Proceedings of the

TWENTY—EIGHTH ANNUAL

Gulf and Caribbean Fisheries Institute

BAL HARBOUR, FLORIDA OCTOBER, 1975

Sponsors

University of Miami
Rosenstiel School of Marine
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National Oceanic and
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MIAMI, FLORIDA MAY, 1976

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Announcement

A new uniform dues structure was adopted by the Board of Directors of the Gulf and Caribbean Fisheries Institute at their annual meeting, October 1975. Annual membership dues will be $20.00 per person per year; there will no longer be company memberships.

The membership year of the Gulf and Caribbean Fisheries Institute begins on November 1 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.

A registration fee will be charged to those attending the annual GCFI meetings. This registration fee will vary with the location and costs of holding the Institute.

Membership and registration fees together with funds from the University of Miami's Rosenstiel School of Marine and Atmospheric Science 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 DIRECTOR
GULF & CARIBBEAN FISHERIES INSTITUTE
4600 RICKENBACKER CAUSEWAY
MIAMI, FLORIDA 33149

Acknowledgment

The Gulf and Caribbean Fisheries Institute has successfully served the fisheries community by providing practical information to commerical fishermen and a forum for the discussion of conservation and fisheries policy for 28 years. During this period, profound changes have been made in nearly all aspects of fish harvesting and processing; better fishing methods, new products, new markets and new marketing systems have been developed. Biological knowledge essential to the management of major regional fisheries has been acquired, and an awareness of the role of estuaries in the sustaining of the productivity of populations of fish and shellfish has been engendered. More recently, economic problems have affected all fishery operations and the implications of extended fisheries jurisdiction are of concern to fishermen, fishery administrators, and scientists. GCFI meetings have focused on all of these issues striving to inform industry so that it might act in its own best interests.

Credit for sustained interest and viability of GCFI is due in a large measure to the sage advice and willing cooperation of the Institute's Board of Directors. This issue of the *Proceedings* is dedicated to those members retiring in 1975.

With sincere appreciation for their long and valuable service to GCFI, we announce the retirement from the Board of the following members:

Hector Ferreira	– 1957
Charles E. Jackson	– 1961
Mauricio Madero	– 1961
John Mehos	– 1959
L.C. Ringhaver	– 1958
Howard O. Sturgis	– 1965
Richard T. Whiteleather	– 1960

FISHERIES JURISDICTION SESSION

MONDAY – A.M. – OCTOBER 27, 1975

Chairman – Clifford V. Varin, *President,*
Fire Island Sea Clam Company, Inc.,
West Sayville, New York

The New Ocean Regime

WARREN S. WOOSTER, *Dean*
Rosenstiel School of Marine and Atmospheric Science
University of Miami
Miami, FL 33149

The agenda for the Gulf and Caribbean Fisheries Institute includes topics of vital interest to oceanographers and fishery scientists as well as to fishermen. All of these parties will be affected by the new ocean regime that is under development.

Law of the Sea negotiations have been going on now for more than 5 years, and the end is not in sight. The present exercise began with the recognition that there was no proper maritime regime for exploitation of deep seabed resources which suddenly, 100 years after their discovery, appeared to be economically harvestable. Early in the deliberations there arose a noble concept, the common heritage of mankind, which was warmly embraced by the General Assembly of the United Nations. But as time has passed, that heritage has been ground away by the relentless advance of nationalism, and it is now clear that the great bulk of ocean resources, be they animal, vegetable or mineral, are going to end up in the hands of the coastal states.

Although the United States as a major maritime power has pressed vigorously for narrow territorial limits, there is no doubt that this country, with its tremendous coastline and island territories, will benefit more than most countries from a broad extension of jurisdiction over coastal resources. At the same time, there are important segments of our people, such as those who fish in distant waters, who are less than enthusiastic about the way that sea law is developing. Oceanographers are in somewhat the same boat as the distant water fishermen, and I would like to comment on a few aspects of the impending ocean regime of special interest to the fisherman and oceanographer:

1. Although the Law of the Sea negotiations were initiated because of the need for a regime for deep sea mineral exploitation, a resource issue of

greater importance and complexity is that of fisheries.

2. Fishery resources, apart from highly migratory species such as tuna, are almost entirely coastal, almost all of the world catch being taken within 100 miles of the coast.
3. Unilateral extensions of national jurisdiction over coastal fisheries began in the 1950s and are almost certain to be sanctified by international agreement on a 200-mile exclusive economic zone (EEZ).
4. Within the EEZ, coastal state jurisdiction should be limited to control over resources. The international community will retain some rights – for example, freedom of transit and overflight – and may lose others – for example, freedom of scientific research.
5. Establishment of the zone will affect fishery management by extending the authority and responsibility of the coastal state at the expense of other countries or organizations.
6. It has been proposed that in the EEZ, there should be maximum utilization of living resources – i.e., if the coastal state can't utilize all of the total allowable catch, the surplus should be made available to fishermen from other countries.
7. In the simplest case – a single stock of fish residing entirely within the EEZ of one country – effective management should be easy to achieve, presupposing that the necessary data and understanding are available.
8. Few cases will be so simple. Usually several countries will be exploiting the single population, and joint action will be required for effective management to be achieved.
9. Assuming the goal of management is to maintain an optimum yield, among the data required are measures of catch and effort and of composition of the catch. These can be used to determine the effect of the fishery on its target population.
10. That population is also affected by environmental changes, especially during the early stages of its development; some day fishery scientists will learn how to use environmental data to predict the success of recruitment.
11. If the coastal state gains control over all marine scientific research in the EEZ, it may become difficult to collect environmental data required for management purposes.
12. A distinction has been proposed between "fundamental" and "resource-related" research, with more liberal treatment proposed for the former. But all research is in some degree resource-related. More useful distinctions are between open and proprietary research, or between research that is directly related to exploitation of resources (i.e., with short-term payoff) and other kinds of research.

The new ocean regime will affect all of our activities in the Gulf and Caribbean. The Rosenstiel School is engaged in both education and research in that region. Our graduate students become acquainted with this important part of the world ocean, and we welcome students from bordering countries. The importance of the ocean and its resources is becoming more widely evident, and I

foresee a great increase of marine scientific activity in the countries surrounding the Gulf and Caribbean as it is recognized that scientific understanding is a prerequisite for rational use.

The principal activity of the Rosenstiel School is research, and we operate in the Gulf and Caribbean and elsewhere in the tropical ocean. Most of our research is "resource-related" in the broad sense since it is concerned with understanding the processes of change in the ocean. Changes in the abundance, distribution, and availability of living resources are an obvious part of such investigations. In fact, it is usually easier to study the dynamics of change in an exploited population than in a wild one because of the intensive sampling performed by the fisherman. On the other hand, scarcely any of this research is directly related to the exploitation of resources, and all of it is openly published and widely available to all concerned.

I would like to see a more vigorous and systematic study of the Gulf and Caribbean, following in the footsteps of the international CICAR project and synthesizing the data that are now available into a coherent whole. From such an analysis it should become evident where our knowledge is inadequate and where further research is required if we are to use these waters and their resources wisely. We at the Rosenstiel School are prepared to work closely with other institutions in the region in such a study and in the continuing research program that should ensue. Perhaps the Gulf and Caribbean Fisheries Institute, together with other interested organizations, can play a part in helping to make this possible.

The Status of Extended Jurisdiction over Our Fishery Resources

WILLIAM F. ROYCE, *Director*
Extended Jurisdiction Project Office
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
Washington, D.C. 20235

We are in the midst of highly complex international and national negotiations about extended jurisdiction and the management of the fishery resources. I can follow the action best by relating it to fundamentals and, therefore, I shall discuss briefly the major trends even though some of you may be familiar with them.

The first of the trends is the change in the world's fisheries. Prior to the present century, the world's fishing was largely confined to sailing ships which worked in coastal waters, although there were a few which crossed oceans in search of whales or fish for salting. With the development of powered ships and refrigeration systems, the vessels became much more effective, and after World War II the fishermen of the world began intensively to expand their operations. They developed vessels that could fish in any ocean and bring the catch home in good condition. In a few fisheries they developed equipment that could catch 1,000 tons or more of fish per-man-per-year. They built large fleets of these vessels and, following 1950, the world catch doubled about every 11 years, to reach a level of 70,000,000 tons in the early 1970s. Now many nations are capable of large scale fishing off the coasts of other countries.

Along with the recent development of the fisheries came a development of the ocean sciences related to managing the fisheries. The scientists learned to assess the condition of the stocks, and with reasonable accuracy, to predict the effects on the stocks of alternative fishing practices and environmental changes. Now techniques are widely available which give people hope that social goals can be achieved by managing the fisheries.

These technical and scientific developments have not been followed by similar development of control of the fishing. That within the territorial seas of 3- to 12-miles width is clearly within the authority of the coastal country, but few countries, including the United States, have exercised adequate scientifically based control. The fishing on the resources outside the territorial sea has been essentially uncontrolled except in a few cases in which international treaties have been effective.

The consequence of the present fishing capabilities and the scanty control has been the collapse of several of the world's largest fish stocks and a situation in which most of the familiar fish stocks of the northern hemisphere are being fished to the limits of their productivity. More fishing cannot take more catch from these on a sustained basis and can cause them to collapse.

This situation is a major concern for the United States because we have, within 200 miles of our coasts, about 10% of the world's fish resources. The total catch in this area is about 6 million tons annually of which more than half is taken by foreign fishermen. Some of the stocks in this zone have collapsed and many are being fished close to the maximum sustainable catch. Most of the fishing is not under effective control.

The extension of authority of coastal countries in the oceans has undergone a slower change. For several centuries the accepted limit of sovereign authority was 3 miles but recently there have been numerous extensions of various kinds of authority. Most of these have been unilateral assertions of authority of as much as 200 miles. These complex issues of the use of the oceans have been discussed at three Law of the Sea Conferences sponsored by the United Nations.

The most recent conferences ended in May 1975 and produced a "single negotiating text." This text is not an agreement but represents a summary of the deliberations by the Chairman of the Committees. The fishery articles, in the opinion of many participants, are close to being agreeable to most countries.

The text has received extensive study and has been considered most carefully by our representatives in Congress who have used its provisions as a basis for the bills which would extend the jurisdiction of the United States over the fish resources and establish a fisheries management system for the country as a whole.

The single negotiating text includes some critical rights and responsibilities for coastal states.

Article 45. In the exclusive zone (200 miles) the coastal state has "sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether renewable or non-renewable, of the bed and subsoil and superjacent waters."

This very broad authority is constrained by some responsibilities in Articles 50 and 51. Some of these are: "The coastal state shall determine the allowable catch of the living resources in its exclusive economic zone.

"The coastal state, taking into account the best evidence available to it, shall ensure through proper conservation and management measures that the maintenance of the living resources in the exclusive economic zone is not endangered by overexploitation. . .

"The coastal state shall promote the objective of optimum utilization of the living resources in the exclusive economic zone. . .

"The coastal state shall determine its capacity to harvest the living resources of the exclusive economic zone. Where the coastal state does not have the capacity to harvest the entire allowable catch, it shall. . . give other states access to the surplus of the allowable catch.

"Available scientific information, catch and fishing efforts statistics, and other data relevant to the conservation of fish stocks shall be contributed and exchanged on a regular basis. . .with. . .all states concerned.

"In granting access to other states to its exclusive economic zone under this article, the coastal state shall take into account all relevant factors, including. . . the significance of the renewable resources of the area to the economy of the

coastal state concerned and its other national interests. . .the requirements of developing countries. . .in harvesting part of the surplus, and the need to minimize economic dislocation in states whose nationals have habitually fished in the zone. . . ."

There are many other pertinent provisions but I believe it is clear that the coast state shall manage the coastal fishery resources on the basis of scientific evidence, and with full publication of the information concerning those resources.

The congressional action in bills HR 200, which has been passed by the House, and S 961, which has been passed by the Senate Committee, contains similar obligations in the form of standards which apply to the fishery. They are as follows from HR 200: (1) Management and conservation measures shall be based upon the best scientific biological information available. (2) To the extent possible, an individual stock of fish shall be managed throughout its range. (3) Management and conservation measures shall not discriminate between residents of different states. (4) Management and conservation measures shall be designed to achieve the optimum sustainable yield of a stock of fish on a continuing basis. (5) Management and conservation measures shall promote efficiency in harvesting techniques. (6) Management and conservation measures shall be formulated to allow for unpredicted variations in fishery resources and their environment and for possible delay in the application of such measures. (7) Management and conservation measures shall not result in unreasonable administration or enforcement costs. (8) Management and conservation measures shall be designed to prevent depletion of fisheries resources.

Both of these bills include provisions for the management of the fisheries with the major responsibilities for the development of management plans assigned to regional councils. Both bills establish seven such councils. Both bills provide for membership on the councils from states, interested public, and the federal government. Both bills provide for the implementation of fishery management plans by the federal government and by the states. Both bills protect the interest of the states with respect to management within the 3-mile zone.

There are differences between the two bills which time does not permit me to discuss here. You people who are interested will want to carefully examine them with respect to whether they provide for an effective working partnership of the states and federal government in the management of the fisheries, and communicate your views to members of Congress.

While Congress has been working on these bills, the administration has pointed out the difficulties and dangers of unilateral actions on the part of the United States. This was addressed by Secretary Kissinger in his speech before the American Bar Association in Montreal, on August 11, where he said, "Unilateral legislation on our part would almost surely prompt others to assert extreme claims of their own. Our ability to negotiate an acceptable international consensus on the economic zone would be jeopardized," and "to conserve the fish and protect our fishing industry while the treaty is being negotiated, the United States will negotiate interim arrangements with other nations to conserve the fish stocks, to ensure effective enforcement, and to protect the livelihood of our

coastal fishermen. These agreements will be a transition to the eventual 200-mile zone." Such negotiations have begun at the meeting in September of the International Commission for the Northwest Atlantic Fisheries, and they will be continued in subsequent international meetings.

Many of you are aware that Mexico and Canada have been considering an extension of fisheries jurisdiction. The President of Mexico has, according to newspaper accounts, asked his Congress to prepare a declaration of a 200-mile zone, but the Government of Canada, despite growing pressure from the fishing industry, still insists that it would prefer international action to unilateral action.

Interstate Marine Compact Commissions Role in Fisheries Management

IRWIN M. ALPERIN, *Executive Director*
Atlantic States Marine Fisheries Commission
Washington, D.C. 20036

For those who may be uninformed about the relations and structure of the interstate marine fisheries compact commissions, let me provide a brief background. There are three interstate marine compacts granted the consent and approval of Congress: the Atlantic States Marine Fisheries Commission (ASMFC) with 15 member States; the Gulf States Marine Fisheries Commission (GSMFC) with 5 member States; and the Pacific Marine Fisheries Commission (PMFC) also with 5 member States. ASMFC was the first to be created in 1942 and the others soon followed (ASMFC is now in its 34th year). Each state within a commission is represented by three delegates or commissioners: a state fisheries director, a member of the state's legislative body, and an appointee of the Governor. (Florida, incidentally, is a member of both Gulf and Atlantic Commissions.) All three commissions have advisory bodies although their composition varies. The federal fisheries agency, presently the National Marine Fisheries Service, is designated as the primary research agency of the Gulf and Atlantic Commissions but is not so named in the Pacific compact.

What is the purpose and the function of the Commissions? The purpose of the Atlantic States Marine Fisheries compact is to provide the better utilization of the fisheries of the Atlantic seaboard and it shall do this, reads the compact, by development of joint programs for the promotion and protection of these fisheries and the prevention of physical waste from any source. The other compacts have similarly worded prefaces. But the commissions are not granted any regulatory or management authority to achieve this, with one exception that I will refer to a bit later, and so must act as agencies of inquiry, of debate, and of recommendation – these latter to the several legislatures, to the governors, to the state administrative and management agencies, and presumably also to the federal fisheries agencies and the Congress. Essentially this is how the commissions have operated until now – with individual embellishment, of course, over the years, providing both services and support to member states as regional needs and changing times have dictated.

In 1950 Congress granted an amendment to ASMFC which provided that any two or more consenting states could designate the Commission as a joint regulatory agency with respect to specific fisheries in which such states have a common interest. This is an interesting concept for interstate management of shared fisheries resources (because some states do not even have the constitutional authority to make interstate agreements for fisheries) but unfortunately until very, very recently these provisions were never invoked. And perhaps now it is too late. Almost positively, this regulatory function so long neglected, so badly needed, will be preempted through federal legislation that is before the Congress today.

Since the Commissions were not granted any powers to make or enforce regulations, except in the special case made above, which incidentally, requires individual state ratification (only 9 of 15 have done so in ASMFC in the past 25 years), what could have been the Commissions' role all these years? It seems to me essentially to recommend, to the several states involved with any species of fish, regulations appropriate to the protection and optimum utilization of such species for simultaneous legislative or administrative enactment. In this idealized concept, the compacts afford a method for a constructive joint approach to common problems of management that the states operating individually cannot solve. Additionally, in two of three instances, and for practical purposes, today, in all three cases, the compacts recognize the federal interests by providing for federal agency participation and mutual support. Nevertheless, the compacts preserve states' responsibilities by requiring the Commissions to report their recommendations to the several states affected by any problems for final action by them. Finally, I believe the compact commissions were designed as practical institutions in that they create no super government agency but utilize existing state and federal agencies in a *common* effort to solve problems that are unsolvable otherwise. That they have been unable to resolve many of these problems stems from political and human frailty — one cannot fault the compacts.

More recently the interstate compact commissions have supported a new initiative of the National Marine Fisheries Service (NMFS) called the State-Federal Fisheries Management Program (SFFMP). The Commissions play a supportive role in communications, planning, coordination, and administration of the SFFMP, under which fisheries management plans are being prepared for important target species on each of the coasts. These include northern shrimp in the Gulf of Maine, southern shrimp off the south Atlantic states, the surf clam and northern lobster of the north and middle Atlantic areas, menhaden in the Gulf of Mexico, Dungeness crab and other selected species off the Pacific coast.

ASMFC has gone one step further with the Gulf of Maine shrimp. By combining the management planning of the SFFMP with the provisions of Amendment No. 1 to our Compact, it has organized a Northern Shrimp Section which promulgates regulations for this fishery. Three states, Maine, New Hampshire, and Massachusetts, share this fishery. Much of the fishery is conducted beyond the territorial sea of the individual states, in fact, outside the U.S. contiguous fishery zone. Based on studies of a state-federal scientific team and policy decisions of a state-federal subcouncil of the Northeast Marine Fisheries Council (a regional council composed of 11 state administrators and the NMFS regional director), the Northern Shrimp Section promulgates regulations which are then adopted by ASMFC. To date these regulations include an optimum mesh size to conserve the small androgynous male shrimp and a closed season to help control annual landings which are above maximum sustainable yield (MSY). This is a cooperative effort involving the Commission as a regulatory (management) institution, state and federal administrators, and scientists providing financial and technical input, while the states practice cooperative reciprocal enforcement. I believe this system could be a practical solution to regional fisheries management for a considerable number of inshore and estuarine-oriented species and should

be more universally applied. As I stated above, it probably has developed too late in the scheme of things to be considered further. Unless, perhaps, we can adapt it to fisheries that are predominantly inside the 3-mile limit but passing through invisible state boundaries.

We have now before us the era of fisheries management under extended jurisdiction. Both House and Senate versions of bills currently before Congress provide for regional management councils that will develop management plans for stocks of fish throughout their range. The House version, Marine Fisheries Conservation Act of 1975, (HR 200), even has preemptive language that would enforce regulations within the territorial sea which up to now have been the prerogative of the individual states. Interestingly, the House bill takes cognizance of the interstate commissions and includes the executive director for the geographical area as a Council member. The Senate bill, Magnuson Fisheries Management and Conservation Act, (S 961), has no provision for marine fisheries commission input *per se* but its accompanying report suggests that the commissions will provide staff support to the regional management councils.

And what about the individual States? ASMFC passed a resolution as early as 1969 favoring extended fisheries jurisdiction. When the original Studds-Magnuson bills, which provided for interim extended fisheries jurisdiction but with no management provisions, were introduced in the 93rd Congress the ASMFC states voted 14 to 1 (Florida dissenting) in favor, but that was 2 years ago. These same states respond somewhat differently today. They have reservations. Now that the bills before Congress have management titles, and especially certain provisions of HR 200, the states are seeking amendments or at least trying to affect what comes out of congressional conference that will favor states' rights and states' needs. The states are opposed to the ultimate powers vested in the decisions of the Secretary of Commerce and most emphatically perturbed over potential preemption of fisheries within the territorial sea. They are dismayed by the large council structure that includes user-group participation. They feel that federal licensing will deprive them of funds upon which they depend to support their own fisheries research and management programs. On the other hand, the states are in favor of regional councils with strong management responsibilities and powers but only if the state directors are included as members. They recognize that, on the key issue of initiative and authority for the councils, S 961 accords them a stronger role than HR 200, but S 961 does not specifically guarantee their membership on the Council; the amended version of HR 200, as passed by the House, now does. They are pleased with the language of S 961 which specifies that the Secretary of Commerce *shall* review management regulations recommended by the councils (as well as accepting their management plans) and the Secretary *shall* adopt such regulations (when consistent with national standards) for the management of the fishery involved. They are displeased with this as part of HR 200 which is weak in regard to the above, granting the Secretary powers without "due process."

Finally, what might be a role for the interstate marine fisheries commissions in the new era of fisheries management under extended jurisdiction? Let me quote to you from a letter to Senate Commerce Committee Chairman Warren Magnuson by John Harville, Executive Director of the PMFC. "With respect to

designation of an appropriate role in this new management regime for the present interstate marine fisheries commissions, I believe this should take the form of staff support for the Regional Councils, after the pattern already in effect with respect to NMFS' State/Federal Fisheries Management Program. . . . I urge that the legislation . . . specify that kind of relationship and thus recognize past achievements of the marine interstate fisheries commissions in communications, planning, and coordination of State-Federal interactions, and Commission capabilities to apply existing experience and institutional machinery to facilitation of the new Regional Council management functions."

Dr. Harville goes on to say, "I think it important that the Congress be on record in calling for this kind of adaptive evolution of the interstate marine fisheries commissions. The Congress created those Commissions in the late '40s to assist the States to work more effectively together on shared fisheries problems. The quarter-century since that creation has expanded both State and National needs, and our institutions should evolve accordingly."

I am in accord with that view. While providing staff support to the councils, the Commissions must not be absorbed into the new councils. The Commissions would continue to provide the states with a communicating mechanism with one another and with the legislative and executive branches of the federal government. The interstate compacts should retain their identities as state-funded and state-governed entities for continuation of their many present services to the states, to the Commission associates and their regional constituencies and to the nation, aside from any role in fisheries management.

If regional management is truly upon us, there are only the three alternative roles for the Commissions: (1) they might be abolished as no longer needed; (2) they might disappear into the council structure; (3) or they should, as I believe, be continued for all the other services provided to their member states while developing through contract staff support a relationship to the councils similar to that performed within the State/Federal Fisheries Management Program. This latter role should be the rational choice.

Suggested State Legislation for Effective Management of Marine Fisheries

W. MASON LAWRENCE, *Consultant*
Natural Resource Management
Delmar, New York 12054

In 1972 the National Marine Fisheries Service embarked on a new initiative, the State-Federal Fisheries Management Program. The goal of the program is to bring about the rational management of domestic inter-jurisdictional fisheries through the development and implementation of comprehensive fisheries management plans so as to optimize social, recreational, and economic benefits on a sustainable basis. At present, management plans are being developed for seven fisheries under this program, including penaeid shrimps along the South Atlantic states and the menhaden in the Gulf of Mexico.

In general, it has been possible for the state administrators to agree on policies, standards, and regulation for a fishery. However, it has been difficult to obtain timely approval by the state legislative authorities of the agreed upon actions. This has proved to be a significant obstacle to the achievement of the management programs. Although there had been an awareness of the need for improvements in state legislation relative to management of marine fisheries, experience with the State-Federal Fisheries Management Program has resulted in a clearer recognition and definition of this need.

Another anticipated development, extension of U.S. fisheries jurisdiction to 200 miles from our coasts, will give the United States its first real opportunity to deal comprehensively with the management problems of its coastal fisheries. For the states to participate effectively in the mangement of these fisheries, they must have the capability to cooperate with the adjoining states and the federal government in the development and implementation of unified management plans. Otherwise, a single fish stock will either be subject to different and often conflicting management regimes in different jurisdictions, or the federal government may find it necessary to preempt the management authority for a stock to assure proper protection and use of the stock.

DEVELOPMENT OF MARINE FISHERIES MANAGEMENT ACT

In recognition of these needs, the National Marine Fisheries Service in June 1974 contracted with the Council of State Governments to produce suggested state legislation for effective management of marine fisheries. The Council set up an 11 member National Task Force, 6 state legislators and 5 state fisheries agency heads, to develop this legislation. I was retained by the Council of State Governments as the project director to assist with this work.

In the course of developing the suggested legislation, the staff of the Task Force examined the marine fisheries laws of the 24 coastal states, the 8 Great Lakes states, American Samoa, Guam, Puerto Rico and the Virgin Islands, and

conducted interviews with the heads of the state fisheries agencies and representatives of the recreational and commercial fishing and environmental groups in 21 states. During the period from September 1974 to May 1975, the Task Force met four times to discuss the various issues and drafts which led to the suggested legislation.

The suggested "Marine Fisheries Management Act" was presented at the National Conference on Effective Management of Marine Fisheries at Hyannis, Massachusetts, in June 1975. Copies of the suggested Act are currently available in two formats: as a separate brochure, and as a part of the Council of State Government's 1976 Suggested State Legislation, a copy of which is furnished to each state legislator in the 50 states. The National Task Force's final report, entitled "To Stem The Tide—Effective State Marine Fisheries Management," which contains the recommendations of the Task Force and the suggested Act, should be available from the Council of State Governments or the National Marine Fisheries Service by December 1, 1975.

RECOMMENDATIONS OF THE NATIONAL TASK FORCE

The National Task Force made three recommendations relating to the suggested Act: (1) Each coastal state fisheries agency should compare the statutory basis for its operation with the suggested Act and seek adoption of those sections or parts, modified to conform to the general construction of its statutes, that would improve its capabilities for marine fisheries management. (2) Each coastal state fisheries agency's attention is directed to the most important needs for modification of present statutes, as determined from an examination of existing state statutes and discussion of problem areas in fisheries management with state fishery heads, and to the sections of the suggested Act that address these needs. These needs include: adequate regulatory authority, adequate catch statistics, appropriate licensing of commercial and recreational fishing, intergovernmental cooperation, advisory input from resource users and interested citizens, and effective penalty and enforcement deterrents. (3) Since the basic provisions of the suggested "Marine Fisheries Management," although designed primarily for marine fisheries management, are equally applicable to the management of freshwater fisheries, the directors of inland fisheries agencies should seek the adoption of those parts of the Act that would improve their agencies' capabilities for fisheries management.

I would note that since September 1975 resolutions embodying these three recommendations have been adopted without dissent at annual meetings of the International Association of Game, Fish, and Conservation Commissioners, The American Fisheries Society, and the Atlantic States Marine Fisheries Commission.

The National Task Force also made seven other policy recommendations in their final report on issues not dealt with specifically in the legislation, which they felt were of prime importance to effective marine fisheries management.

DISCUSSION OF THE MARINE FISHERIES MANAGEMENT ACT

In developing the suggested legislation, the Task Force attempted to provide what they believed to be the basic ingredients of a Marine Fisheries Management

Act. They recognized that a state's marine fisheries statutes would include additional specific provisions relating to such items as prohibitions, license requirements, license fees and other special provisions. They hoped, however, that as is provided for in the suggested Act the regulations pertaining to the management of fish stocks would be promulgated through the regulatory authority of the agency, in order to provide the flexibility needed for prompt and effective responses to changing needs in management.

The Task Force reviewed the two basic forms of organization of state fisheries agencies, the commission and department forms, and included a discussion of both forms in its final report.

On the basis of interviews with 21 coastal and Great Lakes states, it was found that states which have a commission type of fisheries agency favored that form of organization, whereas states having a department type agency favored their form of organization. Apparently, the people in either type of organization were comfortable with the type with which they were familiar and skeptical of any major changes in basic organization. It was concluded that both types have their advantages and limitations and either type can operate effectively and efficiently. Hence, there is included in the suggested state legislation Alternative Sections 4, one establishing a commission type agency and one establishing a department type agency. All states currently have one of the two basic forms of organization, or a variation thereof. Recent history suggests that there probably will be few changes in the basic organization of state fisheries agencies.

With reference to operation of state fisheries agencies, a major problem faced by many agencies is that their management capabilities are severely constrained by the lack of adequate authority to regulate fisheries within the states' jurisdiction. A few state fisheries agencies have appropriate authority to regulate fisheries but in many states the fisheries agency's authority to regulate ranges from none to limited authority in a few defined situations. In the latter situation, management regulations are established by legislation. The delay and uncertainty of management by legislation prevents effective action since most state legislatures meet for only a few months a year and in some states only every other year. The problem is greatly increased when two or more states are involved in the management of a shared resource.

It was concluded that state marine fisheries agencies should have the authority to adopt, modify and repeal regulations pertaining to the management of marine fisheries resources. It is important also that the state fisheries agencies be given the authority to adopt emergency regulations to be effective on promulgation and to be subject to comment, objection and public hearing with a reasonable time following promulgation. Such emergency regulations may be needed to protect fish stocks for which a harvest quota has been established, to prevent serious depletion of certain stocks or to protect public health.

Sections 6,7, and 8 of the suggested legislation are designed to provide the state fishery agency with adequate authority to manage the fisheries and to take emergency action when needed to protect the public interest. These provisions will give a state the necessary flexibility to cooperate with adjoining states and the federal government in the management of shared resources and to respond

promptly and effectively to changing needs of management within the state. For those states whose fisheries agencies do not have adequate regulatory authority, these three sections are considered to be the most important in the suggested legislation.

In relation to regulations it should be noted that many of the coastal states have outmoded or inappropriate fisheries laws and regulations on their books. Each of these states should take appropriate action to repeal or modify any existing laws or regulations that do not fulfill a valid management purpose.

It is generally accepted that in order for the people of the U.S. to receive the maximum benefits from their valuable marine fisheries resources, these resources must be properly managed. To achieve such management of fish resources shared by several states or shared among several states and the federal government, each affected state must have the ability to participate effectively in the development and carrying out of the management plans. Section 9 of the suggested legislation makes it the responsibility of the state fisheries agency to cooperate with other states and the federal government to develop integrated management plans for shared fisheries resources. This section also provides for coordination between the fisheries agencies and other state agencies whose activities affect fish resources.

Section 10 empowers a state fishery agency to enter into reciprocal agreements with an adjoining state for joint management of fisheries in a boundary water. Specifically, it provides for adoption of unified regulations, reciprocity in licensing, and "hot pursuit" of violators of fisheries regulations.

Effective management requires information on the abundance, distribution, and condition of fish stocks and effects of various fishing levels and of environmental changes on stock abundance and distribution. Measurements of the amount of fish caught and the effort required to catch them are basic inputs in such stock assessments. At present only a few states are obtaining reliable information on their commercial fisheries catch and none are obtaining complete and timely data on their marine recreational catch. Section 11 provides the legal basis for obtaining catch statistics on commercial and recreational fisheries. It provides flexibility that will permit a state to cooperate with other states in obtaining integrated catch statistics on a regional or coastal basis.

