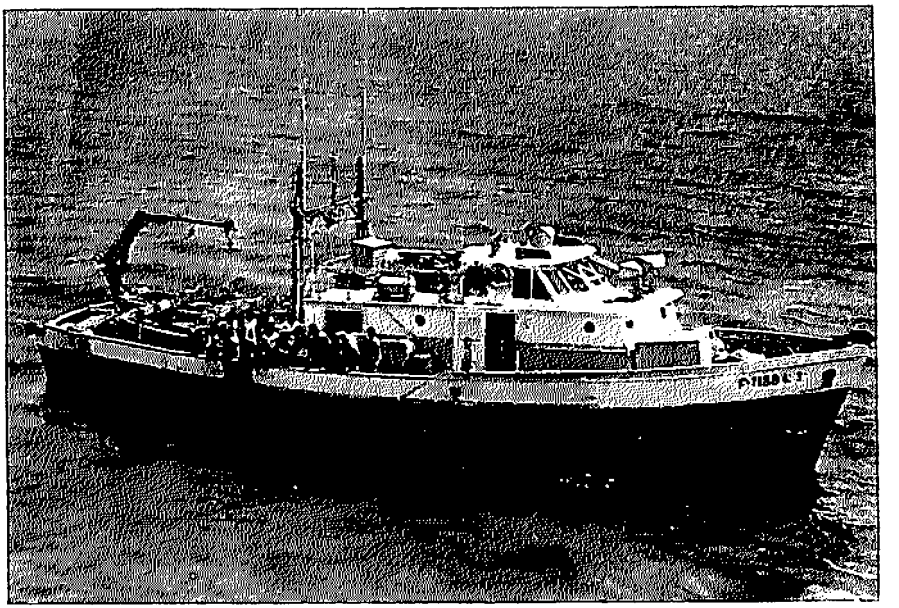

Fig. 4. Cuban Lambda class 75-foot fishing vessels used in the Tortugas - East Gulf area.

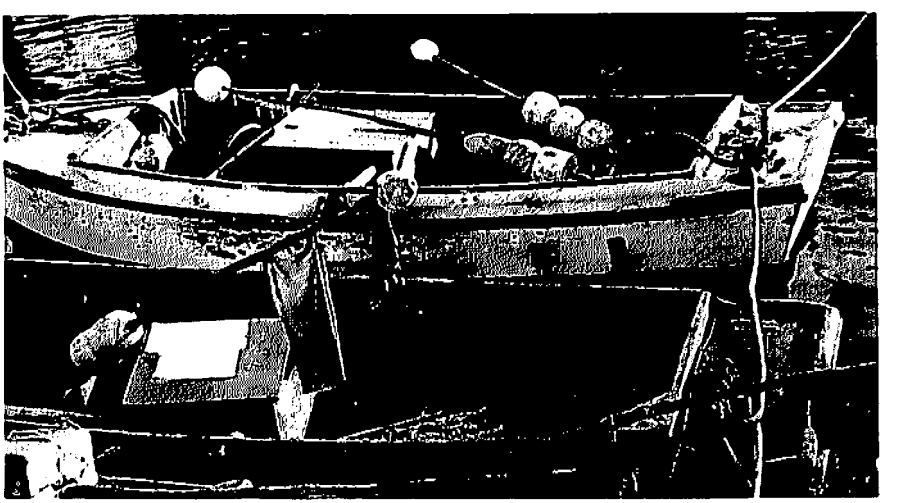

Fig. 5. Cuban motor dories with baited longlines used in the Tortugas - East Gulf area (official U.S. Coast Guard photograph).

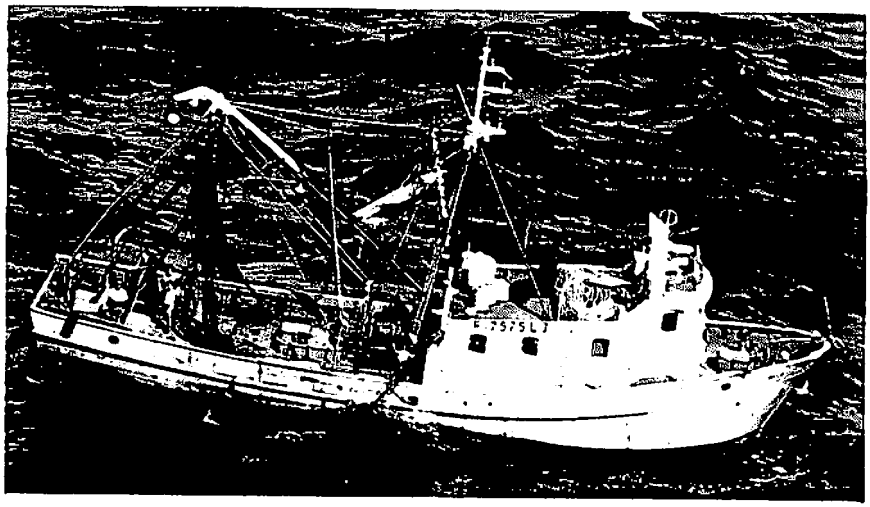

Fig. 6. Spanish built Cuban 75-foot shrimp trawler observed on the Tortugas shrimp grounds in February 1971.

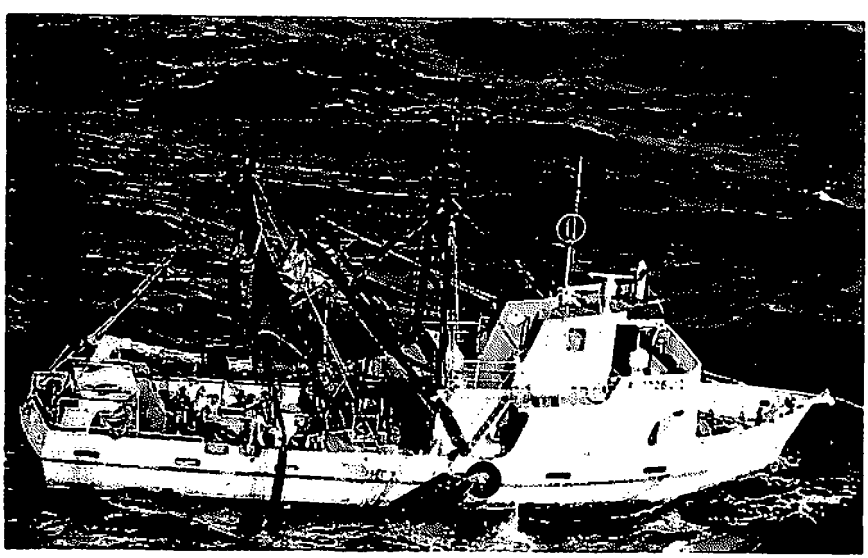

Fig. 7. French built Cuban 83-foot shrimp trawler observed on the Tortugas shrimp grounds in February 1971.

pounds valued at $74,000. This estimate was based on the average daily catch of U.S. shrimp trawlers on the Tortugas grounds during the past winter,[4] the estimated number of Cuban trawlers fishing each month, the number of fishing days per vessel (16 days) and the number of vessel days per month (Table 3). Each trawler was credited with a catch equal to 75% of the average daily production of U.S. trawlers for that month. The efficiency of the Cuban boats was probably not equal to that of U.S. vessels (Cuban fishermen interviews) and the catch was probably somewhat smaller because the Cuban vessels were generally fishing further offshore than U.S. vessels, in less productive areas. The estimated value of the shrimp catch was based on the general 1970 Gulf value of $0.47 per pound (heads-on weight) but may have been somewhat higher because larger shrimp, but fewer numbers, are usually taken in deeper areas.

The single Soviet trawler observed fishing in the Tortugas area was believed to be an exploratory fishing vessel engaged in systematic research. Past Soviet fishery research in the Gulf was described in detail by Sal'nikov (1965).

North - Central Gulf

Japanese longliners have fished for tuna in the north and western Gulf since 1963. The effort was limited and apparently escaped the attention of U.S. sport and commercial fishermen until the summer of 1969 when a longliner was seen operating in an area 38 to 54 miles south of the South Pass entrance to the Mississippi River. Because of concern for the billfish stocks in the famous sport fishing grounds south of the Mississippi Delta, many complaints to congressmen ensued. The Japanese, however, were operating well beyond the limits of the U.S. contiguous fishery zone and, therefore, beyond U.S. jurisdiction.

In August of this year (1971), five Japanese longliners accompanied by four small catcher vessels (approximately 70 feet long) were observed fishing primarily for yellowfin tuna between 43 and 80 nautical miles south and southwest of the Mississippi River Delta (Table 2). The catcher boats are towed by the longliners when in transit. Because of the size of the longliners (150-175 feet long) and the intense local interest in their operations, we believe that we identified all of the vessels engaged in this operation.

The yellowfin tuna and incidental billfish catch in the north-central Gulf area was estimated at 445,000 pounds valued at about $111,000. These figures are based on an estimate of 59 fish taken each day by each longliner with average weights figured at 92 pounds for individual yellowfin, 207 pounds for blue marlin and 51 pounds for white marlin,[5] giving an estimated daily catch of 4,940 pounds per vessel. Each longliner was credited with 15 days of fishing and the catcher vessels catch was considered to be equal to a single longliner, giving a total of six longliner units and 90 vessel days (Table 3). The marlin catch was estimated at about 10 to 20% of the total catch. The value of the catch was figured at $0.18 a pound for yellowfin and $0.50 a pound for marlin (arbitrary value of marlin catches explained previously).

The private agreement with the Japanese discussed in the southern mid-Atlantic section also applies to this area. Surveillance observations of Japanese

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[4] U.S. catch data obtained from Mr. John K. Bishop, Jr., Statistics and Market News Division, National Marine Fisheries Service, Key West, Florida 33040.

[5] Daily catch estimates obtained from Mr. John P. Wise, Southeast Fishery Center, National Marine Fisheries Service, Miami, Florida, 33149.

longline fishing this summer indicated that the Japanese vessels were generally complying with the agreement.

Western Gulf

Mexican shrimp trawlers began fishing off the Texas coast in about 1963. They appeared in force during the summer of 1970 when we received reports of 50 to 100 vessels from U.S. fishermen. Reports received this summer indicated that 50 to 200 Mexican trawlers were operating off the coast. A few complaints were registered by our shrimp fishermen but most of them accepted the Mexicans without comment — apparently because of extensive U.S. shrimping off the Mexican coast.

Surveillance patrols off the Texas coast during this summer identified 58 individual Mexican shrimp trawlers between Galveston and the Mexican border. Thirteen were sighted in June, 49 in July, and 3 in August (Table 2). Patrols were restricted to the area between the beach and about 30 nautical miles offshore because of the large number of U.S. trawlers operating on any one day and our interest in Mexican use of privileges granted under the U.S.-Mexican Fishery Agreement in the 9 to 12 mile zone. Mexican trawlers are very similar to U.S. trawlers, requiring close scrutinization at very low altitude. Many additional unidentified trawlers were observed outside of the patrol areas.

We made extrapolations of the possible number of Mexican trawlers operating off the Texas coast each month by using simple proportions including the number of Mexican vessels observed, the number of U.S. trawlers observed and the probable total number of U.S. trawlers operating off the coast on any one day. A minimum of approximately 1,500 U.S. trawlers consistently operated off Texas during the summer. Statistical trip records show that about two-thirds of the trawlers were at sea at all times so we can safely assume that at least one-half, or about 700 U.S. trawlers were at sea on any one day during favorable weather. Monthly surveillance patrols produced ratios of U.S. to Mexican vessels as follows: June 60 to 11; July 83 to 41; August 185 to 3.[6] Based on the conditions stated above, proportions indicate the possible number of Mexican trawlers as 128 in June; 345 in July and 11 in August. The reduction of Mexican vessels fishing in August was possibly because of adverse weather conditions in the Gulf due to hurricanes. These estimates seem reasonable when compared with fishermen reports of up to 200 Mexican vessels fishing off the Texas coast and the Mexican inventory of about 600 shrimp trawlers licensed to fish in the Gulf of Mexico. The July estimate of 345 vessels may be somewhat high but the catch per vessel day estimate was conservative.

The Mexican shrimp catch off the Texas coast was estimated at 2.8 million pounds valued at about $1.3 million. These estimates were derived by crediting the estimated number of Mexican vessels fishing each month with 16 fishing days[7] and a catch equal to 75% of the average daily catch of U.S. vessels landing at Port Aransas, Texas, during the month[8] (Table 3). The efficiency of Mexican shrimp trawlers was believed to be less than that of U.S. trawlers.

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[6] Sightings made during random enforcement patrols are not included because the number of U.S. vessels sighted during these patrols was not recorded.

[7] We believe that some of the Mexican trawlers fished 20 to 25 days.

[8] U.S. catch data obtained from Mr. Thomas N. Scott, Jr., Statistics and Market News Division, National Marine Fisheries Service, Port Aransas, Texas 78373.

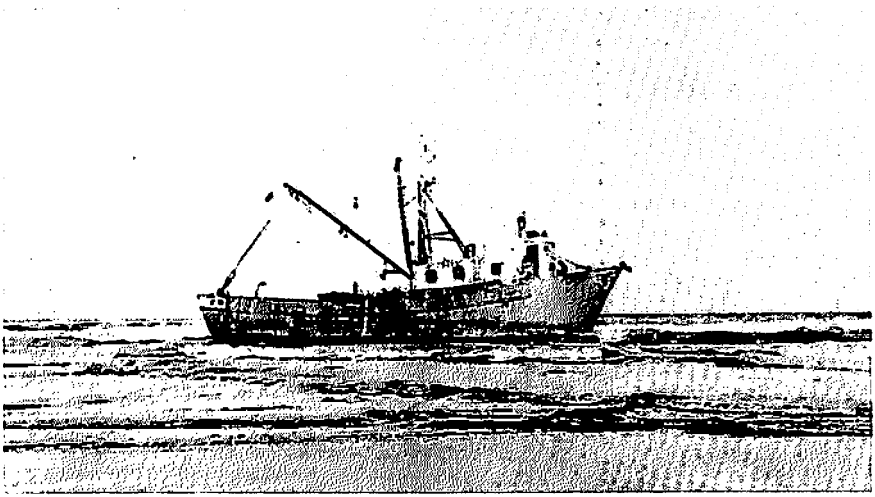

Fig. 8. Cuban shrimp trawler grounded on the Texas coast by Hurricane Fern (official U.S. Coast Guard photograph).

Mexican fishermen are allowed to fish in the outer 3 miles of the U.S. fishery contiguous zone under the terms of the U.S.-Mexican Bilateral Fishery Agreement in force from January 1968 to January 1973. This privilege is granted in return for similar rights given to U.S. fishermen off the Mexican coast. Under the agreement, the catches by each nation in the other's exclusive fishery zone are not to exceed the cumulative catch taken during the 5 years preceding the agreement.

Seven Cuban shrimp trawlers (five Spanish built, two French built) appeared off the Texas coast in September (1971) and began fishing between 20 and 35 miles offshore between Freeport and Pass Cavallo. Their operations were interrupted by Hurricane Fern and four of the vessels were grounded 6 miles south of Aransas Pass on September 12 (Fig. 8). The others were allowed to enter Port Aransas to effect repairs and await the salvage of the grounded boats by commercial tugs. Crewmen stated they were prepared to fish off Texas for 45 days. The flotilla departed Port Aransas on September 29, apparently for the Campeche area. The catch of the Cuban trawlers was considered negligible.

CONCLUSIONS

The estimated foreign catch of 100 million pounds off the southeastern United States between October 1970 and October 1971 amounted to about 8% of the foreign catch off the northeastern U.S. in 1970 (1.3 billion pounds) and about 5% of the U.S. domestic catch in the southeast region (2 billion pounds at $193.5 million, 1970). We are relatively fortunate in this region in comparison to the northeastern U.S. where the foreign catch is currently about 98% of the domestic catch. We have reason for concern, however, if we consider that foreign fishing off the southeastern U.S. before 1963-1964 was negligible.

A comparison of the estimated value of Atlantic and Gulf foreign catches

gives further insight into possible future problems in the Gulf area. Soviet Bloc vessels in the southern mid-Atlantic area accounted for about 91% (sea herring and Atlantic mackerel) of the total southeastern catch but only 52% of the value. Cuban, Mexican and Japanese vessels fishing in the Gulf accounted for only 8.6% of the catch (snapper, shrimp and tuna) but 46% of the value. Consequently, the monetary motivation for further foreign exploitation of Gulf fishery stocks is considerable.

The probability of a considerable expansion in foreign exploitation of Gulf snapper and grouper stocks is not great with existing fishing methods (creole longlines and handlines) and sea bottom conditions on the grounds (rock, coral and loggerhead sponges). Japanese longlining efforts for Gulf tuna, however, have apparently increased by about 50% in the last 3 years. In addition, Cuba now has about 30 longline vessels obtained from Spain, and they have shown an interest in the tuna stocks in the northwest Gulf. Increases in tuna exploitation are, therefore, likely.

Exploitation of shrimp stocks seems to offer the greatest possibility for foreign fishing expansion in the Gulf area. Foreign exploitation of shrimp in international waters off the U.S. Gulf coast has at least doubled in the last 3 years. The combined Mexican and Cuban shrimp fleet is currently estimated at 720 modern trawlers capable of distant water fishing. Development of a prototype shrimp trawler is underway in the Soviet Union and these vessels could be deployed in the Gulf and Caribbean from bases in Cuba. Approximately one-third of the Gulf coast shrimp catch, with a value of about $36 million, comes from international waters off the U.S. Gulf coast. Uncontrolled foreign fishing would constitute a significant threat to the shrimp industry of the southeastern United States.

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Management of Fishery Resources for Optimum Returns Would It Work in the Gulf of Mexico?

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INTRODUCTION

During the past decade, even the past 5 years, there has been a substantial modification in the thinking of many of the most knowledgeable practitioners, as well as theoreticians, of marine fishery management, regarding what is needed to make management more effective. Effective today it is not, with few exceptions, either on the national or international scale. Examine what has happened biologically and economically during the past decade under our present system, to haddock, yellowtail flounders, northwest Atlantic herring, Bering Sea flounders, king crab and so on and so on.

In the light of this record, what does the U.S. government propose for the future? The U.S. in its 1971 presentation at Geneva, has proposed essentially a continuation of the present international system, plus a provision for anadromous fish and a few additional provisions for settling disputes, similar to those developed at the 1958 Geneva Conference on Law of the Sea. These additional provisions for settling disputes are part of the 1958 Fisheries Convention, which has not been ratified by a majority of the major fishing powers and of the less developed nations, and I suspect from the record of the two preparatory meetings in 1971, are even less acceptable to these nations now than during the past decade. The 1958 Convention was concerned with the then current and developing problems. The current U.S. position seems to me to be looking backward to the problems of the 1960's and earlier, not forward to the problems of the present and future.

Concepts of fish resources management have changed drastically during the past half century and particularly the past decade. In 1920 there was little effective marine fishery management in the U.S. and mighty little in the rest of the world. Marine fishing generally amounted to uninhibited hunting under the common property concept and assumption that if and when fish became scarce in one area the hunters could shift to another area or species. It is true that a few thoughtful people, such as Johan Hjort in Norway and Will Thompson in the U.S., had begun some statistical analysis of this assumption, but we had no successful management programs in being.

During the next three decades, 1920-1950, the management concept was developed further, and most successfully put into practice in the North Pacific Halibut and the Sockeye Salmon Commissions. In the northeast Atlantic some progress was made among European fishing countries in the North Sea Overfishing Convention, which slowed down overfishing but did not bring it to a halt, or even less, reverse the downward trend. By the 1940's I believe that the maximum sustainable yield concept was somewhat further advanced among fishery research and management people in North America than in Europe. In a "Forum Discussion of Principles and Methods of Fishery Management", presented before the Atlantic States Marine Fisheries Commission in December,

1942, I stated: "I believe that most of us will agree that the ultimate aim of all our fishery work is to obtain the maximum continuous yield (optimum yield) from our fishery resources in the way of food, value, recreation, or other return, for the benefit of our country, our state, our people and our fishing industry (fishermen, dealers, etc.)."

MAXIMUM SUSTAINABLE YIELD (m.s.y.)

The concept of maximum sustained yield was first formally stated as the objective of management, in the Northwest Atlantic Fisheries Convention negotiated in 1949, in the phrase "in order to make possible the maintenance of a maximum sustained catch". The concept received further recognition in the North Pacific Fisheries Convention among Canada, Japan and the U.S.A., negotiated in 1951, where it was specified as the objective which would "best serve the common interests of mankind, as well as the interests of the Contracting Parties". What was even more significant, it was cited as the first and principal condition which must be met for a stock to qualify for "abstention", as follows: "Evidence based upon scientific research indicates that more intensive exploitation will not provide a substantial increase in yield which can be sustained year after year." Later it achieved international stature at the 1955 Rome Technical Conference on the Conservation of the Living Resources of the Sea, and in 1958 it became the primary element in the definition of conservation in the "Convention on Fishing and Conservation of the Living Resources of the High Seas". Most of the international conventions dealing with fishery management which the U.S. had negotiated since 1950, include m.s.y. as the primary management objective.

It may be noted that the 1958 Convention "Fishing and Conservation of the Living Resources of the Sea" uses the phrase "maximum sustainable yield" whereas the earlier bilateral and multilateral conventions use "maximum sustained yield". There is an interesting story behind this. In 1954, before the 1955 Rome Conference and the 1958 Geneva Conference had been scheduled (or even conceived), I visited Ottawa and London to explore with their fishery and Foreign Office people support for an effort to convene a world conference including technical as well as legal experts, for the purpose of developing worldwide standards for dealing with international conservation problems. At that time a number of north European countries, which had lost practically all of their high seas fishing fleets during the war, were rapidly rebuilding and expanding their new and more efficient fleets. The United Kingdom had come through the war and immediate post war years with her fishing fleet in considerably better shape than those of the other European countries. The United Kingdom fishery experts saw that the delayed but rapid buildup of the other European fleets soon would lead to a return of the excessive fishing capacity of pre-war years which had caused serious overfishing in the North Sea. This overfishing was highlighted in Michael Graham's book "The Fishing Gate". To forestall a repetition, the British were pressing for a North Sea agreement which would halt further expansion of the European fishing fleets. Incidentally, this would leave the U.K. fleet in a dominant position and for that reason, among others, the proposal had been rather cooly received by other countries.

The British were reluctant to shift their objective from this "limited entry" to the m.s.y. approach. Furthermore, Michael Graham was not satisfied that the

phrase "sustained yield" was the proper technical term. He proposed "sustainable" as being more appropriate. After extensive discussion and in view of the very limited or negligible possibility of securing international agreement on the limitation of fishing effort desired by the British, they agreed to support the concept of "maximum sustainable yield", and this expression later was sanctified in the 1958 Geneva Fisheries Convention.

Since 1958 m.s.y. generally has been accepted in theory as the objective of international fishery management, but in practice has been honored more in the breach than the observance. Probably only in the halibut, salmon and Inter-American Tropical Tuna Commissions, has there been a realistic and reasonably successful effort to observe this objective.

MAXIMUM ECONOMIC YIELD (m.e.y.)

The concept of improving the economic yield from fishing by limiting participation (of others) goes back to the early days of fishing. Certainly the Japanese have formally practiced the art for many years. The first serious attempt by government in the U.S. to implement such a regime was the Maryland Management Plan, promoted particularly by Bob Nesbitt and others in the late 1930's and early 1940's (debated in the Forum Discussion of fishery management at the regular meeting of the Atlantic States Marine Fisheries Commission on December 9, 1942). This plan was initiated in Maryland in the early 1940's, with limited entry and the Grandfather provision, but became mixed up with politics and never was effectively implemented.

The efforts of the U.K. to secure agreement in Europe to limit the amount of fishing capacity in the North Sea Fisheries, referred to earlier, can be classified as an effort to improve or maintain the economic yield by limiting participation. It failed because the other Europeans thought they could secure a bigger share of the pie, even though that pie might decrease in overall size.

During the 1950's the economists got into the act in a big way. Largely because of the greatly improved statistics amassed for the conservation programs for halibut and salmon, it was possible to show with considerable statistical precision that the sustainable catches of these species could be taken with much less gear and fishing effort. The limitations on length of fishing season, number of fishing days and restrictions on kind of gear used, provided dramatic evidence of surplus fishing capacity. The economists demonstrated the substantial savings that could be made by limiting participation to the most economic level of fishing capacity, a savings which could be absorbed by government or divided among government, consumer and fishermen. However, they failed to recognize, tackle and resolve the numerous problems that would develop from such a reduction; the social, legal and political problems that would arise from reduced employment and reduced capital equipment. Most boat owners and fishermen were not persuaded that their uncertain and probably little understood prospects under m.e.y. justified giving up their traditional freedom of entry. Furthermore, how many were prepared to dedicate their future to maximizing the net economic yield (not necessarily their own)? There were such satisfactions as leisure, way of life and so forth to be considered. I think that there also was considerable concern regarding how such a system would operate, to what extent their operations and earnings would be dictated by government bureaucrats. It became increasingly clear that m.e.y. by itself was not a very saleable objective.

OPTIMUM RETURNS

As the problems that would be engendered by an m.e.y. system have become clearer, there has been a growing shift to support "optimum returns" as the most desirable and realistic objective of fishery management, a mix of biological, economic, social and possibly political considerations. Questions of unemployment, alternative employment, way of life and overall community benefits, cannot be ignored. Such a mix may vary considerably in different situations, and therefore does not have any universal determinable value. For a given stock of fish the optimum might be quite different for two countries. Therefore, under the common property concept, it does not provide a usable common objective for an international convention, for its evaluation could be quite different for the several member countries.

IMPLEMENTATION OF "OPTIMUM RETURNS" AS AN OBJECTIVE

If "optimum returns" is to be taken as a viable objective of fishery management we must have an acceptable procedure for determining the proper mix of biological, economic and social values. Furthermore, if net economic return is to be a factor, the system must include provisions for limiting participation. A first conclusion might be that the mix should be determined by government. However, I doubt that many in industry are prepared to support this. They would have many justified and many unjustified reservations regarding how such a mix would be developed. Extensive management detail and the resultant expansion of bureaucracy would be required and administering officials would be subject to strong political and financial influences as well as personal convictions. I very much doubt that adequate political support could be developed for such a procedure.

It seems probable that normally most of the decisions on mix would principally affect the participants in the fishery. Assuming that original participation is established through some provision such as the Grandfather clause, then the methods and rate of controlling and reducing fishing capacity and the type of gear used would principally affect the participants, who could balance the current impact of such measures against future gains. However, if other activities such as recreation and mining took place in the same area, these interests would be affected by the measures used. Furthermore, the public would be concerned in regard to whether the fishery resources were managed on a sustainable or non-sustainable basis, as a continuing harvest or a depletable resource.

Another question of general concern: how would the increased net returns from improved efficiency in production be divided? How would the increased earnings be apportioned among the producer, the consumer and society? If government operated the entire management apparatus, would it absorb a large part of the increased earnings through bureaucratic costs or user charges?

A third and most important question: how would you secure the political support needed to install such a management system, support from the producer, the processor and the public? The producer must be convinced that he would be better off under the proposed system, the processor must be convinced that he would be better off or at least no worse off, and the public must be convinced that it would benefit through reduced prices, increased supplies, increased public revenue or better use of the resources.

All of these questions pose serious problems and we have little direct domestic experience on which to base answers.

CONCLUSION

Many, if not most, of the problems I have discussed stem from or are intensified by the tradition hallowed concept of marine fishery resources as common property. In the past, particularly the distant past, there were good reasons for this point of view. With the recent rapidly changing relationship of fishing capacity to the extent of the resources, the common property concept becomes increasingly archaic, that is, if one is concerned with optimizing the returns from marine fishery resources. This is being acknowledged by more and more knowledgeable fishery people who have been frustrated by the problems of securing improved management, domestic and international, under the present system.

Development of some form of property concept, international and domestic, at least for some fishery resources, would greatly facilitate solutions to the management problems I have noted.

Under such a concept the mix of biological, economic and social considerations to secure "optimum returns", could be determined by participant-government management bodies, with representatives of the participants playing the primary role on issues which principally affect participants, and the government on issues which affect the public interest. The latter issues might include the requirement to harvest on a sustainable yield basis, provisions for recreation, navigation and others.

Such a system also would facilitate an appropriate division of the increased earnings resulting from better economic and biological management of the fishery, through our accepted tax system. Development of property values, and increased earnings after covering management costs, would produce public revenues through property and income taxes, comparable to other business and industry. Society, by taking its share of earnings after a profit was made, rather than before, would not inhibit management for long range returns and the development of marginal resources.

The final problem, and one of overriding importance, is securing needed support for the desired system. No matter how biologically and economically sound the concept may be, and advantageous to society, it is not likely to go anywhere unless it is generally acceptable to the producers, the processors and the public.

From my general experience in domestic and international fisheries management and examination of the various attempts to develop management along some such line as I have proposed, I am persuaded that programs can be developed for many fisheries which would be demonstrably advantageous to the three groups just mentioned. However, I do not believe that we know enough at present to lay out any precise formula. Each fishery must be studied and measures developed to satisfy its particular problems. Then these measures must be tried out on a trial and error basis.

The feature of this approach to management which most of all appeals to me, is that it would provide strong incentives for the producers of fish to support better management, both long range and short. Participants would be assured that they individually would benefit from improved yields, an assurance that is sadly lacking in our present common property management system. This lack is

largely responsible for the increasing deterioration in national and international marine resources.

IMPLEMENTATION

As I earlier stated, I know of no precise formula for implementing the management system I have discussed. However, I believe that certain general guide lines can be set out.

The basic requirement is not limited entry but establishment of some sort of property concept. This concept almost automatically involves limited entry but it must also include certain other important features. To begin with, a single authority must be established with power to enact and enforce adequate measures for the resources to be managed.

In connection with the University of Miami "Decision Seminars" held over the past academic year, I ventured to set out some of the general guide lines for fish stocks outside of the jurisdiction of the several states, which seemed to me to be appropriate and or necessary for establishing a management system for optimum returns. They are as follows:

A. *Objectives of the Management System:*

1. Achieve optimum sustainable returns (in terms of quantity, value and costs) through use of: (a) leases to manage and harvest certain fishery resources (stocks of fish); (b) fishing licenses to control number of participants in the fishery and/or fishing capacity for certain fishery resources and (c) other measures.

2. Provide incentives for the participants to support management for optimum sustainable returns, by making leases and licenses long term, renewable and subject to purchase and sale, thus enabling holders to benefit from current restraints on their fishing operations and investment of their time, effort and money to improve future production.

3. Increase efficiency of operations and reduce production costs by reducing and/or preventing use of excess fishing capacity.

4. Provide a substantive role in decision making for representatives of the participants. This would involve giving them a controlling voice on management decisions primarily affecting the participants and appropriate influence on other decisions of primary importance to others, subject to suitable guide lines with respect to matters of public interest.

B. *Leases* (particularly applicable for stocks with a fixed or limited range):

1. May be granted for specific fishery management units, to cooperatives, partnerships, corporations or individuals.

2. Where resources are being fully utilized, the first priority would be to the organization which included the majority of those engaged in the fishery or was approved by the majority of those so engaged.

3. Where resources are unutilized or under-utilized, the lease would go to the highest bidder, provided that each of those who had been engaged in harvesting the resource during a stipulated base period would be eligible, at nominal cost, for a license covering the producing capacity (size and/or equipment of vessel) he used during the base period.

4. Leases would be transferable by open market purchase and sale.

C. *Licenses* (particularly applicable for stocks of fish which range rather widely and intermingle to a substantial extent with other stocks):

1. All vessels which had participated in the fishery during a stipulated base period would be eligible for licenses at nominal cost. Such licenses would be related to the fishing capacity of the boat or other producing unit (Grandfather clause).

2. Licenses would be transferable by open market purchase and sale.

3. Licenses might be of different categories, related to the extent to which the boat had participated in the fishery.

4. Measures taken to increase the returns per boat or licensed unit of gear, such as buying up and retiring licenses to reduce excess fishing capacity, would be financed by special assessments. The size of the individual assessments would be related to the extent to which the participants would benefit from such measures, e.g., size or fishing capacity of boat.

D. *Management Procedures*

1. Leased fisheries: The organization holding the lease would have the responsibility to manage the resource for optimum returns, subject to the following requirements: (a) Management must be on a sustainable basis; (b) Where management measures for this resource substantially impinge on measures for other resources, the measures would be developed in cooperation with the other management organization or organizations; (c) Where proposed management measures for this resource substantially impinge on public activities such as recreation, transportation and so forth, the measures would be subject to review and approval by a committee including representatives of such other activities; and (d) (tentative) If agreement cannot be reached under (b) and (c) the issue would be referred to a review committee appointed by the Secretaries of the departments concerned with the involved issues.

2. Licensed fisheries: Management programs for licensed fisheries would be developed and administered by the National Marine Fisheries Service (NMFS), subject to the following: (a) For each management unit consisting of one or more stocks of fish, a management committee would be established made up of representatives of the license holders with a representative of the NMFS as chairman; (b) Management measures primarily affecting the resources and license holders included in the management unit, would be subject to review and approval of the management committee, provided that: the measures must be consistent with management of the resources on a sustainable basis and the total licensed fishing capacity must not be limited to less than the amount required to fully harvest the stock; (c) Where management measures for this resource substantially impinge on measures for other resources, the measures would be subject to review and approval by the combined management committees for this and such other resources; (d) Where management measures for this resource substantially impinge on public activities such as recreation, transportation and other such interests, the measures would be subject to review and approval by a committee including representatives of such other activities; and (e) (tentative) If agreement cannot be reached under (c) and (d), the issue would be referred to a review committee appointed by the Secretaries of the departments concerned with the involved issues.

Certainly many problems will develop when we set out to apply such a system to particular resource management units, particularly where mixed and supplemental fisheries and mixed fishing fleets are involved. In section D, management procedures, 1(d) and 2(e), I have outlined a tentative procedure for resolving such problems when agreement among diverse interests cannot be achieved. However, I am sure that real solutions cannot be developed until we sit

down with those involved and work out procedures for specific management units.

In order to initiate such a program the first requirement is that some one administrative body have authority to develop and enforce the necessary measures. For stocks of fish found predominantly outside of state jurisdiction, this would be the national government. This government now has the responsibility but no legislative authority to manage such stocks on this or any other basis. For stocks found predominantly within the waters of a single state, the program could be administered by a state agency, if this agency were given the necessary legislative authority. To manage a stock of fish ranging the waters of two or more states, these states would have to give broad authority to an interstate body to develop and enforce such a system without requiring further state legislative action on specific measures and without the right of veto by individual states. Lacking such action by the states, this program could be administered only by the national government or some national agency such as TVA or an interstate port authority.

The complexities of a management program would vary substantially among the different resources. Probably the simplest situations would be found where a single self-sustaining stock of fish occupied a limited geographic area and was the principal component of the catch of a fishing fleet which concentrated on this fishery for all or most of the year. The Georges Bank haddock fishery approached this situation prior to advent of the foreign fleets. The New Bedford yellowtail flounder fishery also approached it, but there were several other fleets which looked to this resource for supplemental catches. The sea clam fishery of the middle Atlantic coast appears to provide favorable conditions, except that recruitment in specific geographic areas appears to be so irregular that a fishing fleet would find it impossible to make out over a period of years, if confined to a limited geographic area. For this reason probably the entire middle Atlantic fishery would have to be included in any sea clam management unit.

Now at last I am coming to the question I am supposed to talk about. Will fishery management for optimum returns work in the Gulf of Mexico? I have reviewed some of the principal requirements for fishery management for optimum returns and some of the great advantages it could provide over the present system. But I must admit that I don't know enough about the fishery resources of the Gulf and the economic and social problems of these fisheries, to give you specific answers for these resources. I have briefly discussed this question with friends in this area and have not received specific answers. I doubt that such specific answers can be secured without sitting down and working out measures for specific resources. However, I am sure that such management could be worked out, at least for some fisheries, if the needed broad legislative authority were available and the program proceeded on a careful trial and error basis, much as the Canadians have used in their salmon program in British Columbia.

What would be the most promising fisheries to explore in more detail? What fisheries most closely approach the less complex situation which I have outlined: involve a single self sustaining stock of fish which occupies a limited geographic range and make up the principal component of the catch of a fishing fleet dependent on this stock for all or a substantial part of the year? Having identified such a stock, we then should examine the extent to which this fishery overlaps other management units and what sustainable gains can be secured by the proposed management, in terms of increased yields, increased earnings,

improved conditions of employment and other social developments advantageous to the individual, the community and society in general.

The menhaden fishery would appear to offer favorable possibilities. Shrimp offer some possibilities, but certainly a challenge, for the stocks are wide-spread and fishery operations diverse. Red snapper might offer a possibility if one could eliminate foreign fishing complications. I am sure there are others, perhaps local stocks of fish. I hope that some of you in the audience, with a much greater knowledge of the Gulf fisheries, will give us the benefit of your views regarding Gulf possibilities.

TUESDAY — NOVEMBER 16, 1971

Chairman – T. A. Wastler, *Office of Water Quality Programs, Environmental Protection Agency, Washington, D.C.*

Pollution Management in the Coastal States

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FOREWORD

The pendulum of pollution management in the coastal states will swing back and forth between the extreme views of the conservationists, guided by emotion, and the selfish views of the business interests, guided by economic factors. The problem is to establish a structure to manage the pollution of the coastal zone on a systems management basis concept. The thing that makes this management problem complex is the fact that the management of pollution in the coastal zone must strike a proper balance between the ecological viewpoint of the conservationist, the economic viewpoint of the industrialist or the user, and the technical information which the manager must have in order to achieve a balance between the other two. Then we reach the key to the problem, and that is the political management structure which must be developed in order to implement the management decisions and make them work.

