NOAA Technical Memorandum NMFS-SEFSC-308

Intra-Americas Sea Marine Science Meeting of U.S. Experts

Report of a Workshop Held in Miami, Florida, December 17-19, 1990

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July 1992

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July 1992

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This report should be cited as follows:

Brown, B. E., W. A. Erb, and G. A. Maul. 1992. Intra-Americas Sea Marine Science Meeting of U.S. Experts. NOAA Technical Memorandum NMFS-SEFSC-308, 125 p.

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Cover Photo: Map of the "West Indies from the Best Authorities by T. Bowen, *Geogr.*" The map was printed in London in 1773, and a photography was provided by its owner, Dr. Harris B. Stewart, Jr., of Scarborough, Maine, USA.

EXECUTIVE SUMMARY

The December 1990 meeting of more than sixty U.S. Experts in Marine Science of the Intra-Americas Sea made 21 recommendations, with deadlines and agencies responsible to carry them out. These recommendations were a consensus of two days of institutional reports, individual conversations, and workshops. The one overwhelming recommendation was to support the UNEP and IOC in the region through active U.S. scientists' participation in problem identification, project planning and execution, and information transfer. A regional emphasis on marine science issues with clearly defined impacts on U.S. interests was considered essential to generating the financial support necessary to successful project implementation.

A summary of the recommendations from the three workshops is given below; the items are *not* in order of priority.

1. RECOMMENDATION: Extend the Sea Grant Program to the region, perhaps by implementing the international Sea Grant authority, capitalizing, for example, on the requirements of the Cartagena Convention which mandates a "Sea Grant type" program (CEPPOL) in the region; U.S. Territories, Commonwealth, and States in the region to be fully included.

   RESPONSIBILITY: NOAA

   DEADLINE: 1992

2. RECOMMENDATION: Make key policy makers aware of IOCARIBE and UNEP related issues, resources needed to address these issues, and benefits to be gained for such support.

   RESPONSIBILITY: As appropriate

   DEADLINE: 1991

3. RECOMMENDATION: Initiate active involvement with UNOLS, SECOR (the SouthEast Consortium for Ocean Research) and other such committees by institutions within the region to foster ship-time requests and information on planned cruises.

   RESPONSIBILITY: UPR, CVI

   DEADLINE: 1991

4. RECOMMENDATION: Provide copies of research vessel clearance requests to the American Embassy in Cartagena for distribution through IOCARIBE to all Gulf/Caribbean marine research institutions and universities with marine science departments.

   RESPONSIBILITY: State Department

   DEADLINE: 1991

5. RECOMMENDATION: Publish cruise plans on electronic bulletin boards and in newsletters of IOCARIBE, UNEP, and NOAA with sufficient lead-time to allow foreign participation; encourage other countries in the region to widely publish cruise dates and space availability.

   RESPONSIBILITY: IOCARIBE Secretariat

DEADLINE: 1991

6. RECOMMENDATION: Advertisement of ship-time opportunities to be an agenda item at March 1991 IOC Assembly.

   RESPONSIBILITY: State Department, IOCARIBE Secretariat

   DEADLINE: January 1991

7. RECOMMENDATION: Secondment of U.S. scientists and/or technicians at IOCARIBE and UNEP/RCU offices both for one to two year assignments, and for shorter durations as specific projects demand. The purpose would be to assist the organizations in the execution of projects, planning, and to generate better understanding of common goals.

   RESPONSIBILITY: NOAA, EPA, IOCARIBE, UNEP, other

   DEADLINE: 1992

8. RECOMMENDATION: Establish a National Committee for Intra-Americas Sea Marine Science as a subcommittee of PIPICO; U.S. National Representative to IOCARIBE to chair and report regularly.

   RESPONSIBILITY: NOAA/NMFS

   DEADLINE: 1991

9. RECOMMENDATION: Convene in late 1991 an "issues oriented" follow-on meeting to advise USDEL to 1992 IOCARIBE meeting and to other international bodies on (1) agenda items, (2) how to support programs, (3) management issues, and (4) shared resources and problems.

   RESPONSIBILITY: NOAA, State, NAS

   DEADLINE: September 1991

10. RECOMMENDATION: Provide wide international distribution of this report and follow-on reports.

    RESPONSIBILITY: NAS

    DEADLINE: April 1991

11. RECOMMENDATION: IOCARIBE Secretariat to encourage all member states to participate in TEMA meeting in March 1991 in Paris.

    RESPONSIBILITY: IOCARIBE Secretariat

    DEADLINE: January 1991

12. RECOMMENDATION: Present results of this meeting to the IOC Assembly in March 1991 in Paris.

    RESPONSIBILITY: State Department

DEADLINE: February 1991

13. RECOMMENDATION: Work with WECAFE to develop an ocean sciences needs assessment for fisheries resources in the Caribbean.

    RESPONSIBILITY: WECAFE, IOCARIBE

    DEADLINE: SC-IOCARIBE-IV (July 1992)

14. RECOMMENDATION: Demonstrate the importance of research applications to the development of new sustainable economic activities for the region, such as environmentally sensitive tourism development. Research results on the impact of human activities on coastal ecosystems, etc., needs to be incorporated into management plans that maintain a balance between resource conservation and lucrative tourist recreational activities.

    RESPONSIBILITY: UNDP, UNEP, IADB, WB, USAID

    DEADLINE: Reports 1991; UNCED 1992

15. RECOMMENDATION: Initiate a focused educational program targeted on high level government decision-makers stressing the importance of basic scientific research to sustained economic development, public health, etc.

    RESPONSIBILITY: IOCARIBE Secretariat, UNEP RCU

    DEADLINE: 1992 UNCED

16. RECOMMENDATION: Recognizing that narrowly trained researchers in basic oceanographic science will find scarce funding within their countries, increase training opportunities for those individuals in marine and coastal resource management.

    RESPONSIBILITY: IOCARIBE, UNEP, regional institutions

    DEADLINE: 1992

17. RECOMMENDATION: Develop a marine advisory service that will (a) enhance training opportunities, (b) translate research into economically relevant information for decision-makers and local businesses, and (c) provide a vital link between research and economic development.

    RESPONSIBILITY: Sea Grant Institutions

    DEADLINE: 1992

18. RECOMMENDATION: Special attention to study of regional oceanic circulation within the context of enabling decision-makers to understand and advance applied research/policy objectives in such areas as fisheries management, pollution control, and to prepare for potential effects of global climate change.

    RESPONSIBILITY: IOCARIBE Secretariat

    DEADLINE: 1992 UNCED

19. RECOMMENDATION: Establish a satellite receiving dish and data collection center which could be used for fisheries oceanography and management, and for forestry. Provide access to satellite data to local fisherman and foresters to provide a high profile demonstration.

    RESPONSIBILITY: USF and IADB or WB

    DEADLINE: 1992

20. RECOMMENDATION: Establish a regional oceanographic data center with (among other things) electronic bulletin board, with the express purpose of data exchange enhancement and elimination of difficult to access NODC gray literature for countries bordering the Intra-Americas Sea.

    RESPONSIBILITY: NODC

    DEADLINE: 1991

21. RECOMMENDATION: At the upcoming IOC Assembly, identify the IOCARIBE as a region where TEMA activities should be pursued and given the highest priority. The IOCARIBE Secretariat should communicate this on an urgent basis to all IOCARIBE member states and urge them to participate in the special TEMA meeting in Paris, March 1991.

    RESPONSIBILITY: IOCARIBE Secretariat

    DEADLINE: January 1991

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1.0 INTRODUCTION

The Department of State and the National Oceanic and Atmospheric Administration, with the support of the Ocean Studies Board of the National Academy of Sciences, held a two-day workshop, which focused on marine science in the Intra-Americas Sea: the Gulf of Mexico, the Caribbean Sea, the Bahamas, and the northeast coast of South America. The workshop had several objectives including: (1) identification of U.S. marine science interests and projects; (2) clarification of the purpose, requirements and goals of regional scientific organizations; (3) generation of ideas and mechanisms to facilitate marine science projects with high scientific priority and potential for supporting regional organizations; (4) encouragement of applied scientific research for development priorities; and (5) development of communication networks between scientists and organizations.

The meeting was co-chaired by Dr. Bradford E. Brown, U.S. National Representative to IOCARIBE, the Sub-Commission of the Intergovernmental Oceanographic Commission (IOC) for the Caribbean and Adjacent Regions, by Mr. William Erb, Alternate U.S. Representative to the IOC, and by Dr. George A. Maul, IOCARIBE Vice Chairman. It was held at the NOAA National Marine Fisheries Service, Southeast Fisheries Center, 75 Virginia Beach Drive, Miami, Florida, 17-19 December 1990.

Approximately 100 persons were invited, representing a broad spectrum of federal, state, and non-governmental organizations. Due to limited space for the meeting, the list of invitees was somewhat restricted to program directors or their designated representative, and to senior scientists who are actively pursuing marine research in the Intra-Americas Sea. Limited support for the meeting was available from the National Academy of Sciences.

The workshop commenced at 1 p.m. on 17 December with presentations by representatives of organizations having marine science programs in the region. Invited participants included representatives of the IOCARIBE, the United Nations Environment Programme (UNEP), NOAA, the Minerals Management Service, the National Science Foundation, NASA, the U.S. Agency for International Development, and others. Of particular interest to U.S. experts were presentations of the IOCARIBE Medium Term Plan (1990-1995) (IOC, 1990), and UNEP's Caribbean Environmental Program (UNEP, 1989). These presentations emphasized United Nations development activities and reinforced the important linkages between science and its applications for wise management and development of coastal and ocean resources--especially given the growing international emphasis on integrating environmental concerns into development activities (i.e., the preparations for the 1992 United Nations Conference on Environment and Development: UNCED). Also, state and private institutions such as universities, oceanographic institutions and marine laboratories, and other non-government organizations described their program activities and interests.

On the morning of 18 December, various individuals made presentations concerning particular programs or projects that are being planned or underway within the region. The afternoon of 18 December was devoted to working in small groups to discuss convergent interests and to outline a report. Finally, on December 19 a session was convened to discuss mechanisms for improved cooperation, ideas for supporting the needs of organizational bodies within the region, and general discussion of means to enhance communication, information exchange, funding, and science opportunities in general.

Each participating U.S. expert had written information about their existing and planned activities. Committees were formed to compile that information into a report which would describe the linkages between the activities and the organizational activities and responsibilities in the region. The report would reflect the U.S. commitment to the region, and to cooperation in solving regional problems with scientists and organizations located in the wider Caribbean region. This work continued on the morning of 19 December; the workshop closed at noon with a plenary session.

2.0 STATEMENT OF GOALS AND OBJECTIVES

2.1 William Erb, Department of State

Welcome all of you who have traveled during a very busy time of year. This attests to the importance of the Caribbean region, at least as perceived by us.

Back in 1986, the National Academy of Sciences sponsored a similar meeting; however, its objective was to develop a scientific plan for the Caribbean by identifying research projects that would/could be undertaken cooperatively with Caribbean partners. The purpose and objectives of this meeting are stated in the introduction. Some of these objectives will be achieved fairly easily. Identification of projects and programs is fairly straightforward. However, our real task is to improve the coordination, management and usefulness of marine science in the region. The initial beneficiaries of our work should be ourselves the scientists, administrators of national and intergovernmental programs, educators and governments. In the long term, the region will benefit.

How we do this and what we come up with will be up to you. There isn't much need to identify the problems or the priority areas of the region. What we need to do is maximize the resources we have available to tackle the problems.

Last week we concluded negotiations for establishing an organization for the north Pacific, which will be known as PICES. It will include the U.S., PRC, USSR, Canada and Japan. In the Caribbean, perhaps because of the complexity and diversity of the region, we have UN organizations such as UNESCO (IOCARIBE) and UNEP (Regional Seas Program) to serve as the catalysts for cooperation. Let's think of ways to make these organizations work. At the same time let's improve opportunities for U.S. marine science in the region as well as sound environmental management practices.

The United States strongly supports the cooperative program known as the Caribbean Environmental Pollution program (CEPOL), sponsored by UNESCO's IOC and UNEP's Regional Seas Program. Their programs will be described later and we need to ensure strong U.S. input to these programs.

I look forward to our work and the opportunity to explore all sorts of new and exciting ways of making marine science work in the region.

2.2 Harris B. Stewart, Jr., IOCARIBE

This will be brief, as you have an interesting afternoon ahead. My remarks are based on more than 25 years of involvement with IOCARIBE and its predecessor, the Cooperative Investigation of the Caribbean and Adjacent Regions or CICAR (which someone has pointed out means "goat" in Turkish). They also reflect the results of a multi-national UNESCO mission on which I served in the early 1980's, a mission to evaluate the present status of marine science and the needs marine research could address effectively on a string of eight independent English-speaking islands stretching in an arc from Jamaica to Georgetown, Guyana. The various recommendations resulting from that mission were confirmed and reinforced by the subsequent multi-year studies by the group at Dalhousie University in Halifax, Nova Scotia.

I like to formulate problems in terms of goals and objectives, and mine for marine research in the Caribbean (I don't like the term "Inter-Americas Sea") come out like this:

The long-term goal is the establishment of an indigenous regional marine science capability that will permit the nations--both island and continental--to solve their own marine problems without having to rely on expertise from outside the region.

I see three major objectives, the attainment of which will go far towards achieving this goal.

(1) The provision of money, facilities, equipment and instrumentation. There is little the individual scientist can do in this regard, rather this is the role of national foreign assistance agencies such as USAID and CIDH, private foundations, and intergovernmental agencies including the JOC, UNDP, FAO, UNEP, and UNESCO among others (Fenwick *et al.*, 1990). Serious consideration by these agencies should be given to the establishment and support of regional centers for cooperative use by the scientists of many nations in the region. The pollution analysis laboratory on St. Lucia is an example of this.

(2) The provision of training and education in marine science and technology. Here the individual marine scientist doing research in the Caribbean can play a lead role. Any marine research project planned for the region should include local scientists, "proto-scientists," and technical personnel as an integral part of the research. Where appropriate, locals should be involved in the full spectrum from planning through publication. This is not a one-directional support activity, for the U.S. scientist obtains local knowledge otherwise unobtainable, relevant historical information and data, and willing, often eager, hands to help with the field work. In addition, the researcher can offer public lectures, meetings with local administrators, and talks at local schools, thus improving what some term the level of marine literacy. When potential marine scientists can be identified, they should be encouraged to seek the funds for a university education. Too often students from lesser developed countries who study at U.K. or U.S. universities find life there considerably more enjoyable and jobs more plentiful and lucrative than back home, and their new capability is lost to their homeland. One approach to this brain-drain problem is to have them educated at universities within the region: UNAM in Mexico City for those who speak Spanish, the U.W.I. campuses at Mona, Jamaica; Cave Hill in Barbados; and Port-of-Spain, Trinidad, for those who speak English; and the Mayaguez Campus of the University of Puerto Rico for both. These entail less culture-shock and less incentive to remain away from home once their formal education is completed.

(3) The research should be primarily applied research or at least research the results of which might in time be of some use to the area where it was carried out. At this point, basic research is an unaffordable luxury for many of the Caribbean nations. Thus, your research should have a local or regional relevance.

Throughout the eastern Caribbean there are three major revenue-producing industries: tourism, agriculture, and fisheries. Marine research projects that contribute to these activities would not only be welcome locally, but many granting agencies look with more favor on proposals that provide some benefit to the host country.

With this last objective in mind, I have five areas where marine research is especially needed:

(1) Fisheries: Most of the fisheries in the Caribbean are of the small-boat artisanal type. Coastal stocks in many areas have been overfished and depleted, and the small boats are forced to go farther and farther offshore to get a decent catch. The whole system from catching through processing to distribution needs to be improved. Fisheries management practices need to be developed and implemented in many nations. However, the gringo scientist should be aware of local customs and traditions, or his project may face disaster. For example, with the introduction of refrigeration of fish on Grenada, the housewives rejected the fish brought inland because it did not smell the way it used

to when brought up in the hot trunk of an old Chevrolet that for years delivered their fish. Or again, the Canadian government provided big outboards for the traditional sailing fishing boats on St. Lucia, and the masts and sails were removed. It was a status symbol, macho, to have this big motor on your boat. Occasionally, these machines malfunctioned or ran out of gas far from home port, and some fishermen were lost. The suggestion was made that they reinstall the forgotten sails to save fuel and to ensure they could return if the big motors stopped working. But the fishermen would not hear of it. This was retrogressing, this was not for the technologically mature. They would have none of it. This is one more example of the importance of involving locals in your marine research project. They know things you don't and can be immeasurably helpful.

(2) Pollution: Trash on the beaches, deteriorating water quality, and the sanitation problems that result from improper waste disposal--human and otherwise--plague many of the Caribbean nations, particularly the island ones. The gullies that indent many of the more mountainous islands provide a convenient place to dump domestic and agricultural trash (e.g., banana bags). Then come the torrential rains of summer, and the accumulated trash is washed away. It sounds at first blush like an efficient natural disposal system. However, this "gully-wash" ends up in the coastal ocean. The beaches that lure the tourists are littered with garbage and trash moved alongshore by the longshore current. The plastic bags that had once covered the banana bunches settle on the nearshore reefs and kill the corals. Any research directed towards any aspect of this pandemic Caribbean problem would be most welcome.

(3) Destruction of Coral Reefs: Dynamiting to recover reef fish, anchoring dive boats on reef corals, banana bags on reefs, removing corals for sale, all of these activities are contributing to the destruction of the nearshore Caribbean reefs, scuba diving, skin diving, and snorkeling over luxuriant coral reefs are major tourist attractions. No reefs, no tourist divers. It's that simple. The nearshore reefs also disperse the energy of approaching waves to reduce beach erosion. This leads to number 4.

(4) Coastal Erosion: On Dominica and some of the other mountainous eastern Caribbean islands, the only place where roads can be built is along the narrow strip of coast between the mountains and the sea. Yet in numerous places, the sea has chewed into the land to the extent that roads have been undermined or tumbled into the sea. Boulders in plastic baskets have been used with limited success in Dominica, but the problem remains. Research on more efficient rip rap, on offshore submerged breakwaters at critical locations, and on the preservation of protective nearshore reefs is badly needed.

(5) Mining of Beach Sand: On several islands of the eastern Caribbean it is illegal to remove sand from the beaches. Clean sand beaches are an important tourist attraction and need to be preserved. But because there is little or no sand and gravel for construction aggregate, the "midnight miners" remove great quantities of sand from tourist beaches. Not only does this leave unsightly water-filled holes on an otherwise pristine beach, it also reduces the ability of the beach to protect coastal property from the destructive action of storm surges related to the frequent tropical storms in the region. Are there other sources for construction aggregate? Are there other non-sand construction materials? Can the tourism beaches be saved from the "midnight miners"? There must be some research possibilities here.

One last observation: IOCARIBE and the Caribbean Environment Programme of UNEP have over the years established a functioning cooperative relationship. Many U.N. agencies with Caribbean involvement send a representative to meetings of other U.N. agencies, but generally that is as far as "cooperation" goes. The IOCARIBE-UNEP/CEP model should be adopted and expanded for greater cooperation and project coordination among the numerous U.N. agencies and others with Caribbean programs. This meeting today is a step in that direction.

In conclusion, I am sure that my personal bias shows through. I do not apologize for it. I happen to love the area and its people. It is a fascinating part of our world, but it needs help, lots of help. Marine science can help solve some of their problems. This is a challenge to you, the U.S. marine science community. I wish you success in your discussions, deliberations, and planning over the next two days. I sincerely hope that you will develop a meaningful coordinated research effort in support of IOCARIBE's activities in the Caribbean Sea. It needs doing.

2.3 Robert R. Lankford, University of Puerto Rico

Development Background

Marine science, by and large, is new to the Americas. With the exception of the U.S. and Canada, Western Hemisphere countries have had surprisingly little maritime tradition or contact with the sea and consequently relatively little interest in developing viable national infrastructures in marine science and technology. Throughout Latin America and the Caribbean, economic institutions and customs traditionally have been oriented to the land rather than to the sea and its resources, thus proving the observation that "a coastal state is not necessarily or automatically a maritime state." From a diagnostic viewpoint, our neighbors to the south have long suffered from a type of oceanic hydrophobia, a condition which has strongly influenced national development policies which not uncommonly placed marine affairs at the bottom of priority totem poles.

The first glimmerings of marine science development in Latin America began rather sporadically in the 10 to 15 years following World War II, initially in Argentina and Brazil, then somewhat later in Mexico, Colombia, Venezuela, Chile and Puerto Rico. Some of the remaining countries have followed suit with varying degrees of success. Others, particularly the small island states, have essentially no marine science capability. In these formative years, the only available human resources with experience in matters pertaining to the ocean were to be found in the naval forces, usually in the hydrographic sections, and in fisheries agencies, the latter not uncommonly attached to ministries of agriculture. It is significant to note that in the early days there were very few trained marine scientists, essentially no educational potential in oceanography and limited or no research capacity. Publications often were little more than BT compilations and salinity measurements from the navies and species lists or landing statistics from the fisheries offices. On the other side of the coin, it is more significant, however, that this formative period produced a number of leaders in marine affairs who not only recognized developmental problems in their respective countries but who also had the personal ability and drive to seek solutions. Rather understandably, they turned to the UN system, especially to UNESCO and FAO, for development assistance, most often provided through expert consultations and international cooperative programs in oceanographic research.

Intergovernmental Stimulus

In 1968, the Intergovernmental Oceanographic Commission of UNESCO organized and coordinated its first venture in regional marine science cooperation named CICAR (Cooperative Investigations of the Caribbean and Adjacent Regions), an intergovernmental association which subsequently became IOCARIBE. The fundamental purpose of these intergovernmental operations was to conduct multi-national oceanographic research programs in the Caribbean region which, by their nature, were too large or complex to be undertaken by individual countries. In theory, such cooperation would not only yield scientific results but also the scientific and technical manpower base of participating developing countries would be enhanced through close association with the "major players" which, in the case of CICAR and IOCARIBE, were the marine scientists and their institutions from the United States, the UK,

the USSR, France, and West Germany. In a more formalized context, this desirable and much needed scientific manpower build-up was called TEMA (Training, Education and Mutual Assistance). Throughout the history of cooperative marine science in the Caribbean, the U.S. and Puerto Rico have been and remain major and respected contributors, contributors not only in funding, but also in providing and sharing scientific and technological expertise, being valued leaders in research initiatives and strong supporters of TEMA in all its aspects.