In recognition of the growing interest in aquaculture and the need for careful regulation of aquacultural operations, the suggested legislation includes a section on aquaculture, Section 12, and a section on ocean ranching of anadramous fish, Section 13.

Section 2 of the Suggested Legislation, Findings, and Declaration of Purpose, sets forth the value to a state of its fisheries resources and the state's policy and objectives in relation to these resources. This is believed to be a good general statement of the objectives of fisheries management and one which is applicable to each of the coastal states.

The remaining sections of the suggested legislation treat definitions, duties of the commission or director, and enforcement, penalties and forfeitures. Two parts of Section 14 relating to enforcement should be noted. One, there is a provision for civil settlement of violations, which it is believed will permit

prompt and equitable prosecution of many violations. Two, authority is provided to revoke the licenses of a person who settles or is convicted of more than one violation in a 5-year period. Both of these are considered to be helpful enforcement tools.

The appendices to the legislation consist of suggested sections on controlled entry and quality assurance. Several states expressed an interest in these aspects of management and they are included for the information and possible use of the interested states.

Florida's Position Regarding HR 200 (Extended Jurisdiction)

HARMON W. SHIELDS, *Executive Director*
Florida Department of Natural Resources

and

EDWIN A. JOYCE, JR., *Director*
Division of Marine Resources
Tallahassee, FL 32304

Several years ago efforts were made to have the northern lobster declared a creature of the continental shelf because of extenuating problems resulting from foreign fisheries offshore of the northeastern United States. Florida was one of the few states opposed to this action, primarily because it was felt that this would establish a precedent whereby many other nations would follow suit, probably forcing the exodus of Florida fishermen from many foreign waters. Of particular interest were the Bahama fisheries for spiny lobsters. In spite of several years of negotiations by FDNR, this did indeed come to pass and some 280 Florida vessels were excluded from fishing in the Bahamas, causing severe repercussions to the Florida spiny lobster fishing industry. Once the Bahamas had made this declaration, the U.S. Department of State began negotiations to try to save Florids's traditional fishery rights on the Bahamas Banks and come to some agreement in maintaining those fishing rights. All of these efforts failed, leaving Florida's spiny lobster fishermen to go on welfare, to search for other fishing methods, and to otherwise be virtually forgotten by the federal government.

Now we have HR 200, a bill which has just passed the House of Representatives. Its main thrust is to extend United States jurisdiction unilaterally to the 200-mile limit instead of the present 12 miles. Florida is also opposed to this, as are the Secretary of Commerce and President Ford, on the basis that such a unilateral extension would disrupt and undermine the multi-national negotiations going on under the Law of the Sea Conference. The establishment of a 200-mile limit through the auspices of the Law of the Sea Conference would automatically set up the foundation whereby national and international agreements would be reached to preserve traditional fishery rights and to make mutual exceptions. On the other hand, a unilateral extension by the U.S. would force similar reaction on a nation-by-nation basis which would create uncertainty, confusion, and would force us back to the negotiating table in a manner very similar to what happened in the Bahamas. As we've already pointed out, those negotiations failed miserably. However, Florida is again in the minority on this particular issue. Many states strongly need help to protect their fisheries which extend beyond the 12-mile limit and they see the 200-mile limit as being the answer to these problems. Thus, Florida has apparently lost this battle.

However, HR 200 does many more things than just extending unilaterally the fishery management zone. It sets up extensive regional councils whose sole duty is to gather data and provide fishery management plans for the consideration of the Secretary of Commerce. These councils are well represented by states and fisheries agencies and contain great expertise in fishery matters. They are well founded for their knowledge in these areas. Yet in spite of this, the final authority rests with the Secretary of Commerce in all major matters. Thus, the regional councils are simply figureheads to gather data and present plans which may be vetoed by the Secretary of Commerce. Among the major items which can be decided by the Secretary of Commerce alone is preemption of the state jurisdiction to the coastline. This would allow the federal government to take over all fishery regulations, not just to the edge of the states' territorial sea, which is currently 3 miles, but right to the coastline. In addition, some of the animals which have been suggested for fishery management under HR 200 are oysters and anadromous fishes which would carry the preemption clear into the internal waters of the state. No formal definition of internal waters is given in the bill, and this is another serious problem. Thirdly, it gives the Secretary the ability not only to establish sport and commercial fishing licenses, but to determine where and for what these funds will be spent. It is possible, under the present wording of the bill, that license fees, forced upon and paid by Floridians and Florida tourists, would be spent in Oregon on the salmon industry. Florida feels these major decisions should not rest in the hands of a single individual located in Washington. If these regional councils have been properly set up and established to have peer group expertise, then we feel that preemption and these other major changes and considerations should be initiated by a vote of the regional councils rather than resting in the hands of a single federal employee.

The Western Central Atlantic Fishery Commission (WECAFC): Its Implications and Impact

PHILIP M. ROEDEL
Fisheries Advisor
U.S. Agency for International Development
Washington, D.C. 20523

HISTORY AND FUNCTION OF WECAFC

The concept of a regional fisheries commission concerned with the West Central Atlantic has been with us for a long time. Ideas as to its geographic scope and its areas of responsibility have ranged from a single-purpose shrimp commission for the Caribbean to a managerial body concerned with all fisheries in the Western Atlantic from Cape Hatteras to the mouth of the Amazon.

There was general, but certainly not unanimous, agreement among nations that some sort of a body was needed, and there was general, but again certainly not unanimous, agreement in the U.S. commercial and sport fishing industry that this was the case.

The major debates revolved around several critical issues: what should such a body's geographic area of competence be; should such a body have managerial and regulatory authorities, or should it be limited to coordination of efforts and the compilation and dissemination of information; should it be concerned with all species or should it be limited to shrimp; should it be established within or outside of the United Nations – Food and Agriculture Organization family?

The question of a West Central Atlantic body was brought before the FAO's Committee on Fisheries (COFI) at its Eighth Session held in Rome in April 1973. This followed extensive discussions during a meeting of COFI's Subcommittee on the Development of Cooperation with International Organizations Concerned with Fisheries held in Vancouver, Canada in February 1973.

I participated in both of those meetings, and the debate was intense with respect to the topics I have noted, though there was eventually enough give-and-take to permit everyone concerned to reach substantial agreement. Essentially we had left Vancouver agreeing (1) that there was need for a *non*-regulatory body that would provide a forum for discussion of matters of mutual concern, (2) that it should be set up as a subsidiary body of FAO, and (3) that it should be concerned with all species, but with emphasis on shrimp. Its exact geographic extent and its precise terms of reference remained to be determined, though with respect to the latter point the Subcommittee recognized the particular need for (1) collection and compilation of statistics and biological data, (2) research coordination, (3) information exchange, and (4) training. The Subcommittee recommended that COFI set up an *ad hoc* Working Party to consider these matters during the Eighth Session.

The FAO staff subsequently prepared draft terms of reference designed to

reflect the Subcommittee's views, which, with the Subcommittee's report, were presented to the Eighth Session (FAO documents COFI/73/4 and COFI/73/4 Sup. 1.).

The Working Party met as suggested, and proposed with respect to geographic area "that such area should include the whole Western Central Atlantic as defined by FAO for the purpose of fishery statistics. It considered that this was desirable in order to encompass all stocks not yet covered by international fishery bodies responsible for adjacent areas." Further, it endorsed the terms of reference drafted by the FAO staff (FAO Doc. COF/73/4 Sup. 2.).

COFI accepted these findings and recommended to the FAO Council that the Director-General of FAO be authorized to establish the body (FAO Fish. Rept., 135, 1973).

The Council took action in November 1973 (61st Session, Resolution 4/61). It noted in the resolution "the need for international cooperation for the conservation, development and utilization of the living resources, especially shrimps," and stated that the new body "would not be concerned with management and regulation of the fisheries." The Resolution defines the geographic area in these terms:

> The Commission's area of competence shall be all marine waters of the Western Central Atlantic bounded by a line drawn as follows:
>
> From a point on the coast of South America at 5° 00′ N latitude in a northerly direction along this coast past the Atlantic entry to the Panama Canal; thence continue along the coasts of Central and North America to a point on this coast at 35° 00′ N latitude; thence due east along this parallel to 42° 00′ W longitude; thence due south along this meridian to 5° 00′ N latitude; thence due west along this parallel to the original point at 5° 00′ N latitude on the coast of South America.

This boundary is identical with that of FAO's statistical area 31.

The terms of reference are unchanged in substance from those recommended by COFI:

> (a) to promote and assist in the collection of national statistics and biological data relating to fisheries in general, and the shrimp fisheries in particular; and to provide for the compilation and dissemination of these data on a regional basis;
>
> (b) to facilitate the coordination of national research programmes and to promote, where appropriate, the standardization of research methods;
>
> (c) to promote the interchange of information relating to the fisheries of the region;
>
> (d) to promote and coordinate, on a national and regional basis, studies of the effect of the environment and of pollution on fisheries, and studies of appropriate methods of control and improvement;
>
> (e) to promote and assist the development of aquaculture and stock improvement;
>
> (f) to encourage education and training through the establishment or improvement of national and regional institutions and by the organization of training centers and seminars;

(g) to assist Member Governments in establishing rational policies for the development and utilization of the resources consistent with national objectives and the conservation and improvement of the resources; and

(h) to promote and coordinate international aid to further the achievement of the objectives referred to in the preceding sub-paragraphs.

FAO has taken the actions asked of it, and WECAFC is a reality which last week (Oct. 20-23, 1975) held its First Session in Port of Spain, Trinidad and Tobago.

Even though WECAFC has neither managerial nor regulatory authority, its importance to U.S. fishermen both commercial and sport is quite clear. Over time, the debates at its meetings and the recommendations it makes are sure to have an impact on all fisheries in the area, regardless of the outcome of Law of the Sea negotiations. Certainly organizations such as the Gulf and Caribbean Fisheries Institute will have a major interest in WECAFC, and can, I believe, make significant contributions to its success.

THE ROLE OF THE AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)

The interest of USAID may be less evident, for many of you here will remember that in recent years the Agency's concern with fisheries has diminished, and that its major imput has been in the field of tropical aquaculture, largely in the freshwater environment.

In the past year, the United States has reaffirmed its interest in fisheries development as part of AID's program. This reflects a growing concern in governmental circles, fisheries and otherwise, with the increasing problems of nutrition in much of the world, the seemingly neglected potential of small-scale fisheries and a tendency to overlook the difference in human terms that a relatively modest increase in coastal and inland catches could make.

Taking stock of the strengths and weaknesses of the United States in fisheries science and technology, it seems self-evident that the fisheries sector can do more than it has toward helping alleviate the world food shortage. The United States has a considerable body of technical knowledge and experience in fisheries, a large part of which could usefully be transferred to the lesser developed countries (LDCs).

The disciplines in which competence is required, especially biology, economics, statistics, law, and public administration, are all subjects in which the United States has strong capabilities.

In developing concepts as to an appropriate U.S. bilateral fisheries assistance program, AID collaborated with NOAA's Office of Marine Resources, and this led in March 1975 to my secundment to AID as a fisheries advisor with the task of evaluating the existing AID fisheries program and of recommending policy positions for fisheries development. The evaluation is taking into account small-scale fisheries, aquaculture in the broadest sense, and the conservation and

management needs of LDCs, especially those likely to be brought about by increased coastal state control over coastal resources.

It is too early to say what precise form USAID policy will take with respect to fisheries. However, the Agency's administration fully supports, and the Congress has endorsed, a strong position tailored to today's needs, so our planning calls for the creation of a viable and responsive fisheries program as the Agency's goal. Its magnitude and exact direction remain to be delineated, but I believe it will encompass small-scale fisheries, aquaculture, and fisheries management and administration.

THE FIRST SESSION OF WECAFC

The first session got the new body off to a fairly good start. The results were not earthshaking, nor, in fairness, could they have been expected to be, for this was after all largely an organizational meeting.

The test of WECAFC's substance will come during the next 2 years of work and its performance at its second session in 1977. Two things bear watching and these relate to membership and participation.

Membership is open to nations whether or not they are riparian to the West Central Atlantic and regardless of whether they fish there. Twenty-three, including such unanticipated signators as Togo and Zaire, have adhered, and the application of the Bahamas is sure to be approved. However, one of the "Big Four" fishing nations in the area, Mexico, is not a member. Neither are three smaller producers from the Caribbean, Barbados, the Dominican Republic, and Honduras. (Tables 1 and 2).

Table 1. Member nations of the Western Central Atlantic Fisheries Commission (WECAFC) at the time of the First Session

Brazil*	Netherlands*
Colombia*	Nicaragua
Cuba*	Poland*
France*	Senegal
Guatemala	Spain*
Guinea	Togo
Guyana	Trinidad and Tobago*
Haiti	United Kingdom*
Italy*	United States*
Jamaica	Venezuela
Japan	Zaire
Korea*	

*Attended the First Session

Twelve member nations attended the first session: Brazil, Colombia, Cuba, France, Italy, Korea, Netherlands, Poland, Spain, Trinidad and Tobago, the U.K., and the U.S. The Bahamas, Canada, and the USSR sent observers.

The significant absentee was the region's number two producer, Venezuela. Other Caribbean member nations that did not attend were Guatemala, Guyana, Haiti, Jamaica, and Nicaragua.

Table 2. Western Central Atlantic fisheries catches exceeding 2000 MT in 1973

	(000 MT) Catch	Member WECAFC
United States	886.2	yes
Venezuela	144.5	yes
Mexico	132.6	no
Cuba	72.5	yes
Colombia	27.8	yes
Korea, Rep. of	19.8	yes
Jamaica	18.0	yes
Guyana	17.6	yes
Trinidad & Tobago	12.8	yes
Dominican Republic	8.9	no
U.S.S.R.	8.8	no
Nicaragua	7.9	yes
Guadeloupe	4.8	(France)
Honduras	4.3	no
Barbados	4.0	no
Surinam	3.8	(Netherlands)
Bahamas	3.1	(appl. pending)
Martinique	3.0	(France)
Haiti	2.2	yes
Total Catch in Area	1405.0	

Data from FAO Yearbook of Fishery Statistics, 1973, vol. 36.

The host government, Trinidad and Tobago, was elected chairman of the session, and Mr. Overand Padmore, Minister of Agriculture, Lands and Fisheries, served in a most distinguished manner. Trinidad and Tobago was later elected chairman to serve through the next session 2 years hence. Vice-chairmen include Brazil, Cuba, and Colombia, while the Bahamas (contingent on its membership), Guyana, Jamaica, and the U.S. were elected to the Executive Committee.

The agenda included three principal items: (1) a review of existing knowledge of the fishery resources; (2) statistical needs; and (3) possibilities for fisheries development.

With respect to the first item, the review of existing knowledge of fishery resources and identification of future requirements, the Commission, as you would expect, devoted a good deal of time to shrimp and to spiny lobster. On shrimp, the Commission in its draft report "noted that a substantial amount of information on the shrimp resources was available and that several shrimp fisheries were now already fairly heavily or fully exploited, but that with further development of the fishery on some resources and with adequate management of the fisheries, a moderate increase in the shrimp production of the area was thought to be possible."

The Commission agreed that a working party on shrimp stock assessment should be set up. Its terms of reference were later expanded to include spiny lobster.

The Commission discussed the need for more detailed knowledge about fin fish resources as a basis for fishery development, and agreed to establish a Working Party on Assessment of Fish Resources. It emphasized that the Working

Party should concentrate its activities on certain priority areas, especially reef, coastal pelagic, and trawl resources.

The second major agenda item dealt with the need for adequate statistical information on fishing activities and catches. The subject received a great deal of emphasis, and the draft report says: "It was agreed that there was need for international standardization and improvement of the fishery statistics in the area and that measures were needed to ensure dissemination of these statistics. It was therefore decided to set up a WECAFC Working Party on Fishery Statistics."

The final substantive item, and I think the most important, dealt with prospects for development of fisheries in the Western Central Atlantic.

An advisory team to the FAO Department of Fisheries had concluded that the possibilities for development were considerable, although certainly not everywhere identical. In the Antilles, for example, the immediate opportunities lay with existing small-scale fisheries.

Several delegations, perhaps particularly the U.S., stressed the importance of improving post-harvesting facilities and techniques that would lead to wider marketing opportunities for small-scale fishing communities.

Delegations emphasized the need to provide employment, food, and cash income, and pointed out that appropriate institutional frameworks were essential to progress. Similarly, governments in the region needed to take a more decisive attitude toward fisheries development.

Finally, in this context, and I think most significantly: "Delegations stressed the need to give priority to the provision of every assistance to the small scale fisherman to free him from poverty. Small scale fishermen contributed a major part of fish landings in many countries in the Western Central Atlantic and this situation was likely to remain unchanged. Purely commercial criteria could not be accepted in establishing priorities for action to improve small scale fisheries. The importance of developing acceptable social criteria was emphasized" (from the draft report).

Another factor affecting fisheries development is the International Project for the Development of Fisheries in the Western Central Atlantic, which was approved by UNDP in January 1975 and became operational in March 1975 using UNDP funds: $124,000 for an 18-month period. Consultants, in cooperation with FAO, are preparing reports on the primary areas of project activity (statistics, resources evaluation, small-scale fishery development, fishing industry development, marketing, and training). The Commission, while endorsing these activities, pointed out that the UNDP funds would not be sufficient to support everything, and hoped that such activities as pelagic surveys, small scale fishery development, and aspects of training would be supported by bilateral donors.

The Commission also agreed to act as the Government Cooperating Agency for the project, and to do this through an Executive Committee that would act for it on all project matters between sessions of the Commission. Hence, the importance of this Committee, of which the U.S. is, as I said earlier, a member.

Several delegations said that their governments would at least consider supporting the WECAFC project through their bilateral aid programs. In this

connection, Canada and the UK sent their fisheries assistance people to the meeting, these men serving in each instance as his country's delegate.

Coastal aquaculture received some attention as a possibility for fisheries development in the WECAFC area, though opportunities were considered marginal for most of the littoral states.

While WECAFC's competence is limited to marine waters, it did endorse a proposal to establish a joint working party of aquaculture specialists to advise the Regional Fisheries Advisory Commission for the Southwest Atlantic (CARPAS), WECAFC and the proposed inland fishery body for Latin America.

The Commission strongly recommended that a Latin American Center for Aquaculture be established soon. Such a Center could, it felt, be a major factor both in conducting and in coordinating aquaculture research in the region.

SUMMARY OBSERVATIONS

The Commission at its first meeting established three working groups that will deal with: (1) stock assessment of shrimp and lobster resources, (2) assessment of fish resources, and (3) fishery statistics.

It endorsed a joint working party on aquaculture and a Latin America Center for Aquaculture.

It endorsed the FAO/UNDP Western Central Atlantic fisheries development project, and, through its Executive Committee, will act as the project's government cooperating agency.

Its members emphasized time and again the importance they placed on small-scale marine fisheries development, believing this should be a major aspect of WECAFC's work.

As I said at the beginning, WECAFC has its problems. However, its members, at least those who attended the first session, are keenly interested in making the organization a success, and many of them are prepared to play dynamic roles. I include the United States in this group, and my prediction is that by the time of the second session WECAFC will be a major fisheries force in this part of the world.

CONTINENTAL SHELF SESSION

MONDAY – P.M. – OCTOBER 27, 1975

Chairman – J. R. Jackson, Jr., *Manager,*
Exploration Department Environmental Affairs,
Exxon Company, Houston, Texas

Multiple-use Conflicts between Fishermen and other Users of the Ocean with a Consideration of a Possible Expanded Federal Role

ROLAND F. SMITH
Chief, Office of Living Resources
Office of
Associate Administrator for Marine Resources
National Oceanic and Atmospheric Administration
Rockville, MD 20852

There was a time when commercial fishermen were the dominant users of ocean space over mid- and outer-continental shelf areas. Since World War II, however, the fisheries as well as other ocean industries and ocean-related activities have increased dramatically, and multiple-use conflicts have occurred in areas never before subjected to such pressures. Recent concern among fishermen about this increased competition for ocean space has been brought about largely because of greatly expanded efforts to extract fossil fuels from offshore areas, many of which also are our most productive fishing grounds. However, offshore oil and gas development is not the only multiple-use conflict experienced by commercial fishermen, as we shall see.

Assessing the potential environmental impact of commercial and industrial activity on living marine resources is a statutory responsibility of government, both federal and state. This mandate is carried out with important contributions from academia, industry, and the general public. It is a regulatory and advocacy role well-recognized and generally accepted by everyone.

The purpose of this paper is to consider the various types of multiple-use conflicts faced by commercial fishermen, and to review the role of the Federal Government in helping fishermen and workers in other industries to make a living on the same ocean at the same time. I propose to discuss the non-environmental factors – that is, the physical, economic, and social aspects of ocean development that may affect the ability of fishermen to function effectively

under mounting multiple-use conflicts. These problems are not new; but they are no longer localized to a few fishing ports or on isolated fishing grounds. Instead, they occur coast-wide – indeed, worldwide. They are becoming far more complex and have potential impacts on many more fishermen. The conflicts occur because of competition for ocean space and port facilities, competition for labor and services, and pressures upon the fisherman to change his life style. Such competition and pressures may cause injury, endanger lives, damage vessels and gear, create costly delays, or force a fisherman against his will into other occupations or social patterns.

Listed here are major categories of ocean activities that may conflict or compete with U.S. commercial fishing operations, as follows: (1) Foreign fishing, (2) Marine recreation, (3) Shipping, (4) Offshore installations, (5) Submarine cables, (6) Ocean dumping, (7) Marine mining, and (8) Offshore oil and gas exploration and recovery[1].

(1) Foreign Fishing: Conflicts between United States and foreign commercial fishermen have been highly publicized, especially in areas such as Georges Bank, where U.S. fishing vessels must compete with the larger and faster trawlers and factory ships of foreign nations. Competition is for both the resources and for ocean space, resulting in decline of stocks, collisions, and gear losses. International negotiations have produced better conservation regulations and methods for dispute settlement, but the problems continue among fishermen and fishing nations. Under extended fisheries jurisdiction, it will be possible to reduce this type of conflict as mechanisms are established to allocate resources and reduce excessive fishing effort.

(2) Marine Recreation, especially boating and fishing, is one of our most rapidly expanding ocean activities. While data are unavailable, observations suggest that the number of commercial fishermen displaced or inconvenienced by the expansion of port facilities to accommodate recreational boaters exceeds those similarly affected by offshore oil and gas development. Significant competition for certain resources as well as ocean space also has developed between some recreational and commercial fishing groups. Here, too, with the authority soon to be obtained through extended fisheries jurisdiction there is an opportunity for the states to work with the Federal Government to help reduce these kinds of conflicts.

(3) Commercial Shipping tonnage has more than doubled in the last 20 years and is expected to double again in the next decade. Super carriers (above 100,000 dead weight tonnage) will increase in number and will change drastically ocean routes, cargo flows, port developments, and even the demographic

[1]Statistics used in this discussion under items 3 to 8 were obtained largely from the report "The Effect of Increasing Multiple-Use of Ocean Space and Resources on World Fishery Production and Extraction," by Robert P. McGeevy, University of Washington, Institute for Marine Studies, Washington. Working Paper #4 prepared for the 8th Session of ACMRR and sponsored by the FAO Department of Fisheries and the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration.

patterns of coastal regions. Electronic and other vessel traffic control systems will become much more common in areas with heavy ship traffic; and while these will reduce collisions and gear losses, the added traffic will restrict commercial fishing in specific areas or at certain times.

(4) Offshore Installations on the nation's continental shelf areas will increase dramatically in variety and number in the coming decade. Besides oil rigs, these may include air and marine terminals, giant power plants, mineral extraction and desalinization facilities, other industrial complexes, storage areas (both surface and submerged), recreational facilities, and perhaps even cities. Most of these kinds of structures already exist somewhere in the world. In the United States, numerous offshore islands are being contemplated. Los Angeles plans an offshore airport; and of the 20 to 30 nuclear power plants projected by 1985 for U.S. marine areas, at least 8 to 10 will be located offshore. Such facilities will compete for ocean space and port facilities, and create navigational hazards; and the extent to which commercial fishermen will be impacted will depend on the area and the degree to which adequate planning has been undertaken to accommodate all interests.

(5) Submarine Cables: Contrary to popular conceptions, communications satellites will not replace submarine cables; on the contrary, by 1980, nearly double the existing capacity, or 27 million circuit miles of cables must be added. Submarine power cables also will increase, especially in connection with development of offshore installations such as power plants and industrial complexes. The major interference of these to fishermen is the snagging of trawling gear. This does not happen too frequently (68 transatlantic cable breaks in the past 15 years), but both fishermen and cable owners suffer severe economic losses when such accidents occur.

(6) Ocean Dumping activities are increasing worldwide; but it is now U.S. policy to regulate this practice and to develop alternatives to this method of waste disposal. We can expect to see, in the next few years, the start of a decline in the amount of waste materials disposed of in the U.S. coastal areas; consequently, a reduction in the amount of fishing area destroyed or rendered unavailable for fishing. This reversal in the historical trend is already in evidence in the Gulf of Mexico, where ocean dumping of industrial wastes has dropped substantially since 1973. Around the United States there are 119 approved ocean dump sites, 98 of which are used for dredge spoil. The remaining 21 (mostly in the northeast) are used for sewage sludge, industrial wastes, and construction debris. Most of these dump sites are located in poor or marginal fishing areas. Thus, the competition for space is minimal. In some areas, such as in the New York Bight, pollution from ocean dump sites has spread to adjacent fishing grounds, driving away fish and shellfish or making them unsuitable for human consumption.

(7) Marine Mining: Many coastal areas will see increased development of offshore sand and gravel resources; dredging for fossil shells will continue although this is not expected to increase significantly; more facilities for the extraction of chemicals and fresh water from the sea are projected; deep-sea mining is on the verge of becoming commercially viable. All of these activities and their associated onshore processing plants and ship support activities will add to the competition for ocean space and port facilities used by fishermen.

(8) Offshore Oil and Gas Developments: Because this aspect of ocean development has had the greatest publicity, there has developed an opportunity for all vested interests to become organized – resulting in a polarization of views and the concomitant flurry of activities associated with such emotional confrontations. Regardless, there are many important lessons to be gained, as will be noted later.

Since 1947, 2,075 platforms have been located beyond 3 miles and additional structures are being built to drill in water from 1,000 to 6,000 feet. These offshore structures and their land-based terminals are connected by pipelines. An indication of the intensity of this development can be realized by the fact that off Louisiana there is a total of 4,875 miles of pipelines.

In addition to the movement into deeper waters in the Gulf of Mexico, new areas off other sections of the U.S. coasts are in the process of being developed. Many of these are in areas of traditionally heavy and productive fishing by both domestic and foreign vessels, such as Georges Bank in the Northwest Atlantic and the Gulf of Alaska. For the United States, these offshore areas represent about 10% of the total known U.S. oil reserves,[2] but 30-40% of the world's oil production is expected to come from beneath the oceans and, again, is mostly from rich fish producing areas. Thus, the potential for conflict with commercial fishing operations amply justifies the concerns of fishermen.

All offshore structures and development create the same generic type of multiple-use problems for fishermen: (1) competition for space, (2) navigational hazards, (3) seabed obstructions, and (4) interference with fishing activities. The net result means that important fishing grounds can be lost, or rendered inaccessible to fishermen. The latter would come about because of the need to maintain sufficient distances from such structures to avoid collisions, especially in heavy seas or because of poor visibility, such as would occur at night or in fog. Sufficient distance also must be maintained to avoid entanglement of fishing gear in debris discarded from the offshore structures. Sea bed obstructions, such as those associated with the underwater completion of oil wells, inactive studs, and underwater pipelines can cause sizeable economic losses from damaged or lost fishing gear. These activities and operations associated with offshore structures can be particularly serious for bottom trawlers; other operations such as purse seining and midwater trawling are much less seriously affected.

[2]Geological Estimates of Undiscovered, Recoverable Oil and Gas Resources in the U.S.– U.S.G.S. Circular 725; statistics from American Petroleum Institute and American Gas Association.

Aside from the potentially serious environmental hazards from spills, dredging, and channelization, nearshore operations supportive of the offshore activities may, as noted earlier, compete with commercial fisheries for port space, service facilities, and labor to the point where the fishermen may be seriously disadvantaged economically.

Having listed the principal ocean activities that conflict with commercial fishing, and recognizing that the projected increase in such activities has the potential of creating much more conflict, what can be said about a possibly increased federal role to help resolve them?

In considering the need for an expanded federal role to resolve multiple-use conflict problems involving fishermen, it is relevant to review what has been accomplished in the past. Because of the amount of available documentation, experience with the oil and gas industry can provide an insight as to how similar or related future problems might be addressed.

The first lesson learned from oil industry -- fishing industry conflicts is that it is possible to work together in mutual trust, to the benefit of both groups. However, every possible effort must be made to eliminate or reduce the conditions that can lead to confrontation. Haphazard and rapid onshore development of support facilities, terminals, refineries, petro-chemical plants, and others, will create congestion in local ports; excessive and costly competition for labor and services will occur, not to mention a host of other social and economic impacts on the local fishing community. Under such conditions, polarization of views are certain to develop; thus, greatly delaying workable accommodations.

We can also conclude from oil – fishing experiences that not all activities need to be located in the coastal zone. Even boat building is not so water-dependent that it cannot be conducted inland. The location, or relocation, of such activities to inland areas can take the pressure off coastal regions where limited space needs to be reserved for essential water-dependent activities.

Many conflicts between fishermen and offshore oil producers in the Gulf of Mexico were resolved by the oil and fishing industries working with appropriate agencies. When workable solutions were reached, the necessary regulations were promulgated by the U.S. Department of the Interior. Louisiana has pioneered in this approach and her success has had worldwide impact in terms of achieving better understanding of the problems and their solutions.

Recently, in New England, the Atlantic Offshore Fish and Lobster Association (with data supplied by the National Marine Fisheries Service) persuaded the Bureau of Land Managmeent of the Department of the Interior to withdraw from proposed lease sale 71 tracts on Georges Bank totalling 400,000 acres, on the grounds that fishing on these areas involves techniques which cannot be used where physical obstructions exist.

In the United Kingdom, good success in alleviating friction between offshore oil producers and fishermen is apparently being achieved through the Fisheries and Offshore Oil and Consultative Group, comprised of representatives of both industries and appropriate government agencies. This group deals with issues of a general nature and organizes subcommittees to handle specific problems. Direct

consultation may be arranged between individual oil companies and fishery representatives concerning specific problems such as pipeline routes. Small group meetings in local fishing ports are sponsored by bringing together skippers from fishing boats and those from supply boats and other support vessels.

To date, there has been no comparable U.S. federal activity which comes to grips with these kinds of non-environmental issues. Environmental impact statements, required under the National Environmental Protection Act of 1969 (NEPA), deal only indirectly with these kinds of problems. Yet, with the projected increases in ocean development and recent legislative authorities given federal and state governments (the Coastal Zone Management Act of 1972 [Public Law 92-583]; the Marine Protection, Research, and Sanctuaries Act of 1972 [Public Law 93-627]; the Deepwater Port Act of 1974 [Public Law 93-627]; and proposed extended fisheries jurisdiction legislation), something more may be required in the way of policy guidance and other assistance at the federal level.