Key Problem Areas

I have identified five key management areas that are common to all coastal states in the management of pollution problems in the coastal zone. These are: (1) fresh water pollution management, both surface and submerged; (2) air pollution management in the coastal areas; (3) management of the mineral deposits within the coastal zone, including petroleum and natural gas; (4) management of the coastal marshlands, wetlands and the estuarine areas, including ocean dumping; and (5) management of the recreational areas, including sea islands. I have not listed atomic radiation pollution management, since the federal government retains exclusive jurisdiction in this area.

Definition of the Coastal Zone

It is believed that each state must prepare its own working definition of its coastal zone. A master definition relying on international law is well nigh impossible. Each state must come to grips with the legal questions concerning territorial limitations with the federal government and adjacent states. It is suggested that a *working* definition must be adopted by each state in order to

implement a coastal zone management plan. One example is the *working* definition of the coastal zone of Georgia: "The coastal zone of Georgia is the area covering the bottom of the waters, the surface of the waters, and the air above the waters, and land extending from a seaward boundary, which would be coordinates marking the bottom of the slope of the continental shelf. The coastal zone would extend from the shore inland to a boundary which is the western-most county lines of those counties which contain the Pleistocene "Wicomico" (100-foot contour) shore line." This working definition has been reviewed and approved by the Attorney General's office and the State Geologist of Georgia.

THE COASTAL STATES ORGANIZATION

The primary thrust of the Coastal States Organization has been, to date, in the area of coastal zone management. The Coastal States Organization is a group of gubernatorially appointed delegates from 26 of the 32 coastal and Great Lakes states, commonwealths and territories.

The goals of Coastal States Organization are: (1) communications between states on matters of mutual interest to member states; (b) joint consideration of certain problems or projects of mutual interest; (c) development of representative positions; (d) interjection of state interests and positions into national legislative activities of mutual concern, such as National Oceanographic Program and National Coastal Zone Research Program; and (e) interjection of state interests into activities of federal agencies active in oceans, estuaries and coastal zone.

Activities of the Organization to date include: (a) helping develop legislation relating to National Coastal Zone Management and National Coastal Laboratory programs (specifically - S 2802); (b) working with the Executive Branch on the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA); (c) developing organization and (d) assisting development of state programs in the coastal zone.

COASTAL POLLUTION MANAGEMENT ISSUES

There have been some questions raised by the various delegates to the Coastal States Organization which identify some key issues on coastal zone pollution planning and management. Some of these are:

How strongly should regulatory and management controls be exercised? This is not the threshold question among coastal issues; in fact, a good case can be made for deferring the adoption of controls for 2 or 3 years. The purpose of such timing is to evolve the control mechanisms as a part and parcel of a comprehensive plan for the coast, developed after thorough studies, meetings, hearings and so forth. But control is the ultimate question, the one which matters most to most people concerned about the coast. It quickly settles on specifics: can outer continental shelf lands near prime fisheries be withdrawn from oil exploration and leasing? To what degree can privately-owned land in a coastal wetland be kept out of development through regulation?

How should responsibilities be divided among levels of government? It has been fairly easy, in Washington, D.C., to decide that the states ought to bear the primary responsibility for coastal planning and management, while the federal government provides funds and local governments are given authority to regulate

minor decisions. It has not been as easy, in the state legislatures, to agree that a state agency should control development and land use in the coastal towns in the area of pollution management.

How should a state government's participation be organized? On the planning side, a state must decide whether to single out the coastal zone for intensive planning attention or to make a coastal zone anti-pollution plan as a consistent and integral element of a statewide land and water use plan. In organizing management and regulation, a state must decide whether to turn the job over to an existing agency, a new coastal agency or an inter-agency commission set up to implement the coastal zone plan. Another management concept would be "lead agency" for specific areas of management.

How far inland should planning and controls extend? Proposals range from the modest (e.g., to the line of vegetation or of extreme high water) to the ambitious (every county touching the coast, or the second tier of counties). In some states, the landward extent of the coastal zone will depend greatly on how strong the land use controls are.

How far seaward should planning and controls extend? For the state, the simplest answer is to extend the coastal zone program out to the limits of the state's jurisdiction — but those limits are presently in dispute before the Supreme Court. The Atlantic coastal states claim that their colonial charters, predating the Constitution, give them jurisdiction far beyond the 3-mile limit established by Congress. Should the federal arguments prevail, several states may still find it possible to expand their areas of coastal waters under the 3-mile rule. Particular attention should be paid to Supreme Court rulings which permit a state to "close off" — assume jurisdiction over — bays, gulfs and sounds under 24 miles in width. The bottom of the slope of the continental shelf could be used as a working definition of the seaward extent.

FEDERAL ROLE IN POLLUTION MANAGEMENT[1]

Three new federal environmental agencies, created in 1970, provide some useful and interesting parallels for state organizational change. The federal organization of its grants and regulatory programs is of further interest because it is a strong, if indirect, incentive on state governments to align their own agencies in a similar manner, in order to facilitate doing business with an increasingly powerful federal government. In addition to the structure of federal environmental quality agencies, the content of federal programs is important. Both the financial aid and regulatory aspects of federal programs have encouraged state governments to initiate and strengthen certain functional components of their programs.

On the first of these points, the federal government, recognizing some of the same institutional fragmentation and gaps that have troubled many states, created three new environmental organizations in 1970. Two of these organizations were formed by consolidations of existing environmental programs, and one new unit was set up to carry out a new function.

In the fall of 1970 the federal government consolidated its major pollution control programs into the Environmental Protection Agency (EPA), a new administrative agency with a regulatory emphasis. The main objective of this

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[1]The subject matter herein has been excerpted from a report by Elizabeth Haskell, Fellow, Woodrow Wilson Institute, Smithsonian Institute.

consolidation was to integrate pollution control planning and standards-setting, to avoid federal policies that merely traded one form of pollution for another variety in the environment. The reorganization was the product of extensive analysis by President Nixon's Council on Executive Reorganization, a special task force set up to study the entire federal executive structure. A separate reorganization process, which was begun in the Johnson Administration and culminated in 1970, consolidated air monitoring and research and smaller marine programs in a National Oceanic and Atmospheric Agency (NOAA). After much debate this new agency was located in the Department of Commerce. Earlier that same year, Congressional initiative resulted in the National Environmental Policy Act of 1969, which established the Council on Environmental Quality (CEQ) in the Executive Office of the President, to act as an overall advisory, coordinative and planning unit for environmental policy. Its purview ranges across pollution control, conservation, land use, population and other environmental issues. A second job of the CEQ is to increase concern for the environment in all federal agencies, although it has no enforcement mechanism to guarantee this concern.

While the genesis of each organization was different, and the main motives for their creation ranged from highly politican in the case of NOAA to strongly analytical in the case of EPA, each move was designed to redirect and integrate federal policy to focus on environmental problems in a more comprehensive way. The federal environment agency that is likely to have the greatest impact on states is EPA, because of its many grant and regulatory programs.

While the message in EPA's creation was consolidation, the internal structure of that organization implies that separate pollution program categories will remain, at least for the immediate future. Thus, states can expect federal pollution control standards and financial aids to be administered for the meantime as before, with separate programs for air pollution control, water pollution control, solid wastes management, radiation and pesticides. Within most of these categories, further segmentation of grants is made along functional lines. There are grants for planning, manpower training, construction, research and overall grants to support a state, local or regional pollution control agency. Analysis is underway within EPA to see if integration of these programs is merited. But today federal programs continue to encourage similar separately identifiable pollution control programs at the state level. State governments simply find it an easier administration process when doing business with the increasingly powerful federal partner, to structure their agencies to match federal ones. And, because states compete with one another for federal dollars, there is a tendency for many to believe that their share will be greater if the federal agencies can readily identify a beneficiary state program or organization similar to their own. Those states that do not have organization patterns that match the federal ones, such as in Illinois and in Washington's new Department of Ecology, may find some difficulties in relating to federal anti-pollution agencies.

While the federal structure has encouraged, somewhat unconsciously, a similar state fragmentation of environmental activities, the content of federal environmental programs has had many positive effects on state activities. Federal grants or requirements to set environmental standards have been incentives to states to strengthen their environmental management efforts. The level of federal financial aid for air, water and solid wastes pollution control programs increased sharply since the mid-sixties. This has directly influenced the size, scope and in

some cases the very existence of corresponding state programs. Many states' solid waste management programs, which are characteristically the smallest and newest of states' anti-pollution efforts, were initiated to receive federal planning dollars. Today, these federal funds make up the bulk of the states' expenditures for this purpose. Federal assistance for state and local air pollution control programs is larger both in terms of total dollars and percentages. In order to receive the various types of assistance, states have had to set up corresponding programs or redirect existing programs to match federal strategies.

State governments have also often been required to perform specified environmental functions, as a condition of a grant or loan. For instance, state-wide recreation planning is required to receive federal Land and Water Conservation Fund monies. More recently, river basin planning and state-wide assessment of waste water treatment needs will be required in order for a state to be eligible for Office of Water Quality grants for municipal waste treatment plants.

In addition to using financial inducements to persuade states to set up programs and take other environmental steps, Congress has in recent years levied on the states the statutory option to either set water and air quality standards or have the federal government do it for them. The Water Quality Act of 1965 issued such a choice to the states regarding establishment of interstate water quality standards and implementation plans. Similarly, until 1970, states were also asked to establish air quality standards in federally designated air quality regions, with the federal government taking over only if a state failed to act effectively. By the 1970 amendments to the Clean Air act, however, the federal government now sets the initial ambient air quality standards, with the states drawing up the plans to implement these pollution limits. Most states have had to initiate new activities or expand existing programs in order to comply with these federal standards-setting laws within the required time period.

Through the influence of standards-setting and granting procedures, EPA officials are reaching down more into state governments to set specific requirements for state water and air pollution control programs, and for their administrative structures.

CONCEPT OF A STATE ENVIRONMENTAL ORGANIZATION

When a state creates a structure of pollution control management in the coastal zone, it should make sure that local interests can be properly balanced against federal interests. I stress this balanced concept of pollution management in the coastal zone.

I have developed a conceptual framework which leads from the local through the state to the federal government (Fig. 1). When a state has adopted a working definition of the coastal zone, it should place that geographical entity under the jurisdiction of a "Coastal Zone Planning Management Authority". Reporting to the authority would be local planning commissions.

At the state level I would structure a State Environmental Protection Agency. This agency would serve the following functions: (1) would be the channel through which all federal monies, grants and regulations concerning pollution management would funnel; (2) would be the agency where all environmental impact studies would be administered within the state; (3) would be the agency through which all federal environmental regulations would flow to the various regional planning and management authorities within the state and (4) would be

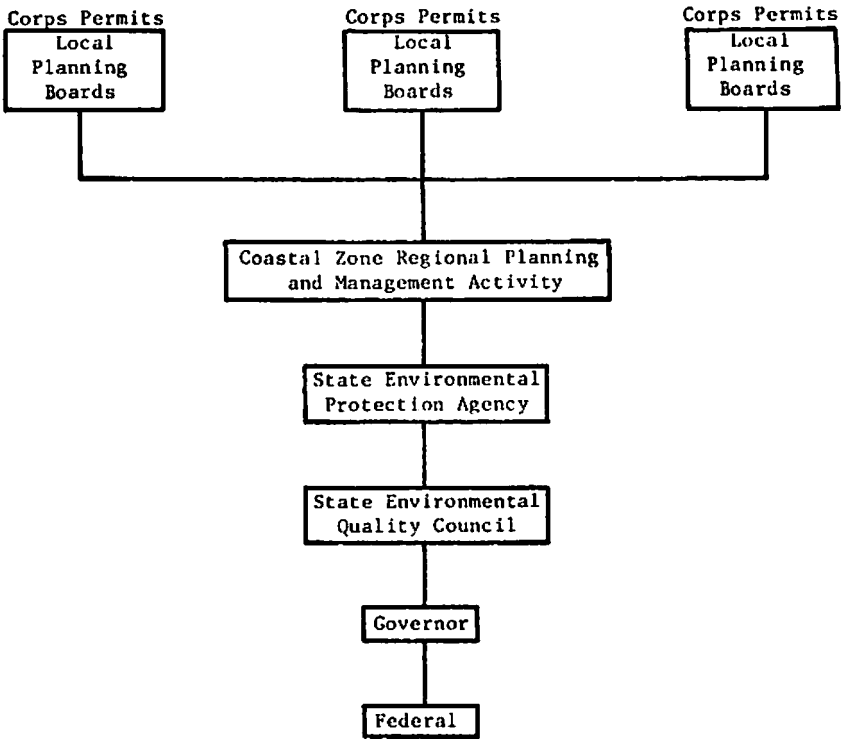

Fig. 1. A concept of a state environmental organization.

the agency through which appeals would funnel from the local areas.

The final structure which I believe is needed within the states is an Environmental Quality Council created by the Legislature and reporting directly to the Governor. This council need not be more than seven members. Its duties would be primarily that of an Environmental Grand Jury. It would adjudicate and recommend to the Governor courses of action where disputes have occurred between local interests and the federal government. Hopefully this would provide the proper balance which I have strived to structure in this paper where the economic, technical and environmental aspects of coastal zone management can be properly administered.

In structuring this concept within a state I have set aside the coastal zone as a distinct region because I believe that it is the area where the majority of environmental pollution problems now exist within the states.

In conclusion, I believe that the interaction of the states and local interests with the federal government will result in the pendulum swinging very shortly back toward the side where economic interests will begin to exert a profound effect in pollution management. The states must structure their organization where local economic interests cannot stymie the management processes in the state and federal government.

Lastly, I believe that an Economic Impact Statement should now parallel all environmental Impact Statements, and that both statements should be accorded equal priority by those who have the chore of granting or refusing permits.

Compatibility of Petroleum Activities in the Coastal Zone

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INTRODUCTION

Many of us who are part of the petroleum industry have been hesitant to take part in programs such as this. I think the big reason is that your industry — fishing — is one in which we have no particular expertise. Now we are finding that we must know more and more about the fishing industry and that's because the waters adjacent to the continental United States hold great promise not only for the fishing industry, but also for the petroleum industry. Your work in the offshore helps feed the nation's people. My industry's work in the offshore helps fuel the nation's economy. Both are vital endeavors.

Which brings me to the reason I came today. Your Executive Secretary said it better than I could when he was kind enough to note that I have taken the initiative "to come to the fishing industry to open lines of communications." In trying to open lines of communications between these two highly important industries, I think we can benefit by knowing more about each other.

Let me begin by putting the oil business in perspective. When Colonel Drake discovered oil in 1859, the average man in this country worked from morning till night with the modest hope of gaining little more than shelter, food and clothing for his family. Drake's discovery made it possible for us to expand our per capita use of energy—and our standard of living increased proportionately.

Figure 1 titled "Energy consumption vs. per capita income" tells the story. The United States is the top per capita energy consumer, and our per capita income is also number one among the major countries of the world. India, on the other hand, has the lowest per capita use of energy—and their per capita income is also the lowest.

UNITED STATES ENERGY DEMAND

Petroleum—oil and natural gas—supplies 75% of our energy requirements, with coal supplying most of the rest. Without petroleum, life as we know it in the United States couldn't exist. And just to maintain our standard of living, we will use twice as much energy in 1985 as we are using now. Energy demand in the United States doubled from 1950 to 1970—20 years. The next doubling will take 5 years less. By the year 2000 our energy demand will probably have shown a sixfold increase in only half a century.

The scale on the left side of Figure 2 indicates this nation's demand for energy in quadrillion BTUs from 1950-1985. The trends are the important feature. Trends in energy consumption are not unlike population trends and Gross National Product trends—they're up. In the case of energy, this continued increase in consumption has forced us to look to the future, to plan ahead so that energy demands can be satisfied. It is imperative that we have adequate supplies of energy to keep the nation moving. If we run short, who gives up what? Let's look at how energy is used in the United States.

We use it at home for heating and air-conditioning, for cooking, for running

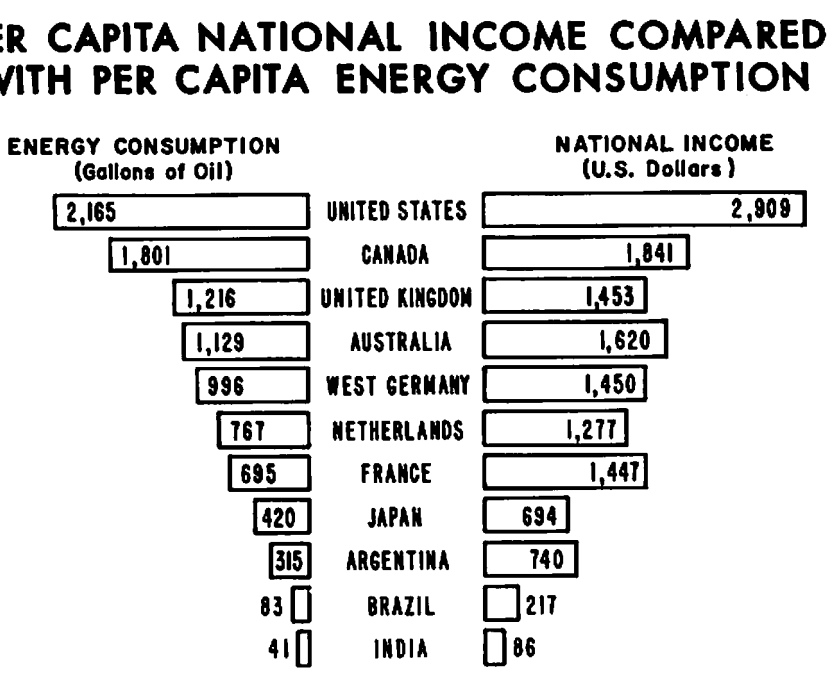

Fig. 1. Energy consumption vs. per capita income.

appliances. This is shown as Residential-Commercial, which also includes energy for schools, shopping centers, hospitals, this meeting room and similar establishments. About 23% of all energy used today and projected for 1985 goes to this sector.

Nearly the same is used in the Transportation area—cars, trucks, trains and aircraft.

By far the largest of the energy markets is the Industrial Sector. This covers energy required for process heat and equipment operation, as well as the raw materials for plastic, rubber, metallurgical coke and the myriad of other products turned out by the petrochemical industry.

Figure 3 (U.S. energy demand by fuel source) has the same arrangement as the previous one—but it shows the other side of the coin. It shows where we get our energy. Primarily, it's from oil, gas and coal. By 1985, coal will increase to 20% of the supply, and synthetics will be entering the picture. However, it is primarily nuclear power which will be expanded to fill the gap which would otherwise result from the sharp decrease in share of the market for gas; and by 1985, nuclear power will supply 11% of the total. That decrease for gas will be solely because of lack of availability.

FLORIDA ENERGY DEMAND

The national energy picture is made up of many pieces and parts. Since we are here, let's look at Florida which is a good example. We all know that Florida has strong economic incentives to help assure dependable sources of energy

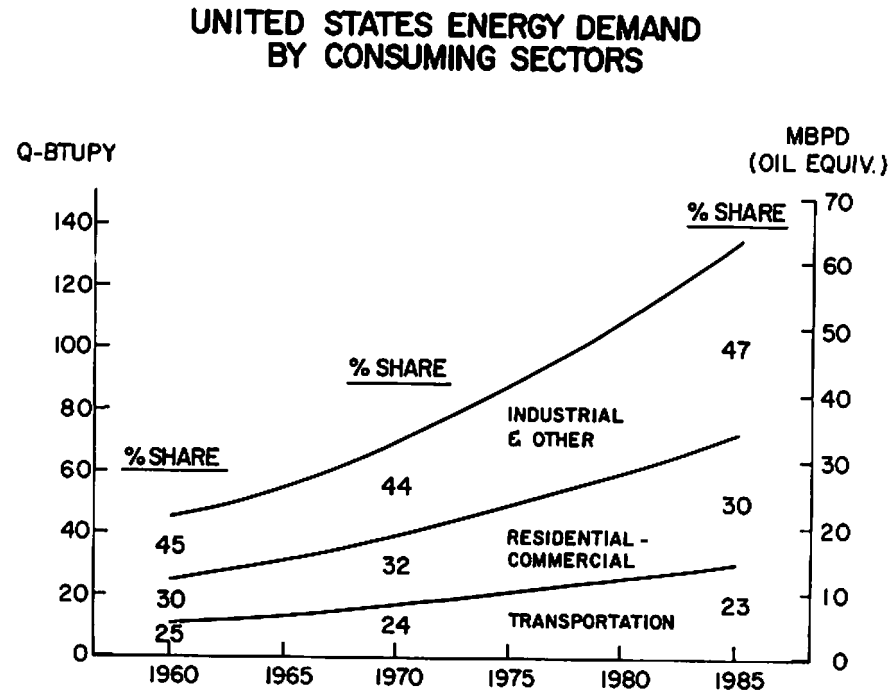

Fig. 2. United States energy demand by consuming sectors.

supplies. Consider, for example, that Florida is seventh among the 50 states in motor gasoline consumption and third among the 50 states in jet fuel consumption. No doubt the state's tourist trade helps push these rankings up in these two areas of energy consumption. Not only is the state dependent upon petroleum for gasoline and jet fuel, but also for 80% of Florida's rapidly growing demand for electricity.

On the supply side, Florida must get most of its energy from outside the state although there has been commercial production of crude oil at Sunniland Field in Collier County since 1943. Since then, about 300 exploratory wells have been drilled in Florida. Only recently, however, have the results been more than modest.

Last year (1970), the community of Jay in Santa Rosa County made headlines around the state (Fig. 4). An extremely significant oil find was made there in June. This discovery in the Florida Panhandle has sparked the hope of some—and the fear of some—that Florida can become an important source of energy production. By the spring of 1972, crude separation, sweetening and sulphur handling facilities will be capable of handling 26,000 barrels of oil, 26 million cubic feet of gas and 172 tons of sulphur per day.

The stakes are high. Florida already has a multi-billion dollar tourist industry. The petroleum industry could also be significant. Responding to a request of the Secretary of the Department of Interior, the National Petroleum Council has estimated that Florida and its adjacent continental shelves, not including the Florida Panhandle, may have future reserves of 7.8 billion barrels of crude oil

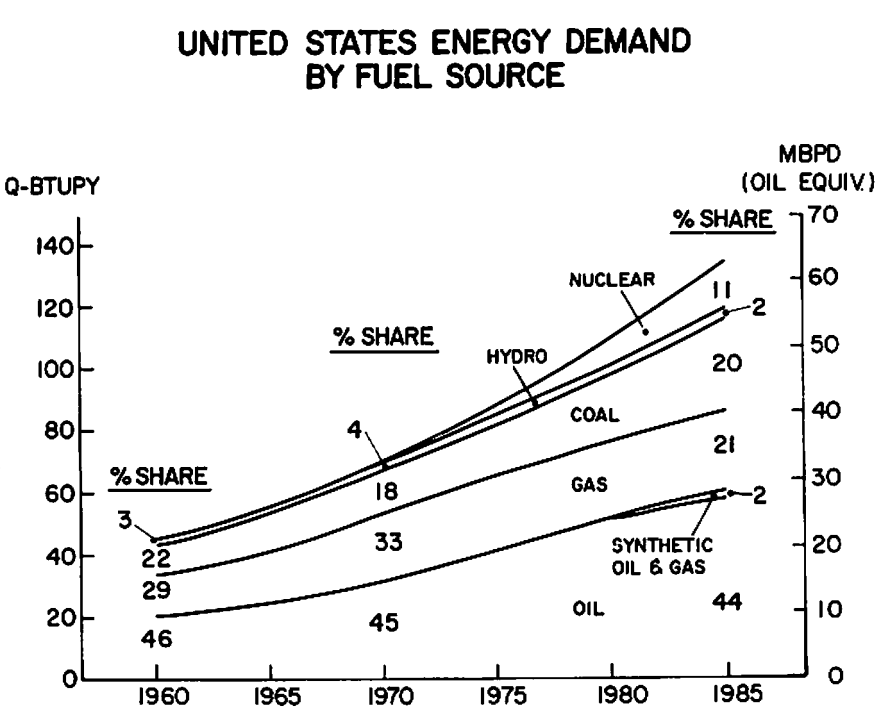

Fig. 3. United States energy demand by fuel source.

and 13.0 trillion cubic feet of natural gas. Although the Council provided no comparable estimate for the Florida Panhandle and its adjacent continental shelf, the Jay Field discovery may indicate that this area is equally attractive. However, it must be noted that estimates of this nature are made without regard to critical factors of timing, technology and economics.

COMPATIBLE USE

That brings us to the crucial question. Can coastal states have tourism and fishing and oil? Or will one drive out another? I submit strongly that there is no need for either/or decisions. Our decisions must be based on this simple premise: Land areas and coastal zones—whether in Florida or any other state—are natural resources in and of themselves. We must plan wisely for their use. And this planning must recognize that with very few exceptions, several diverse activities can coexist in harmony if the concept of compatible use is applied to their management.

Compatible use is a flexible framework of use priorities designed to achieve the greatest long-term social and economic benefits. Compatible use means that if one use is paramount, other uses should be permitted to the extent that they do not unreasonably interfere with the dominant use.

For example, let's assume that fishing is the paramount use in offshore areas. Should oil exploration and production be permitted? Yes—provided, of course, that the oil activities do not unreasonably interfere with fishing. In Louisiana,

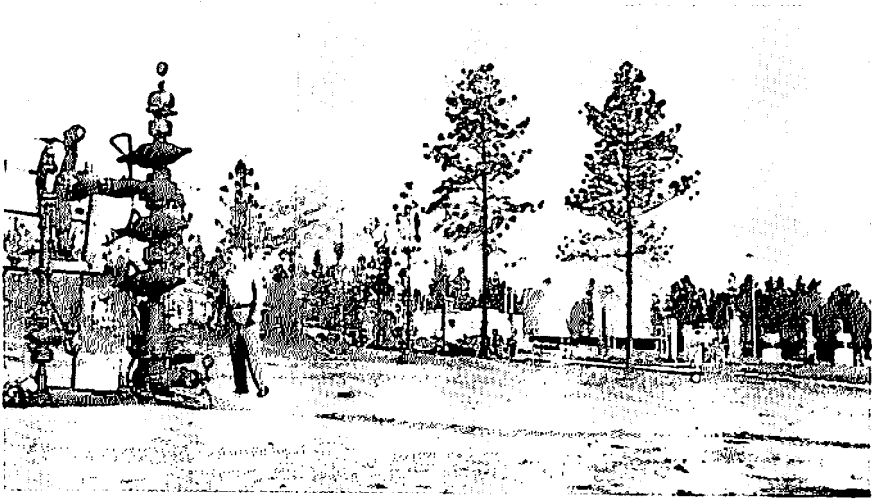

Fig. 4. Jay Field discovery well and plant.

where the picture in Figure 5 was made, there has been a long history of compatible use between fishing interests and oil operations. At times there have been disagreements, but these have been family-type arguments—similar to those we might have with our own families. But we can also point to many, many examples of giving each other support. At the recent environmental hearings in New Orleans, the fishing industry furnished strong support for offshore leasing off eastern Louisiana.

I fail to see how we can disagree on this concept of compatible use—up to now. The conflict comes when we discuss "unreasonable" interference. Are

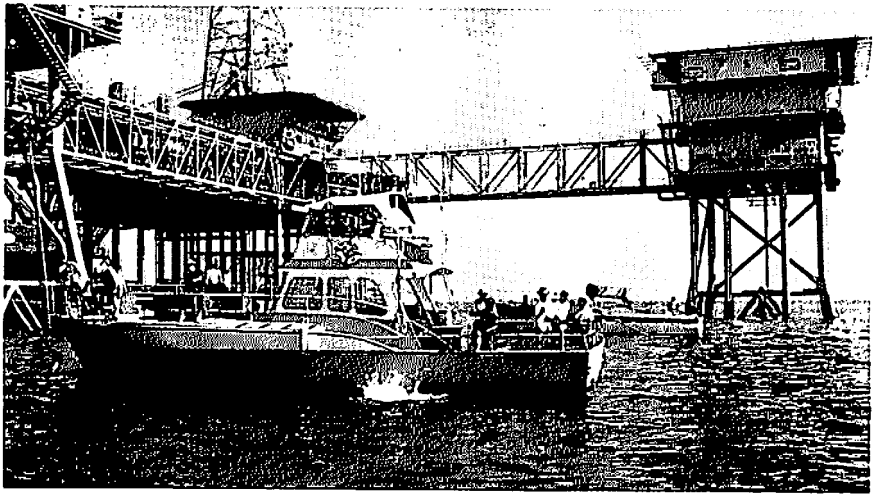

Fig. 5. Fishing boat at platform in offshore Louisiana.

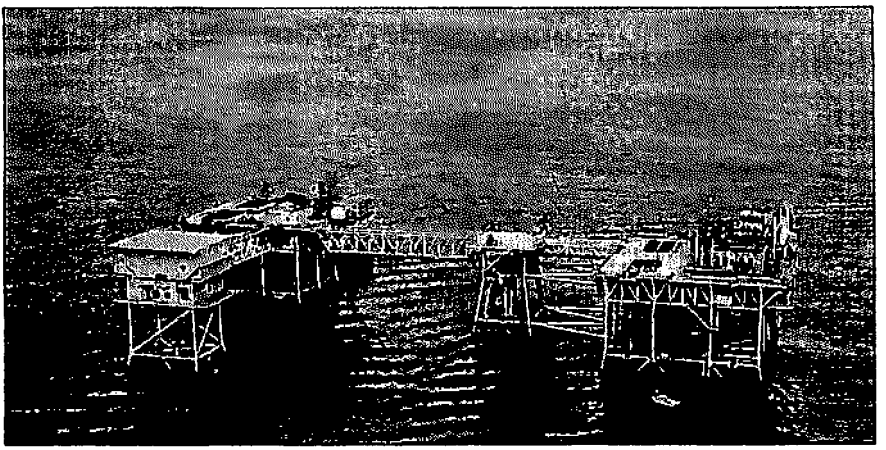

Fig. 6. Offshore platform.

platforms (Fig. 6) in your traditional trawling lanes an unreasonable interference? What about oil spills?

Let's examine this. If an offshore platform is in your way—it's in your way. There can be no question about that. But is this unreasonable interference with fishing—or is it an inconvenience? In the Gulf of Mexico offshore Louisiana, there are more than 17 million acres of surface area out to the 600-foot water depth. All of the oil production platforms offshore Louisiana take up 378 acres of surface area. In other words, for every acre our platforms occupy, there are some 45,000 acres to fish in. Only you can judge if that is an unreasonable interference with your operations. There are others who have opinions about offshore platforms. Some people don't like their looks. Sports fishermen sing their praises. Platforms also serve as navigation aids and provide a haven in times of distress.

Let's consider oil spills. If oil is spilled in sufficient quantities to drive fish from your fishing areas, then that is certainly an unreasonable interference. Those who get beyond the news headlines know that the oil industry has not harmed fishing. More than 14,000 oil and gas wells have been drilled on the marine margins. We have had six blowouts involving oil, only three of which were reported to cause severe pollution.

And none of these were the environmental disasters many thought they would be. The fishing industry is still going strong off the coast of California and in the Gulf offshore Louisiana. Many scientific studies of Santa Barbara, Louisiana, England and other locations have shown any damage from oil spills to the marine environment to be temporary and the affected areas have recovered well.

Fish and shrimp catches are at record levels in the Gulf (Fig. 7), and commercial fishing has increased substantially in the years since 1947 that oil operations have been carried out offshore Louisiana. The waters off Louisiana are attracting fishermen from other states—including Florida—and from other nations. Obviously, we can't claim to have aided commercial fishing and we do not intend such an inference, but we see no indication that we have done anything to harm it.

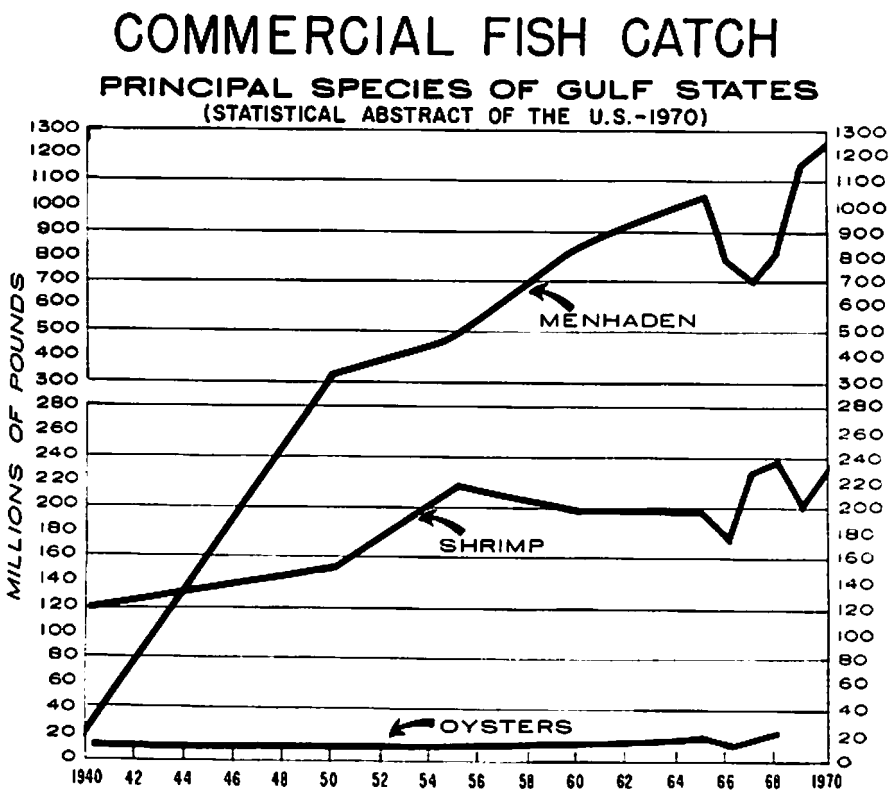

Fig. 7. Commercial fish catch—principal species of Gulf states.

Actually, our platforms have the same attraction for fish as do natural reefs. Such marine life become attached to the structures and they attract larger fish. It is more than coincidence that Louisiana's sport fishing industry has grown almost in direct relationship to the increase in offshore petroleum activities.

Two concerns fishermen have had will not be problems in new areas of operation. One is the use of dynamite for seismic work. We no longer use dynamite. The tools we use today have impulse-type sound sources which provide equally good or better results. The resulting sound signal neither harms nor frightens fish.

Another concern has been underwater obstructions on which shrimp nets could be snagged. The law which required our leaving exposed structures on abandoned wells in the offshore has been changed. Off Louisiana, significant progress is being made in removing, buoying or covering with a platform these remaining stubs. This work is expected to be completed by the summer of 1972.

SUMMARY

Now, let me summarize the points I think are important to all of us:

(1) We are in a time of transition in energy—from an historic surplus of domestic energy to a current situation in which domestic supplies will not be

adequate to meet our needs.

(2) This "gap" between domestic supply and domestic demand, which must be filled by imports, presents serious problems of security—not just military security, but economic security. Foreign wars not involving this country, political disruptions abroad and breakdown of distribution systems overseas are a few examples of events that could cause interruptions of supplies to this country. Even short-term interruptions of supply could result in severe limitations on our supplies of fuels for transportation, heating and manufacturing. Economic disruptions in this country would follow.

(3) When we look at the current situation with respect to each type of fuel, we find that with coal, nuclear, hydro and natural gas producing at maximum capacity during the next 15 years, oil and natural gas still must supply two-thirds to three-fourths of the total demand. Since domestic oil production is virtually at capacity now, we will have to rely more and more on imported oil—and there will be accompanying security problems since most of the growth in imports will be filled from Middle East sources.

(4) Even so, the domestic energy supply picture can be improved—we can reduce to acceptable levels our dependency on foreign energy sources. This is a vital point: We can maintain reasonable self-sufficiency of energy supply if we all work together. One of the first things we need to do is find more oil and gas here at home. We in the industry find it of great concern that some states are taking the attitude that "you can explore and produce oil elsewhere, but don't explore and produce it in our state. We want you to supply us with the products, provide us with the energy, but we do not want the activities taking place here." On the other hand, we find a trend among other states to the effect that "if you want energy, if you want natural gas, if you want petroleum products, then move to our state and we will supply it here for your industries, but we do not wish to ship our energy out of state." We've come to the point in time that neither of these approaches will serve the nation's interest.

(5) It is in the offshore areas where significantly large reserves of oil and gas are to be found in the United States. This can put the fishing industry and the oil industry on a collision course—or, it can make us co-users of the land and the sea for the good of all.

(6) Results to date and geologic evidence indicate substantial undiscovered petroleum potential in Florida—both onshore and offshore— and other states have undeveloped offshore petroleum potential. We believe the national interest—and the interests of these states—requires that these potential petroleum reserves be explored and, if found, developed.

(7) Our industry is well aware that we deal in a commodity that can pollute at any time if it is accidentally spilled by us, by a shipper, or by any user of petroleum products; and we cannot now or is it likely that we will ever be able to give a 100% guarantee that we will never have an oil spill; however, we do believe that we have a high level of the required technology to discover and develop these resources in a compatible manner that will properly protect the environment and be acceptable to other private interests and the public.

The real challenge, I believe, is to keep the lines of communications open for frank and honest discussion of mutual interests.

That's what I have tried to work toward today—and I would welcome further visits with you to provide additional details where that would be useful to you. And, we want to know more about the fishing industry so that we conduct our operations in harmony with yours.

The Threshold of Environmental Reason

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It was about 4 years ago that I appeared at your Institute and presented the current environmental views in a paper that was later entitled the "Environmental Horror Story," and I believe that it was. It was rather widely reprinted, and at the time I believed that it might have had a small part to do with the developing awakening of the public relative to the environmental crisis in our estuaries.