An Assessment of Regional Cooperation

After more than 20 years of CICAR and IOCARIBE, it is both fair and necessary to ask, "How well has all this worked?" - "Have our partners to the south really benefited?" - and, "What have we gained, if anything?" There are probably no really simple or straightforward answers to these questions. In this case, however, some generalizations may be of use.

"How well has all this worked?" - Have these years of intergovernmental meetings, expert workshops, joint research planning, etc., really accomplished anything? One answer most certainly is that CICAR and IOCARIBE have not worked as originally planned or anticipated. An alarmingly few of the seemingly countless resolutions and recommendations to establish major research activities in the region have been implemented with any degree of success. In retrospect, the reasons seem fairly obvious and, in part, hark back to hundreds of years of land-oriented economies and traditions. Additionally, there have not been the necessary national commitments of economic and human resources among Latin American and the Caribbean countries to develop marine science infrastructures. Without such commitments and functional infrastructures, there can be only minimal or token participation in regional cooperative research. Finally, it must be recognized that only a few of the adopted recommendations for cooperative oceanography had either the political attraction or wide popular appeal necessary for national support. Many proposed programs were far too esoteric - some were obviously beyond existing capabilities - while others bordered on irrationality.

One major program did succeed, however, and continues to grow and serve the needs of region today in cooperation with UNEP's Caribbean Environmental Programme. This is the IOCARIBE regional marine pollution program of research and monitoring called CARIPOL. It is instructive here to determine why CARIPOL succeeded while other recommended programs never passed the discussion and planning stages. Apart from the dedicated leadership of a few individuals, and a strong TEMA component to train many researchers in methods and techniques, CARIPOL succeeded because marine pollution and its effects on the collective well-being of the Caribbean is of immense popular concern and therefore subject to political attention and response. Ergo!! IOCARIBE countries have participated actively and responsibly, so much so that CARIPOL serves today as a role model of international cooperation in marine affairs. The lesson to be learned here is that in most developing countries where oceanographic expenditures must take a back seat to those destined for public health, education, improved transportation, communications, etc., only those marine science efforts, whether national or regional, which have general public support will thereby gain national commitments for implementation. This, by the way, seems to explain why the weather services of the world have so few problems when budgets are drawn up. Everyone is interested in weather.

"Have our neighbors benefited?" The answer is affirmative. One of the outstanding benefits or successes of the CICAR and IOCARIBE years had been completely unanticipated from the outset. This spin-off oddly was in the socio-political arena rather than in oceanography. As these cooperative marine science organizations matured, there developed a rather close-knit community of national representatives or delegates from participating countries characterized by strong personal and professional ties. To a marked degree, IOCARIBE meetings have an almost class reunion atmosphere of old friends getting

together after a protracted absence. This condition of trust and friendship has produced some unexpected benefits. For example, Capt. X calls long-distance to his friend, Dr. Y, to say that his R/V has just lost an entire hydrographic cast. Can Dr. Y help? The answer, Yes, is soon followed by a shipment of mothballed Nansen bottles and thermometers, and Capt. X is back in business. Dr. Y later gets a first look at the complete data set from Capt. X's latest cruise. This is the Mutual Assistance part of TEMA in its intended operational form.

Another benefit to our neighbors, although real, is more difficult to assess. Specifically, delegates to CICAR and IOCARIBE meetings have gained valuable experience and established contacts in other countries. As a direct consequence, they have gained important recognition at home. Their heightened reputations and political stature, in turn, have significantly enhanced their capabilities to build and provide ongoing support for national marine science infrastructures in their home countries. Many of the "old hands" today are in key positions in their governments or universities where they are even more influential in turning national attention to the sea and its potential resources.

In all honesty, however, it must be stated that the majority of the DCs in the region have not taken advantage of the many assistance opportunities made available by the U.S. and other industrialized countries. At meeting after meeting, U.S. and other delegations have extended offers for training and education, many with provisions for some level of financial assistance. For example, Puerto Rican members of the U.S. delegations to IOCARIBE consistently have offered such assistance at the University of Puerto Rico Department of Marine Sciences; to date, the University has had no "takers." The answer to this seemingly negative response is actually a result of the previously mentioned "hydrophobia," debt-ridden GNP's, and inadequate or even non-existent infrastructures for professional opportunities in the countries of the region. This situation may change, particularly in the larger, wealthier countries. But among the smaller, less affluent nations, hope for developing any capability to deal with marine affairs problems seems to lie in the formation of small consortia of cooperating states, e.g., the multi-national fisheries unit of the Organization of East Caribbean States.

"What have we gained, if anything?" Again, there are no simple answers to the question except to say that the U.S. and Puerto Rico have indeed gained by this regional experience. And certainly there are no quantifiable assessments possible. But what, even in general terms, have we gained? As mentioned above, CICAR and IOCARIBE have produced a closely knit association of marine scientists and science administrators throughout the Caribbean and adjacent regions. Such association and personal contact can open doors, smooth misunderstandings, turn up a critical but unpublished report, and perhaps even ease the hurdles in obtaining clearances for our R/Vs to operate in other EEZs or territorial seas. On the political front, our participation and cooperative stance in IOCARIBE have done much to improve our otherwise rather tarnished international image in the hemisphere. To a significant degree, the inclusion of Puerto Rican scientists in Caribbean marine affairs has had the positive and needed impact to diminish or overcome the "Colossus of the North" syndrome.

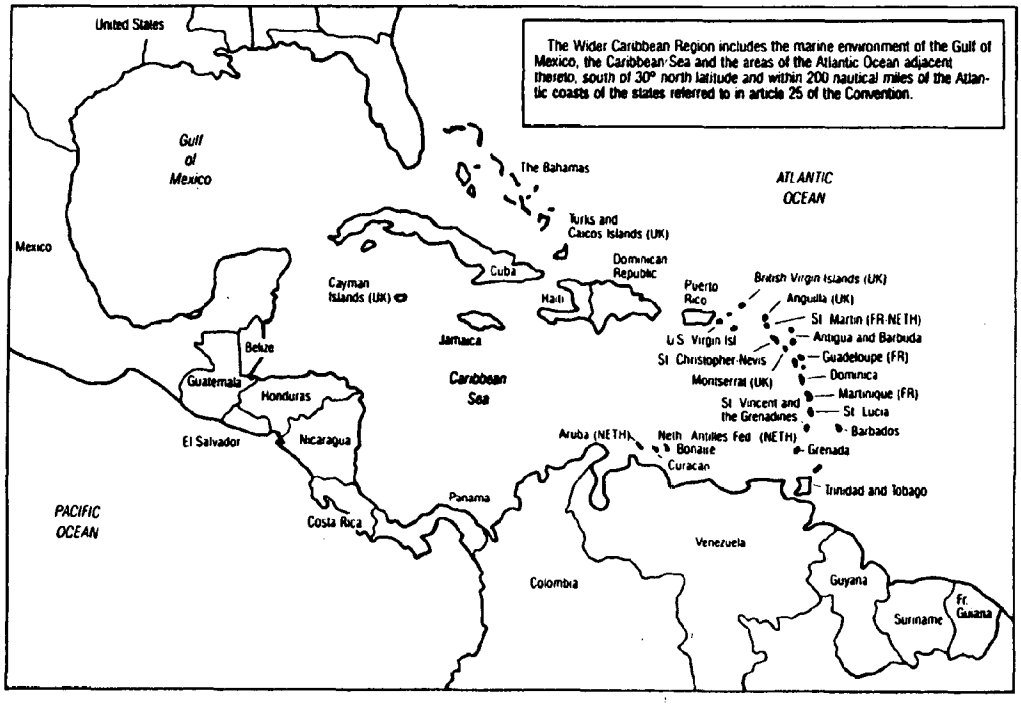
In retrospect, it seems fair to say that the U.S.-Puerto Rico association with CICAR and IOCARIBE has produced and will continue to produce positive results and benefits across a broad spectrum of interests, but most identifiably in international relations and in advancing marine science opportunities in this rather large and critical region. We should seriously consider the continuation of our involvement. The rationale for such activities is well expressed in an excerpt from a recent document by the Marine Division of the National Association of State Universities and Land Grant Colleges:

> "The benefits of society, and to our foreign policy by assisting foreign countries in the marine sciences are difficult to quantify. However, if marine science is valuable to the U.S., then it certainly should be more so to the developing countries as they evaluate and exploit their new marine territories."

3.0 INTERNATIONAL REPORTS

3.1 The IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE) (Fernando Robles, IOCARIBE)

The IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE), was established as the First Sub-Commission of the Intergovernmental Oceanographic Commission (an organization with functional autonomy attached to and co-located with UNESCO), through Resolution of the Twelfth Session of the IOC Assembly (Paris, November 1982). The Sub-Commission provides broad oversight and co-ordination of regional international ocean science programmes and services of interest to its Member States. IOCARIBE evolved after the Co-operative Investigation of the Caribbean and Adjacent Regions (CICAR; 1968-1975) and an experimental six years period as "Association" (1976-1981). IOCARIBE comprises twenty two Member States and its Secretariat was established and has been in function since 1986, in Cartagena de Indias, Colombia (Annex I).



Annex I: Map of the "Wider Caribbean Region" (UNEP) or the "Caribbean Adjacent Regions" (IOC). Early European oceanographers mistakenly called the area the "American Mediterranean."

Main on-going scientific programmes and services relate to research and monitoring of regional impacts of global climatic and other environmental changes.

The programme on Physical Oceanography and Climate is implemented through two main projects: "Climate Change Impacts and Ocean Physical Processes" and "Ocean Circulation in the Caribbean Sea and Adjacent Regions: An IOC Proposal to the European Space Agency for ERS-1 Science, Application and Validation". They were presented at the meeting by Dr. G. Maul, Vice-Chairman of the Sub-Commission. Details about the first proposal are given in Annex II. The projects are to be performed during the next five years. Among the long-term objectives are efforts to reduce the scientific uncertainties

Annex II: Projects Relevant to the IOCARIBE Medium Term Plan

Program	Name of Project	Responsible	Implementation	Budget U.S. $
Physical Oceanography	1. Ocean circulation in the Caribbean Sea and adjacent regions: An Intergovernmental Oceanographic Commission proposal to the European Space Agency for ERS-1 science, application, and validation.	IOC/IOCARIBE	1990-1993	180,000
	2. Climatic and other environmental changes: Establishment of a regional monitoring network.	IOC/IOCARIBE	1990-1992	166,000
	3. Climatic change, impacts and ocean physical processes.	IOC/IOCARIBE and regional institutional bodies	1990-1995	1,382,000
Ocean Science in Relation to Living Resources	1. Satellite ocean analysis for recruitment (SOAR).	USB, Texas A&M Univ.	1990-1991	156,000
	2. Fish-estuarine deltaic recruitment (FEDERP).	USA, Mexico, Colombia, Venezuela, Brazil	1990-1995	2,500,000
	3. Peneids recruitment (PREP).	USA, Mexico, Colombia, Venezuela, Brazil	1990-1995	5,000,000
	4. Coral reef demersal recruitment (CORDERP).	USA, Cuba, Venezuela	1990-1991	95,000
Ocean Science in Relation to Non-Living Resources	1. Substrate mapping, sample collecting and analysis.	(An *Ad-hoc* Group of Experts has been charged with the task to finalize a project on Impacts of Sea-Level Changes on the Coastal Zone - Effects on Erosion and Sedimentation)	-----	-----

Annex II: Projects Relevant to the IOCARIBE Medium Term Plan

Program	Name of Project	Responsible	Implementation	Budget U.S. $
Ocean Science in Relation to Non-Living Resources (cont.)	2. Preparation of geo-morphological maps of the coastal areas.	"	------	------
	3. Beach dynamics and monitoring.	"	------	------
	4. Quaternary palaeo-oceanographic studies.	"	------	------
	5. Geotectonic, morpho-structural and geodynamic studies of deep trenches.	"	------	------
	6. Water and conti-nental material fluxes towards the sea.	"	------	------
	7. Evolution of coastal fringe in the beach zone.	"	------	------
	8. Management of coastal ecosystems including legal aspects.	"	------	------
Marine Pollution Research, Control and Abatement	1. Control of domestic, industrial and agricul-tural land-based sources of pollution.	IOC/UNEP and national institute under the super-vision of the CEP POL focal points	Mar 1990-May 1991	238,000
	2. Baseline studies on pesticide contamina-tion.	IOC/UNEP, UNAM, EQ-UCR Univ. of W. Ind., Jamaica, CEHI, CIOH, NOAA	Mar 1990-Oct 1991	265,000
	3. Monitoring and con-trol of the sanitary quality of bathing and shellfish growing water.	IOC/UNEP, WHO/PAHO, Nat. Inst.	Mar 1990-Sep 1991	190,000
	4. Monitoring and con-trol of pollution by oil and marine debris.	IOC/UNEP, IMO, ARPEL	Mar 1990-Sep 1991	221,000

Annex II: Projects Relevant to the IOCARIBE Medium Term Plan

Program	Name of Project	Responsible	Implementation	Budget U.S. $
Marine Pollution Research, Control and Abatement (cont.)	5. Site-specific studies of damaged ecosystems and development of proposals for remedial action.	IOC/UNEP, Nat. Inst.	Mar 1990-Sep 1991	212,000
	6. Development of environmental quality criteria.	IOC/UNEP, WHO/PAHO FAO (etc.), Nat. Inst.	Mar 1990-Oct 1991	238,000
	7. Research on the significance of organo-tin as pollutant of the Wider Caribbean region.	UPR, CEHI	Mar 1990-Aug 1991	65,000
	8. Coordination of CEP POL.	IOC/UNEP	Mar 1990-Oct 1991	155,000
Ocean Mapping	1. IBCCA	IOC	Ongoing-1995	------

about the magnitude, direction and possible impacts of climatic and other environmental changes. In the short term perspective one of the main goals will be to train experts in measuring and interpretation of parameters to these changes. Central to these projects, is an operational network of Sea-Level stations throughout the Caribbean (regional component of the IOC Global Sea-Level Observing System - GLOSS).

As an expansion of the IOCARIBE programme on Marine Pollution Research and Monitoring (CARIPOL), a joint IOC/UNEP Marine Pollution Assessment and Control Programme for the Wider Caribbean (CEPPOL) has been established in 1990, aimed at activities related to Monitoring, Research, Control and Abatement of Marine Pollution. The programme comprises projects on: "Control of Domestic, Industrial and Agriculture Land-based Sources of Pollution": "Base-line Studies on Pesticide Contamination"; "Monitoring and Control of Sanitary Quality of Bathing and Shellfish Growing Waters"; "Monitoring and Control of Pollution by Oil and Marine Debris"; "Site-specific Studies of damaged Ecosystems and Development of Proposal for Remedial Action"; "Development of Environmental Quality Criteria"; and, "Research on the Significance of Organotin as Pollutant (Annex III).

A Project Proposal on "Caribbean Coastal Zone Changes: Their Relationship to Sea-Level and other Forcing Processes and Implications for Management" is being developed with partial support of ICOD, Canada and the EC. The project document was finalized by an Ad-Hoc Group of Experts during the Second Congress on Marine Sciences, Havana, Cuba, 18-21 June 1990 (IOC, 1990).

Other regional programmes relate to two major initiatives: Ocean Science and Living Resources where the problem of "recruitment" in main fisheries is addressed through four sub-projects: "Satellite Ocean Analysis (SOAR)", "Fish-Estuarine Deltaic Recruitment (FEDERP)", "Shrimp Recruitment (PREP)", and, "Coral Reef Recruitment (CORDERP)". Dr. J. Day introduced at the meeting the FEDERP Sub-Project and Dr. M. McGowan the CORDERP Sub-Project (Annex IV). Other major initiative deals with Marine Information Management where an appropriate mechanisms to assure an adequate and stable flow of all kind of supporting information, is under consideration.

These and other programmes are developed as part of the IOCARIBE Medium Term Plan: 1990-1995 (bibliographic ref. IOC/INF-809). With the planning phase essentially completed, the operational phase is now being pursued. Some actions will require "started" or "catalytic" funding. Perhaps most importantly, the success of these programmes/projects during these six years, is contingent on strong and consistent support from Member States and International Organizations governmental and non-governmental.

3.2 The Caribbean Environment Programme
(Sálvano Briceño, UNEP)

Established under the aegis of the United Nations Environment Programme, the Caribbean Environment Programme aims to protect and develop the marine environment of the Wider Caribbean Region. Thirty-seven States and Territories comprise the Wider Caribbean Region, an area characterized by great cultural diversity of its marine and coastal ecosystems. The region's politics are similarly diverse, with contending ideologies, competing trade and economic alliances and differing political traditions. Despite these differences, there exists a strong sense of regional coherence generated by centuries of interchange and interaction. All of the States and Territories share a common resource--their regional seas--the Gulf of Mexico and the Caribbean, which together with the adjacent areas of the Atlantic Ocean and its coastal areas, constitute the Wider Caribbean Region.

The Caribbean Environment Programme (CEP) emerged as a result of many years of work by governmental and non-governmental representatives of the Caribbean community (UNEP, 1989), assisted

Annex III: Recommendations of SC-IOCARIBE-I, SC-IOCARIBE-II and SC-IOCARIBE-III

Program	Recommendation	Sate of Implementation
	SC-IOCARIBE-I	
Marine Pollution Research and Monitoring	Pollution research and training.	Workshop, training course, steering committee (two sessions), two publications.
OSLR	OSLR-IREP workshop in tropical demersal communities.	Workshop.
OSNLR	Activities on coastal dynamics and shoreline stability.	Symposium, proposal for three regional projects.
Ocean Mapping	International bathymetric charts for the Caribbean and the Pacific coast of Central America.	Editorial board (three sessions), workshop, regional project being implemented.
Ocean Dynamics	Ocean-atmosphere interactions.	Meeting, workshop, proposal for regional project.
TEMA	Regional network of educational and research institutions.	Without major progress.
Relation with other programs	Cooperation between IOCARIBE and UNESCO in COMAR.	Without major progress.
	SC-IOCARIBE-II	
Physical Oceanography and Climate	IOCARIBE program in physical oceanography and climate.	Regional project, three publications.
Marine Pollution Research and Monitoring	Regional program on marine pollution research and monitoring.	Implementation of phase I and II of the CARIPOL program, proposal for joint IOC/UNEP regional program (CEP POL), regional group of experts (one session), workshop, training course, about 35 publications.
OSLR	Recruitment in tropical coastal demersal communities.	Group of experts (one session), workshop, four proposals for regional projects, publications.
	Regional response to mass fish mortalities in the IOCARIBE region.	Without progress.

Annex III: Recommendations of SC-IOCARIBE-I, SC-IOCARIBE-II and SC-IOCARIBE-III

Program	Recommendation	Sate of Implementation
OSNLR	Regional component of the program on OSNLR.	Training course, meeting.
IOOE	Development of the IOOE system in the IOCARIBE region.	Without progress.
Marine Information Management	Regional system for marine information management.	Without progress.
Relation with other programs	Interaction between IOCARIBE and the COSALC component of COMAR of the Division of Marine Sciences of UNESCO.	Without progress.
	SC-IOCARIBE-III	
Physical Oceanography and Climate	Physical oceanography and climate.	Projects on physical oceanography and climate are being implemented.
Marine Pollution Research and Monitoring	Marine pollution research and monitoring component of GIPME-MARPOLMON.	The CEP POL program with many projects has been approved/implemented.
	Dr. Atwood's involvement in CICAR, IOCARIBE association and IOCARIBE Sub-Commission.	--------
OSLR	Regional component of the IOC-FAO program on Ocean Science in Relation to Living Resources (OSLR).	TRODERP sub-projects SOAR, PREP, FEDERP and CORDERP are being implemented.
OSNLR	Regional component of the IOC-UN (OALOS) program on Ocean Science in Relation to Non-Living Resources (OSNLR).	Project on Impacts of Sea-Level Changes on the Coastal Zone-Effects on Erosion and Sedimentation is being implemented.
Marine Information Management	Regional system for marine management.	Development of marine debris data base in progress.

Annex III: Recommendations of SC-IOCARIBE-I, SC-IOCARIBE-II and SC-IOCARIBE-III

Program	Recommendation	Sate of Implementation
COMAR	UNESCO major inter-regional project on research and training leading to integrated management of coastal systems (COMAR).	Revision of situation with UNESCO re-initiated.
	Scheduling of sessions of the IOCARIBE Sub-Commission.	Action being take.

Annex IV: IOCARIBE-TRODERP-CORDERP
(COral Reef DEmersal Recruitment Project)

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PROGRESS REPORT OF CORDERP (December 18, 1990)

(presented 17 December 1990 at the Intra-Americas Sea Marine Science Meeting of U.S. experts, Miami, Florida)

Part 1: Background

The objectives of CORDERP as stated in the IOCARIBE Draft Medium Term Plan revision 3 (SC-IOCARIBE-III/8(2) rev 3) are:

(1) Describe the population genetics of spiny lobsters and four species of snapper throughout the Caribbean coral reef biotope.

(2) Perform fishery biological studies of the most representative species in their ecosystem.

(3) Determine physical processes and biological interactions within the ecosystem and in artificial reefs.

Following recommendations in the 1989 workshop in Caracas, Venezuela in September 1989 (IOC Workshop Report No. 60), a CORDERP meeting was held in Havana, Cuba in June 1990. The proposals presented at the Caracas meeting were discussed, the status of the United States SEFCAR project on lobster genetics was reviewed, and plans for research in Puerto Rico and Martinique were presented. Because of the differences in priorities and development of recruitment studies among various participants, it was agreed to pursue bilateral/multilateral cooperative projects without attempting a fully pan-Caribbean recruitment experiment at this time. A workshop was proposed to be held in conjunction with the Association of Marine Laboratories of the Caribbean meeting in June 1991 to report additional progress and to plan a major regional symposium on CORDERP related subjects.

Part 2: Progress in SEFCAR

(The southeastern Florida and Caribbean Recruitment Project of the University of Miami, funded by U.S. National Oceanographic and Atmospheric Administration [NOAA]).