NOAA is the federal agency responsible for the conservation of living marine resources and, as such, is actively involved in assessing the environmental impacts of ocean development. The National Marine Fisheries Service (NMFS) in NOAA is intimately concerned with the problems of recreational and commercial fishermen. A case can thus be made for placing responsibility for resolution of multiple-use conflicts involving fishermen in the National Marine Fisheries Service. Such a trend is already developing in some NMFS regions, where local commercial and recreational fishing groups seek out the Regional Director as the advocate for fisheries in these types of problems. This is because the Regional Director and his staff generally have good rapport with the fishermen and good communications with state and federal agencies concerned with encouraging and/or regulating those other ocean activities. What needs to be more effectively developed is better communication with the ocean developers. There is, in fact, a catalytic role which NOAA-NMFS can play in getting opposing factions together, and it can involve at least five major areas:

1. Insuring that each group clearly understands the other's problems and mode of operation.

Direct interaction between fishermen and other ocean industries is an essential first step in creating understanding and cooperation. Most of the conflicts between commercial fishermen and oil and gas producers in the Gulf of Mexico have been successfully resolved in this manner. For example, one of the major complaints of fishermen, the presence of debris on the bottom, cannot be resolved by regulation, but by a better understanding of the problems of the fishermen on the part of the skippers who operate the support vessels that service the offshore structures.

2. Keeping active and open channels of communication among all concerned parties.

As an activity develops in a new area of ocean space, a period of adjustment will be needed between the new user and fishermen. This early period of understanding and adjustment must be met with a good attitude on the part of both

users, thus it is most essential to keep lines of communication open at all times during this difficult period. In addition, the mechanisms which exist for communication and coordination among governmental agencies must be used fully and effectively so that the actions of one agency do not create unnecessary conflicts with user groups which may be another agency's concern.

3. Exploring the potential benefits that can accrue to both groups.

Fishermen can bring important and valuable skills, such as boat handling and knowledge of local hazards and weather conditions, to other ocean users. Other ocean industries can employ excess labor and equipment from the fishing industry; offshore structures can provide fishermen with weather observations, first aid, and other emergency measures. The fact that oil rigs attract and concentrate fish is a well-known example of how the activities of one group can benefit another.

4. Avoiding confrontations that force a "winner-loser" situation.

All parties must work to accommodate tradeoffs and compromises that are based on sound judgment and that lead to rational solutions. Other ocean industries should consult more with fishermen and with state and local governments to avoid last-minute confrontations and to ease the problems of adjustment caused by their increased activities. For example, consideration might need to be given to developing new fishing gear technology or different operating procedures that could easily be accommodated without seriously affecting fishing efficiency or costs. Essential port facilities and services of the new industry can be planned to also improve existing accommodations needed by fishermen.

5. Assuring that commercial and recreational fishing interests get proper consideration in regional economic analyses and planning activities that relate to other ocean industries.

The Office of Coastal Zone Management, the Office of Sea Grant, and the National Marine Fisheries Service—components of NOAA—can play an important role by providing essential data to assure that fishermen's contributions to the local culture and regional economics are recognized and given equitable consideration. In this connection, the National Marine Fisheries Service and the Fish and Wildlife Service are cooperating with the Office of Coastal Zone Management in the development of criteria which states can use to give full consideration to all fishing interests in the development of state coastal zone management plans.

In summary, we are moving into an era of dramatically increasing activity and development throughout most of our continental shelf area. This will have a

tremendous impact on the economy and social patterns in many of the nation's coastal communities, and the ultimate effects are difficult to predict. There is no shortage of prophets, however, ranging from those who see nothing but gloom and doom to those who liken the coming decade of ocean development to the Golden Age of Sail that stimulated the economic development of New England in the mid-1800s. The truth is obviously somewhere between these extremes, but where and how we end up on this continuum depends on how well we all plan and work together – a trite phrase perhaps, but nevertheless containing the truth that leads to triteness. The fact is that there are no major technical problems impeding ocean development that are beyond the capacity of science and engineering to solve. The real problem is in the resolution of social, economic, and other multiple-use conflicts. This is perhaps the area the Federal Government – especially NOAA – needs to address in a more positive manner, to ensure equitable consideration of our important fishing industries.

Identification and Mapping of Fishing Banks on the Outer Continental Shelf of the Gulf of Mexico

DOUGLAS ELVERS

and

JAMES B. JOHNSTON
United States Department of Interior
Bureau of Land Management
New Orleans OCS Office
New Orleans, LA 70113

ABSTRACT

The Bureau of Land Management (BLM) began leasing in Gulf federal waters for oil, gas, and sulfur in 1954. Between 1954 and 1971, 23 lease sales were held with the value of the prospects the principal factor guiding the sales. In 1971, formal environmental impact statement preparation began and by 1973 concern for fishing banks, shrimping areas, shipwrecks, and coral reefs brought about special stipulations in the Florida Middle Ground, Stetson Bank, East and West Flower Garden banks, and 18 Fathom Lump.

Regional maps of fishing grounds in the lease areas were sketchy and detailed bathymetric maps for the Gulf of Mexico were limited to 1:1,000,000 maps and Coast and Geodetic Survey (C&GS) – National Ocean Survey Nautical Charts. The BLM in New Orleans prepared a series of visuals for impact statements displaying undersea features. These have become a popular item for those people not already familiar with Gulf bathymetric features, fishing banks, and coral reefs.

Much of the information shown on the BLM visuals was derived from areas shown by commercial fishing publications, nautical charts, and locations given to us by seagoing biologists and geologists (from universities, state and federal agencies, and offshore operators) as well as sport divers and fishermen.

The National Ocean Survey (NOS) has completed nine 1:250,000 scale bathymetric maps covering areas from the Rio Grande to Florida Middle Ground. These maps are useful guides to pinpointing many Gulf fishing banks. The precision of water depths, locations, and configurations of these areas is proving helpful in managing oil and gas operations near these banks. The 1:250,000 scale maps from the areas of Big Boy near the SEADOCK fairway to Sackett Bank near the LOOP fairway detail the salt dome related snapper banks along the shelf edge. Breton Sound, Pensacola, and Destin Dome sheets detail hardbanks, sand ridges, submerged channels, and islands important to fishing in this area.

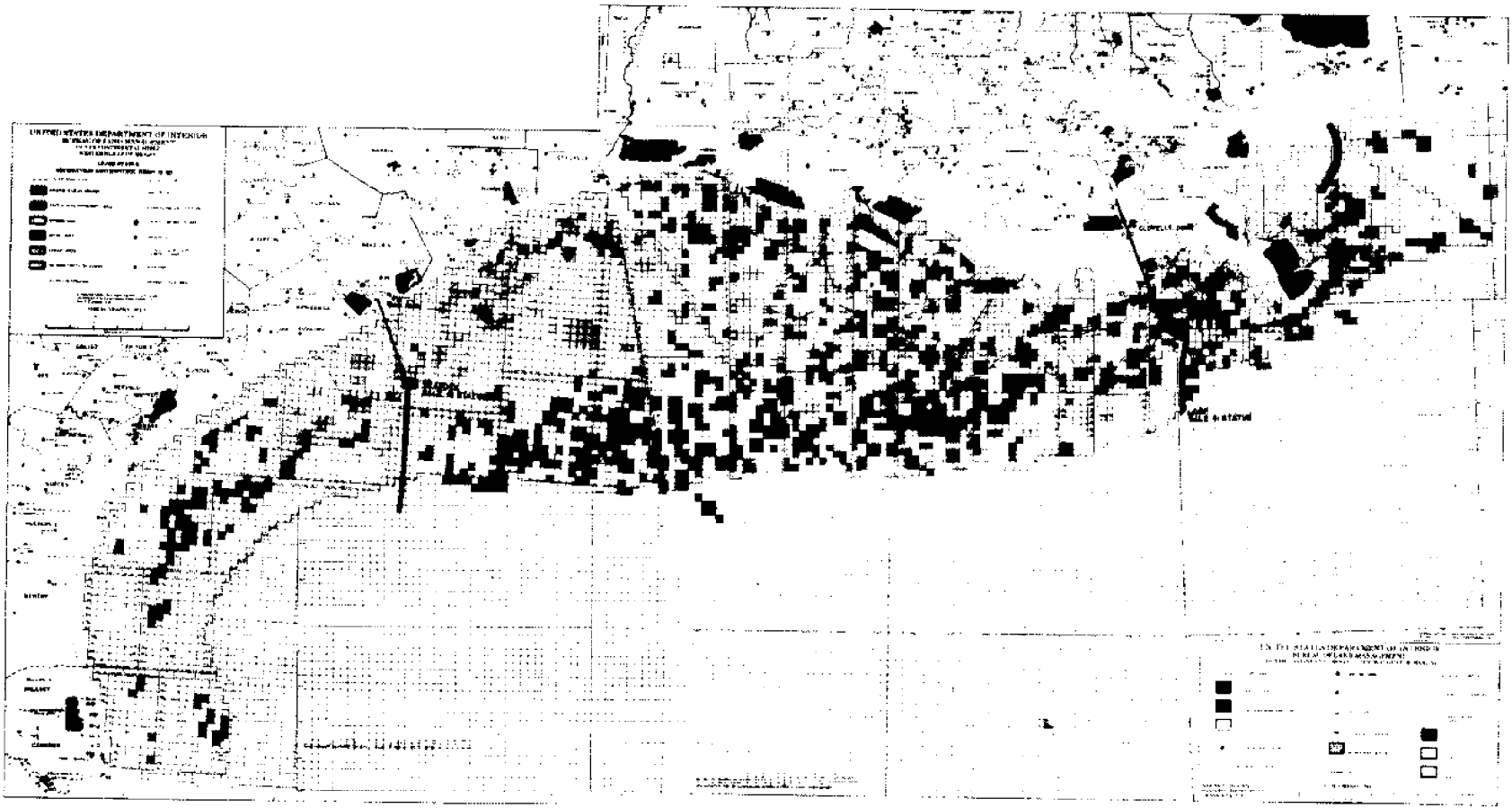
Additional detailed maps on a 1:12,000 (1 inch = 1,000 feet) scale have been prepared for BLM on hardbanks in offshore Texas by Texas A & M, Lorac, and Decca survey companies. Fifteen banks from Mysterious Bank off Port Mansfield, Texas to 28 and 29 Fathom banks, directly east of the Flower Garden banks are now available.

Fishing grounds related to bathymetric and geologic features for the Gulf of Mexico can be accurately mapped with modern navigation, side scan sonar, and narrow beam soundings. We hope to add additional details to fishing grounds by use of BLM, NOS, and industry data taken in the course of special studies for impact statements, baseline investigations, archaeologic, and geologic hazard surveys for the Gulf of Mexico and South Atlantic continental shelf and slope.

INTRODUCTION

The Bureau of Land Management (BLM) began leasing the Gulf of Mexico Federal OCS (Outer Continental Shelf) for oil, gas, and sulfur in 1954. Between

Figure 1. Lease status prior to Sale 41 showing the LOOP and SEADOCK areas proposed for deepwater terminals.



1954 and 1971, 23 lease sales were held with the value of the prospects the principal factor guiding the sales. In 1971, formal environmental impact statement (EIS) preparation began and by 1973 concern for fishing banks, shrimping areas, shipwrecks, and coral reefs brought about special stipulations in the Florida Middle Ground, Stetson Bank, East and West Flower Garden banks, and 18 Fathom Lump. Figure 1 illustrates the leasing activity in the central and western Gulf of Mexico. These maps are available as color visuals for Final Environmental Impact Statement (FEIS), proposed OCS Sale #41.

IDENTIFICATION OF BANKS

At the outset of EIS preparation, regional maps of fishing grounds in the lease areas were sketchy and detailed bathymetric maps for the Gulf of Mexico were limited to 1:1,000,000 maps and Coast and Geodetic Survey (C&GS) -- National Ocean Survey Nautical Charts. The BLM in New Orleans prepared a series of visuals for impact statements displaying undersea features. They have become popular items for those people not already familiar with Gulf bathymetric features, fishing banks, and coral reefs. Figure 2 shows the location of such features as the Flower Gardens, Stetson, Southern Bank and many other banks. Figure 3 is a set of two color visuals constructed for FEIS Proposed OCS Sale #41 showing underseas features of the northern Gulf of Mexico.

Much of the information shown on the BLM visuals was derived from commercial fishing publications, nautical charts, and locations given to us by seagoing bologists and geologists (from universities, state and federal agencies, and offshore operators) as well as sport divers, and commercial and sports fishermen. A list of our principal contacts for the construction of visual No. 4, (Figs. 2 and 3) as well as the MAFLA (Mississippi-Alabama-Florida) area is shown in Table 1.

Additional information on fishing bank locations can be gathered for offshore Texas and Louisiana from the OFFSHORE FISHING CHART series published by Tidewater Fishing Publications, Inc., Seabrook, Texas. More detail for the western Gulf and particularly the bays, channels, and estuaries is given by fishing charts published by the Bookmap Corporation, San Antonio, Texas. Fishing information in the eastern Gulf is detailed in two publications by Moe (1963 and 1970). We also recommend the following agencies for information regarding each state and its offshore fishing areas

(a) Texas Parks and Wildlife Department
Marine Laboratory
Rockport, Texas

(b) Louisiana Wildlife and Fisheries Commission
Oysters, Water Bottoms, and Seafoods Division
New Orleans, Louisiana

(c) Gulf Coast Research Laboratory
Marine Fisheries Section
Ocean Springs, Mississippi

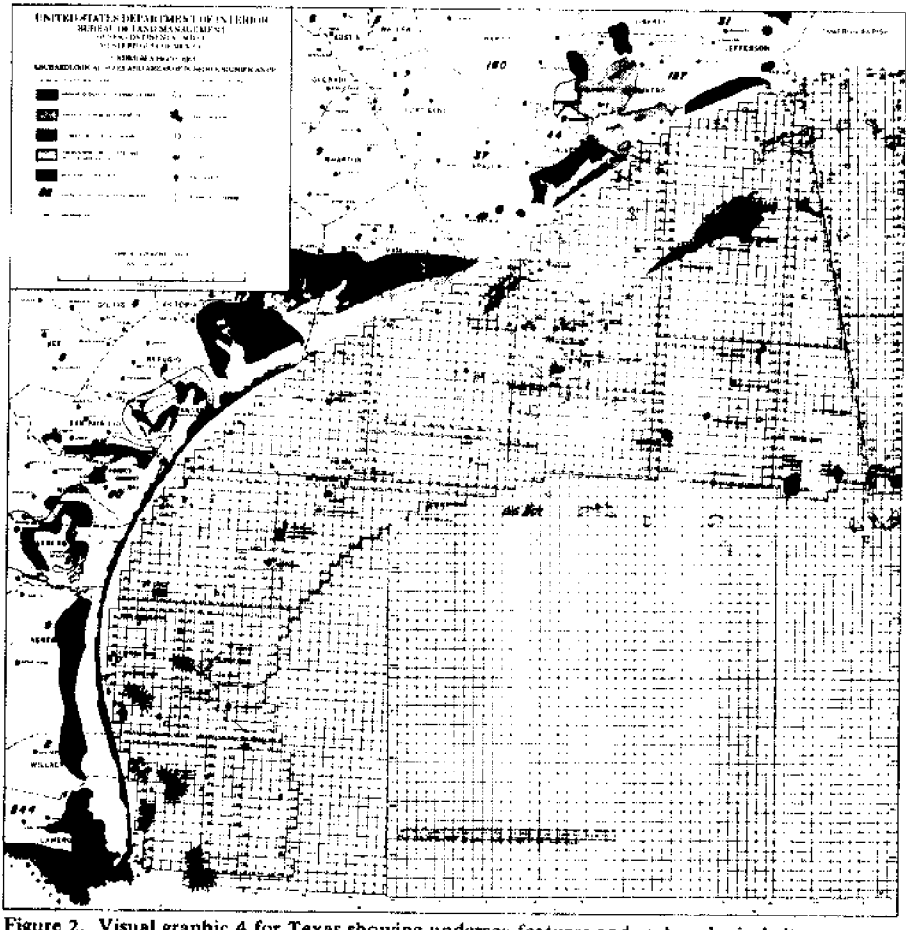


Figure 2. Visual graphic 4 for Texas showing undersea features and archaeological sites.

(d) Alabama Department of Conservation and Natural Resources
Marine Resources Division
Dauphin Island, Alabama

(e) Florida Department of Natural Resources
Marine Research Laboratory
St. Petersburg, Florida

Offshore Louisiana oil and gas platform locations are shown by the WELLS FISHING MAPS published by Fishing Publications, Inc., Houston, Texas. Platform locations farther offshore and the locations of the banks along the edge of the continental shelf commonly referred to as "Snapper-grouper banks" or the "Galveston lumps" are shown by C&GS, National Ocean Survey Charts 1115, 1116, and 1117. The A series of these charts (i.e. 1117A) includes a red lease block graticule. The Flower Garden banks, Little Sister, and 18 Fathom Lump

are part of this group of banks caused by an alignment of salt dome intrusions that were situated at elevations above the level of sediment burial.

Many of these banks are reported to have hard or coralline caps above the salt layers (Edwards, 1971; Bright and Pequegnat, 1974), and the conditions of the reefs generate an excellent habitat for fish. Carbonates associated with these banks have been discussed as early as 1937 by Shepard, and research particularly on the Flower Gardens began in the 1950s by Carsey (1950), Ekman (1953), Greenman and LeBlanc (1956), Parker and Curry (1956), Shepard (1960), Pulley (1963), and Stoddard (1969). Edwards (1971) reports a history of investigations in "The Geology of West Flower Garden Bank" through 1971. Submersible investigations of the West Flower Garden were organized by Alderdice in 1972 and the East Flower Garden by Bright in 1974. The locations of these salt dome related banks generally extend from Big Boy Bank (Fig. 2) in the west near the proposed SEADOCK fairway to the eastern border of Figure 3 along the edge of the continental shelf. Leasing for oil and gas now encompasses the area near several of these features (Fig. 1).

Table 1. List of Primary Contacts

PERSONS CONTACTED	AFFILIATION	LOCATION
Philip Oetking, Ph.D.	Southwest Research Institute	Corpus Christi, Texas
Louis Rizzo	Bookmap Corporation	San Antonio, Texas
Steven Frishman	South Jetty Newspaper	Port Aransas, Texas
Donald Wohlschlag, Ph.D.	Marine Science Institute - University of Texas	Port Aransas, Texas
C.E. Bryan and others	Texas Parks & Wildlife Dept.	Rockport, Texas
Robert Alderdice	Consultant	Galveston, Texas
Thomas Bright, Ph.D., and others	Department of Oceanography - Texas A&M	College Station, Texas
Nugent Brashear	Consultant	New Orleans, Louisiana
Farley Sonnier	Attorney	Lafayette, Louisiana
James Meachin	Exxon Oil Company	Houston, Texas
Wayne Swingle	Alabama Dept. of Conservation	Dauphin Island, Ala.
Richard Geyer, Ph.D.	Dept. of Oceanography - Texas A&M	College Station, Texas
Sherwood Gagliano, Ph.D.	Coastal Environments, Inc.	Baton Rouge, Louisiana
James Prunty	Mobil Oil Company	New Orleans, Louisiana
James Barkuloo	U.S. Fish & Wildlife Service	Panama City, Florida
Rolf Juhl and others	National Marine Fisheries Service	Pascagoula, Mississippi
Larry Ogren	National Marine Fisheries Service	Panama City, Florida
Charles Futch and others	Florida Dept. of National Resources	St. Petersburg, Florida
Martin Moe	Aqualife Research	St. Petersburg, Florida
Thomas Hopkins, Ph.D.	University of Alabama	Dauphin Island, Ala.
Thomas Pulley, Ph.D.	Houston Museum of Natural History	Houston, Texas
Eugene Shinn	Shell Oil Company	Houston, Texas
Joseph Colson and John Thompson, Ph.D.	Gulf States Marine Fisheries Commission	New Orleans, Louisiana

MAPPING OF BANKS

The Bureau of Land Management has an interest in the protection of fishing grounds, particularly fishing banks with unique assemblages of biota, through

Figure 3. Visual graphic 4 for Texas and Louisiana showing undersea features in reference to the LOOP and SEADOCK deepwater terminals.

BLM's multi-use functions of managing oil and gas leasing operations in conjunction with other values and uses of the Federal OCS. Much of the early BLM efforts to protect these areas continues in the compilation of information about these areas, such as their exact position, relief, extent, biological assemblages, and use in commercial or recreational activities. Table 2 lists some of the BLM requirements for accurate bathymetry in multi-use management of the OCS.

Table 2. Requirements for Accurate Bathymetric Maps Are Listed below as Used in Managing Offshore Oil and Gas Operations

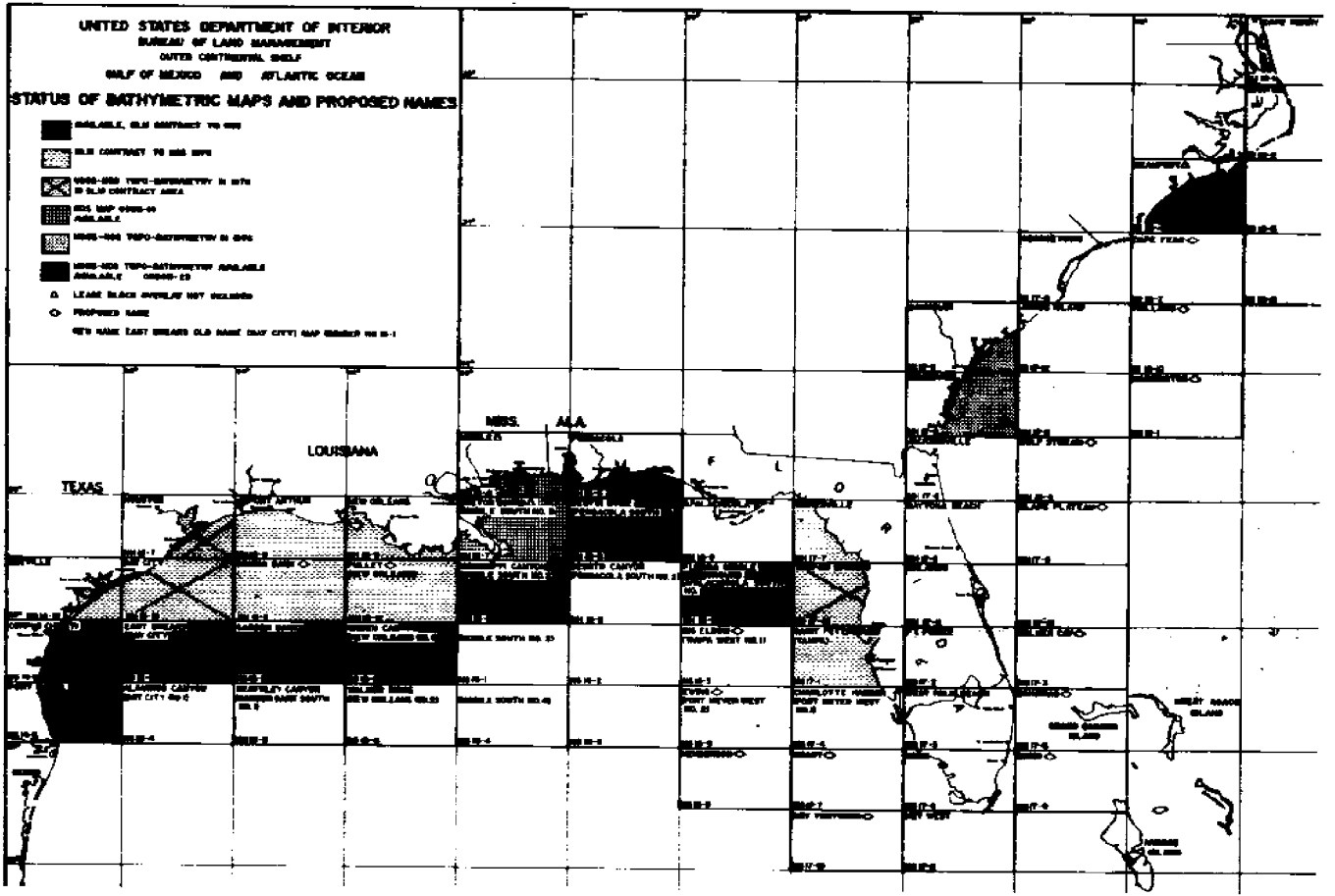
1. Determination of slope gradients in mudslide areas for geologic hazards.
2. Base maps for plotting individually reported geologic hazards, as mud lumps, gas seeps, and faulting.
3. Determination of bathymetric features such as high and low relief areas, fishing banks, coral reefs, and other features.
4. Determination of high probability areas for shipwrecks and submerged aboriginal (Indian) living sites.
5. Determination of the upper and lower limits of practical use of geophysical instrumentation for archaeological and biological survey stipulations.
6. Depth requirements on shunting of drill cuttings.
7. Location of favorable areas for recreational uses (such as diving and underwater parks).
8. Base map for almost all offshore environmental information such as shoaling areas for tornadoes, cable and pipeline burial requirements, depth information for tract selection, depth information for EIS and Sale Matrix.
9. Location of favorable areas for other uses of the seafloor and subbottom.

The original intent of the BLM environmental visuals was to identify areas of important undersea features with a generalized (not site specific) accuracy. However, coral and fishing areas with applicable special stipulations have grown from 5 to approximately 50 in the past year and a variety of maps, including the BLM visuals, were used to locate these areas until accurate bathymetric maps of the operating areas could be obtained.

Under a Bureau of Land Management contract, the National Ocean Survey (NOS) has completed nine 1:250,000 scale bathymetric maps covering areas from the Rio Grande River to the Florida Middle Ground (Fig. 4). These maps are now available from the Bureau of Land Management, New Orleans, Louisiana, and the National Ocean Survey, Rockville, Maryland. They were constructed from original Coast and Geodetic Survey work dating from 1937 and supplemented by modern survey data contributed by oil companies, university research, and U.S. Navy surveys.

The Corpus Christi and Port Isabel maps (Figs. 5 and 6) contain additional detailed information from maps on a 1:12,000 (1 inch-1,000 feet) scale for hardbanks surveyed by Texas A & M University, Lorac, and Decca survey companies under contract with the Bureau of Land Management. Fifteen banks from Mysterious Bank east of Port Mansfield, Texas to 28 and 29 Fathom banks, east of the Flower Garden banks were surveyed in 1974 and 1975. Maps of these areas are available in the Texas A & M final report to BLM at a scale of

Figure 4. Status of bathymetric mapping in the Gulf of Mexico and South Atlantic OCS areas.



1:12,000. These data were reported by Bright and Rezak (1975) showing the banks at a preliminary scale. Hospital Bank was previously surveyed by Oetking in 1969 for Southwest Research Institute and mapped at a scale of approximately 1:6,600.

DETAILING AREAS

Soundings for BLM mapping specifications are contoured at a 2-meter interval out to the 200-meter depth and a 10-meter interval for greater depths. Identification of low relief areas requires a 2-meter contour interval. A 1-meter contour interval would in some cases be more desirable; however, special survey conditions preclude a 1-meter interval for routine surveying in varying sea conditions. Electronic navigation is necessary to maintain proper track-line spacing and place the survey in the modern network used in offshore oil and gas operations for precise drill site locations. Narrow beam bathymetry linked with dual sidescan sonar and supplemented by minisparker or boomer (vibrating plate) high resolution seismic profiling is the most feasible equipment for mapping of bathymetric features.

Surveys that do not utilize the above equipment do not obtain total coverage of the sea floor or give the flexibility needed to interpret sea floor conditions necessary for modern map interpretation for continental shelf operations. Most survey companies use these modern methods and produce multipurpose bathymetric and geologic hazard maps useful in decision making in operating near environmentally hazardous or sensitive areas.

Sidescan operations are normally restricted to water depths of 10 to 100 meters due to towing difficulties (Henderson, 1975). Precise navigation is generally limited by transmitter tower height, power transmission, and coastline configuration to ranges of 200 to 400 km maximum. Line spacing is a function of navigational precision and sidescan capabilities. Normal line spacing for sidescan coverage ranges from 150 to 300 meters.

Detailed submersible mapping began at the West Flower Garden Bank under auspices of the Flower Garden Ocean Research Center (Bright and Pequegnat, 1974) and Stetson Bank was studied for Burmah-Signal Oil Co. by Bright, et al. in 1974.

Detailed studies of the central and southern bank areas are in preparation by U.S. Geological Survey, Corpus Christi and Texas A & M, College Station. Berryhill (1975) and Bright and Rezak (1975) presented summaries of geological results from BLM funded baseline study contracts in this area. Prior to these studies only generalized information was available for these banks. Early sparker surveys showed that these banks appeared to rest on a flat lying formation that was broken by low normal faulting. Some of the banks (Mysterious, Big and Small Adam, and the Snapper Bank region to the south) were nearly buried by a layer of unconsolidated sediment from 10 to 20 meters in thickness. These banks rise from as little as 4 to 6 meters above the sediments. Only Hospital Bank (Oetking, 1969) had been adequately surveyed showing the maximum relief in this area at 22 meters, rising from 78 to 56 meters at the eastern end of

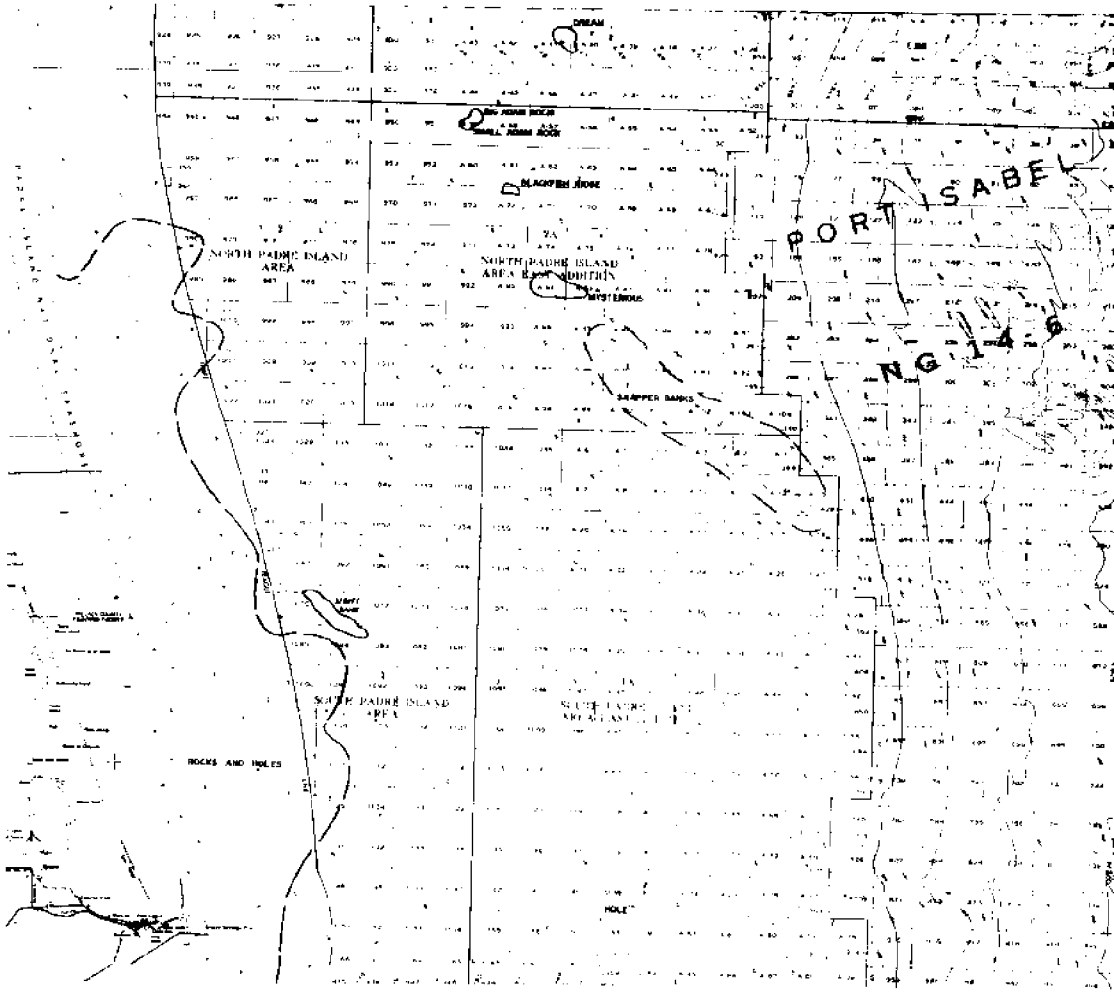


Figure 5. Port Isabel and Brownsville 1:250,000 maps NOS NG 14-6 (OCS) showing the southern hardbank areas.

the bank. Most of these banks had been located by C&GS surveys in the late 1930s and the OFFSHORE FISHING CHARTS further defined their locations by Loran A coordinates and headings from the nearest fishing ports.