At the present time, I look with amazement upon the results of such early efforts, and feel very much like the fellow who has a bear by the tail. What so many of us had advocated for years has occurred, and now the public is only too well aware of the environmental situation. The environmental theme has crept into political campaigns, bureaucratic reorganization, industrial migration, television programming and even the "woman's lib" movement. When objectively viewed, it closely resembles a nest of fire ants when stirred with a stick.

Upon the announcement of another environmental crisis, there are so many federal, state, county, city and private groups rushing to the rescue that the environment is trampled underfoot in the effort to save it. By the latest figures available there are over 260 chartered national organizations who regulate, review and direct various programs relative to the environment. Add to this number the agencies, bureaus, branches and sections of the municipal, state and federal government and some idea can be had of the fecundity of the environmental movement.

The reptilian monsters that once wandered across the earth's surface eventually disappeared because of the food and mobility problem. It may well be that our environmental movement is developing the same category. This is best exemplified by the threadlike path that an environmental statement relative to a proposed project must traverse on its route from inception to completion.

Naturally, field data will have to be accumulated and collected. This will involve the services of geologists, economists, engineers, hydrologists, biologists, statisticians, development planners, soil conservationists, sanitarians and historians. For even a small project the time involved is a minimum of 6 months. Once the field data is obtained it must be assembled and conclusions drawn from the information presented. This involves another 2 months. Once the statement is written, it is reviewed by the respective administrative echelons within the initiating agency and any one of these echelons can demand a revision. When the statement finally has organizational approval, it is sent to the coordinating agencies for their review. For most projects the number of agencies involved in this stage are at least eight federal agencies, six state groups, plus an untold number of private groups who feel they have an active interest in the project. Altogether, the statement will be reviewed by at least 20 coordinating groups, and within each of these groups, there are at least five or six individuals who give it their personal attention.

Upon completion of the coordinating agency reviews, the statement is returned to incorporate any suggested changes developed by other agencies, or

to explain why such suggested changes were not made. This portion of the program will take at least another 3 months, and it now starts its path through the same maze of officialdom for a review of the review. This operation can be expected to last another month and upon the termination of this stage, it heads for the President's Council on Environmental Quality. The above notwithstanding, when a project has finally cleared the last hurdle, received the last review and gets a stamp of approval, it has been reviewed by various professional personnel innumerable times, and has taken a period of time no less than a year and a half.

Legislatively, environmental considerations have been inundated by laws, regulations, acts and program directives. There are so many of these dictums that it is nearly impossible to determine which of them should be followed on any particular project. There are over 40 national or federal statutes and orders, and 26 major directories ranging from the Department of Agriculture to the Department of State, all of which have designated environmental responsibilities. Each type of environmental problem has a myriad of responsible groups that are actively responsible for that particular problem. Land use and management problems, for instance, are assigned to 11 federal agencies. Each individual state has an involvement when such problems are within its boundaries, and each agency involved has its own set of rules and regulations relative thereto. It is unfortunate but true, that the most qualified people in our country are so busy with portioning out the problems to the right group in order that no-one will feel neglected or overlooked, that they have little time to solve the problem itself.

All this public hue and cry is a bit humorous to those of us, who prior to 1965, have had the distinction of being laughed out of meetings because we said water pollution was becoming a problem. Perhaps this is why many of us look askance when some "johnnie-come-lately" is quoted as a foremost authority on this, that, or the other. Truth and popularity do not always go hand in hand, but it is amazing to see how many environmental crusaders and authorities have emerged from the woodwork now that environment is a popular cause.

This speaker made a trip into a controversial area, and in one day alone was able to count at least ten alligators, three bald eagles, flocks of limpets, thousands of bass and other game fish on their beds, as well as otter, beaver, reptiles and wading and shore birds. Botanical specimens ranged from cypress trees to wild orchids. Imagine the speaker's amazement when he heard this area described as a natural disaster area by an official of that state's game and fish commission. Personal desires to ride in the front seat of the environmental popularity wagon are having a chaotic effect on the long-range integrity of both the agencies or institutions involved, as well as that of the individuals themselves. Recently, a federal agency requested a state institution to undertake a study of alternate waste-water disposal systems for the city of Chicago. Much to the disgust of many of us, certain staff members of this institution refused to do the investigation because they did not agree with some of the past programs of the initiating agency. The fact that over a million and a half people were needing this solution apparently was of no concern. What did seem to concern them was the fact that in doing this work they might be considered as being "outside the circle" The only commitment demanded of this study group was an honest investigation followed by an honest report. It was a clear case of what some people consider to be the more important, an answer to a critical environmental problem, or a nebulous object such as popularity and classification as "one of the boys".

In an effort to get something done, many have adopted the old reliable solution of "When in question, or when in doubt; run in circles, scream and shout."

One of the first efforts in this direction resulted in some figures that will remain as classic. Realizing that boats in many cases do not have on-board sewage treatment, it could be assumed that boats were contributing a great deal to the total pollution problem. Some aspiring statistician took the problem in hand, and with his computer under one arm, and his statistics under the other came up with a hum-dinger of a revelation. The report stated that there were 1.3 million marine toilets in use among the 8 million pleasure boats in the United States. Investigation by the National Association of State Boating Law Administrators, who doubted this figure, revealed that all the marine toilets ever made by all the manufacturers combined only amounted to a number between 500,000 and 600,000. If all those were still in use, which is doubtful, it would still fall far short of the reported 1.3 million.

The report also concluded that 81% of all sailboats were under 14 feet, and 50% of these had marine toilets. The most popular sailboat ever built is the 14 foot Sunfish with over 80,000 units on the water at the present time. According to the report analysis, 40,000 of them, or 50% as stated, have marine toilets.

Unfortunately in our effort to cure our environmental ills, we have been treating symptoms and not disease. As usual when this is done, other side effects have developed that threaten the patient to a degree equal to, if not greater than, our original concern. The two fundamental factors responsible for our environmental condition are over-population and over-concentration of that population. Correlated with this is the general desire for what we have come to consider as the necessities of life.

In association with a greater population comes one of the more critical problems of our times, that of energy shortage. This decrease of available energy per capita is increasing every day. Now once again, some of us are finding ourselves in a position where we can be hooted out of a meeting. As with the pollution problem of former years, no-one wants to be one of those advocating the development of more power resources. Nuclear power creates atmospheric pollution and thermal problems. Fossil fuel plants develop the same ogres, and hydro-power is a nasty combination of two dirty words. If, however, you believe that there was a noise when there was a fish kill on the local river, wait until you hear the bedlam that will insue when your wife has to cook Sunday dinner on one burner because there is not enough heating power to go around, and this is as much the environment as is clean water, wilderness areas and pure air. I never expect to visit all of our wilderness areas, float down all of our wild rivers or fish in all of our preserved streams. I do, however, expect to take a hot shower, eat a warm breakfast and enjoy a cold drink just about every day of my remaining years. I, for one, do not intend to revert to a nomadic, Indian-like, child of nature existence as some would have us do.

At the present time, I am told that the demand will reach three times the amount now available. To meet the demand, in face of more stringent environmental restrictions, is going to be a problem for the power industry to meet and solve.

If we who are associated with, and interested in our environment are to arrive at objective conclusions and programs, we must go deeper into the problem than the treatment of symptoms. This is especially true to those of us whose interest is centered along our coastlines. The highest concentration of populations lie

within 35 miles of our nations coastlines, including the Great Lakes. These areas are where overpopulation and overconcentration are the most apparent and the most pressing.

As for decentralization of the masses, the future is dim indeed. Unless one believes in genocide based on geographical distribution, the only alternative is arbitrary assignment of locale. To this system, most of us would violently disagree. Most of us still want to feel that we have some choice relative to where we are going to live and what we are going to do for a living. I would hate to feel that I could be told that in the morning I would be moved, lock, stock and barrel, to Oklahoma, even if I have nothing against Oklahoma. I just don't want to live there, and above all, I don't want to be told that I must live there. In the meantime, however, these pressures and problems keep growing, and the solutions do not appear to be in the number of ducks we save, the fish we catch or the wilderness that we have preserved.

The time for the popularity footrace is over. We must now get down to the nitty-gritty and see what we can salvage from this environmental orgy. There are some serious questions that must be answered, and some conclusions that must be reached. In essence, environment is the key factor in the social organization of mankind. We must decide now what our objectives are going to be, and then take the steps to attain those objectives. The problem of mercury and other materials in our seafoods is a good illustration of this blind wandering. As of this date, I have yet to hear of any scientist who can positively state that this presence of noxious materials in our deep-water fish is due to a sudden increase in mercury content in the fishes' environment with a resultant absorption of the material into the system of the fish, or is it now detectable because of the improved techniques for determination of the material in more minute quantities? If the latter case is true, and I for one am prone to believe this situation, why all the fuss? It can be easily demonstrated that the poundage of swordfish landed in the United States went from 2,700,000 pounds in 1968 to 600,000 pounds in 1970. At the same time, the population of the United States rose from 179,223,000 in 1960 to 200,000,000 in 1970. This means that the national average of available swordfish per capita went from .01 pounds per person to .003 pounds per person. If only 25% of the people in the United States ate swordfish, this would still mean that there would be but .012 pounds per person consumption. In other words, there were not enough swordfish available for a person to eat enough to have a tiny trace of mercury poisoning, and yet, an entire industry was dashed to pieces because of the apparent desires of some to have us live in a near sterile environment.

Take the case of pesticides in milk. Some authority said that if an expectant mother drank milk with the formerly acceptable levels of pesticide in it, it would, or could, result in deformed children. This is true, but no one said how much of the milk she would have to drink. So, someone did figure it out. Based on the acceptable maximum amount of pesticides in milk, according to the former standards, an expectant mother would have to drink around a hundred and some gallons of milk per day, every day, for the last 6 months of her pregnancy, and then something might happen in the way of a child deformity, but even that couldn't be promised. The only thing that could be stated was that if a pregnant woman drank 27,000 gallons of milk in 6 months, something was sure to happen.

Use of this example does not mean that anyone condones the proliferant use of pesticides. The point that must be made is that sensationalism can no longer be acceptable.

The problem of impounded waters as compared to free-flowing streams is an enigma to an honest fisheries biologist. Faced with an expanding population which results in an increased use demand for recreational waters, as opposed to those who feel that a free flowing stream must be preserved for their own personal enjoyment, the fisheries manager is in a quandary. Should he provide for the majority of the water recreationalists, or should he provide for the much smaller group of purists. I don't have the answer, and I doubt if any honest fisheries biologist will admit that he has. There can be no answer, outside of personal desires, until our true national objectives are ascertained.

By definition, which is so specific that many of our modern ecologists would rather forget it, environment is the complex of climatic, edaphic and biotic factors that act upon an organism or an ecological community and ultimately determine its form and survival. Note that this includes the entire complex, and not only those particular segments thereof to which the individual has a special interest. As I have attended the meetings of various organizations with all sorts of initials for names, and slogans for titles, it is only too obvious that this grass-roots movement among the people themselves has made this strong environmental movement possible. In one evening, I have heard an obviously well-educated, well-cared-for, enthusiastic woman stand before the microphone with the ease of a veteran politician and proclaim the need for the protection of a river or a wood-lot. I have heard her state that the environment should be protected and in so doing, list the considerations that are needed. At the same time, however, her own son is driving around in a powerful automobile, adding to the air pollution problem. The automobile was given to him in return for a promise to get his hair cut, stay in school and stay away from drugs. This kid, his haircut, his automobile and his drug problem, is an environmental problem as much as is the wood-lot or the river she is trying to save. Perhaps, both she and her husband should try to solve their own environmental problem before they venture forth into new fields.

My neighbor, a well-meaning soul, is going full-out in an attempt to keep a park in a certain location. He is the first to loudly proclaim that we must clean up the environment. You should hear him complain, however, when the county assessed us all an additional $5 a month to pay for a new sewer system.

The environmental picture of today is a 100% operation. The fault of undesirable environment lies 100% on someone else's shoulders, and the solutions lie 100% within each person's own personal improvement program. In all the years I have been working with this problem, I have yet to talk to a pollutor or an environmental miscreant. It is always the next fellow down the river or up the river.

We had better stop kidding ourselves. The guilty persons relative to environmental ills are you and I. We have lived too long on an artificial biological platform. We have ventured too far from basic and fundamental biological laws. The fundamental precept of survival of the fittest has been replaced by the system of protection for the weakest. How long would the people here assembled continue to survive if all the insulin were taken away from this group, if all eye-glasses were broken, if all dentures were destroyed, if all anti-biotics were eliminated, tranquilizers taken away, and the various other physical, mental and spiritual crutches taken away? Should we do just that in order that we reduce our problems to the fundamentals? Not by a long shot. No one in his right mind will pull the bung from the barrel of life and not expect to suffer therefrom.

The human race has been just about two jumps ahead of mass removal for some time. We are in a race for survival with nature as the competitor. It is very much like the tortoise and the hare. Nature keeps grinding away at a slow but steady pace while we scamper all over the place. For every pesticide we develop, nature develops a pest that is not affected. For every disease we conquer, nature develops a strain that can hit from another angle. We dare not stop, for natural laws will never stop.

If we are to continue to exist on a level that we can accept as tolerable, we must stop being two forces, one of the idealistic and the other materialistic, and combine our efforts. Things will never be as pristine and pure as we would like to have them; they never have been, in spite of what some would lead you to believe. At the same time, we must refrain from trampling those desirable characteristics underfoot in the name of materialistic progress. The true solution to our environmental problems is not going to be easily come by. It is going to require sacrifices from all sides. When a compromise is reached, then progress will be made in all directions.

The best comparison of the situation at present can be made relative to sailing. In a stout breeze, when reaching for the mark in a race, it is a great temptation to let the boat keel over, enjoy the thrill of riding the high side, watching the spray fly and the sound of rushing water. It sounds good, it looks good, and makes a big impression, but it is not winning races. You should keep the boat on an even keel, let the sail take full advantage of the wind, and let the hull ride over the water and not plow through it. In so doing, you get all the factors working together, and so it is with the environmental situation. If we can get all the factors working together by recognition of the fact that suitable total environment is everyone's problem, responsibility and objective, we can produce what we want to produce in an environment in which we can all enjoy living. Now is the time to assign a true value to all of our total environmental factors. The time for logical and considerate solutions is at hand, and we must not wait too long and waste too much time in useless name-calling before we confront the problems before us. As was said, "Let us go forth together."

Florida's Rationale for Coastal Zone Management

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The coastal zone of Florida is the state's most important and valuable asset. It contains the richest and most diverse combination of plants and animals, is the focus of our industrial and economic activity, and attracts the vast majority of our visitors and new residents. In fact, over 70% of our population is concentrated in only 16 coastal counties, and these, for the most part, are clustered along the narrow coastal fringe. If present trends continue, the coastal counties will contain over 10 million residents by the year 2000 — only a generation away.

This growth, however, is not without side effects. Man does not hold a monopoly on the coastal zone; he is, in fact, an intruder into an area that, through the functioning of countless natural checks and balances and millions of years of evolution, became one of the most biologically productive areas on earth. But the fragile strands that make up the web of checks and balances were woven by forces of nature, without interference by man. Thus, when the weight of man's activities are thrust upon one strand, repercussions are often felt in portions of the web quite remote from the area acted upon, and may remain unseen until other strands break under the stress. Unless strands can be rewoven, by nature, the end result is complete collapse of the system.

The wide range of effects of man's activities in our coastal zone is rudely illustrated throughout Florida. Attempts at flood control and land development have amplified water shortages in the Everglades and pose a threat to estuarine resources dependent upon receipt of fresh water in the proper amounts, quality and timing. Escambia Bay suffers repeated massive fish kills because of secondary effects of man. Boca Ciega Bay was sacrificed for houses. Miami River, Lake Worth, Banana River and the St. Johns are open sewers, in danger of being destroyed completely. Major shellfish beds are now unsafe to utilize; others have been killed outright. Once popular swimming areas can no longer be used. Development has caused severe erosion of many of our once-beautiful beaches. . . . The list goes on and on, interrupted occasionally by uncoordinated stop-gap remedies instituted by single-purpose agencies.

The solutions to these problems do not require condemnation of all developers and industry. Neither do they call for a house-cleaning of all governmental agencies. What they do call for, however, is an awareness of the trends that have developed, anticipation of consequences resulting from the trends and the creation of a system for altering trends toward more favorable end products.

The state now has a number of tools that can be utilized to help alleviate adverse effects of coastal development. These tools, although inadequate in several respects, provide Florida with a relatively good foundation upon which to build an effective coastal zone management program. Some of the primary ones include:

State control of most submerged lands and water column use — results in permits and/or leases for such activities as bulkheading, dredge and fill, docks, aquaculture or living and non-living resource extraction.

Beach development control — designed to prevent construction practices, even on private property, which might induce or accelerate erosion of Florida's beaches.

State establishment of water quality standards — this action, though subtle in character, can have very wide-ranging repercussions on coastal development, for any activity that may degrade surface water quality is subject to regulation.

State establishment of special use areas — includes the Aquatic Preserve System, State Wilderness System, Parks and Wildlife Refuges.

In spite of the many tools Florida has to work with, it has become apparent that past coastal zone management efforts simply are not adequate to the task. There are several reasons for this, but the primary ones are that past efforts, for the most part, have been too narrow in scope, uncoordinated and reflect the limited interest of the individual agencies involved. They have primarily been reactions to problems that already exist. There has never been a serious attempt in Florida to analyze at the state level the resources of our coastal zone and the demands on those resources and to comprehend the interfaces between various land uses, water uses and the natural environment. Such analysis and understanding is a basic step toward realizing orderly development and optimum use of our coastal areas.

The Florida Coastal Coordinating Council, which was created by the 1970 Florida Legislature, unites in one body the directors of the three state departments with primary concern for the coastal environment, namely the Department of Natural Resources, Department of Pollution Control and the Trustees of the Internal Improvement Trust Fund. The Executive Director of the Department of Natural Resources serves as chairman. The Council, which has its own staff, has four primary assignments: (1) develop a comprehensive coastal zone management plan for Florida; (2) coordinate state coastal zone research; (3) coordinate federal, state and local agencies with responsibilities in the coastal zone and (4) act as a clearinghouse for coastal zone information.

The key words in these charges are research, coordination and plan. Accomplishment of these tasks will allow the state to make crucial policy decisions based on facts, in advance, rather than reacting to individual problems after they occur. It is important to note that, even though the Council is placed under the Department of Natural Resources, it is inter-departmental in its functioning. This allows maximum input from those agencies having a direct interest in the coastal zone, yet prevents domination by any one interest group. It is also important to note that the Council's efforts will involve a continuous program, rather than be stop-gap in character.

In order to carry out its charges, the Council adopted a set of general guidelines to be used in management efforts in the coastal zone. These are as follows:

The Coastal Coordinating Council is to be considered the future coastal zone authority for Florida as the term is used in pending Federal legislation.

The principal consideration in all coastal resource use allocations will be maintenance and, where indicated, improvement of environmental quality.

Public interest will be the primary consideration against which all uses will be measured.

Policies and criteria will be established to provide joint use of resources by compatible activities and for allocation of exclusive use by non-compatible activities.

All criteria established for allocation of coastal resources will provide for maximum retention of options for the future.

The Florida Coastal Zone Master Plan will promulgate policy and criteria as guidelines for regional and local planning for allocation of local coastal resources.

Past resource-use planning has lacked coordination, comprehensiveness and follow through. It has generally been centered around straight-line projections of population growth trends and per capita needs. After projecting these needs to a certain point in time, we have usually tried to determine the most technically and economically feasible method of meeting the demands, whether it be inter-basin transfer of municipal water supplies, creation of reservoirs, construction of highways, acquisition of recreation lands or development of nuclear power plants. The President's National Goals Research Staff addressed itself to the results of such actions:

> **"Historically we have tended to do that which was technically possible, if it were economically advantageous, on the simple ground that this represented 'progress'. However, as technology has increased with great rapidity, it has forced on us increasing unplanned social and environmental problems we did not anticipate and do not want."**

This procedure is problem solving by reaction, or at best by projection, and has been a major cause for many of Florida's social and environmental ills.

Realizing that planning on the basis of projected population increase or on contemplated increase is frought with a multitude of built-in perils, the Council has decided to attempt a relatively new approach to the problem. This approach does not concern itself primarily with anticipated conditions by the year 2000 or any other time frame. Rather, it attempts to determine the type and degree of use that the various portions of the coastal zone can withstand without degradation of its basic resources. With this approach, planning will consider the "optimum" conditions and then support measures which will help obtain them, whether it be city size and shape, population distribution or direct allocation and use of resources.

Unlike previous planning approaches that often actually encouraged continuation of past trends and subsequent unnecessary destruction of resources, the Council's approach attempts to alter trends by identifying those areas especially sensitive to development; those areas where limited development is compatible; those areas where carefully guided intensive development can occur without serious consequences. By basing plans on the use tolerance of the land and water resources, and providing a mechanism for analyzing and solving conflicts, serious second and third order consequences of development within our coastal zone can be avoided or at least anticipated by those responsible for decision-making at the various levels of government.

One of the first problems encountered by the Council was to decide on a working definition of Florida's coastal zone. As defined in the creating state bill, "coastal zone means that area of land and water from the territorial limit seaward to the most inland extent of maritime influences." Speaking in very general terms, this definition seems fairly reasonable. But speaking in terms of coastal zone management, such an area defies delineation. If maritime influences on the atmosphere are considered, this area would include all of Florida. If considerations are restricted to the most inland extent of salt water surface flow, then management efforts are far too narrow in scope. It is obvious that, for working purposes, the most favorable boundary location lies somewhere between these two extremes. The Florida coastal zone has been defined on the basis of selected Census Enumeration Districts with the inland boundary varying from approximately 5 to 25 miles inland from the coast or from the shoreline of

estuaries. The use of the Census Districts allows planners to use census data giving population totals, distribution, housing and income patterns. No other system of defining a coastal zone allows such ease in utilizing available statistics and computer support.

In recent years, man's understanding and appreciation of environmental sciences has increased to the point of realization that certain shoreline areas must be preserved in their natural state if marine resources and the quality of life in Florida are to be maintained. Working on this premise, the coastal zone of Florida may basically be classed in one of three general land and water use categories: (1) Preservation — no development; (2) Conservation — limited development and (3) Development — intensive development. It is felt that this scheme is general enough to allow local government to perform adequately, yet specific enough to encourage wise use of our coastal resources.

The primary areas of concern to the Council will be those designated as preservation or conservation. Within these areas, state criteria and guidelines should be relatively strict and will emphasize maintenance of future options. On the other hand, areas designated for development with certain exception will be subject primarily to local and state controls now in effect or created for purposes other than direct management of natural resources. The Coastal Coordinating Council, working with an interdisciplinary team, is developing the criteria for defining such areas.

Preservation areas are recommended to be protected from any further development except in extreme cases of overriding public interest authorized by the Cabinet or the Legislature. The preservation concept includes considerations of ecologically sensitive flora and fauna as well as fragile topographic features such as beaches, marshes and dunes. Included are historical and archaeological sites and any unique environmental features peculiar to the region such as selected springs, caves, waterfalls and reefs. This resulting environment would offer enhanced aesthetic values, recreational opportunities and substantial hurricane protection to the residents. It is further recommended that this be a state-level zoning responsibility because of the often intensive development pressures brought to bear at the local level.

The Council has selected the Escambia-Santa Rosa counties of western Florida as a pilot study area in which to work out the format and methodology to be followed in developing a coastal zone management plan for the entire Florida coastal zone. For convenience, we collectively refer to this area as Escarosa. Locations within Escarosa that should be preserved in their natural state have been mapped.[1] Some of these areas have already been developed and are thus in conflict. Little can be done about existing conflict areas, at least until man's effects are washed away in a good storm. There remains approximately 6.5% of the land on which any development should be discouraged.

Conservation areas are recommended to be used for extensive land uses as opposed to intensive uses. The conservation concept includes lands inherently unsuited to high density, intensive development because of physical limitations of the soil and/or high flooding probability. They are not considered critical to ecological balance but do provide buffer zones for preservation areas and represent a retention of use options for future generations. The lands with soil

[1] Reproduction of figures showing type of land and water use was not possible for this paper. After February 15, 1971, a detailed report may be obtained by requesting "Coastal Zone Management in Florida, 1971" from: Coastal Coordinating Council, Room 682, Larson Building, Tallahassee, Florida 32304.

limitations, herein called "marginal lands", could in the future be used for development but would require a considerable expenditure of capital based on present technology and engineering.

Conservation lands can be utilized for open space recreation, greenbelts, forestry, game management, wildlife refuges and for certain types of agriculture as well as grazing. Development should be limited to low density uses, bearing in mind that ground floor elevations of new construction situated in flood prone areas must be above the 100-year flood level to qualify for federal flood insurance. Scenic easements are recommended for the immediate foreground of locations with an outstanding view of the landscape. Construction of marinas and other shoreline recreational facilities would be permitted provided environmental safeguards are complied with.

The water areas are Class III as delineated by the Department of Pollution Control and designated for fish and wildlife propagation with pollution levels compatible with body-contact water sports. The water areas also include special uses such as aquatic preserves and aquaculture leases.

The conservation zoning category is recommended to be primarily a state-level responsibility, since the majority of the subcategories are established by state or federal action. County and local zoning participation would be encouraged for parks (other than state owned), scenic vistas, marginal lands and controls of the limited development.

In delimiting conservation areas in Escarosa, the first step is to note the hurricane flood zone. In the absence of historical information, an elevation contour is normally used. For river basin flood zones, it is often assumed that alluvial soils are a valid indicator of the 50-year flood zone (areas having a 2% probability of flood occurrence in any year). Marginal lands or those lands with limited capabilities for development are determined through analysis of aerial photographs and maps providing: topography, surface geology, general vegetation, general soils, available ground water, permeability, wetness and natural resources.

Within Escarosa, 30% of the land area is not in conflict with preservation or development land uses and should be considered within the conservation category.

Allocation of land use within designated development areas of Escarosa is primarily the responsibility of local government. Local, state and federal governments do, of course, provide a spectrum of criteria, guidelines and regulations for such development. The Coastal Coordinating Council is attempting to consolidate and summarize a great portion of this information. The state will maintain an active interest in the development of "key facilities". Key facilities are facilities, including proposed large-scale private development, which tend to induce development having an impact of more than local significance upon the environment, including major airports, highways and highway interchanges, recreational facilities and such other public and private facilities as may be designated by the State. It can be anticipated that the State will also take a direct interest in development immediately on the shoreline and for some fixed distance inland, perhaps on the order of 1,000 feet. It is obvious that something more than just local controls are needed but what direction they might take requires considerably more research, analysis and discussion before a logical and reasonable plan can be recommended.

With limited shoreline and increasing competitive demands, agencies with advisory or controlling powers over shoreline development must consider

priorities of land use. Those activities that can only function through use of waterfront property or access to it must have first priority for inclusion in shoreline areas designated for development. Of second priority are those activities that can function without a shoreline but a shoreline location significantly enhances the land use on an economic or aesthetic basis. Any waterfront use, of course, must still make every effort to minimize environmental impact. Land uses not requiring a coastal location, or that are not economically or aesthetically enhanced to a significant degree should not be allowed waterfront usage as there are sufficient inland areas. Multi-uses of a locale are to be encouraged. A considered priority of shoreline uses can be summarized as follows:

1. Preservation
2. Conservation (including recreation)
3. Development (a) military (where necessary to assure the security of the area and country); (b) transportation (when waterfront location is mandatory); (c) utilities (when waterfront location is mandatory) -- (transportation and utilities are fundamental to the development of any area); (d) water related industry; (e) water related commercial; (f) residential; (g) commercial enhanced by waterfront and (h) industry enhanced by waterfront.

One of the most serious defects of past planning has been the inability to follow through with implementation. The State of Florida will face the same problem in its coastal zone management program unless it receives support from the citizens, the Legislature, the Cabinet and the various state and local agencies involved. This is a formidable challenge, considering the diversity of interests represented. However, widespread interest at all levels of government indicates that effective coastal zone management in Florida can move from the status of pipe dream to reality if the State shows the necessary leadership. In light of this, recommendations for implementing the plans will be developed by the Council, with participation by all levels of government and the private sector.

In the interim, the mere identification of Florida coastal zone areas that should be preserved can be effective. Traditionally, areas of Florida coastal zone are being preserved as the exception rather than the rule. It is not infrequent that extensive plans are made, monies expended and, in some cases, construction begun before opposition to a development is apparent. The results are conflict and confrontation with further expenditure of energy and dollars on both sides. Such an approach is unfortunate, impractical and needless.

Without exception, each state agency and many representatives of private industry have expressed the same thought: "Tell me what areas are not to be disturbed early enough so that we may plan to avoid them. We wish to avoid controversial areas, where possible, and not expend monies and energy needlessly."

It is considered that the most immediate and meaningful contribution the Florida Coastal Coordinating Council can make is to coordinate the documentation of those areas of Florida's coast (submerged lands, wetlands and uplands) on which any development should be restricted or at least reviewed and controlled, thus making development the exception rather than nondevelopment the exception. This results in development agencies, industry and individuals knowing the path of least resistance. It is our intention to have recommended preservation areas for the entire coastal zone completed by July of 1972.

Can Coastal Resources Survive Development? [1]

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The people of Florida have struggled for more than a decade to formulate sound coastal resource management policies. Stated simply, the problem is to maintain highly productive and attractive bays and estuarine systems in the face of urban, industrial and agricultural development in adjacent uplands.

Development projects involving large tracts of bay bottom and estuarine and coastal marshland proceeded virtually unchecked in the years following World War II. The mangrove and grass marshes were regarded as waste land easily converted to valuable real estate by filling them with sediments from the adjacent bays. These activities were regarded as beneficial to society and were actively encouraged by policies and the approval of local and state agencies. Gradually, as an understanding of the ecological role of these coastal systems became known and the magnitude and implications of the estuarine loss became clear, there arose a demand for controls.

Recently a complex permit system requiring local, state and federal authorization has evolved, significantly slowing coastal development and preventing many destructive projects. This system tends to minimize damage, but it does not solve the more basic problems of preserving the inherent natural productivity and aesthetic features of coastal areas and providing for community growth and increased use of coastal areas. Meanwhile, development proceeds, albeit more slowly, but with many of the destructive results of former years.

Florida can no longer afford simply to take inventory of the growing number of disastrous projects and make dire predictions of environmental calamity. Positive, realistic programs are required which look beyond total preservation as the only solution. Total preservation implies public ownership and large portions of many very valuable coastal systems are in private ownership. Clearly, it is not possible to purchase all of these private holdings. For undeveloped coastal areas subject to development, we must have a workable generalized plan which may be applied to most, if not all, coastal areas. Such a plan should protect the valuable and productive biological systems while providing for sound upland development. The Coastal Coordinating Council of the Florida Department of Natural Resources is currently developing a statewide coastal management plan.

Before the State program, a movement by private citizens in Naples was started to preserve a unique coastal area of Collier County. This Florida county is among the fastest growing in the United States. In 1964 many residents were apprehensive that the rapid growth of their community and the proposed development of Marco Island represented a threat to the undeveloped mangrove wilderness lying between Naples and Marco Island.

This same year formal application was made to construct a road from East Naples into the Rookery Bay area, thus providing easy access to the region and opening it to large scale development. A small group of farsighted citizens started a publicity campaign which convinced a large number of residents,

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[1]Contribution No. 1469 from the Rosenstiel School of Marine and Atmospheric Science, Univ. of Miami, Miami, Fl. 33149.

including the Collier County Commission, that the road was not in the best interests of Collier County and the application was denied. Subsequently this group organized and became the Collier County Conservancy. Taking the initiative to thwart new road proposals and other threats to the environment, the Conservancy set out to permanently protect a portion of the mangrove wilderness south of Naples. After a period of review and consultation it became clear that the only permanent protection was ownership.

Contributions from more than 1,500 individuals and a matching grant from the National Audubon Society raised $450,000 by the end of 1967. These funds were used to purchase 2,600 acres of privately owned uplands adjacent to Rookery Bay. In addition, State owned tidelands were included creating the 4,000-acre Rookery Bay Sanctuary (Fig. 1). With cooperation and assistance of

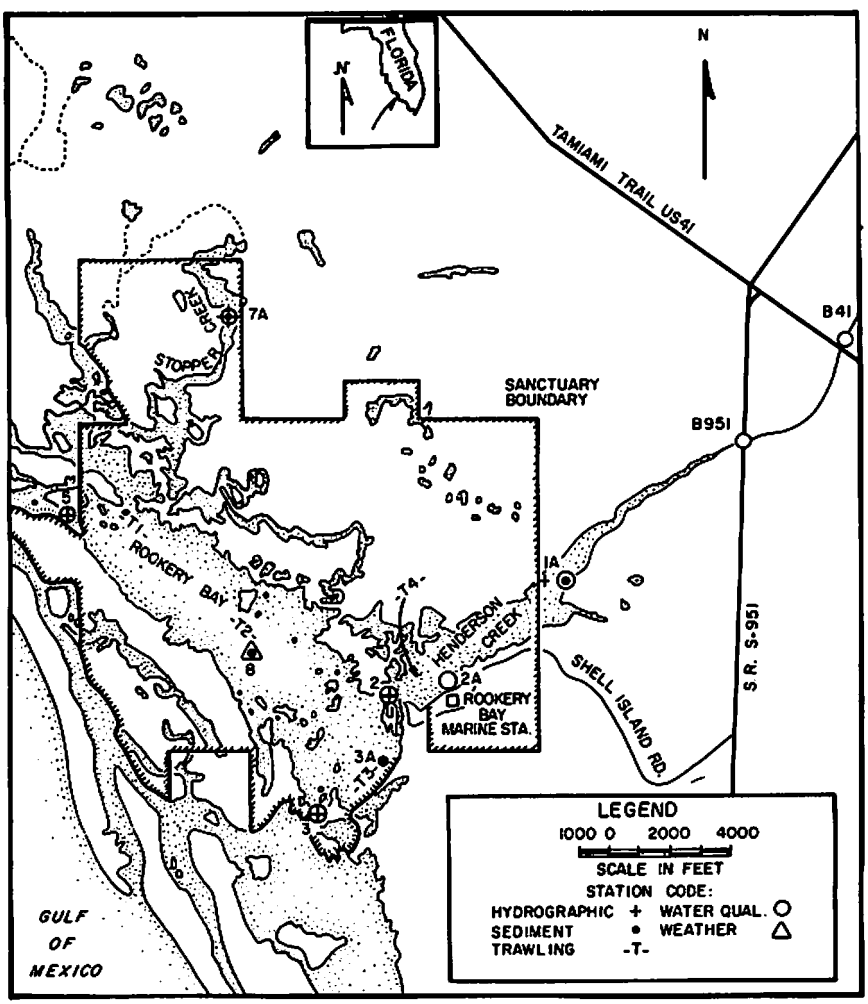

Fig. 1. Rookery Bay Sanctuary showing sampling locations.

the Nature Conservancy of Washington, D.C. the tract was deeded to the National Audubon Society as part of their extensive sanctuary holdings and a permanent warden was assigned to supervise it.

At this point, the Conservancy, having made a very considerable achievement, could have turned over the responsibilities for the protection of the Sanctuary to the National Audubon Society and the County. Instead they continued to participate actively in a complex and difficult management problem. The Conservancy realized that ownership was insufficient to ensure the complete protection of the Sanctuary. It was not a self-contained ecological unit. The Sanctuary was susceptible to damage by activities on adjacent private land. Furthermore, because the region is primarily a water environment, some of the major threats to its health are water related. A decline in the quality or change in the quantity of fresh water supply to the Sanctuary could seriously damage it. Thus, the long range health of the Sanctuary was dependent on protection from ongoing and increasing development in nearby areas.

One possible solution was the purchase of additional land, but the very presence of the Sanctuary had already increased land values prohibiting large scale additions. Furthermore, additional acquisition would still leave a boundary, with Sanctuary land on one side and privately-owned property on the other. The threat of damage from the outside would remain. The most reasonable approach was to acknowledge that development was inevitable in the privately held lands around the Sanctuary and to develop a plan whereby man could live near a valuable natural system without appreciably changing it.

The Conservation Foundation of Washington, D.C. was invited to participate in a feasibility study to determine if such an idea was workable. The Foundation agreed to participate and funded a 6-month study to examine the possibilities and determine if further research was justified. Work began in the fall of 1967 and the major objectives were: (1) to determine if conservation and development could be compatible in the area surrounding and ecologically related to the Sanctuary; (2) if so, to recommend a development program for this area and to suggest methods of implementing the program; and (3) to identify some general principles which might be applicable in other areas to help bring together conservation and urban development.

The study was a multi-discipline approach which brought together a team of experts from fields such as land planning, real estate, engineering, upland and estuarine ecology and law. The team effort resulted in a report in 1968 entitled the Rookery Bay Area Project.

The conclusions were encouraging. In answer to the pressing question of whether conservation could co-exist with development, the report suggested that "with careful coordinated planning and development, the area can be profitably developed by private owners and at the same time the Sanctuary can be safeguarded. In fact, protection and enhancement of the Sanctuary is basic to profitable, quality development of the surrounding area and will advance the economic interest of the developers."

These favorable results encouraged further study and the Conservation Foundation and the University of Miami, working in association with the Collier County Conservancy, applied for and received a grant from the Office of Water Resources Research, of the United States Department of Interior. The purposes of this grant were (1) to determine whether man can manage water and related resources in such a way as to maintain and improve the quality of the human environment in an area such as Rookery Bay, and (2) to determine if the principles and concepts emerging from the study could be applied to other

regions with similar problems. The Office of Water Resources Research grant approved in 1969 enabled the research by the University of Miami to begin at the newly established Rookery Bay Marine Station in early 1970.