Annex IV: IOCARIBE-TRODERP-CODERP
(COral Reef DEmersal Recruitment Project)

(1) Spiny lobster population genetics

Mitochondrial DNA analysis of adult lobsters from throughout the Caribbean is being performed at the Rosenstiel School of Marine and Atmospheric Science, University of Miami. Specimens have been collected or received from several locations including the Bahamas, Mexico, Colombia, Cayman Island, Antigua, Puerto Rico, British Virgin Island, Trinidad-Tobago, Martinique, and Brazil. These samples will be analyzed to determine relationships among populations in the source locations and they will be compared with the genetics of post-larval lobsters which settle in Florida which is downstream from all these locations except for the Bahamas.

(2) Determine physical processes and biological interactions within the ecosystem and in artificial reefs

Plankton samples and physical oceanographic observations were collected in the Florida Keys during 1989 and 1990. A local gyre named the Pourtales Gyre and a countercurrent system were confirmed to exist near the Florida Keys when the Florida Current is in an appropriate offshore position. Analysis of the distribution of planktonic fish larvae and lobster larvae show the effect of this gyre. Fish larvae with nearshore spawning can be retained, potentially, long enough to recruit back to the general area where they were spawned. Larvae of fish which spawn offshore, or downstream from the most frequent position of the gyre, are swept away by the current. If fish spawn in fixed locations, then variable recruitment may be caused by variability in the timing and spatial extent of the gyre. Lobster larvae also show interspecific differences in nearshore-offshore distribution. Preliminary indications are that some slipper lobsters (*Scyllaridae*) are retained locally but that the commercially important spiny lobster (*Panulirus argus*) is subjected to long distance transport during the larval stage. This pattern predicts that the population genetic analyses will not show consistently distinct subpopulations throughout the Caribbean. Satellite-tracked drifters showed that the gyre and countercurrent can entrain water from upstream in the Loop Current in the Gulf of Mexico. This water would contain spiny lobster larvae from upstream sources in the Caribbean. Therefore, variability in the gyre and current may also cause variability in recruitment of spiny lobsters to the Florida Keys. These results suggest two important implications for the wider Caribbean region. First, some species which are locally retained may be managed locally but others with widely dispersing larvae must be managed regionally. Second, if recruitment variability can be related to oceanographic variability of local gyres and countercurrents, then recruitment predictions can be made from physical oceanographic observations such as those proposed in the SOAR subproject of TRODERP.

by the United Nations Environment Programme (UNEP) and the Economic Commission for Latin America and the Caribbean (ECLAC). This was a grass-root, regionally initiated process, set in motion by a deep concern for the future of social/economic development and resource management in the region. Its evolution was an exhaustive process involving extensive discussions and consultations. Eventually differences in view points and political perspectives were overcome in the interest of regional cooperation. Today, after years of negotiation, the States and Territories have come together in pursuit of a common goal: the protection of the marine and coastal environment through the promotion of balanced and sustainable economic development.

At Montego Bay, Jamaica, in April 1981, 22 States and Territories adopted the Action Plan for Caribbean Environment Programme and established the Caribbean Trust Fund. In March 1983, at Cartagena de Indias, Colombia, two years after the adoption of the Action Plan, the following legal instruments were adopted:

- The convention for the protection and development of the marine environment in the Wider Caribbean (Cartagena Convention); and

- The protocol concerning cooperation in combating oil spills in the Wider Caribbean Region.

These two major instruments entered into force on 11 October 1986, and to date, have been ratified by 18 States (Antigua and Barbuda, Barbados, Colombia, Cuba, Dominica, France, Grenada, Guatemala, Jamaica, Mexico, Netherlands, Panama, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, United Kingdom, United States of America, and Venezuela).

This process was further enhanced with the establishment of the Regional Coordinating Unit in Kingston, Jamaica, which was formally inaugurated in May 1987.

Under the Cartagena Convention, the Contracting Parties are obligated to prevent, reduce and control pollution from ships, land-based sources, air-borne sources and sea-bed activities. The Parties are also required to protect unique and fragile ecosystems and the habitats of endangered species and to engage in technical assistance programmes, information and to promote regional cooperation, among others.

In this regard, the Caribbean Environment Programme at the Conference of Plenipotentiaries on Specially Protected Areas and Wildlife in the Wider Caribbean Region (Kingston, 15-18 January 1990), achieved an additional objective, that is the signing of a second Protocol to the Cartagena Convention. The protocol on specially protected areas and wildlife in the Wider Caribbean Region was signed by 13 Contracting Parties. In addition, the process of extending the protocol concerning cooperation in combating oil spills to include other hazardous substances was also significantly advanced.

The Wider Caribbean Region is only one of ten Regional Seas Programmes of the United Nations Environment Programme which today, brings together over 130 states bordering shared seas around the world--States that have an interest in cooperating for their own and mutual benefit.

UNEP has provided the initial impetus by bringing governments together to develop a flexible legal framework within which further agreements can be negotiated as needs require and policies allow. UNEP also provided some initial "seed money" for programme development, but the governments of the region themselves have taken over funding and management, drawing on the technical advice of the UN and other agencies. The result is a gradually evolving

action-oriented programme rooted in the needs of the region, as perceived by the governments concerned. It is important to note that during the last three years, the States and Territories of the Caribbean have become increasingly involved in the Programme. The ratification of the Convention, as well as the contributions to the Caribbean Trust Fund, are clear examples of their commitment.

As stated in the Brundtland Report, "The political strategy behind the (Regional Seas) programme and the requirement that management and financing be undertaken by the participating countries have clearly been crucial to its success."

The Caribbean Environment Programme is at present providing an adequate and effective regional institutional framework to deal with the coordination required to address the marine and coastal environmental problems of the region. The Cartagena Convention, its protocols, along with the Action Plan, the Regional Coordinating Unit and our network of Focal Points of the Programme provide a unique regional system for cooperation in this subject. However, it will only be completely effective once all concerned governments and organizations participate actively.

For the 1990-1995 period, the Action Plan for the Caribbean Environment Programme is focusing on five priority areas:

- Assessment and control of marine pollution (CEPPOL) jointly being implemented with the Intergovernmental Oceanographic Commission (IOC/UNESCO).
- Specially protected areas and Wildlife (SPAW).
- Information systems for the management of marine and coastal resources (CEPNET).
- Integrated planning and institutional development for the management of marine and coastal resources (IPID).
- Education, training and public awareness for the management of marine and coastal resources (ETA).

3.3 Multinational Project on the Environment and Natural Resources (Alberto G. Lonardi, OAS)

Resolution CIECC 770/88, adopted by the OAS Inter-American Council in September 1988, established the Multinational Project on the Environment and Natural Resources with the following objective for the 1990-95 six-year period: "To promote knowledge, protection and improvement of native species and varieties, the study of existing potential for their rational exploitation and the development of technologies suitable for those purposes and for the development of clean technologies that will enable the industrial sector to advance while preserving the environment." The goals of the Project, as agreed in the programming meeting held in Washington, D.C. on December 11 to 15, 1989, are: "To help generate, adapt and develop regional capability in planning research, evaluation, and management of terrestrial and marine natural resources, in order to maintain the environment and its natural processes, to preserve biological diversity and to increase its productivity, in each of the member states and at the regional level." . To this end, and based on the initial priorities set up by the countries themselves at the end of 1989, the Project will focus on

the following:

(1) Development of a regional network of institutions and creation of new, or reinforcement of existing, postgraduate courses for training in planning, management, conservation and development of natural resources and the environment. Includes the creation of postgraduate courses in Argentina, Brazil, and Mexico and the reinforcement of one in Costa Rica, training in environmental economics and management, and the financing of students from other countries to attend the above mentioned activities. The budget is U.S. $200,000 per year.

(2) Management, conservation and development of water resources, inland waterways, the coastal zone and the Exclusive Economic Zone of Latin America and the Caribbean. Includes the preparation of country environmental profiles, research and monitoring of dams and reservoirs, and pollution research, training in limnology and satellite imagery interpretation, research in productivity of coastal waters using remote sensing, coastal erosion and pollution control and recovery, development of mariculture and pisciculture, and design of prospective policies and strategies for the environment. The budget is U.S. $550,000 per year.

(3) Management, conservation and development of wildlife and domestic fauna and flora. Involves research in conservation, management and improvement of Andean camelidae and caprines species as well as research in wildlife fauna with emphasis in tropical species, and research and training for the development and management of indigenous plant resources, isolation and characterization of bioactive compounds, validation of medicinal plants, creation of inventories and data banks, workshops and symposia, with a budget of U.S. $280,000 per year.

(4) Evaluation and development of non-conventional energy resources. Consists of the establishment of a subregional network for the evaluation of solar energy, the selection and adaptation of suitable solar energy technology conversion for rural development, training of participants, and the holding of a Plasma Physics Seminar, with a budget of U.S. $70,000 per year.

Twenty-five countries will participate in one or more of the four areas mentioned above, through more than 50 universities, specialized institutes and other executing agencies. The total funds assigned to the OAS Project amounts to U.S. $1,100,000 per year, which are going to finance 50 multinational activities to be held during 1990-1991. The multinational activities will be related to research, human resource development and training, design of policies and strategies, and information exchange.

These lines of work will be pursued by organizing multinational courses, seminars, workshops for training in scientific techniques, and for the updating of scientific and technical knowledge, conferences, research projects and publications. All participating institutions will also exchange their experiences among themselves and with institutions from USA and from other countries outside the region, at periodic meetings of coordination.

This multinational project maintains coordinating links with other regional, non-governmental and international organizations devoted to global issues like the conservation of the environment, global warming, ocean pollution, coastal and ocean development, etc., and serves as a reference point of information exchange for participating institutions of the region.

4.0 WORKSHOP REPORTS

4.1 Group I: Mechanisms to Facilitate Marine Science Projects (Rapporteur: George A. Maul, NOAA/AOML)

WORKSHOP REPORT: The working group was asked to focus on the following issue and to provide appropriate recommendations: "The generation of ideas and mechanisms to facilitate marine science projects with high scientific priority and with potential for supporting regional organizations."

1. RECOMMENDATION: Extend the Sea Grant Program to the region, perhaps by implementing an international (hemispheric?) Sea Grant, capitalizing, for example, on the requirements of the Cartagena Convention which mandates a "Sea Grant type" program (CEPPOL) in the region; U.S. Territories, Commonwealth, and States in the region to be fully included.

   RESPONSIBILITY: NOAA

   DEADLINE: FY-1992 budget item

2. RECOMMENDATION: Make key policy makers aware of IOCARIBE- and UNEP-related issues, resources needed to address these issues, and benefits to be gained for such support.

   RESPONSIBILITY: As appropriate

   DEADLINE: 1991

3. RECOMMENDATION: Initiate active involvement with UNOLS, SECOR (the SouthEast Consortium for Ocean Research) and other such committees by institutions within the region to foster ship-time requests and information on planned cruises.

   RESPONSIBILITY: UPR, CVI

   DEADLINE: 1991

4. RECOMMENDATION: Provide copies of research vessel clearance requests to the American Embassy in Cartagena for distribution through IOCARIBE to all Gulf/Caribbean marine research institutions and universities with marine science departments.

   RESPONSIBILITY: State Department

   DEADLINE: 1991

5. RECOMMENDATION: Publish cruise plans on electronic bulletin boards and in newsletters of IOCARIBE, UNEP, and NOAA with sufficient lead-time to allow participation requests; encourage other countries in the region to widely publish cruise dates and space availability.

   RESPONSIBILITY: IOCARIBE Secretariat

   DEADLINE: 1991

6. RECOMMENDATION: Advertisement of ship-time opportunities to be an agenda item at March 1991 IOC Assembly.

RESPONSIBILITY: State Department, IOCARIBE Secretariat

DEADLINE: January 1991

7. RECOMMENDATION: Secondment of U.S. scientists and/or technicians at IOCARIBE and UNEP/RCU offices both for 1-2 year assignments, and for shorter durations as specific projects demand. The purpose would be to assist the organizations in the execution of projects, planning, and to generate better understanding of common goals.

   RESPONSIBILITY: NOAA, EPA, IOCARIBE, UNEP, other

   DEADLINE: 1992

8. RECOMMENDATION: Establish a National Committee for Intra-Americas Sea Marine Science as a subcommittee of PIPICO; U.S. National Representative to IOCARIBE to chair and report regularly.

   RESPONSIBILITY: NOAA/NMFS

   DEADLINE: 1991

9. RECOMMENDATION: Convene in late 1991 an "issues oriented" follow-on meeting to advise USDEL to 1992 IOCARIBE meeting and to other inter national bodies on (1) agenda items, (2) how to support programs, (3) management issues, and (4) shared resources and problems.

   RESPONSIBILITY: NOAA, State, NAS

   DEADLINE: September 1991

10. RECOMMENDATION: Provide wide international distribution of this report and follow-on reports.

    RESPONSIBILITY: NAS

    DEADLINE: April 1991

11. RECOMMENDATION: IOCARIBE Secretariat to encourage all member states to participate in TEMA meeting in March 1991 in Paris.

    RESPONSIBILITY: IOCARIBE Secretariat

    DEADLINE: January 1991

12. RECOMMENDATION: Present results of this meeting to the IOC Assembly in March 1991 in Paris.

    RESPONSIBILITY: State Department

    DEADLINE: February 1991

4.2 Group II: Human Resources, Development and Education
(Raporteur: Arthur Paterson, NOAA/DAS)

Human Resources Development and Education:

1. IOCARIBE, in coordination with CEP, should initiate a focused educational initiative targeted on high level government decision makers on the importance of basic scientific research, e.g., IOCARIBE program, to national economic development priorities.

2. The scientific community and regional institutions such as IOCARIBE and UNEP should serve as a catalyst to the training of marine and coastal resource managers--literate in basic oceanographic sciences--recognizing that more narrowly trained basic oceanographic researchers will find few jobs and scarce funding within their countries.

3. The scientific community and regional institutions such as IOCARIBE and UNEP should develop a marine advisory service that will (a) enhance training (formal and non-formal) opportunities, (b) translate research into economically relevant information for both decision makers and local business, and (c) provide a vital link between research and development. In addition, the advisory service can play an important role in the advancement of marine environmental/scientific curriculum in the schools, starting at the primary level as well as promote adult education and public policy participation.

4. The U.S. should demonstrate higher level commitment to IOC/TEMA and should send a representative to the upcoming TEMA meeting in 1991.

Environmental Information and Data from Basic Research:

1. Demonstration of a long-term commitment by the research community to a subregion/problem, will significantly enhance access to geographic areas and to data. It would enhance opportunities for local scientist contributions, local in kind facility support, local training, and possible development of complementary research that may have a more "applied" focus.

2. An electronic bulletin board for the Caribbean was strongly supported.

Basic Research Applications/Implications for Development Priorities:

1. The scientific community and IOCARIBE should give special attention to the study of oceanographic circulation variations within the context of efforts to understand the regional physical oceanographic circulation patterns. This will enable decision makers to understand and advance applied research/policy objectives in such areas as fisheries management and pollution, as well as prepare for potential effects of global climate change.

2. Regional scientific, environmental and economic organizations should collaborate in specific "demonstration" projects which link research objectives/with development goals. Development of a "success track record" requires a long-term commitment by both researchers and Caribbean countries to specific environmental problems. An ecosystem research approach might advance both research and development priorities in a more direct manner. (Centrally located joint laboratories might help to focus scarce human and financial resources on research projects with important socio-economic applications.)

3. Establish a satellite data receiving dish and data distribution center for NOAA AUHRR Local Area Coverage data which could be used for fisheries oceanography and management and forestry. Access to satellite data for local fishermen (already available to U.S. long liner pelagic fleet) would provide a high profile demonstration of the utility of fisheries oceanography to economic concerns.

4. Establish important links between the research and economic development sectors in the arenas such as tourism development (Edgell, 1990). Coastal ecosystems (including species distribution) will change as a result of increasing tourist development and pressure. Research can play an important role in helping to maintain the balance between resource conservation and lucrative tourist recreational activities.

5. Design integrated projects with research-to-management ("cradle-to-grave") focus. The National Estuarine program might serve as one model.

General Observations:

1. Although the U.S. science community (oceanographic) community is aware of the important economic development implications of its research agenda, its attention is focused on basic research priorities/scientific unknowns rather than on socio-economic issues per se.

2. The development implications of marine and coastal basic environmental processes research are diverse: human resources, tourism, coastal development and multiple resource use management, fisheries development, etc. These fields are generally extraneous to the original research design and primary investigation.

3. There is a major communication gap between the oceanographic research community and the users of researcher results outside the science community, such as government decision makers and resource managers. This is true within countries as well as between IOCARIBE, CEP and potential donor agencies.

4. IOCARIBE must initiate an active partnership with other organizations in order to take advantage of the economic development benefits of basic research.

4.3 Group III: Communication and Networking
(Rapporteur: Norman L. Guinasso, Jr., TAMU)

The Committee discussed at length the role of electronic communication in increasing the interaction of those interested in the Caribbean. Some thought was given to the establishment of an electronic Caribbean bulletin board, patterned after the bulletin boards run for WOCE, Gulf of Mexico (GULF.MEX) and others using the OMNET system (see Appendix B). Information on various programs and activities could be posted on the board which would, over time, come to be a way to contact all those interested in oceanographic affairs in the Caribbean.

It was pointed out that many countries did not have access to OMNET, or if access was available, it was only through an expensive international telephone call. Some mechanism had to be found to communicate the information posted on the bulletin board to the broader community without electronic mail.

The Committee then discussed the role of various newsletters in furthering communication among the Caribbean interests. The U.S. NOAA Status and Trends Newsletter was put forth as an example of what was needed for the Caribbean. This newsletter gives a brief overview of who is doing what, where they are doing it, and what is available. It was noted that many newsletters covering oceanographic topics now exist and serve specialized needs such as pollution, fisheries, turtle research, etc. Best known is the IOCARIBE newsletter, produced quarterly by Fernando Robles in Cartagena, Colombia.

Some discussion of newsletter content then followed. Scientists and governments are encouraged to share and describe what they are working on. Information is sometimes used in unusual ways. International banks, e.g., have needed to know the swordfish stocks near various islands to judge the viability of loans to fishing interests.

Alberto Lonardi described communications used by the OAS. They use TELEX and FAX to communicate to OAS office in each country. There is an information program in the scientific department which is the focal point for the preparation of manuals. OAS sees the need for increased support for communications in marine science. The OAS information exchange programs work daily with universities and OAS governments.

Fernando Robles presented his perspective on communication flows in the Caribbean. He made the following points:

1. Mail sometimes works very badly in the Caribbean. Delivery can sometimes take one month. Airmail is expensive.

2. Telephone works well, especially between capital cities. International telephone calls are expensive.

3. FAX works well. Everyone has a FAX.

4. Telex is expensive, especially the cost of renting equipment.

5. He is sending some news via automatic dialing FAX/computer. This could be the best way to send low volume newsletters in the future.

6. Telemail (OMNET) is the best means of communication, but does not work well except in Tabago, Colombia, Mexico and Puerto Rico.

The group felt that the best way to increase communication flow was to increase the amount of information in and the frequency of publication of the IOCARIBE newsletter. This newsletter would complement a Caribbean electronic bulletin board in that it would serve to disseminate electronic information to a wider audience.

Interests not connected to electronic mail could be reached by automatic FAX or by mail. The group discussed publishing a monthly IOCARIBE newsletter in addition to the present quarterly. The monthly newsletter need not be printed in multiple languages as are the quarterly newsletters and need not be printed in as formal a style.

IOC would probably not object to the newsletter appearing in one language. Robles should not be asked to do this unless he is given addition resources.

Recommendation:

The Committee recommended that additional support be sought for the IOCARIBE office in Cartagena to assist with the publication of the additional newsletters. Specifically, we recommended that one additional professional person be funded to work in Cartagena. This person could possibly be seconded from NOAA or other U.S. agency.

Additional Items:

Requests for NODC data by Caribbean scientists have run into roadblocks because many cannot afford the NODC charges. Question: Can the U.S. pay the NODC charges as contributions in kind to IOC for data requests forwarded by the IOCARIBE office?

The recommendations made in the 1986 report by John Sylvester, "Report of Consultant Mission to Selected Caribbean Island States," are still timely and valid.

5.0 CLOSING REMARKS
(Bradford E. Brown, U.S. IOCARIBE Representative)

First, I want to express my sincere appreciation to all of you for your willingness to attend and participate in this discussion. Secondly, I thank you for your preparations of the materials that formed the basis for our discussions and for the hard work and efforts expended at this meeting. Our shared concern around the need for enhancing the work of IOCARIBE and related organizations and the U.S. participation therein is resulting in specific recommendations. We are here because we believe the work in the Intra-Americas Sea is important scientifically and that the results of our research can have significant impact on the well-being of the entire region, a region that works to obtain badly needed economic development which, without utilizing the results from scientific research, can well fail to be sustained economic development. All of the international scientific bodies concerned with the Caribbean should cooperate in enhancing the research. The resources of IOCARIBE, UNEP, WECAFE and independent organizations such as the Association of Island Marine Laboratories of the Caribbean and the Gulf and Caribbean Fisheries Institute can have greater input together than separately. Where appropriate, linkages should be made with bi-lateral efforts such as the Mexus-Gulf Cooperative Research Agreement between fisheries laboratories of the United States and Mexico. The United States fishery management councils, particularly the Caribbean Fishery Management Council but also the Gulf of Mexico Fishery Management Council, can be important in this effort as well.

The 50 or so institutions of higher education bordering the Intra-Americas Sea and particularly the Caribbean island institutions, i.e., the University of Puerto Rico in Mayaguez with its Sea Grant Program, the College of the Virgin Islands with its involvement in resource management training development throughout the Caribbean, can be very important for U.S. involvement in the region.

As I look at the recommendations from our discussions, it becomes obvious that the core of the recommendations are similar to those made earlier by knowledgeable people working in IOCARIBE. However, recommendations must not only be made but to be effective they must fall on responsive ears. Furthermore, it often requires significant follow-up on the part of those making the recommendations to achieve its acceptance. Thus, I am particularly excited about the recommendation that an advisory body to PIPICO be formed, consisting primarily of individuals right here in this room. This can well provide

the structure necessary for moving these recommendations, as well as adapting them to specific policy issues faced at IOCARIBE meetings.