It was recognized by fishermen that even a 2-meter rise in the flat ocean floor in the Port Isabel-Corpus Christi map areas (Figs. 5 and 6) constitutes reliable fishing areas particularly for snapper (Bryan, 1975; Johnston, Adams, and Foster, 1975). Inspection of the Corpus Christi and Port Isabel maps illustrates

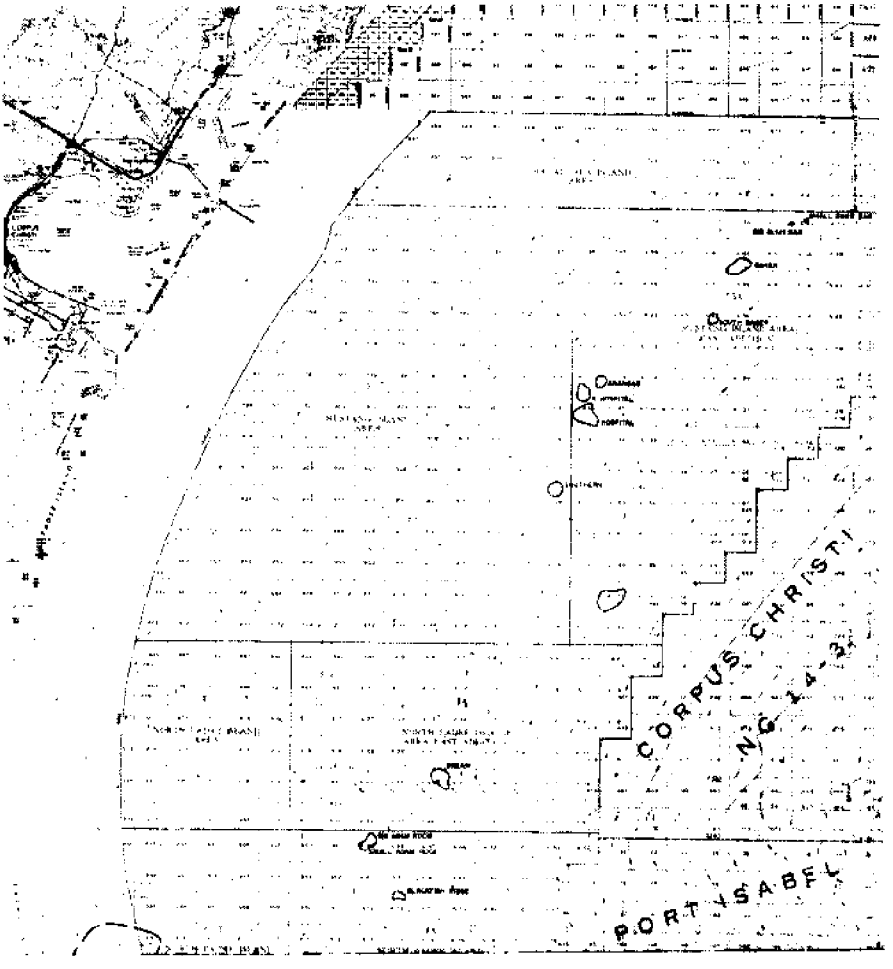


Figure 6. Corpus Christi 1:250,000 maps NOS NG 14-3 showing the central hardbank areas.

that the central bank area (Fig. 5) is an arcuate group of banks extending from Big and Small Dunn Bar (Mustang Island Block A-54) through Hospital and Southern Bank to a smaller bank in Mustang Island Block A-171. The southern banks extend in an arc from Dream through Mysterious and the Snapper banks region (Fig. 6).

THE ORIGIN AND FATE OF THESE BANKS

The age of these banks is relatively young in terms of geologic time; and early Indians could have fished these banks in their infancy (Gagliano, 1975). The growth of coralline areas is particularly affected by water depth and temperature

as well as water clarity and chemistry. Deeper banks could have been shoal during the last glaciation when the sea level was lowered to near 100 meters (Fig. 7, Fairbridge, 1960) as the ice accumulated to a maximum extent on the continents. Areas in South Texas and along the Louisiana-Texas shelf break could have been in an environment similar to the present day Bahama Islands with shallow water lagoons and coral growth occurring in arcuate barriers (Figs. 5 and 6). Banks such as the group including Mysterious and Baker would have become drowned to such depths (after approximately 11,000 years ago) that growth in elevation would essentially have ceased. At that time the lower portions of 18 Fathom Lump and Stetson would have been situated in shallow water. Now they are considered to be in a stressed condition by deep submergence. Also on the borderline but still producing divergent biota are the Flower Gardens and Florida Middle Ground. Sea level has not appreciably changed in the past 6,000 years (Fig. 7) and the Flower Gardens and Florida Middle Ground should continue their status as growing coral banks.

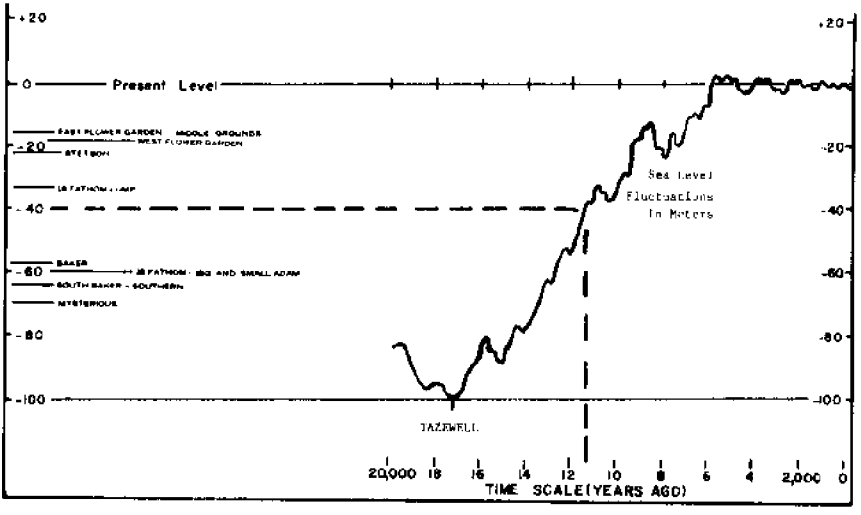


Figure 7. The rise and fall of sea level following the Wisconsin glaciation (from R.W. Fairbridge, 1960).

Drilling operations began near these banks in 1974 and protective stipulations developed by the Department of the Interior will not permit drilling or dumping of cuttings and muds on the coral banks. Monitoring of operations before, during, and after drilling, particularly at the Flower Gardens and Stetson Bank, has commenced. The status of environmental stipulations and monitoring around the important fishing banks will be the subject of a later report.

Relatively stable sea level and temperature regimes have been advantageous to the growth of coral banks as well as to man's activities in the coastal zone. Careful operations around the biologically sensitive areas are a mutually agreeable situation between industry, federal and state agencies; monitored in most

cases by university or private researchers concerned with the environment. The most dangerous petroleum pollution viewed is the nearly uncontrolled dumping of crank case oil by private citizens and garages in upland storm sewers, and the cleaning of tankers while underway or anchored on prominent banks. (Office of Technology Assessment, 1975).

ACKNOWLEDGMENTS

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LITERATURE CITED

Berryhill, Henry
1975. Summary, Environmental Geology, South Texas Outer Continental Shelf, Bur. of Land Management. Environmental Studies Program for the South Atlantic Outer Continental Shelf Area, Oct. 14-17, 1975.

Bright, T.J. and L.H. Pequegnat
1974. Biota of the West Flower Garden Bank. Gulf Publishing Co., Houston, Texas. 435p.

_____and R. Rezak
1975. Fishing banks of the Texas Continental Shelf. In: Colloquium on Snapper-Grouper Fishery Resources of the Western Central Atlantic. Gulf States Marine Fisheries Commission, New Orleans, La.

_____ W. Pequegnat, R. Dubois, and D. Gettleson
1974. Biological Baseline Survey – Stetson Bank, Gulf of Mexico for Signal Oil & Gas Co., Houston, Tex.

Bryan, C.E.
1975. Personal Communication. Texas Parks and Wildlife Dept., Rockport, Texas.

Carsey, J.B.
1950. Geology of Gulf Coast coastal area and continental shelf. Bull. Amer. Assoc. Petrol. Geol. 34:361-385.

Edwards, G.S.
1971. Geology of the West Flower Garden Bank. Texas A&M Sea Grant Pub. TAMU-SG-71-215. 199p.

Ekman, S.
1953. Zoogeography of the Sea. Sidgwick and Jackson Ltd. London. 417p.

Fairbridge, R.W.
1960. The changing level of the sea. Sci. Amer.

Gagliano, S.M.
1975. How offshore oil has stimulated continental shelf archaeology. New Orleans Geological Society, V 15, No. 11, Sept. meeting.

Greenman, N.N. and R.J. LeBlanc
1956. Recent marine sediments and environments of northwest Gulf of Mexico. Bull. Amer. Assoc. Petrol. Geol. 40:813-847.

Henderson, R.F.
1975. Recent developments in sidescan sonar and application in the offshore oil fields, Offshore Technology Conference, Houston, Paper # OTC 2220.

Johnston, J.B., J.K. Adams, and R. Foster.
1975. The red snapper resource of the Texas Continental Shelf. In: Colloquium on Snapper-Grouper Fishery Resources of the Western Central Atlantic. Gulf States Marine Fisheries Commission, New Orleans, La.

Moe, M.A., Jr.
1963. A survey of offshore fishing in Florida. Professional Papers Series Number Four. Florida State Board of Conservation Marine Laboratory, St. Petersburg, Fla.

———
1970. Florida's Fishing Grounds, 2nd Printing. Great Outdoors Publishing Co., St. Petersburg, Fla. 80p.

Oetking, Philip.
1969. Bathymetric Map of Hospital Rock, Southwest Research Institute, Corpus Christi, Texas.

Office of Technology Assessment.
1975. Oil Transport by Tankers: An Analysis of Marine Pollution and Safety Measures. Supt. of Doc., U.S. Gov. P.O. Wash. D.C. 20402, #052-070-03091-7.

Parker, R.H. and J.R. Curray.
1956. Fauna and bathymetry of banks on continental shelf, northwest Gulf of Mexico. Bull. Amer. Assoc. Petrol. Geol. 40:2428-2439.

Pulley, T.E.
1963. Texas to the tropics. Bull. Houston Geol. Soc. 6:13-19.

Shepard, F.P.
1937. Salt domes related to Mississippi submarine trough. Bull. Geol. Soc. Amer. 40:2428-2439.

Shepard, P.
1960. Recent sediments, N.W. Gulf of Mexico. AAPG. Tulsa, Okla. 394p.

Stoddard, D.R.
1969. Ecology and morphology of recent coral reefs. Biological Reviews. 44:433-498.

Current Studies toward the Protection of the Environment in the MAFLA Area

JAMES E. ALEXANDER
SUSIO
St. Petersburg, FL 33701

ABSTRACT

Present studies in the Outer Continental Shelf of the Mississippi-Alabama-Florida (MAFLA) area include both benthic and water column sampling. The nature of the work being conducted within each discipline (biology, chemistry, and geology) is discussed, especially the significance of these efforts as they relate to the protection of the MAFLA environment.

Contaminant Effects on Biota of the New York Bight

JOEL S. O'CONNOR
MESA New York Bight Project
National Oceanic and Atmospheric Administration
State University of New York
Stony Brook, NY 11794

ABSTRACT

The Marine EcoSystems Analysis (MESA) Project of NOAA was initiated in 1973 to assess the impacts of man's activities and the natural influences on the New York Bight. Several examples of contaminant impacts on marine resources have been identified rather quickly: (1) high prevalence of diseases in several species of finfish and shellfish, (2) major alterations in the distribution and abundance of bottom living organisms, (3) widespread distribution in exceptionally high numbers of coliform and fecal coliform bacteria, indicative of pathogenic bacteria (which findings have led to closure of clam fishing operations in extensive areas around and landward of ocean dumping sites), (4) presence of transfer-resistant (R^+) bacteria which are resistant to broad spectra of heavy metals and antibiotics, and (5) noxious concentrations of suspended particulate material, flotsam and surface slicks, particularly on beaches used very intensively for bathing and sportfishing.

INTRODUCTION

Even the most optimistic marine scientists now affirm that the wastes of dense human populations often degrade adjacent coastal ecosystems in some respects. The degree of degradation is typically debatable, and varies with many factors from location to location. In this paper I summarize some of the biotic degradation observed in the New York Bight (Fig. 1), a coastal indentation containing one of the most man-dominated coastal ecosystems in the world. The combined effects of 18 million people and their energy-intensive activities adjacent to the New York Bight have disturbed the Bight ecosystem in several readily perceptible ways. I have chosen to summarize only those impacts which are already documented convincingly.

Some of the ecological effects were noted years ago by several investigators. Partial summaries of these earlier observations are in National Marine Fisheries Service (1972), Pararas-Carayannis (1973), and Buzas, et al. (1972). However, for the effects summarized below, most of the documentation has been done during the first 2 years of the Marine EcoSystems Analysis (MESA) Project by MESA-associated investigators. Additional ecological effects, beyond those described in this paper, will undoubtedly become evident with continuing investigation.

The annual quantities of contaminants now reaching the New York Bight are impressive: sewage sludge, 3 to $4.3 \times 10^6 m^3/yr$; dredge spoils, $> 7 \times 10^6 m^3/yr$; acid wastes, $> 2 \times 10^6 m^3/yr$; construction debris and cellar dirt, $4.5 \times 10^5 m^3/yr$; atmospheric fallout of: Cd, Cr, Cu, Fe, Pb, and Zn, 3940 to 32,000 metric tons/yr; plus suspended solids, 49,000 to 500,000 metric tons/yr; and total nitrogen,

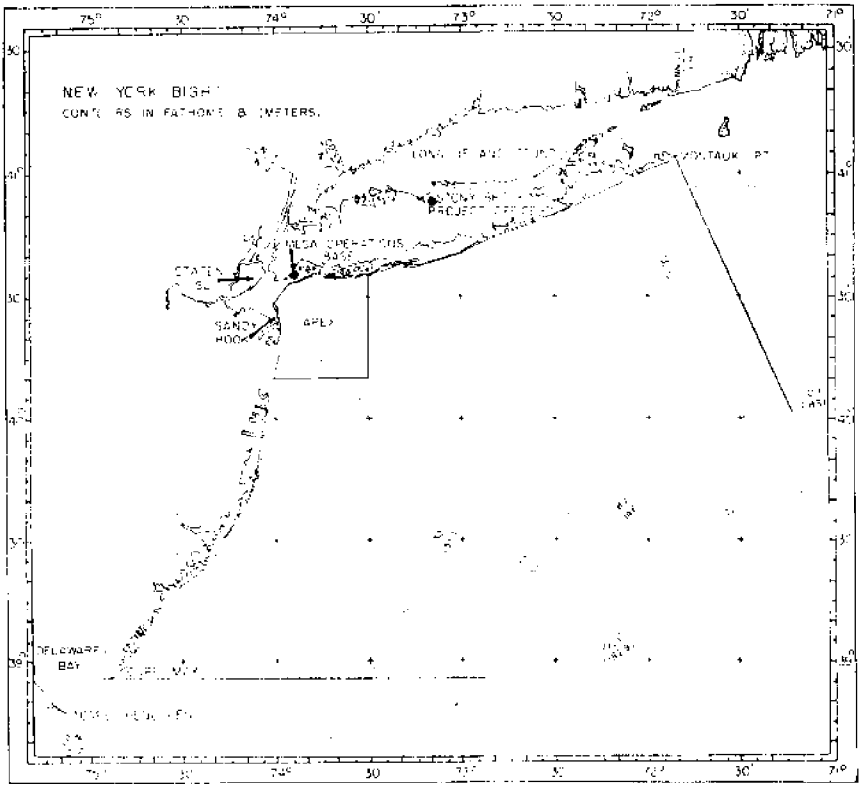

Fig. 1. New York Bight, with MESA-defined limits, and innermost portion of the Bight termed the Apex.

24,000 metric tons/yr; municipal and industrial wastewater containing: oil and grease, 72,000 metric tons/yr; and total nitrogen, 79,000 tons/yr; runoff and groundwater influx containing: oil and grease, 124,000 metric tons/yr; and total nitrogen, 55,000 metric tons/yr.

A detailed and useful summary of the sources and quantities of contaminant inputs to the Bight is given by Mueller, et al. (in press), from which most of the above figures are derived.

Given these enormous volumes of contaminated inputs, and their concentration near the apex of the New Jersey-Long Island shores, one would expect most contaminant effects to appear in the Apex. As will be shown, most effects do seem to be so "localized" although the locale is much larger than most degraded coastal ecosystems.

Fin Rot Disease

Trawl hauls from the Bight since spring 1973 have yielded five species of flatfishes: yellowtail flounder *(Limanda ferruginea)*, summer flounder *(Paralichthys dentatus)*, fourspot flounder *(Paralichthys oblongus)*, winter flounder

(Pseudopleuronectes americanus), and windowpane *(Scophthalmus aquosus)* with eroded fin tissue. In addition to these flatfishes, several other fish species have exhibited fin rot disease in the New York Bight area for several years (Mahoney, Midlige, and Deuel, 1973). At least superficially similarly diseased fishes have been observed in the Irish Sea; Puget Sound, Washington, USA; Sandy Hook Bay, New Jersey, USA; southern California coastal waters, USA; and the Gulf of Maine, USA (Ziskowski and Murchelano, 1975) and Narragansett Bay, Rhode Island, USA, (Levin, Wolke, and Cabelli, 1972).

The causes of fin rot disease in the Bight are still uncertain. Its histopathology in winter flounder has been studied by Murchelano (1975) who characterizes fin rot grossly as a progressive necrosis of the anal and dorsal fins and, less frequently, of caudal fins. The fin and fin rays are eroded, with congestion and hemorrhage of blood vessels in the fin remnant (Fig. 2). While the causes of fin rot remain unknown for Bight fishes, Murchelano (1975) seems to have ruled out a primarily bacterial etiology. However, Levin, et al. (1972) have defined the bacterial etiology of (another ?) fin rot disease in winter flounder of Narragansett Bay, Rhode Island.

Since 1973, winter flounder seem to have the highest incidence of fin rot in the Bight. The seasonal incidence in this species, illustrated in Figure 3, is significantly greater inside the Apex than outside during the spring of both 1973 and 1974 ($P < 0.01$ using the t test on arc-sine square root transformed data). The same test indicates significantly more diseased winter flounder in the Apex ($P < 0.01$) over all seasons combined (Ziskowski and Murchelano, 1975). The reason for higher incidence in spring (Fig. 3) is unknown.

Diseases of Crustacea

Some species of crustacea also contract pathologies of their gills and exoskeletons. The exoskeletal "shell disease" of lobsters *(Homarus americanus)* and rock crabs *(Cancer irroratus)* appears to occur primarily in specimens on and near the benthic deposits of dumped sewage sludge and dredge spoils (NMFS, 1972, Sect. 2). Further, the areas of skeletal erosion were primarily on the appendages where contaminated sediments would be expected to accumulate (Young and Pearce, 1975). Equal numbers of crabs and lobsters from relatively uncontaminated areas were exposed, in aquaria, to organic deposits taken near the sewage sludge and dredge spoil dump sites, and to clean sand substrates by Young and Pearce (1975). Skeletal erosion appeared in all crabs and lobsters exposed to both of these contaminated sediments, but none of the crustacea held on clean sands developed any pathology. Histological sections of the diseased animals revealed "pitting and cracking away of the [exoskeletal] laminae" and, in advanced stages, the exoskeleton was replaced by an external blood clot. The lobsters exposed to sewage sludge also exhibit gills fouled with granular material; their chitinous covering is often eroded and the underlying

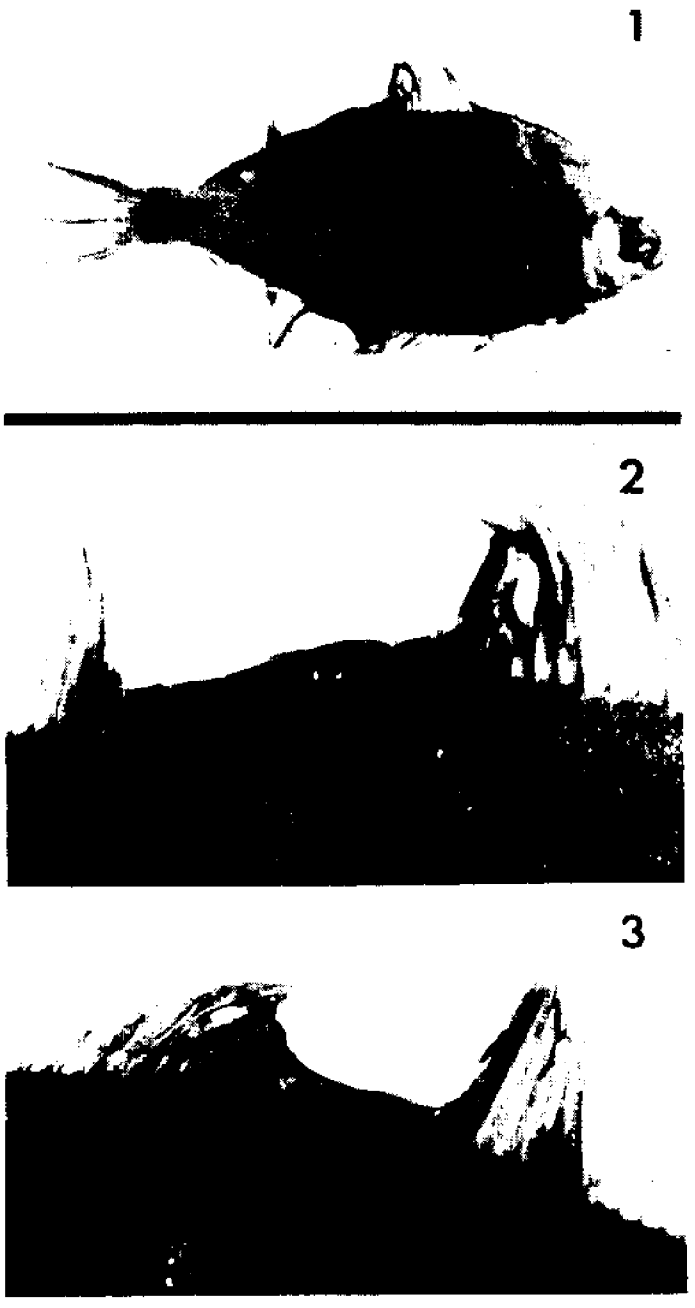

Fig. 2. (1) Winter flounder with fin rot disease of dorsal and anal fins. (2) Dorsal fin. (3) Anal fin. (Photos courtesy of J. O'Reilly, NOAA, NMFS, Middle Atlantic Coastal Fisheries Center, Sandy Hook, N.J.).

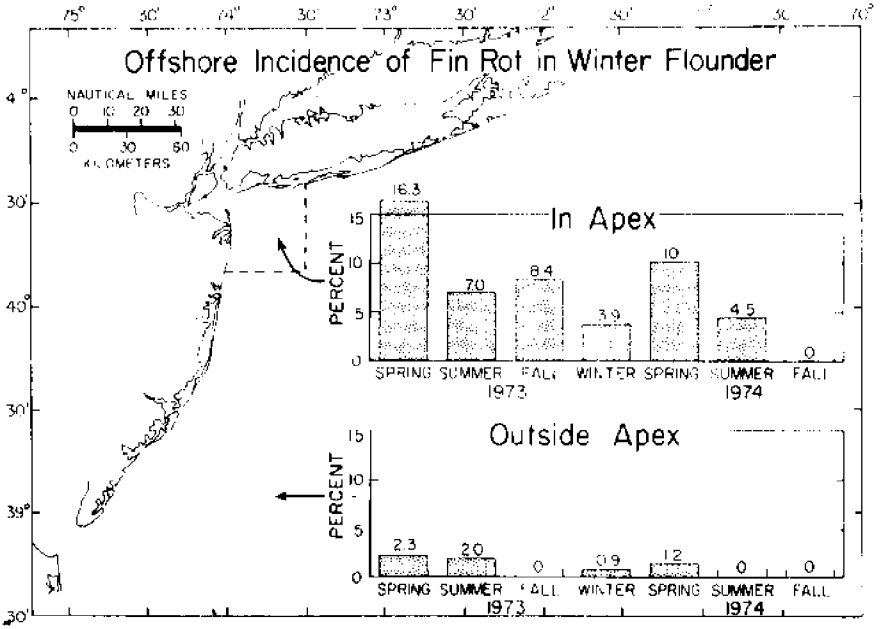

Fig. 3. Seasonal incidence of fin rot in winter flounder *(Pseudopleuronectes americanus)* in the New York Bight.

tissue is killed (Young and Pearve, 1975).

A similar shell disease of the caridean shrimp, *Crangon septemspinosa,* was found to be common in the inner Bight and Raritan and Sandy Hook bays (Gopalan and Young, 1975).

The percentage incidence of these diseases in crustacea of the Bight is not known. However, Young and Pearce (1975) have pointed out that potentially significant mortalities might occur from the effects of gill fouling and necrosis combined with low oxygen concentrations over wide areas of the Apex. The latter phenomenon has since been documented even more precisely by Segar, Berberian, and Hatcher (in press).

Degradation of Benthic Invertebrate Assemblages

Essentially all students of coastal ecological impacts of contaminants agree that benthic invertebrates typically show marked local changes in community composition. Such impacts were documented around sewage outfalls in Biscayne Bay, Florida, by McNulty (1961), off California by Greene and Smith (1975), Smith and Greene (in press), and around the dredge spoil and sewage sludge dump sites of the Bight by NMFS (1972). Commercial-size surf clams *(Spisula solidissima)* (larger than 3 in. or 7.6 cm) are unusually rare in an area of about 520 nautical mi^2 (1,550 km^2) surrounding the Apex dump sites (MESA, 1975). Based upon recent intensive sampling, MESA investigators have begun to

quantify the degree of reduction in species diversity and abundance of benthic macrofauna in the harbors south of New York City and the Bight Apex where sediments are most heavily contaminated. McGrath (1974) has summarized the benthic ecology of Raritan and Lower bays, noting especially the unusually low densities of macrofauna relative to comparable unpolluted areas. Pearce and Radosh (in press) have summarized the historical work on benthic macrofauna of the Bight and preliminary results of some MESA cruises. Figure 4 illustrates the unusually low densities of macrofauna in Raritan and Lower bays, and in some sediments of the Apex most modified by solid waste dumping. Some of these most contaminated areas also have unusually little diversity in species composition (Fig. 5). The high contaminant levels and extended flushing time of the bays south of New York City cause greatly depressed macrofaunal densities and species diversity throughout these bays. However, despite the great volumes of dumped and waterborne materials settling in the Apex, average and high densities of macrofauna are widespread, often with species diversities typical of unstressed areas.

Another illustration of contaminant effects from sewage sludge dumping is given in Figure 6. This figure shows the human artifacts taken from the stomach of one white hake *(Urophycis tenuis)* caught near the sewage sludge dump site. This and other fish species clearly eat injurious artifacts if presented along with their normal diet of benthic fauna.

Bacterial Contamination

It has been known for some time that shellfish near the sewage sludge site may contain unacceptably high concentrations of coliform bacteria (Buelow, Pringle, and Verber, 1968). A circular area of 6 nautical mi (11 km) radius around the sewage sludge dump site was closed to shellfishing in 1970 by the U.S. Food and Drug Administration (FDA). In 1974 the FDA expanded this closure area as shown in Figure 7 because of bacterial contamination from ocean sewage outfalls and seaward flow of contaminated waters from Lower Bay and other bays (Meyer, 1974, personal communication).

A recent study has provided significant insight into the correlation between bacterial concentrations of bathing waters and associated illnesses. This epidemiological study compared beaches at Coney Island and Riis Park of the Rockaways. Given data from 2 years, the rate of gastrointestinal symptoms (vomiting, diarrhea, nausea, or stomach ache) among swimmers at Coney Island was significantly higher than that of non-swimmers. A significant difference between swimmers and non-swimmers was not found at the "relatively unpolluted" Rockaways beach (Cabelli, et al., in press). These workers also found that, while even carefully defined coliform bacterial concentrations were not the best indicator of disease rate, waters with coliform concentrations of 200 MPN/100 ml resulted in gastrointestinal (GI) disease rates of 3-4% of the bathers, and 1-2% of "severe attack" GI rates (Cabelli, et al., in press). Thus it is clear that, at least in the "barely acceptable" bathing waters studied on Coney Island, fecal contamination of bathing waters continues to be a public health problem.

Fig. 4. Numbers of benthic macrofauna per 0.1 m^2 as estimated from Smith McIntyre grab samples. Grab locations are denoted by dots, with two grabs per location in the Apex. The sampling density (78 stations) in the bays south of New York City does not permit indication of sampling locations. (From Pearce and Radosh, in press.)