Following the establishment of the Sanctuary, the Collier County Conservancy raised funds to buy crucial parts of the shoreline of the Rookery Bay system still in private ownership. In 1969 a 40 acre private home site within the Sanctuary was purchased and made available as a field research station. The Conservancy continued to press for control of the shoreline and by 1971 succeeded in obtaining by purchase or gift all of the shoreline within the original boundaries of the Sanctuary. Gifts of highly strategic property were made by the Collier Development Corporation and the Deltona Corporation, two land developers in the county. This was tangible evidence of the interest of the developers and their willingness to cooperate.

The overall objective of the research program was to provide base-line information on the hydrography, water quality and the abundance and distribution of animals and plants in and near the Sanctuary before alterations in nearby areas obscured the natural values, and to study, analyze and provide planning guidance in all decisions related to use and development of the lands adjacent to the Sanctuary.

The results of the ecological base-line research will be directly applicable to environmental management of the Rookery Bay Sanctuary. The water quality studies will be used to formulate water quality standards for the Sanctuary and adjacent areas. These data will be especially useful since they will reflect conditions existing in the predevelopment period when the Sanctuary was apparently "healthy". The hydrographic study will produce data on rates of exchange between Rookery Bay and outside waters, circulation patterns within the Sanctuary and tidal amplitude levels at critical locations. These data will be instrumental in water management decisions relevant to proposed artificial waterways, changes in the shoreline of natural streams, such as Henderson Creek, and in the disposition of excess fresh water runoff and sewage effluents. With knowledge of the tidal amplitude and water head pressures at critical locations in the Sanctuary and the changes produced in both of these by the wind, it will be possible to predict the rate of exchange and the direction of water flow and thus anticipate effects on the Sanctuary environment.

Quantitative information on the abundance and distribution of animals in the Sanctuary is being obtained from monthly samples in four typical habitats using an otter trawl. These data will provide a predevelopment picture of the species, numbers and distribution of animals in the Sanctuary. Subsequent samples made by trawl during and after the development of the outside areas will provide a measure of the relative health of the Sanctuary. Such comparisons make use of the animals themselves as sensitive detectors of environmental change.

Thus the ultimate objective of the project is a comprehensive quantitative description of the Rookery Bay Sanctuary during the predevelopment period which, when compared with subsequent environmental monitoring, will permit the detection and control of changes in the basic environment of the Sanctuary. This will enable the effects of development to be identified and measured. Finally, the information will be used to establish planning criteria which will permit development but at the same time maintain and safeguard the Sanctuary.

In summary, we believe that this project is an example of the impact a small group of dedicated individuals in a concerned community can have in aiding in the solution of the environmental crisis in Florida. Also it is an illustration of the benefit derived from a unified multidiscipline approach to a complex problem.

State-Federal Management Initiative

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Pressure on the once thought inexhaustible fishery resource by massive foreign fishing fleets, our domestic fishing industry and a large population of recreational fishermen is relentlessly expanding. The time has come to develop some system for adjusting this pressure and metering it to the limits of maximum sustained yield of the resource. Further postponement will only compound the acuteness of this problem.

With the formation of the National Oceanic and Atmospheric Administration (NOAA) in the U.S. Department of Commerce, a sturdy fishery management focal point has been created. The National Marine Fisheries Service under NOAA has legislatively been assigned the responsibility for the total living marine resource including both recreational and commercial interests. Our basic goal, therefore, is conservation of the resource which, stated another way, means its wisest utilization.

We are restructuring our organization to cope better with these new responsibilities. In so doing, we are giving major emphasis to the problem of increasing demands on the fishery resource. The State-Federal fishery management initiative is one of these new approaches.

Those problems to which this initiative responds are of the kind that people frequently choose to ignore rather than try to resolve. They are very sophisticated as well as difficult, and some of the tools needed for their solution are yet to be formulated and tested.

Perhaps the foremost problem is generated by the fact that fish in the water are common property. Fishermen, therefore, have no property rights to them. Since everyone owns the resource, there is a natural tendency to overcapitalize a growing fishery. The result, particularly in many mature fisheries, is too many units of gear, too many fishermen, too many boats, too much capital or all of these.

Historically the states have exercised the right to manage their living marine resources. This has led to a multitude of management systems which are often tailored to the needs of a given state, but they are often not tailored to the needs of the fish stocks which are unable to delineate state or national boundaries. Further, some managerial schemes tend to take the form of instituting inefficiencies through such means as gear restrictions rather than dealing with the real problem of too many fishermen pursuing too few fish. The State-Federal fisheries management initiative will deal with these problems by developing cooperative management plans that will assure the rational use of fishery resources for both sport and commercial purposes.

The initial draft of this initiative was developed several years ago along with draft legislation designed to implement the provisions of the Geneva Law of the Sea Conference of 1958, and to provide managerial authority for the contiguous fishery zone of the United States. This draft, developed in the old Bureau of Commercial Fisheries, was reviewed by fishery administrators of the coastal

states about two or three years ago, and its initial form was altered in many respects to reflect their comments. Because of the changes brought about by the President's Reorganization Plan No. 4, this proposed legislation has not as yet been introduced into the Congress.

The closest possible cooperation between the states and the federal government is required for the successful implementation of the initiative. We should be prepared to face the fact, however, that there may be some loss of independence currently exercised by individual states. Logically, migratory marine fisheries should be under some sort of common governance for national management. On the other hand, the draft legislation would give the states additional opportunity to join in regulation of fisheries within the contiguous fishery zone. Therefore, this initiative should be acceptable to all or most of the coastal states because of the long-range economic and social gains that will result from this scheme. To do the job requires a half-dozen steps and perhaps a half-dozen years. It involves the following steps: (1) strengthening the mechanism for control of international exploitation of resources adjacent to the U.S. coasts; (2) establishing national guidelines for managing fisheries; (3) providing a mechanism through legislation for states and groups of states and the federal government to manage fishery resources cooperatively; (4) helping to improve the capability of states to conduct management-oriented research; (5) evaluating the feasibility of alternative programs of state and/or federal management systems and (6) implementing specific management programs for each fishery.

We began conducting basic studies of the problem in FY 1971 with $660,000 appropriated for this purpose. Economic studies were made to look into the extent of overcapacity in our major fisheries; the detrimental impact of existing regulations; and examination and evaluation of alternative management schemes and how they might be implemented. In FY 1972 — with another $608,000 — we plan to emphasize (1) measuring fleet capacity versus resource capability for the major fisheries; (2) developing legal and legislative requirements for limited entry-type management plans and (3) studying the socio-economic structure of various fishing areas and the possible impact of new management schemes on local areas.

In the international area, our efforts will be expanded to include: (1) preparation of necessary background material and analyses to ensure appropriate strategies at the forthcoming Geneva Law of the Sea Conference; (2) greater in-depth backup work necessary for the almost continuous bargaining associated with the 18 conventions, treaties and executive agreements now in force and (3) expansion of the monitoring, evaluation and analysis of foreign fishing activities in waters adjacent to the United States.

Our statistics program is being improved to allow further automation of data storage, retrieval, tabulation and printing of publications; the implementation of scientific sampling procedures; the shortening of the time lag in releasing information and the collection of additional statistics, particularly economic data needed for improved management programs.

In our opinion, it will take several years to resolve both the international allocation and the internal management problems. Therefore, we cannot afford to wait for resolution of the first before starting on the second. We must tackle both at the same time. If all goes well, we will have available an international allocation system at about the same time that we have worked the "bugs" out of the State-Federal system.

Some questions have been raised with respect to research aspects. Again, obviously, rational management schemes depend on an adequate scientific base. We are currently undertaking the so-called MARMAP program (Marine Resources Monitoring, Assessment and Prediction), which is designed to furnish the scientific data base we require in a timely fashion, filling the gaps in existing programs through a nationally coordinated effort. If all goes reasonably well, the scientific results will start flowing in the necessary quantity at about the time the international and national problems are resolved.

A fundamental objection to the joint management proposal has been expressed by some state officials. Their objection was to the basic concept of limited entry. Yet some sort of limited entry appears to be the only rational way of coping in a sound economic way with such matters as overcapitalization that arise from the common property nature of the resource. The answer, from our point of view at least, is that fish are indeed different because of their common property nature and it is in the broad interest of society and the free enterprise system itself to have economically sound fisheries.

Another question frequently raised dealt with the impact of the proposed initiative in state waters. The answer is that the federal government has no intention of preempting any state's authority inside the territorial sea.

We have begun discussions with state officials to formulate plans and review possible concepts for the State-Federal management initiative. These discussions will be continued in an effort to obtain mutual agreement on guidelines for the establishment of the initiative and a proposal for renewing of the highly successful PL 88-309 State Aid authority which will complement this program. State officials have been most cooperative and we feel confident that a consensus on the basic concepts can be obtained in the near future.

It is our thought that the new legislation should contain provisions to implement various aspects of the initiative through a system of additional grants to the states that will not require state matching funds. However, the manner of state adherence to certain performance standards for resolving managerial problems would be specified. If this additional money becomes available, it would be provided to the states for projects which would be of particular value in devising and administering joint State-Federal management plans. These plans would take into account social and economic factors as well as biological. Preference should be given to projects that would especially benefit management of multi-state fisheries, projects for development and implementation of management plans and projects contributing to improved regulations and to their enforcement.

We are now developing our program for FY 1973. Recommendations therein will be for action necessary to bring the foregoing management plan closer to fulfillment. Reflecting on the conditions of many U.S. fisheries, it is our judgment that only through a program like this can our fisheries be rationally managed in the future.

Seafood Standards and Aquaculture Session

WEDNESDAY — NOVEMBER 17, 1971

Chairman — Wendell A. Mordy, *Director, Sea Grant Institutional Program*
University of Miami, Miami, Florida

Uncle Is Moving In

H. R. ROBINSON
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and

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If upon your arrival home after a hard day's work you were greeted by the announcement that your "uncle" was moving in to live with you, your immediate response might be "the hell you say"... or possibly even something more emphatic.

Should you stop to think about it, however, you probably spend more time at work than you do at home with your loved ones — and this fact makes it difficult to understand the long indifference of many people in industry to the forthcoming Federal Fish Inspection legislation. Perhaps the fact that the subject has been before the Congress since 1966 has resulted in such a seeming indifference. Whatever the reason, you can now start to adjust your thinking, for *Uncle Is Moving In* and will soon become a very real part of your everyday business life.

The Wholesome Fish and Fishery Products Act of 1971 is presently the subject of consideration by the Senate. Last May hearings were conducted by the Subcommittee on the Environment of the Senate Commerce Committee. Three bills were officially considered at those hearings — S. 296, S. 700 and S. 1528, but in reality the major portion of the hearings were concerned with a new section of S. 1528 dealing with Surveillance for Dangerous Materials. The proposed bill, as considered last month by the Senate Commerce Committee, was put together by the staff of the Commerce Committee and contained portions from all three original bills, plus some new language tossed in by the staff. For purposes of this report I will refer only to S. 2824 as reported by the Senate Commerce Committee on November 8th. S. 2824 is now before the Senate and is expected to be passed and sent to the House before Congress adjourns.[1]

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[1] S.2824 was passed by the Senate in December 1971 and is now being considered by the House of Representatives.

To fully understand the Wholesome Fish and Fishery Products Act it is essential that you understand that this is not a new law which will stand on its own, but instead is an extensive amendment to the existing Federal Food, Drug and Cosmetic Act (FDC). As such, once enacted, it will be inserted into the FDC Act in a number of various places — and will lose the individuality which it now possesses.

The general objective of the bill is expressed in the Congressional Findings as follows:

> It is essential that the health and welfare of consumers be protected by assuring that fish and fishery products distributed to them are of good quality, wholesome, not adulterated, and are properly marked, labeled and packaged.
>
> It is hereby found that all fish and fishery products regulated under the amendments made by this Act are either in interstate or foreign commerce or substantially affect such commerce, and that Federal regulation and cooperation by the States and other jurisdictions as contemplated by this Act (including cooperation through federally approved State programs for control of shellfish growing areas and shellfish harvesting) are appropriate to prevent and eliminate burdens upon such commerce, to effectively regulate such commerce and to protect the health and welfare of the consumer.

The bill provides that the Secretary (Secretary of Health, Education and Welfare) will survey establishments and vessels to inform himself concerning the operations and sanitary conditions thereof for the purpose of developing adequate standards of good processing practices, including but not limited to sanitation and quality control. Thereafter, the Secretary shall prescribe standards of sanitation and quality control — with the initial regulations to be issued within one year. The initial regulations will become effective one year after they have been issued, with the possibility of an additional one year delay if the Secretary finds that additional time is needed.

Sixty days after the regulations become effective all establishments and vessels must have an official certificate — and from then on that certificate is a must if you are to engage in business. The Secretary shall issue certificates upon application accompanied by "such assurance as may be required" that such establishment or vessel is and will be maintained in compliance with applicable standards. The bill provides that certificates may be suspended, after opportunity for hearings, for failure to comply with requirements. Further, a certificate may be summarily suspended (1) for failure to permit access for inspection or (2) where an inspection discloses conditions which would involve undue risk of imminent harm to consumers.

The original idea behind the proposal for fishery inspection was that it should be patterned after meat and poultry inspection, which have a form of continuous inspection. We would do well, therefore, to ascertain what continuous inspection of fish and fishery products will mean:

> The term 'continuous inspection' means inspection by an inspector at least once daily while processing or at such less frequent intervals as may be prescribed by the Secretary where he determines that daily inspection cannot reasonably be provided because of the illness, weather, geographical remoteness, the seasonal nature of processing operations or other extreme conditions beyond control. As a part of such inspection the Secretary may further require, at his discretion, that an inspector be on duty at all times during which the processor is operating.

It becomes readily evident from this definition that you are going to see a lot more of Food and Drug Administration (FDA) inspectors than you ever have in the past. This being the case, let us now see how this affects the various segments of the commercial fishing industry. We will begin with establishments.

> The term 'establishment' means the premises, buildings, structure, facilities and equipment (including vehicles) used in the processing of fish and fishery products.

The use of the word 'processing' makes it necessary to understand that:

> The terms 'process', 'processed' and 'processing', with respect to fish or fishery products, mean to harvest, handle, store, prepare, produce, manufacture, preserve, pack, transport or hold such products.

A careful study of these definitions reveals that a lot of people who never considered themselves as being a part of the commercial fishing industry now find themselves covered by this act, including warehousemen, truckers and others.

The bill provides for inspection of establishments as follows:

> For the purpose of preventing the use in interstate commerce of fish or fishery products which are adulterated or misbranded, the Secretary shall cause to be made, by inspectors appointed or commissioned by him for that purpose, a continuous inspection of each establishment where fish or fishery products are processed for interstate commerce.

Let us now look at vessels, which are defined for purposes of this fish inspection bill as follows:

> The term 'vessel' means a vessel, as defined in section 3 of title I, United States Code, which is engaged primarily in the processing of fish for landing and human consumption in any State.

This is typical Washington lawyer talk and requires that you must look up another law to find out what a vessel is. Should you bother to refer to section 3 of title I, United States Code, you will learn that:

> The word 'vessel' includes every description of water craft or other artificial contrivance used, or capable of being used, as a means of transportation on water.

The type of inspection contemplated for vessels differs somewhat from that applicable to establishments as the bill provides that:

> For the purpose of preventing adulterated fish or fishery products from being introduced into interstate commerce, the Secretary may require, whenever he considers it appropriate, inspections, by inspectors appointed or commissioned by him, of such fish or fishery products at dockside. The Secretary, at his discretion, may further require that adequate inspections be made by such inspectors of vessels processing fish or fishery products for interstate commerce.

The bill provides that any inspector appointed or commissioned under the act shall at any reasonable time have access to any establishment or vessel where fish or fishery products are processed. It further provides that denial of access to such inspector shall be grounds for suspension of your certificate of registration. It also provides for sampling, detention and reinspection of fish or fishery products at any establishment or vessel, as well as providing for condemnation of products found to be adulterated.

There is at least one provision of the bill with which few would disagree, that being the provision which states that the cost of inspection shall be borne by the United States, except that the cost of overtime and holiday pay for inspection service performed at the convenience of the establishment and not owing to conditions of harvesting or processing beyond the control of the establishment, shall be borne by the establishment.

The bill authorizes an official mark which *may* be used on labels or packages, however, it does not make the use of such official mark mandatory. The bill also carries provisions relating to labeling and packaging which some students of the bill interpret to require premarket clearance of labels and packaging. Of course, in addition to this bill your labels and packages must still comply with the Fair Packaging and Labeling Act. The bill does provide that established trade names which are not false or misleading are permitted.

A sometimes overlooked provision of the bill deals with "storage or handling regulations" and specifies:

> Regulations issued pursuant to subsection (a) shall include standards prescribing conditions under which fish or fishery products capable of use as human food shall be stored or otherwise handled by any person engaged in the business of buying, selling, freezing, storing or transporting, in or for interstate commerce, or importing, such articles.

Senator Hart and others who originally proposed fishery inspection legislation soon found that one of the major problems arose from the fact that imports of fishery products account for over 60% of the total supply as consumed in the United States. In an effort to be fair to the domestic industry the bill provides that:

> No fish or fishery products which are capable of use as human food shall be imported into the United States if such articles are adulterated or misbranded or otherwise fail to comply with all the inspection, good processing practice, and other provisions of this subpart and regulations issued thereunder applicable to such articles in interstate commerce within the United States.

That sounds real good, however, there is the real problem of ascertaining compliance. The bill further provides that the Secretary, after consultation with the Secretary of State, shall establish regulations for the inspection of foreign establishments which process fish or fishery products for importation into the United States. In event our inspectors are refused access to any foreign country or foreign establishment, the Secretary of the Treasury shall issue an order prohibiting imports from that foreign country or foreign establishment, as the case may be. These new and added provisions came out of the Senate Commerce Committee discussions on the bill, and have not previously been seen by the domestic industry. Since the United States is an importer of fish or fishery products it becomes absolutely necessary that these provisions of the bill be studied carefully, for we do need the continuity of supply from foreign sources.

The bill provides that foreign systems which are at least equal to our own may be certified. It also provides that at least an annual inspection, investigation and evaluation of the foreign system will be conducted. Products imported into the United States are still fully subject to dockside inspection, and FDA has by its past testimony indicated that it planned to step-up the degree of dockside inspection.

The Secretary may issue regulations as to the records required to be maintained concerning the receipt, delivery, sale, movement or disposition of fishery products, as well as records bearing upon sanitation and quality control in establishments or vessels, or relating to labeling. Such records must be maintained for two years, and must be made available for copying on request. The Secretary may also by regulation require reports.

The bill carries a provision for the "administrative detention of fish or fishery products" for a period of up to a week during which time the product cannot be moved.

The bill carries certain exemptions including (1) the processing by any person of fish of his own raising or harvesting exclusively for use by him and members of his household and his nonpaying guests and employees provided such person does not engage in the business of buying or selling fish or fishery products capable of use as human food, (2) retail dealers selling directly to consumers and (3) fish houses and cold storage facilities in which no processing is performed except unloading, icing and shipment. In the exemption for retail dealers there is also an exemption for trucks. There is some question as to whether this exempts the entire trucking industry or whether it applies only to trucks of fish peddlers, and the report would tend to indicate the latter.

The bill provides that regulations will be issued covering fish or fishery products not intended for human food. Such products must be denatured or otherwise identified as required by regulations, except if they are naturally inedible by humans.

The opportunity for hearing and judicial review of denial, withholding, suspension or withdrawal of certificates, as well as instances bearing upon the withholding of approval of labeling or packaging are set forth in detail on pages 24-26. In short, you have the right to appeal to the Secretary any decision which adversely affects you, and if the Secretary does not grant relief you can take the matter into the courts. The bill also authorizes the Secretary to issue subpenas requiring the attendance and testimony of witnesses and the production of documentary or other evidence.

Like the meat and poultry inspection programs, this bill envisions that states which establish and maintain a program at least equal to the federal program can administer the program, and Uncle Sam will put up 50% of the cost of such a program. If within two years the states do not come up with an acceptable program, then the Secretary can superimpose the provisions of the federal program upon intra-state activities within the affected state. Even if a state has an approved program of its own, there are also provisions permitting the Secretary to apply the federal program to any establishment within the state when there is cause to do so. Inspection of establishments in any state processing fish or fishery products solely for distribution in such state is also authorized under the guise of checking upon the effectiveness of the state program. Thus, for practical purposes, this inspection bill covers both INTRA and INTER-STATE operators.

Research through grants or contracts with public or private agencies, including studies, experiments and demonstrations, are authorized (1) to improve sanitation practices and (2) to develop improved techniques of surveillance and inspection.

The bill provides for a "National Advisory Committee" of not more than 21 members. The majority of the members shall have no economic interest in the commercial fisheries industry and shall be drawn from the public (including persons representative of consumer and environmental protection organizations who must make up not less than one-third of the membership).

Probably one of the least known yet most far-reaching provisions of this bill is entitled "Surveillance for Dangerous Materials" (beginning on page 37) and applies to *all foods.* Remember, this entire bill amends and will become part of the Federal Food, Drug and Cosmetic Act, and that act defines 'food' thusly:

> The term "food' means (1) articles used for food or drink for man or other animals, (2) chewing gum and (3) articles used for components of any such article. [Sec. 201 (f)]

This section starts off brilliantly by stating that in order to protect consumers from the dangers of dangerous materials which may be found in food, there will be an intensive screening system for the detection of such materials in food. The term 'dangerous material' means any material which there is reason to believe might reach toxic levels in significant quantities of food so as to threaten human health. The term 'intensive screening' means that level of surveillance required to provide reasonable assurance that the presence of dangerous materials in food does not constitute an unreasonable threat to human health. To the extent practicable, such research shall utilize data on human exposure which relates to consumption patterns and the accumulative effect on human metabolism.

It is provided that not more than 180 days following enactment the Secretary will propose regulations specifying all dangerous materials and the screening procedures to be followed. Regulations can be amended not only by action of the Secretary but also upon petition of any interested party. Hearings on objections to the proposed regulations or changes thereof are provided for. The level of research and testing can be increased at any time there is a threat to the public health. Analyses to determine the presence and amount of dangerous materials in food shall utilize the best available technology. It is provided that the results of any analyses or research shall be made available to the public except when the Secretary determines that disclosure of such information would result in competitive injury. There is reasonable question as to whether pet foods are covered, even though the report tends to indicate that they are not.

The only section of this bill which does not amend the Federal FDC Act is the section as added about the Fisheries Loan Fund, and this would amend the Fish and Wildlife Act of 1956 to make the loan provisions applicable to establishments and by providing $35-million initial capital, which is 15-million more than presently is in the loan fund. Remember, however, the 40-thousand dollar maximum loan restriction still applies.

In summary let us now examine what we are about to receive. The proposed legislation only sets forth the broad guidelines. The legislation will be implemented by regulations issued by the Secretary. All canner organizations have constantly stressed that such regulations should be subject to the General Administrative Provisions of the FDC Act and specifically that Sec. 701 (e), (f) and (g) should be applicable to regulations proposed by the Secretary. The staff of the Senate Commerce Committee constantly objected to this, indicating that it made it too difficult for the Secretary to issue regulations. It is our contention that these safeguards are needed to protect those being regulated, for as we now see the bill you don't have much to say about the regulations. Congress is delegating "law making" authority to the Secretary. It is only just that those who will be affected should at least have the right and opportunity to comment upon the regulations before they take effect.

The chances of doing anything about this bill at the Senate level are about nil. Remember, however, it still must be considered by the House. Do yourself a favor — get a copy of S. 2824, study it and then communicate your thoughts to not only your elected representative but also to your trade associations.

Uncle is moving in! You are on the verge of getting all of the government for which you have been paying. This is a luxury you may not enjoy!

Food and Drug Administration Guidelines for Contaminants in Fishery Products

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One need only be a reader of the newspapers to realize that the fishing industry has had a very rocky time over the past few years. There have been a number of health related problems — botulism, mercury, pesticides, industrial contaminants — which have generated disproportionate publicity. I would like to try and put some of these problems in perspective while telling you a little about the Food and Drug Administration's (FDA) regulatory and research activities in the areas of fisheries products. Perhaps I might also offer some insights into some of what FDA feels may be the emerging health problems associated with fisheries.

Traditionally, the FDA approach to fisheries products has related to microbiological quality, generally to in-plant sanitation. In the 1960s, public health attention was focused on the virus threat posed by the consumption of raw oysters and clams. Fortunately, no more major outbreaks have occurred involving this disease, although this potential public health problem remains as a reminder to all of us to maintain our established sanitary controls. The 1970s have caused us to reassess the potential health hazard presented by the vast array of industrial and toxic waste materials dumped daily into our waterways. The question of how these chemicals affect the quality of our aquatic food supply has taken on new proportions and many scientists and public officials are searching for answers. Quite predictably, the effects upon fish, shellfish and clam resources have been severe. It would seem that the public, regulatory officials and the fishing industry itself need to consider a few very basic facts about fisheries products when considered against the rest of the foods we eat in order to anticipate problems before they assume crisis proportions.

Fish are grown and harvested in a relatively uncontrolled environment when compared to our other protein sources. While fish roam wide areas in search of food, meat is produced in the confines of a pasture or a feed lot. Everything that a meat animal eats is decided by the producer. A few years ago serious pesticide problems in animal feeds which carried over into milk were discovered. The problem was corrected in a short period of time by more careful selection of feed and changed spraying practices. When pesticide residues in fish occur, however, solution is difficult and a long time coming. I think as a society we are being very unrealistic in being surprised that our fisheries are hurt by problems caused by careless or purposeful disposal of our land wastes.

The FDA has had an active fresh-water fish pesticide analysis program for a number of years. In fiscal year 1971, 600 samples of fish were analyzed for pesticides. As might be expected almost all contained some residue level of DDT and its analogs. (558 residues of DDE, 447 of DDT and 392 of TDE). Every widely used chlorinated pesticide was also detected but not as frequently. These included aldrin, dieldrin, endrin, heptachor and heptachor epoxide, toxaphene and BHC. PCB (1254) which is not a pesticide but an industrial contaminant was also found in 346 samples. As I have said before, the majority of these fish were

fresh water fish. There have, however, been some federal seizures of kingfish which contained more than 5 parts per million (ppm) DDT and its analogs. While truly adequate pesticide surveys of ocean fish species need to be undertaken, information from our total diet studies would indicate pesticide levels in ocean fisheries products are generally below any level of serious public health significance.

As I mentioned before, PCB residues have been found at some level in 346 of 600 fish samples examined. This would be strictly from environmental contamination. Much of the recent publicity about PCBs related to accidental industrial contamination of fish meal from leaks in heat transfer equipment in a plant. This type of contamination is easily handled. The source of the contamination is simply eliminated. Would that the environmental problems were as easily solved.

Man's various activities during recent years, ranging from wide-spread burning of fossil fuels to the careless dumping of millions of pounds of mercury contaminated wastes, have undoubtedly increased the concentration of mercury in many productive areas of our surface waters to the extent that a significant segment of the world's food resources has been affected.

In March 1970, the Canadian Food and Drug Directorate announced that Lake St. Clair, an international boundary lake, was being closed to commercial fishing. Industrial plants at Sarnia, Ontario and nearby, have discharged enough mercury over a period of many years to seriously pollute not only Lake St. Clair and the St. Clair River, but also most of the western basin of Lake Erie. The microbiological flora of these streams had converted the mercury discharge to methyl mercury which had found its way up the food chain until finally concentrated at dangerous levels in certain species of fish flesh. This triggered a great deal of state and federal activity which had great impact on the fishing industry.

On our part, the FDA initiated a Compliance Program in April 1970. Since fish were found contaminated with mercury residues from industrial wastes and other sources discharged into fishing areas, there was a need for the FDA to determine the extent of this problem. The concern in the U.S. with respect to tuna began in December 1970. The canned tuna program analyzed the entire canned tuna supply of the U.S. This included all domestic and imported canned tuna on the market between December 16, 1970 and February 1, 1971. When the survey of the entire tuna pack was published in February 1971, less than 4% of all the tuna examined exceeded the guideline. Species and size were the determining factors in predicting which fish might be at or above the guideline.

On December 23, 1970, Commissioner Edwards announced that the precautionary program of sampling tuna for mercury was being extended to another deep water fish; i.e., swordfish. Since December 26, 1970, all of the swordfish in cold storage and offered for entry into the U.S. has been examined for mercury. On May 6, Commissioner Edwards announced that test results showed only 42 of 853 swordfish samples to be within FDA's 0.5 ppm guideline and 53% exceeded 1 ppm. Therefore, at this time he issued a public warning against the consumption of swordfish.

After the smoke had cleared and some of the analytical resources of our laboratories were freed, a statistically valid analysis program of the 19 most commercially important fish was undertaken by FDA. The results of this survey indicated that while the mean mercury level in saltwater fish was quite low, approximately 0.09 ppm of mercury, certain species such as snapper, bonito and

mackerel would have a number of fish above the 0.5 ppm mercury action level established by FDA. Of over 1,000 lots examined, it has been necessary to initiate seizure or recall actions against 14 lots of snapper, 3 lots of bonito and 3 lots of mackerel. Other predator type fish have also been implicated but not in commercially significant quantities.

The National Canners Association, the Japanese Canned Food Association, the National Fisheries Institute, the American and Japanese Tuna Packers and the halibut industry of the Pacific Northwest have all instituted quality control programs which will go far toward minimizing the necessity for regulatory action on the part of the federal government.

I know that as fishermen you are questioning the necessity of such activities. You are saying, "Where are the people injured from eating fish? Look at the people injured by smoking or consumption of alcohol!" While I can sympathize with this feeling, the responsibility of the FDA with respect to this problem is quite clear. We must continue to monitor the whole of the nation's food supply, identifying and isolating the problem areas while taking positive action to remove from the channels of commerce those foods found to contain excessive mercury residues. In order to meet this responsibility our basic philosophy is to seek control measures maximizing the safety to humans, based on the best available data, both animal and human. In properly carrying out this assigned task relative to mercury in fish, one should not see any direct cause and effect relationships in our population relative to mercury poisoning from this source.

There are no formal tolerances for mercury in food products. The registered uses of mercurial compounds as pesticides or fungicides are on a no-residue basis. The FDA has established certain "Administrative Guidelines" covering the presence of mercury treated seed in wheat intended for food and also covering mercury residues in fish, shellfish and other aquatic organisms. The guidelines allowed for legal action on wheat when 10 or more pink kernels, each containing greater than 1.0 ppm mercury, were found per 500 grams of wheat. Legal action will be instituted against fish when 0.5 ppm or more of mercury is found in the edible portions. The mercury in fish guideline has been the subject of tremendous controversy during the past several months. Various consumer groups and individuals representing themselves as consumer advocates have asserted that the figure is too high and should be lowered to assure that the public health will not be endangered. Other voices, primarily from the various industries directly involved, have maintained that the guideline level is too low.

Let us examine this guideline and how it was established. The types of data available at the time the FDA guidelines for mercury in fish were established were derived from: (1) Minamata Episode (used in the original Swedish evaluation), (2) intake of methyl mercury in man from contaminated fish and blood levels of mercury and (3) studies in the distribution and excretion of Hg-203 labelled mercury in human volunteers, in conjunction with data in brain levels of mercury in test animals and human autopsy cases.

Consideration of this data led to the establishment of the 0.5 ppm mercury in fish guideline. This guideline is under continuous review. The conclusion of a ten scientist study group to Sweden and Finland, in August 1970, where a great deal of work had been done in this area, was that the FDA guideline of 0.5 ppm mercury in fish is, for the present, a sound basis for the protection of the public health. The mercury in fish guideline was again reviewed in April 1971 by an Ad Hoc Committee of scientific and medical experts from this country and Canada with respect to the high levels of mercury found in swordfish. The Committee

expressed support (11 of 13 non-FDA members) for the maintenance of the 0.5 ppm guideline.

In May 1971, four members of the Bureau of Foods visited Japan. The most recent Japanese data reaffirmed and reinforced the present FDA guideline for mercury in fish.

Therefore, controversy notwithstanding, the consensus of the scientific community with expertise in the area of mercury toxicity is that the 0.5 ppm mercury figure is adequate, appropriate and necessary for the protection of the consuming public.

If anyone can bring forth hard scientific facts necessary to demonstrate that this level is either too high or too low, we stand ready to change this action level. Mind you, I said *facts* and not *opinions.*

Another related area of concern is the concentration of metals besides mercury in our foodstuffs. FDA and the Public Health Service have had a metals in shellfish program in operation since 1966. Many shellfish growing areas in the U.S. have been classified and shellfish analyzed for metals content. The metals included in this survey are cadmium, lead, chromium, zinc, copper, cobalt, nickel, iron and manganese. These metals arise in shellfish from both natural sources, the weathering of rocks, and also from industrial discharges and airborne contamination of rivers and streams. When baseline data of this type is available, meaningful alert systems can be devised. Abatement of the source pollutants can be attempted when metals levels rise by statistically significant amounts.

It has been well-known to medical scientists for a number of years that oysters contained large amounts of cadmium when compared with other foods. Cadmium can produce a wide range of adverse effects in man and animals when the intakes are in excess of typical population exposures. Based on present knowledge of dietary intakes of cadmium we can see no particular problems resulting with regard to oysters.

These are some of the regulatory problems we are concerned with at FDA. We have not touched on the problems associated with oil spills in food producing areas, the problems associated with processing in smoked fish which may contain botulism spores, or nitrosamine formation when nitrites are used in fish processing. There is a common trend with all the problems we face now or anticipate in the future. There is a common deficiency of knowledge to adequately define problems. We need a great deal more toxicological, analytical and engineering information before we can come close in every case to the goal of industry and government, a pure wholesome and safe fisheries product.

Definite positive steps are underway, however, to solve many of the major fisheries problems, at least as they relate to FDA. While the scope of many of these problems is very broad, FDA stands ready to work with anyone, individuals, firms or trade associations, in achieving our goal of consumer protection through product integrity.

Industry Activities in Response to the Heavy Metals Problem in Seafoods

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Just a year ago at this meeting, I was of the very premature opinion that the "mercury in fish" problem was solved. The summer months of 1970 had seen a series of discoveries in various fresh water fish of mercury presence above the Food and Drug Administration (FDA) guideline of 0.5 ppm. In each case, the action step had been the same — close the offending body of water. Simultaneously, or later in some cases, officials took action to shut off the sources of mercury.

We had a pollyanna attitude that mercury in fish was an isolated problem caused by nasty industrial polluters. We believed that the impact on the fish industry would be minimal, causing loss of a few fish temporarily. Victims would be a few score of individual fishermen who were unfortunate to have selected Lake Erie, Pickwick Reservoir, Brunswick estuary or some similar spot, as the location to attempt to earn a living by catching fish. We calculated the damage from the fresh water mercury discoveries and determined it meant loss of only a small percentage of our supply — a percentage that could be written off on an industry-wide basis without too much difficulty.

These ostrich-like attitudes were shattered rather abruptly in early December (1970) with the disclosures to the press by chemist McDuffy that his analyses of commercial canned tuna fish and frozen swordfish showed over the guideline.

The industry belatedly realized that the mercury problem was for real — now that it involved one of our very largest volume fish products, and one of the staples in the frozen fish trade.

The tuna industry, through efforts of the individual packers, the Tuna Research Foundation and the National Canners Association, established testing procedures to check out all lots in inventory, with the intent of segregating those fish which could not meet the guideline. The FDA, of course, was working overtime also, to monitor activity by the domestic packers and to directly handle the imported pack. The end result was the loss of only a very small percentage of the inventory.

The swordfish problem was not as easily salvaged. Upon notification that swordfish sampled by the FDA showed approximately 50% to be over the guideline of 0.5 ppm, with some reaching levels three and four times the guideline, the industry members through NFI, to which most major swordfish dealers belong, took several immediate steps.

The *first,* and perhaps most effective action, was notification of overseas producers that all new shipments should cease. Since 95% of the swordfish was imported, this action was of great significance.

Second, shipments already on the water were either returned to home ports or held at the port-of-entry for testing. I might add, FDA would have seen to that even if the industry hadn't agreed to it.

Third, testing began on the cold storage inventory, estimated to be anywhere from 2 to 4 million pounds. This step proceeded slowly because of lack of

laboratory facilities. Further disillusion occurred when analyses revealed that the mercury levels were too high. There was no way of segregating under guideline from over guideline fish, since almost all were over the guideline. Trade was essentially shut off.

The FDA then began the task of sampling and testing warehouse stock. The FDA tests very rapidly confirmed the reluctant decision that virtually the entire inventory was unacceptable. The total known inventory was almost completely accounted for. It was either seized, embargoed or voluntarily kept from the market.

A very small amount of trade evidently continued, since the FDA found some stock in the stores and restaurants. This resulted in the FDA public recommendation that the public not eat any swordfish. This was a disastrous announcement, whose reason still escapes me.

In the meantime, however, other problems remained. For example, what to do with several million pounds of frozen swordfish that the nation's health authority said was unsuitable for sale? The product could not be fed to animals, since that use was also forbidden by the FDA. It was not legal to attempt any sort of blending operation, that is, to mix a product with little or no mercury content with the high analyses fish in an effort to reduce the average. Even just dumping the product was a problem since anti-pollution laws prevented burning it or dumping it into the sea. A few companies decided the easiest way out was to let the FDA seize the product, since the courts then had the problem of disposal. However, this step was not acceptable, for economic reasons, to any firm with any quantity of product. Several companies had inventories in excess of $250,000. The end result was organization of a swordfish negotiating committee within the NFI, which carried on a short-term exchange of correspondence with the Frozen Fish Export Association of Japan. The exchange boiled down to a single issue—who was going to bear the brunt of the costs involved in shipping millions of pounds of swordfish back to Japan? The product could be remarketed in that country, which does not agree with the FDA as to the significance of mercury in fish. However, normal marketing channels did not exist.