Those recommendations that relate to remote sensing and its availability and the use of electronic bulletin boards for rapid communication merit extensive efforts to develop. These are technologies that were not as readily available in the earlier years. It is particularly important that these tools be utilized in a way that support the training responsibilities of IOCARIBE and other organizations with similar objectives such as UNEP and OAS.

I wish to acknowledge the leadership of George Maul as IOCARIBE vice-president who has been my mentor on IOCARIBE. Bill Erb of the State Department conceived the concept of this workshop and has worked hard for its success. I want to thank my special assistant, Essie Duffie, for her efforts with regards to the logistics of this meeting and, in advance, her efforts in seeing that a good report is forthcoming. I also wish to thank our Center secretary, Virginia Broadnax, for working effectively in making smooth arrangements for this meeting.

Finally, I want to respond to the comments that have been made by at least some of you as to the prospects for real action with regard to increasing the effectiveness of IOCARIBE and the U.S. involvement in the important research needed in this area. I can only respond by saying that I have no presumptions of more knowledge or effectiveness than my outstanding predecessors as IOCARIBE delegates. Perhaps because I am the new kid on the block; perhaps because fools rush in where angels fear to tread, but I believe that the time is right for a greater recognition of the importance of scientific research in the Intra-Americas Sea area. Because I believe this, I commit myself to utilizing the insights gained at this meeting and the document that we will produce to work towards greater and more effective research involvement in this region.

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APPENDIX A: INSTITUTIONAL SUMMARIES

Federal Agencies

Caribbean Activities of the Southeast Fisheries Center

James Bohnsack and Larry Massey, NOAA/NMFS/SEFC

The Southeast Fisheries Center (SEFC) of the National Marine Fishery Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, is responsible for providing the basic research advice on issues related to fisheries in the purview of the Federal government in the area from North Carolina to Texas, Puerto Rico, and the U.S. Virgin Islands. In addition, it is responsible for the United States' international responsibilities in the entire Caribbean area. It is also responsible for research on large pelagic resources throughout the Atlantic. Many of the fishery resources under investigation at the Southeast Fisheries Center consist of either stocks which move between U.S. and international waters or of different stocks of the same species. The Center's extensive habitat research on coastal areas involves similar ecological areas as those in other countries in the wider Caribbean such as mangroves and seagrasses. The Center has a series of programs to improve data collection, communication, and management of fisheries stocks in the Caribbean region which are described here. Many Caribbean fishery species are likely interconnected through egg and larval dispersal such that fish stocks in one country may depend on upstream recruitment from other areas. Thus, a need exists to better understand the distribution, abundance, biology, and exploitation of stocks to better manage Caribbean fishery resources. While some SEFC programs cover much of the Caribbean, others operate only within U.S. jurisdiction but have application to the greater Caribbean Region. Major programs are discussed below.

Fisheries Statistics

The collection and maintenance of a fisheries statistics database involving catch, effort, value, and biological characteristics of the catch is a significant part of the Southeast Fisheries Center's responsibility. The maintenance of this database is critical to understanding the fisheries resources of the wider Caribbean area. This effort is a cooperative one between the Federal government, the states, Commonwealth of Puerto Rico, and the Territories of the Virgin Islands. Federal grant funds administered by the Southeast Fisheries Center assist the non-Federal partners in this effort.

Caribbean Fishery Management Council

Southeast Fisheries Center provides advice on status of the fishery resources and on fisheries management measures to the Caribbean Management Council for fishery resources around Puerto Rico and the U.S. Virgin Islands. Resources involved at present include shallow water reef fish, spiny lobster, and conch.

SEAMAP

The Southeast Area Monitoring and Assessment Program (SEAMAP) is a cooperative program which engages state and federal agencies in coordinated collection, management, and dissemination of fishery-dependent information (Stephan, 1990). SEAMAP's scope includes marine and estuarine waters and living marine resources within the United States internal waters, territorial sea, and Exclusive Economic Zone (EEZ) in the Gulf of Mexico, U.S. South Atlantic, and the Caribbean Sea. Its scope can be expanded when necessary and appropriate to include geographical areas beyond the EEZ that require cooperative agreements and coordination with foreign governments and international bodies or

commissions. Its goals are to: (1) collect long-term standardized fishery-independent data on the condition of living marine resources and their environment; (2) cooperatively plan and evaluate SEAMAP sponsored activities; (3) identify and describe existing non-independent assessments of regional living marine resources; (4) operate the SEAMAP Data Management System for efficient management and timely availability of fishery-independent data and information; and (5) coordinate and document SEAMAP activities and disseminate programmatic information. SEAMAP began in the Gulf of Mexico in 1981, expanded in 1983 to include the U.S. South Atlantic, and included the Caribbean region beginning in 1988. Primary emphasis for the Caribbean SEAMAP program is on shallow-water reef fishes, lobster, conch, and habitat.

ICCAT

Several countries in the wider Caribbean area are members of the International Commission for the Conservation of Atlantic Tunas (ICCAT). These include Cuba, USA, and Venezuela. Korea and Japan area ICCAT members which fish in the area. Stock assessment of tunas and tuna-like fishes are done through ICCAT. In conjunction with the ICCAT Enhanced Research Program for Billfish, a data collection program was initiated in 1987 in the Caribbean region to assess the status of Atlantic billfish (Istiophoridae). Data are collected from approximately 11 locations on total harvest from recreational and commercial sources. Additional data are collected on age, growth, and movements through tagging programs. Biological data and catch-per-unit-effort data are collected from various tournaments in the U.S. and other countries.

Cooperative Game Fish Tagging Program

A cooperative gamefish tagging program distributes tags and monitors returns to determine age, growth, and movements of major recreational and commercially caught species. Concentration has been primarily on billfishes and tunas but plans exist to expand to more species.

Reef Resources

The SEFC monitors trends in fishery landings and catch-per-unit-effort, and conducts studies on age, growth, distribution, and fecundity of various species. The SEFC has been instrumental in developing methods to non-destructively assess reef fish populations using visual methods. Theoretical and applied research has been conducted on the impacts of fish traps and the use of artificial habitat in reef fishery management. In 1990 a review of problems involving Caribbean fisheries was published (Richards and Bohnsack, 1990). Recent research has examined the design and usefulness of marine fishery reserves for reef fish stocks (PDT, 1990). Reserves may be an ideal way to protect spawning stock biomass and genetic composition of sedentary reef species, while maintaining high quality and quantity of recruits to fisheries. This research on reserves may provide a basis for pan-Caribbean management strategies.

Marine Turtles

NMFS/SEFC sponsored jointly with IOCARIBE and FAO the first two Western Atlantic Turtle Symposia (WATS) in which Caribbean nations presented and exchanged information on the status of sea turtles within national waters. WATS I had 33 nations represented in San Jose, Costa Rica in 1983. WATS II had 38 nations represented in San Juan, Puerto Rico in 1987. Data and species synopsis from both symposia have been published. Current Caribbean turtle activities in Miami focus on collecting

information on turtles that have washed up dead on the coasts of the U.S., Puerto Rico, and the Virgin Islands. These data are incorporated into the NMFS Sea Turtle Stranding and Salvage Network in Miami, which is the only long term database maintained on turtles on a regional basis.

Sharks

In 1991 the SEFC will start a program to improve the quality of data collected on commercial shark landings. Many shark species are known to migrate between the U.S. EEZ and other countries, especially Mexico. The goals are to (1) develop procedures and manuals for shark identification from carcasses, (2) develop species-specific formulae for estimating live weight from various carcass dimensions, and (3) train fishery personnel in data collection and shark identification.

MEXUS-GULF

The MEXUS-GULF program provides a structure for exchange and presentation of fisheries data of interest to the United States and Mexico. This program has facilitated data collection and exchange on age, growth, and movements of mackerels. Discussions are underway to expand this program to sharks.

Republic of Colombia Treaty

In 1981 a joint treaty between the Republic of Colombia and the United States allowed U.S. vessels to fish in waters of Quita Sueno, Roncador, and Serrana. Fishing by both countries is subject to reasonable non-discriminatory conservation measures. Representatives of both countries have established fishing reporting forms to monitor fisheries, have agreed to share data, and have agreed to joint conservation measures for reef fishes, conch, and lobster. This treaty also established a basis for future cooperative research efforts.

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Research Programs, Atlantic Oceanographic and Meteorological Laboratory

George A. Maul, NOAA/AOML

The Atlantic Oceanographic and Meteorological Laboratory (AOML) is a laboratory of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). AOML has four divisions (Hurricane Research, Ocean Acoustics, Ocean Chemistry, and Physical Oceanography), all of which have programs that involve the waters of the Intra-Americas Sea (IAS). AOML has approximately 150 employees and extensively uses the ships and aircraft of the NOAA.

The Hurricane Research Division (HRD) is involved in modeling, observing, prediction, and analysis of tropical storms, including the role of the ocean upon them. HRD scientists routinely use NOAA's instrumented WP-3D aircraft to fly into Atlantic and Pacific storms to gather atmospheric and oceanic data for research purposes and for real-time transmission to the National Hurricane Center for use in forecasts and warnings.

AOML's Ocean Acoustics Division (OCD) designs and deploys novel acoustic measuring systems to study problems such as dredge spoil and sewer outfall dispersion, rainfall rate variability, dynamic height anomaly, and ocean surface currents using HF radio sensing. OAD scientists and engineers work closely with regulatory agencies and other NOAA main line components, and frequently conduct short time duration shipboard experiments in local waters.

Ocean Chemistry Division (OCD) personnel conduct research in both aquatic and atmospheric chemistry, with emphasis on air-sea exchange of gases, biological and geological aspects of carbon flux, and indications of global climate change in marine ecosystems. OCD scientists and technicians mount numerous long time duration research cruises, but in the Intra-Americas Sea the cruises are focused on riverine interactions with the sea, particularly that of the Mississippi with the Gulf of Mexico.

The Physical Oceanography Division (PhOD) is primarily engaged in research into the role of the ocean in global climate, and has extensive programs in both the Atlantic and equatorial Pacific Oceans. In the IAS, the Atlantic Climate Change Program (ACCP) is the central effort and includes measurement programs of currents, tracers, heat flux, sea level, and in collaboration with NOAA's Pacific Marine Environmental Laboratory studies of volume transport from submarine cables. PhOD ACCP cruises are typically month long trips to the outer periphery of the Bahamas, Caribbean, and northeast coast of South America; these ACCP cruises are designed to study the role of the Florida Current and the Deep Western Boundary Current in the North Atlantic heat flux.

All four AOML divisions encourage collaboration with scientists through the National Research Council's Resident Research Program, and by joint efforts with the University of Miami - NOAA Cooperative Institute for Marine and Atmospheric Studies (CIMAS). CIMAS regularly hosts visiting scientists, and helps support postdoctoral and graduate students through externally funded proposals. AOML and CIMAS scientists actively participate in international programs such as WOCE, JGOFS, WCRP, and CEPPOL, and they interact with scientists from NASA, NCAR, NSF and other national agencies.

National Status and Trends Program for Marine Environmental Quality

Andy Robertson, NOS

NOAA's National Status and Trends (NS&T) Program for Marine Environmental Quality determines the current status and any changes over time in the environmental health of the estuarine and coastal waters of the United States, including along the U.S. Gulf of Mexico coast. The NS&T Program consists of four major components: Benthic Surveillance, Mussel Watch, Bioeffects Surveys and Quality Assurance.

The Benthic Surveillance Project determines concentrations of contaminants in sediments and bottom-dwelling fish taken from the same area. Over 77 contaminants are determined by the NS&T Program including organic chemicals such as DDT and its metabolites, other chlorinated pesticides, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons, and butyltins as well as trace and major elements such as lead, zinc, cadmium, silver, arsenic, and mercury. Also, the frequency of external disease conditions and internal lesions (liver tumors) in the bottom fish are being documented. Currently, there are about 20 Benthic Surveillance sites in estuaries and coastal waters of the Gulf of Mexico, including both urban and rural areas. Samples are generally collected biennially at these sites.

The Mussel Watch Project determines the same contaminants as in the Benthic Surveillance Project but in mussels or oysters as well as sediments. The bivalves are collected on a yearly basis from approximately 200 sites in the United States; and sediments at the same sites on a less than yearly basis. About 60 of the sites are located in the Gulf of Mexico. Plans are being developed for expansion of the NS&T Program to include sites in Puerto Rico and the American Virgin Islands. It is anticipated that 10-15 sites will be sampled on a periodic (less than annual) basis. The initial sampling will take place during 1991 or 1992 and will be carried out in coordination with the International Mussel Watch Program that is being sponsored by NOAA in conjunction with IOC and UNEP. The International Mussel Watch Program is planning to collect bivalve mollusks from a number of sites in the Caribbean Basin in 1991 for analysis of chlorinated hydrocarbon contaminants.

The Bioeffects Surveys consist of a series of intensive two- to three-year studies primarily conducted in those regions where a potential exists for substantial environmental degradation. These studies will provide detailed assessments of the magnitude and extent of ecosystem degradation, and are primarily focused on bottom fish. Studies include reproductive impairment, genetic damage, and the evaluation of new indicators of contamination such as DNA damage and enzymatic activity in fish livers.

The quality of data generated by the NS&T Program is overseen by the Quality Assurance (QA) Program component which is designed to document sampling and analysis procedures, and to reduce intralaboratory variation to 10% and interlaboratory variation to 20%. To document laboratory expertise, the QA Program requires all NS&T laboratories to participate in a continuing series of intercomparison exercises utilizing a variety of materials. Some non-NS&T laboratories voluntarily participate in the QA program, and additional monitoring laboratories are welcome.

Selected samples from the Benthic Surveillance and Mussel Watch projects are preserved in a specimen bank in liquid nitrogen. These specimens will be available for retrospective analysis.

To date, more than 150 publications, reports, technical memoranda and presentations have been derived from the Program. Microfiche and hard copy of the Program data is also available.

Role of the Ocean and Coastal Services Group in Caribbean Science and Development

H. Suzanne Bolton, NOAA/OLA

The Ocean and Coastal Services Group is a component of the Constituent Affairs Division (OLA) within the Administrator's Office of NOAA. Our major role is in developing mechanisms for improving awareness of and access to NOAA marine and coastal products, services, and intellectual properties for domestic and international constituents. While we do not conduct research in the technical arena, we are conversant in the marine sciences and actively facilitate the participation of scientific components of NOAA in forums wherein a broader technical community may profit from agency expertise.

Past Caribbean and South American Activities

The EPA Office of International Activities has sought our assistance in developing a mechanism for South and Central American governments to gain computer access to real/near-real time oceanographic data from NOAA's Monterey facility.

We assisted the same EPA office in an assessment of NOAA GIS approaches being considered for the Caribbean region through the Caribbean Environmental Program.

Current Activities

The Group initiated and coordinated NOAA's recent activities in the Second International Symposium and Workshop on Ecotourism. In cooperation with the National Ocean Service Office of International Affairs, we developed a format for and initial distribution draft document, "U.S. Federal Agency Assistance for Ecotourism Activities." This document is being redistributed to the Federal agencies in order to expand the range of scientific and management capabilities that draw upon the U.S. experience in planning, protecting, researching, and managing unique or particularly sensitive natural habitats. This document will be periodically updated and maintained by this office.

For the uninitiated, "ecotourism" or low impact tourism is an industry that focuses on marketing unique ecological or cultural areas for the public experience. While this emphasis is of particular concern for the many and varied coastal margins of the United States, the same is perhaps of even greater concern to developing nations for whom ecotourism may potentially represent a large part of their economic livelihood. The dramatic increase in tourism that focuses on the observation and enjoyment of unique or particularly significant natural habitats and environs places new emphasis on the need for integrated concepts of coastal zone planning and management. Ecotourism will be a forcing mechanism on many Caribbean, Central and South American nations to encourage sound coastal zone management.

The needs created by the increased pressures on especially sensitive environments and/or species resulting from a rise in "ecotourism" provide opportunities for the transfer of U.S. technologies and experiences to nations whose economies are based in part or primarily on tourism. Ecotourism, then, provides local economies with a basis for maintaining valuable ecological habitats in a natural or near-natural state in the face of competing pressures for uses of such protected acreage. The economic value of protected habitat in terms of aesthetics, ecosystem function, and endemic uses balances sustainability with the pressure for exploitation of renewable and non-renewable resources.

During the Ecotourism Symposium, NOAA met with the environment and tourism ministers of countries represented to discuss the U.S. role in technology transfer. The next conference in 1991, directed to the environment and tourism, will be organized by Belize. They have asked for our participation in the organization and development of that conference to ensure that the scientific and technical components necessary for the development of sound "ecotourism" policy are emphasized. We will assist, as broker, to encourage this technology transfer and scientific participation.

The Belize Conference will also be the basis for the development of proposed "Ecotourism Principles" to be presented in 1992 in Brazil at the U.N. Conference on International Environment and Development. Through this mechanism, the scientific and technical considerations can be directly incorporated into a working document for broader consideration. Participation by U.S. scientists with expertise in particularly sensitive habitats or species is critical to this development.

NHC's Support

Stephen Baig, NOAA/NWS

Name of Agency

National Weather Service/National Hurricane Center

Type of Assistance Available

Technical support is available for persons needing training in tropical meteorology, tropical cyclone forecasting, storm surge estimation and natural disaster preparedness related to tropical cyclones. Technical support is also available for investigators wishing to pursue research problems in tropical meteorology.

Description of Program

The World Meteorological Organization (WMO) has designated the National Hurricane Center (NHC) as the Regional Specialized Meteorological Center (RSMC) for the western hemisphere. This Center provides routine interpretation, analysis and forecast products year round and tropical cyclone forecast and warning guidance for all countries in the region. NHC conducts, under the aegis of the WMO, long and short-term practical training courses in tropical meteorology including tropical cyclone forecasting. NHC carries out a programme of research in tropical cyclone forecasting and cooperates with other investigators interested in various aspects of tropical meteorology.

How to Apply

Individuals desiring the opportunity to study and/or work at NHC must apply through the Meteorological Services in their own countries, which in turn may request support from the WMO.

Who to Contact

Individuals should request nomination by the Chief of the Meteorological Services in their respective countries. Notice of interest may also be made to:

James R. Neilon
Chief, International Activities Division
NOAA/National Weather Service
Silver Spring Metro Center 2
1325 East-West Highway, Room 14344
Silver Spring, MD 20910 USA
Telephone (301) 427-8090

Summary of Activities and Plans

Jimmy C. Larsen, NOAA/PMEL

Florida Current Transport Variations

1. Continue to monitor the volume transport of the Florida Current east of Jupiter, FL (27°N) by measuring the voltages between Jupiter and Settlement Point, Grand Bahama Island. Daily values of transport have been observed since December 1981. An attempt will be made in 1991 to improve the cable-ocean contact at the Jupiter end of the cable.

2. Continue to monitor the volume transport of the Florida Current south of Key West, FL by measuring the voltages between Key West and Havana, Cuba. This monitoring effort began in May 1990 and will continue until at least 1992. The voltage-transport conversion factor will be determined in 1991.

3. The transport variations of the Florida Current from 1981 to 1989 have been compared with simultaneous daily atmospheric pressure, winds, wind stress, and curl of the wind stress from FNOC values for the northern hemisphere. This is a study to determine the source for the transport variations observed in the Florida Current east of Jupiter.

OAR Interests in the Intra-Americas Sea

Barbara Moore, NOAA/OAR

The Office of Oceanic and Atmospheric Research (OAR) within NOAA has a number of programs with marine science interests in the Intra-Americas Sea. Some of those will be addressed in other presentations. The interests of Sea Grant, the National Undersea Research Program (NURP) and Office of Global Programs (OGP) are summarized here.

Sea Grant

The mission of the National Sea Grant Collection Program is to promote the development, conservation, proper management and maximum social and economic utilization of the nation's marine resources. It promotes the concept of fostering working partnerships between universities, industry, government and the community. The Sea Grant program at the University of Puerto Rico is a major federal effort to extend university contacts throughout the Caribbean and is considered the "flagship" program for the area. One component of the Puerto Rico program is at the College of the Virgin Islands. Representatives of both these institutions are listed in another segment of the agenda and will be able to provide first hand information on their programs.

National Undersea Research Program

This program provides support to scientists and engineers for the study of biological, chemical, geological and physical processes in the world's oceans and lakes. NURP assists researchers by providing access to a suite of modern undersea facilities including submersibles, habitats, air and mixed gas SCUBA and remotely operated vehicles. The science program supported by NURP has a number of priority areas as illustrated in Figure 1.

A major part of the research program is carried out by a network of National Undersea Research Centers (NURCS) which are located around the U.S. to build and execute field programs. Research teams are built by the Centers through development and submission of research proposals through NURP principal investigators.

The Caribbean Marine Research Center is one of four national centers. With facilities at Riviera Beach and Turkey Point on the Gulf of Mexico, and on Lee Stocking Island in the Exuma Caya, Bahama Islands, they were created under the auspices of the Perry Foundation and are affiliated with a number of universities in the southeastern U.S.

The Caribbean Center's science program focuses on research which: develops low-cost aquatic food production in the Caribbean and similar locations around the world; studies physical and ecological relationships in benthic environments in the Caribbean; forms scientific bases for rational habitat utilization through conservation and enhancement; and defines ecological requirements of important species residing in the coastal areas of Florida and the Caribbean nations.