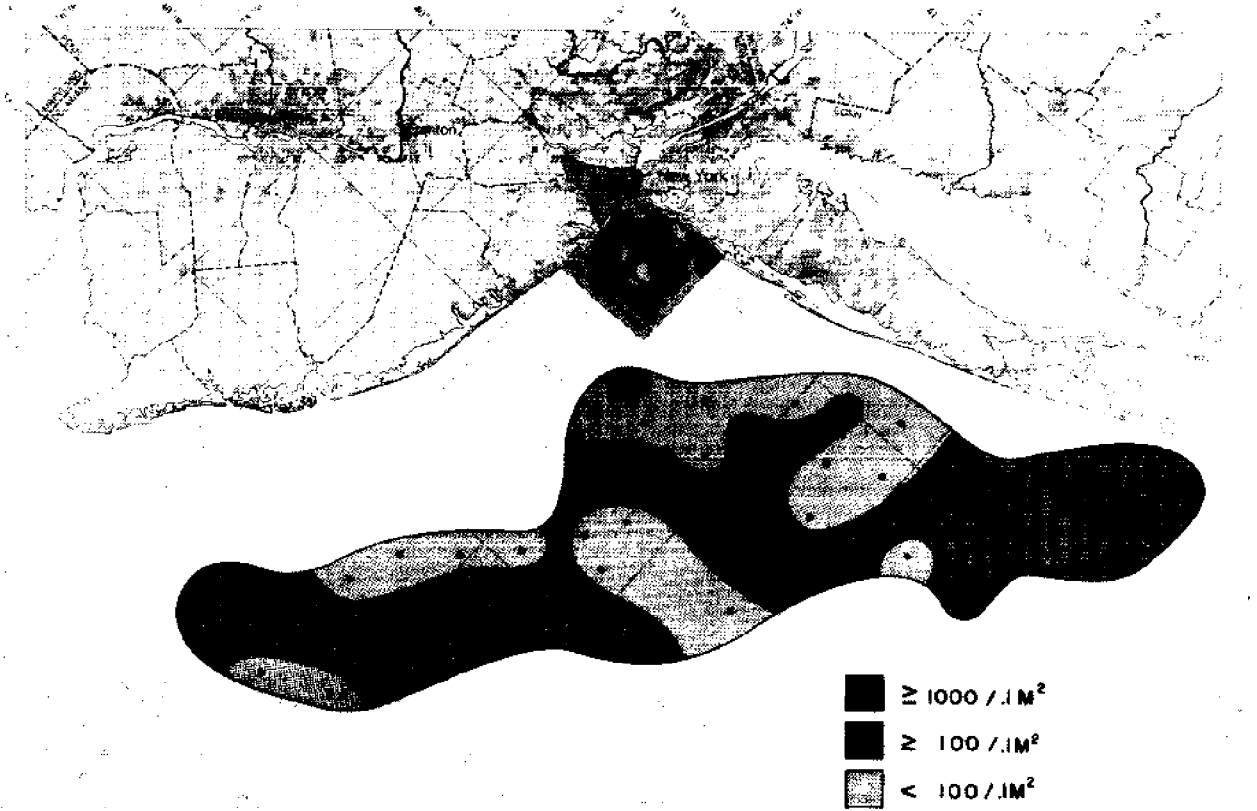

Fig. 5. Species diversity (H') of benthic macrofauna as estimated from Smith McIntyre grab samples. Grab locations are denoted by dots, with two grabs per location in the Apex. The sampling density (78 stations) in the bays south of New York City does not permit indication of sampling locations. (From Pearce and Radosh, in press.)

Widespread usage of antibiotics has contributed immensely to the cure of disease throughout the world over the past 30 years. However, this widespread usage has resulted in strains of pathogenic and coliform bacteria which are resistant to relatively high concentrations of the antibiotics. Resistance to normally toxic heavy metals has also evolved in some bacteria. One form of resistance, called the R factor, can be transmitted among several genera of bacteria. Coliform bacteria, for example, have been found not only to transmit the R factor, but also to serve as a reservoir through which pathogens, for example, *Salmonella*, will become resistant to antibiotics (Anderson, 1968; and Grabow, Prozesky, and Smith, 1974). Coliform bacteria from the Bight have the transfer resistance factor (plasmid) for heavy metals and broad spectra of antibiotics (Koditschek and Guyre, 1974). A portion of the protocol used to determine the incidence of multiple antibiotic and metal resistance in coliforms is illustrated in Figure 8.

The presence of multiple antibiotic and metal resistance in coliform (and perhaps other) bacteria in the New York Bight is not viewed by public health experts as a public health hazard. However, this rapid evolutionary response of bacteria to contaminant concentrations is now worldwide, and constitutes a serious public health problem under some circumstances (Grabow, et al., 1974).

Aesthetic Impacts

Among the most significant contaminant impacts in the Bight, and elsewhere, are those which disappoint man's expectations about his piece of ocean and coast; about the marine areas which are readily accessible. While aesthetic impacts may not pose public health hazards or degrade biological communities, large numbers of people feel strongly about these unpleasant visual, auditory, tactile, or olfactory attributes of their forseen-as-natural environment.

For instance, despite the lack of turbidity measurements in bathing waters, superficial observations can verify that the waters south of Fire Island become much more turbid as one approaches New York Harbor from the east. The Fire Island beaches of Hempstead Town and others further west, including New Jersey, are at times seriously fouled with debris ranging in size from cigarette filters to large planks. The intertidal beaches of the Apex are commonly fouled with large numbers of "tar balls" which are viewed as noxious by beach users. That essentially no effort has gone into the documentation of these contaminant effects does not diminish their significance. These aesthetic kinds of environmental degradation as perceived by the public seem to be fully as significant as some of the more conventionally measured impacts.

DISCUSSION

Several biotic effects clearly arising from human contamination of the inner New York Bight have been summarized. These indicators of marine environmental degradation are of the sorts summarized by Sindermann (1972).

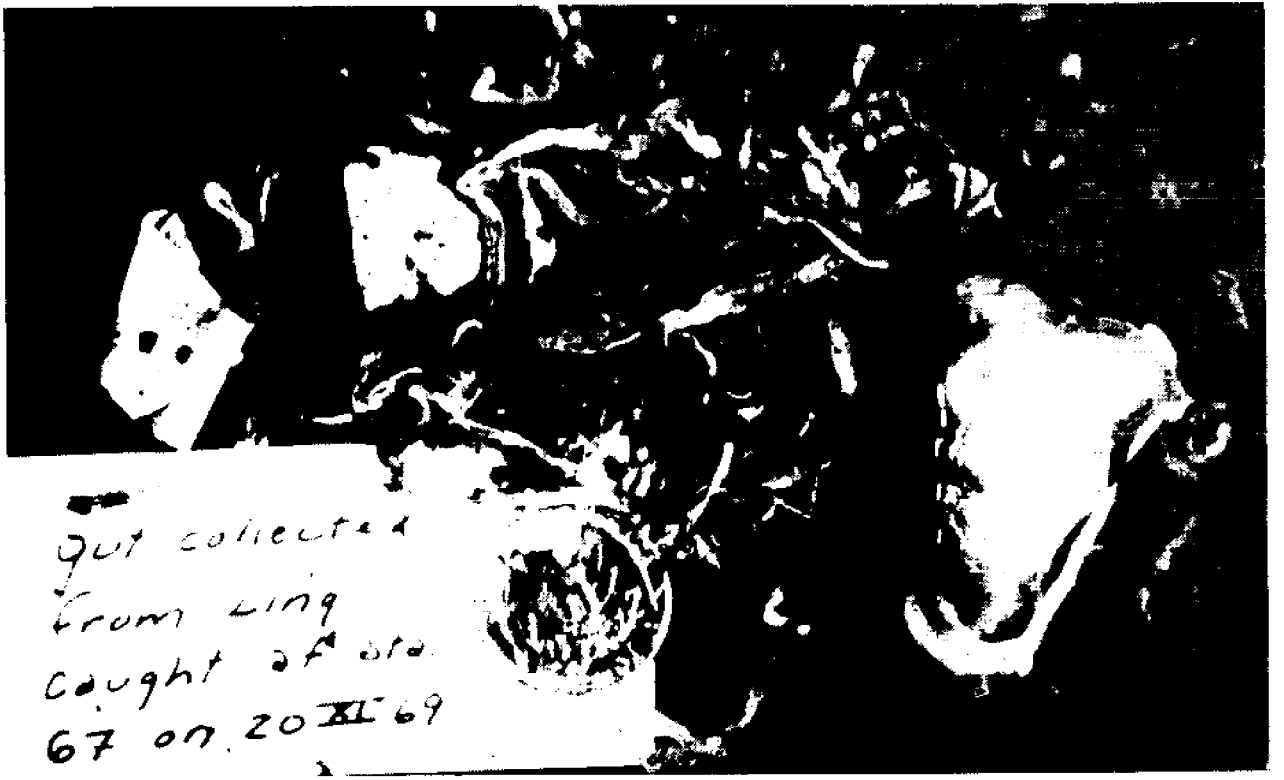

Fig. 6. Stomach contents of a white hake *(urophycis tenuis)* caught near the sewage sludge dump site. The coin is to illustrate scale. (The figure is courtesy of Dr. John B. Pearce. NOAA, NMFS. Middle Atlantic Coastal Fisheries Center, Highlands, New Jersey.)

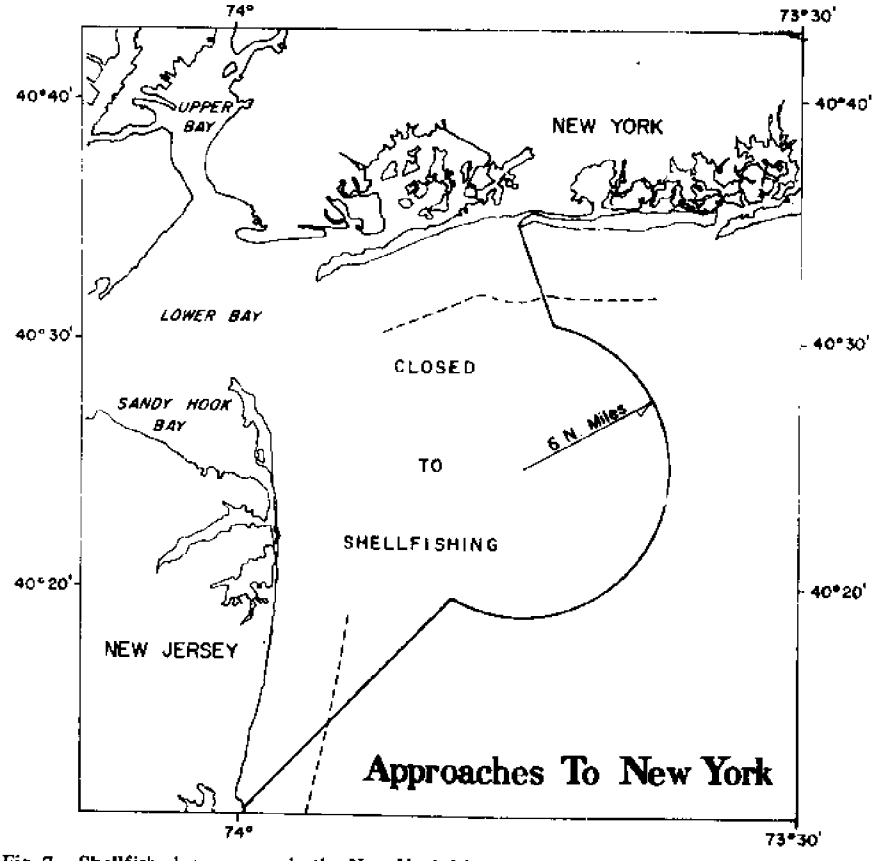

Fig. 7. Shellfish closure areas in the New York Bight as of May 1974.

Investigators are commonly cautioned, and appropriately so, about attributing to contaminants the major changes in abundance, distribution, or attributes of marine organisms which arise so frequently from natural causes. Because these natural fluctuations are commonly so great in comparison with contaminant effects, reasonably sophisticated and time consuming experimental designs are often necessary to clearly distinguish contaminant effects from natural effects. Thus, the presence of so many marked biotic effects which are unequivocally due to artificial contamination of Bight waters and sediments, based upon studies of only 2 years or less, emphasizes the unusual degree to which man has come to modify this area of seacoast. The natural benthic communities have been drastically modified over at least 150 nautical mi^2 (514 km^2), and 244 nautical mi^2 (838 km^2) of open ocean bottom have been closed to shellfishing. Ocean dumping appears to be the principal cause of these effects and most of the others summarized, although other sources of contamination are contributory.

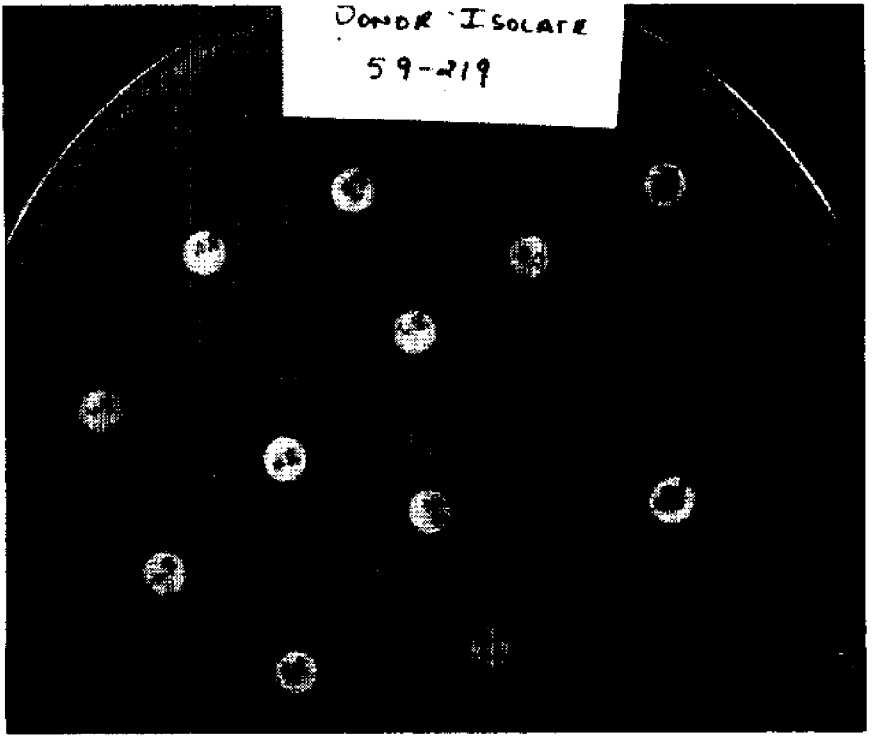

Fig. 8. Bacterial culture and discs saturated with heavy metals and antibiotics. The dark zones (zones of inhibition) around some discs indicate effective toxicity. Bacterial growth up to some discs indicates bacterial resistance to the normally bacteriostatic compound on the disc. This culture is resistant to five antibiotics. (The figure is courtesy of Dr. Leah Koditschek, Montclair State College, Upper Montclair, N.J.)

The most obvious, readily documented contaminant impacts in the Bight are all associated with bottom deposits of dumped material, except for the fouling of surface waters and beaches. Yet, most of the contaminants entering the Bight are from non-dumping sources. These more diffuse sources of contamination (riverine transport, surface runoff, and atmospheric fallout) result in more subtile biotic effects than those of the more concentrated dumped materials. Thus, additional biotic indications of artificial contamination may become obvious after more lengthy observations.

ACKNOWLEDGMENTS

In addition to the several MESA investigators upon whose work this summary is based, special thanks go to John Pearce, David Radosh, Leah Koditschek, and John Ziskowski for their kindness in permitting usage of data and illustrations prior to formal publication.

LITERATURE CITED

Anderson, E.S.
1968. The ecology of transferable drug-resistance factors in the Enterobacteria. Ann. Rev. Microbiol. 22:131-180.

Buelow, R.W., B.H. Pringle, and J.L. Verber.
1968. Preliminary Investigation of Waste Disposal in the New York Bight. U.S. Department of Health, Education and Welfare, Northeast Marine Health Sciences Lab., Narragansett, R.I. 34 p.

Buzas, M.A., J.H. Carpenter, B.H. Ketcham, J.H. McHugh, V.J. Norton, D.J. O'Connor, J.L. Simon, and D.K. Young.
1972. Smithsonian Advisory Committee Report on Studies of the Effects of Waste Disposal in the New York Bight. 59 p. (Available from NTIS AD-746 960).

Cabelli, V.J., A.P. Dufour, M.A. Levin, and P.W. Habermann.
(in press). The impact of pollution on marine bathing beaches: An epidemiological study. Proc. Special Symposium on the Middle Atlantic Continental Shelf and New York Bight. ASLO Special Publication No. 2.

Gopalan, U.K. and J.S. Young.
1975. Incidence of shell disease in shrimp in the New York Bight. Mar. Poll. Bull. 6 (10):149-153.

Grabow, W.O.K., O.W. Prozesky, and L.S. Smith.
1974. Drug resistant coliforms call for review of water quality standards. Water Res. 8:1-9.

Greene, C.S. and R.W. Smith.
1975. Numerical analysis of data on a benthic community.pp. 69-83 In: Annual Report for the Year Ended 30 June 1975, Southern California Coastal Water Research Project. El Segundo, California.

Koditschek, L. and P. Guyre.
1974. Antimicrobial-resistant coliforms in New York Bight. Mar. Poll. Bull. 5(5):71-74.

Levin, M.A., R.E. Wolke, and V.J. Cabelli.
1972. *Vibrio anguillarum* as a cause of disease in winter flounder *(Pseudopleuronectes americanus)*. Canad. J. Microbiol. 18:1585-1592.

Mahoney, B., F.H. Midlige, and D.G. Deuel.
1973. A fin rot disease of marine and euryhaline fishes in the New York Bight. Trans. Amer. Fish. Soc. 102:596-605.

Marine Ecosystems Analysis Project (MESA).
1975. Ocean Dumping in the New York Bight. NOAA, Marine Ecosystems Analysis Project, U.S. Government Printing Office,Washington, D.C. 78p.

McGrath, R.A.
1974. Benthic macrofaunal census of Raritan Bay – Preliminary results. Paper No. 24, Proc. Third Sympos. on Hudson River Ecology, March 22-23, 1973. Bear Mountain, N.Y. Hudson River Environmental Society, Bronx, N.Y.

McNulty, J.K.
1961. Ecological effects of sewage pollution in Biscayne Bay, Florida: Sediments and the distribution of benthic and fouling organisms. Bull. Mar. Sci. Gulf Carib. 11(3): 393-447.

Mueller, J.A., J.S. Jeris, A.R. Anderson, and C.F. Hughes.
(in press). Contaminant Inputs to the New York Bight. NOAA, Environmental Research Laboratories, Boulder Colorado. MESA Technical Memorandum.

Murchelano, R.
1975. The histopathology of fin rot disease in winter flounder from the New York Bight. J. Wildl. Diseases. 11:263-268.

National Marine Fisheries Service (NMFS).
1972. The Effects of Waste Disposal in the New York Bight. NOAA, National Marine Fisheries Service, Middle Atlantic Coastal Fisheries Center, Highlands, New Jersey, Vol. 1-9. 749p. (Avail. from NTIS, AD730531 through AD730539.)

Pararas-Carayannis, G.
1973. Ocean Dumping in the New York Bight: An Assessment of Environmental Studies. Coastal Engineering Research Center. U.S. Army Corps of Engineers, Tech. Memo, No. 39. 159p.

Pearce, J.B. and D. Radosh.
(in press). Benthic Fauna of the New York Bight. MESA New York Bight Atlas Monograph No. 14. (Avail. from New York Sea Grant Institute, Albany, New York at $4.00.)

Segar, D.A., G.A. Berberian, and P.G. Hatcher.
(in press). Oxygen depletion in the New York Bight Apex – Causes and consequences. Proc. Special Symposium on the Middle Atlantic Continental Shelf and New York Bight. ASLO Special Pub. No. 2.

Sindermann, C.J.
1972. Some biological indicators of marine environmental degradation. J. Wash. Acad. Sci. 62:184-189.

Smith, R.W. and C.S. Greene.
(in press). Patterns in biological communities in an area of wastewater discharge. J. Water Poll. Control Fed.

Young, J.S. and J.B. Pearce.
1975. Shell disease in crabs and lobsters from New York Bight. Mar. Poll Bull. 6(7):101-105.

Ziskowski, J. And R. Murchelano.
1975. Fin erosion in winter flounder. Marine Poll. Bull. 6(2):26-29.

FISHERIES BIOLOGY SESSION

TUESDAY – A.M. – OCTOBER 28, 1975

Chairman – William Seaman, Jr., *Assistant Director, Sea Grant Programs, University of Florida, Gainesville, Florida*

Gear and Economic Efficiency Results of a Sea Grant Twin-Trawl Demonstration in South Carolina[1]

KENNETH J. ROBERTS
Clemson University
Clemson, SC 29631

and

RAYMOND J. RHODES
S. C. Wildlife and Marine Resources Department
Charleston, SC 29412

ABSTRACT

Twin trawls have been utilized by a few commercial shrimpers and refined through sea trials by Sea Grant programs in North Carolina and Georgia. However, South Carolina shrimpers have not invested in the new equipment. Two-seam nets were used on a vessel of a class (40-59 ft.) which was thought could benefit most from twin trawls. The 2-month demonstration was designed to indicate the economic feasibility of utilizing the twin trawl for brown shrimp harvesting in shallow water (less than 30 ft.). The analysis of results through partial budgeting indicates that this gear increases yield sufficiently to justify the additional investment on vessels of similar horsepower and length.

INTRODUCTION

Most gear research on the shrimp otter trawl has concentrated on improving the catch efficiency of the net itself (e.g., Marinovich and Whiteleather, 1969; Seidel, 1969). In contrast, the recent twin trawl experimentation does not represent an effort to improve the efficiency of the trawl net design itself. Instead, it

[1]Contribution No. 55 from the South Carolina Marine Resources Center. This investigation is a result of extension work partially sponsored by NOAA Office of Sea Grant, Dept. of Commerce, under Grant No. 04-6-158-44009.

is basically a return to the principles which motivated trawler owners in the South Atlantic states and Gulf of Mexico to switch from pulling one net to two nets during the late 1950s. The benefits of double-rig trawling to fishermen also seem to apply to the twin trawl. For example: (1) By allocating the catch among more nets, the crew's ability to handle the gear increases because the nets and doors are smaller for the same effective trawl sweep. (2) It is also believed that the double-rig trawling design increases the bottom line's linear contact with the substrate compared to the single-rig design. The second factor is also apparently important in the twin trawl design (Dave Harrington, personal communication).

Although there was some twin trawl experimentation by trawler owners in the South Atlantic states and in the northern Gulf of Mexico in the 1960s, not until recently did it gain the interest of the industry in the Southeast (Bullis and Floyd, 1972; Harrington, Bartlett, and Higgins, 1972). The increase in fuel costs, especially during 1973, has probably contributed to this recent interest. Prior to the drastic increase in fuel costs, shrimpers frequently repowered their vessels with larger engines or replaced the vessel with a larger, more powerful vessel in order to pull larger nets. The scarcity and high cost of capital in 1974-75 to finance such new purchases also encouraged shrimpers to evaluate the suitability of twin trawls as an alternative means of increasing linear contact of the net with the bottom. In the Carolinas and Georgia, the choice of increasing vessel size (length) and consequently horsepower has an additional disadvantage since many vessel owners like to maintain the alternative of fishing in the shallow estuarine and near-shore waters. In South Carolina, this particular phenomenon is reflected in the length and horsepower of resident vessels (Tables 1 and 2). Many vessels (Table 1) are less than 69 feet in length, with about 59% between 40-59 feet. The twin trawl may represent an additional alternative for trawler owners for increasing the vessel's fishing power without concurrently increasing capital needs.

During 1973 and early 1974 South Carolina trawler captains made such frequent requests of the Sea Grant Extension Advisory Program for twin trawl information that a demonstration was arranged. In May, 1974, the trawler *Captain Gene*, owned by the University of Georgia, conducted a demonstration of twin trawls for shrimpers at four South Carolina ports. Subsequently, meetings were held with captains to explain net designs and show a film which included scenes of the gear operating underwater. The demonstrations and meetings were held to provide enough information about various aspects of the gear that each captain could decide on its usefulness in his particular operation. In 1974, only one captain invested capital and time in twin trawls following the meetings. Apparently, three factors were at work: (1) captains had received sufficient information and rejected its use in the near future, or (2) the meetings and demonstrations were imperfect substitutes for a full scale commercial test, and 3) undoubtedly the financial losses during the 1974 shrimp season increased the reluctance of owners to risk new gear experimentation then. That year produced losses ranging from $6,658 to $13,610 per trawler (Roberts, 1975).

Table 1. Registered length of double-rigged shrimp trawlers licensed as resident South Carolina owners during fiscal year July 1, 1974, to June 30, 1975

Length Class (Feet)	Number	Percent	Accumulated Percent
19 and less:	1	.3	.3
20-29:	8	2.9	3.2
30-39:	29	10.7	13.9
40-49:	81	29.8	43.7
50-59:	78	28.7	72.4
60-69:	55	20.2	92.6
70-79:	16	5.9	98.5
80-Greater:	4	1.4	99.9

Prior to the 1975 shrimp season, the president of the South Carolina Shrimpers Association identified, via a request for a commercial test, that the second factor was responsible. The commercial demonstration would fit the industry's learning profile by permitting shrimpers to teach other shrimpers.

Table 2. Reported horsepower of double rigged shrimp trawlers licensed as resident South Carolina owners during fiscal year July 1, 1974, to June 30, 1975

Horsepower (Class)	Number	Percent	Accumulated Percent
69 and less:	7	2.6	2.6
70-119:	39	14.4	17.0
120-149:	16	5.9	22.9
150-164:	27	10.0	32.9
165-189:	77	28.4	61.3
190-279:	49	18.1	79.4
280-399:	45	16.6	96.0
400 and Greater:	11	4.1	100.1

PROCEDURE

The demonstration was conducted with nets designed by the two captains participating and purchased by the Sea Grant Extension Marine Advisory Program. The participating captains thought the twin trawl was best suited to the brown shrimp fishery from mid-June to mid-August. A demonstration to isolate the merit of the gear was designed as follows: (1) A trawler with low horsepower, comparatively slow towing speed, and restricted outrigger length was equipped with the twin trawl gear. Such boats are numerous in South Carolina and have comparatively few means of increasing productivity. (2) The catch of the boat equipped with the twin trawl was compared with that of a standard double-rig trawler. (3) The two vessels trawled the same area for equal periods. (4) One captain controlled, when both trawlers were shrimping, the fishing time and duration of the trip. (5) Weekly reports on the productivity of both trawlers were provided.

This procedure tended to equalize stock availability, captain's skills, and productive fishing time in order to focus on the gear's performance. Although Chleborowicz (1974) evaluated the twin trawl's benefits in North Carolina from an engineer's standpoint, he made no attempt to eliminate the effects of captain's skills, number of trips, and area fished.

Two captains from Shem Creek near Charleston, South Carolina, agreed to assume the risk of working the gear during the brown shrimp season and to conform to the above procedure. The *South Seas*, a 56-foot trawler with a 180-horsepower engine and 36-foot outriggers, was the test boat. During brown shrimp season it would normally pull 60-foot two-seam nets. The *South Seas* worked under the direction of Wally Shaffer, Jr., captain of the comparison vessel, *Carol El*. The *Carol El* is a 70-foot trawler with 325 horsepower which during brown shrimp season pulls 75-foot two seam nets. The authors assume that the *Carol El* has a higher fishing power compared to the *South Seas* due to its higher horsepower.

RESULTS RELATING TO GEAR EFFICIENCY

The *South Seas* and *Carol El* conducted the demonstration from June 28, 1975 to August 22, 1975 on grounds between the north jetty of Charleston harbor and Capers Island. The specifications of the two-seam twin trawls with which the demonstration began are shown in Table 3. The nets were designed and built locally to acquaint local net builders with the design and to attract their attention to the demonstration. The towing speed of the *South Seas*, while faster than that experienced with conventional 60-foot two seam nets, was not up to expectations. One of the four nets was modified to specifications shown in Table 3 and compared for productivity to a net with the original design. There being no production differential, the remaining nets were similarly modified. After these modifications the towing speed on the *South Seas* increased to that of the larger *Carol El*. Apparently the reduced webbing decreased the hydraulic drag of the net.

Two minor adjustments which were made in early July had a significant beneficial effect on the ease with which the gear was worked. The four doors were 5 feet by 30 inches with 3/4 by 6-inch runners. Initially the concern was whether or not two such doors would spread the twin 33-foot nets. Excessive spread was experienced as evidenced by the inside doors tangling frequently behind the vessel in spite of adjustments made in the towing cable's length. Paint was sprayed on the inside doors after each adjustment to identify the degree of success. After several trials, "windows" were cut in the inside doors to achieve a 25% reduction in surface area. A second adjustment proved successful in correcting a minor but aggravating problem. A highly buoyant line with a plastic float attached was used between the bags to prevent the bag straps from becoming tangled in the chaffing gear.

The second net modification indicated in Table 3 occurred in the last week of August. White shrimp began to comprise most of the catch at the end of the third week in August. The captains modified the wings in one of the nets and

Table 3. Specifications for two-seam nets used in Sea Grant twin trawl demonstration, 1975

Item	(footrope length: 33ft., 1 ¾ inch mesh, 12 thread twine) Original	Modification #1	Modification #2*
Top body	275 meshes	240 meshes	240 meshes
Bottom body	257 meshes	216 meshes	180 meshes
Taper (top & bottom)	2:1	3:1	3:1
Body depth	200 meshes	150 meshes	150 meshes
Top corner	50 wide, 55 long 20 jib.	40 wide, 55 long 20 jib.	22 wide, 55 deep 20 jib.
Bottom corner	30 wide, 75 long 20 jib.	20 wide, 75 long 20 jib.	22 wide, 75 deep 20 jib.
Bag	120 meshes	95 meshes	95 meshes

*Essentially this is an 80 mesh wing at 2:1 taper from where the body sews to the end of the corner.

added more floats in an effort to improve capture of white shrimp. This proved to be unsatisfactory. Although the nets were removed from the *South Seas* on August 27, the data in the economic presentation to follow ends with the termination of the brown shrimp "season." This "season" was defined by industry simply as the emergence of white shrimp as the majority of the catch, i. e., August 22, 1975.

RESULTS RELATING TO ECONOMIC CONSIDERATIONS

The determination of production relationships and the specification of relevant variables in the production process is a passion of firm management-oriented economists. No attempt was made to make the demonstration previously described into a tightly controlled research project on production relationships. To do so would have dampened industry interest in conducting the demonstration as a means of self education. As it turned out, the shrimpers had designed the demonstration to isolate the performance of the twin trawls separate from stock availability, fishing time, and skill of the captains involved. This does not fully satisfy the econometrician whose job it is to statistically test production hypotheses based on cross section or time series data. The demonstration did not provide such data but did generate useful information. The shrimper as a decision-making businessman is concerned about the components of a particular decision and their associated dollar amounts. To this information he will naturally apply his own preference function for risk and discount rate.