In the end, the product was disposed of mostly by returning it to Japan. Some was shipped to other nations with similar attitudes to mercury. In no case did the U.S. company recover all its costs. Several firms are still attempting to recover from their losses which exceeded $100,000. All told, we estimate losses from the swordfish inventory disposal to exceed $1-million.

What I've described thus far has been the "bail out" action taken by the industry. Concurrent with these actions were many meetings, discussions and finally, decisions. Initial attitudes of people in the swordfish business were not very peaceful. Several firms felt the Association, or individuals, should challenge the FDA guideline in court. This move was discarded as being impractical and unnecessary. We felt that if the evidence could be produced that would convince a judge that the guideline was wrong, then that same evidence would convince the FDA to reevaluate the guideline, without the need for court action.

While the details of the swordfish problem consumed a great deal of time and effort on the part of the industry, their resolution does nothing to solve the more deep rooted difficulties, that of heavy metals in fish generally. Concurrent with the work described thus far, a more comprehensive, more important program was taking shape. This is a long-term program involving industry sponsored action and coordination with that under way by organizations outside the industry.

I think we can categorize the work in three distinct, but interrelated, fields: (1) *Assessment* — projects aimed at determining the extent of metal presence in fishery products; (2) *Investigative* — projects seeking an understanding of the true nature of the problem; i.e., what is the relationship of heavy metals in fish to health of fish consumers and (3) *Public Relations* — communications action designed to convey better understanding of the actual situation and solicit appropriate government response.

The assessment concern, of course, was immediate. Did we have another swordfish problem on our hands? Immediately after the swordfish difficulty emerged, NFI commissioned a rapid, superficial survey of all key fish products to see which other species might be affected by presence of mercury at levels near or over the guideline. The survey also covered five other metals (arsenic, silver, cadmium, selenium and lead).

The findings did not cause any alarm since none of the species tested showed consistent over guideline results for mercury. For other metals, we decided there would not be any major problems. However, less than 75 samples were tested so the results are not conclusive. The project served to point out several less important species which would be borderline for mercury, and that other metals had not reached generally alarming stages.

Concurrent with the industry surveys were more comprehensive product samplings by the FDA, the National Marine Fisheries Service (NMFS), state governments and several overseas governments.

The FDA surveyed about 20 major products at the wholesale level. From this came seizures of imported snapper. As of this time, no further action has been taken. In fact, Commissioner Edwards released a statement through the NMFS recently in which he reaffirmed that there were no problems with any marine fish other than swordfish.

NMFS has two major surveys under way: (1) a survey of 34 processed fishery products for the presence of mercury, lead, arsenic, cadmium and chromium and (2) a survey of approximately 100 species of commercial and recreational fish and shellfish taken from all U.S. fisheries, for mercury and other heavy metals.

The processed product survey is 90% completed. It is expected that full results will be in before the end of the calendar year (1971). The 100-species survey, overall is only about 10% completed. However, the completed segments of this survey include in-depth analyses of species and products of high commercial and recreational importance.

The in-depth studies turned up various problems. Generally, there was an association between size of individual fish within a species group and the degree of mercury presence. Also, there were geographical variances, such as found in halibut where the fish being caught immediately in the coastal areas of Alaska and Washington showed some problems, with the rest of the species being generally clear.

All of these surveys, plus those conducted by the state governments and foreign governments, from time to time generated flurries of activity in other species. I've mentioned seizures of imported snapper. There were problems with large northern lobsters until the procedure was established to analyze all meat, rather than just a portion of it. The most significant problem was in the halibut industry. This was solved by an industry testing program and rejection of very large fish from certain areas. We may still run into a few problems with several other species, but hopefully the investigative activities of the research have flushed out all potential problems.

The second area of research is investigation. With the knowledge that the present 0.5 ppm guideline presents serious problems to the tuna industry, wipes out swordfish and certain fresh water species businesses, complicates halibut production and sales and could be serious for certain other species, it is essential that the relationship of mercury in fish to the health of fish consumers be determined.

The present U.S. guideline is based on the history of illnesses and deaths caused by presence of methyl mercury in fish and shellfish consumed by people in Minimata and Niigata, Japan. The best available data indicates two or three of the symptomatic cases in Niigata had mercury levels of 0.2 ppm in their blood. Using a no-effect safety factor of 10, it was determined that mercury levels should be held below 0.02 ppm. Swedish data indicate a 70 day half-life of mercury in humans. This was translated by some to an acceptable daily intake (ADI) of 0.03 mg for a 150 pound person. In the course of a year, this amounts to .03 mg x 365 or 11 mg. Forty-eight pounds of fish with a mercury level of 0.5 ppm will contain 11 mg of mercury. At a third of a pound per serving, this means 144 meals, all of fish containing maximum guideline levels of mercury.

Several very important questions remain unanswered.

(1) Will mercury-blood levels in excess of 0.2 ppm indeed cause symptoms? The three reported cases of Niigata seem to be exceptions. Other cases there showed considerably higher levels. Further, in our opinion, the method of analysis used at Niigata is suspect. This could explain why symptoms have not been detected in persons whose mercury-blood level exceeded 0.2 ppm, such as was the case in Sweden.

(2) Will consumption of fish as part of a balanced adequate diet, as opposed to an all fish subsistence diet, such as occurred in Japan, cause the same build up of mercury in the human system?

(3) Does the consumption of fish whose mercury level is relatively low — 0.2-1.0 ppm — result in mercury build up in the system in the same relationship as that caused by very heavily contaminated fish (5-20 ppm) as was the case in Japan? Reports of the Anti-Coronary Club analyses by the New York Health Department raise questions of this kind.

(4) Is the mercury found in deep water marine species identical in toxicity and availability to that found in areas where pollution by industrial discharge is the cause?

(5) Could the Japanese cases have been caused by more than methyl mercury? The bodies of water were polluted by other chemicals as well. Is there perhaps a synergistic effect yet undiscovered?

Lack of answers to the above and other questions is the reason why the ADI of 0.3 mg must be considered as an interim judgment. In addition to questions relating to the ADI, there is also a serious question as to relationship of the guideline to the ADI, i.e., what is the likelihood of exceeding the ADI when the guideline is 0.5 ppm as opposed to 0.7 ppm, 1.0 ppm, etc.? As has been pointed out, a consumer of 48 pounds of fish annually, all of which contained 0.5 ppm mercury, would reach the ADI. However, all fish do not contain 0.5 ppm, and relatively few people consume 48 pounds of fish annually. In other words, what is the relative risk of exceeding the ADI if the guideline were 1 ppm? To answer the question, one must know consumption patterns and levels of mercury in various species. The NMFS is constructing a computer program that analyzes the mercury exposure in a 1,500 household sample. Total fish consumed by

household is tabulated by variety. Typical mercury levels are assigned to each variety. The result should provide some indication of risk at various guideline levels. The report is expected within 6 months.

The answers to the earlier questions require longer term research. We are attempting to remain informed as to projects under way at universities and government labs. A survey has been conducted which produced considerable data.

Some of the more pertinent projects include: (1) Work by Dr. A. J. Liston, Food and Drug Directorate of Canada, who is conducting chronic studies with rats, cats and guinea pigs to determine an ADI for both mercury and cadmium. (2) Work at the Medical Research Council Laboratories, Carshalton, Surrey, England, where Dr. L. Magos is determining the highest daily dose of methyl mercury which at steady state is not toxic to the brain. (3) New York Health Department study of anti-coronary club consumers which showed no difference in mercury-blood levels between this group, which has a long time fish eating history, and others in the population. (4) Dr. Hochberg at the National Institute of Health in Atlanta studied mercury levels in the hair and blood of Pribiloff Island Indians who consume large quantities of seal liver and meat. (Seal liver has a very high mercury content.) Even though mercury-blood levels were reported above those which supposedly would accompany symptoms, no clinical symptoms were detected. (5) Likewise, a study directed by Dr. Morrison of the Food and Drug Directorate of Canada, has been unable to detect symptoms in natives of north central Canada who eat large quantities of fish from lakes with a high mercury content. This is a rather extensive study of more than 10,000 individuals which is not completed. (6) A most unusual study is that reported October 13 at the American Public Health Association convention. Michigan medical researchers tested tissues from cadavers dating back to 1900. Their conclusions were that mercury levels in Americans have decreased since 1913.

A short list of these and other projects under way is appended to this paper.

The third major industry work area has been in public relations. The press treatment during the first quarter of 1971 was devastating. Unfortunately, the coverage very often was sensational and inaccurate, painting all fish with the same broad brush. The need for counter public relations was evident.

The basic tool in our work to change opinions of key members of the public has been an "influentials" mailing program. A list of 2,400 editors, consumer group leaders, educators and others has been receiving on a monthly basis, brief memos covering news clippings that report a more comprehensive view of the problem. This program was initiated in January, and we think it has been quite beneficial. Our strategy was to give the widest circulation possible to positive authoritative statements from others, rather than to attempt to be information sources ourselves. The October 1971 mailing, for example, included a clipping on the American Public Health Association's report of declining mercury levels.

Other aspects of the program included a series of network and syndicated radio interviews; and most importantly, a spirit of full cooperation with the press. We answered questions as completely as we knew how and tried to show that our industry was facing a problem in a public minded manner, to assure the consumer that his welfare was being protected.

There is no doubt the industry was damaged by the mercury incidents. We lost a sales volume of $25 million a year in swordfish. Individual swordfishermen lost their livelihood. Some food chains, depending heavily on swordfish, lost sales volume of 20-25% that have not yet recovered.

The overall impact is greater than swordfish, however. Retail fish sales generally remain sluggish, almost a year after the problem broke. Of course, prices and short supplies contribute to this. However, the steady increase in per capita consumption enjoyed during the past 3 years will be reversed this year.

Sales, of course, are only part of the story. There's a feeling of uncertainty that cautions against major investments in inventories. This, in turn, prohibits concentrated promotions and other volume activities, which are the only means of achieving overall industry growth. Hopefully, we can regain industry progression during 1972, if we aren't beset by other problems.

My final point is to touch briefly on legislative needs. Very simply, I don't believe the discovery of a potential hazard, such as mercury in swordfish, should have cost the industry the millions it did. Somehow, precipitous action, of the type we experienced, should be avoided. We are relying on the Fishery Product Inspection legislation to avoid abrupt actions, but rather to allow timely discovery of potential problems and to find solutions prior to reaching the precipice.

We also feel that some form of compensation program is needed to protect the fisherman and others in the industry against bankrupting losses. Finally, the water quality laws need strengthening. Hopefully, the current congressional work in this area will bear fruit.

From these experiences I have drawn several conclusions. They serve only to show we are headed in a single direction. (1) The accumulation of research results should continue. At some point, if results continue to be favorable, FDA should be informally approached to discuss a guideline modification or a change in its interpretation. (2) If research appears lacking in any key area, industry should either sponsor same or find a sponsor. (3) Pressure on NMFS should be continued and increased to accelerate its research. (4) Favorable results should continue to be circulated to influentials. (5) Compensation legislation attempts should be continued. (6) The Hart Bill should be supported.

We would hope that the end result of these experiences will enable our society to benefit in the future. Humans, swordfish, metals are all part of nature. New facets of our interrelationships will continue to be found. Our need is to gain true understanding in a more sophisticated, less frightened manner.

APPENDIX

A Partial Listing of Current Mercury Research

Absorption and Elimination of Dietary Mercury. . . .
Dr. J. K. Miettinen - University of Helsinki, Helsinki, Finland

Automated Methodology for Mercury Analysis. . . .
Dr. Roger G. Herdman - New York State Department of Health, 84 Holland Avenue, Albany, NY 12206
Dr. A. B. Morrison - Food and Drug Directorate, Tunneys Pasture, Ottawa, Canada

Biotransformation of 203 Labled Mercury. . . .
Dr. Thomas W. Clarkson - University of Rochester, Rochester, NY
Dr. T. Norseth - Institute of Occupational Health, Oslo, Norway

Distribution of Mercury and Cadmium in Estuarine Environment. . . .
Dr. Theodore J. Kneip - New York University Medical Center, 550 First Avenue, New York, NY 10016

Determination of A.D.I. for Mercury and Cadmium. . . .
Dr. A. J. Liston - Food and Drug Directorate, Tunneys Pasture, Ottawa, Canada
Dr. L. Magos - Medical Research Council Laboratories, Carshalton, Surrey, England

Distribution of Mercury and Cadmium in Plants Algae and Bacteria. . . .
Dr. J. Barber - Imperial College of Science and Technology, London, England

Embrionic Toxicology of Mercury. . . .
Dr. Robert W. Miller - National Cancer Institute, Bethesda, Maryland 20014

General Investigation of Mercury. . . .
Dr. D. C. Fang - Oregon State University, Corvallis, Oregon
Dr. J. B. Hook - Michigan State University, East Lansing, Michigan
Dr. T. T. Kurland - Mayo Clinic, Rochester, Minnesota
Dr. Bernard Weiss - University of Rochester, Rochester, NY 14602

Mercury in Birds — Predatory, Fish Eating, and Waterfowl. . . .
Mr. J. A. Keith - Canadian Wildlife Service, Ottawa, Canada

Mercury and Cadmium Brain, Liver and Kidney Damage, and Recovery. . . .
Dr. Bernard Weiss - University of Rochester, Rochester, New York

Monitoring Body Burden of Mercury in Populations. . . .
Dr. T. B. Eyl, 3227 Mayer Drive, St. Clair, Michigan 48079
Dr. Hochberg - Center for Disease Control, Atlanta, Georgia 30333
Dr. A. B. Morrison - Food and Drug Directorate, Tunneys Pasture, Ottawa, Canada

Natriuretic Effect on Kidneys Caused by Mercury. . . .
Dr. B. R. Neckay - University of Texas, Galveston, Texas

Neutron Activation Analysis for Mercury and Other Heavy Metals. . . .
Dr. Theodore J. Kneip - New York University Medical Center, 550 First Avenue, New York, NY 10016

Protein (Enzyme Synthesizing Systems) Effect of Mercury on Liver, Kidney and Brain. . . .
Dr. Paul Brubaker (NIEHS) P. O. Box 12233, Research Triangle Park, North Carolina 27709

Renal Regeneration After Toxic Dose of Mercury and Effects of Acute and Chronic Loading of Mercury. . . .
Dr. Wallace G. Campbell, Jr. - Emory University, Woodruff Building, Atlanta, Georgia 30322
Dr. Francis Binkley - Emory University, Woodruff Building, Atlanta, Georgia 30322

Renal Toxicity of Heavy Metals — Mercury and Cadmium. . . .
Dr. E. C. Faulks - University of Cincinnati, Cincinnati, Ohio

Restoration of Mercury Contaminated Lakes and Rivers. . . .

Dr. A. Jernelov - Institute for Air & Water Pollution, Stockholm, Sweden
Dr. Lars Landler - Swedish Water & Air Pollution Laboratory, Stockholm, Sweden

Teratological Effects of Mercury. . . .

Dr. Richard Doherty - University of Rochester, Rochester, New York

Toxicity of Mercury — Gross and Subcellular. . . .

Dr. Bertram D. Dinman - University of Michigan, Ann Arbor, Michigan 48104
Dr. T. Norseth - Institute of Occupational Health, Oslo, Norway
Dr. Ronald Klein - National Institute of Environmental Health, Research Triangle Park, North Carolina 27709

Turnover of Mercury in Aquatic Systems. . . .

Dr. A. Jernelov - Institute for Air & Water Pollution, Stockholm, Sweden

Microbial Survey of Imported Shrimp[1]

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INTRODUCTION

Importation of frozen shrimp is a multimillion dollar industry in the United States. In 1970, imports accounted for 53% of the U.S. shrimp supply (218.7 million pounds) valued at over 200 million dollars (Anonymous, 1971). These shrimp are often suspected of contributing excessive microbial loads as well as enteric pathogens to the processed shrimp products. However, little or no data has been reported to support these charges. Most bacteriological surveys (Green 1949a,b,c,d; Williams et al. 1952a,b; Silverman et al. 1961 and Carroll et al. 1966) have been conducted using only domestic fresh and frozen products. This study was designed to provide data on the microbial quality of imported frozen raw shrimp.

METHODS

Forty-six imported frozen samples representing 17 countries and four domestic fresh samples were collected from three Florida seafood plants (Table 1). The imported samples were of two types: frozen headed (24 samples) and frozen peeled and deveined (P + D) samples. Fresh samples were usually analyzed within 4 hr of receipt, while frozen samples were stored at -20C until thawed for analyses.

A total of four subsamples from each sample were prepared for analyses as follows: three 50 g subsamples were homogenized separately by Waring blender for 2 min in the following diluents: 450 ml phosphate buffer, 50 ml distilled water and 225 ml double strength gram-negative enrichment broth (GN). The buffered phosphate water homogenate was used to inoculate standard plate count agar (SPC); trypticase sulfite neomycin agar (TSN) for *Clostridium perfringens;* trypticase soy broth with 10% sodium chloride (10% TSB) for coagulase positive staphylococci; lauryl sulfate tryptose broth (LST) for coliforms and *E. coli;* Kenner's fecal streptococcal agar (KF) for enterococci; and antibiotic potato dextrose agar (APD) for yeasts and molds. The distilled water homogenate was used for measuring the pH of the shrimp tissue immediately after preparation. *Salmonella* and *Shigella* (SS) analyses began with enrichment in the GN broth homogenate. This homogenate was washed into a sterile flask with 225 ml sterile distilled water and incubated for 24 hr at 32C. The fourth subsample (25 g) was homogenized with 225 ml glucose-salt-teepol broth (GSTB) for 2 min in a Waring blender for *Vibrio parahemolyticus* analysis.

Total plate counts were conducted by the American Public Health Association (APHA) method (American Public Health Association, 1970). Triplicate pour plates per dilution were prepared with SPC agar using 1 ml aliquots of serially diluted buffered homogenate. Incubation was at 22C for 5 days.

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[1] Florida Agricultural Experiment Station Journal Series No. 4156.

TABLE 1
Distribution by Country of 50 Imported and Domestic Shrimp Samples

Country	Number of Samples
India	11
Panama	7
United States	4
Venezuela	4
Mexico	3
Saudi Arabia	2
French Guiana	2
Trinidad	2
Guatemala	2
Pakistan	2
El Salvador	2
Thailand	2
Costa Rica	2
Guyana	1
Taiwan	1
Iran	1
Kuwait	1
Honduras	1

Yeasts and molds were isolated on APD agar (Koburger, 1968). Triplicate pour plates per dilution were prepared with 1 ml aliquots of the serially diluted buffered homogenate and incubated for 5 days at 22C.

Coagulase positive staphylococci were selectively enriched by inoculation of 1 ml aliquots of the serially diluted phosphate buffered homogenate into a 3-tube most probable number (MPN) series of 10% TSB. Loopfuls from 10% TSB tubes showing turbid growth after incubation for 48 hr at 32C were streaked onto Vogel Johnson agar (VJ). The VJ plates were then incubated for 48 hr at 32C. Coagulase tests were performed on the isolated colonies obtained from the VJ plates as the final confirmatory step.

The APHA method for examination of seawater and shellfish (American Public Health Association, 1970) was followed for total coliform and fecal coliform analyses. Incubation temperatures were, however, changed to 32C instead of the recommended 35C.

Presumptive enumeration of enterococci was on triplicate KF agar pour plates. Ten representative colonies were picked from countable plates of each sample and confirmed as enterococci if they were capable of growth in brain heart infusion broth (BHI) containing 6.5% salt, growth at 10 and 45C in 3 days, and were capable of reducing 0.1% methylene blue milk. Confirmed enterococci counts were calculated by multiplying the percentage of the ten colonies from each sample which were confirmed as enterococci times the presumptive count.

Clostridium perfringens was recovered on triplicate TSN agar pour plates anaerobically incubated for 24 hr at 45C in gas-pak Brewer jars. Nonmotile, obligately anaerobic cultures capable of reducing nitrate to nitrite and producing a stormy fermentation in iron milk medium were reported as confirmed *Clostridium perfringens.*

A double selective enrichment procedure was used for the isolation of SS.

A 10 ml aliquot from the GN enrichment broth homogenate incubated for 24 hr at 32C was pipetted into 90 ml tetrathionate broth (TT). The TT broth was incubated 24 hr at 32C. Loopfuls of this broth were then streaked onto three plates each of xylose lysine desoxycholate (XLD) and SS agars, and both sets of media were incubated for 24 hr at 32C. Representative isolated colonies on these media were then confirmed using American Organization of Agricultural Chemists (AOAC) methods (Anonymous, 1967). The final confirmatory test for *Salmonella* was a slide agglutination test with polyvalent somatic antiserum. *Salmonella* cultures were then sent to the Florida State Department of Health for species determination.

Vibrio parahemolyticus was enriched in the GSTB homogenate for 24 hr at 32C. Loopfuls of this homogenate were then streaked onto three plates of previously prepared thiosulfate-citrate-bile-salts agar (TCBS) and incubated at 32C. Suspected *Vibrio* colonies were confirmed biochemically.

Lower incubation temperatures and mildly selective enrichments were used whenever possible in this study to reduce the combined stresses of temperature and the action of inhibitory agents on the debilitated micro-organisms which survived the rigors of freezing. For this reason, an incubation temperature of 32C was used in place of the usually recommended 35C for many of the above analyses. Also, the total plate count was determined after 5 days at 22C since this temperature produced higher counts than 35C.

RESULTS

Imported frozen headed shrimp samples as a group had lower total plate counts, fecal coliform counts and enterococci than the P + D samples. The four fresh samples had greater numbers of coagulase positive staphylococci and higher coliform counts than either headed or P + D samples.

Total plate counts: Fifty percent of all the samples had total plate counts greater than 1,200,000 per gram, with the range being from 1,800 to 30,000,000 per gram. Imported P + D samples had the largest average and geometric mean count of all three groups of samples (Table 2). While the headed samples had a high average count of 3,200,000 per gram, this group also had the lowest geometric mean count (420,000 per gram). Seventeen P + D samples (77%) had total plate counts greater than 1,000,000 per gram compared to only nine headed samples (38%). Also, 55% of the P + D samples had counts greater than 2,000,000 per gram, while only 33% of the headed samples recorded counts greater than this number.

Yeasts and molds: The average yeast and mold count for all samples was 750 colony forming units (CFU) per gram, with a range of 10 to 17,000 CFU per gram. Greater than 95% of the P + D samples and 87% of the headed samples had less than 1,000 yeasts and molds per gram. The sample with the 17,000 CFU per gram exhibited a musty and earthy odor.

Staphylococci: Coagulase positive staphylococci MPN's were uniformly low, ranging from 0 to 230 per gram for all samples. Headed samples had the lowest numbers, while fresh samples had the greatest numbers of staphylococci (Table 2). Twelve headed (50%) and nine P + D samples (41%) were negative for coagulase positive staphylococci, whereas 46% of headed and 42% of P + D samples recorded MPN's from 1 to 100 per gram.

Coliforms: Coliform data was divided into total coliform MPN's and fecal coliform MPN's. Total coliform MPN's ranged from 0 to 4,300 per gram (Table

TABLE 2
Some Quality Observations on 50 Imported and Domestic Shrimp Samples

	Frozen Headed (24)	Frozen P + D (22)	Domestic (4)
	organisms per g		
Total Count			
range	1,800-30,000,000	130,000-9,300,000	250,000-1,600,000
average	3,200,000	3,300,000	840,000
geometric mean	420,000	1,900,000	670,000
Staphylococcus			
range	0-150	0-230	0-230
average	18	48	60
Coliforms			
total			
average	80	62	2,000
range	0-1,100	0-430	0-4,300
fecal			
average	1.8	2.6	62
range	0-40	0-43	0-230
Enterococci			
average	6,300	27,000	6,700
range	0-120,000	0-340,000	93-19,000
Yeasts & molds			
average	1,000	380	1,100
geometric mean	190	230	1,000
range	10-17,000	30-1,600	640-1,400
	pH		
pH			
range	7.1-8.0	6.7-7.5	7.1-7.7
average	7.4	7.1	7.4

2) with an average of 230 per gram for all samples. Twenty samples were negative for any coliforms, while only one imported headed sample had an MPN greater than 1,000 per gram. Fresh samples had the highest total coliform numbers of all samples tested.

Fecal coliform MPN's were lower than the total coliform MPN's (Table 2). The overall range was from 0 to 230 per gram with maximum MPN's of 40 and 43 per gram for headed and P + D samples, respectively. Only eight samples contained fecal coliforms. *E. coli* was isolated from four samples, *Enterobacter aerogenes* from six samples and both microorganisms from two samples. Imported headed and P + D samples had a 10-fold lower average MPN than fresh samples.

Enterococci: Confirmed enterococci counts averaged 16,000 organisms per gram, with a range of 0 to 340,000 organisms per gram (Table 2). P + D samples,

as a group, had 10-fold higher counts than either headed or fresh samples. Seven samples (14%) were negative for enterococci, and of these, six were headed samples and one was a P + D sample. Twenty-three headed samples (96%) had 10,000 or less enterococci per gram compared to only 12 P + D samples (55%).

Salmonella, Shigella, Clostridium and Vibrio: Only one sample (P + D) contained *Salmonella.* This isolate was identified as *S. lexington.* A *Clostridium perfringens* count of three organisms per gram was recorded for a headed sample, while *Vibrio parahemolyticus* and *Shigella* were not detected in any of the samples.

Shrimp tissue pH: Shrimp pH values ranged from 6.7 to 8.0 for all samples (Table 2) with no apparent relationship to microbial counts.

DISCUSSION

Table 2 shows that both headed and P + D samples had average total plate counts in excess of 3,000,000 per gram. However, the geometric mean count data showed that P + D samples actually had 10-fold higher counts than headed samples, while headed and fresh samples had comparable counts. The higher counts for P + D samples can be explained in several ways. First, there is considerably more handling during processing of P + D samples than headed samples. Poor sanitary habits of workers and/or improperly sanitized machine surfaces may have been sources of contamination. Secondly, during removal of the exoskeleton the natural shrimp microflora may have been partially replaced by land microorganisms (Pedraja, 1970). These contaminants, as well as some of the remaining natural flora, may then more easily attack the shrimp tissue. However, removal of the exoskeleton should have resulted in reduced microbial numbers.

The total count data is in agreement with other studies. Approximately 31% of the samples in this study had counts of 500,000 per gram or less compared to 36% for Kachikian et al. (1959); 36% for Silverman et al. (1961) and 39% for Carroll et al. (1966). Also, the range of counts for this study was smaller than that reported by Kachikian et al. (1959), but larger than that reported by Silverman et al. (1961). Freezing appeared to have had a debilitating effect on yeasts and molds (as it undoubtedly had on other organisms), since the counts for frozen samples were lower than the counts for fresh samples. However, it should be noted that only four fresh samples were used in this study.

Coagulase positive staphycoccal MPN's were low with 22 samples recording negative counts. One should consider, however, the possibility that the MPN's were low because these microorganisms are easily overgrown by competing organisms during enumeration.

The significance of enterococci in a raw frozen shrimp product is not known with any certainty. Varga and Anderson (1968) showed that enterococci are capable of multiplying in lobster and fish residues on inadequately sanitized machine surfaces. Extremely high counts would, therefore, lead one to suspect poor sanitary procedures. It should be noted that 96% of the headed samples had counts less than 10,000 enterococci per gram as compared to only 59% of the P + D samples.

Total coliform MPN's indicate that the imported headed and P + D samples analyzed had markedly lower counts than fresh samples. This undoubtedly is the result of freezing on these organisms. Both *Enterobacter aerogenes* and *E. coli* were isolated in this study, their low numbers indicating that fecal contamination was minimal.

Only one sample (P + D) was found to contain *Salmonella*, and *Shigella* was not detected in any of the samples. These results may indicate that the salmonellae and shigellae were too debilitated to survive the selective enrichments. It is more likely, however, that the data is correct, indicating little enteric pathogen contamination in these imported products.

The importance of *Clostridium perfringens* as a food poisoning organism has been widely demonstrated in recent years. The detection of only one positive sample at a level of three organisms per gram is not surprising since the vegetative cells of this organism are very susceptible to freezing. From the data it would appear that the organism is, therefore, of little importance in these imported frozen samples.

Vibrio parahemolyticus, while not demonstrated in these samples, has been isolated from shrimp and other shellfish by several researchers. This organism is also extremely susceptible to freezing and this fact may account for our failure to isolate it from the samples examined.

Shrimp tissue pH did not appear to be a useful indicator of shrimp quality as pH values did not correlate well with total plate counts. This indicates that factors other than bacterial activity will affect the pH of shrimp tissue.

SUMMARY AND CONCLUSIONS

Headed samples, as a group, had lower total plate counts, fewer fecal coliforms and fewer enterococci than P + D samples. P + D samples had fewer yeasts and molds, fewer total coliforms and a lower average pH than headed samples. The four fresh samples had more yeasts and molds, more coagulase positive staphylococci and more coliforms and fecal coliforms than the frozen imported samples. P + D samples had the highest average enterococci counts while headed and fresh samples had approximately equal counts.

On the basis of the results described above, a number of conclusions can be drawn. The principle one being that imported shrimp, as well as domestic, entering a plant must be considered as potential sources of inoculum for equipment and product. While the levels of contamination were generally low (except for total counts), the presence in these products of organisms of public health significance must be taken into consideration during the handling of the product to avoid cross contamination. Salmonellae and coliforms usually can be adequately controlled by the use of chlorine rinses, however, the more resistant nature of the staphylococci to this sanitizing agent makes it imperative that the product entering the plant contain low levels of this particular organism.

Since the complete history of the products analyzed in this study is not known, it is rather difficult to speculate as to what would be an acceptable total count on the basis of this work.

A number of factors contribute to the microbial load on shrimp; i.e., normal flora, water quality, icing and sanitation. The most important ones being adequate icing and sanitation. If imported shrimp are to continue contributing to the U. S. domestic market, steps to improve the microbial quality of these shrimp must be instituted.

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Fish Poisoning in the Eastern Caribbean

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INTRODUCTION

"When I first got here I thought that I'd be able to practically exist on fish.....";"I was poisoned 15 times before I left my father's house: he always liked to buy the big fish because there was more meat.....";"I can't get a contract for grouper or snapper with any of the hotels: they buy the same fish from Santo Domingo for 10 cents a pound more.....";"Where are all the seafood restaurants? I thought this was an island....." These comments and others like them represent a biotoxicological problem which has always plagued the eastern Caribbean. Ciguatera fish poisoning, scombroid poisoning and to a lesser extent "clupeoid", tetraodontoid and elasmobranch poisoning have been reported since pre-Columbian time and the problem shows no sign of lessening.

This paper will present the basic facts of fish poisoning in the eastern Caribbean area as we presently know them. It will not attempt to review the voluminous literature from the Pacific; the reader is referred to excellent summaries of Halstead (1967) and Banner (1971). At the present time we have very little "hard data" on the chemistry, biogenesis and biology and pharmacology of the fish poisoning problem in the area. We have yet to confirm that the most important type of poisoning, ciguatera, is in fact identical to the toxin from the Pacific. The sections on ciguatera are therefore based on our local observations and inferences from studies in the Pacific are noted.

TYPES OF FISH POISONING

Fish poisoning in the eastern Caribbean can be broken down into three major groupings. The endotoxins from the puffer-like fishes with the additional rarely reported cases of clupeoid, elasmobranch and hallucinogenic fish poisoning form the first group. These incidents represent a very small percentage of the total number of cases reported; several years of casual data-gathering and 6 months of active research have only producted two accounts in the last 4 years, both of clupeiotoxism.

The biology, chemistry and pharmacology of puffer fish poisoning have been accurately summarized elsewhere (Bagnis, 1970). Although the world-wide fatality rate is high (61%), very few cases of tetraodon poisoning are reported in the Caribbean, probably because the puffers are not highly esteemed as a food fish. This may also be the reason for the low incidence of reports of elasmobranch poisoning in the area. Shark has been harvested recently in an effort to produce a packaged seafood product ("Sea Flake") with generally good customer acceptance; there have been no instances of elasmobranch poisoning brought to our attention as a result. Hallucinatory fish poisoning (icthyoallyeinotoxism) is also an apparently rare event in the eastern Caribbean; it has been described to us by an herbalist on St. Thomas but an actual case history has not been received.

Clupeoid poisoning is a form of icthyosarcotoxism caused by ingestion of the flesh of fishes of the order Clupeiformes. The symptoms are frequently violent with an extremely high case fatality rate. The onset of symptoms is noted with a sharp, metallic taste in the mouth followed rapidly by severe gastrointestinal upset with distinct indications of vascular collapse (drop in blood pressure, cyanosis). This may be accompanied or rapidly followed by neurological disturbances (nervousness, dilated pupils, violent headache, tingling) and in severe cases respiratory distress, convulsions, coma and death. The toxin is apparently particularly virulent: death may occur within 15 minutes. The literature reports that persons have died while in the act of eating the fish — "part of the fish was still in the victim's mouth at the time of death" (Halstead, 1967).

Fish in the families Clupeidae (herrings), Engraulidae (anchovies), Albulidae (bonefishes) and Elopidae (tarpons) have been reported as toxic in the Caribbean; our experience has been limited to two cases involving the clupeoid fishes *Harengula humeralis* (yellow-billed sprat) and *Opisthonema oglinum* (thread herring). One case is reported from a fisherman on Tortola, B.V.I. who (with his family of five) ate "yellow bill sprat" (probably *Opisthonema oglinum* from his description of a "spine on the back fin") caught in Great Harbor, Peter Island, B.V.I. He reported "bad fish poisoning" symptoms generally similar to ciguatera poisoning: the rapid onset reported above was present. He forced all of the members of his family to vomit and all took a "heavy dose of sulphur" (a patent medicine). He did not contact local public health authorities. The family recovered from acute symptoms within 36 hours. (This incident took place in late 1967 and was reported in April 1971; the interview was thus clouded by time and at least two subsequent incidents of ciguatera poisoning.) The second case is reported by Halstead (1970) from Antigua, W.I. from 1968 (?) when "some small surface-feeding 'herring-like' fish were eaten." Two people died in this outbreak. Halstead suggests that local terminology of "yellow-billed sprat" is applicable to *Harengula humeralis*. The violence of the episode suggests that this case was an example of classic clupeiotoxism while the Tortola case is not definitely separable from ciguatoxism.

The chemical nature and biogenesis of clupeiotoxism is not presently known. Numerous authors have suggested that fish caught during the summer months are more likely to be toxic. All reported incidents are from fish caught close to tropical islands. There are several references in the literature to planktonic blooms as the causative organism, specifically a "monad" (dinoflagellate?) (Halstead, 1967); *Skujaella* (=*Trichodesmium*) (Randall, 1958) or to "swarming of palolo worms" (Halstead, 1967). It is probable that the toxin is produced by some planktonic form as the clupeoid fishes are for the most part plankton feeders; this may add strength to the position that clupeiotoxism is a separate entity from ciguatera poisoning. Clupeiotoxin is not thought to be degraded by normal cooking and the degree of freshness does not seem to have effect on the toxicity.

Clupeiotoxism may pose a wider threat to public health than the occasional locally consumed fish. If the toxin is indeed caused by "blooming" plankton organisms the likelihood of a large school of toxic fish cannot be overlooked. The sardine and anchovy groups are frequently thought of as ideal fish for Fish Protein Concentrate production; we have no data on the ability of current FPC technology to eliminate the toxin from the raw fish.

The second major group of poisonings experienced in the eastern Caribbean is the result of bacterial decomposition of fresh fish. In the Virgin Islands and throughout the northern Leeward Islands fish are typically sold "fresh" from the boat. Very few fishermen use ice or gut the fish before sale, in fact there is a strong feeling among older citizens that such preservation is used to camouflage the true "freshness". Eastern Caribbean fishermen do not use live-wells and fish frequently spend a good part of the day in the sun. These conditions obviously tend to promote bacterial decomposition of the fish and the consequent toxicity problems; it is interesting that the younger people in St. Thomas, U.S. V.I. who tend to buy fish in the supermarket report a significantly lower incidence of fish poisoning attributable to scombroids.

We presume that an undetermined proportion of the poisonings reported are the result of some sort of bacterial decomposition. In many "mild" cases the only complaint is of gastrointestinal distress; the neurological symptoms specific to ciguatera and ciguatera-like toxins are not noted. Many of these cases may be attributable to scombroid poisoning but the symptoms may not be sufficiently pronounced for a proper diagnosis to be made.

The distinct histamine-like toxicity caused by bacterial degradation of the flesh of fish of the family Scombridae is a relatively common type of fish poisoning throughout the Caribbean. The symptomology includes a distinct "sharp" or "peppery" taste upon eating the fish followed by intense headache, dizziness, a variety of circulatory disfunctions, gastrointestinal distress, dryness of the mouth and inability to swallow. These symptoms are followed by generalized erythema, the face becomes swollen and flushed, eyes are sunken and an urticarial eruption may develop covering the entire body. In severe cases there may be additional complications of shock and respiratory distress. Death has been reported in a few cases but acute symptoms generally dissipate in 8 to 12 hours. This toxic reaction is brought about by the bacterial degradation of histidine in scombroid muscle tissue which produces a substance designated as scombrotoxin. Scombrotoxin probably has a combination of chemical constituents including saurine, histidine and possibly other toxic compounds. The disease responds well to treatment with anti-histaminic drugs; this specific treatment has mitigated the severity of scombroid poisoning as a public health problem in recent years.

In the eastern Caribbean scombroid poisoning has been reported from *Acanthocybium solandri* (wahoo), *Scomberomorus cavalla* (kingfish or king mackerel), *S. regalis* (spanish mackerel) and *S. maculatus* (cero). We are not aware of cases reported recently from the eastern Caribbean in the tunas *(Auxis, Euthynnus, Sarda, Scomber, Thunnus)* but these genera may also be incriminated. There probably is no true seasonality to scombroid poisoning although the incidence in any one area can be correlated with local "runs" of the particular species involved. Thus there seem to be more poisonings during the tourist season when sport fishing pressure is high.