Further information on the NURP Program can be obtained from:

NATIONAL UNDERSEA RESEARCH PROGRAM PRIORITY FRAMEWORK

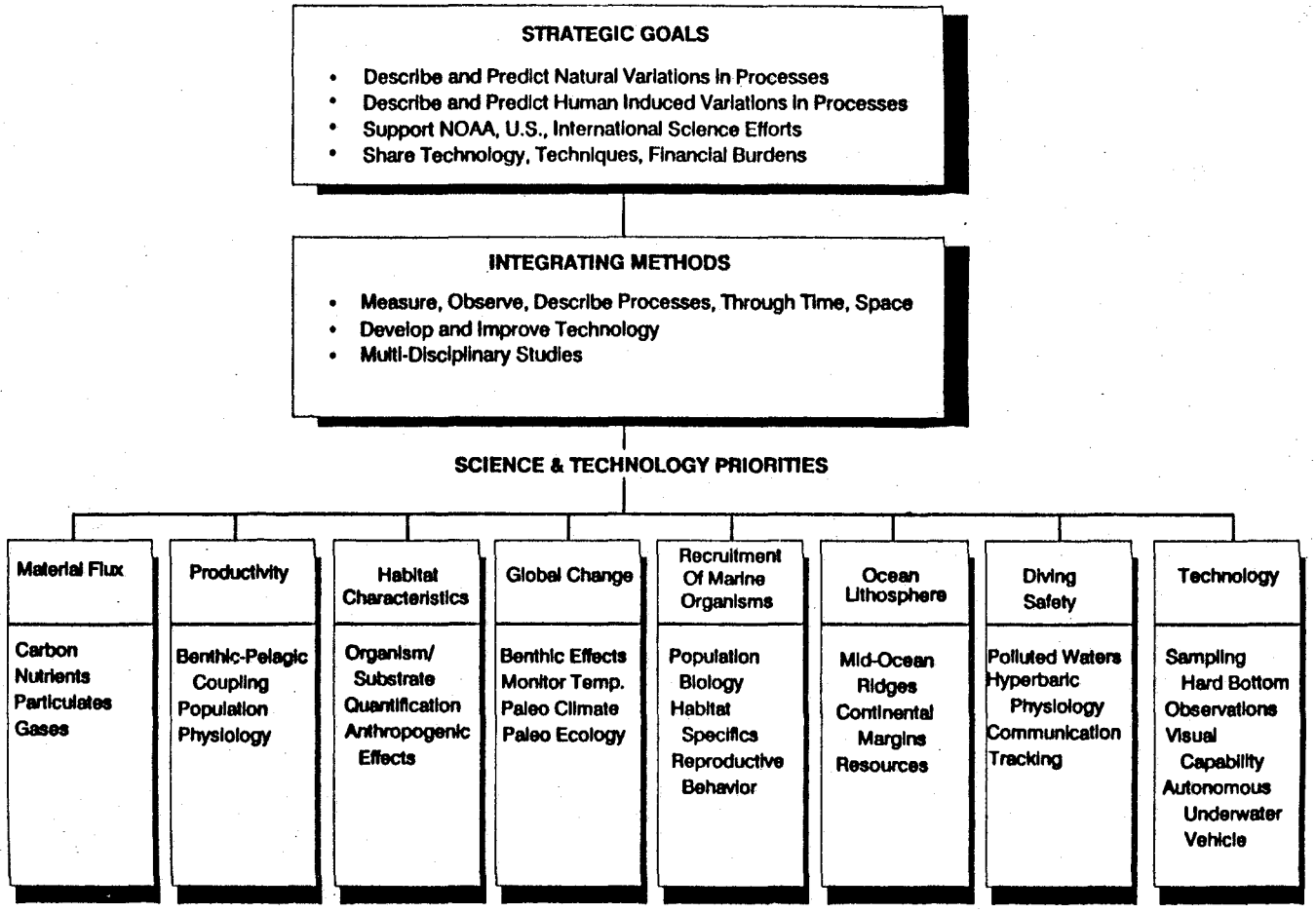

Figure 1

Dr. David Duane
NOAA/National Undersea Science Program
1335 East-West Highway
Silver Spring, MD 20910
Telephone (301) 427-2427

Mr. Robert Wicklund
National Undersea Research Center
Caribbean Marine Research Center
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(809) 336-2557 (Exuma Cays, Bahamas)

Office of Global Programs (Climate and Global Change)

Current interest in this region involves support of a scientific workshop to (1) assess the relationship between coral bleaching and climate change, looking at bleaching as a global phenomenon but with a focus on the Caribbean, and (2) to develop an interagency research plan to study coral reef ecosystems in the context of global change. Plans for this workshop are in their early stages. We have had two meetings with representatives from OGP, NURP, NMFS, and the Office of the Chief Scientist in NOAA, EPA, NSF, National Park Service, and Smithsonian. The workshop will be jointly supported, probably by these agencies, and perhaps by USGS as well. It will probably be held in late May of 1991, early enough to distribute the research recommendations to the agencies and researchers in time to support research in FY 1992. These research recommendations will be useful for planning by the Marine Ecosystems Response Project of the NOAA Climate and Global Change Program.

The workshop will involve perhaps 30-40 invited, non-government biologists, geologists, oceanographers, climatologists, paleoclimatologists, and chemists. These people will be selected based on their expertise in their discipline and their interest and experience in Caribbean and tropical environments.

Prior to the meeting, some of the participants will be contracted to analyze and assess the data and relationship between recent coral bleaching events (in the Caribbean and elsewhere) and climate change. These data will be presented and discussed by workshop participants from all disciplines, and then conclusions will be made concerning the claim that bleaching is an indicator of global warming. The result of this part of the workshop will be a thorough analysis of the bleaching phenomenon and a long-range research plan.

The initial discussions on coral bleaching will naturally lead to broader discussions about potential impacts of global change (ocean and air warming, sea level rise, deforestation and associated sediment runoff, pollution, etc.) on reef environments (biological and physical). Participants will again produce a long range research plan.

The research plans will essentially be recommendations to funding agencies such as NOAA, NSF, EPA, etc. Agency representatives will be on hand, however, to provide feedback on the plans as they are being developed.

Further information on this workshop can be obtained from:

Mr. Matt Huston
NOAA/Office of Global Programs
1335 East-West Highway
Silver Spring, MD 20910
Telephone (301) 427-2474

Minerals Management Service Environmental Studies Program for the Gulf of Mexico

Murray Brown, MMS

The MMS Environmental Studies Program (ESP) was initiated in 1973 to support the Department of the Interior's oil and gas leasing program by providing current and reliable information on the effects of oil and gas development on the Outer Continental Shelf (OCS). The ESP is planned and implemented by the four MMS Regional Offices serving the Gulf of Mexico, Alaska, and the Atlantic and Pacific coasts; the ESP is managed through the MMS headquarters office in the Washington, D.C. area.

The OCS Lands Act Amendments of 1978 authorize the studies program, and provide three primary mandates: (1) to establish information for assessment and management of environmental impacts on human, marine, and coastal environments of OCS and affected coastal areas; (2) to predict impacts from oil and gas activities; and (3) to monitor the human, marine, and coastal environments by providing time-series or data-trend information to identify significant changes in quality or productivity of environments, and to identify the causes of these changes.

In 1988 the program was refocused from support of the OCS leasing program to an emphasis on post-lease decisions. This includes emphasis on regions of known oil and gas resources and on long-term, low-level cumulative impacts of oil and gas development; particularly through studies of environmental processes.

From 1973 through fiscal year 1990, the MMS ESP has funded more than $513 million in marine, coastal, and social research nationwide. Of this total, approximately $79.7 million has been devoted to studies in the Gulf of Mexico. About two-thirds of that sum has supported major environmental studies to provide a fundamental management information base regarding the habitats and ecosystems of the Gulf's continental shelf, and to further our understanding of the circulation of the waters of the Gulf of Mexico, both throughout the deep Gulf basin and on the continental shelf. The remaining funds have been devoted to studies of the ecological effects of oil and gas activities (including oil spills); to characterization of the environmental and social features of the coastal zone (including wetlands losses); to studies of coastal and marine birds, marine mammals, and sea turtles; to studies of the economic impacts of the oil and gas industry in the Gulf of Mexico; to protection of historic shipwrecks and pre-historic cultural sites on the OCS; and to information management and transfer.

Studies now underway or in development address many topics:

- coastal mapping and environmental analysis through sophisticated computer-supported techniques;
- long-term monitoring of the health of the Flower Garden Banks;
- mapping of southwest Florida Shelf seagrass habitats;
- habitats and special environmental features of the Mississippi-Alabama Shelf ecosystem;
- chemosynthetic communities of the deep Gulf, and of the potential for impact by oil and gas activities;
- distribution and behavior of sea turtles and marine mammals, especially near offshore oil and gas structures;
- circulation of the Gulf, especially of the northwestern Gulf shelf;

- environmental effects of long-term production of oil and gas at offshore platforms;
- impacts of the "oil bust" on the Gulf of Mexico regional economy;
- impacts of long-term oil and gas activities both to coastal Louisiana environments and to social institutions in Louisiana;
- long-term recovery from oil spill impacts by seagrass, coral, and mangrove communities in Panama;
- toxicity of spilled oil and of oil dispersants used for spill clean-up.

Major program emphasis over the next five years is expected to be on the marine ecosystems and circulation of the Texas-Louisiana Shelf, and of the Mississippi-Alabama-Florida Shelf; long-term monitoring at offshore sites to study natural environmental variability; studies of long-term or chronic effects of oil and gas production; and oil spill prevention, control, or cleanup.

Study planning is implemented by the Regional Office, by development of a "Regional Studies Plan" (RSP). Studies are usually funded as competitive contracts to the private sector, although some projects are awarded cooperatively to other Federal agencies or to State institutions. A few awards are made each year non-competitively in response to unsolicited proposals. The study planning (RSP and NSL) and contracting timeline is about three years. Study durations are typically two to five years, so the time elapsed from initiation of study planning until study completion and report delivery is about five to eight years. All study reports are provided to appropriate depositories and libraries, and are distributed to the interested public. All marine data are archived in the National Oceanographic Data Center (NODC), and all reports and digital models are archived in the National Technical Information Service (NTIS), both within the U.S. Department of Commerce.

For a bibliography of reports and digital data sets, planning documents, or other aspects of the MMS Environmental Studies Program for the Gulf of Mexico, please write or call:

Chief, Environmental Studies Section (Mail Stop 5430)
Minerals Management Service/Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394
Telephone (504) 736-2897 or FTS 686-2897

Coastal and Marine Activities: Gulf of Mexico and Caribbean

James D. Brown, U.S. Fish and Wildlife Service

The Fish and Wildlife Service is the principal Federal agency responsible for the conservation and management of the Nation's fish and wildlife resources. In meeting this responsibility, many of the Service's activities involve inland terrestrial and freshwater aquatic habitats and species. Service activities involving offshore habitats and species are relatively limited. However, the Service is heavily involved in the management and protection of coastal and estuarine fish and wildlife resources.

Service activities in the Gulf of Mexico (Gulf) and the Caribbean are conducted by three different regions. The Service's Southwest Region is responsible for the coast of Texas and the western Gulf of Mexico. The Regional Office is located in Albuquerque, New Mexico. The Southeast Region is responsible for the eastern and central Gulf of Mexico, and for Puerto Rico and the U.S. Virgin Islands in the Caribbean. These two regions are responsible for all operational and management activities in the Gulf and the Caribbean. Research activities, however, are the responsibility of the Research and Development Region, which is headquartered in Washington, D.C.

The Service controls extensive landholdings on national wildlife refuges along the Gulf coast and in Puerto Rico and the Virgin Islands. The Service manages over 700,000 acres on 39 refuges located in coastal areas throughout the Gulf and the Caribbean. These refuges include valuable wetlands, open water, and upland habitats that are managed intensively for waterfowl, shorebirds, wading birds, fisheries, endangered species, and other wildlife. Examples of refuges managed specifically for endangered species include the Crystal River National Wildlife Refuge, Florida (West Indian manatee); the National Key Deer Refuge, Florida (Key deer); the Sandy Point National Wildlife Refuge; St. Croix, Virgin Islands (sea turtles); and the Aransas National Wildlife Refuge, Texas (whooping crane).

The Service is placing special emphasis on accomplishing the objectives of the North American Waterfowl Management Plan. This international Plan, participated in by the United States, Canada, and Mexico, proposes to restore waterfowl and other migratory bird populations to the levels of the early 1970's by protecting about six million acres of wetlands from the Gulf to the Arctic. Activities involve restoring wetlands, assisting farmers with conservation programs, educating the public, and protecting wetlands. The Plan designates six key areas, called Joint Ventures, for immediate attention. The Gulf Coast Joint Venture, which includes the coastal zone in the States of Texas, Louisiana, Mississippi, and Alabama, is one of these areas. This is one of the most important wintering areas in North America for waterfowl and other migratory birds. An interagency team has developed a Gulf Coast Joint Venture Plan, which proposes wetlands acquisition, enhancement, restoration, and creation, as well as other activities.

Service field offices located in all States bordering the Gulf and in Puerto Rico conduct extensive environmental coordination and investigation activities affecting coastal habitats. These include investigation of Federal water resource development projects and participation in the planning process, investigation of Corps of Engineers permit applications for wetlands alteration projects, mapping of wetlands, environmental contaminant studies and surveys, listing and recovery of endangered species, participation in the Environmental Protection Agency's National Estuary Program, and participation in the Minerals Management Service's Outer Continental Shelf oil and gas leasing program. The Service places special emphasis on the protection of coastal wetlands and nearshore waters, especially in those areas that can contribute to accomplishing the goals of the North American Waterfowl Management Plan. Working to reduce the rate of coastal wetlands loss in Louisiana is one of the Service's highest priorities. The identification and resolution of contaminant problems also is a high priority, as is the protection and recovery of endangered species. The West Indian manatee and the sea turtles are highly visible and

important endangered species in the marine and coastal areas under consideration. The Service has designated full-time recovery coordinators for these species, and these individuals are located at Jacksonville, Florida.

Fisheries activities in the Gulf of Mexico focus on the restoration of self perpetuating populations of the Gulf race of striped bass and the Gulf sturgeon throughout their historical ranges. The latter species has been formally proposed for listing as an endangered species. These efforts are centered at the Field Office located at Panama City, Florida. Various biological studies are being conducted on the striped bass and the sturgeon in the Apalachicola River, Florida, and on the sturgeon in the Suwannee River, Florida. The Service is planning to establish a new position of Gulf of Mexico Anadromous Fisheries Coordinator, who will be located in Ocean Springs, Mississippi. This person will work with the Gulf States and other organizations to expand restoration activities. The Service also has a Gulf of Mexico Cooperative Agreement with Gulf States to promote the restoration of striped bass and other anadromous fishes.

Research activities in the Gulf and the Caribbean are conducted by a number of research facilities, such as the Patuxent Wildlife Research Center, Laurel, Maryland; the National Fishery Research Center, Gainesville, Florida; the National Wetlands Research Center, Slidell, Louisiana; and the Cooperative Fish and Wildlife Research Units located at state universities in the Gulf States. Ongoing research projects include basic biological studies on the Gulf sturgeon in the Suwannee River, Florida; studies of contaminant body burdens in redhead ducks wintering in coastal Florida, Louisiana, and Texas; and investigations into the ecology of wintering redhead and canvas-back ducks in the same three states. Plans include the expansion of the latter study to include the eastern coast of Mexico. The Service is planning new research initiatives in the Gulf involving global climate change and oil spill pollution research. The first study will address the affects of global climate changes on coastal wetlands and on benthic biomass and distribution. The oil spill pollution study will focus on risk assessment models and restoration techniques for wetlands and wildlife communities.

Marine Studies Conducted by the Caribbean Field Office

Vance P. Vincente, U.S. Fish and Wildlife Service

Marine studies conducted by the Caribbean Field Office (CAR) of the U.S. Fish and Wildlife Service may be divided into two broad categories: programs directly oriented towards the conservation and recovery of marine endangered species populations; and, programs directed towards the conservation of critical marine habitats (e.g., coral reefs, seagrass beds, mangroves, beaches, mud flats). These studies are coordinated with academic and research institutions, private entities, and regulatory agencies (Federal and Commonwealth).

Federally listed marine endangered and threatened species being studied by CAR include three species of sea turtles (the hawksbill turtle, *Eretmochelys imbricata*; the green turtle, *Chelonia mydas*; and the leatherback turtle, *Dermochelys coriacea*), one marine mammal (the West Indian manatee *Trichecus manatus*) and one sea bird (*Sterna dougallii*). Specific projects directed towards the conservation of these species and their habitat are mentioned below.

Marine Endangered Species

Hawksbill Turtle

- Nesting habits, nesting habitat protection and general demographic information of hawksbill populations at Mona Island (west coast of Puerto Rico).
- Field foraging studies of juvenile and adult hawksbill turtle populations at Isla de Culebra (east coast of Puerto Rico).
- Composition and relative concentrations of fatty acids in the muscle tissue and in food items of hawksbill turtles.
- Gut content analysis of poached hawksbill specimens.

Green Turtle

- Growth rate and population dynamics of green turtle populations at Isla de Culebra.
- Habitat utilization and grazing patch dynamics of green turtle populations at Isla de Culebra.
- Identification and mapping of foraging grounds in Puerto Rico (including Vieques and Culebra Islands) and in the U.S. Virgin Islands.

Leatherback Turtle

- Nesting, tagging, morphometry and reproductive success of leatherback populations at Culebra Island. An environmental education program concerning leatherback turtles have also been developed.

West Indian Manatee

- Dispersion analysis and population density fluctuations of the West Indian manatee on the coast of Puerto Rico and Vieques Island.
- Evaluations of habitat and food resource utilization of manatee populations at eastern Puerto Rico and Vieques Island.

Marine Habitat Studies

Littoral and Inner-Sublittoral Habitats

- Environmental assessments and reconnaissance studies of sites proposed for beach erosion control actions in Puerto Rico and in the U.S. Virgin Islands.
- Evaluations of marine sites proposed for development or for conservation.
- Assessments of marine habitats (coral reefs, mangroves, seagrass beds) impacted by density independent events (e.g., hurricanes).
- Assessments of seagrass beds and mangrove forests impacted by density independent events.

Other Studies

- Other studies related to the marine environment include assessments of sea bird species in Puerto Rico, Culebra Island, Vieques Island.

Roseate Tern

- Color banding of adult and chick populations of Roseate Terns (*Sterna dougallii*) are being coordinated among researchers in Puerto Rico, in the U.S. Virgin Islands and in the British Virgin Islands to determine intermixing among colonies.
- Studies involving possible predatory interactions between Roseate Terns and Laughing Gulls.
- Studies involving intraspecific interactions in mixed colonies of breeding Roseate and Sandwich Terns.
- Surveying of possible unrecorded nesting keys for Roseate Terns.
- Determining nesting success in Culebra Island and in La Parguera, Puerto Rico.

Gulf of Mexico Research Activities and Plans

John A. Leese, Institute for Naval Oceanography

The Institute for Naval Oceanography (INO) was formed by the Secretary of the Navy in 1986 to conduct a focused research program, directed toward achieving an ocean forecasting capability to significantly improve support to naval warfare missions and weapons system development. The long-term INO goal is to develop and demonstrate mesoscale eddy-resolving ocean prediction systems on a global basis. The near-term objective is to develop a North Atlantic Ocean Prediction System which can consist of regional and basin models.

The INO has done a significant amount of ocean modeling research and experiments in the Gulf of Mexico during the past several years. The Gulf of Mexico provides an outstanding area because the computer requirements fit within those available to INO in terms of size and costs. Dr. Kantha adapted the Princeton University primitive equation ocean model in this region during 1989. The Princeton Model was combined with a revised four-dimensional data assimilation scheme developed by Dr. Derber at the NOAA's Geophysical Fluid Dynamics Laboratory to form the Primitive Equation Data Assimilation Model (PEDAM). This model was combined with the data, evaluation and visualization modules needed to form an ocean prediction system for the Gulf of Mexico. This prediction system is used in conducting a number of experiments and simulations.

One of the experiments conducted was the construction of a dynamic climatology for the Gulf of Mexico. The Levitus data set was used as input data to the PEDAM by using all observations for each day of the year and ignoring the year. The resultant daily climatological summaries look consistent in a qualitative manner but no quantitative evaluation has yet been performed on the fields produced.

INO recently conducted a demonstration observing system simulation experiment (OSSE) in the Gulf of Mexico. The primary objective was to assess the effects of different input data on a numerical ocean prediction system. Plans are to extend this very preliminary work to more specific types of data, such as satellite altimeters or acoustic tomographic measurements.

During the summer of 1990, a TRial Ocean Prediction Experiment (TROPE) was conducted in the Gulf of Mexico. The primary objective was to evaluate a modular ocean mesoscale prediction system being developed by INO as part of a project entitled Experimental Center for Mesoscale Ocean Prediction (ECMOP). This modular system will provide a capability for ocean modelers to evaluate their models by providing a central facility containing the support infrastructure including data and software for model evaluation and visualization.

INO has prepared a research quality GEOSAT satellite altimetry data set for the period for December 1986 to December 1989, with improved accuracy over others available. This data set has been used by INO in several Gulf of Mexico experiments. In particular, GEOSAT data in the Gulf of Mexico showing the Loop Current and eddies have been compared directly to sea surface heights generated by the model and to observed multi-channel sea surface temperature fields. The GEOSAT data set also allows for tracking of eddy paths over extended periods of time.

During 1990, INO researchers performed several case studies on the Gulf of Mexico response to hurricanes. We have also taken ocean model outputs and interfaced these with an acoustic propagation model, to develop an end-to-end system for ocean model evaluations. Results show the effect of fronts and eddies on acoustic transmission loss.

INO is an active organizer and participant in workshops, many of which are directly related to the Gulf of Mexico. These include:

- A 1990 Environmental Data Base Management Workshop held in Monterey, sponsored by INO and the NOAA's Center for Ocean Analysis and Prediction (COAP).

- A 1990 Workshop held in Long Beach, MS, sponsored by INO and Chief of Naval Research on the topic of "Tomographic Data in Ocean Models."

- A Workshop entitled "Air-Sea Interaction and Air Mass Modification over the Gulf of Mexico," sponsored by INO, Texas Institute of Oceanography, and NOAA. This will be held in January 1991 in Galveston, Texas.

Gulf of Mexico Program Update

Frederick C. Kopfler, Environmental Protection Agency

Established in August 1988, the Gulf of Mexico Program was developed with the purpose of achieving the following goals:

- Provide a mechanism for addressing complex problems in the Gulf of Mexico that will cross state, federal, and international jurisdictional lines.
- Provide better coordination among federal, state, and local programs affecting the Gulf, thus increasing the effectiveness and efficiency of the long-term effort to manage and protect the resources of the Gulf.
- Provide a regional perspective to address research needs for the Gulf, which will result in improved information and methods for supporting effective management decisions.
- Provide a forum for affected user groups, public and private educational institutions, and the general public to participate in the "solution" process.

The following organizational structure was set up to help the Program meet these goals:

Policy Review Board. Twenty senior level representatives of state and federal agencies, and representatives of Technical and Citizens Committees guide and review activities of the Program.

Citizens Advisory Committee (CAC). Five citizens appointed by the governor of each of the Gulf Coast States, representing environment, agriculture, business/industry, development/tourism, and fisheries, provide public input and assistance in disseminating information relevant to the goals and results of the Program.