Information on fuel consumption, gear costs, days fished, and weekly catch was collected on the two trawlers for both the 1974 and 1975 brown shrimp season. Table 4 indicates the results of the 1975 demonstration and the previous year's shrimp catch. In 1975, the twin trawl equipped *South Seas* surpassed its 1974 performance with two conventional 60-foot two-seams (Table 4): (1) For

Table 4. Comparison of productivity of twin trawls during May 28 – August 22, 1975, Sea Grant demonstration

	South Seas	Carol El	Total
1974			
days fished	43	43	86
catch (lbs)	11,773	22,514	34,287
1975			
days fished	43	43	86
catch (lbs)	8,438	12,300	20,738

Notes:

1. South Seas - Carol El comparison: 1974, 11,773 lbs. ÷ 22,514 lbs. = 52%; 1975, 8,438 lbs. ÷ 12,300 lbs. = 69%
2. 1974 versus 1975 individual comparison: South Seas, 8,438 lbs. ÷ 11,773 lbs. = 72%; Carol El, 12,300 lbs. ÷ 22,514 lbs. = 55%
3. South Seas production as percent of total: 1974, 11,773 lbs. ÷ 34,287 lbs. = 34%, 1975, 8,438 lbs. ÷ 20,738 lbs. = 41%

the same period in each year with an equal number of trips, the *South Seas* reached 52% of the *Carol El's* production in 1974 and 69% of the *Carol El's* production in 1975. (2)While production fell between 1974 and 1975 for identical fishing effort for both trawlers, the *South Seas* produced 72% of what it had in 1974, while the *Carol El* reached only 55% of its 1974 production. (3) If one were to view the two boats as a unit owned by one captain, a relevant comparison would be that the *South Seas* produced 34% of the trawlers' total catch in 1974 and 41% of the combined catch in 1975.

The partial budgeting technique will enable a dollar estimate of twin trawl feasibility based on the information available. A partial budget is used to generate decision information that concerns only one part of the business, e. g., the brown shrimp season. Essentially the technique involves combining cost and production information on the contemplated change in the business. The total pluses and minuses are compared to reveal a net benefit or cost. Cost information for the analysis is presented in Table 5. For comparison purposes the partial budget is arranged to simulate the choice facing a captain as to the feasibility of purchasing new twin trawls or conventional two seams. The partial budget for the decision to equip the *South Seas* and similar boats with twin trawls or conventional two seams is as follows: (1) Increased costs? (The cost of the twin trawl gear) $ 2,947.50 (2) Decreased costs? (The cost of conventional two seams) $ 1,926.75 (3) Increased receipts? (Twin trawl production, 8,438 lbs., at $1.44 per lb. heads off) $12,150.72 (4) Decreased receipts? (Conventional two seam production in 1975, if proportional to 1974 catch, 6,396 lbs., at $1.44 per lb. heads off)[2] $9,210.24 (5) Potential gross benefit is decreased cost *plus* increased receipts: $1,926.75 + $12,150.72 = $14,077.47 (6) Potential gross debit is increased cost *plus* decreased receipts: $2,947.50 + $9,210.24 = $12,157.74 (7) Net benefit: $14,077.47 – $12,157.74 = $1,919.73.

[2]Assumes the *South Seas'* production compared to the *Carol El's* production in the 1975 period of study would have been the same as in 1974 (52%) if conventional two seams were fished in 1975 (.52 X 12,300 lbs. = 6,396 lbs.).

Table 5. Twin trawl and conventional gear costs for brown shrimp fishing in Charleston, South Carolina, May 1975

Item	Twin Trawl Quantity	Twin Trawl Cost	Conventional Quantity	Conventional Cost
Nets	5*	$1,897.74	2	$1,146.89
Doors	4	559.94	4	713.86
Dummy sleds	2	189.90	0	-
Cable (ft.)	500†	205.00	0	-
Chain (ft.)	152	75.92	120	66.00
Miscellaneous (splices, thimbles)	–	19.00	0	-
Total		$2,947.50		$1,926.75

*A spare net was built to facilitate testing of modifications. It is recommended that the five net approach be adopted commercially.

†Necessary for middle bridle on twin trawls.

The net benefit of using the twin trawls during this 7-week period of 1975 was $1,919.73. The implication from this demonstration and partial budget is that twin trawls will pay their way. If the assumption cited in footnote 2, although plausible, fails to please the puritanical, the information can be arranged in another manner. A comparison of the costs of the two gear types reveals that twin trawls would require additional initial investment of $1,020.75. With the average brown shrimp price for the June to August 1975 period for 41- to 55-count sizes in Charleston being $1.44 per pound, the break even catch is approximately 710 pounds. Thus, 710 pounds more shrimp would have to be landed for the same effort if the additional investment were to be repaid in one season. Captains expect the useful life of nets to be at least two seasons on the shrimp grounds in South Carolina. Consequently, the increased catch necessary, at 1975 prices, to pay the additional cost of the twin trawl gear would be approximately 710 pounds.

SUMMARY

The demonstration reported in the paper was a blend of Sea Grant Extension expertise and native intelligence provided by industry participants. The need evolved from extension work over an 18-month period. The demonstration would not have been successful without the problem specification phase. Industry participants focused on gear efficiency improvements and economic feasibility consideration. The gear and economic findings of the demonstrations suggest increased use of twin trawls on similar boats for brown shrimp in South Carolina.

LITERATURE CITED

Bullis, Harvey R., and Hilton Floyd.
1972. Double-rig twin shrimp-trawling gear used in Gulf of Mexico. *Marine Fisheries Review 34 (11-12)*: 26-31

Chleborowicz, Arthur G.
1974. Evaluation of twin-trawl shrimp fishing gear. North Carolina State University, *Sea Grant Publication UNC-SG-74-10* (Addendum), December, 1974: 14 pp.

Harrington, David L., Martin R. Bartlett, and James Higgins.
1972. Shrimp fishing with twin trawls. University of Georgia, *Marine Extension Bulletin No. 1*, Nov. 1972. 6pp.

Marinovich, Steve, and Richard T. Whiteleather.
1969. Gulf of Mexico shrimp trawls. Current trends in design and prospective developments in DeWitt Gilbert,ed. The future of the fishing industry of the United States. *University of Washington Publications in Fisheries*, New Series, Volume 4, 1968: 176-181.

Roberts, Kenneth J.
1975. Marine Business Aid Sheets Nos. 1-4, South Carolina Sea Grant Extension Marine Advisory Program, Charleston, South Carolina.

Seidel, Wilber R.
1969. Design construction, and field testing of the BCF electric shrimp-trawling system. *Fishery Industrial Research 4 (6)*: 213-231.

Abundance and Potential for Fisheries Development of Some Sardine-like Fishes in the Eastern Gulf of Mexico[1]

EDWARD D. HOUDE
Division of Biology and Living Resources
Rosenstiel School of Marine and Atmospheric Science
University of Miami
Miami, FL 33149

ABSTRACT

A survey of eggs and larvae of sardine-like fishes was carried out in the Eastern Gulf of Mexico from 1971 to 1974 to determine adult biomass of these fishes and to evaluate their potential yield to commercial fisheries. The aggregate spawning biomass of sardine-like fishes was approximately 1.1 million metric tons during that period. Thread herring (*Opisthonema oglinum*) biomass averaged 241,000 metric tons; scaled sardine (*Harengula jaguana*) biomass averaged 184,000 metric tons; and round herring (*Etrumeus teres*) mean biomass was 379,000 metric tons. No estimates were obtained for Spanish sardine (*Sardinella* spp.) biomass, but it may be about 250,000 metric tons. The menhaden (*Brevoortia* spp.) resource apparently is small in the Eastern Gulf and its biomass was not estimated. The potential, maximum sustainable harvest of all sardine-like species on an annual basis likely does not exceed 525,000 metric tons from the Eastern Gulf of Mexico.

INTRODUCTION

Sardine-like fishes are abundant in the Eastern Gulf of Mexico. Catches of these fishes could add significantly to the Gulf menhaden fishery, and thus make valuable contributions to fishmeal and oil production in the United States. Among species that have been considered in this respect are thread herring *(Opisthonema oglinum)*, Spanish sardines *(Sardinella* spp.*)*, scaled sardines *(Harengula jaguana)*, and round herring *(Etrumeus teres)*. The thread herring, in particular, was thought to have good potential for fisheries development (Bullis and Carpenter, 1968; Fuss, Kelly, and Prest, 1969; Klima, 1971; Wise, 1972). However, there were no reliable estimates of stock size for any of these fishes in the Eastern Gulf of Mexico.

The Sea Grant program at the University of Miami began investigating the sardine-like (clupeid) stocks in the Eastern Gulf during 1971. Surveys of clupeid eggs and larvae were carried out from 1971 through 1974, the major objective being to obtain estimates of adult spawning stock and to determine fishery potential. I gave an earlier report on those surveys in which I justified the technique, gave background information on survey development, and made some preliminary stock estimates (Houde, 1973). Fishery-independent stock estimates, obtained from egg and larvae surveys, have proved to be a good technique

[1]This paper is a contribution from the Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Florida 33149.

for obtaining biomass estimates. Estimates within an order of magnitude of true stock size, when no fishery exists from which extensive biological or catch-effort data can be obtained, are possible using this method. Other objectives of the surveys were to determine spawning areas and spawning seasons for the various species, and to investigate the biology of early life stages.

METHODS

Survey methods and data summaries for the 17 cruises were recently published (Houde, et al., in press). Houde (1973) also outlined methods used to collect fish eggs and larvae to obtain abundance estimates. A total of 867 plankton collections was made using double oblique tows of a 61-cm paired Bongo net sampler with 505-μm and 333-μm mesh nets. The sampling area ranged from the 10-m to the 200-m depth contour (nearshore to more than 230 km offshore) in the Eastern Gulf. Most stations were located inside the 50-m contour (Fig. 1). Station data for each cruise have been tabulated and charts illustrating positions of each station have been drawn (Houde, et al., in press). Seasonal abundances of fish eggs, fish larvae, and zooplankton volumes from 1972 to 1974 cruises were illustrated on contour charts (Houde and Chitty, in press).

Estimates of annual abundance of spawned clupeid eggs were obtained to determine adult biomass. Saville (1964) and Ahlstrom (1968) have discussed the rationale that allows the relationship between number of spawned eggs and adult standing stock to be determined. In addition to estimates of spawned eggs it is necessary to know the relative fecundity (eggs spawned per g of body wgt) and the sex ratio of the stock. I determined relative fecundities from gonad analyses and assumed that sex ratios were one to one. My estimates of annual spawning were obtained from the plankton collections, using techniques similar to those described by Sette and Ahlstrom(1948) and Smith (1972). Estimating errors are large using these techniques, but I believe that my standing stock estimates of adult thread herring, scaled sardines, and round herring will be useful to predict potential for fisheries development of these stocks.

RESULTS

Stock estimates were obtained for thread herring, scaled sardines, and round herring. I was not successful in obtaining stock estimates for Spanish sardines and made no attempt to estimate menhaden biomass in the Eastern Gulf. Menhaden eggs and larvae were uncommon in our plankton collections, leading me to believe that the biomass is small in this area. Spanish sardine eggs and larvae were common but the possibility of two species being present, the inability to define the spawning season, and difficulty in estimating relative fecundity made it impossible to estimate stock size.

Thread Herring

Thread herring spawn during the spring and summer months in the Eastern Gulf. The season probably extends from April through August over most of this

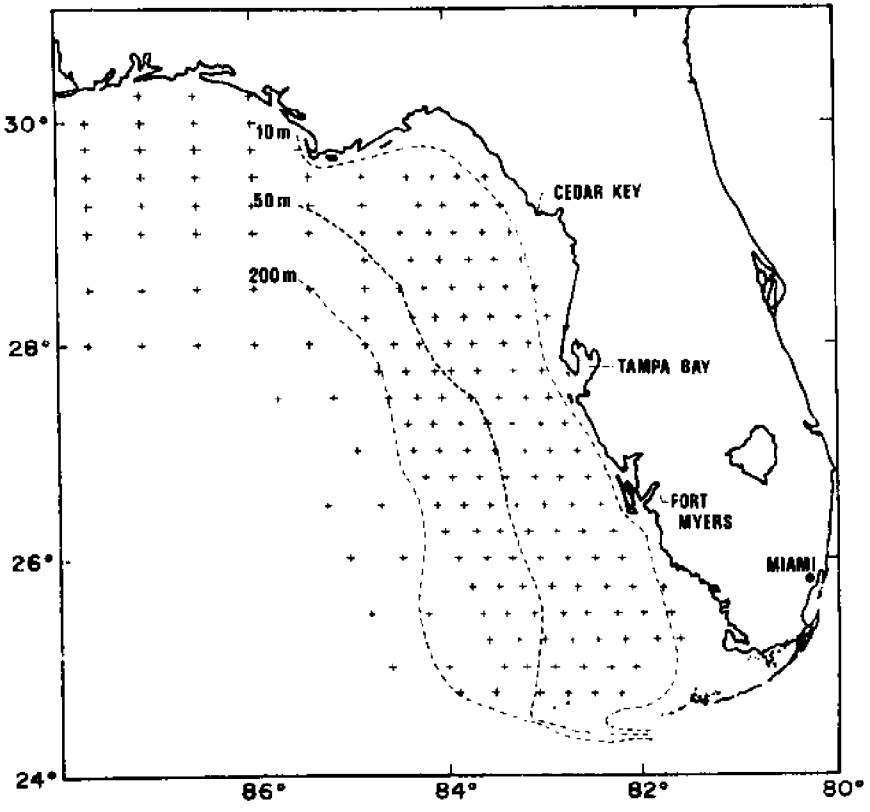

Figure 1. Sampling area and stations for Gulf of Mexico ichthyoplankton cruises from 1971 to 1974.

area, but some spawning may occur as early as February in the southeastern sector. This corresponds well with the spawning season reported by Fuss, et al. (1969) who determined the spawning season from examination of gonad development in adult thread herring from the Eastern Gulf of Mexico. I collected eggs when sea surface temperature ranged from 22.5 to 30.5 °C. Most spawning occurs within 30 miles of the coast and virtually all spawning is within 60 miles of the shore. The distribution and abundance of eggs for June-July 1973 is illustrated in Figure 2. Spawning was most intense between latitudes 26°00'N and 28°00'N (Ft. Myers to Tampa Bay). Egg distribution data indicate that the biggest part of the adult spawning population is located there during the spring and summer months. Kinnear and Fuss (1971) reported north-south migrations by thread herring in the Eastern Gulf. They found schools migrating north in spring and south in fall, presumably in response to changing temperature conditions. Such migrations must occur, but it seems apparent from my egg and larvae distribution data that a large part of the population remains in the Ft. Myers-Tampa Bay area even in the summer months.

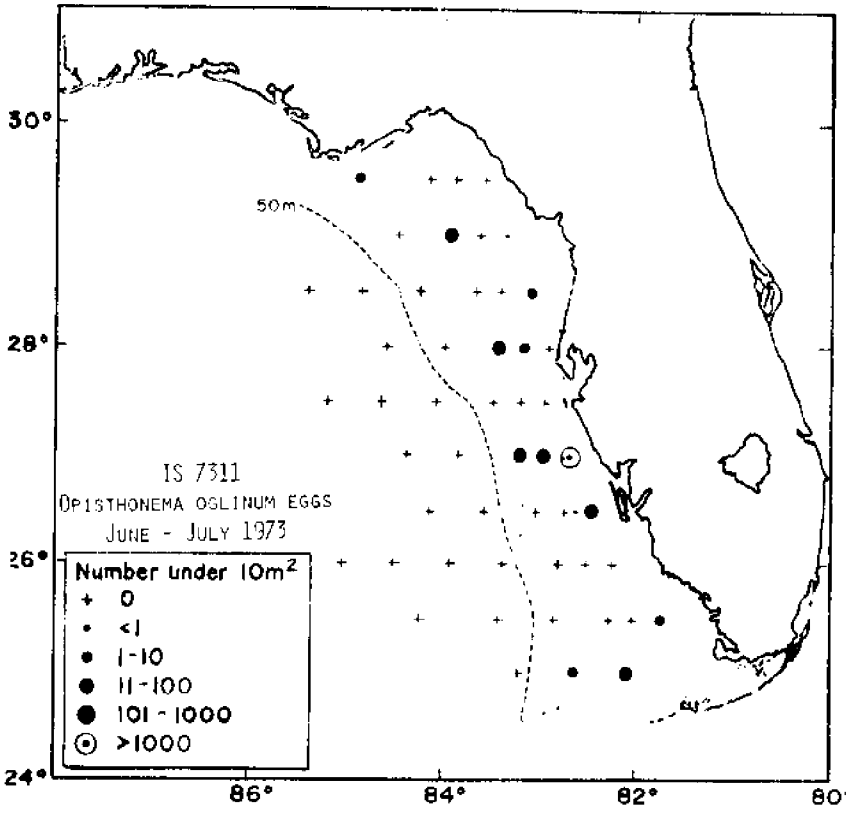

Figure 2. Distribution and abundance of thread herring *(Opisthonema oglinum)* eggs during June-July 1973 in the Eastern Gulf of Mexico.

Estimates of thread herring egg abundance were obtained for 1971, 1972, and 1973 (Table 1). The annual spawning estimates ranged from 14.1×10^{12} to 110.6×10^{12} eggs. Biomass estimates, based on eggs spawned, ranged from a low of 47,000 metric tons (m.t.) in 1972 to 372,000 m.t. in 1973. The 1972 estimate almost certainly is a poor one because Hurricane Agnes interrupted the one cruise scheduled at the peak of the thread herring spawning season in June of that year. The mean biomass estimate for 1971 and 1973 (Table 2) is 241,000 m.t.

The estimates that I have obtained are only for adult stock. It is possible that some part of the juvenile stock of thread herring, and also of other clupeids, could contribute to the fishable stock in the Eastern Gulf. The fishable biomass may be greater than the adult biomass if fish less than one year old (less than approximately 130 mm in length) are acceptable to a fishery. However, it seems unlikely that the fishable stock of thread herring on Florida's west coast could have exceeded 450,000 m.t. from 1971 to 1973.

Table 1. Estimates of annual spawning and adult biomass for three species of clupeid fishes from the Eastern Gulf of Mexico.

SPECIES	YEAR	EGGS SPAWNED ($\times 10^{12}$)	BIOMASS (metric tons)
Thread Herring	1971	32.4	109,000
	1972	14.1	47,000
	1973	110.6	372,000
Scaled Sardines	1971	4.1	16,000
	1972	39.1	148,000
	1973	102.6	387,000
Round Herring	1971-1972	111.0	718,000
	1972-1973	19.4	131,000
	1973-1974	42.5	287,000

Scaled Sardines

Scaled sardines spawn during spring and summer in the Eastern Gulf. The spawning season apparently begins in March and continues through August. A few eggs and larvae were collected in a February cruise in 1971, south of latitude 26°00'N, indicating that some spawning occurs during winter in the southernmost part of the survey area. I believe that spawning prior to March is negligible compared to that in April through August. Scaled sardine eggs were collected when surface temperatures ranged from 21.0 to 31.0°C. They were most abundant within 20 miles of the coast, where water depth was less than 20 m. There was no single area on the Florida west coast where spawning was observed to be most intense.

Distribution and abundance of eggs in the May 1974 cruise (Figure 3) reflect the nearshore occurrence of this species. In that cruise several stations were sampled where water depths were only 4 to 10 m; these stations were located closer to shore than any in previous survey cruises. Biggest catches of scaled sardine eggs were made at those stations; mean abundance there exceeded mean abundance at regular stations by a factor of 1.85. I believe that scaled sardine eggs were undersampled during most of the survey cruises because our stations were too far offshore. This could have resulted in an underestimate of scaled sardine biomass, perhaps by as much as 30%. There was no evidence, based on the May 1974 cruise, that eggs of other clupeid species were more abundant nearer to shore than at our regular stations.

Scaled sardine annual spawning estimates ranged from 4.1×10^{12} eggs in 1971 to 102.6×10^{12} eggs in 1973 (Table 1). The apparent increase in spawning between 1971 and 1973 probably is real and may represent a recovery of this population from the severe red tides of 1971 in coastal areas of the Eastern Gulf. Adult biomass estimates ranged from a low value of only 16,000 m.t. to a high of 387,000 m.t. (Table 1). Mean biomass for the 3 years is 184,000 m.t. If the stock was underestimated by as much as 30%, because of undersampling, then the mean estimate might be as high as 263,000 m.t.

Table 2. Estimated potential yields of three species of clupeid fishes from the Eastern Gulf of Mexico. Estimated yields are given for three possible levels of M, the natural mortality coefficient.

SPECIES	MEAN BIOMASS ESTIMATE (metric tons)	ESTIMATED MAXIMUM SUSTAINABLE YIELD (metric tons)		
		M=0.50	M=0.75	M=1.00
Thread Herring*	241,000	60,250	90,375	120,500
Scaled Sardines	184,000	46,000	69,000	92,000
Round Herring	379,000	94,750	142,125	189,500
Aggregate Potential Yield		201,000	301,500	402,000

*1971 and 1973 data only.

Round Herring

Round herring spawn during the cooler months in the Eastern Gulf. Eggs were collected from November to May; peak spawning took place during January and February. Eggs were present when surface temperatures ranged from 18.5 to 26.5°C but most were collected when surface temperature was less than 25°C. Fore (1971) reported spawning by this species from December to March in the Northern Gulf of Mexico, mostly between the 25- and 110-m depth contours. Eggs were collected in our survey at stations between the 30- and 200-m contours, but most were found where depth was less than 100 m. The distribution and abundance of eggs in January 1973 are illustrated in Figure 4. Some spawning probably occurred beyond the limits of the survey area, but the major part of the adult population is found on the continental shelf between 100- and 200-km offshore. There were two areas of intense spawning. The more important of these was west of Tampa Bay (27°30'N to 28°30'N) and the second area was north of Dry Tortugas (25°00'N to 25°30'N, 82°00'W to 82°30'W) (Fig. 4).

Total eggs spawned during three seasons were estimated. In 1971-1972, the estimate was 111.0×10^{12} eggs, in 1972-1973 it was 19.4×10^{12} eggs, and in 1973-1974 it was 42.4×10^{12} eggs (Table 1). Adult biomass estimates corresponding to those egg estimates were 718,000 m.t., 131,000 m.t., and 287,000 m.t. The mean estimate for the three spawning seasons was 379,000 m.t. Although the estimates are not very precise it is apparent that a large stock of this species is present in the Eastern Gulf.

FISHERY POTENTIAL

Aggregate biomass of thread herring, scaled sardines, and round herring, based on the sum of the three mean estimates, is 814,000 m.t. In addition, the stock of

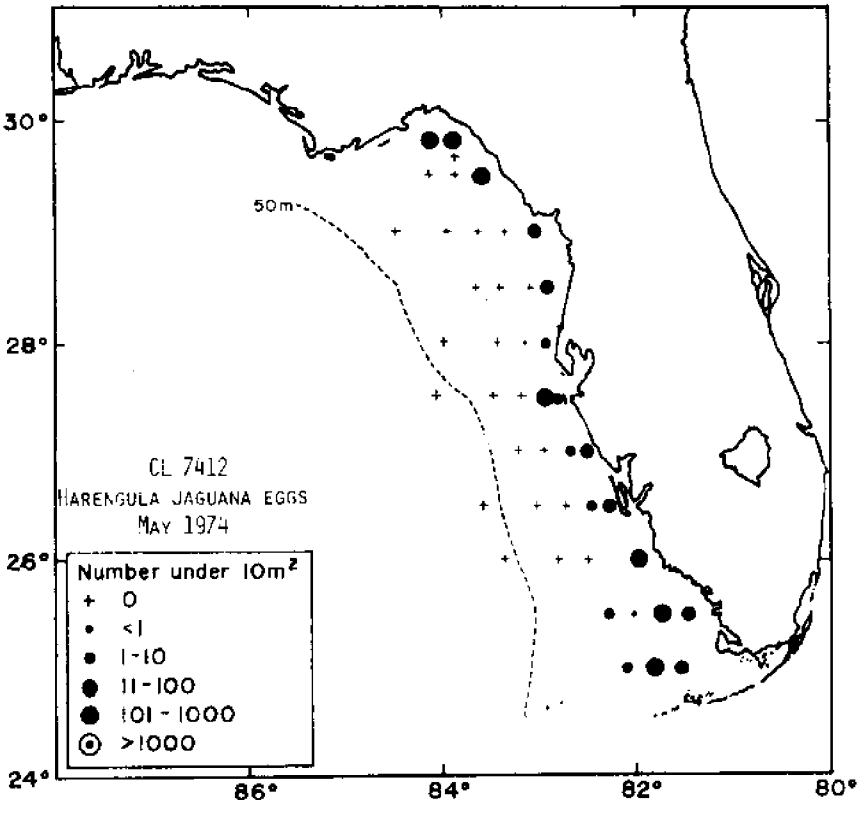

Figure 3. Distribution and abundance of scaled sardine *(Harengula jaguana)* eggs during May 1974 in the Eastern Gulf of Mexico.

Spanish sardines must be large, perhaps about the same size as the thread herring stock. If the Spanish sardine adult stock is 250,000 m.t., then the aggregate clupeid biomass is about 1,100,000 m.t. in the Eastern Gulf. Menhaden biomass apparently is small, but it would contribute some additional amount to the stock estimate.

A preliminary estimate of potential annual yield can be obtained from the biomass estimates using a technique proposed by Alverson and Pereyra (1969) and Gulland (1971 and 1972). They proposed that a potential yield estimate could be obtained from the relationship,

$$C_{max} = X M B_0$$

where

C_{max} = maximum sustainable yield
X = 0.5, the fraction of initial stock size at which maximum sustainable yield can be obtained

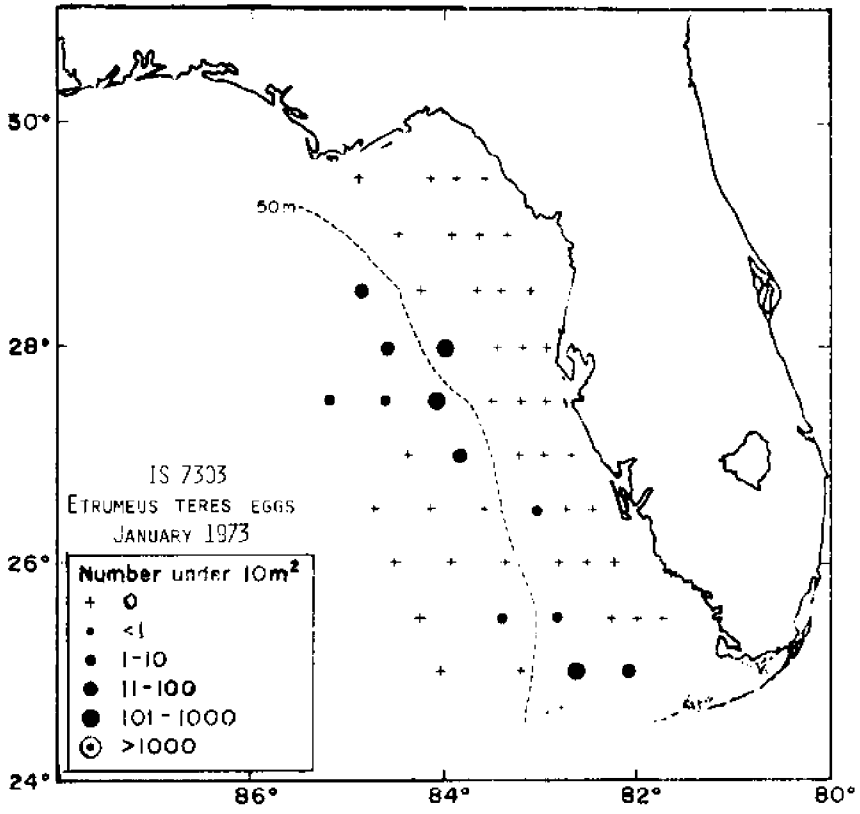

Figure 4. Distribution and abundance of round herring *(Etrumeus teres)* eggs during January 1973 in the Eastern Gulf of Mexico.

M = the instantaneous rate of natural mortality

B_0 = the initial stock size (i.e., the virgin biomass)

My mean estimates of stock size can be assumed to approximate the virgin biomass because none of the stocks is significantly exploited. No estimates of M are available for any of these stocks. Because they are virtually unexploited, M ≅ Z, the total mortality coefficient. Total annual mortality of subtropical and tropical clupeid species is high, M often being in the range 0.50 to 1.00 (e.g., Beverton, 1963), which corresponds to annual mortality rates of 39 to 63%. Setting M equal to 0.50, 0.75, and 1.00, I have calculated the potential annual yields for thread herring, scaled sardines, and round herring (Table 2). Estimated total aggregate potential yield ranges from 201,000 to 402,000 m.t.; none of these species seems capable of supporting a fishery exceeding 200,000 tons on an annual basis. If Spanish sardine biomass is 250,000 m.t., they could contribute from 62,500 to 125,000 m.t. to the annual yield, raising the total aggregate yield to a maximum of about 525,000 m.t.

The mortality coefficient (M or Z) could be higher than the values that I have used in Table 2. Short-lived fishes with life spans of from 3 to 5 years might be expected to have M values exceeding 1.00 (Tanaka, 1960). If this is true for any of the Eastern Gulf clupeid stocks, then my estimates of potential yield are too low. For example, if life span is 4 years, then M would equal approximately 1.15, and my yield estimates should be increased by 15%. Good data on age structure and mortality rates of the Eastern Gulf clupeid stocks need to be obtained in future research on these fishes.

CONCLUSIONS

A large potential fishery resource is present in the Eastern Gulf that likely could support a 500,000 m.t. annual yield. Although none of the stocks seems as abundant as Gulf menhaden in the Northern Gulf of Mexico, in aggregate Eastern Gulf clupeids must total more than 1,000,000 m.t. A legal ban on purse seining, excepting baitfishing, within 3 leagues of the west Florida coast and a lack of knowledge of availability of fish are constraints on development of these fisheries. The purse seine ban makes it impossible to harvest scaled sardines, and a large part of the thread herring population also is inaccessible. Round herring and much of the Spanish sardine resource are located offshore but may be unavailable to standard purse seining techniques. Unless there is a combination of change in Florida law and advances in fishery technology, the latent clupeid resources in the Eastern Gulf may remain undeveloped for many years.

ACKNOWLEDGMENTS

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LITERATURE CITED

Ahlstrom, E.H.
1968. An evaluation of the fishery resources available to California fishermen. Univ. Wash. Publ. Fish. n.s. 4: 65-80.

Alverson, D.L. and W.T. Pereyra.
1969. Demersal fish explorations in the northeastern Pacific Ocean – an

evaluation of exploratory fishing methods and analytical approaches to stock size and yield forecasts. J. Fish. Res. Bd. Canada 26: 1985-2001.

Beverton, R.J.H.
1963. Maturation, growth and mortality of clupeid and engraulid stocks in relation to fishing. Rapp. Proces-verb. Cons. int. perm. Explor. Mer 154: 44-67.

Bullis, H.R., Jr., and J.S. Carpenter.
1968. Latent fishery resources of the central West Atlantic region. Univ. Wash. Publ. Fish. n.s. 4: 61-64.

Fore, P.L.
1971. The distribution of the eggs and larvae of the round herring, *Etrumeus teres*, in the Northern Gulf of Mexico. ASB Bull. 18: 34.

Fuss, C.M., Jr., J.S. Kelly, Jr., and K.W. Prest, Jr.
1969. Gulf thread herring: aspects of the developing fishery and biological research. Proc. Gulf Carib. Fish. Inst. 21: 111-125.

Gulland, J.A.
1971. The fish resources of the ocean. Fishing News (Books) Ltd., Surrey, England. 255 p.