The third general type of fish poisoning is described as ciguatera fish poisoning. Evidence from the Pacific suggests that there are at least three (probably more) distinct toxins capable of producing the ciguatera syndrome. Many authors (and many physicians in the eastern Caribbean area) have not separated the diagnosis or treatment of ciguatera from that of scombroid poisoning and some confusion has resulted. Both ciguatera and scombroid poisoning have been occasionally reported from the same fish in the Pacific (Halstead, 1967); we have no such reports from the Caribbean in recent years.

SYMPTOMOLOGY AND PUBLIC HEALTH ASPECTS OF CIGUATERA

In the absence of precise chemical and biogenic data we have defined ciguatera in terms of its symptomology. The following symptoms are extracted from Halstead (1967), Bagnis (1970) and Banner (1971) and are quoted as they appear in Teytaud and Brody (1971).

Ciguatera fish poisoning in its simplest uncomplicated form develops within 3 to 5 hours after the fish is eaten. There is a sudden onset of abdominal pain followed by nausea, vomiting, and a watery diarrhea. The gastrointestinal symptoms will occur in about 40 to 75 percent of the cases. The victim feels weak, generally ill, and may experience muscle aches throughout the back and thighs in about 10 percent or more of the cases. Soon after, the victim complains of numbness and tingling in and about the mouth which then extends to the extremities (present in about 50 percent or more of the cases). Fever, headache, and rash are generally absent, and the patient has no desire for food. The acute symptoms usually subside in about 8 to 10 hours, and within 24 hours after onset most of the patient's symptoms will have completely subsided except for a feeling of weakness. However, the numbness and tingling may continue to a lesser extent for a period of 4 to 7 days. The foregoing resume is typical of the majority of uncomplicated ciguatoxications that are generally encountered by the practicing physician in an endemic ciguatoxic locality.

Ciguatera, like many other diseases, may vary greatly in its clinical manifestations depending upon the toxicity of the fish that is eaten, the individual's sensitivity to the poison, amount of fish ingested, and other factors. In a broader sense ciguatera fish poisoning may be characterized as follows: the onset of symptoms may vary from almost immediately to within a period of 30 hours after ingestion of the fish, but is usually within a period of 6 hours. The initial symptoms in some cases are gastrointestinal in nature, consisting of nausea, vomiting, watery diarrhea, metallic taste, abdominal cramps, and tenesmus, whereas in other patients the initial symptoms consist of tingling and numbness about the lips, tongue, and throat. This may be accompanied by a sensation of dryness of the mouth. The muscles of the mouth, cheeks, and jaws may become drawn and spastic with an accompanying sensation of numbness throughout. Generalized symptoms of headache, anxiety, malaise, prostration, dizziness, pallor, cyanosis, insomnia, chilly sensations, fever, profuse sweating, rapid weak pulse, weight loss, myalgia, and back and joint aches may be present in varying degrees, or one or more of these symptoms may be entirely absent. The victims usually complain of a feeling of profound exhaustion and weakness. The feeling of weakness may become progressively worse until the patient is unable to walk. Muscle pains are generally described as a dull, heavy ache, or cramping sensation, but on occasion may be sharp, shooting, and affect particularly the arms and legs. Victims complain of their teeth feeling loose and painful in their sockets. Visual disturbances consisting of blurring, temporary blindness, photophobia, and scotoma are common. Pupils are usually dilated and the reflexes diminished. Skin disorders are frequently reported that are usually initiated by an intense generalized pruritus, accompanied by erythema, and maculopapular eruptions, blisters, extensive areas of desquamation - particularly of the hands and feet - and occasionally ulceration. There may also be a loss of hair and nails.

In severe intoxications the neurotoxic components are especially pronounced. Paresthesias involve the extremities, and paradoxical sensory disturbances may be present in which the victim interprets cold as a "tingling, burning, dry-ice or electric-shock sensation", or hot objects may give a feeling of cold. In regard to the paradoxical sensory disturbance (P.S.D.), a classic example is that of a naval officer who was poisoned by an amberjack. Four weeks later he was observed subconsciously blowing on his ice cream, which was "burning his tongue", in order to cool it. Ataxis and generalized motor incoordination may become progressively worse. The reflexes may be diminished, muscular paralyses may develop, accompanied by clonic and tonic convulsions, muscular twitchings, tremors, dysphonia, dysphagia, coma, and death by respiratory paralysis. The limited morbidity statistics show a case fatality rate of about 12 percent. Death may occur within 10 minutes, but generally requires several days.

Table 1 summarizes the symptoms occurring during the first 24 hours after ingestion as they were reported by 25 persons who were interviewed following ciguatoxications of minor to moderate severity in St. Thomas, U.S.V.I. during 1971. Several of these reports represent the symptoms produced in different individuals by a single fish; they therefore do not represent 25 separate outbreaks.

TABLE 1

Summary of Symptoms Manifested by 25 Ciguatoxicated Individuals During First 24 Hours After Ingestion of Fish[1]

Symptom	Percentage Reporting
Abdominal pain	96 (96)
Nausea	88 (92)
Vomiting	68 (68)
Diarrhea	96 (96)
Numbness, tingling about mouth	56 (64)
Headache	48 (48)
Numbness in extremities	48 (56)
Metallic taste	24 (36)
Weakness	96 (96)
Muscle aches	40 (48)
Paradoxical sensory disturbance	32 (32)
Itching	64 (68)

[1]Percentages in parentheses represent change in original descriptions following questions by the interviewer.

Several additional symptoms were reported by three or fewer (less than 12%) of the persons interviewed. These symptoms include lack of coordination, muscle spasm, high fever, visual disturbances, diminished reflexes and skin rash. It is notable that none of these persons required hospitalization and only three reported visiting a physician (several others contacted a physician by telephone during the time period 24 - 72 hours after ingestion).

Virtually all of the persons interviewed reported noticeable symptoms of ciguatoxication for several days after the onset of the incident. Most commonly reported was extreme weakness and lethargy lasting up to 2 weeks. Many victims reported gastrointestinal symptoms well into the third day along with itching and/or skin rash. Those persons reporting the paradoxical sensory disturbance stated that it persisted for at least 3 days, in some cases 10 days or 2 weeks. The bulk of the other symptoms noted were reported as having dissipated within the first 24 hours.

We are currently undertaking a more extensive epidemiology reporting program in cooperation with local media, physicians and public health authorities. Data from this survey combining questionnaire and interview procedures should be available early in 1972. At this time we have no accurate estimate of the magnitude of the ciguatera poisoning problem in the Virgin Islands or for that matter anywhere else in the eastern Caribbean. Outbreaks in

Puerto Rico are sufficiently notable to receive coverage in the major English-language media which suggests that they are infrequent. The officials responsible for public health record-keeping in St. Thomas, on the other hand, estimate three or four cases per week are seen in the emergency room; if our 25 cases reported in Table 1 represent typical reporting ratios there may be as many as 30 cases per week in St. Thomas. These figures probably represent the maxima however and cannot be confirmed. Reports of ciguatoxication in the British Virgin Islands have stated that virtually "everybody" has been poisoned at least once (some as many as 15 times) but medical advice is almost never sought. Interestingly the British Virgin Islands are the only demographic unit mentioned by Halstead (1970) where fish poisoning is "not regarded as deterrent to the development of the fisheries programme".

The pattern of sporadic reporting of ciguatera poisoning despite the relatively high incidence of the disease is common throughout the northern Leeward Islands. Information from Halstead (1970) and our own contacts with fishermen, inter-island traders, charterboat operators and fishery personnel in the region suggests that the problem is indeed severe. Virtually every person contacted from St. Kitts, St. Maarten, St. Eustatius, Anguilla and Montserrat had either been a victim himself or knew of a close friend or relative who had been poisoned within the last 5 years. Very few of these cases were brought to the attention of a physician; most public health officials believe that "only the very severe cases are brought to the attention of the medical authorities" (Antigua: Halstead, 1970). One long-time resident of St. Kitts estimates only about one case in ten receives medical attention; as might be expected the bulk of the cases reported involve tourists and non-native residents.

GEOGRAPHIC DISTRIBUTION

The geographic distribution of ciguatoxic fish in the northern Virgin Islands is shown in Figure 1. The island of St. Croix, on a separate geological platform, is not reported as producing ciguatoxic fish in any appreciable quantity and has been omitted from this figure. A large number of the areas indicated have been reported as producing toxic fish for centuries. It cannot be presumed that these are the only localities; toxic fish are frequently caught in other areas.

In the Virgin Islands there is an extremely strong feeling among the fishermen that the south side of the Virgin Bank from Sail Rock east to Peter Island consistently produces toxic fish. Other fishermen would extend this area east and north to include most of the coastline of Virgin Gorda, some would include the Horseshoe Reef and Anegada. Still others (particularly those who regularly fish this southern Bank) state that only specific locations in this area produce toxic fish and that reef areas or "banks" only a few miles away are free of ciguatera. Virtually all fishermen feel that the entire north side (the Atlantic side) of the Bank is free of toxicity with the exception of a very few species. This pattern of geographic distribution of ciguatoxic fishes seems consistent with those areas reported by earlier authors (Walker, 1922; Arcisz, 1950; Brown, 1945; de Sylva, 1956; Mann, 1938). Other writers quoted in Halstead (1967), notably Hill (1868); Rogers (1899) and Gilman (1942), are contradicted by local fishermen, at least for the bulk of the species implicated elsewhere in the Virgin Islands.

In almost all reports on the geographic locality where toxic fish are caught the interviewee was referring to depths of 30 fathoms or less; the bulk of reports

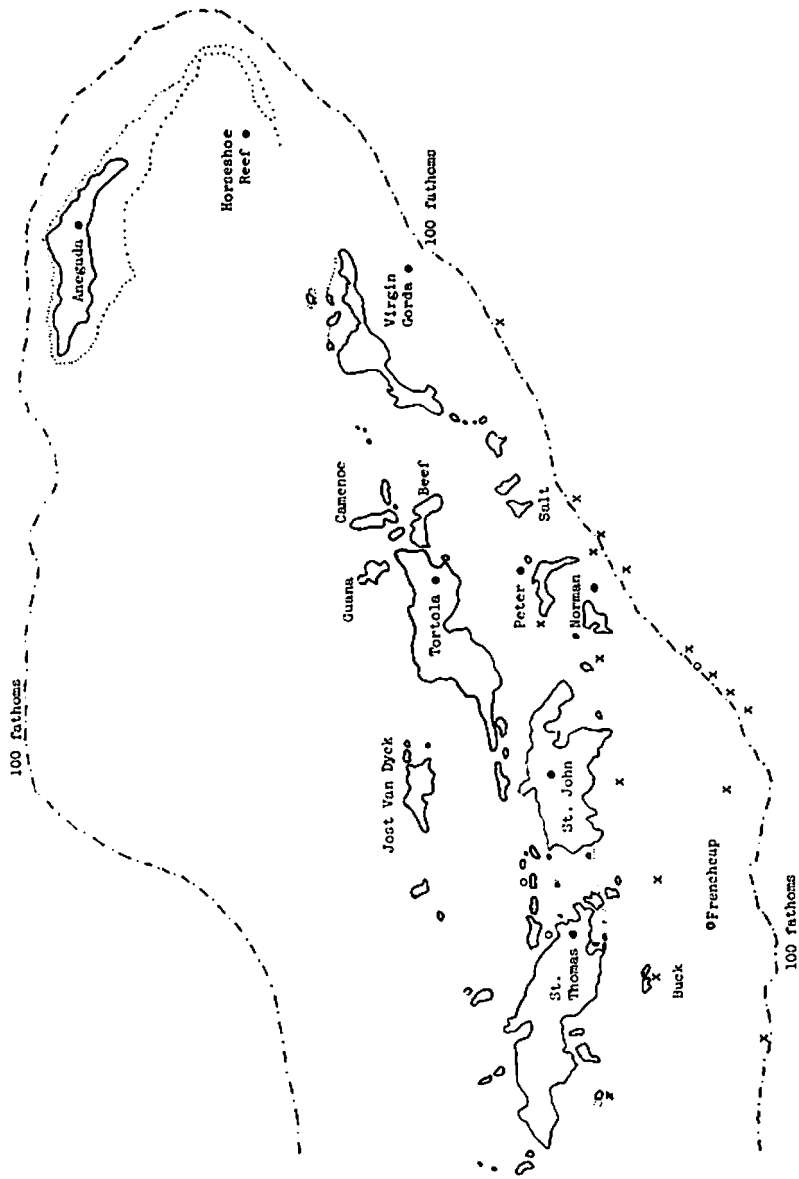

Fig. 1. Map of the Virgin Islands. • Islands or areas mentioned in the literature as ciguateric. X Sites of reported ciguatoxications 1968-1971. —•— 100 fathom contour. ····· shallow reef.

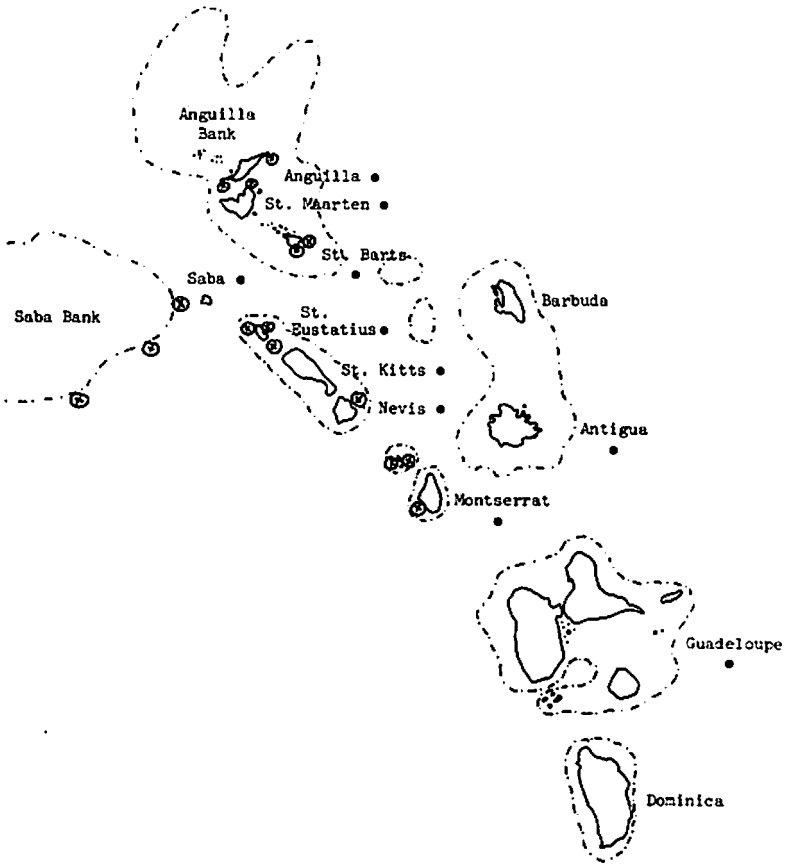

Fig. 2. Map of the Leeward Islands. • Islands reported in the literature as producing ciguatoxic fish. ⊗ Specific localities reported as toxic. —•— 100 fathom curve.

refer to reef areas in 8 - 15 fathoms, but this may be an artifact of fishing methods rather than a biological distribution. The relationship of depth to capture of ciguatoxic fishes is discussed in a later section.

The areas reported (by our contacts and by Halstead, 1970) as producing toxic fish in the northern Leeward Islands are shown in Figure 2. These data are plotted along with areas mentioned as toxic by various authors in Halstead (1967) and do not represent an intensive survey. More specific data will be presented in a later paper. The more southerly group of islands in the eastern Caribbean (Martinique south to Trinidad: The Windward Islands) have not commonly been reported as producing ciguatoxic fish in this century. Earlier authors make reference to a variety of species and locations but this is not confirmed by present residents.

Although no quantitative data are available it seems clear that the majority of ciguatera poisoning outbreaks in the eastern Caribbean occur in a rather small

area from Montserrat north to the Virgin Islands including all of the northern Leeward Islands and portions of Saba and Anguilla Banks. Beyond this area ciguatera poisoning is limited to sporadic outbreaks which generally involve large specimens of only a few species.

SPECIES REPORTED AS CIGUATOXIC

More than 400 species of fish have been implicated in ciguatera poisoning on a global basis (Bagnis, 1970). Of these 400, 91 species could conceivably be found in the eastern Caribbean. It is possible that an even larger number could be associated with ciguatoxications if they were desirable as food fish. There are also a number of reports of molluscs, crabs and lobsters producing the disease. Appendix I lists the 24 fish most frequently reported as toxic in the Virgin Islands. All of these species are valued as food fish with the exception of barracuda and amberjack; these two species have such a bad reputation as ciguateric that only the smallest specimens can be sold. It is somewhat surprising that the moray eel is as highly esteemed as it is, considering reports of toxicity from the Pacific. In St. Thomas eels are typically purchased by individuals from Spanish Caribbean cultures (Puerto Rico, Dominican Republic, Cuba), areas where ciguatera is less frequently reported. The fish at the top of the list tend to be reported as toxic more frequently than those lower down.

In general the larger specimens of these species are more frequently incriminated in ciguatera poisoning incidents. The fish generally can be considered "shore-fishes" or "reef-fishes" and for the most part conform to the pattern noted by other authors (Randall, 1958; Halstead, 1967; Banner, 1971): toxic fishes are not common at depths greater than 80 - 100 fathoms. Two notable exceptions in the Virgin Islands are the blackfin snapper, *Lutjanus buccanella*, and misty grouper, *Epinephalus mystacinus*. We have data on two outbreaks affecting five people from blackfin snapper caught in deep water and three additional outbreaks implicating misty grouper (which has not been taken at depths of less than 55 fathoms) involving at least ten persons during mid-1971. These data appear in Appendix II. Additional data on ciguatera from deep-living species is noted in a later section of this report. Although Banner (1971) states "true ciguateric fishes appear to be only those fishes tied directly to the flora and fauna of coral reefs. . . . ." there is excellent clinical data to support these outbreak reports; several members of our staff were among the victims. Samples have been retained for extraction and bioassay to quantify the toxicity of these fish (see also section on fisheries development).

CHEMISTRY AND PHARMACOLOGY

Our knowledge of ciguatera poisoning in the eastern Caribbean is presently based upon clinical reports and is only beginning to be quantified by chemical and biological assays. On the basis of symptomology and from the species implicated it is highly probable that ciguatera poisoning in the eastern Caribbean is produced by very similar (if not identical) compounds to those known from the Pacific. Scheuer and other workers at the University of Hawaii have isolated what they consider to be the primary toxin and, in cooperation with Hashimoto and his colleagues at the University of Tokyo, several secondary toxins. The primary toxin (deemed ciguatoxin) is insoluble in water, soluble in polar organic

solvents, heat stable to 100C, stable below 0C as a crude toxin but unstable in the semipurified or purified form unless extracted, purified and stored in an inert atmosphere at low temperatures. The non-crystalline product has the empirical formula $(C_{35}H_{65}NO_8)_n$ and the molecule has indications of a quaternary nitrogen atom, one or more hydroxyl groups and a carbonyl function. It is not a phospholipid. A crystalline product is currently undergoing analysis to determine its structural formula (Banner, 1971).

Present evidence (again from the University of Hawaii group) suggests that ciguatoxin acts upon excitable membranes to increase the permeability of Na + ions, upsetting the ionic balance of the membrane. Ciguatoxin is not an anticholinesterase *in vivo*, despite earlier papers, and various therapies for ciguatoxication based on stimulation of cholinesterase cannot be endorsed at the present time. The toxin is active at the level of 0.025 mg/kg when injected into mice with a toxin yield of 5 - 10 mg/kg from highly toxic flesh. The toxin is carried at a uniform level throughout the musculature of toxic fish but may be 50 to 100 times as concentrated in the viscera, particularly the liver.

Our laboratory in St. Thomas is currently using an acetone - diethyl ether extraction with purification by silicic acid column chromatography developed by Scheuer (pers. comm.) and bioassay using intraperitoneal injection into 20± gram Charles River CD-1 mice. We have previously used other extraction techniques including crude aqueous extraction with emulsifiers and a variety of experimental bioassay techniques. Our conclusions are basically the same as the workers in Hawaii although based on much less experience: careful solvent extraction and purification are necessary, rigidly controlled bioassay procedures are required and experienced laboratory personnel are an absolute requirement. To date there has been no rapid, simple colorimetric or other chemical test for ciguatoxin developed. Screening programs are exceedingly expensive and difficult to manage and are only in operation in Japan on a limited basis for selected samples from highly suspect areas. As much as we might desire it, we are not very close to a rapid means of identifying ciguatoxic fish in the laboratory and even further from a simple test which might be part of a housewife's shopping kit.

The traditional West Indian methods of determining if a fish is ciguatoxic have been discussed at length by previous authors. Appendix III lists these methods as reported to us by natives of the Virgin and Leeward Islands. Many housewives swear by some particular method utilizing visual inspection of external characters of the fish. Most admit that in practice both the visual methods and those requiring addition of some indicator are unreliable. We have submitted each of these methods to an assay with at least two known toxic fish and two non-toxic fish and have not found them reliable.

BIOGENESIS AND TRANSMISSION OF CIGUATOXIN

At the present time we have no accurate data on the mechanisms of biogenesis of ciguatoxin (or its related compounds) nor information on its transmission through the food chain. Banner, Helfrich, Randall and others at the University of Hawaii have concentrated a good deal of effort on these problems in the Pacific and their findings to date are summarized below (from Banner, 1971): (1) No causative agent or organism has yet been identified as producing toxins similar to ciguatoxin. (2) No definite evidence has been found to suggest that: (a) copper or other metallic ions act as chelators, trace minerals or catalysts

in the formation of the toxin; (b) no demonstrable increase in ciguateric fishes was noted in areas where "new surfaces" were exposed by natural disasters, dredging, blasting or predation by *Acanthaster;* and (c) contamination of the marine environment by pollutants (specifically wax esters at Wake Island) have no effect on ciguatera. (3) Normally non-toxic omnivores can be made toxic when fed small amounts of toxic fish over a period of time. (4) Toxic *Lutjanus bohar* retain toxicity for up to 30 months when fed a non-toxic diet. (5) A detrital feeding acanthurid *(Ctenochaetus striatus)* has demonstrable ciguatoxin in the flesh, viscera and gut contents. (6) Most carnivores seem to carry the same toxin (ciguatoxin) although additional toxins (eg: Aluterin, ciguaterin) may also be present. It should be noted that Dr. Banner will present a paper entitled "Biological Origin and Transmission of Ciguatoxin" tomorrow (18 November 1971), which could shed some new light on this subject.

Given the similar symptoms and species distribution reported in Pacific and eastern Caribbean ciguatera poisonings, it is reasonable to assume that similar biogenesis and transmission of the toxin can be expected. There are several persistent beliefs among eastern Caribbean fishermen which will be repeated here although we have been unable to confirm them.

1. Ciguatera is produced by fish which eat the fruit or leaves of manchineel (*Hippomane mancinella*). This theory has been proposed since 1511 (by Peter Martyr of Anghera; Halstead, 1967) and is probably based on advice to early explorers from Caribbean Indians. *Hippomane* is certainly toxic but its pharmacological action is quite different. It is doubtful that this theory is correct.

2. The most persistent theory in the Virgin and Leeward Islands involves copper. Natural copper deposits ("copper banks") are presumed to exist and fish which feed on these banks become toxic. Some of the more sophisticated fishermen suggest that it is not actually the copper metal but a small "sea moss" (which grows in areas where copper concentrations are high) which actually manufactures the toxin or a precursor. The "sea moss" responsible has been pointed out to us by several fishermen (actually three species: *Enteromorpha lingulata* from shallow water at Buck Island, St. Thomas; *Cladophora* sp. from fish pot warps south of Flanagan Island, U.S.V.I.; *Chaetomorpha* sp. from rocky subtidal at Buck Island, St. Thomas). None of these algae showed toxic activity when extracted with Tween and injected I.P. into mice; we plan to repeat this experiment with solvent - solvent extraction and column chromatography when these algae can be collected from historically toxic areas. Most fishermen suggest that the production of toxic "sea moss" is seasonal with peak growth in late spring or early summer. The association of ciguatoxin with copper is not limited to copper banks by fishermen; it is proposed that shipwrecks (particularly older wrecks with copper-sheathed bottoms) and copper antifouling paints supply all of the copper needed. We can in no way confirm the theory of copper-induced ciguatoxin at this time.

3. A theory proposed by a few fishermen and completely unproven at this time attempts to explain the high concentrations of toxic fish on the south of the Virgin Bank (with the lower toxicity reported from the same species on the north side of the Bank) and in the area from Antigua north to the Anegada Passage. It is proposed that the toxin is produced by some organism (presumably a primary producer) which is found only in areas where deep, cold, nutrient-laden water is upwelling. The theory is reasonable when applied to the southern Virgin Bank and the southeastern portions of Saba Bank, both noted as

producing toxic fish, as there is good evidence that upwelling does indeed occur in the Anegada Passage. The upwelling process cannot be confirmed in the St. Kitts – St. Eustatius – Redondo area at the present time due to lack of data. The specific organism(s) responsible and the mechanism of toxin production are not known by the proponents of this theory.

We are, therefore, no closer to an accurate description of the biogenesis or transmission mechanisms of ciguatoxin than purely theoretical considerations. We have proposed a series of studies similar to those undertaken by the University of Hawaii group including chemical, ecological and epidemiological programs for the next 3 years to attempt a better understanding of this problem.

EFFECTS OF CIGUATERA POISONING ON THE DEVELOPMENT OF FISHERIES

We have every reason to believe that ciguatera poisoning is a major impediment to the sale of local finfish in the Virgin Islands and thus is a strong deterrent to expansion of the commercial fisheries. Interviews by Halstead (1970) suggest that this is true throughout the Leeward Islands too, although residents of Antigua, St. Kitts and St. Maarten express the opinion that there is little alternative to continued buying of local fish and risk of intoxication.

In Dammann's 1967-68 survey of commercial fisheries of the Virgin Islands slightly more than half of total finfish consumption was from local (U.S. and British V.I.) sources (1,672,400 of 3,084,373). We have no data on how much of the fish imports could be replaced by local production if ciguatera were not a problem. Interviews with fishermen suggest that very few hotels and restaurants catering to the tourist trade would purchase locally caught grouper, snapper, jacks and kingfish because of fear of fish poisoning. Dammann's Table 9 "Fisherman-reported problems in the Virgin Islands commercial fishery" does not include any data on this subject, however Table 12 indicates that only two (2 of 79) of the fishermen contacted felt that there were "no fish" (commonly reported as ciguatoxic) so one might assume that ciguatera was indeed considered a problem.

Two investigations of fisheries development potential in the Virgin Islands area have recently been completed. The first (Dammann *et al* 1970) developed lines of approach carried out in the second project (Brownell and Rainey, 1971) for expanding the Virgin Islands fisheries through exploitation of deep water stocks. This effort was motivated by several natural limiting factors on the shallow water fish populations, among them the risk of ciguatera poisoning. It now appears that even species previously considered non-toxic because their normal depth-range is greater than 100 fathoms are implicated in ciguatoxications. Brownell and Rainey (1971) report three outbreaks from misty grouper (*Epinephelus mystacinus*) taken at 130-135 fathoms and the only documented case of ciguatera from a silk snapper (*Lutjanus vivanus*) from 110 fathoms. Two questionable outbreaks are reported by Dammann *et al.* (1970) from *Epinephelus nigritus* (actually *E. mystacinus*). In addition to the outbreaks reported for *E. mystacinus* and *Lutjanus buccanella* in Appendix II, we are aware of several outbreaks from *L. buccanella* attributed to fish caught during the exploratory fishing projects of the UN/FAO Caribbean Fisheries Development Programme (CFDP) in 1970 and '71. We are currently extracting and bioassaying about 2 tons of fish caught on UN/FAO cruises from areas where toxicity is reported. These data will be reported in early 1972. Although these data will

provide us with a more precise estimate of the proportion of ciguatoxic fishes in the deep shelf – shelf-slope populations, we have already ascertained that this resource is not free of ciguatoxin.

The toxic blackfin snappers caught by the CFDP came from Saba and Anguilla Banks; fishermen in Montserrat reported that most known poisonous fish had been captured in deep water — up to 250 fathoms (Halstead, 1970). It is highly probable that the abrupt dropoff to depths of 200 fathoms or more surrounding many of the Leeward Islands harbor excellent stocks of food fish but it is quite likely that some of these species carry ciguatera poisoning.

Halstead's 1970 survey found that fishermen, fisheries officers and public health officials were almost unanimous that ciguatera was a deterrent to development of the commercial fisheries. Most islands reported ciguatera in fish from depths of 0-60 fathoms and the most frequently toxic are all among the first ten species listed in Appendix I. At least two large commercial fishing operations in St. Maarten have given up shallow water fishing because of repeated ciguatoxications by their catch; several fishermen have reported having to discard large catches of jacks and grouper because their previous catches had caused poisoning. In the small communities of the Virgin and Leeward Islands an individual fisherman is occasionally completely boycotted because of his reputation for regularly landing toxic fish. Fishermen are expected to be able to determine whether or not a particular fish is toxic; an occasional exception is accepted, however.

The fisheries of the Virgin and Leeward Islands do not lend themselves to exploitation by large vessels with modern ground fishing gear. The pelagic stocks are apparently not sufficient to support a much larger fishing effort than is currently in progress. There are probably not sufficient stocks in the shelf-edge populations to withstand intensive fishing pressure equivalent to the Gulf of Mexico – Florida Straits snapper industry. The majority of fishermen in the eastern Caribbean are owner-operators of small boats (20 feet or less) who rarely go more than 10 miles from their home port. These fishermen could be trained and proper gear could be utilized for exploiting the area's natural stocks both in shallow and deep water but fish poisoning cases would be likely to increase. A thorough understanding of the ciguatera problem must be developed before expansion of the fishery can be effectively accomplished.

SUMMARY AND CONCLUSIONS

1. Fish poisoning in the eastern Caribbean is reported from all of the islands of the northern Virgin and Leeward Islands groups. Puerto Rico, Hispaniola and St. Croix have a much lower incidence rate as do the Windward Islands (Trinidad to Martinique).

2. Although clupeoid, elasmobranch, tetraodontoid and hallucinatory fish poisoning are reported from the eastern Caribbean, scombroid poisoning and ciguatera poisoning are considered to be most important. Because scombroid poisoning can be prevented by modern preservation techniques and treatment of the disease is specific and effective, it is considered a less severe problem than ciguatera poisoning.

3. Epidemiological reporting of ciguatoxications has only been begun in the last month throughout the Virgin Islands and a careful survey of the Leeward Islands must await additional funding. Ciguatera is presently reported as a severe public health problem with only a fraction of the cases reaching medical

attention. The problem seems most severe in the area from Montserrat north to the British Virgin Islands including the southeast portion of Saba Bank and the southern shelf of the Virgin Islands plateau.

4. The chemistry, pharmacology and ecology of ciguatoxin and closely allied compounds are at present poorly understood. The symptomology and species distribution of the toxins in the eastern Caribbean strongly suggest that a situation exists which is very similar to that described from the Pacific islands by the Marine Biotoxins group at the University of Hawaii over the past 16 years.

5. Toxicity in eastern Caribbean fishes seems to be more prevalent among the large carnivores of reef or reef-related habitats. There are a number of data which suggest that ciguatoxin(s) are produced by some organism in the reef food web and that the toxin is passed through the food web without significant modification and is concentrated by the larger carnivores.

6. Development of the commercial fisheries in the eastern Caribbean is severely impeded by the prevalence of ciguatoxin in commercially desirable species. There is good evidence that the shelf-edge stocks of snapper and grouper are not free from ciguatera poisoning as previously proposed and that exploitation of this presently underutilized resource may be impeded by this toxicity.

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APPENDIX I

Species most commonly reported as toxic in the Virgin Islands area

Species	Common Name
Sphyraena barracuda	Great barracuda; barra
Seriola dumerili	Amberjack; amber
Caranx latus	Horse-eye jack
Caranx ruber	Bar jack; carang
Caranx hippos	Crevalle jack
Lutjanus jocu	Dog snapper; dog tooth
Mycteroperca venenosa	Yellowfin grouper; gramminix
Scomberomorus cavalla	Kingfish; king mackerel
Caranx fusus	Blue runner; hard nose
Gymnothorax funebris	Green moray (probably Conger or Congo eel)
Epinephelus adscensionis	Rock hind
Mycteroperca bonaci	Black grouper
Scomberomorus regalis	Cero (often mistaken for "spanish mackerel")
Caranx lugubris	Black jack
Lutjanus griseus	Grey snapper
Lutjanus buccanella	Blackfin snapper
Epinephelus mystacinus	Misty grouper (often erroneously called Warsaw grouper)

Epinephelus guttatus	Red hind
Seriola rivoliana	Almaco jack
Caranx bartholomaei	Yellow jack
Apsilus dentatus	Black snapper
Epinephelus morio	Red grouper
Lachnolaimus maximus	Hogfish
Belistes vetula	Queen triggerfish; old wife

APPENDIX II

Outbreak reports from fishes caught at depths greater than 500 feet during 1970-71 (data from interviews; Ciguatera Case Repository numbers refer to CRI files)

CCR-71-011. Blackfin snapper - *Lutjanus buccanella* - about 4 lbs. Fish caught south of Frenchcap Cay, U.S.V.I. at about 40 fathoms by local fisherman. Fish was eaten by three people all of whom reported abdominal pain, loose bowels, nausea and vomiting, in that order. Onset between 3 and 6 hours after ingestion. Secondary symptoms included extreme weakness, listlessness and itching which developed 12-24 hours after ingestion and lasted for several (5 - 7 days). None of the victims reported previous intoxication.

CCR-71-018. Blackfin snapper - *Lutjanus buccanella* - about 3 lbs. Fish was purchased on the waterfront at St. Thomas by young couple visiting relatives on the island. Fish was broiled with sauce, no symptoms developed until about 8 hours after ingestion. Vomiting, diarrhea, weakness in the knees and dull headache persisted all the following day. Late afternoon produced P.S.D. for man but not wife. Returned to mainland 3 days after ingestion, no follow-up available.

CCR-71-008. Misty grouper - *Epinephelus mystacinus* - 36 lbs. Fish purchased at the dock - caught (apparently) south of St. John. Victims bought 5 lbs (two large steaks); refrigerated them and cooked fish next evening. Four persons had dinner of this fish; three young men and a young lady - one man and the lady reported nausea, vomiting and weakness within 6 hours; headache, nausea and weakness persisted for "3 or 4 days". The third victim had no violent symptoms of gastrointestinal origin but was lethargic and felt "weak in the joints" next day. The fourth person did not report any illness.

CCR-71-021. Misty grouper - *Epinephelus mystacinus* - 56 lbs. Fish caught by local sport-commercial fisherman at the "Warsaw Pocket" (misnamed since the area produces misty groupers) - about 3-1/2 miles south of Norman Island, B.V.I. at depth of about 120 fathoms. Fish was filleted and headed; at least six persons ate fillets with no ill effects. Two more people made soup of the head; they reported some intestinal discomfort and weakness, tingling sensations and lethargy the following day. Five other persons fried a small section of the liver: each reported eating "not more than a few bites" that night. All awoke within 3 hours with violent

abdominal cramps, vomiting and violent headache. Severity of gastrointestinal symptoms continued for 6 hours or so, then extreme weakness, sinus-like headache and watery bowels persisted for 2 - 4 days. P.S.D. and tingling and numbness in the lips were reported about 16 hours after ingestion by three of the five. All reported persistent symptoms of weakness and soreness in all body joints for 7 - 10 days. P.S.D. persisted for at least a week in two victims.

CCR-71-023. Misty grouper - *Epinephelus mystacinus* - about 30 lbs. Steaks were sold to about four persons none of whom apparently developed ciguatera symptoms. A soup was made of the head and eaten by three persons. All described gastrointestinal distress, diarrhea and nausea within 3 - 6 hours; apparently the symptoms disappeared within about 24 hours for two of the victims; the third reported listlessness, weakness and achy joints which lessened by the third day after ingestion.

APPENDIX III

Methods for identifying ciguatoxic fish as described in the folklore of the Virgin and Leeward Islands (from interviews; Dammann *et al.*, 1969; Halstead, 1967)

I. External characters of the fish or fish flesh which indicate toxicity:

- More yellow or brassy color, especially about the head
- Stripes (in species where they are not normally obvious)
- Darker coloration
- Red coloration to the eyes
- Yellow mucus on inner lining of gullet
- Green tint to raw flesh
- Tiny black "veins" running through the musculature
- Brassy or coppery odor to the flesh
- Teeth are black
- Suspect species with roe is toxic
- Enlarged or bloated stomach
- Flesh tastes bitter or hot in mouth

II. Indicator organisms which suggest toxicity:

- Worms in the flesh (particularly jacks and mackerel) (Worms in the stomach indicate a non-toxic fish)
- Isopod ectoparasites ("cockroach") are not found on toxic fish (jacks)
- Flies will not land on flesh
- Ants will not eat

III. Methods employing an indicator:

- Silver turns black when boiled with toxic fish
- Sweet potato turns black when boiled with toxic fish

The Design of An Aquaculture Enterprise

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INTRODUCTION

Often the decision to undertake aquacultural enterprises is achieved after too little consideration of the many severely limiting factors and clear and present risks that confront such ventures. Probably the initial critical determination that must be made, with a certain degree of quantitative assurance, relates to the marketability of the aquafoods to be produced. Without a market there can be no enterprise. Almost of equal significance is the state of the production technology to be used — "seed" procurement, grow-out techniques including nutrition and feed supply, disease control, predator management and harvesting. Processing technology and product development skills are additional major requisites.