Technical Steering Committee: Representatives of state and federal agencies, academia, and private and public sectors, appointed by governors or by the Policy Review Board provide technical support to the Board.

The Gulf of Mexico Program is currently in the process of developing action plans to address concerns for the following priority areas.

Marine Debris

Projects that are underway or projected for this year: The Program is supporting efforts to designate the Gulf of Mexico as a special area under MARPOL Annex V. Such a designation would make it illegal for ships to dispose of all waste materials in the Gulf (plastics are already prohibited by law). Efforts are also being made to have the next-to-last Saturday in September designated as National Beach Cleanup and Appreciation Day. The Gulf of Mexico Program supports the effort for the "Take Pride Gulfwide" beach cleanup. The September 1990 results showed 37,000 volunteers for the five Gulf states participated in the cleanup, collecting 551 tons of trash covering over 1,300 miles of coastline.

Habitat Degradation

For 1991 there are several projects underway or planned:

- Quantify losses and gains of habitats that occur as a result of regulatory programs. (Characterization Report)
- Convene a workshop to develop recommendations for attaining no net loss of habitats.
- Review success of compensatory mitigation which is included as a permit condition.
- Facilitate the availability of coastal and marine plans for restoration efforts.
- Identify and prioritize research needs to reduce loss of Gulf habitats.

Coastal and Shoreline Erosion

The following activities are underway or planned for 1991:

- Convene a workshop to assess the feasibility of the development of a Gulfwide Geographical Information System (GIS).
- Ship shoal environmental study: to evaluate this shoal as a potential sand source for coastal and shoreline erosion problems.

Public Health

The following projects are underway or proposed for this year:

- Development of minimum criteria for septic systems in critical areas.
- Survey of states for bathing beach monitoring practices.
- Evaluate methods for enumerating *E. coli* and *Enterococci* in Gulf coastal waters.

Nutrient Enrichment

Projects underway or proposed for this year:

- Animal Waste Management Demonstration Project.
- Evaluation of constructed wetlands as a method of reducing nutrients from runoff water.
- Assessing the use of chlorophyll meters for determining fertilizer needs in irrigated rice production areas.
- Report on "Sources and Quantities" of nutrients from throughout the U.S. portion of the drainage area of the Gulf.

- Report on the "Impacts and Effects" of nutrient overenrichment in the Gulf.

Toxic Substance and Pesticides

Projects underway or projected for this year:

- Initiate identification of existing federal, state and local monitoring plans and contaminant levels in the Gulf.

- Identify, characterize and assess current state of local, state and federal programs in the Gulf States for disposal of toxics, pesticides and containers, including petroleum products.

- Assess known and/or potential contribution from each source of input identified above.

Clearly, many of the projects listed for the above issue areas could benefit from information that currently exists within educational and research institutions, as well as local, state and federal agencies. If you are aware of information that could be of assistance, please contact us at the Gulf of Mexico Program Office at (601) 688-3726.

EPA's Program in the Wider Caribbean

Marilyn Varela, U.S. Environmental Protection Agency

EPA has a number of activities involving training and technology transfer in the wider Caribbean which are in the developmental and early program stages. Categories of activities include: (1) support to the United Nations Environment Program (UNEP) Caribbean Environment Program and Cartagena Convention under the UNEP Regional Seas Program; (2) environmental outreach to the investment community, in conjunction with the Department of Commerce Caribbean Basin Initiative, and other mechanisms; (3) subregional training, technical assistance and other support involving water quality issues; and (4) the development of a cooperative environmental institute and network.

UNEP/IOC

Under the UNEP Caribbean Regional Seas Program, two new functions have been established by UNEP and the Intergovernmental Oceanographic Commission (IOC) since 1989: (1) Caribbean Environment Program Pollution (CEPPOL) activities, focusing on research and monitoring, control and abatement of land-based sources (LBS) of marine pollution; and (2) Caribbean Environment Program Network (CEPNET) for data management. EPA was asked by UNEP and the IOC, communicated through Department of State, to assist them in development of an LBS protocol, the next priority protocol under the Cartagena Convention. The Region has decided to take a water-quality-based approach to control and abate LBS. EPA co-sponsored with UNEP and the IOC a water quality criteria and effluent guidelines workshop in November 1990 with invitation to technical representatives from all governments of the wider Caribbean. Progress was made to identify water uses; to reach consensus regarding applicability of criteria and effluent guidelines from temperate to tropical waters; and to select minimum criteria which could be incorporated into a protocol.

A second water quality workshop is planned for September 1991 on the subject of monitoring strategies related to water criteria and effluent guidelines. A third is envisioned for 1992 on a comprehensive coastal plan strategy for the wider Caribbean. Coordination with other federal agencies, such as NOAA, will be an important component.

EPA was also requested by UNEP and the IOC, as follow-up to the first 1990 water quality workshop, to provide technical expertise in bathing and shellfish-growing waters pathogens, and relationship of temperate and tropical water indicators. Also, EPA will advise UNEP and the IOC on species used in bioassays as a basis for criteria, and temperate species specificity and relation to tropical species.

Under CEPNET, EPA initiated in 1989 a prototype regional geographic information system (GIS) to be used as a tool for interpretation of data and intergovernmental decision-making. Data themes chosen for geo-referenced data relate to specially protected areas and wildlife and land-based sources of marine pollution, to support the protocols under the Cartagena Convention on these topics, either in-place or being developed.

Sub-Regional Assistance

EPA has been requested by the English-speaking eastern Caribbean to assist them in development of specific effluent guidelines for municipal and industrial point sources of pollution. Pilot projects are

to be performed in conjunction with the Caribbean Environmental Health Institute (CEHI) in St. Lucia, which represents 13 small islands, and will address municipal waste water problems in Jamaica and industrial waste water needs in Trinidad. Technical assistance to the eastern Caribbean will also be provided in the area of pesticide regulations and analytical methodologies for crop residues.

Investment Community Outreach

EPA plans to work with the Agency for International Development (AID) to provide training and technology transfer in environmental management, environmental auditing, pollution prevention and risk assessment to governments in the Caribbean as they review development and investment proposals, as well as to industry and potential investors in the Region. The initial focus suggested is for environmental assistance to the tourism industry, where environmental impacts from projects can have a clear economic feedback. Focus on environmental measures to protect the resources enjoyed by tourists as well as their own citizens is becoming a priority by many governments in the Caribbean.

Environmental Institute and Network

EPA is in the early planning and conceptual stage to develop an environmental center and network for training, technical assistance and other activities with outreach throughout the wider Caribbean. It would build upon existing institutions and programs, tying in with university consortia in the Caribbean and U.S. mainland capabilities. Various federal, state and local government and non-governmental bodies will provide participating centers of the network. Puerto Rico will be the coordination center, because of U.S. domestic interests, the Island's cultural ties into the Region, and because of communication and transportation linkages.

State Agencies

U.S. Virgin Islands, Department of Planning and Natural Resources

Jim Beets, Division of Fish and Wildlife

Summary of Activities

Reef Fish Resources

The Division of Fish and Wildlife (DFW) has maintained a fisheries-dependent data collection program since 1976. DFW summarizes landings data from fishermen logbooks and conducts a port sampling program to provide information on total landings of major resources (including lobster and conch), species composition and population parameters based on commercial landings.

Fisheries-independent data collection has been conducted for 2+ years using two methods: (1) visual census; and (2) trap catch. This project has been funded by the National Park Service to assess the reef fish resources within the Virgin Islands National Park/Biosphere Reserve. Data from this project has allowed the evaluation of Hurricane Hugo damage, estimates of yield per unit area, species composition of catch compared to visual assessment, and comparison of methods. Additionally, tagging data has allowed calculation of growth rates and frequency of recapture.

Recreational Fisheries

An eight-year port sampling program has allowed the documentation of the vigorous blue marlin fishery which has the highest CPUE in the world. Other pelagic species increase in importance as the marlin season ends in September-October.

Blue Marlin Biology

The seasonal aggregation of blue marlin (*Makaira nigracans*) north of St. Thomas is possibly a spawning aggregation. Last year we perfected blood sampling of live specimens which will allow for stress analysis and possible reproductive studies. We intend to conduct telemetry studies next summer to evaluate the success of release of specimens and to track normal diel movements within the local area.

Reef Fish Recruitment

Aspects of reef fish recruitment has been investigated using fish attractors and artificial reefs. The importance of structure and habitat has been documented. The importance of species composition and predation is being investigated.

Baitfish Resources

Many pelagic fisheries and fish and seabird migrations are dependent on seasonal baitfish migrations. The local fisheries are very dependent on a single species, the dwarf herring (*Jenkinsia lamprotaenia*). DFW has monitored local abundances and conducted life history and population dynamic studies on this species. This species appears very susceptible to climatic and water quality conditions. Studies on additional species are in progress.

Conch Resources

A moratorium on queen conch (*Strombus gigas*) has been in effect for 3+ years. Monitoring has been established to evaluate resource recovery from overharvesting. A reproductive study will be conducted this summer to evaluate the effect of population density and potential for natural enhancement.

Habitat Evaluation

Mangrove areas are important nurseries for marine organisms. Unfortunately, the value is not understood and the few mangrove systems Remaining in the Virgin Islands are being destroyed. DFW has been conducting studies to document the condition, nursery value and economic importance of these systems.

Most of the benthic habitats on the insular shelf are not documented and their relative condition and value are unknown. DFW is in progress of mapping habitats for future assessment and monitoring using a towed underwater video system. This information will be used with existing photogrammetric and oceanographic data to produce resource maps.

Seabird Biology

Continuing investigations have documented the effects of storm damage by Hurricane Hugo. Population status of 15 species have been monitored for 12 years. Reproductive biology of several species has been investigated demonstrating great variability in nesting success among years and habitats. These resources may be valuable indicators of climatic and resource fluctuations and/or long term regional changes.

Sea Turtle Biology

Nesting biology studies on leatherback turtles (*Dermochelys coriacea*) have been conducted on Sandy Point, St. Croix for 10 years. Aspects of reproductive biology have been documented as well as local vertical and spatial movements using time/depth recorders and satellite telemetry. Population sizes, growth rates and movement patterns of green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles have also been studied for 10 years in the northern Virgin Islands and Culebra, Puerto Rico.

Future Plans

In addition to continuation of the monitoring and investigations listed, DFW has planned the following projects:

Fisheries-Independent Monitoring

The Reef Resources Work Group of the SEAMAP-Caribbean Program has proposed monitoring projects for reef fishes, conch and lobster in Puerto Rico and the Virgin Islands. Unfortunately, no funding is available for this desperately needed program. DFW intends to conduct a pilot study south of St. John using standardized fish traps to evaluate the reef fish resources of the area. If successfully funded, this program will provide information on catch per unit effort, platform production, yield per habitat, species composition and species assessments.

Critical Resource Studies

Several topics have been identified although funding has not been secured. These are areas where DFW recognizes a critical need for future research.

(a) Parrotfishes (*Scaridae*) are the primary species in commercial landings in the U.S. Virgin Islands (>60% by weight) since the decline in snapper/grouper catches. Little is known about any aspect of parrotfish biology. DFW plans to initiate age and growth investigations and reproduction studies.

(b) Water quality parameters are important indicators of habitat condition. DFW plans to monitor light transmissivity, turbidity, water temperature and dissolved oxygen at selected stations when funds for equipment purchases can be obtained.

(c) Habitat condition has been assessed for a few of the important habitats in the Virgin Islands. DFW plans to conduct investigations on productivity of selected critical habitats (coral reefs, seagrass beds, algal plains), to identify critical nursery habitats for protection and to established sustained monitoring stations at selected locations.

History, Current Activities, Goals and Perspectives
Puerto Rico Department of Natural Resources (formerly of CODREMAR)

Yvonne Sadovy, Fisheries Research Laboratory

History

The Fisheries Research Laboratory began operations in 1969, with the purpose of monitoring, characterizing and developing Puerto Rico's commercial fishing industry, under the Commercial Fisheries Research and Development Act of 1964, PL88-309, under the co-sponsorship of the U.S. Department of the Interior and the Department of Agriculture of the Commonwealth of Puerto Rico. In 1979, in an attempt to integrate a number of fishery programs that were at that time dispersed throughout various government agencies, the Laboratory came to form part of the newly created public corporation, CODREMAR (Spanish acronym for Corporation for the development and administration of marine, lacustrine and fluvial resources of Puerto Rico), ascribed to the Department of Natural Resources, through Law 82 of June 7, 1979. On August 23, 1990, Law 61 eliminated CODREMAR and the Laboratory was incorporated into the Department of Natural Resources proper. The Laboratory is funded from both Federal (Interjurisdictional Fisheries Program, State-Federal Cooperative Statistics Program, Dingell-Johnson) and Commonwealth sources.

Current Activities and Goals

Laboratory activities cover three principal areas:

The first concerns the collection and management of data from the commercial fishing communities of the Island. Data on landings are collected directly from fishermen or buyers. Information on composition and length-frequency of capture fish and shellfish, as well as effort by gear type, is collected as part of a bioprofile program. A census of the fishing community, including the number of fishermen and boats, as well as the number and type of gear, is periodically undertaken. Information so collected is returned to the fishing communities in the form of a three-monthly bulletin "Actualidades Pesqueras." There are currently nine personnel in this area: five field agents; two data entry personnel; a secretary and a project leader. Short-term goals are to increase fishermen participation in the program, to improve and expand the sampling intensity and scope of the bioprofile program, as well as to publish summaries of historical data sets on file.

The second area concerns the periodic fishery-independent monitoring of fisheries resources, and studies on areas of current concern related to their management and use. Recently completed, for example, was a research project designed to establish the potential biological and economic consequences of changing the size of the mesh used on fish traps, a principal gear in the artesenal fishery of the Island. This study arose out of the perceived need to reduce bycatch and the capture of juveniles of a number of species, while maintaining an economically-viable trap fishery. A multivariate analysis is currently being carried out to determine minimum sampling requirements for a long-term fisheries resource monitoring program using fish trap and hook and line, as well as to establish a compatible sampling program with the Division of Fish and Wildlife of the U.S. Virgin Islands, and possibly with other areas in the Caribbean. The geographic extent of coverage of the program and its sampling protocol depend on funding levels. This division comprises two crews of three each to operate two 42 ft. long research vessels, the *Miguel Abreu* and the *Guayanilla II*, as well as a project supervisor.

The third area concerns a recently-established (1987) research division. This area has established a program for the determination of age, growth and reproduction of species of commercial an recreational importance in the geographic region. Current research concerns the age, growth and reproduction of the red hind, *Epinephelus guttatus*, coney, *E. fulvus*, and white grunt, *Haemulon plumieri*, and reproduction in the trunkfish species, *Acanthostracion polygonius*, and *A. quadricornis*, in the dolphinfish, *Coryphaena hippurus*, and in the silk snapper, *Lutjanus vivanus*. The recreational fishery of the dolphinfish is also being monitored. This division currently comprises four scientists. Short-term plans include the establishment of a facility for the laboratory-validation of periodic marks in fish hard parts for those species for which field validation is not feasible.

Perspectives

Long-term plans include the continued participation in fishery-dependent data collection programs, fishery-independent monitoring, and development of the research capacity of the facility. In particular the age, growth and reproduction work will be emphasized. The closer relationship with the Department of Natural Resources will involve personnel in orienting and coordinating with department law-enforcement rangers and research personnel, and in taking an active role in recommendations for the use, administration and potential for development of coastal marine resources.

Proposal to Census and Monitor Population of Caribbean Seabirds

David S. Lee, North Carolina State Museum

The Caribbean region contains an interesting assemblage of breeding marine birds that are of global importance. Of the 23 taxa of seabirds nesting in the Caribbean, 15 represent small populations whose conservation status is of concern. Most of these are endemic species or races, and the remainder are taxa with the majority of the world's population residing in the Caribbean. The conservation of Caribbean seabirds has largely been overlooked.

Originally, the Caribbean was relatively free of avian predators, but since the 1700's, man and introduced animals have devastated many nesting seabird populations. Today, most significant populations of seabirds in the Caribbean are restricted to small inaccessible islands, cays and rocks. The rapid economic growth in the area now jeopardizes even these remote areas.

There has never been a complete inventory of the seabirds of the Caribbean and there have only been a few recent studies of selected sites. Many apparently important nesting sites have not been inventoried since the 1950's and some have not been surveyed since the last century. Areas that have been monitored show sharp declines.

The problem of local protection is exacerbated by the large number of independent political units, languages and dialects, and currencies. Furthermore, seabirds are top-order predators in their respective food chains and as such provide a valuable yardstick against which to monitor the general health of oceanic systems.

Statement of Purpose

A four-year survey of the seabird colonies of the Caribbean is planned. A comprehensive atlas/registry of each of the 23 seabird taxa breeding in the region will be prepared and information on colonies will be made available. This atlas will be similar to the National Atlas of Coastal Waterbird Colonies in the contiguous United States, 1976-82. Colony catalogues exist or are planned for all North American regions except the Caribbean.

The information obtained would be published (in locally appropriate languages) as a current registry of colonies, and would serve as the first complete assemblage of base-line data against which to monitor future change (i.e., global change, "El Niño," sea-level rise). Whenever possible we plan to involve local biologists and others who are interested in conservation issues in our initial study and feel this is essential. The registry would be available to all persons and agencies making resource-use decisions in the Caribbean. The information will then be used for proposed future monitoring in which we plan to train local students, biologists and regional conservation agencies to monitor and manage seabirds under local jurisdictions. This will allow local people to make environmental assessments and plan economic development.

The documentation of the seabird populations at various nesting islands will also include information on the extent to which colonies are exploited for eggs and the removal of mangroves for charcoal. In addition, the correlation between current stages of plant successional communities and the micro-distribution of species specific nesting sites will be studied.

In future stages of this project, we plan to develop manuals in appropriate languages that will provide standardizations for data gathering, methodologies for providing needed data within the realistic scope of limited local budgets and manpower, and instructions for teaching appreciation, conservation, and management of local seabird populations. We also hope to be able to oversee the establishment of locally prepared educational programs which would include brochures, posters, slide sets and video presentations aimed at the local protection of seabirds.

This proposal was endorsed in October 1990 by the International Council for Bird Preservation (Cambridge, UK) and by persons in various key agencies in several Caribbean countries.

Marine Projects of the Island Resources Foundation

Roy A. Watlington

The following list is a summary of current marine and coastal resource projects. (Key words: research, planning, monitoring, resource assessment, LTM, Hugo, seagrass, environmental profiles, marine archaeology)

1. Hurricane Hugo Virgin Islands Coastal Damage Assessment. Fifty sites including ex-post audits and documentation or pre-Hugo changes, changing site rankings as SNA's, APC's, potential territorial park sites.

2. Post Hugo Coastal System Recovery Monitoring in Virgin Islands. Includes review/redesign of territorial ambient systems monitoring regimes.

3. Planning a Virgin Islands Territorial Park System. Comprised principally of Hugo damaged sites requiring management protection for accelerated recovery feasibility study of about ten high priority sites. (Notes: NOAA/OCRM funding via VIDPNR, IRF prime in cooperation with WHOI, USACORP of Engineers, Univ. of the VI, US NPS [VINP], Extension Service [June 1990 to February 1991; key IRF investigators are Towle, Bacle, Schottroff, Watlington, Ehle, Ray].)

4. Eastern Caribbean Country Environmental Profiles (book). Being prepared for USAID by IRF teams for the six OECS countries (Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent). Deliverables in final camera ready drafts consisting of approximately 300 page environmental overview documents, averaging 75 tables and 75 figures each, plus a bibliography. Scheduled for publication in early 1991. N.B.: Each "profile" has a chapter on marine and coastal resources.

5. Sea Grass Transplantation: An Experimental Mitigation Project on St. Croix for the Virgin Islands Port Authority. Final post-installation phase of three acre transplant involving grow-out monitoring. Experimental site NOT badly damaged by Hugo. Reports available. Principal investigator is Dr. Mary Lou Coulston.

6. Coral Reef Assessment and Long-Term Monitoring at Buck Island Reef National Monument. Initiated originally by WIL with benthic survey work started in 1988 (at site of previous 1976 transects), this project's final year is being managed by IRF. Dr. John Bythell and Dr. Betsy Gladfelter are principal investigators. The effort is part of a larger NPS Coral Reef Assessment program managed by Dr. Caroline Rogers of the VINP on St. John, U.S. Virgin Islands. Details on request.

7. Miscellaneous (details on request).

    a. Review of Fisheries and Marine Resource Management for Government of Bermuda (conflict resolution).

    b. Dredging monitoring, St. Croix for Virgin Island Port Authority.

    c. Marine Archaeological Surveys (four).

    d. Virgin Islands Resource Management Cooperative (planning the marine component of phase II).

Research Programs of the Caribbean Marine Research Center

William Head

Introduction

The Caribbean Marine Research Center (CMRC), funded by the National Undersea Research Program of NOAA and the Perry Foundation Inc., conducts research aimed at problems of natural resources and marine food production for Caribbean regions including the Bahamas, southeast United States and the Gulf of Mexico. Although only six years old, CMRC has become one of the largest marine research institutions in the Caribbean.

The general goals of the Center are (1) to provide facilities and support for scientific research on the marine environment, (2) to develop technology for low-cost aquatic food production in the Caribbean and similar locations around the world, (3) to study physical and ecological relationships on deep, shallow-reef and other benthic environments of the Caribbean, (4) to develop the scientific bases for rational habitat utilization through conservation and enhancement, (5) to define ecological requirements of important species residing in the coastal areas of Florida, the Bahamas and other Caribbean nations, and (6) to provide a field laboratory for educational programs in all of the marine sciences geared toward graduate and undergraduate curricula, and technical training in aquatic food production.

Although the Center maintains an office in Riviera Beach, Florida, most of the research is carried out close to the Center's field laboratory at Lee Stocking Island in the Exuma Cays, Bahamas.

Research programs of the Center fall under four major categories: (1) marine aquaculture; (2) benthic resource ecology; (3) fisheries oceanography and recruitment processes; and (4) marine geology. All of these research activities incorporate scuba diving and/or deep submersible systems to varying degrees.