———
1972. The scientific input to fishery management decisions. Univ. Wash. Publ. Fish. n.s. 5: 23-28.

Houde, E.D.
1973. Estimating abundance of sardine-like fishes from egg and larval surveys, Eastern Gulf of Mexico: preliminary report. Proc. Gulf. Carib. Fish. Inst. 25: 68-78.

———,S. Berkeley, J. Klinovsky, and C. Dowd.
(in press). Ichthyoplankton survey data report. Summary of egg and larvae data used to determine abundance of clupeid fishes in the Eastern Gulf of Mexico. Univ. Miami Sea Grant Tech. Bull. 32.

——— and N. Chitty.
(in press). Seasonal abundance and distribution of zooplankton, fish eggs and fish larvae in the Eastern Gulf of Mexico. NOAA Tech. Rep. NMFS SSRF.

Kinnear, B.S. and C.M. Fuss, Jr.
1971. Thread herring distribution off Florida's west coast. Commer Fish. Rev. 33(7-8): 27-39.

Klima, E.F.
1971. Distribution of some coastal pelagic fishes in the Western Atlantic. Commer. Fish. Rev. 33(6): 21-34.

Saville, A.
1964. Estimation of the abundance of a fish stock from egg and larval surveys. Rapp. Proces-verb. Cons. int. perm. Explor. Mer 155: 164-170.

Sette, O.E. and E.H. Ahlstrom.
1948. Estimation of abundance of the eggs of the Pacific pilchard *(Sardinops caerulea)* off southern California during 1940 and 1941. J. Mar. Res. 7: 511-542.

Smith, P.E.
1972. The increase in spawning biomass of northern anchovy, *Engraulis mordax*. Fish. Bull., U.S. 70: 849-874.

Tanaka, S.
1960. Studies on the dynamics and the management of fish populations. Bull. Tokai. Reg. Fish. Res. Lab. 28:1-200.

Wise, J.P.
1972. Gulf and South Atlantic fisheries. Commer. Fish. Rev. 34(3-4): 9-12.

Aquarium Fish Hobby: Its Impact on the Economy and Environment of Southern Florida

C. RICHARD ROBINS
Division of Biology and Living Resources
Rosenstiel School of Marine and Atmospheric Science
University of Miami
Miami, FL 33149

The purpose of this paper is to call attention to a fishery that exists for tropical marine fishes for use in aquaria. Like other fisheries there are both recreational and commercial aspects, the recreational fishery being represented by those persons who go into the field to collect fishes for their own use, the commercial fishery being represented by those who sell their catches in local or distant markets. Unlike most fisheries, the gear employed is essentially the same in recreational and commercial fishing. Some may doubt or question that such fishes qualify as commercial fishes, but certain species may be sold for $20-$30 apiece in northern markets and the total value per year runs into many millions of dollars in return to the fishermen alone. Obviously these are fishes of considerable value.

I have recognized for some time that some basic conflicts were arising that inevitably would lead to legislation and control of the fishery. The difficulty is that viable statistics are unavailable and, in fact, are not now being kept, a very poor basis for initiating legislation. Also, legislation concerning most fisheries is initiated by state and federal agencies. Municipalities may act to close areas to fishing but do not alter the basic fishing law. The fishery for marine tropical fishes is subject to control at all levels and control is being initiated at the local level without state guidelines. The aquarist attempting to capture fish for his home aquarium may soon encounter a bewildering array of laws as he seeks his fish from one locality to another along our coast.

It is my hope to gather data on this fishery and to encourage the state in its efforts to this end with the aim of seeing a position paper prepared on the topic for presentation to the Florida Chapter of the American Institute of Fisheries Research Biologists for approval and publication. The aim is to provide needed guidelines and to prevent unnecessary or undesirable legislation.

This preliminary report is to describe the problems as I see them and to call for accumulation of proper data by which the fishery can be evaluated, particularly with regard to the following: (a) biological impact of the fishery; (b) economic value of both recreational and commercial aspects of the fishery to Florida; (c) social conflicts; (d) miscellaneous matters such as educational needs, forums whereby aquarists can discuss the problem with agency officers (both state and federal), the need for basic bological studies on the major fish species and an assessment of available biological knowledge of all fishes of present or potential value in this regard.

THE NATURE OF THE FISHERY

Types of Fishes

A wide variety of fishes are sought including gobies (Gobiidae*), sleepers (Eleotridae), blennies (Blenniidae, Clinidae), demoiselles (Pomacentridae*), angelfishes (Pomacanthidae*), butterflyfishes (Chaetodontidae*), fairy basslets (Grammidae*), grunts (Pomadasyidae), soldierfishes (Holocentridae), sweepers (Pempheridae), goatfishes (Mullidae), topminnows (Cyprinodontidae). In all, several dozen families and more than 100 species are involved, though the number most intensively fished and traded in Florida is currently about 50. In the list above, those with an asterisk include the species most often sold commercially and exported to northern markets. Most of the species are short-lived, with a life span of one to several years and with a rapid population turnover. None is an endangered species and the nature of the fishery is such that none is going to be threatened by either recreational or commercial aspects of the fishery. The situation in Florida is not to be compared to southern California (especially Catalina Island) where small populations (outposts) of fishes more common to the south are subject to intense collecting activity. Garibaldis *(Hypsypops rubicunda)*, for example, are highly visible, brightly colored fish and their removal from a cove or section of coast, though not endangering the species, does detract from the general scene. California has a narrow, steep rocky shore and shelf, and thus the fishing effort is concentrated in a much smaller zone than in Florida.

Gear

The gear used in the fishery is varied. Some collectors use small dip nets (over very fine mesh) and jars and rely on their deftness to capture prey. Others employ a variety of slurp guns; essentially suction tubes of clear plastic with a pistol-grip release and an attached container into which the prey is tumbled. Chemicals are used to stun fish which then are recovered, and placed quickly in good water in a jar. Chemicals are expensive and are employed in small amounts (a few cubic centimeters at a time) through a squirt bottle. They are particularly successful for hole-dwelling species. Such applications do not affect surrounding areas and are not an environmental problem. The State of Florida Department of Natural Resources has been studying this problem and the results of their studies should soon be available (Edward Joyce, personal communication).

Location of the Fishery

Almost all of Florida's coastline is involved in this fishery but the major effort is from Palm Beach (where the nearness of the warm Florida Current to the shore provides suitable temperature for tropical species) through the Florida Keys. Elsewhere in the United States, most activity is in Hawaii and California but fishes are caught along most of the eastern seaboard in the summer when lenses of Gulf Stream water bring juveniles of tropical fishes into coastal waters.

Even in Florida the populations of some species north of the Keys are temporary, being established each summer as the water warms and disappearing during cold winters when the temperature drops suddenly. Why should not an ephermeral resource of this type be utilized?

Conflicts and Value

Conflicts between the fishery and other groups that use the same environment exist under certain circumstances. Collecting activity of any sort is not compatible with the purposes of underwater trails which are set out for the education and enjoyment of those who want to dive and observe or photograph but not collect. Such areas are very limited. In these and other limited high-use areas, collecting activities can be distracting and local areas can be depopulated, reducing the value of these areas to other users.

Whereas most fishermen purchase tackle and bait, those who collect marine tropicals purchase swimming and diving gear, tanks, air, etc. A club outing can take up many motel rooms. Food is purchased and boats are rented, so the impact in an area especially during slack periods in tourism can be considerable. Data on numbers of man hours spent in collecting, and dollars spent for transportation, room, board, boat and gear rental, and other merchandise are needed, and the collection of such data should be undertaken by the clubs themselves so that they can demonstrate effectively to the state the economic value of their activity. Data on numbers, kinds, and dollar value of fishes caught are essential and the State of Florida Department of Natural Resources apparently already is working to this end. With regard to the commercial end of the fishery, estimates of taxes received from the state from fish sales, and the value of the fishery to the transportation industry are needed. Tropical fishes comprise a major item of air transport in Florida though probably only a small percentage of this involves marine tropicals collected in Florida.

Finally I emphasize that I have discussed only fishes. Problems involving the collection of coral and other invertebrates and especially the collection of live mollusks for their shells involve a different set of problems and coral collecting, in particular, can be extremely damaging to the environment.

CONCLUSIONS

1. The collection of marine tropical fishes for personal use and sale constitutes a *bona fide* fishery.

2. The fishery does not involve species important to other fisheries nor does it involve endangered or threatened species.

3. The fishery has no impact relative to the biological success of any fish species.

4. Information is needed relative to the economic impact in Florida of both recreational and commercial aspects of the fishery. Man days, dollars spent on food and lodging, boat and gear rental, and the purchase of aquarium products are all relevant to this impact.

5. Information is needed and is currently being acquired by the Department of Natural Resources relative to the effects of chemicals on coral and on the fishes collected.

6. Regulation is required only where there are direct conflicts between this fishery and other recreational uses such as nature trails and underwater photography. Except for such areas, there is no *a priori* basis for excluding this fishery from state and national parks and monuments or reserves.

Progress toward Management of the Atlantic Bluefin Tuna [1]

GRANT L. BEARDSLEY
and
FREDERICK H. BERRY

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Center
Miami, FL 33149

The Atlantic bluefin tuna *(Thunnus thynnus thynnus)* is a wide ranging, long lived species, and a popular and important multiple-use resource. Over its broad range it is the object of a variety of sport and commercial fisheries, both long term and recently derived. In recent years, concern about severe declines in catches in many fisheries has been followed by international recommendations and the United States' actions to manage and conserve this resource. This report outlines Atlantic bluefin tuna management progress that has been made in the U.S. through November 1975. This progress is discussed under three categories: Regulations and Management, Catch Statistics, and Research.

All tonnage weights in this report are in short tons; short tons x 0.90718 = metric tons.

REGULATIONS AND MANAGEMENT

International

International action to manage has come from the International Commission for the Conservation of Atlantic Tunas (ICCAT), formed in 1969. The U.S. is one of 15 member countries. At its November 1974 meeting, ICCAT modified and adopted a U.S. proposal that became effective 10 August 1975 as an ICCAT recommendation. This recommendation specified two actions: (1) that taking and landing of Atlantic bluefin tuna less than 6.4 kg (14 lbs) should be prohibited (with incidental catch tolerances), and (2) that fishing mortalities be limited to recent levels for 1 year. This recommendation was extended for an additional 2 years at the November 1975 meeting of ICCAT.

In the western North Atlantic, meetings were held early in 1974 and 1975 between representatives of the U.S. and Canada regarding management of Atlantic bluefin tuna. Unilateral action resulted from each country, as catch restriction recommendations in 1974 and regulations in 1975.

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1 Contribution Number 449, Southeast Fisheries Center, Miami Laboratory, National Marine Fisheries Service, NOAA, Miami, FL 33149.

United States

No regulations or recommendations that would restrict the catch of Atlantic bluefin tuna existed for U.S. waters prior to 1974. The 1974 catch restriction recommendations for U.S. fishermen were based on gear type by area, and are summarized as follows:

Cape Cod and north -- Based on giant tuna, usually heavier than 300 lbs, the purse seining quota was set at 225 short tons (ca 675 fish); "other commercial" catches at a quota of 250 short tons (ca 750 fish); sport fishing with no quota but a tag-and-release recommendation.

Mid-Atlantic U.S. -- Based on small or school tuna, usually weighing less than 115 lbs, the purse seining quota was set at 1200 tons, and minimum and maximum sizes of 14 and 115 lbs; sport fishermen with a bag limit set at one fish per angler per day, and minimum and maximum sizes as for purse seiners.

These recommendations were published for the National Marine Fisheries Service in the Federal Register (24 June 1974). They were not widely publicized except to purse seine operators. Our interpretations of their effects are discussed under the section on catch statistics.

The State of Massachusetts adopted regulations in 1974 to limit the catch of giant bluefin in waters off Massachusetts. These required the advance licensing of fishermen and the reporting of all bluefin landed in Massachusetts. No other states actively participated in Atlantic bluefin tuna regulation during 1974 and 1975.

In early 1975, proposed regulations for the taking of bluefin were published in the Federal Register (2 April 1975, 18 April 1975). These were prepared in anticipation of the possible listing of the bluefin as a threatened species under the Endangered Species Act of 1973. This action was abrogated by subsequent federal legislation that established the Atlantic Tunas Convention Act of 1975, Public Law 94-70. The President signed this Act into law on 5 August 1975. The Act and its regulations became effective upon publication in the Federal Register (13 August 1975). Its apparent effects on the 1975 fishing season are discussed under the section on catch statistics. The catch restrictions were based primarily on catch quotas by weight ranges and gear types. They are outlined in Table 1.

Weight Restrictions

The U.S. regulations supported the ICCAT recommendation to prohibit the taking of bluefin less than 14 lbs round weight (fish less than 2 years old). These younger tuna are very susceptible to over-fishing, and this catch restriction will help increase the catches of larger bluefin. The U.S. regulations further prohibited the taking of bluefin between 115 and 300 lbs (the weight class referred to as mediums). This weight class, presumably representing direct recruitment to the spawning stock, apparently has been severely reduced by fishing and has been relatively rare in U.S. catches in recent years. Tolerances were permitted, however, (as incidental catches) for taking these two weight classes by two kinds of gear only. Purse seine vessels fishing for Atlantic bluefin between 14 and 115

Table 1. Outline of ICCAT recommendations and of U.S. regulations for taking Atlantic bluefin tuna under the Atlantic Tuna Convention Act of 1975 (Public Law 94-70), by weight class and gear type

WEIGHT (LBS)	ICCAT RECOMMENDED CATCH LIMITS	U.S. BLUEFIN TUNA REGULATIONS (P.L. 94-70)			
		PURSE SEINE	ANGLING (ROD & REEL)	HAND GEAR (HARPOON, HAND LINE)	INCIDENTAL (not fishing for bluefin tuna)
< 14	NO CATCH	TOLERANCE (15% in number or 4% in weight, included in total)	TOLERANCE (1 per angler, per day, included in total)	NONE	TOLERANCE (2% of total weight of other fish per trip; per 30 days for traps)
14-115	LIMITED (restricted fishing mortality to recent levels)	1,100 TONS	4 per angler, per day	NONE	TOLERANCE (2% of total weight of other fish per trip; per 30 days for traps)
115-300	LIMITED (as above)	TOLERANCE (15% in number or 4% in weight, included in total)	TOLERANCE (1 per angler, per day, included in total)	NONE	TOLERANCE (2% of total weight of other fish per trip; per 30 days for traps)
> 300	LIMITED (as above)	200 TONS	2,250 BLUEFIN TUNA (no more than 200 of these from South of Chatham, Massachusetts)		TOLERANCE (2% of total weight of other fish per trip; per 30 days for traps)

lbs were allowed tolerances beyond these limits not to exceed either 15% of the total number or 4% of the total weight taken on any one trip. Persons angling for bluefin between 14 and 115 lbs were allowed to take one larger and one smaller fish per day. In addition, persons or vessels fishing for species other than bluefin (with any gear) were allowed to incidentally take bluefin of any size that did not exceed 2% of the total catch per trip (per 30 day period for traps).

Quotas

The total quotas for weight categories by gear type are given in Table 1. A special provision for bluefin greater than 300 lbs stipulated that no more than 200 of the total quota (2,250) could be taken south of a line extending from the entrance to Chatham Harbor, Massachusetts, east into the Atlantic Ocean. Bluefin of any size that were taken as incidental catches were included in their respective weight-gear class quotas, where applicable.

Seasons

The season for catching bluefin by all allowable kinds of gear was opened on 1 January 1975, although the regulations did not become effective until 13 August 1975. The purse seine quota for school tuna had already been exceeded when the regulations became effective, and the season was closed when the

regulations were published in the Federal Register. The season for purse seining for bluefin greater than 300 lbs was closed on September 22 by notice in the Federal Register (September 24) after the catch of the last set exceeded the quota. The season for fishing for bluefin greater than 300 lbs by other than purse seining (essentially by hand gear) was closed on September 16, by publication of this closure notice in the Federal Register (September 12). There was no closed season for angling for bluefin between 14 and 115 lbs.

Enforcement

The 1975 regulations became effective late in the fishing season. There was one incident of enforcement arrest (where a vessel was apprehended for purse seining after that season closed). One state participated in enforcement through a NMFS contract to make late and post season boat patrols off Rhode Island. NMFS enforcement personnel made late and post season cutter patrols (with the Coast Guard) and air patrols in Cape Cod Bay, and checked dealers, processors, markets, and air freight companies in New York and New England.

CATCH STATISTICS

Although some catch statistics of Atlantic bluefin tuna landed along the northeastern U.S. have been recorded since 1947, total numbers, weights, and most of the specific size and gear records prior to 1975 are fragmentary and incomplete. A major effort of the Southeast Fisheries Center Miami Laboratory toward management of the Atlantic bluefin tuna has been to improve catch statistics. Records for 1975 are more comprehensive and complete than any prior year, but further improvements are needed. The catch records are discussed under seven categories: purse seine for school tuna, purse seine for giant tuna, sport fishing for school tuna, hand gear fishing for giant tuna, traps, other gear catches of school tuna, and other gear catches of giant tuna. Total U.S. catch estimates and records by gear type and general fish size for 1973, 1974, and 1975 are given in Table 2. U.S. catch estimates for regulated weight classes by different gear types for 1975 are given in Table 3.

Purse Seine for School Tuna

Fishing by U.S. purse seiners in 1973 was unrestricted.

The 1974 catch was 13% less in total weight than in 1973, and was 27.5% less than the recommended catch quota. Two factors promoted this lower catch: (1) most purse seine captains voluntarily restricted their catches of the relatively abundant one-year-old age group, and (2) availability of older fish was limited by their relative scarcity and bad weather.

The 1975 catch by U.S. vessels was 72% higher than mandated by the 1975 quota. Only about 10% of the total number of bluefin landed were 1-year-old fish, weighing less than 14 lbs. With the exception of 58.1 tons, the entire U.S. catch for 1975 was made prior to August 13 when the regulations became

Table 2. U.S. catches of Atlantic bluefin tuna for 1973, 1974, and 1975, by gear type for general fish size in numbers of fish and weight in short tons (Estimated values are followed by an asterisk)

GEAR TYPE	1973 CATCH	1974 CATCH	1975 CATCH
Purse seine	1,000 tons	870 tons	1891.47 tons
(school tuna)	–	–	161,427 tuna*
Sport angling	?	206 tons*	128.07 tons*
(school tuna)	?	45,000 tuna*	16,860 tuna†
Purse seine	321 tons	53 tons	303.04 tons
(giant tuna)	–	167 tuna	1,068 tuna‡
Hand gear	686 tons*	543 tons*	780.17 tons*
(giant tuna)	2,056 tuna§*	1,500 tuna‖*	2,336 tuna††
Traps	22.7 tons*	12.2 tons*	7.91 tons
	48 tuna*	49 tuna‡‡*	48 tuna§§
Other incidental	?	?	2.23 tons*
	?	?	20 tuna‖‖*
Totals	2,029.7 tons	1,684.2 tons	3,112.89 tons
			185,227 tuna

† includes 35 ABT of 3.07 tons, each between 115 and 300 lbs; excludes ABT greater than 300 lbs

‡ includes 32 ABT of 1.48 tons, each less than 115 lbs

§ minimum size or weight not known

‖ minimum weight is 115 lbs

††includes 5 ABT of 0.57 tons, each between 115 and 300 lbs

‡‡includes 16 tuna of 0.31 tons, each 14-115 lbs; one tuna of 0.075 tons, of 115-300 lbs; and 32 tuna of 11.8 tons, each greater than 300 lbs

§§includes 8 ABT of 0.07 tons, each less than 14 lbs; includes 16 ABT of 0.48 tons, each between 14 and 115 lbs

‖‖ includes 15 ABT of 0.63 tons, each between 14 and 115 lbs

effective. The 1975 fishery began in late June, and 9 U.S. and 2 Canadian seiners participated.

Purse Seine for Giant Tuna

Despite concentrated efforts by one purse seiner in Cape Cod Bay during September 1974, the catch was relatively low, only 24% of the recommended quota.

Table 3. U.S. catches of Atlantic bluefin tuna during 1975 by four weight classes for different gear and fishing types, in short tons and numbers of fish (numbers are beneath tons and in italics)

GEAR TYPE	WEIGHT-CLASS				TOTALS
	< 14	14-115	115-300	> 300	
Purse seine (school tuna)	67.06 *15,779*	1822.0 *145,614*	2.41 *34*		1891.47 *161,427*
Purse seine (giant tuna)	–	1.48 *32*	2.26 *19*	299.3 *1,017*	303.04 *1,068*
Sport angling (school tuna)	55.4 *12,064*	69.6 *4,761*	3.07 *35*		128.07 *16,860*
Hand gear (giant tuna)	–	–	0.57 *5*	779.6 *2,331*	780.17 *2,336*
Traps	0.07 *8*	0.48 *16*	0.06 *1*	7.3 *23*	7.91 *48*
Incidental		0.63 *15*		1.6 *5*	2.23 *20*
Totals (tons) Totals (numbers)	122.53 *27,851*	1894.19 *150,438*	8.37 *94*	1,087.8 *3,376*	3112.89 *181,759*

Two purse seiners fished for giant bluefin in Cape Cod Bay in September 1975, and caught 303 tons, 51% greater than the quota. Fifty-one of the 1,068 tuna caught were smaller than 300 lbs round weight (5% of the total number, 1.2% of total weight).

Sport Catch of School Tuna

Prior to 1975, no reliable statistics are available on the sport catch of small bluefin tuna along the mid-Atlantic coast of the U.S. In 1975 contracts were negotiated with Adelphi and Rutgers universities to conduct a detailed survey of the bluefin tuna catch off New Jersey and New York. The total estimated catch of bluefin tuna by sport fishermen in 1975 is estimated at about 17,000 fish. About 78% were landed in New Jersey and 15% in New York. Seventy-one percent of the catch consisted of fish less than 14 lbs.

In the restricted category for 115-300 lb bluefin, where a tolerance of only one per angler per day was allowed, there were no apparent major violations. Only about 80 fish of this weight range were caught by sport fishermen in 1975 (about 0.5% of the total number caught). We noted from our survey records that the bag limit of four tuna per angler per day was exceeded in a relatively few instances, and on trips where bluefin were caught, the average number of bluefin caught per angler per trip was less than one.

Hand Gear Catches of Giant Tuna

The principal areas of capture of giant bluefin tuna by harpoons, hand lines, and rod and reel in the U.S. are from Cape Cod Bay through Maine. Relatively few have been landed south of Chatham, Massachusetts, in recent years. Records of these catches have been kept for Cape Cod Bay and vicinity since 1947. Adequate catch records for most other areas were not obtained prior to 1975. In 1974, the State of Massachusetts kept records for that state, and the National Marine Fisheries Service attempted to obtain and compile the numbers and sizes landed in other states. In 1975, the National Marine Fisheries Service assumed responsibility for maintaining catch records from all areas.

There was little compliance by fishermen with the recommended quota for 1974. We recorded an estimated 1,500 bluefin landed in the U.S. in the weight category of 115 lbs and greater with total weight estimated at 543 tons.

In 1975, the National Marine Fisheries Service attempted to maintain an updated total of giants (greater than 300 lbs) landed in the U.S. during the fishing season so that the season could be closed when the 2,250 quota was caught. Our estimate of 2,000 giants caught as of September 10 was the basis for the decision to close the fishing season for giants at 0001 hours on September 16. Obviously the within season estimate was low. Only 46 giants were recorded as landed during September 11 through 15, and our current recorded catch of 2,359 giants is 4.8% higher than the quota set, although 5 of these giants are known to have been caught after the season closed. Of this total recorded catch, only 2,331 were caught by hand gear. An additional 28 giants from incidental catches (see below and Table 3) were added to the total, as required by the regulations.

Only 46 giant bluefin were recorded as landed south of Chatham (Louisiana to Rhode Island) in 1975. This was only 23% of the 200 giant quota allotted for that area.

Hand gear caught only 4 bluefin weighing between 115 and 300 lbs north of Chatham in 1975 (all by harpoon). South of Chatham about 80 of these fish were caught (all by rod and reel).

The flow of these economically valuable giant bluefin from catching vessel to their ultimate destination is often diverse or indirect (including landings, dealers, processors, truck drivers, transport boats, and airplanes). Sampling catches at various sites and from various sources frequently produced duplicate records of individual fish. To ascertain these duplications, we determined that the minimum data needed were: date caught or landed, name of catching vessel, captain's name, landing name, dealer or other destination, and weight (round or dressed). We attempted to obtain all of these items, as well as kind of gear used, from all giants landed in 1975, and we were successful in obtaining all 7 of these items for about 10% of the total recorded catch.

Traps

Catches by stationary fish traps have been declining in recent years. We know of only three sites with traps that caught bluefin in 1975. At Narrangansett Bay a single day's trap catch produced 12 bluefin weighing a total of 159 lbs. The trap at Chatham caught 1 bluefin of 19 lbs. In Provincetown, where traps have been catching bluefin for about 65 years, two traps caught 35 bluefin weighing a total of 15, 716 lbs between July 24 and October 20. Catches of bluefin weighing less than 300 lbs at the Provincetown traps for the last 3 years (in percentage of total catch by number and by weight, respectively) were: 1973, 17 and 2.6%; 1974, 35 and 3%; 1975, 34 and 6.6%.

Other Gear Catches of School Tuna

We received reports that in 1975 school tuna were landed by commercial gill-net boats, swordfish longline boats, and offshore lobster boats using hook and line. Accounts of the numbers and sizes of tuna caught by these methods are as yet fragmentary, but we suspect that they probably amount to less than 5% of the total number caught by sport fishermen.

Other Gear Catches of Giant Tuna

We have records of only 5 giant bluefin caught by other gear in 1975 (2 each by longline and paired trawl and 1 by dragging).

RESEARCH

Research activities have concentrated on several important aspects of the biology and population dynamics of Atlantic bluefin tuna. One of the initial problems facing any rational management scheme is the accurate determination of the number of stocks in the North Atlantic. There is firm evidence from tagging that trans-Atlantic migrations do occur in some years. Based on this evidence ICCAT has recommended that for the present the North Atlantic be treated as having a single stock of bluefin. We are attempting to make a more accurate determination of stock definition in the Atlantic. Studies on morphometrics and meristics, for example, reveal significant differences between eastern and western Atlantic specimens. Western Atlantic bluefin have a greater number of pectoral fin rays, a longer second dorsal, and in juveniles, a greater number of gill rakers. These studies suggest that more than one stock exists in the North Atlantic, and work is continuing to expand and refine these analyses. We are also examining the use of biochemical techniques for stock identification and some preliminary work on western Atlantic samples has been completed.

We are also placing a great deal of emphasis on age and growth studies. The last important analysis on age and growth of bluefin was done in 1960 and the techniques used may have been somewhat subjective.

In 1974, two reports summarized recent efforts to improve aging techniques. These utilized the rings (presumed to represent annuli) on both vertebrae and otoliths, with otoliths providing the more promising results. In general these studies showed two important things: (1) Giant Atlantic bluefin tuna live longer than previously believed. An otolith of a fish believed to be 27 years old has been examined, while a previous maximum age of 18 years (based on scale

interpretation) had been reported. (2) Giant Atlantic bluefin tuna of one age may be of quite variable size (in body length and in weight), so that the size ranges of fish of different ages may overlap appreciably.

The Southeast Fisheries Center Miami Laboratory is currently refining aging techniques for Atlantic bluefin tuna. We collected samples of vertebrae from approximately 1,300 fish and otoliths from about 750 fish of various sizes caught along the northeast U.S. in 1975. From these, a tentative age structure analysis is planned for completion during 1976.

One of the most important tasks in the Atlantic Bluefin Tuna Program is an analysis of the population dynamics of Atlantic bluefin and an annual assessment of the status of stocks. New analyses are being conducted utilizing the method of cohorts and treating the North Atlantic as both a single stock system and as one containing both an eastern and western stock. Considerable emphasis is also placed on providing sound scientific data for use in determining catch quotas for the U.S. fishery and for making allocations of catch between the various fisheries. We are continuing our tagging work in cooperation with Woods Hole Oceanographic Institution, and these studies provide us with estimates of annual mortality rates and allow us to monitor the status of the immature stocks as they move through the purse seine fishery.

Other studies include new estimates of the fecundity of western Atlantic bluefin, new analyses on the spawning distribution and spawning seasons, larval abundance estimates, aerial surveys of the spring migration of spawning and post-spawning adults past the western edge of the Bahama Banks, and an analysis of the sex distribution among the various fisheries on both sides of the Atlantic.

SUMMARY

Progress was made in 1974 and 1975 toward effective management of the stock or stocks of Atlantic bluefin tuna. Efforts and interest related to this goal, both international and within the U.S., continue to increase.

Although the estimated total catch increased in 1975, (ca 55% over 1973 and 87% over 1974), it obviously would have been much higher without the application of the Atlantic Tuna Convention Act of 1975 late in the 1975 bluefin fishing season. The catch for these years is less than half of the catch of a peak year such as 1963 when 6,361 tons were taken by purse seine alone.

Although the estimated 1975 U.S. catch of bluefin tuna less than 14 lbs appears excessive, it is only about 17% of the estimated 138,000 bluefin tuna of that size caught by purse seine alone off the U.S. in 1966.

There are indications that various provisions of the Act will be modified for 1976 to more effectively conserve, to make optimum use of the resource, and to more equitably partition the harvest to the various user groups. Results from improved catch statistics and expanding research on the biodynamics of the Atlantic bluefin tuna will contribute to this.

LITERATURE CITED

Federal Register.

1974 (June 24). Atlantic bluefin tuna study and certain other actions. 39(122): 22444-22445.

———————.

1975 (April 2). Atlantic bluefin tuna. Proposed "threatened" status. 40(64): 14767-14768.

———————.

1975 (April 2). Atlantic bluefin tuna. Threatened species–fish. 40(64): 14777-14778.

———————.

1975 (April 18). Atlantic bluefin tuna as a threatened species. Hearing. 40(76): 17302.

———————.

1975 (August 13). Atlantic tuna fisheries. 40(157): 33978-33981.

———————.

1975 (September 12). Atlantic tuna fisheries. Bluefin tuna season closure. 40(178): 42384.

———————.

1975 (September 24). Atlantic tuna fisheries. Bluefin tuna season closure. 40(186):43916.

Outline for a Southeastern Region Recreational Fishery Program Development Plan

ROBERT CUMMINS, JR.
National Marine Fisheries Service
Southeast Fisheries Center,
Miami, FL 33149

In 1973 the National Advisory Committee on Oceans and Atmosphere recommended development of a National Plan for Marine Fisheries of the United States and suggested that it be done by the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce. The Plan subsequently was developed, and by 1975 a draft had been reviewed by more than 3,000 commercial and recreational fishermen in public and private meetings, state and federal fishery administrators, officers and directors of fishing organizations, representatives of environmental and recreational groups, and scientists from academic and agency organizations. The Plan proposed specific recommendations to move fishery agencies toward achievement by 1985 of broad goals related to the national interest in marine fisheries and provides guidelines for developing national and regional recreational fishery Program Development Plans (PDP).