However, not the least significant of the essential considerations required are the numerous, demanding and diverse site selection criteria that must be satisfied in order to accomplish a successful aquabusiness. I shall limit my comments primarily to this subject although I shall have to allude to the other matters noted above as they bear directly on making the site selection decisions.

The choice of a location in which to grow aquatic animals commercially has often been dictated by personal, and sometimes parochial, preference for a particular site; by fortuitous ownership or accessibility to a plot of land; by superficial and casual analysis of the requirements or even merely by capricious or whimsical judgment. Such a critical decision should instead be determined by the most comprehensive analytical procedures that can be applied. We must start with a detailed understanding of the life-cycle of the animal to be reared, so as to define, with some reasonable level of confidence, the tolerance limits within which the various environmental parameters can vary. Given an understanding of these biologically imposed limits, the best cultural technology that is available to accomplish optimum growth and economic production will then define additional site requirements.

To realize the high return on investment that aquaculture, as a new high risk venture, should provide, we have found that a certain economic scale must be achieved. The moderately large size of the production facility, and consequently, the considerable quantity of animal product to be produced, suggest that vertical diversification into a processing plant and marketing of a diverse product line may be a wise course to follow. When the site requirements for processing and marketing are then added to the requisites for the production units, the list of site selection criteria will be expanded greatly.

Presently in the U.S. and in Europe, aquacultural enterprises are generally conceived as monoculture systems in which one animal is to be reared in an improved and managed environment. On the other hand, in several Asian and Israeli culture schemes polyculture is extensively practiced. There, two or more animals, occupying different and non-competitive ecological niches, are grown simultaneously in the same controlled environment. These animals may share similar tolerance limits such as water temperature and salinity, but they feed at

quite different trophic levels. An outstanding example is the various species of carp which, when grown together, do not interfere with each other, but rather the growth of all species is enhanced by virtue of each contributing in its peculiar way to the maintenance of a healthy community and environment.

On the other hand, the occupants of the culture facility may be of widely different phyla, such as molluscs, crustaceans and finfish all growing together with no ill-effects but, in fact, with symbiotic or commensal associations that considerably increase yields of each species over those achieved with monoculture.

If we intend to practice polyculture, an even more discriminating choice of site must be made than if our culture system is planned to grow only a single species.

We have been guided, to a considerable degree, in developing the total strategy for an aquaculture industry by the experience with terrestrial animal husbandry. However, the real and very significant differences between air and water growing media must be recognized and factored into the risk analysis of aquaculture ventures. Technologies have been developed, or are evolving, in the aqueous environment that are functionally analogous to terrestrial animal husbandry technologies, without necessarily being homologous in physical structure. We can list these in terms of increasing levels of intensity of culture.

RANCH MANAGEMENT OF AQUATIC ANIMALS

The most extensive system of aquatic animal management that can be considered aquaculture, is to utilize natural water embayments or sheltered coves, in either fresh or saline waters, as the open range was used in early western ranching. Considerable tidal flushing or other hydrological means of maintenance of water quality is desirable. Minimum use of confining nets or fences will be required by the appropriate sites. Young animals are released onto the range to forage or browse in quest of natural feed. Stocking may be from captured fry or from hatchery stocks derived from induced spawning.

An essential environmental management requirement is to control predation and competition in the natural populations that share the environment. This is usually accomplished by chemical means. Limitation of pollution of natural coastal lagoons or bays is usually difficult, but it must be done. Fouling and storm damage to confinement structures must be avoided. Capital and feeding costs are low, but yields are also quite low, and therefore an extensive area is required to yield sufficient volume of product to justify the undertaking.

The selection of a location for such a system of aquaculture demands not only that extensive areas be ecologically suitable, but that they be free of competitive uses, unpolluted, legally and socially available, amenable to surveillance and have sufficient natural productivity to support large populations of the crop animal.

Harvesting usually entails the labor-intensive practices and high costs of the cattle round-up, but since the areas are large, the gear and methods of traditional commercial fishing may be employed.

STATIC POND OR POOL AQUAFARMING

The next more intensive system of culture is the static pond method that is engineered to confine dense populations of crop animals in earthen, concrete or otherwise structured ponds or pools. Here, because of the large biomass per unit

volume of water, reliance on natural productivity alone is usually not adequate to support the large number of crop animals which must be grown to justify the investment. Natural productivity of static ponds is a function of the indigenous population of plants and animals, the fertility in the water and the intensity, quality and duration of sunlight. Therefore, a supplemental or a complete diet must be brought and distributed in the ponds to ensure sufficient yields.

The considerable amount of earthwork for pond construction, water supply and drainage canals imposes rigorous demands on the site selection mission to find appropriate soils and topography to minimize construction costs.

The lentic or static pond, whether it is filled with fresh or saltwater, is, for the most part, a closed habitat as opposed to a cattle range or even a feed lot. Toxic or deleterious materials when introduced can accumulate by recycling into the energy chain, and become ultimately concentrated in the crop. This is particularly true if it is a secondary carnivore such as channel catfish. Persistent pesticides, for instance, may be introduced into the system in the feed, leached from the soils, blown in from crop dusting or added with make-up water. Once they have entered the lentic habitat they are likely to remain until they are removed in the harvested crop. These considerations impose further important concerns for the site selection strategist. Nonetheless, even with the added cost of feed, pond construction and toxicants, static pond culture is still a major freshwater aquafarming technique.

RACEWAY CULTURE

When an abundance of flowing fresh water is available or where strong tidal flushing can be utilized, the accumulation of metabolic wastes and toxic agents can generally be greatly reduced; and other limiting environmental stress conditions, such as oxygen depletion, can be considerably mitigated. Lotic habitats that can serve as sites for raceway systems are indeed sought and vied for. As an alternative to natural gravity flow or tidal movements to transfer water, one can turn to mechanical pumping, using diesel-electric power. Of course, if one is fortunate enough to locate the aquafarm at the effluent discharge of an electric power generating plant, pumping costs can be shared with, or totally borne by, the power production function.

The use of power plant effluents is applicable to both fresh or saltwater aquafarming. The heated effluents of power generating stations can provide the essential input into an environment that might otherwise be unsuitable for commercial aquaculture because of the low winter water temperatures. A properly managed outfall of a power plant can be mixed with ambient-temperature water to adjust the culture water temperatures to a desirable range for the favorable growth of the crop throughout the year. This, then, can be the determining factor in a given site selection decision. In raceway culture a complete ration must be provided, for little natural productivity is available in the fast flowing water within the raceway.

CAGE OR BASKET CULTURE

Still another technology that is rapidly gaining wide acceptance for certain finfish and crustacea is to confine the animals in wire mesh or net cages, suspended or supported in rather large water bodies. Lakes or sheltered ocean bays have been used successfully, and recently cages suspended in fast flowing

canals and other waterways have yielded very high productivity, with good economics. In cage culture, as in raceways, very little reliance can be placed on natural productivity, and consequently a complete nutrient ration must be supplied. The site requirements for cage aquaculture are in many ways more demanding than static pond systems. The institutional constraints resulting from legalized, but competitive, uses of aquatic environments impose on aquaculture generally, but cage culture in particular, the adverse effects of urban and industrial uses, navigation, waste disposal, dredging and mining and sport and commercial fishing. These may well become the limiting factors in site selection for cage culture, and often limit the siting of other systems of culture as well. In cage culture, the easy access to the crop may invite poaching, and therefore surveillance requirements impose additional site selection demands.

CLOSED HIGH-DENSITY CULTURE SYSTEMS

Even more intensive culture systems, which employ entirely closed, water recycling mechanisms, are being developed and used commercially. They are, therefore, less dependent on large volumes of clean natural water, and consequently demand less stringent environmental conditions. In closed systems, the culture water is cycled through biological and mechanical filters which purify it for reuse. This practice is justified, particularly when the water supply is limited or the water must be heated and the calories conserved. The use of closed systems probably can more readily avoid the introduction of heavy metals, persistent pesticides and other pollutant materials. Such systems may ultimately prove to be preferred as suitable natural environments become scarcer, and higher costs become more readily tolerated. The high capital investment demanded by closed cycle systems of culture generally can be justified only when sites for more extensive systems are no longer available, and when the productivity is commensurate with high production costs, and when the products that are produced can demand high market price. For such intensive, high density systems, site selection criteria become less limiting, but nonetheless the decision is critical, since we are never entirely free of the physical environment nor can we neglect the economic, political and social environmental influences.

Whereas filter feeding organisms, such as the molluscs, certain crustaceans and some true fish, can make a living from naturally occurring phytoplankton alone, the carnivorous fishes, such as the salmonids and flatfishes (which are confined in raceways or closed culture systems), must be provided with nutritionally complete rations. Even in this latter case, site selection is not entirely freed from feed considerations, since proximity to raw materials supply for on-site formulation, or the cost of transport of pelletized rations from off-site sources are important location considerations. Intermediate between these extremes are certain warm water, fresh water animals, such as the catfish (Ictalurus), which can garner a great deal of their feed from naturally occurring production in the culture pond, and thus require only a diet supplement.

A CHECK LIST OF CRITERIA

The following checklist of site selection criteria cannot be readily ranked into any priority order because different requirements among species will significantly reorder the list. Cultural technologies will also reorder the list, and

geographical limits, however imposed, will materially change the priorities. It is a trial at assembling a comprehensive inventory of needs that attempts to include all kinds of environmental characteristics, and therefore the entire list need not be used for any given single site.

The list of site selection criteria grew out of an experience which was not limited by species, systems or geography alone. Rather, it was dictated initially by market characteristics and requirements. The market, therefore, defined the size and shape of the enterprise to include certain species, whose cultural requirements could be met by certain cultural systems, which in turn could best be practiced in certain specially endowed environments. We then searched out that very special environment, to locate the particularly appropriate site that fulfilled most of the other requirements.

The list of criteria is offered with the expectation that it is as applicable to site selection in the Gulf of Maine as it is in the Gulf of Honduras or the Gulf of Thailand. That is, the list should have the universality which could make it useful in locating low, middle and high latitude aquaculture ventures in domestic and in foreign lands. I have been especially cognizant of private sector investment requirements in economically developing nations in the tropics where aquaculture is notably well suited, and where a successful venture can make a significant contribution to economic growth and rural development.

Many of the criteria noted here are so obvious that it may be insulting to bring them to your attention, but they must be included for completeness, to remind ourselves of the interrelatedness of the various components of an aquaculture business enterprise. This checklist is presented primarily to serve as a guide in planning. It is not offered as a recipe to be followed as a cookbook, but rather it should be viewed as a device to discipline the decision making process and thus, to aid in the establishment of sound businesses.

A CHECKLIST OF SITE SELECTION CRITERIA FOR AQUACULTURE

I. ECOLOGICAL PARAMETERS

A. *The Physical Environment*
   1. Hydrological factors
      a. Water properties
         1) Temperature range — diurnal, seasonal, annual variability
         2) Salinity range, osmotic concentrations, tidal and seasonal variations
         3) Solutes
            a) Dissolved nutrients contributing to productivity
            b) Dissolves gases, e.g., 0_2, CO_2, H_2S, NH_3
            c) Toxic or deleterious compounds
         4) Bacteriological and viral content
            a) Coliform organisms
            b) Other microbiological contaminants
         5) Turbidity range, light penetration
         6) Color — light absorption
         7) Sedimentation — silt burden
            a) Degree
            b) Kind

8) Detritus content — inorganic and organic
9) pH, buffer system
10) Alkalinity
11) Hardness
12) Watershed characteristics
    a) Area gradients
    b) Cover, run-off
13) Ground water supply
    a) Aquifers
    b) Water table depth
14) Tidal flushing
    a) Rates
    b) Oscillations
15) Wave action range
    a) Storm to calm
16) Currents

2. Meteorological factors
   a. Wind — prevailing direction
      1) Velocities
      2) Seasonal variations
      3) Storms
   b. Light — total annual solar energy impingement
      1) Intensity of radiant energy
      2) Quality of light
      3) Photoperiod — diurnal cycles
   c. Air temperature — mean, minimum, maximum
   d. Relative humidity or dew point — mean, minimum, maximum
   e. Precipitation
      1) Rainfall amounts
      2) Rainfall annual distribution
      3) Storms
3. Edaphic factors
   a. Soil type — profile — subsoil characteristics to ground water table
   b. Percolation rate — coefficient of hydraulic permeability
   c. Topography
   d. Particle size and shape
   e. Angle of repose — wet and dry
   f. Fertility
   g. Microbiological population
   h. Leachable toxins, e.g., pesticides, heavy metal ions
   i. Color — infrared reflection — absorption

B. *The Biological Environment*
   1. Biotic resources
      a. Primary productivity — photosynthetic activity
      b. Secondary productivity — number of trophic levels
      c. Total natural production as feed
   2. Seed source from wild populations of species to be grown, e.g., spatfall, availability of gravid females

3. Eutrophication resulting in microorganism populations
    a. Natural origins
    b. Man-made origins, domestic and industrial

II. ECONOMIC CLIMATE

A. *Land*
1. Costs
2. Restrictions on ownership
3. Zoning regulations

B. *Labor*
1. Wages; minimum wages, severance pay, other fringe benefits
2. Availability of labor, proximity to production and processing sites
3. Union rules and government regulations
4. Liability laws
5. Availability of professional management
6. Availability of engineering skills

C. *Transportation*
1. Accessibility of facilities — length of haul to port or market
2. Road system for trucking
3. Railroad service
4. Shipping ports, cargo handling facilities
5. Airports, cargo handling.

D. *Materials and Services*
1. Raw materials supply
    a. Feed
    b. Fuel
2. Equipment availability
3. Service and maintenance
    a. Spare parts
4. Finished goods — import duties
5. Packaging materials availability

E. *Construction Costs*
1. Earth moving
2. Piping
3. Wells
4. Buildings

F. *Communications*
1. Telephone, telex, cable

G. *Power Costs*
1. Public power
2. Private production

H. *Financial*
1. Sources of capital

a. Commercial banks
b. Development banks
2. Operating credit
3. Financial controls
4. Constraints on movement of capital
5. Currency stability

I. *Markets*
1. Proximity to domestic and foreign
2. Trade practices

III. POLITICAL SYSTEM

A. *Stability*

B. *Government Service to Economic Development*

C. *Natural Resources Policies*

IV. LEGAL FRAMEWORK

A. *Incentives to Private Investment*
1. Tax abatement
2. Duty free import

B. *Constraints*
1. Equity limits
2. Fishing limitations
3. Water rights — riparian, ownership and lease conditions

V. SOCIAL PARAMETERS

A. *Competing Uses of the Environment*
1. Adverse effects of urban and industrial uses
2. Waste disposal
3. Power generation
4. Recreational uses
5. Mining— sand and gravel, petroleum
6. Dredging
7. Navigation
8. Irrigation
9. Sport fishing
10. Commercial fishing

B. *Customs with Respect to Use of Common Property Resources*
1. Redress of losses due to poaching

C. *Community Services*
1. Schools
2. Medical care
3. Housing
4. Protection
5. Cultural resources

The integration of the above criteria into a biologically and economically sound system of production, processing and marketing requires a benefit/cost analysis that at this time defies our capabilities. The essential hard data are just not available to us. Each of these criteria must be weighed in relation to all others, and even if we knew the range over which they could vary practically, we do not understand how the complex interaction would affect the working of an enterprise. That is, we are not sufficiently knowledgeable regarding interactions among these variables to weigh them wisely in an effort to estimate a benefit/cost ratio.

These variables are for the most part non-linear and in relation to each other; they form multi-dimensional spaces. The interaction plots are extremely complex and determining the optima is still beyond our skills. However, we should note that complex systems of production, such as these to which we refer today, have been undertaken by entrepreneurs who somehow intuitively integrated the components into a workable system. Not, however, without failures, which we must be prepared to confront, compensate and learn from. We may someday have sufficient command over this field of knowledge to enable us to build a mathematical model with sufficient verisimilitude to represent the real aquatic world, and guide us to efficient utilization of the living resources of the seas and the lakes so as to make a contribution to freedom from hunger. But there is much yet to be done.

THURSDAY — NOVEMBER 18, 1971

Chairman — William B. Hannum, Jr., *President, Sea Farms, Inc.*
Key West, Florida

The Lobster Fishing Industry of Mt. Pleasant, Bequia Island, West Indies

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INTRODUCTION

Relatively little is known about the subject of fishing in the West Indies. The land has monopolized the attention of most writers, reflecting the traditional interest of the islands in cash crop agriculture. Although a number of technical publications are available on West Indian fisheries, there still exists a large gap in our knowledge concerning West Indian fishing lore, and the nature and distribution of marine industries in the islands. Hopefully, this study will make a contribution to the better understanding of fisheries in the West Indies.[1]

The purpose of this study is to describe the marine industries of Mt. Pleasant, Bequia Island, northernmost island of the Grenadine archipelago.[2] Special emphasis is placed on commercial lobster fishing which has developed in recent years as the community's most important activity in terms of income and employment.

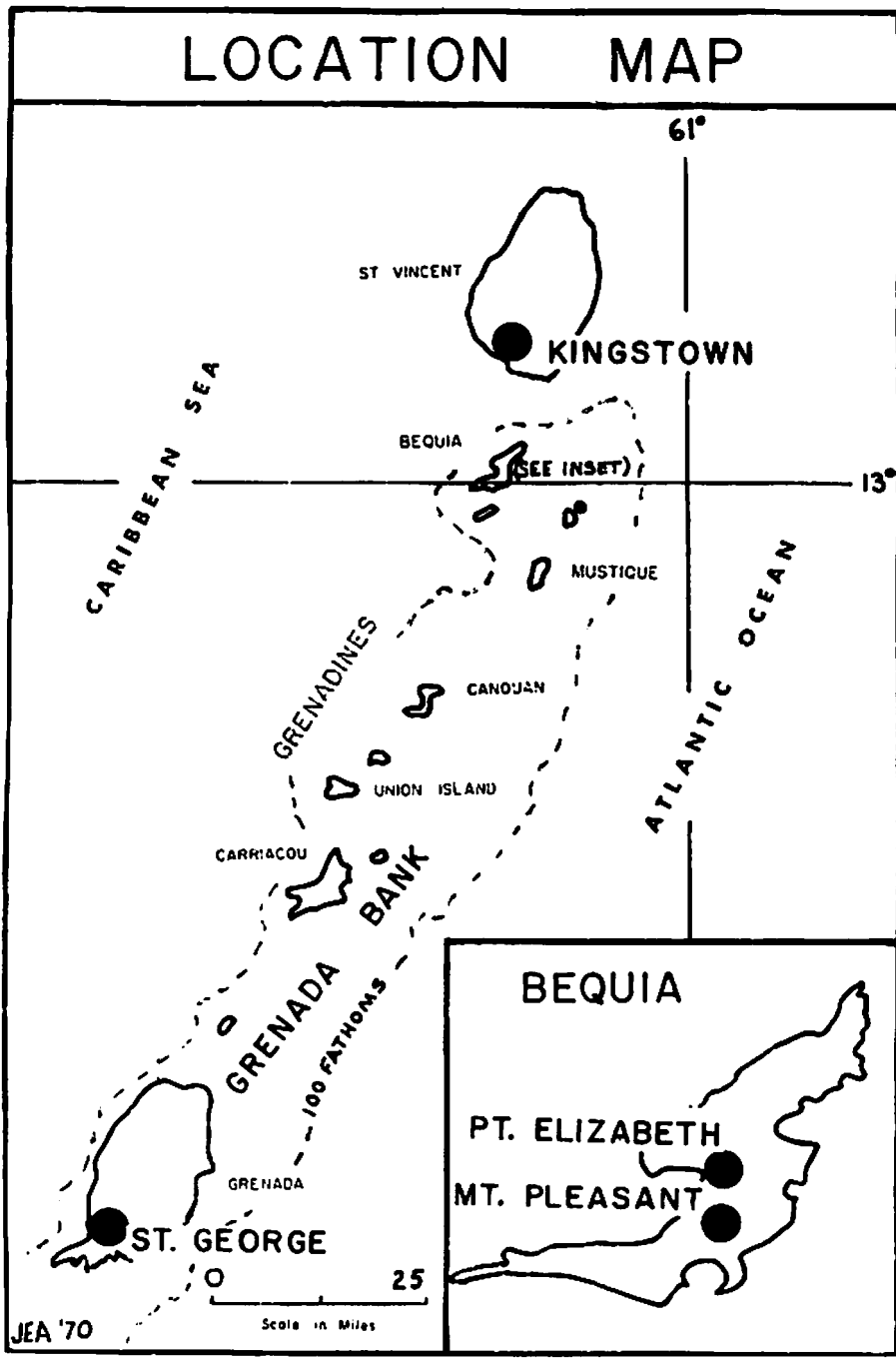
THE COMMUNITY

Mt. Pleasant is a community of approximately 100 white inhabitants living in 20 households dispersed over the summit of Bequia Island's central upland. Mt. Pleasant offers a spectacular view of the Grenadine Islands and most of its half square mile surface is exposed to the refreshing trade winds. However, these attractions for settlement are little compensation for the community's acute shortage of arable land.

The most striking features of Mt. Pleasant's landscape are its sparse, dry

[1]The field research for this study was supported by the Foreign Field Research Program conducted by the Division of Earth Sciences, National Academy of Sciences — National Research Council and financed by the Geography Branch, Office of Naval Research, under contract Nonr-2300(9).

[2]The Grenadine Islands are comprised of a chain of over 100 small volcanic islands, islets and reefs that stretch 70 miles between St. Vincent and Grenada in the Lesser Antilles. The total area of the Grenadines is approximately 35 square miles and has a population of 15,000.


LOCATION MAP
61°
ST VINCENT
KINGSTOWN
CARIBBEAN SEA
BEQUIA
(SEE INSET)
13°
MUSTIQUE
GRENADINES
CANOUAN
UNION ISLAND
ATLANTIC OCEAN
CARRIACOU
BANK
GRENADA
100 FATHOMS
GRENADA
ST. GEORGE
0
25
Scale in Miles
JEA '70
BEQUIA
PT. ELIZABETH
MT. PLEASANT

vegetation and its eroded hillsides. The windward slopes are parched by the trade winds, and for most of the year the vegetation, consisting of savannah grass and drought-resistant shrubs, has a brown, withered appearance.

Erosion goes on at a terrifying rate. Dark basaltic boulders protrude everywhere through the thin soils. On the steep slopes slumping is severe.

Agriculture is virtually non-existent. Small patches of maize, pigeon peas and cassava are cultivated near a few of the households, but there are no commercial crops of any kind. A small number of emaciated cattle and sheep graze the sterile upland. Repelled by unproductive soil and the absence of remunerative employment on land, the able-bodied men of Mt. Pleasant have turned to the sea for their livelihood. Many of the males are engaged in shipbuilding and sail making while others work on local trading schooners based at Pt. Elizabeth, Bequia. However, the leading enterprise of the community is lobster fishing which offers employment to nearly 20 men.

DEVELOPMENT OF THE LOBSTER INDUSTRY

Before 1950 the spiny lobster was little exploited in Bequia and the Grenadines. There was no significant demand for the product in the neighboring islands of St. Vincent and Grenada and the shellfish was not gathered for home consumption. The majority of people living in the islands were not accustomed to preparing or eating spiny lobster.

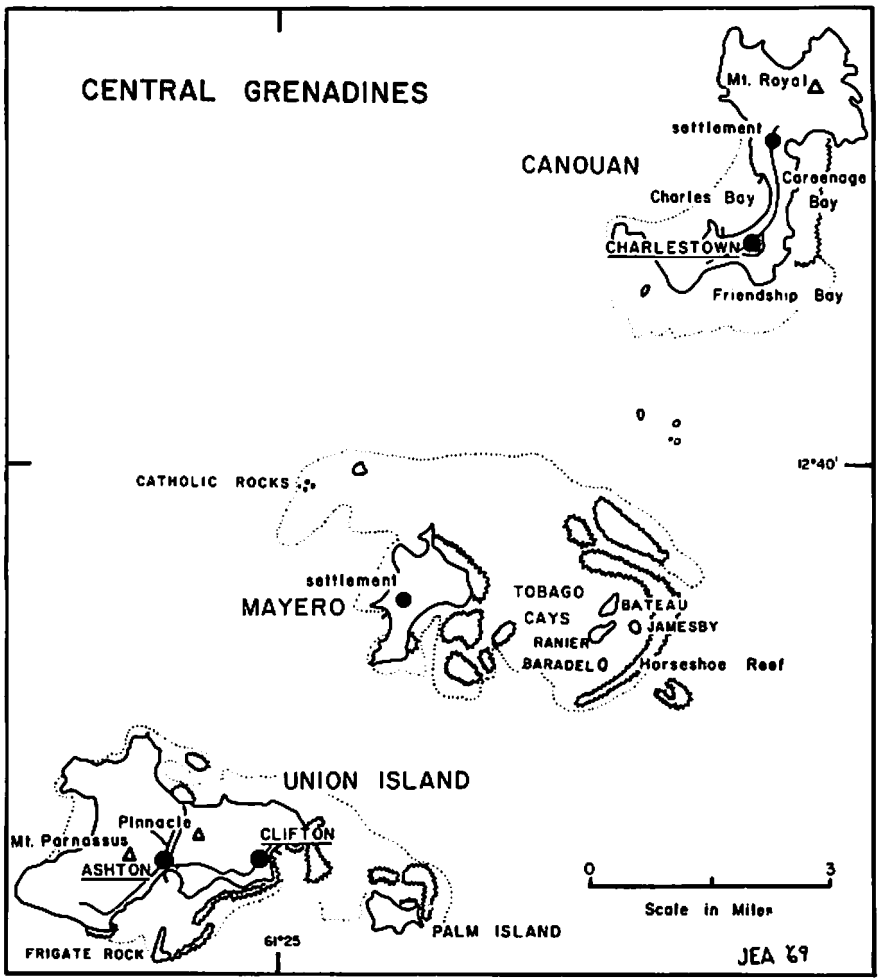
In the early 1950's, Martinique began to purchase a wide variety of marine products, including spiny lobster, from Bequia fishermen. Martinique ran one and sometimes two trading schooners to the Grenadines on a monthly basis. These vessels, equipped with cold storage facilities, were able to operate in the islands for 8 to 10 days at a time before returning home with large quantities of chilled and frozen fish. In 1957 Martinique merchants offered Mt. Pleasant fishermen 62 cents (B.W.I.) a pound for lobster tails and 25 cents a pound for most species of freshly gutted fish (Wiles, 1957). Before devaluation in 1969, one British West Indian dollar was valued at 66 cents to the American dollar. In this study monetary values are quoted in West Indian currency.

Lobster gathering offered Mt. Pleasant males an unusual opportunity to make extra income. This activity was relatively easy, as well as rewarding. One knowledgeable informant reported that during the 1950's lobsters could be found "under every rock and ledge in just a few feet of water." Several dozen of the crustacea could be gathered by one diver in a few hours.

Initially, lobster fishing in the Grenadines was characterized by small-scale operations which could be suspended at any time without a serious dislocation of labor and capital. Divers used small sailing craft to reach lobster grounds. Normally the crew consisted of one oarsman and one or two divers. While the diver(s) probed for lobster over nearby reefs, the oarsman rowed close behind and collected the lobsters from the divers.

In the early 1950's lobsters were caught with homemade spears, or by hand. From about 1955 to 1964 Mt. Pleasant fishermen used the arbalete, a sling-powered harpoon gun of French design, to spear lobster. The arbalete and other skin diving gear were introduced to the Grenadines by Martinique fishermen accompanying the trading schooners engaged in the fish trade. There was probably also some influence from St. Vincent as sport fishermen of that island had been skin diving for finfish since the late 1940's.

One advantage of the arbalete is that it is light enough to be carried under one



arm giving the diver freedom of the other hand for swimming. The sling gun has two or four strong rubber bands which drive a long steel-barbed spear. The projectile is retrieved by a line which runs from the spear to a reel mounted on the gun. The arbalete is ineffective beyond a range of nine feet so divers must maneuver close to their quarry before releasing the harpoon.

In 1964, Bequia divers adopted a wire snare to catch lobsters, a device that had several important advantages over the harpoon gun, noted later in this study. However, the arbalete is still used by Bequia divers to spear turtle, barracuda and reef fish.

DISTRIBUTION AND CONSERVATION OF LOBSTERS

The coral-fringed coasts of the Grenadine Islands together with their outlying reefs provide an excellent habitat for spiny lobster (*Panulirus argus*). Spiny

lobsters are found mainly on rock, coral and hard sand bottoms adjacent to reefs and headlands. The crustacean normally avoids soft, muddy grounds and strong currents. Lobsters usually are encountered in less than 5 fathoms of water, well within free-diving range; however, fishermen report catching them at depths of 6 or 7 fathoms.

Spiny lobsters feed at night on small shelled animals including young conch, sea snails and clams (Smith, 1958: 14). During the day they find shelter under rocks, seafans, seagrass and large sponges. Fishermen detect the presence of lobster by their whips, or antennae.

The Grenada Bank, which is dominated by the Grenadines, is the best-stock lobster ground in the Windward Islands; however, it is a narrow formation and does not support the lobster population found elsewhere in the Caribbean and western Atlantic, notably British Honduras, Cuba and the Bahamas.[3] The Grenadines have the capacity to support only a modest lobster fishing effort and, even then, provisions must be made to regulate fishing intensity.

In May 1954, the St. Vincent Government, which has administrative jurisdiction over the northern Grenadines, enacted legislation to protect spiny lobsters. The major provisions of St. Vincent's Lobster Protection Ordinance are summarized (Anon, no date): (1) It is unlawful for any person to expose for sale, buy or have in his possession any lobster of less than 1 pound in weight, or measuring less than 9 inches in total body length. (2) It is unlawful for any person to take, catch, destroy, or have in his possession, sell or offer for sale any female lobster when the same shall be found to be carrying eggs. (3) A closed season is established from May 1st to September 30th. The date of the closed season may be altered in the Government Gazette.

In 1965 Grenada passed a similar ordinance, to protect spiny lobsters in the southern Grenadines, which are dependencies of Grenada.

St. Vincent's and Grenada's lobster ordinances are designed largely to protect breeding stock, but there is no limit placed on the number of legal-sized specimens that can be caught in the open season. As a result of fishing pressure in the open season there has been a serious depletion of lobster grounds in the Grenadines. Fishermen complain frequently about the scarcity of lobster and, in recent years, divers have been forced to extend their search into all parts of the Grenadines and to greater depths.

CONTEMPORARY LOBSTER FISHING INDUSTRY

Reorganization of the industry: The Martinique fish trade with the Grenadines ceased in 1959. Since then Mt. Pleasant fishermen have delivered their catch to St. George's, Grenada, on the southwest coast of the island. Unlike the Martinique trading pattern, Grenada sends no vessels into the Grenadines to pick up lobsters from fishermen. Mt. Pleasant fishermen built two motorized sloops for the purpose of transporting lobsters from the Grenadine fishing grounds to St. George's. The two lobster sloops are family-owned and operated. Although vessel owners do no fishing themselves, their sons comprise the nucleus

[3] The Grenada Bank is a volcanic formation that extends over 100 miles from the St. Vincent channel to a point 20 miles south of Grenada. The northern 70 miles of the Bank is occupied by the Grenadine Islands, of which Bequia is the northernmost island. The Grenada Bank is a narrow formation measuring only 10 to 17 miles in width, and its border is marked by a steep descent to ocean basins. Most of the submarine formation is less than 20 fathoms below sea level.

of the two seven men crews, each having four divers, two motorboat operators and one cook.

Lobster fishing pattern: The lobster fishing season, which is regulated by St. Vincent's Lobster Protection Ordinance, begins October 1st and ends the last day of April. Normally three or four fishing trips are made in the Grenadines in the 7-month season. One or two expeditions are made before Christmas, followed by two trips after the holiday period.

There is no fixed or regular schedule for lobster fishing trips. Generally each trip lasts about 5 weeks, followed by an indefinite rest period at home. Expeditions may be delayed for a considerable period because of adverse weather conditions and difficulties in gathering a crew.

At the start of a fishing trip the sloop is fueled and ice and provisions are taken aboard. Most of these supplies are purchased in Kingstown, St. Vincent.

Most lobster fishing is done in the central Grenadines, including the east and south coast of Canouan, the Tobago Cays and Petit St. Vincent. The favorite lobster fishing ground is located in the vicinity of the Tobago Cays and nearby reefs, lying about 1 mile east of Mayero. The Tobago Cays are a group of four waterless and uninhabited islets bordered on the north and south by Horseshoe Reef. The two eastern islands, Jamesby and Baradel, lie on a slightly submerged coral and sand formation which is also shared by Horseshoe Reef, a few yards to the east. The west lying islands, Bateau and Ranier, are separated from this complex by a tortuous channel 4 to 8 fathoms deep. Shallow drafted vessels approach the channel either from the northwest or from the southwest. Sloops and other small vessels, including yachts, find secure anchorage in the channel or on the leeward side of Bateau Island.

Two square stern boats powered by outboard motors are used to ferry lobster divers from the anchored sloop to nearby reefs. These small, shallow-drafted boats are maneuvered easily over slightly submerged reefs and around coral obstructions, giving divers good access to lobster lairs.

In probing for lobster, divers swim slightly submerged breathing through a snorkel. Visibility is about 10 to 12 feet in the exceptional clarity of the inshore waters. Marine life is easier to detect over sandy or shell bottoms than over moss-covered or dark rock bottoms. Lobster divers work close to rocks and coralline reefs generally in depths of from 1 to 4 fathoms. Strong currents, breakers and rough water are dangerous for divers, and are avoided.

As noted earlier, from 1955 to 1964, Bequia fishermen used harpoon guns to catch spiny lobsters. But spearing lobster had two serious disadvantages: (1) the meat was damaged by the projectile resulting in an inferior product and (2) fishermen were dependent on a fresh supply of ice to keep the crustacean from spoiling. Tails were removed and iced in the sloop's cold storage compartment. After 8 or 9 days, when the ice supply ran low, the catch was delivered to St. George's, Grenada, and a new supply of ice was brought aboard.

In the years since 1964, Mt. Pleasant divers have captured their quarry with a wire snare. This device, of local invention, consists of a copper wire noose attached to the end of a 6- foot pole. The loop is placed around the "flapper" or tail of the lobster and pulled tight. The wire is of sufficient thickness (18 gauge) to keep the tail from being cut, and the pole is long enough to permit divers to capture the shellfish in deep crevices. After the lobster is snared it is brought to the surface and given to a boatman.

Lobsters are kept alive in wire cages anchored in about 2 feet of water. At market time they are transferred to the vessel and placed in giant containers

measuring 4 x 4 x 2 feet. These are built by nailing chicken wire over a stout wooden frame. Several hundred pounds of live lobster can be held in one cage.

Lobsters are gathered 8 or 9 days before they are taken to market in St. George's Grenada. The catch varies depending largely on weather conditions and the abundance of lobster. Four divers, working steady over a 7-day period, can gather upwards of 3,000 pounds of lobster (live-weight) representing approximately 2,000 specimens. However, the average catch is usually no more than half of this amount. Normally three or four deliveries are made to market in the course of one 5-week fishing trip.

MARKETS

St. George's, Grenada: Mt. Pleasant fishermen deliver most of their lobster catch to two food firms located at the waterfront in St. George's harbor. Both firms sell lobster to a Trinidad wholesaler who delivers the product, by ocean liner, to Port-of-Spain, Trinidad. The demand for lobster in hotels and restaurants is good, but the Grenadines satisfy only a small fraction of this market.

No records are available on lobster landings in Grenada before 1965. Mr. Pressey, the major buyer, claimed that from 1960 to 1963, Mt. Pleasant divers delivered up to 1,000 pounds of lobster tails monthly which is equivalent to 3,000 pounds of live-weight lobster (the tail makes up approximately one-third of the lobster's total weight). Since 1964 there has been a sharp decline in the amount of lobster delivered to St. George's. This has been due to over-fishing resulting in the depletion of lobster stocks in the Grenadines.

St. Vincent: St. Vincent's potential market for lobster does not exceed 2% of the island's 100,000 population, consisting of a few tourists, and well-to-do merchants who occasionally buy the shellfish for a weekend meal. Lobster fishermen do not find it profitable to sell their product in St. Vincent on a regular basis because of the limited demand. In St. Vincent spiny lobsters retail for about $1.00 (B.W.I.) per pound live weight, which is about equal to the best cuts of fresh beef in the Kingstown market.

Tourist market: Bequia divers sell a small but increasing quantity of their catch to hotels and tourist resorts in Grenada, St. Vincent, and the Grenadines. Fishermen also sell lobster to yachts passing through the Grenadines. The booming tourist industry of the Grenadines promises to become the leading market for spiny lobster in the near future. Fishermen prefer to sell lobster to tourist establishments as they generally receive a better price for the product than the regular markets.

ACTIVITIES DURING THE CLOSED SEASON

During the lobster closed season, Mt. Pleasant lobster fishermen are relatively inactive. Trolling and skindiving for finfish are relatively popular activities in this period. In May and June, Mt. Pleasant fishermen troll for bonito and other pelagic fish with artificial spoons attached to wire lines rolled on reels. Throughout the closed season they also spear snapper, grouper, crevalle and barracuda. The bulk of the catch is sold in Kingstown, St. Vincent.

PROBLEMS AND PROSPECTS

The Mt. Pleasant lobster industry is in serious difficulty, as reflected by the

decreased landings of this shellfish after 1964 and the negative attitude of fishermen engaged in the lobster trade.