Research Programs

Aquaculture

Since July 1984 CMRC has undertaken a program to identify potential candidate species for mariculture development. Research has been aimed at developing technology for marine culture of tilapia (a euryhaline, freshwater finfish group) as an inexpensive source of animal protein for Caribbean islands and similar regions where freshwater resources are limited. The program is now becoming involved in the extension of scientific results to practical application through various projects in the Caribbean. Over 35 papers have been written on tilapia mariculture experiments conducted at CMRC.

Benthic Resource Ecology

Benthic research at CMRC is presently focusing on the queen conch, *Strombus gigas*, one of the most important food species of the Caribbean region. This species has been heavily fished throughout the Caribbean and is commercially threatened in some areas.

The general goal of this research is to study mechanisms of queen conch distribution, reproduction, recruitment and abundance through experimental field studies that can ultimately be applied to sound management practices. Particular emphasis is being placed on mechanisms and processes ranging from larval ecology to reproductive biology and biogeography.

Fisheries Oceanography

This program is concentrating on the Nassau grouper, *Epinephelus striatus*, among the most important foodfish in the Caribbean. Fishing pressure has significantly depleted this species in most countries, particularly the island nations of the Caribbean. Despite its popularity as a foodfish, the biology of the Nassau and other groupers is not well understood, which has impeded progress toward their rational stock management.

The examination of recruitment processes of larvae and ontogenetic changes that occur in habitat requirements of *E. striatus* are key aspects of this research.

Spiny Lobster

A major study of the spiny lobster, *Panulirus argus*, has been initiated by CMRC, including pelagic recruitment processes, settlement, selection of habitats by juveniles, and recruitment of postlarvae and juveniles. Additionally, CMRC is studying the effects of artificial shelters (casitas) on the concentration and/or enhancement of lobster stocks in the Bahamas, Mexico and Florida.

Marine Geology

The unique geological features of the lower Exuma Cays have provided a rich opportunity for a marine geology program at CMRC. In 1984 large fields of giant lithofied subtidal columnar stromatolites were discovered off Lee Stocking Island.

The Bahamian subtidal stromatolites provide a new set of environmental parameters for interpreting spatial distribution, orientation, water depth, salinity constraints on growth forms, and the timing of cementation and mineralization of ancient stromatolites.

Coral Bleaching

During the late summer and fall of 1987 and 1990, unprecedented levels of zooxanthellae loss resulted in bleaching and some mortalities in stony corals and other reef cnidnaria and sponges throughout the Caribbean, Bahamas, and southern Florida waters. Scientists examining bleaching in the Exumas discovered a high proportion of bleaching at 10-55 m. Warmer-than-usual water, which was prevalent in the region during the summer, is thought to be responsible for this occurrence, but further study is required to ascertain the causative agent(s).

Caribbean Temperature Studies

In an effort to assign a cause to the coral bleaching phenomenon and to discern the possible role of temperature in this and other biological processes, CMRC has initiated a long-term, Caribbean-wide seawater temperature study. Subsurface recording thermographs have been placed at various depths in eight locations around the Bahamas, south Florida and the Caribbean, including Puerto Rico, St. John (Virgin Islands) Barbados, Martinique, Belize, Tobago, Jamaica, Colombia, and Panama. Over three years of data have now been collected in some locations.

Effects of Ultraviolet Light (UV-B) on Marine Organisms

Many scientists believe that a potential hazard to marine organisms exists if the stratospheric ozone layer is depleted enough to increase the amount of ultraviolet light that reaches the sea. CMRC has conducted studies on the effects of UV-B on DNA underwater. This is the first study that has used DNA as a biological indicator of UV-B damage and could establish a baseline for monitoring the health of primary organisms in the ocean.

Universities

Summary of Marine Science Interests and Activities Dealing with the Gulf of Mexico and Caribbean
Louisiana State University

Charles A. Wilson

Coastal Fisheries Institute

Louisiana State University's Coastal Fisheries Institute (CFI) was created in 1983 to help provide state, regional and federal agencies and the fishing community with a unified, comprehensive, university-based fisheries research program. CFI scientists conduct scholarly research towards understanding the interdisciplinary processes that influence marine fish populations and their use. CFI consists of eight faculty and 18 research associates and conducts a wide variety of research that coordinates and integrates knowledge from ecology, oceanography, zoology, biochemistry, economics, law, and statistics to address timely questions and serious problems such as recruitment, estuarine-coastal ocean interactions/coupling, overfishing, pollution, habitat loss (and fisheries responses to habitat loss), and resource utilization disputes that threaten renewable fishery resources.

Research at CFI centers around three general programmatic areas dealing with: (1) life history, recruitment, habitat ecology, and general biology of marine and estuarine nekton; (2) law; and (3) economics. Analyses of resultant data are ensuring effective management of such species as red drum, black drum, spotted seatrout, mullet, shrimp, and various pelagic species and are enhancing our understanding of the larval and juvenile habitat requirements of these and other estuarine-dependent species.

CFI has played a lead role in influencing fisheries research and management in the Gulf region. Multidisciplinary-based fishery management is on the ascendance worldwide and CFI is in a unique position to cooperate with other groups and provide a better understanding of the complex ecological interactions of habitat, climatology, meteorology, and oceanography upon year-class strength and recruitment success in northern Gulf fisheries.

Future plans include: the use of dual beam hydroacoustics and side-scan sonar to determine the ecological relationships between nekton and habitat; determination of microhabitat requirements of target species in various nursery systems (e.g., mangroves and spartina marshes); measurement of the effect of biota and abiotic factors; age, growth and reproductive biology, and the determination of recruitment mechanisms that effect larval fish and crustaceans.

Laboratory for Wetland Soils and Sediments

The Laboratory for Wetland Soils and Sediments (LWSS) investigates sediment chemistry/plant relations in natural wetland ecosystems such as salt marshes, fresh and brackish marshes and swamps, and floodplains as well as the chemical and biological behavior of plant nutrients and toxic substances in wetland ecosystems.

To provide information on these wetland ecosystems, the LWSS investigates chemical and biological processes occurring in wetlands, with emphasis on the biogeochemical and nutrient cycles that affect plant growth. The environmental impacts of pesticides, toxic heavy metals, hydrocarbons, and plant nutrients in wetlands are major areas of expertise. The effect of disposal operations on water quality, chemical and microbiological transformations of toxic heavy metals, plant nutrients, pesticides and other organic contaminants, and on the movement of these contaminants into the food chain has been and is being

investigated in a number of experiments. Interactions between the atmosphere, water bodies, and wetlands are also being investigated.

Coastal Studies Institute's Research in the Gulf of Mexico

Coastal wetlands in the northern Gulf of Mexico are experiencing the most severe erosion and land loss problem in the United States. Coastal Studies Institute personnel are working on the critical physical processes that affect wetland loss and the geological subsidence related to dewatering and compactions of deltaic sediments that are stacked through the process of delta switching. With increased awareness of the wetlands' problems, it is anticipated that the physical process and sedimentological work now underway will be necessary for design and implementation of mitigation procedures. A long-term tradition of coastal work will be continued by CSI researchers.

A program to study the impact of oil and gas seeps on the Louisiana continental slope has been in progress for three years. During this period, research submersibles supported through the granting process with NOAA-NURP have been used to directly observe and sample the complex seafloor topographies, sediments, and chemosynthetic communities associated with seeps over the slope's full depth range. Two additional drive seasons have been granted and long-term experiments regarding carbonate production and microbial community dynamics are being planned. This slope project is the current focal point for a long-term interest in understanding the marine geology of the Gulf of Mexico slope province. Coastal Studies Institute personnel intend to continue intensive research work in the slope province for at least the next decade.

The development duration and dissipation of seasonal hypoxia over the Louisiana inner shelf is partially controlled by the physical environment. Coastal Studies Institute personnel are studying the physical processes which contribute to this phenomenon. In conjunction with personnel from the Department of Oceanography and Coastal Sciences and LUMCON, they have monitored the development and progression of hypoxic conditions on time scales from minutes to years. They are developing predictive models for the critical processes. They are also developing larger scale numerical models of the process which cover the entire west Louisiana inner shelf. These studies continue a lengthy history of inner shelf studies, worldwide, by CSI scientists.

Coastal Ecology Institute

Faculty and staff of the Coastal Ecology Institute (CEI), six faculty and approximately 20 research associates, conduct a wide variety of research aimed at gaining an understanding of the ecological processes which structure coastal ecosystems. This research spans the coastal zone from forested fresh water swamps to the continental slope and requires the perspectives and facilities associated with both ecology and oceanography. Due to the great economic value and environmental sensitivity of Louisiana's coastal region, most of CEI's research is of an applied nature.

CEI's various research activities center around the complex coastal environment of the Mississippi River Delta system, but also extend around the Gulf and are beginning to spread into the Caribbean. Sea grass and mangrove systems are of primary interest in southern Florida, Mexico, and Panama in the near future. CEI's Caribbean interests are being supported by a new Latin American initiative at LSU. This initiative is intended to support increased cultural, technical, and educational exchange.

All CEI faculty are heavily involved in the application of research results to policy decisions. In addition to funded research, this activity takes the form of participation on national and international committees and policy boars. CEI frequently accepts contracts to undertake planning and policy review

for agencies charged with management of Gulf of Mexico resources. Areas of the greatest policy-related activity include offshore oil and gas development, alteration of coastal habitats, and multi-user fisheries disputes.

The single objective underlying the diversity of CEI's research is to understand ecosystem function in a truly integrated or holistic manner. Therefore, there is a continuing effort to develop innovative system approaches. To make this endeavor possible, CEI maintains a state-of-the-art information analysis system based on a MicroVax 3600 local host, a Perceptics NuVision Video Workstation, a DEC Vax Station 3500, and a distributed DEC-Apple computing environment. The latest scientific visualization and image processing software is maintained on these systems. For field work, CEI maintains an inshore laboratory vessel, and a complement of both traditional and remote acoustical oceanographic equipment for offshore work. In the laboratory, CEI is equipped for high quality analysis of nutrients in water and sediments. As a whole, LSU greatly compliments CEI's capabilities, and there is no component of a coastal ecosystem which can not be analyzed at better than needed precision and accuracy.

Department of Oceanography and Coastal Sciences

The Department of Oceanography and Coastal Sciences (DOCS) of Louisiana State University is an academic arm for Marine Science interests at LSU. The faculties of the aforementioned research units hold joint appointments in the department, and students usually conduct their research through one of these research units. The department offers M.S. and Ph.D. degrees only.

Research interests of the faculty are generally interdisciplinary, spanning "blue water" oceanography to coastal wetlands. The principal interest groups of the faculty include fisheries ecology, physical and geological coastal sciences, coastal ecology, and the chemistry of wetland soils. Research projects within the last ten years have taken the faculty to the Yellow River (PRC), Korea, the Java Straits, Mexico, Thailand, Alaska, the Caribbean, the Amazon River delta, the Persian Gulf, and to Europe. Much of the regional field work involves studies of the coastal oceanography of the Mississippi River delta and continental shelf as well as nearby estuaries and wetlands. Faculty use state-of-the-art equipment, such as a satellite receiving station (on campus), side-scan sonar, dual beam hydroacoustics, MOCNESS, submersibles, various sophisticated chemical/analytical systems, and image-analyzing systems to address basic scientific questions important to the wise management of coastal resources. Each faculty receives about $100-300 K per annum in external funding for research, several serve on national committees and editorial boards, and all teach courses on a regular basis.

The future of the DOCS is bright. Two faculty members are being added next year (one marine geologist and one unspecified expertise), the curriculum has been revised/expanded, and the recent campus reorganization of scientists raised the departmental faculty number to 25. Participation of faculty from other agencies include those at NOAA, NMFS, NASA, and U.S. COE facilities, as well as from other state campuses and laboratories.

Climate-Related Activities and Plans for Research in the Gulf and Caribbean Region
University of Miami, Rosenstiel School of Marine and Atmospheric Science (UM/RSMAS),
and in Cooperation with the Local Laboratories of the
National Oceanic and Atmospheric Administration (NOAA)

Joseph Prospero and Otis Brown

Cooperative Institute for Marine and Atmospheric Studies

General Description

Within the broader framework of climate dynamics, and of the interrelation of ocean circulation physics and fisheries ecology, scientists at the University of Miami are engaged individually and in cooperation with NOAA scientists in several ongoing studies which relate to conditions in the Gulf and Caribbean region. The Cooperative Institute for Marine and Atmospheric Studies (CIMAS) provides a mechanisms for organizing and administering joint activities involving the University of Miami's Rosenstiel School of Marine and Atmospheric Science (UM/RSMAS) and the respective Miami units of NOAA's Environmental Research Laboratories and the National Marine Fisheries Service.

Climate dynamics oriented studies are focused on the role of variability in the large scale flow of warm waters through the subtropical Atlantic and the Caribbean in the dynamics of northern hemisphere climate, on using the impacts of past circulation fluctuations on the state of the Caribbean Deep waters, and on the records preserved in corals and planktonic components in deep ocean sediments to infer the nature of past climate fluctuations. Various aspects of sea level fluctuations are pursued, including analysis of sea level history based on coastal geology. Fisheries ecology studies are currently focused on impact of physical circulation conditions on recruitment dynamics in the lower Florida Keys, and on the development of biochemical methods to study the genetic interrelation of stocks in different parts of the system. Satellite-based remote sensing methods combined with catch statistics are also being pursued as an avenue to better understanding of large scale connections between physical circulation features and fish stock behavior. The activities described here fit well within the background of plans for IOCARIBE studies in the 1990-95 time frame as detailed in revision III of the IOCARIBE plan (Document IOCARIBE 4/2AA) and in the general setting of IOC workshop report No. 67, "Interdisciplinary Seminar on Research Problems in the IOCARIBE Region," Caracas, Venezuela, 28 November to 1 December 1989.

Current Projects and Plans Relating to Climate Dynamics.

Upper Ocean Circulation Observations

The flow through the Caribbean of surface and thermocline waters which ultimately form the Gulf Stream/Florida Current, its intensity, and the relative significance of subtropical Atlantic recirculation, versus that of tropically or southern hemisphere derived throughflow components is a central problem of the Atlantic Climate Change program (ACCP) of NOAA. A precursor program, Subtropical Atlantic Climate Studies (STACS) has laid a substantial foundation by establishing a long observation time series for Florida Current fluctuations, complemented by observations of the deep water transport patterns on the Atlantic side of the Antilles Island Arc. An intercalibration of monitoring approaches based on tide gauge data, on electromagnetic induction effects in telephone cables, and on direct transport observations, was a significant part of these early efforts. Continued time series observations of the Florida Current transport, and of the Atlantic transport variability off the Inner Antilles is planned under the ACCP. A broader Caribbean effort is yet to be defined within that program.

An important asset for upper ocean variability studies, including those in the Caribbean region, is the satellite data processing and analysis facility at RSMAS which is dedicated to physical as well as biological applications of satellite-based remote sensing of the oceans.

Historical Circulation Data from Corals and Deep Sea Sediments

Isotopic composition variability and physiological signatures of environmental change (band structure) in corals are being studied in the southeast Caribbean and in the Florida Keys by University of Miami investigators. Fundamental research into the physiological basis for climate sensitivity in corals complements this work and should ultimately improve interpretations.

The sedimentary climate record is of particular interest in the Cariaco Basin (Fosa de Cariaco) because anoxic conditions there lead to well preserved band structure, except during low sea level stands in ice ages. This has been documented through decadally resolved analysis of archived cores from the Basin. It is notable that under extreme low sea level stands, probably only a single shallow channel was available for ventilation of the Basin. Higher temporal resolution analysis of recently acquired cores is just beginning. This is expected to shed light on long term climate variability potential in the southern Caribbean upwelling processes.

Continuation of both lines of activity is foreseen, albeit not in place with firm support at the present time.

High Resolution Sea Level History

Funding is currently being sought for a study of sea level trend variability based on coastal geology and vegetation record. The work seeks to contribute in parallel to the development of a better understanding of coast line dynamics on century to thousand year time scales, and to our knowledge of natural sea level variability on time scales commensurate with those arising in our current concerns about human climate impact.

Deep Water Indices of Past Circulation Variability

The several sill controlled deep basins within the Gulf and Caribbean region provide opportunities to discover, in the chemical/physical state of the water column, indications of extremal circulation conditions in the past. Different time scales are involved dependent on sill depths and basin volumes, ranging from decades in the case of the Cariaco Basin to centuries in the case of the Colombian and Venezuelan deep basins. A multi-year project to study the deep water ventilation in the latter basins is just beginning at University of Miami. It will involve current meter arrays in the Anegada and Jungfern Passages deployed for one year, and for a second year in the Anegada Passage only. Tracer studies will address both the deep water ventilation process, and the perhaps reversible exchange of thermocline waters with the Subtropical Atlantic Basin. Tracer work will be concentrated in the passage area.

Much interest attends the observations of very large decadal change in the Cariaco Basin since the mid-seventies. Continued studies of these processes promises to provide improved understanding of climate-related circulation variability, as well as increased confidence in interpretations of coral and sediment signatures of such changes. Transients in ventilation of this basin are related to thermocline oscillations in the southern Caribbean by a combination of seasonal and shorter term forcing effects.

Potential Cooperative Activities Related to Climate Dynamics

Much relevant material regarding data compilation and exchange has been covered in IOCARIBE reports and plans already in existence. Emphasis here is put on potential for enhancing activities related to documenting and understanding interannual and long time scale variability.

The fact that the mean residence time of waters in the upper thermocline and in the surface layers in the Caribbean is of the order of 100 days relative to the large scale throughflow suggests that the Caribbean Basin upper waters respond in their composition to the seasonal fluctuations in transport patterns. This is also confirmed by past observations. Fluctuations in the tropical/interhemispheric through-flow branches should therefore be accessible for study by seasonal surveys in the Caribbean Basin. Use of a number of tracers, including Radium 228, which originates primarily in shelf sediments and has a decay rate eminently suited for the time scales involved, and combined with satellite remote sensing of color and temperature characteristics could form an excellent basis for a pan-Caribbean cooperative program, and joint studies of isolated basin dynamics and exchange between shelf and open basin areas on bi- or tri-lateral basis show much potential.

Although improvement and careful geodetic control of the Caribbean tide gauge network has been emphasized in the general context of sea level rise, it is emphasized here that the recognition of specific seasonal fluctuation modes, and also the testing of numerical model predictions of the seasonal and interannual circulation variability would be much enhanced by its implementation.

With many low lying coastal areas in the region, the long time scale dynamics of tropical coastlines as a biological-physical interaction problem could become a significant object of international cooperative studies.

University of South Florida, Department of Marine Science

Frank. E. Muller-Karger

The University of South Florida's Department of Marine Science is an accredited graduate studies institution located in St. Petersburg, Florida. We have 25 faculty, ranging from biological oceanography and fisheries to geological and physical oceanography. There is also a very strong remote sensing program focused on oceanography from space. We operate two oceanographic vessels through the Florida Institute of Oceanography, and share facilities with the U.S. Geological Survey and the Florida Department of Natural Resources. Currently, our student body is comprised of 80 marine science students with a wide international background.

The University of South Florida has a keen interest in development of scientific programs in the Gulf of Mexico, Caribbean Sea, and western Atlantic Ocean. We have several ongoing studies in this general area, including examination of deep water ventilation of the Caribbean (Kent Fanning, collaborating with Claes Rooth), geology and biology of the Nicaraguan Rise (Pam Mueller and Al Hine), analysis of historical Coastal Zone Color Scanner satellite data (Frank Muller-Karger) and optical characteristics of river plume water (Kendall Carder and Frank Muller-Karger), as well as development of coupled biological-physical numerical models of the region (John J. Walsh, Mark Luther, Robert Weisberg, and Boris Galperin).

Below is a brief list outlining what we perceive are important initiatives that should be implemented in the wider Caribbean. The basis for the initiatives should be to take advantage of this basin's capacity to record events resulting from climatic transients.

1. Establish a long-term interdisciplinary time series station in the Cariaco Trench. This station is a necessary complement to the deep ocean JGOFS. The Cariaco Trench is the ideal location for such a station because of the preserving effect of the anoxic waters found below sill depth. This station would provide an important validation platform for present and future remote sensing missions. In addition to the important scientific value of the station, it would serve as a regional focus for marine science. Several laboratories are located in the immediate surrounding of the Trench.

2. Establish a long-term program of cruises carrying out seasonal hydrographic transects between the northern and the southern Caribbean. The series of transects will help understand short- and long-term flow through the basin, and help interpret sea level measured around the periphery of the basin. This series would provide an important validation platform for present and future remote sensing missions.

3. Establish a satellite data receiving dish and data distribution center for NOAA AVHRR Local Area Coverage data (from Polar Orbiter satellites). A dish located in a central location of the Caribbean would provide data on: Caribbean and Gulf of Mexico waters, western Atlantic waters to south of the mouth of the Amazon River, eastern Pacific waters including the Ecuador coast and upwelling area, and cover of the Amazonian basin, Orinoco basin, and Central American rain forests. An AVHRR station would provide information on, among other problems: coastal sediment transport, sea surface temperature and temperature front location, and vegetation indices at high spatial resolution for forest status and land use change detection. The receiving station should be complemented with Sea-Wifs (NASA's new ocean color scanner) receiving capabilities when the Sea-Wifs is flown in 1993. The data distribution center should be equipped to serve the needs of all nations bordering the Wider Caribbean.

4. Establishing long-term moored current meter stations at the major passages into the Caribbean: Grenada (for surface flow); Jungfern (for surface and deep, ventilating flow); and Windward (for flow into the western Caribbean). These locations should be periodically be visited for nutrient and other tracer measurements. These stations will provide data for understanding transients observed in the interior of the basin.

Overview of Caribbean Research
Harbor Branch Oceanographic Institution

Ned P. Smith

Harbor Branch Oceanographic Institution, Inc., is a not-for-profit organization funded by private monies, grants and contracts. Personnel are involved in research and education in the marine sciences and ocean engineering. The 480-acre complex is located on the west side of Indian River lagoon, about midway between Fort Pierce and Vero Beach, Florida. Research in Caribbean waters is supported by three research ships and two manned submersibles. The R/Vs *Seaward Johnson*, *Edwin Link*, and *Sea Diver* are 176 ft., 168 ft. and 98 ft. long, respectively. The two *Johnson-Sea-Link* submersibles have a maximum working depth of 3,000 ft.