A large and increasing number of people depend on marine fisheries for relaxation and pleasure. The livelihood of many others depends on the business and jobs generated by recreational fishermen. Therefore, any national or regional plan for fisheries must include plans for development, enhancement, and protection of marine recreational fisheries. This PDP attempts to broadly identify program areas necessary to support fisheries management in the Southeast Region and thereby allow state agencies and other constituents to relate to the proposed NMFS regional recreational fisheries program.

A 1974 NMFS contract survey estimated that about 5.7 million residents of New York and the New England states participated in marine recreational fishing and shellfishing during the 12 months ending June 1974. Since these states contain about 18% of the saltwater anglers in the U.S., the nationwide total is probably over 30 million marine recreational fishermen.

A NMFS survey estimated that over nine million saltwater anglers[1] harvested nearly 1,600 million pounds of edible finfish in 1970. This recreational harvest was about equivalent to U.S. commercial landings of edible finfish the same year. The 1970 recreational catch, if sold as commercial landings, would have been about $244 million (ex-vessel price paid to fishermen). The ex-vessel value of domestic commercial landings of edible finfish was about $242 million in 1970.

[1]This estimate was limited to those anglers (1) over 12 years of age, (2) who spend more than 3 days or $7.50 pursuing the sport, (3) only those fishing for finfish, while the 1974 contract survey cited in paragraph 2 above included fishermen of all ages, anyone who went fishing one or more times and those who fished for shellfish.

Marine fishing also has a significant recreational value. During 1970 saltwater anglers spent an estimated $1,225 million while participating in marine recreational fishing activities, an amount almost 5 times the ex-vessel value of their catch. These expenditures by recreational fishermen have a large economic impact on coastal areas. For example, during 12 months ending October 1973, commercial saltwater recreational vessels, e.g. charter and party boats, received over $85 million in gross revenues from recreational fishermen. Although this is only a small fraction of the expenditures for marine recreational fishing, the income these boat operators received is equivalent in value to the fourth most valuable commerical fishery in the U.S.

The preceding statements documenting the significance of the marine recreational fisheries were based upon data collected during the few specialized surveys, e.g., 1960 and 1970 saltwater anglers survey, and special contract surveys, which have been conducted at infrequent, or irregular, intervals. Much of the information on marine recreational fisheries, e.g., number of participants, impact on resources, support in industries and attendant socio-economic factors, remains undocumented and is presently not available when legislation affecting fisheries is being considered.

The Department of Commerce vigorously sought responsibility and authority for marine recreational fishery activities in the 1970 Executive Reorganization. This authority was obtained, and NOAA accepted responsibility for implementing the Migratory Marine Game Fish Study Act of 1959. This Act authorized the development of conservation and constructive management policies for migratory fish of interest to recreational fishermen. NOAA was also assigned responsibility, under the Fish and Wildlife Act of 1956, to provide education and extension services relative to commercial and sport fisheries and generally to promote the wise use of the nation's marine fishery resources.

The lack of a coordinated national marine recreational fishery management program based on biological research and economic and social surveys has restricted NMFS involvement in recreational fisheries. The National Marine Fisheries Service should manage the nation's fishery resources for optimum benefits to the nation and give consideration to recreational and commercial fisheries in relation to their impact on fish stocks, the national economy and social structure. The principal role of NMFS in marine recreational fisheries must be to carry out and support effective management in cooperation with the states and other resource users. Management decisions to optimize the benefits from this nation's marine fishery resources must be based on facts pertaining to each resource and its users.

The regional, state-federal recreational fishery plan should provide a clear definition of roles and responsibilities required for the effective working relationships between and among states and the NMFS. Since most recreationally important fishes are found within state waters, each state should manage the fisheries occurring within its three-mile sea, with assistance or coordination from NMFS when two or more states participate in the same fishery. Federal involvement within the territorial sea should be primarily in the form of cooperative state-federal research and management programs. NMFS should be the lead

management agency where international stocks are involved. The nature of these state-federal relationships is expected to vary regionally according to the needs and interests of the states involved. The role of the NMFS Marine Recreational Fishery Program in offshore waters will be determined by the actual management authority delegated to NOAA/NMFS, and the state-federal institutional structure adopted under extended jurisdiction.

The National Plan for Marine Fisheries presently being refined broadly defines the issues requiring action in this nation's fisheries. The scope and magnitude of marine recreational fisheries require that NOAA/NMFS provide a program framework (PDP) within which national and regionally-oriented activities can be focused. In decisions concerning the nation's marine resources, marine recreational fishing cannot be given full consideration unless information on catch, effort, stock size, and relative species importance is available.

Management of marine fisheries requires the availability of adequate information concerning both commercial and recreational uses of the stocks involved. Catch and effort data generally have been available for most commercial fisheries, but not for recreational fisheries. Commercial catches are landed by a limited number of vessels at specific ports, and are sold to a limited number of buyers. Recreational fishery catches are landed by large numbers of unlicensed individuals at numerous and widely dispersed landing sites, and hence go unreported, except in some cases when recreational anglers sell all or parts of their catch. Therefore, to monitor catch, effort and economics of marine recreational fisheries, specialized methods are required. Participation of the state agencies in developing and implementing recreational fishery programs is essential.

NOAA/NMFS must identify the information needed to develop national and regional marine recreational fisheries policies and must provide the framework to acquire this information. Regional recreational fishery PDP's will be used to form the national PDP.

Recreational fisheries in the NMFS Southeast Region have a larger number of participants, a greater variety of fishing methods, a greater species diversity, and a larger potential for future development than the recreational fisheries in any other region. They interact with foreign and domestic fisheries. Most species range along the Atlantic or Gulf Coasts of the region and must be considered throughout their range. Extensive shallow estuaries are the principal geographic characteristic of the Southeast Region and many of the recreational species are dependent upon estuarine habitat during all or part of their life span.

This PDP outlines a regional undertaking with state and federal participants to manage coastal marine fisheries of concern to the recreational fishermen.

Certain fundamental information about a fishery stock is required before any attempt is made to manage the resource. The PDP is arranged in a logical sequence to obtain this information. Complete information is not required for management recommendations but a determination, to some degree of the following, is mandatory: (1) Identity and distribution of stock, (2) Age or size composition and reproductive age, (3) Catch and effort statistics, (4) Current status of stock size, and (5) Economic and social values.

The National Plan for Marine Fisheries presently being refined defines the issues requiring action in this nation's fisheries. The scope and magnitude of marine recreational fisheries require that research and management agencies agree upon a program framework (PDP) with a goal and objectives within which national and regionally-oriented recreational fishery activities can be focused.

The following goals and objectives provide for full consideration of marine recreational uses of these resources in the Southeast Region.

GOALS:

Conserve and Allocate Marine Fishery Resources and Habitats and Increase Recreational Satisfaction Derived from These Resources

Objective I A scientific data base for fishery management.

Program Area I A Obtain statistics on catch and effort of marine recreational fisheries.

I B Determine distribution, age or size composition, and age of maturity for each stock.

I C Determine the economic and social values of each stock.

I D Determine the status of stocks important to the recreational fisheries in the Southeast Region.

I E Determine habitat requirements for recreational fishes.

Objective II Designation and allocation of fishery stocks and habitats needing management by State, Federal and International agreements.

Program Area II A Determine the fish stocks that should be managed.

II B Establish criteria for and determine optimum yield for each stock.

II C Allocate the stocks for optimum yield and utilization by domestic fishermen, both commercial and recreational.

II D Provide criteria for fish habitat protection and enhancement to land use planners and regulatory agencies.

Objective III An informed recreational fishing constituency that participates in plans, programs and policies.

Program Area III A Establish a regional recreational fisheries coordinator.

III B Arrange State, Federal and Regional forums.

Objective IV Regulation of fish stocks and habitats by State, Federal and International controls.

Program Area IV A Establish regulations for resource allocation and habitat protection.

IV B Establish a permit and licensing system.
IV C Implement regulations.
IV D Measure and monitor the effects of regulations.

Objective V Increase satisfaction derived from recreational fishery resources.

Program Area V A Prepare and distribute information on identification and life history of target species.
V B Prepare and disseminate information on distribution and habits of target species.
V C Prepare and distribute information on use of target species.
V D Determine needs for access and means of increasing access to recreational fisheries.
V E Determine availability of access to recreational fisheries.
V F Increase access facilities where needed.
V G Determine the need for sanctuaries and preserves and, if needed, identify geographical areas.

Status Report of Florida's Research on Spiny Lobster Biology[1]

DALE S. BEAUMARIAGE and EDWARD J. LITTLE
Bureau of Marine Science and Technology
Florida Department of Natural Resources
Tallahassee, FL 32304

In recent months groups ranging in composition from commercial fishermen to representatives of national governments have been intensely discussing existing and proposed regulation of fisheries for *Panulirus argus*, the most valuable of the western Atlantic spiny lobsters. These dialogues illustrate that an understanding of the biology of an exploited fish stock is indispensable in evaluating management concepts. Thus it is timely to summarize existing knowledge of lobster biology, how this insight was obtained, and what remains to be learned.

Diverse and international sources have contributed to our present knowledge, but I will focus chiefly on highlights of research accomplished in Florida. Organizations such as the Florida Board of Conservation (now the Florida Department of Natural Resources), the University of Miami, the National Marine Fisheries Service (formerly the Bureau of Commercial Fisheries), the University of Florida Sea Grant Program, Florida State University, and the National Park Service have all contributed to the biology of larval, postlarval, juvenile, and adult segments of Florida lobster populations.

Important to assessment of the population dynamics of any species is the manner in which young or larvae are produced and ultimately recruited into the adult stock. This information was initially determined for Florida lobsters through research conducted from 1917 through 1920 by Crawford and De Smidt at the old Bureau of Fisheries Biological Station at Key West. Lobster copulation and fertilization were observed and fecundity of lobsters 76-mm to 100-mm carapace length was estimated to be from 500,000 to 700,000 eggs, respectively. Only females greater than 76-mm carapace length bore eggs. Although the flat, spider-like larvae were hatched, rearing was unsuccessful, the researchers finding that "the short embryonic development may predict a long larval life which may render artificial propagation a very difficult problem." This is still the primary obstacle that has confounded all attempts to rear Florida spiny lobster larvae to the juvenile stage.

Research at Key West provided the impetus for the first legislation protecting Florida lobster stocks. Beginning in 1920, commercial harvesting of lobsters was prohibited from the first day of March to the first day of June each year in an

[1]This is contribution number 267 of the Florida Department of Natural Resources Marine Research Laboratory.

effort to conserve brood stock. Despite this demonstration of promising potential of Key West lobster investigations, the facility was all but abandoned after 1920.

In 1944, Smith, Dawson, and Idyll of the University of Miami began comprehensive lobster studies for the Florida Board of Conservation. This research was supplemented by major contributions to larval and postlarval biology by Lewis in the early 1950s. As is true for other palinurids, larvae were shown to drift in the plankton for periods of 6 months or longer before developing into postlarvae. Thus, larvae hatched from Florida stocks were probably carried elsewhere by currents, leaving recruitment to Florida principally from Caribbean sources.

During the early 1960s, there was another great upsurge in research on larval lobsters and their method of recruitment. The Florida Board of Conservation, through the work of Ingle, Sims, and Witham, further demonstrated year-round transport of larvae to Florida via the Yucatan and Florida Currents. Significant retention of larvae spawned from Florida lobsters was again shown to be unlikely, as extensive plankton sampling from the Florida Keys to Stuart produced few larvae in intermediate stages of development. Most larvae taken were either newly hatched, or were late stage specimens. Principal influxes were at night on flood tides. Cultivation of larvae again proved futile, indicating that development might proceed only in oceanic offshore waters.

Although not readily justified from a replenishment basis, protection of egg-bearing female Florida lobsters (requested by the fishing industry) does give the resource a respite from harvesting and is undoubtedly beneficial. One of the principal benefits is as a regulatory example for responsible Caribbean lobster management programs. Also, a small percentage of Florida-spawned larvae may survive to replenish either Caribbean stocks or our own stocks through entrainment in fortuitously cycling currents.

Prospects for further successful exploration of spiny lobster larval biology are not encouraging. Deductions regarding length of the developmental period, factors that trigger metamorphosis, relationships to brood stock density, mortality, places of origin, transport routes, fate of Florida spawned larvae, and larval behavior, all must be based on examinations of larvae of known species identity. Methods for identification are currently unreliable. A bewildering variety of larval developmental stages of at least three similar species of *Panulirus* can be present in plankton samples, mitigating against positive identification of specimens. Cultivation of larvae of known parentage to determine characteristic species morphology has yet to be achieved. Some hope for new understanding of larval biology does however exist in the form of studies on larval transport presently being completed by the National Marine Fisheries Service Southeast Fisheries Center.

Although progress on larval studies may have reached an impasse, the outlook is bright for increased understanding of biology of the postlarval stage. In the early 1950s, recruitment of postlarvae and morphology of early juveniles were first described. Unfortunately, another decade passed before these investigations,

which had been begun by Lewis at Miami, were resumed. Witham, working for the Florida Board of Conservation, devised a floating artificial substrate which approximated the matted vegetation in which postlarvae were known to hide. This innovation greatly facilitated collection of postlarvae. By 1970, Witham, Sweat, and others had found that free swimming transparent postlarvae are recruited throughout the year into inshore nursery grounds, such as the Indian River and Florida Bay, chiefly at night during the interval between the new moon and first quarter moon.

The relationship of recruitment to subsequent lobster abundance, specific environmental factors determining success of postlarval recruitment, and the relationships between egg or larval production and postlarval abundance still need clarification. Research is being initiated now by the Florida Department of Natural Resources, with financial assistance from the National Marine Fisheries Service Federal Aid Office, to address some of these points. If true insight into recruitment can be realized, this information could be applied to forecasting changes in abundance of adult stock as well as to enhancing nursery ground survival of postlarvae and juvenile spiny lobster.

Although some of the principal elements of lobster behavior, growth, and migration were known by 1950, subsequent research has been directed at resolving these subjects in greater detail. Underwater study of lobster behavior by scuba diving has developed into a powerful new tool for this effort. These *in situ* observations have produced new insight into lobster migratory patterns and have shown that trap sampling of the structure of lobster populations may often be misleading. Previous tagging studies indicated that lobsters could travel up to 100 miles from the point of release. However, more recent taggings, coupled with underwater observations such as those of Davis and Herrnkind, revealed that most lobsters roam over rather small home ranges and seldom undertake more than local seasonal migrations.

Also essential to understanding lobster population dynamics is a thorough knowledge of growth and the relation between age and lobster size. Success in obtaining this information has been hindered. Growth cannot yet be accurately deduced from the progression of modal size frequencies because separation of the population into groups of known age is difficult. Possible year round recruitment, differential growth of juvenile groups recruited at different seasons, and variation in growth of individual lobsters may permit several age groups to comprise specific size classes. Past tagging studies have also been ineffectual in providing growth information because too few recaptures were available for remeasurement. Growth of captive lobsters should not be considered representative of growth of wild populations, so our present estimates of lobster growth must be extrapolated.

Monthly carapace length increases of juvenile lobsters average 3.0 to 5.0 mm for the first year of life after postlarval recruitment. Then, at carapace lengths of 40 to 50 mm, these juveniles leave the nursery grounds for deeper waters.

Growth slows, probably not exceeding an increase of 15-mm in carapace length per year. Approximately 3 years would thus be required for a postlarval lobster to reach the minimum legal exploitable carapace length of 76 mm.

The effects of fishing pressure on the structure of juvenile and adult stocks have been an important component of lobster research in Florida since the late 1940s. However, inadequate funding generally prevented the sampling of all fishery areas to acquire an accurate determination of age groups within the exploited population. Nevertheless, valuable observations have been made. The most notable of these are that in recent years, although total annual landings have remained constant, fishing pressure has caused a decline in the average individual size of lobsters landed. These observations indicate that the traditional inshore fishery in Florida is producing the maximum sustainable yield. Lobster measurements made in the late 1940s by Dawson and Idyll and in the early 1960s by Robinson and Dimitriou both showed modes at about 82-mm carapace length and only rather gradual decreases in abundance of larger lobsters. Measurements recently made by Warner and by Davis show that the mode has decreased to between 65 to 75-mm carapace length and that abundance of lobsters larger than 76 mm now declines much more sharply. In addition, most of the female lobster population now being harvested is thought to be comprised of size groups that have not yet had the first chance to reproduce. These studies also indicate that lobsters generally don't become vulnerable to the trap fishery until they have reached carapace lengths greater than 60 mm. Therefore, additional lobster sampling techniques must be used to gain a realistic picture of the entire population structure.

One very important aspect of lobster biology that has been almost completely ignored to date is assessment of lobster stocks in deeper waters or in other areas peripheral to the traditional inshore fishery. Lobsters have been found beneath the Florida Straits, on the continental shelf as far north as the Carolinas, and on the West Florida shelf. However, the distribution and commercial potential of stocks in such areas have yet to be determined. These stocks are of interest not only for establishment of alternative fisheries, but also for the information they might provide concerning lobster growth, migration, recruitment, and interaction with inshore populations. Florida Department of Natural Resources Executive Director, Harmon Shields, recently initiated an exploratory lobster fishing project to provide answers to some of these questions.

An area exceeding 2,000 square miles north of Dry Tortugas has just been surveyed. Bottom topography along the 50-fathom curve showing features which could harbor unfished lobster populations comprise over half of this vast area. Side scan sonar surveillance of the sediments conducted by the University of South Florida marine geologist Dr. Thomas Pyle constitutes the initial phase of this work. The next cruise of DNR's RV *Hernan Cortez* will utilize traps and an underwater TV camera provided by the National Marine Fisheries Service Miami Laboratory to intensify the search over similar promising bottoms for fishable stocks of lobsters.

BIBLIOGRAPHY

Austin, H.M.
1972. Notes on the distribution of phyllosoma of the spiny lobster, *Panulirus* ssp in the Gulf of Mexico. Proc. Nat. Shell. Assoc. 62: 26-30.

Chace, F.A., Jr., and W.H. Dumont
1949. Spiny lobsters-identification, world distribution, and U.S. trade. Comm. Fish. Rev. 11(5): 1-12.

Crawford, D.E., and W.J.J. De Smidt
1922. The spiny lobster, *Panulirus argus* of southern Florida: its natural history and utilization. Bull U.S. Bur. Fish. 38: 281-310.

Davis, G.E.
1973. Notes on the status of spiny lobsters: *Panulirus argus* at Dry Tortugas, Florida. Unpubl. mimeo rep. U.S. Nat. Park Serv., Everglades National Park, Florida. 10 pp.

Dawson, C.E., and C.P. Idyll
1951. Investigations on the Florida spiny lobster, *Panulirus argus* (Latreille). Fla. Board Conserv. Tech. Ser. No. 2, 39 pp.

Eldred, B., C.R. Futch, and R.M. Ingle
1972. Studies of juvenile spiny lobsters, *Panulirus argus*, in Biscayne Bay, Florida. Fla. Dept. Nat. Resour. Mar. Res. Lab. Spec. Sci. Rep. No. 35, 15 pp.

Herrnkind, W.F.
1969. Queuing behavior of spiny lobster. Science 164: 1425-1427.
1970. Migration of spiny lobster. Nat. Hist. 79(45): 36-43.

Ingle, R.M., B. Eldred, H.W. Sims, Jr., and E. Eldred
1963. On the possible Caribbean origin of Florida's spiny lobster populations Fla. Board Conserv. Tech. Ser. No. 40, 12 pp.

Johnson, I.
1974. Statistical trends in the spiny lobster fishery. Pp. 15-19 *in* Seaman, W., and D.Y. Aska, eds. Research and information needs of the Florida spiny lobster fishery. Florida Sea Grant Program, Gainesville, Florida.

Lewis, J.B.
1951. The phyllosoma larvae of the spiny lobster, *Panulirus argus*. Bull. Mar. Sci. Gulf Caribb. 1(2): 89-103.

———— , H.B. Moore, and W. Babis
1952. The postlarval stages of the spiny lobster, *Panulirus argus*. Bull. Mar. Sci. Gulf Caribb. 2(1): 324-337.

Provenzano, A.J.
1969. Recent experiments on the laboratory rearing of tropical lobster larvae. Proc. Gulf. Caribb. Fish. Inst. 21: 152-157.

Robinson, R.K., and D.E. Dimitriou
1963a. The status of the Florida spiny lobster fishery, 1962-63. Fla. Board Conserv. Tech. Ser. No. 42: 1-30.
1963b. Length frequencies of adults of *Panulirus argus* and occurrence of phyllosoma larvae in south Florida. Univ. Miami Rep. No. 63835. 3 pp., 2 tables.

Seaman, W., and D.Y. Aska
1974. Research and information needs of the Florida spiny lobster fishery. Florida Sea Grant Program, Gainesville, Florida. 64 pp.

———, and A.C. Jones
1975. Review of spiny lobster research including results and recommendations of a colloquium held October 1-2, 1974, in Miami, Florida. Florida Sea Grant Program, Gainesville, Florida. 54 pp.

Sims, H.W., Jr.
1963. Notes on artificial propagation of the Florida spiny lobster. Unpub. mimeo rep. Fla. Dep. Nat. Resour. Mar. Res. Lab. (address at Florida Academy of Science Meeting, Miami, Florida, March 1963) 6 pp.
——— 1965. Notes on the occurrence of pre-nauplisoma larvae of spiny lobsters in the plankton. Bull. Mar. Sci. 15: 223-227.
——— 1966. An annotated bibliography of the spiny lobsters. Fla. Board Conserv. Mar. Res. Lab. Tech. Ser. No. 48. 80 pp.

Sims, H.W., and R.M. Ingle
1966. Caribbean recruitment of Florida's spiny lobster population. Q.J. Fla. Acad. Sci. 29(3): 207-242.

Smith, F.G.W.
1948. The spiny lobster industry of the Caribbean and Florida. Caribb. Res. Coun. Caribb. Comm. Port-of-Spain, Trinidad. Fish. Ser. 3: 1-49.
——— 1954. The biology of the spiny lobster. Pp. 463-465 *in* Galtsoff, P.S., ed. The Gulf of Mexico, its origin, waters, and marine life. U.S. Fish Wildl. Serv. Fish. Bull. 55(89).

Sweat, D.E.
1968. Growth and tagging studies on *Panulirus argus* (Latreille) in the Florida Keys. Fla. Board Conserv. Mar. Lab. Tech. Ser. No. 57, 30 pp.

Warner, R.W.
1975. Biological studies of the spiny lobster in South Florida. Unpubl. mimeo rep. Florida Sea Grant Program, Gainesville, Florida. 81 pp.

Witham, R., R.M. Ingle, and E.A. Joyce, Jr.
1968. Physiological and ecological studies of *Panulirus argus* from the St. Lucie Estuary. Fla. Board Conserv. Mar. Res. Lab. Tech. Ser. No. 53. 31 pp.

———, R.M. Ingle, and H.W. Sims
1964. Notes on postlarvae of *Panulirus argus*. Q. J. Fla. Acad. Sci. 27(4): 289-297.

FISHERIES WORKSHOP

WEDNESDAY – A.M. – OCTOBER 29, 1975

Chairman – James B. Higman, *Executive Director, GCFI, University of Miami, Miami, Florida*

Use and Interpretation of Echo Sounding Equipment

ROBERT S. RICH
Rich Electronics, Incorporated
Miami, FL 33142

The intention of this paper is to provide a basic understanding of the operation of echosounders, and the interpretation of echosounder recordings. It is hoped that this information will help the fisherman gain better usage from equipment he now has, and help in the selection of future equipment. This discussion will concern itself with recorders and scope type displays, as these are the most widely used types of echosounders in the fishing industry.

Specifications of equipment which are particularly meaningful in selection of echosounders are: frequency, transducer beamwidth, pulse length, transmitter power, sensitivity, available depth ranges, and auxiliary features such as white-line, gray-line, scale expansion, and bottom locking.

Of course, whichever type of display is used, the transducer plays an equal part in the effectiveness of the equipment. The transducer converts electrical energy into sound waves on transmission, and sound waves into electrical energy on reception. The most common types are magnetostrictive, usually made of nickel or nickel alloy, and ceramic crystal, made from barium titanate or lead zirconate.

The efficiency – least loss of energy in the conversion from electrical energy to sound energy – is highest in the ceramics, as much as three times greater than the magnetostrictive. In addition to efficiency, the characteristics of transducers which influence performance are frequency and beamwidth. The frequency of the transducer you select should be determined by the type of fishing you intend to do. Most fishing type echosounders operate between 30 and 200 kHz. The lower the frequency the more depth range is possible, and the higher the frequency the more definition in shallow water. A frequency of more than 100 kHz would probably be unsuitable for depths greater than 200 meters.

Beamwidth is the angle at which the transducer pulse is transmitted. It is obvious that the narrower the beamwidth the more concentrated is the signal, and consequently more information about what is under the vessel will be received. However, a wide beamwidth will collect information over a larger area, and, especially in a small vessel which rolls and pitches, will provide more continuous information. The term "angular definition" is used to describe the ability of the echosounder to show hazards on the bottom and fish in small trenches or close to a sloping bottom. The wider the beamwidth, the less angular definition, due to masking of the desired echoes by side echoes. Consequently, beamwidth becomes more important the deeper one wishes to use the equipment. For vessels with need for relatively shallow depth, a wide beamwidth is acceptable. However, for greater depth, a beamwidth of between 10° and 20° would be considered optimum.

In the transmitter is determined the pulse length, which is important in determining the amount of radial definition and maximum depth. "Radial definition" is the term used to describe how well the recorder will show separate objects at varying depths. The shorter the pulse length, the greater this definition. However, for great depths, say 300 to 400 fathoms, a long pulse is necessary.

Transmitter power is important, but only when considered with receiver sensitivity – for instance, equipment today of only 100 watts power is often more sensitive than equipment of 15 years ago with 1000 watts of power.

There are many aspects of the recorder itself which are important. First is scale ratio – again the choice is between maximum depth and maximum definition. Most recorders have varying stylus speeds to offer selection of different ranges. For bottom fishing or trawling, or fishing great depths, the problem is to get good definition at or near the sea-bed. The most popular technique to maximize sea-bed definition at present is the "white-line" or "gray-line" technique. This offers no magnification of the echo, but, by a suppression of the very strong sea-bed echo, the fish echoes at the sea-bed are made much more distinctive. Now becoming more widely used is the technique of echo magnification, which enables the equipment to magnify a small segment, say 2 or 3 fathoms, of the depth. When this is coupled with "bottom locking" circuits, the best degree of information about the sea-bed is obtained. Bottom locking is the technique by which the sea-bed is displayed as a straight line regardless of the actual contour of the bottom. Scope type displays will give even better magnification information about fish near the bottom.

I will now mention a few points on interpretation of recordings. A hard flat bottom will be indicated by long black tails on the sea-bed echo. As one approaches rough bottom, tails will also appear on the echogram; this is due to additional reflection of the side echoes by the rough ground. When passing over mid-water fish, usually the echo will appear like an inverted "V." Schools of fish, thermal layers, and plankton will all show on the recording.

The reflected signal is very dependent on the target – that is, the relative consistence of the target as opposed to water, and an air-water boundary provides an almost perfect reflector. For this reason it is believed that the major portion of fish echo comes from the air bladder inside the fish. For the same

reason, objects such as shrimp, which are very nearly the consistency of water, provide a poor reflector, and are difficult to observe on an echo sounder. Shrimp found in northern waters, in extremely dense shoals, are detectable on echo-sounders.

A difficulty is in discriminating between fish at the sea-bed from rocks. This is important for the fisherman in order to locate fish, and for the trawler to avoid an object which may foul his trawl. As mentioned before, the use of white-line or gray-line features enables this distinction to be made. From an ordinary "black-line" recording, it is very difficult to distinguish between fish and bottom, because the fish often will look like part of the bottom itself and will thus reduce the fisherman's possibility of detecting the fish. That is why the "white-line," scopes and other features like the so-called "bottom lock" system are used to a large extent for bottom trawling. By experience, the fishermen are also able to interpret the echograms and distinguish between different types of fish, based on the different markings obtained on the recording paper.

Inasmuch as experiments are now being made with mid-water trawling in the Caribbean area I will briefly comment on that subject. When mid-water trawling is used, it is of great importance to know the position of the trawl with respect to the vessel, the fish, and obstructions. It is also important to know how the trawl is moving, how the fish behave close to the trawl, and to what extent the trawl is filled.

The method of controlling the trawl's position by means of the echosounder depth measurements, adjustment of trawl wire length and trawl wire angle, and the speed of the vessel has gradually been improved by electronic instrumentation. This is a system which we call "trawl eye." The trawl eye is a mating of hydroacoustic sensing equipment on the trawl and recorder equipment onboard. The signal link is a special cable operated by various winch types. This system is capable of showing size and quantity of fish entering the trawl, fish passing over and under the trawl, and the head and ground rope and the trawl's distance to the sea bottom and the surface.

For smaller trawlers not able to handle a large system, a new smaller relatively inexpensive system has been developed. The components making up this system are an echosounder, a transducer unit and a strong electrical cable. In addition a cable winch strong enough to reel in the cable is needed. This system will give reliable information with cable lengths up to 1,500 feet using a standard echo sounder.

Even with all these facilities the trawl skipper is interested in more information. In particular he is interested in knowing the temperature conditions in the sea. Such information may be useful in the evaluation of fish existence. For this purpose we have developed a temperature indicator which is working with the trawl eye system. The temperature is recorded on the echogram which is made by the trawl eye recorder unit. Together with the recordings of fish and bottom, the temperature is also recorded as a thin continuous line on the echogram.

Finally a trawl system may include what we call a trawl watch. The trawl watch gives full information about the trawl's position in the water. Trawl depth and trawl openings are seen on the main echo sounder and superimposed on the

echo sounder's depth recordings. Thus it will be possible to adjust the trawl to get the best fish concentrations. It gives audible and visual warnings of obstacles in the trawl's path with sufficient time to adjust the trawl. The trawl watch takes the signals from the trawl eye and converts them into markings on the main echo sounder together with the depth recordings. All the equipment I have mentioned here today is currently in production and available to anyone who feels he has a need for it.

If we try to look further into the future, I cannot see any new developments on the horizon that will revolutionize the field of fish detection instrumentation. Fish finding equipment will be basically what it is today for many years to come. However, a rapidly developing electronics technology will give us better and more efficient instrumentation as well as instruments that can do more jobs for us. For the mid-water trawl it will be very important to have an instrument that can inform or indicate the catch volume. Automatic control of trawl depths and trawl movements by means of winch operations controlled by computerized equipment certainly will come.

Report of Colloquium on Snapper and Grouper Resources of the Western Central Atlantic

ALBERT C. JONES
National Marine Fisheries Service
Southeast Fisheries Center
Miami, FL 33149

ABSTRACT

A colloquium on snapper and grouper fishery resources was held at the October 1975 meeting of the Gulf States Marine Fisheries Commission (GSMFC). Information on the resource and fishery was presented and problems and possible solutions were discussed. Proceeding of the Colloquium will be available from GSMFC, 511 St. Louis St., New Orleans, LA 70130.

The colloquium technique is recommended as a mechanism for management agencies to obtain information and advice from all concerned groups and, used in this way, is an effective tool in the planning process.

Problems of the snapper and grouper fisheries include increased competition among commercial, recreational, and foreign fisheries, greater fishing pressure on the resource, and decreasing margins between income and costs of operation. Solutions to these problems will come from management action based on reliable statistical and biological information.