The most pressing problem is the inadequate supply of lobster to support the highly capitalized industry. In 1965, the wholesale value of the lobster catch was estimated at $5,000 to $6,000 (B.W.I.). Approximately one-half of this amount was spent for upkeep on the two vessels, and for fuel and other supplies, leaving only a small return for the eight divers and six helpers. As a result, many divers have lost interest in lobster fishing. Frustrated in their attempts to find commercial concentrations of lobster and much fatigued by deep diving, they hesitate to organize new fishing expeditions. The captain of one crew plans to emigrate to the United States, and his boatowner father is looking for a buyer for his fishing sloop.

The small spiny lobster population in the Grenadines cannot support a relatively large-scale, or a highly capitalized fishing effort that has characterized the industry in recent years. In years ahead, the Grenadine lobster enterprise will probably be dependent upon small-scale units, i.e., boats and their crews rather than on motorized vessels.

Furthermore, fewer deliveries of lobsters will be made to Grenada, and it is likely that an increasing amount of the shellfish catch will be sold to resort centers in the Grenadines.

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The Future of the Gulf Menhaden, the United States' Largest Fishery

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INTRODUCTION

Since 1963 the Gulf menhaden (*Brevoortia patronus*) has supported the largest single fishery in the United States. In 1970, the Gulf purse seine fishery landed 1.2 billion pounds and constituted 25% of all fishery products landed by United States' fishermen. The Gulf purse seine catch in 1971 is expected to be about 1.5 billion pounds and thus only 2 to 4% less than the record catch of Atlantic menhaden in 1956 and of the Pacific sardine in 1936-37. National Marine Fisheries Service personnel have sampled the Gulf menhaden in landings since 1964 for age (from scales), fork length, weight, sex and stage of sexual maturity. Full time samplers were stationed during the 1964-68 seasons at Moss Point, Mississippi; and Empire, Morgan City, and Cameron, Louisiana. Occasionally samples were also collected at Apalachicola, Florida; Dulac, and Intracoastal City, Louisiana and Sabine Pass, Texas, the remaining ports where purse seine catches were landed. During the 1969-71 seasons, samplers were stationed at Moss Point, Mississippi; and Morgan City, and Cameron, Louisiana. Samples of landings at the other listed ports were also obtained as time permitted during these later seasons. In addition to securing fish, samplers maintained daily activity records of each vessel and assisted vessel personnel in the maintenance of a fishing log. Daily catch records of each vessel were also collected during the period 1964-71. Catch records for the seasons 1946-63 were made available by plant managers. A part of these data are reported here.

HISTORY AND STATUS OF FISHERY

Landings of Gulf menhaden by the purse seine fleet during the 25-year period 1946-70 show gradual but not consistent annual increase (Fig. 1). Gulf menhaden were reportedly landed as early as about 1900, but annual catches until after World War II remained small. The present purse seine fishery can be considered as beginning in 1946 when 35,000 metric tons were landed. Decreases in landings occurred in 1952, 1953, 1957, 1963, 1964, 1966 and 1967, but the trend has been toward larger landings each succeeding season. Since 1946, annual landings have increased 15 fold. Landings since 1967, the most recent low, have increased 73% to 546,000 metric tons in 1970. Estimated catches in 1971 are 690,000 tons or 26% greater than the previous record 1970 catch.

The distribution of landings by the various states along the Gulf coast for the past 10 seasons, 1961-1970 (Fig. 2), shows that proportionately, Louisiana's landings have increased most. Landings in Texas, and in Florida west coast and Mississippi have each proportionately decreased. Landings in Florida and Mississippi decreased from 30% of total Gulf landings in 1961 to 17% in 1970. Texas landings decreased from 13% of total landings in 1961 to 4% in 1970. A contributing factor for these changes in landings during this 10 year period is the

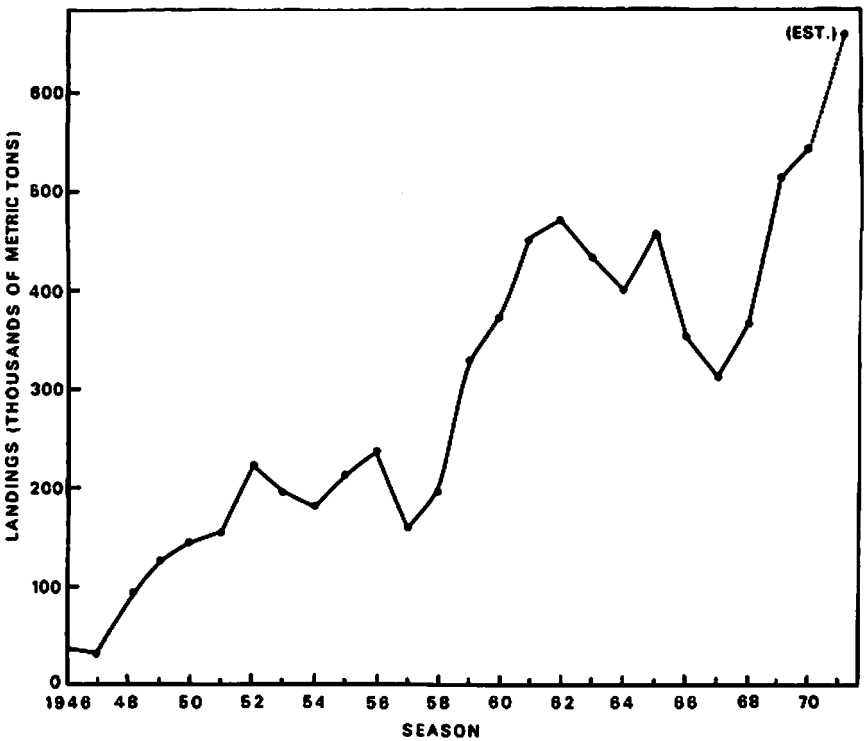

Fig. 1. Purse seine landings in metric tons of Gulf menhaden, 1946-1970.

change in number of carrier vessels and related shore-based facilities which took place during the decade.

The number of operating menhaden reduction plants increased from 2 in 1946 to 14 in 1968. Since then, 12 plants received catches in 1969, and 13 in each of the 1970 and 1971 seasons (Fig. 3).

Spotter aircraft, used to search for schools of Gulf menhaden as well as to aid in the setting of the purse seine, have steadily increased from 1949 when available records show that planes were first used full time in the Gulf fishery. In 1971, 35 airplanes were used (Fig. 3).

Carrier vessels, used to carry the two purse boats and net, as well as the fishermen, to the grounds, and transport the catch back to the reduction plant, generally increased from 4 in 1946 to 86 vessels in 1956. Since then, the number has fluctuated between 68 and 92.

Fish catching ability, although suggested by the number of carrier vessels, is more directly related to size of the vessel and its fish-hold capacity. In 1946, the average size of the carrier vessels, expressed in the vessel's registered net tonnage, was 54 tons. In 1971, the average size of the vessels was 245 tons; a five-fold increase (Fig. 3). The relation of registered net tonnage and fish-hold capacity for the Gulf menhaden fleet has been demonstrated and appears valid.[1] During

[1] A linear surplus-yield model of the Gulf of Mexico's menhaden purse seine fishery, by Robert B. Chapoton. Unpublished manuscript, National Marine Fisheries Service, Mid-Atlantic Coastal Fisheries Research Center, Beaufort, N.C., 28516.

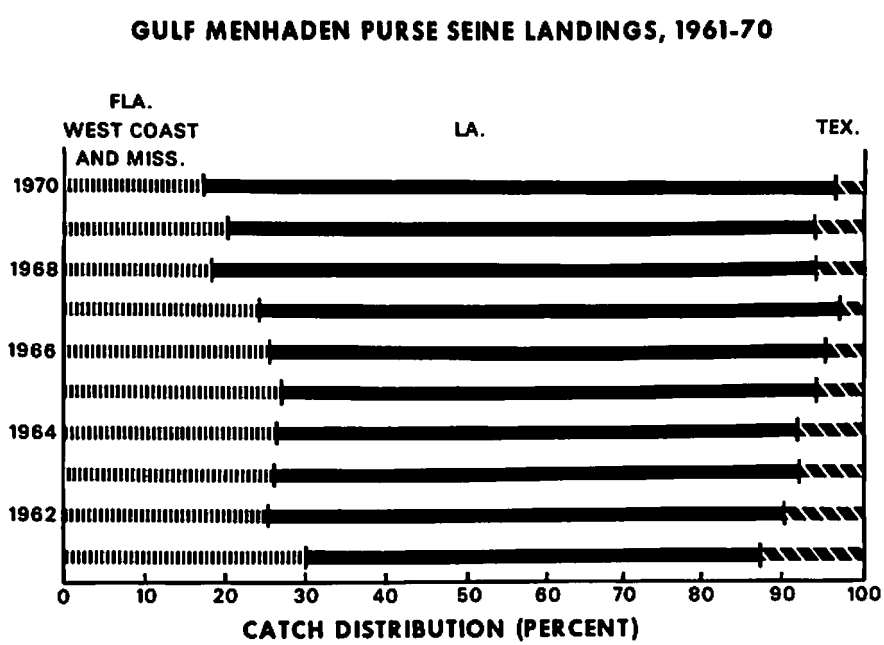

Fig. 2. Distribution of purse seine landings by state, 1961-1970.

the 26-year period shown, the size of the fleet increased at an average annual rate of 14.6%.

Sampling of the purse seine landings for age composition since 1964 shows that the fishery is dependent on principally two age groups of menhaden. The number of fish of each age in landings during the 1967-1969 fishing seasons shows that annually, the number of fish recruited is not consistent (Fig. 4). In 1967, age group 1 comprised 59% of the sampled fish and contributed about 2.8 billion fish to landings that year. In 1968, age group 1 decreased in abundance and comprised only 28% of the sampled fish which represented an estimated 1.4 billion fish, only one-half as many fish as the previous season. In 1969, age group 1 were more abundant, and comprised 68% of samples and contributed about 4.1 billion fish. Also of significance is that a year class will sometimes contribute more fish to landings as age group 2 than age group 1. In 1968, an estimated 1.4 billion fish were landed, but the following year 2.1 billion or 50% more fish of this same year class were landed by the purse seine fleet. Thus, it is evident that Gulf menhaden are not fully recruited until reaching age group 2.

Gulf menhaden of age groups 3 to 5 are present in landings but contribute only a small amount to annual landings, usually less than 15% (Fig. 4). Thus, the current purse seine fishery is dependent on a fish population whose size and age composition can and does change from one fishing season to the next. The comparatively small numbers of older fish, ages 3-5, do not provide for a "cushion" in landings should fish of either age groups 1 or 2, or both, fail to appear on the grounds. Thus, reduced spawning success or survival of young, one year, is immediately evident the next fishing season by the reduced number of 1-year-old fish in landings. While the numbers of age group 1 fish in the landings

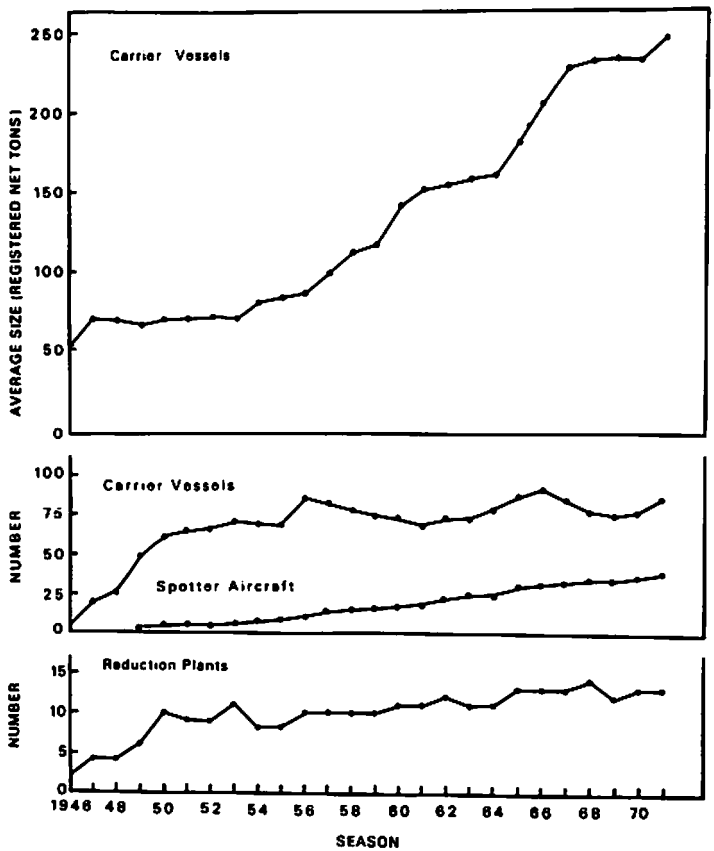

Fig. 3. Number of reduction plants, spotter aircraft and number and average size of carrier vessels in Gulf menhaden purse seine fishery, 1946-1970.

prove that no year class, since 1964 at least, has had a spawning failure, the number of fish recruited as age 1 fish has fluctuated greatly (Fig. 4).

The short life span of Gulf menhaden is in contrast to other clupeid fishes, occuring in more northern latitudes, which have shown not only long life, but have produced dominate year classes which greatly influenced catches in succeeding years. Hjort (1926) reported that the 1904 year class of herring (*Clupea harengus)* annually dominated catches from 1907 to 1919, a span of 13 years. Nicholson and Higham (1965) showed that the 1958 Atlantic menhaden (*Brevoortia tyrannus*) dominated purse seine landings for at least 4 consecutive years. The Atlantic menhaden, a closely related allopatric form of the Gulf menhaden, commonly occurs in catches to age 5, and 8- to 10-year-old members were once not rare. The Atlantic species grows to a fork length of 420 mm and a weight of 1,674 grams (Reintjes 1969). The largest Gulf menhaden sampled thus far was 247 mm in fork length and weighed 296 grams.

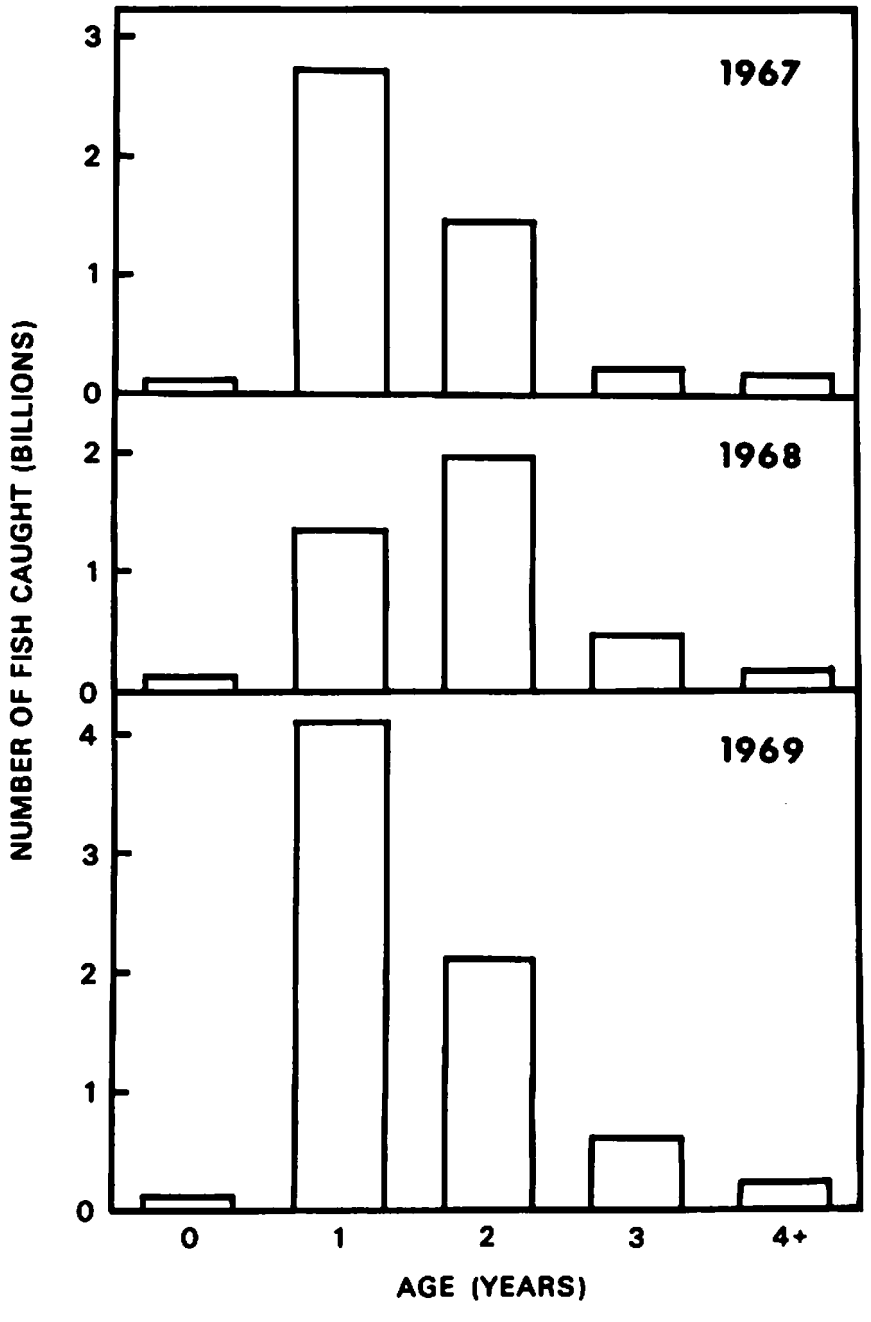

Fig. 4. Estimated number of Gulf menhaden by age landed, 1967-1969.

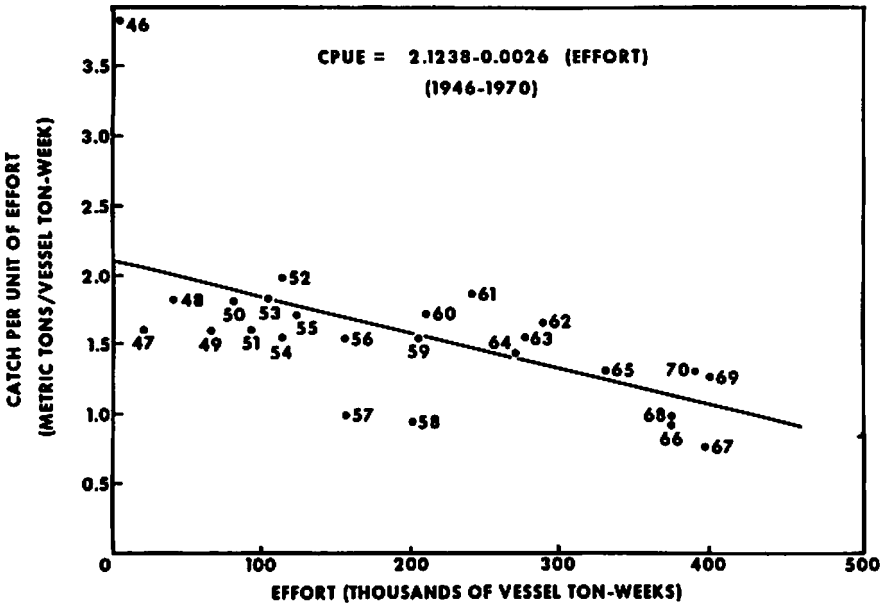

Fig. 5. Equilibrium relation (solid line) between catch per unit of effort and effort in Gulf menhaden fishery, 1946-1970 (numbers refer to years).

ESTIMATES OF MAXIMUM SUSTAINABLE YIELD

The linear surplus-yield model, sometimes called the Schaefer type, assumes logistic population growth. This assumption results in (1) a linear relation between fishing effort and population size and (2) a parabolic curve when yield is plotted against population size or fishing effort (Schaefer, 1954).

A summary of landings and corresponding catch per unit of efforts (CPUE) for the 24-year period (1946-1969) of this fishery has been made, as well as estimates of the maximum sustainable yield.[1] The catch and effort statistics from the 1970 season provide an opportunity for updating. Purse seine landings in 1970 were 546,000 metric tons and fishing effort, calculated as before, amounted to 397,156 vessel ton-weeks of effort. The CPUE for 1970 is thus 1.37 tons of catch per vessel ton-week of effort (Fig. 5). This CPUE is slightly higher than the 1.27 value observed in 1969, but appreciably greater than those of 0.94, .78 and .97 observed for the three previous seasons 1966-1968. By linear regression, the trend of CPUE on effort for 1946-1970 can be summarized by the expression

$$CPUE = 2.1238 - 0.0026\,(Effort)$$

and is shown as the solid line (Fig. 5). The trend indicated appears downward and is only slightly changed from the value previously calculated for the period 1946-69.[1]

The maximum sustainable yield for the Gulf fishery was calculated through use of the constants, a and b obtained above. This, plus a series of equilibrium yields, is indicated by the curved line (Fig. 6). The model indicates that the average annual maximum sustainable yield (catch) for this fishery is 434,000

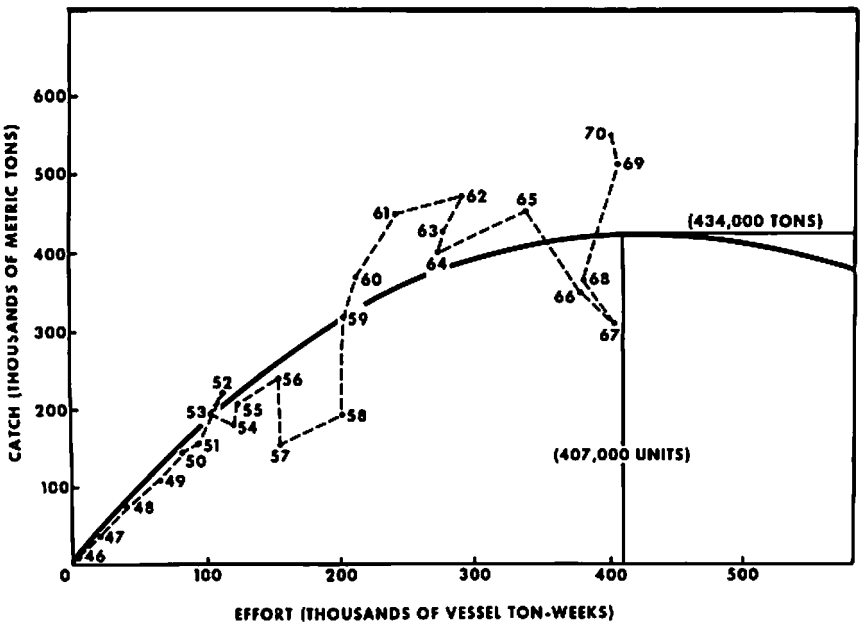

Fig. 6. Equilibrium yield predicted (solid line) and observed catch and effort (dashed line) in Gulf menhaden fishery, 1946-1970. Point of maximum catch (horizontal line) and corresponding effort (vertical line) indicated (numbers refer to years).

metric tons. It is also indicated that 407,000 vessel ton-weeks of effort would produce this yield. As Schaefer (1957) pointed out, additional units of fishing effort greater than that suggested in the model do not produce proportionally more yield. Additional effort will have a negative effect on the population and will tend to reduce future yields. In the Gulf menhaden fishery, as with other major fisheries studied to date, a precise estimate of the amount constituting "too much" is not known. In the Pacific sardine fishery, Murphy (1966) reported that catches exceeded maximum sustainable yield estimates by 20% prior to its collapse. Additional factors, including other fish competition, are believed to have played a part in the rapid decline in the sardine population (Marr, 1960). Cushing (1968) gives examples of other fisheries that show marked changes in apparent abundance, as indicated by landings, and indicates that herring-like, pelagic fishes tend to fluctuate more than do demersal fishes.

An examination of recent annual catches with the model suggests that the Gulf menhaden fishery is reaching or has already reached predicted maximum yields. The average catch during the previous 5 years, 1966-1970, is 423,000 metric tons, or 3% less than the model estimate of 434,000 tons. Landings in 1971 are estimated at 690,000 tons, and while comparisons of landings in a single year are difficult or possibly misleading in a fishery showing wide annual fluctuations, this catch is a significant 59% greater than the level identified as being sustainable.

COMPARISON WITH OTHER UNITED STATES FISHERIES

In a comparison of the Pacific sardine and the Atlantic menhaden fisheries, McHugh (1969) points out some remarkable, though not fully explained, similarities. In like fashion, the Gulf menhaden fishery appears similar to that of the sardine as well as the Atlantic menhaden fisheries, and in some regards, perhaps more striking. The estimated parameters for the three fisheries, each representing, at one time or another, the predominate fishery along the three large coastal areas of the United States; namely, the Pacific sardine on the Pacific coast, the Atlantic menhaden on the Atlantic coast and the Gulf menhaden on the Gulf coast, are listed (Table 1). Reported maximum landings of sardine were made in 1936-37, those of Atlantic menhaden in 1956. Peak landings of the three species are within 4% of one another. Estimates of maximum sustainable yield, each obtained via a different method or modification, are also similar. In each case, landings exceeded the maximum sustainable amount suggested by the models. Because of the arbitrary selection of years and dates when the estimates were made, the three values vary, but they still tend to be approximately comparable. McHugh (1969) asks, "does the history of the sardine fishery offer any lessons that might help. . . .other fishing industries anywhere in the world to avoid the fate of the sardine industry?" It would be reasonable to conclude that even without definitive scientific evidence, the answer is yes. Gulland (1971) points out that in a rapidly expanding fishery, acquisition of irrefutable evidence may not be possible before over-development occurs. Landings of Gulf menhaden increased at an average rate of 59% per year between 1946 and 1970.

TABLE 1

Comparison of Certain Parameters of the Pacific Sardine, Atlantic Menhaden, and Gulf Menhaden Fisheries. Pacific Sardine Data from Murphy, 1966. Atlantic Menhaden Data from Schaaf and Huntsman.[1]

Item	Fishery		
	Pacific sardine	Atlantic menhaden	Gulf menhaden
	Thousand Metric Tons		
Maximum landings	718	712	690[2]
Maximum sustainable yield	427	380-500	434
Landings in excess of max. sustainable yield	91	100	55[3]

[1]Effects of Fishing on the Atlantic Menhaden Stock; 1955-1969. Unpublished Manuscript, William E. Schaaf and Gene R. Huntsman, National Marine Fisheries Service, Mid-Atlantic Coastal Fisheries Research Center, Beaufort, N.C. 28516.

[2]Estimated 1971 purse seine landings.

[3]Based on average of landings 1967-1971.

FUTURE PROSPECTS

History shows that industry tends to increase its capacity to catch and process greater amounts of fish when the resource is near or at its maximum size and supporting near record catches. With a time lag of about 1 year in the Gulf fishery, any increased capacity comes on line the following season. In 1969, the fleet numbered 75 vessels and this was increased slightly to 76 in 1970. Record landings in 1969 and 1970 undoubtedly contributed to optimism, overshadowing the caution that poor landings in 1966 and 1967 had caused, and the 1971 fleet was enlarged. The 1971 fleet numbered 85 vessels, 12% more than the previous year but due to the size of the added vessels, the potential fishing effort was increased 15 to 20% over 1970 levels.

The Gulf menhaden has a high reproductive potential, as evidenced by the successively rapid increase in catches in 1968, 1969, 1970 and 1971, following the recent lows in 1966 and 1967. Conversely, the population evidently underwent a considerable reduction in size in 1966 and 1967 following the near record landings in 1965. Thus, the population and the number of fish recruited has undergone marked changes and will likely continue to fluctuate. At present, the purse seine fleet is totally dependent on the dense schooling Gulf menhaden as no suitable alternate resource has yet been found that would provide a supply of fish to this highly specialized fishery. If for any reason, spawning should decrease and/or recruitment fail appreciably, the fishery will find itself with excess capacity. Use of this excess will tend to reduce the population and will further complicate its recovery and perhaps cause a major decline. The recent history of the fishery suggests that fluctuations in the population and landings should be expected. The Gulf menhaden fishery, as presently outlined, is probably sufficiently understood to permit a reasonable, though possibly conservative estimate of what the resource can be expected to sustain. The correctness of the maximum sustainable yield estimate of 434,000 metric tons will be proven in possibly 5 years.

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South Carolina's New Marine Resources Center

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The estuarine and marine environments of South Carolina are still in relatively good condition compared to many of the more populous coastal states, especially those to the north. The resources that result from and depend upon these environments hold great promise for future development as economic, recreational and aesthetic assets. Development of this coastal zone will occur, but whether it will be wisely done or conducted in a self-destructive fashion depends largely upon the wisdom and effectiveness of the state's marine resource management practices. Effective management of so complex a zone where so many competing interests are vying for what they consider legitimate access is probably not possible without a sound research base.

In 1967, the State of South Carolina recognized the total inadequacy of both its marine oriented management and research programs and took positive steps to correct this condition. For some years, the late Dr. G. Robert Lunz, who was of course well known to this group, almost single-handedly conducted the marine management and research program for the state at Bears Bluff Laboratory. His accomplishments within a difficult organizational structure and an impossible budget climate must be considered remarkable. The respect and admiration that Dr. Lunz commanded were well deserved, and no criticism of his record should be inferred from my remarks. Early in 1968, the Wildlife Resources Commission assembled a team of out-of-state consultants to study the needs of South Carolina and recommend a program to meet those needs. This advisory group was drawn from state and federal agencies as well as universities, and all the members were well known marine scientists or resource management specialists.

The emerging Marine Resources Center that will be described is largely the implementation of the consultants' suggested course of action. The advice of the consultants is being followed much more closely than is often possible.

First, a few remarks on organizational structure. A Division of Marine Resources was created within the South Carolina Wildlife Resources Department, and Dr. James A. Timmerman, Jr. was selected as Director of the Division. Within the Division are two functional units. First, there is a Marine Conservation, Management and Services section which contains the usual spectrum of environmental and fisheries management functions. This unit is the responsibility of Mr. Charles Bearden. Administratively separate, but closely integrated with the management unit, is the Marine Research Laboratory and Educational Program, which is the responsibility of the present speaker.

The Center's purpose is to bring about coordinated, comprehensive management of the coastal zone in South Carolina, and to enhance the development of its resources in a manner consistent with the longterm need of its people. Its functions will include—in addition to management—research, education and advisory services, including extension work.

Several geographic sites were considered, but Fort Johnson on Charleston Harbor was ultimately selected. This site, which is approximately equidistant

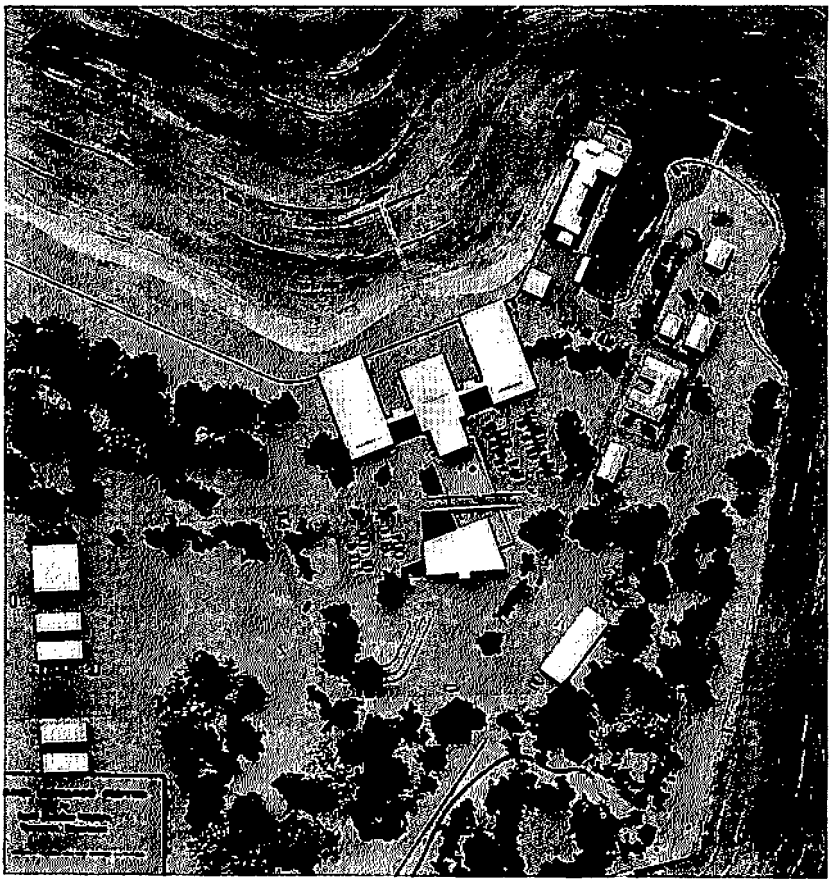

Figure 1. Architect's conception of development of Fort Johnson site.

between the city of Charleston and the open ocean, is comprised of approximately 75 acres of highly desirable land in a spectacular setting. This property was already in the possession of the state and has been transferred to the Marine Resources Division. The choice of site will, I feel certain, prove to have been a wise decision.

Figure 1 is an architect's conception of the development of the Fort Johnson site and must be considered only that. Only a small portion of the total acreage is included in the rendering. The building at the point adjacent to the boat slip is a multistory structure, which will house administrative offices and the personnel of the Management and Conservation unit. This is presently under construction and is scheduled for completion in early spring of 1972. The two large rectangular units are laboratory buildings, one of which is in late stages of construction with completion expected in January of 1972. The second unit is projected for the second phase of construction and present plans call for these two units to be connected by a central building housing offices and an auditorium. The angular building near the center is projected as a small public

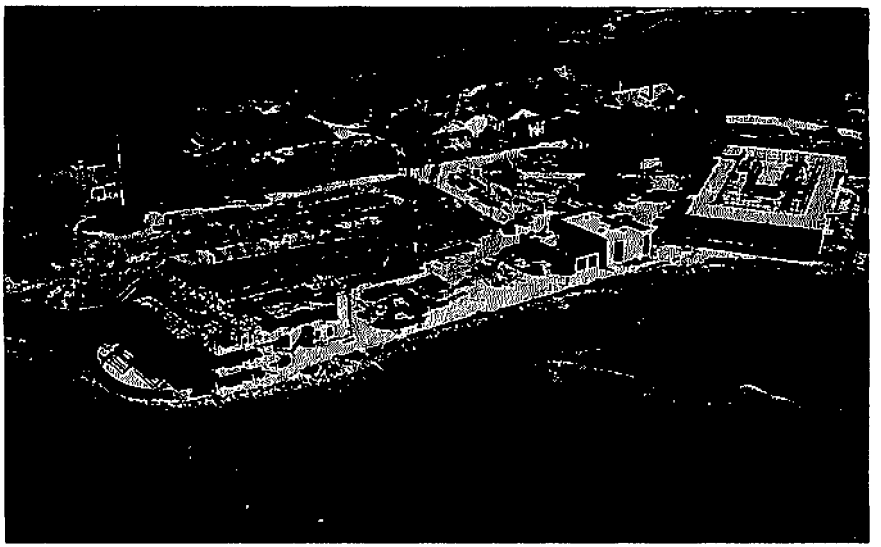

Figure 2. Aerial photograph of construction.

display marine aquarium, and much local interest has been expressed in this. The small H-shaped building to the right of the picture is an existing structure which houses the George D. Grice Marine Laboratory of the College of Charleston.

Figure 2 is a recently taken aerial photograph illustrating tne actual construction at the site. The initial investment in facilities presently under construction exceeds 3 million dollars, and this does not include any expenditure for land. The original funding has come from the State of South Carolina and the Coastal Plains Regional Commission.

Most of the remarks to follow will be restricted to the laboratory building and the emerging program. The initial laboratory building is of modern and architecturally pleasing design. It incorporates 20,000 square feet on the single floor. No space is lost to basic utilities, since these are provided from a separate energy source building. Since this building had to be designed before the research program had evolved, a serious effort was made to build in the maximum possible flexibility. Most of the internal partitions that sub-divide the laboratory and office areas are demountable partitions that would permit internal rearrangement at relatively minor costs.

Many estuarine laboratory sites on the Atlantic and Gulf coasts of the United States present considerable problems for sea-water systems because of the ever-present silt and fouling that occurs in the lines. Charleston Harbor is no exception, and the problem is rendered more difficult because of industrial contamination. For these reasons, the initial design incorporates a completely closed, recirculating sea water system which carries either artificial or natural sea water to all appropriate laboratory areas. An open raw sea water line will provide natural sea water to a large open wet lab area which will also be served by the closed system.

The building also incorporates well equipped chemistry laboratories, environmentally controlled rooms and walk-in freezer and cooler, in addition to the more traditional facilities.

We are now recruiting for the first phase of staffing which will consist of five additional doctoral level marine scientists with adequate supporting staff. The research program will be mission oriented and designed to meet the marine resource needs of the state. As we now envision the program, it will at first consist of about equal parts of direct fisheries related research and environmentally oriented research of South Carolina's coastal zone. Because of the prominence of the shrimp, the blue crab and the oyster to South Carolina's fisheries, at least one crustacean biologist and one molluscan biologist will be included in the original staff. Later stages of development envision a broadened research program to include coastal geology and engineering and physical oceanography.

We believe the Marine Resources Center will make a significant contribution to graduate and undergraduate education in marine science in South Carolina; however, we do not intend to develop an in-house academic program. Rather, we hope to provide shore-side facilities, vessel and technical support to marine science interests in the various colleges and universities within the state. The next major building to be sought would include library facilities for the entire center and teaching facilities set aside for use of educational institutions.

The name "Marine Resources Center" is derived from our hope that with the significant facility now being developed, and with the extensive land holdings yet undeveloped, we will be in a position to attract other marine science facilities to establish on our grounds. We are interested in attracting appropriate laboratories to settle with us, be they university, state or federal in nature, so that the Fort Johnson area on Charleston Harbor will in fact become a true center of marine resource and research activities.