From 1980 to the present, *Johnson-Sea-Link* submersible operations have been conducted throughout the Bahamas, the Windward Islands of the West Indies and along the coast of Central America, Mexico and Belize with the objectives of describing the deep fish. fauna and their ecology at depths between 50 and 500 m. Work in the Fish Biology program, headed by R. Grant Gilmore, has been conducted in collaboration with C. Richard Robins of the University of Miami, Robert Jones of the University of Texas, C. Lavett Smith of the American Museum of Natural History, and James Taylor of the Smithsonian Institution. Over 200 submersible dives have been made to depths of 700 m. Several hundred fishes have been collected and 9000 photos have been taken along with 300 hours of high-quality video tape. Several new fish species have been described from these collections, and additional species are being described by Gilmore and others.

The Zooplankton Ecology Program, leg by Marsh Youngbluth, is conducting research in Bahamian and eastern Caribbean waters to quantify how the abundance, behavior and metabolism of midwater zooplankton affect the production and transfer of energy in marine food chains. Ongoing research projects include in-situ investigations of metabolism (oxygen consumption and nitrogen excretion) by gelatinous fauna and particle flux (transformation and transport processes) by marine snow aggregates of midwater appendicularians.

The Physical Oceanography program at Harbor Branch, headed by Ned Smith, is conducting NOAA-funded research on transport processes in coastal waters. Work is carried out in collaboration with Al Stoner at the Caribbean Marine Research Center on Lee Stocking Island, Exuma Cays, Bahama Islands. Studies are designed to characterize tidal and wind-driven currents which carry larvae of the queen conch (*Strombus gigas*) from offshore spawning sites to shallow-water nursery areas. The approach is to supplement time series from recording instrumentation with computer simulations to understand the underlying physics better, and to obtain information on circulation patterns over a broader range of environmental conditions. Surface drogues are tracked from inner shelf waters of Exuma Sound to the shallow waters of Exuma Bank to reveal the path taken by larvae moving in with the flood tide. Currently, the scope of the program is expanding to include an investigation of the heat budget of Exuma Bank waters, and the density currents resulting from evaporative water losses.

Marine botanist Dennis Hanisak has conducted research on marine macro-algae and seagrasses in various parts of Florida, the Bahamas and the Caribbean. Research programs include the biology of deep-water algae, coral reef algal ecology, conch-algal trophic interactions and algal-nutrient relationships. He has had extensive experience in seaweed cultivation and is interested in the technology-transfer of seaweed mariculture to the Caribbean.

The Bioluminescence Program, headed by Edith Widder, has conducted cruises in Bahamian waters to investigate midwater bioluminescence. Techniques are being developed for recording stimulated

bioluminescence as a means of fine-scale mapping of organism distribution patterns. Research has also emphasized studies of coelenterate bioluminescence. Specially designed sampling devices on the *Johnson-Sea-Link* submersibles permit capture and laboratory study of gelatinous organisms that have never been available for such investigations in the past. Additionally, intensified video cameras mounted on the submersible have made possible the recording of bioluminescence behaviors in situ.

Craig Young has been conducting studies of deep-sea reproduction and larval biology in collaboration with Paul Tyler (University of Southampton), Kevin Eckelbarger (University of Maine), and others. Cruises during the past five years have gone to the northern Bahamas, including Tongue of the Ocean, the Berry Islands, San Salvador, Eleuthera, Cat Island, Andros Island, New Providence Island and Abaco Island, and to Barbados. Research focuses on reproductive processes in deep-sea echinoderms and other invertebrates. Individual studies have focused on larval feeding, larval migration and behavior, recruitment and seasonality of reproduction. From a developmental standpoint, the bathyal echinoid fauna of the Bahamas is now understood better than any other group of deep-sea invertebrates in the world ocean and provides an important model for future experimental work. Young's group has established a long-term deployment at 500 m in the Tongue of the Ocean, where caged animals are being used in experimental studies of fecundity, growth and seasonality of reproduction. Current meters and recruitment collectors have been deployed at the site. Future studies will focus on the role of larval processes in determining population structure and distributions of deep-sea organisms. Lab and field techniques will be combined to determine how seasonal cycles are entrained below the euphotic zone.

The Fish Culture Department, under the direction of John Tucker, conducts pioneering research on aquaculture technology for marine fish, emphasizing reproduction, larval rearing and nutrition. Fourteen species belonging to the herring, anchovy, snook, striped bass, grouper, snapper, porgy and drum families have been reared. The scope of the program includes laboratory and field life history studies, marine fish feed development, and some environmental toxicology research. Tucker has conducted research and taught in North and South Carolina, Florida, Cayman Islands, Jamaica, Australia and Palau; and he has made scientific visits to the Bahamas, Belize, Bermuda, St. Croix, St. Thomas and nine other countries.

The Division of Biomedical Research at harbor Branch has been conducting research in the Bahamas and Caribbean since 1984. Under the direction of Shirley Pomponi, who leads the Sample Acquisition Group, benthic algae, invertebrates (primarily sponges and cnidarians) and ascidians have been collected by scuba, snorkel and submersibles for research on bioactivity of their secondary metabolites. The drug discovery research program focuses on antitumor, antiviral, antifungal and immunomodulatory activity of these natural products. Other related research programs within the division include microbial fermentation, invertebrate cell culture, chemotaxonomy and molecular biology.

LeRoy Creswell has been involved in Caribbean fisheries and aquaculture for the past 15 years. He served with a team of marine biologists in Monroe County, Florida to inventory marine resources of the Florida Keys, then as a fisheries biologist for the Belize Fisheries Administration studying the ecology and fishery of the queen conch, *Strombus gigas*. This work lead to several years research on the mariculture of this species. Creswell has been a consultant to similar research programs throughout the Caribbean and Latin America. He has conducted research on the fisheries and aquaculture of several Caribbean crustaceans, including penaeid shrimp and the Caribbean King Crab, *Mithrax spinosissimus*.

William Lellis is conducting research in mariculture of crustaceans indigenous to the Caribbean basin, with emphasis on the spiny lobster *Panuliris argis*. Initial studies focused on the feasibility of collecting puerulus for subsequent growout, along the determination of environmental and nutritional requirements for optimal performance. Current studies deal with control of seasonal reproduction, diet development and larviculture.

Current Research Activities in the Gulf of Mexico and Future Plans
Jackson State University: Marine Science Program

Jonathan E. H. Wilson

Introduction

Jackson State University (JSU) is one of the few Historically Minority Institutions (HMI) in the nation with a marine science program. The main objective of the JSU marine science program (JSU-MSP) is to introduce minority students to, and provide them with experience in the marine science through their involvement in courses, independent research and oceanographic cruises. The JSU-MSP has a very strong undergraduate emphasis although one or two graduate students (most of them majoring in biology) may be accepted into the program. The curriculum requires that students be well grounded in math, chemistry, biology, physics, computer science and English. Students take core courses at JSU, GCRL and the Duke Marine Laboratory campuses. In addition, students participate in (1) summer internships at various marine laboratories; and (2) field excursions and oceanographic cruises aboard NOAA/NMFS research cruises.

Present Research Activities

The collaboration between JSU and NMFS dates back to the early 1980's; however, the work reported here started about 1½ years ago when a research in marine fisheries grant was funded. The primary objective of this project is to strengthen the linkage between NMFS southeastern region and JSU and help attract more minority students to the marine sciences through their early involvement in research. Aspects of the biology of some near-shore reef fishes in the northern Gulf of Mexico was chosen as a vehicle for such training. The vermilion snapper (*Rhomboplites aurorubens*) was the first species to be studied. Later, other reef fishes such as the wenchmen, hinds and sea basses, which are of interest to NMFS/SEFC, will be studied.

A total of 10 JSU students and one faculty have conducted joint oceanographic surveys with the NMFS Pascagoula Laboratory, in the northern Gulf of Mexico. Two of these cruises have been for reef fishes. All the vermilion snapper samples analyzed so far came from these cruises. Analyses of results have been centered around the study of: (1) morphometrics and the interrelationships between various length measurements; regression equations were generated; (2) use of opercular bones in age and growth studies; the results indicate proportional growth of opercula and fish body; (3) length-weight relationship and variation in condition factor with size; and (4) diet. The other two cruises were to study ichthyoplankton. Although this is not the research emphasis at JSU, the students were encouraged to participate so that they could gain field experience and learn new techniques in biological oceanography. Working with some of the SEAMAP data from the Pascagoula Laboratory, a JSU graduate student has demonstrated the use of GIS in studying marine resources in the Gulf of Mexico.

Future Plans

Our plans for future research in fisheries biology in the Gulf of Mexico include a detailed study of vermilions from the North Central area. At least a bimonthly collection is required to provide sufficient data to establish time of growth ring formation; determination of size and age at maturity; spawning cycle; food; and feeding. A few of these planned research objectives are explained briefly in the next paragraphs.

- Firmly establish the suitability of using opercular bones in aging selected reef fish species in the North Central Gulf of Mexico starting with the vermilion snapper *Rhomboplites aurorubens*.

- Validation of growth rings seen in the opercular using (1) marginal increment analysis (this will require regular sampling throughout the year); (2) length-frequency analyses of population samples (i.e., the Peterson method); (3) plotting length frequencies of the distance from the focus or core to each ring for each age group; (4) comparing mean lengths for each age determined from opercula to those obtained by reading otoliths and scales (Manooch, 1982; Brothers, 1982). It should be noted that scales have been used successfully for aging vermilion snappers (Manooch, 1982; Grimes, 1978).

- Establishment of objective criteria to discriminate growth marks and comparison between readers for consistency in aging vermilion snapper by otoliths and opercula.

- Establishment of the diet and feed periodicities, together with any ontogenetic relationships, in feeding in the vermilion snappers in the Gulf.

References for Activity Summary

Brothers, E. B., 1982. Aging reef fishes. In: *The Biological Bases for Reef Fishery Management* (G. R. Huntsman, W. R. Nicholson, and W. W. Fox, Jr., eds.), pp. 3-23.

Grimes, C. B., 1978. Age, growth and length-weight relationship of Vermilion snapper, *Rhomboplites aurorubens* from North Carolina and South Carolina waters. *Trans. Am. Fish. Soc., 107*(3), 454-456.

Manooch, C. S., III, 1982. Aging reef fishes in the Southeast Fisheries Center. In: *The Biological Bases for Reef Fishery Management* (G. R. Huntsman, W. R. Nicholson, and W. W. Fox, Jr., eds.), pp. 24-43.

Activities and Interests
University of the Virgin Islands: Marine Science Program

LaVerne E. Ragster

The University of the Virgin Islands (UVI), with a current enrollment of 2,466 students, is the publicly supported university system of the U.S. Virgin Islands. UVI, a Historically Black University with a liberal arts tradition, is accredited by the Commission on Institutions of Higher Education of the Middle States Association. The University was established in 1962 and designated a Land Grant College in 1972. The Eastern Caribbean Center at UVI is presently the location of the Secretariat for the Consortium of Caribbean Universities for Natural Resource Management. The University includes B.S. and B. A. degrees in marine biology among its offerings to the local and regional populations it serves. In keeping with the University's mission, the marine science program has included training, research and community outreach components that have had a local as well as regional focus.

Current interests and activities include:

- Identification of additional local and regional opportunities for UVI students to participate in internship activities; including sea expeditions and research experience at other facilities.
- Providing assistance with baseline studies and monitoring of local marine resources needed for the development of the Territorial Park System and decision-making associated with coastal zone development.
- Training local science teachers (especially elementary level) in environmental sciences with an emphasis on marine systems.
- Modification of the marine biology curricula to include an introductory course on resource management.
- Completion of a marine science shoreline facility and the expansion of the capacity of faculty and visiting scientists to conduct research in local and regional marine environments.

Future interests include:

- Continuation and completion of the activities mentioned above.
- Development of a marine technology curriculum at the bachelor level.

An Overview of the Consortium of Caribbean Universities for Natural Resource Management

The Eastern Caribbean Center of the University of the Virgin Islands has served as the location for the Secretariat of the Consortium of Caribbean Universities for Natural Resource Management since August 1989 and will serve in this capacity until August 1992. The Consortium is a grouping of universities, research institutes, and collaborating institutions under the sponsorship of the Association of Caribbean Universities and Research Institutes (UNICA), dedicated to cooperating for improved resource management education in the Caribbean region.

The goal of the Consortium is to enhance the capacity of Caribbean universities to provide practical, high-quality education in resource management relevant to the region's natural and institutional context, especially that of the smaller islands. In meeting its goals, the Consortium will seek to improve information flows among members on course offerings, facilities, student needs, and documentation, as well as share students, faculty and reference materials as necessary. The specific objectives also include encouraging cooperative undertakings such as special courses or curriculum development workshops and recommending standards and procedures for inter-institutional accreditation among members.

The concept of a consortium of universities to develop cooperative programs in natural resource management was first proposed in 1984 by the Science and Technology Committee of UNICA. The proposal was made in response to surveys identifying the increasing need in Caribbean islands and countries for appropriately trained resource managers and the lack of training programs in resource management at regional institutions. In October 1987, a proposal presented by the Caribbean Institute for Resource management (CIRM, University of Puerto Rico) to establish the Consortium of Caribbean Universities for Natural Resource Management under the aegis of UNICA was endorsed at the annual meeting of the UNICA Chancellors. CIRM raised funds for the Consortium's development from the Canadian International Development Agency (CIDA), the U.S. Man and the Biosphere Program, and the Kundstadter Family Fund. To date, 15 of the 45 members of UNICA have accepted the invitation to become members of the Consortium, including all the major universities serving the smaller islands, as well as several from the larger islands, and two from Venezuela which has small Caribbean islands as part of its territory.

Between October 1987 and August 1989 the Interim Secretariat of the Consortium was associated with CIRM, and its Director, Allen Putney, served as the Interim Consortium Coordinator. During this time a Working Agreement was developed to guide the Consortium's evolution and form, and an initial set of specific activities were agree upon by an Ad Hoc Organizing Committee. According to the Working Agreement, the Consortium's programs are determined by a Programme Committee comprised of five members who serve by rotation. A Consortium Coordinator, appointed by the UNICA Secretary General on the recommendation of the Programme Committee, manages its operation and directs the Secretariat. A Technical Advisory Group, comprised of regional experts in environmental and resource management fields, assists in the review of curricula materials to assure their pertinence to practical issues of Caribbean resource management.

Dr. LaVerne Ragster, Professor of Marine Biology at the University of the Virgin Islands, began her service as Consortium Coordinator in August 1989. The appointment was based on a recommendation from the Programme Committee at its first meeting in April 1989 and confirmed by the Executive Committee of UNICA during its regular meeting in Santo Domingo in May 1989. The Programme Committee also agreed that the priorities for the Coordinator's efforts would be the identification of regional educational standards and curriculum guidelines in resource management; faculty training and development; the construction of a Diploma degree in resource management; the compilation and organization of resource management documentation in the region; the establishment of inter-institutional accreditation for Consortium courses; and the design and implementation of special courses in resource management for the islands of the Lesser Antilles. The priority activities of the Consortium reflect the initial long-term objectives identified by the Programme Committee as being appropriate guidelines for the initial phases of the Consortium's maturation. These long-term objectives seek:

- the establishment of inter-institutional accreditation for programmes and courses among member institutions through the development and acceptance of a system which allows for easy assessment of the criteria used to validate courses and degrees throughout the region;

- the development and implementation of effective approaches to faculty training in the region;

- the promotion of learning situations that encourage and facilitate the generation of a growing pool of multi-lingual resource management professionals; and

- the development of an accessible documentation system which would support regional teaching and practicing of sustainable resource management.

The early activities of the Consortium have begun to address priorities approved by the Programme Committee. A review of existing academic curricula and standards from Caribbean, North American, and European universities was completed and used to support a report proposing educational standards and curricula guidelines for natural resource management training in Consortium programs. A workshop for faculty from institutions in the region was held in August 1989 at the Instituto de Tecnologico de Santo Domingo to work on curriculum development in resource management. A technical report on the activities and outcomes of the faculty workshop has been compiled and is available from the Secretariat in English and French. These activities were supported by grants from CIDA and the United Nations Environment Programme-Caribbean Environment Programme (UNEP-CEP). Presently, the University of Puerto Rico is the recipient of a grant from the MacArthur Foundation which supports the development of course modules for the proposed Diploma in Resource Management degree. Additionally, funds from UNEP-CEP have facilitated the planning of collaborative activities between the Consortium and the Environmental Training Network for Latin America and the Caribbean.

The Secretariat of the Consortium will assist member institutions to develop cooperative and collaborative programs that will address the problem of a lack of appropriately trained resource managers in the Caribbean. The University of the Virgin Islands and the other members of the Consortium are aware of the serious challenge facing tertiary institutions and governments of the region with regard to management of precious natural resources that are under high levels of stress from growth and development. As it grows and matures, the Consortium of Caribbean Universities for Natural Resource Management will continue to fulfill its potential to be a valuable and powerful tool in the regional struggle to realize sustainable development.

Information concerning the Consortium's activities and plans can be obtained from Dr. Ragster by writing the University or calling (809) 776-9200, ext. 1343 or 1360.

Activities in the Intra-Americas Sea
North Carolina State University

John M. Morrison

A Multidisciplinary Amazon Shelf Sediment Study (AmasSeds)

The experimental design of this program is to provide a new level of understanding about large river-ocean systems. AmasSeds's five research groups focus on the following topics: physical oceanography, turbidity effects on geochemistry, sediment transport, diagenetic/authigenic processes, and sedimentology/stratigraphy. Each group contains six to ten principle investigators from the U.S. and Brazil. The National Science Foundation supports the participation of U.S. scientists. Brazilian scientists are supported by Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq) and Comissao Interministerial para os Recursos do Mar (CIRM). Three field programs, each about two months long, were completed during the past year. The final cruise is in the spring of 1991. After the end of field operations the complete results of AmasSeds will require several years to process and disseminate.

Reference: AmasSeds Research Group, 1990. A multidisciplinary Amazon Shelf Sediment Study. *EOS, Trans., Amer. Geophys. Union, 77*, p. 1771.

Venezuelan Geology

In the interval 1969-1985, Dr. Michael M. Kimberly of the Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, worked in several areas around the Caribbean basin, particularly in Colombia, where he completed field work on a major iron deposit and in the Bahamas where he studies iron enrichment of carbonate sediments. During the past five years, he has worked in northeastern Venezuela (a total of 15 trips) to study ongoing mineralization processes, both marine and nonmarine processes. He has discovered the only place on Earth where silicate ooids are presently accumulating on the seafloor (*Ore Geology Reviews, 5*, p. 1-145). This iron-rich sediment is quite dense and required a new type of device for efficient sampling (*Continental Shelf Research*, in press).

Coastal environments in northeastern Venezuela are among the least studied on Earth. They include a 1 km-wide, halite-precipitating pool just 250 m from the ocean and beach profiles which are nearly perfect logarithmic spirals (*Computers and Geosciences, 15*, p. 1089-1108). To help introduce more Americans to these spectacular phenomena, Kimberly has established an ongoing field camp using the NSF grant and matching funds from North Carolina State University. Other NSF proposals are pending, mostly focusing on the unique ferriferous ooids. Work to data has been facilitated by a close working relationship with Fundacion La Salle de Ciencias Naturales (FLASA). FLASA has provided free shiptime and laboratory facilities for all 15 field excursions.

Subtropical Climate Studies

Dr. John Morrison has been working on the water mass structure and circulation with the Caribbean Sea, Gulf of Mexico and adjacent regions since 1971. Currently he is working with Dr. Robert Molinari of NOAA/AOML on the "Upper Ocean Variability and Thermohaline Circulation Along the Antillean Archipelago and within the Caribbean Sea." The purpose of this work is to use shipboard Doppler acoustic current profiler data (ADCP), conductivity, temperature and depth (CTD) profiles, and profiles

of absolute velocity (Pegasus profiler data) collected within the Straits of Florida, along the Antilles Archipelago and within the Caribbean Sea by NOAA's Subtropical Atlantic Climate Studies (STACS) Program to study the upper ocean variability and thermohaline circulation in the region east of the Antilles Archipelago. Understanding the circulation in this region is one of the keys necessary towards a more comprehensive knowledge of the meridional volume and heat transport in this western boundary current region.

As a part of the STACS Program, western boundary phenomena along the Antillean Archipelago are presently being studied for their possible relevance to both ocean dynamics and climate problems. Exploratory sections have been established along the Antillean Archipelago to study the mean and time varying components of the circulation. In this proposed effort, we will use data, collected during the STACS cruises to this region from 1984 through 1987, to attack three distinct objectives:

1. A general description of the upper layer flows and transports for the region.

2. A statistical description of the upper layer flows based on either a structure function or autocorrelation analysis of the velocity components.

3. Inverse calculations using the ADCP, CTD and Pegasus data to refine transport estimates and water mass balances within the region.

In addition, we hope that we will be able to use the results to point out potential problems in the model formulations for this region. At the present time, the major modeling efforts in this region show serious disagreement in whether or not a seasonally reversing Antilles Current even exists.

Marine Science Program in the Intra-Americas Sea
Louisiana Universities Marine Consortium (LUMCON)

Michael Dagg

The Louisiana Universities Marine Consortium (LUMCON) was established to conduct and promote marine research and education in Louisiana. Construction of a new Marine Center, located 80 miles southwest of New Orleans, and two new research vessels was completed in 1986. The 105 ft. *Pelican* is used for oceanographic research in continental shelf and open waters. The 57 ft. *Acadiana* is used for coastal and river work.

Existing Activities

Ongoing research programs primarily emphasize basic research in the northern Gulf of Mexico. Specific programs include:

- state and federally funded (NSF, NOAA, NASA) programs to examine the impacts of the Mississippi River discharge on the northern Gulf;
- state and federally funded (NSF, NOAA) programs to examine hypoxia in shelf waters of the northern Gulf; and
- state and federally funded (NOAA, MMS, EPA, USGS) programs to study biological, geological and chemical processes in coastal estuaries and bays within Louisiana.
- LUMCON scientists also conduct some applied research, specifically related to the impacts of oil and gas development.
- LUMCON conducts a summer program of university courses in marine sciences. This program draws students primarily from within the state but also some from other parts of the country.

Planned Activities

We plan to expand our research activities in each of the topics listed above but significant changes in direction are not anticipated within the next few years. We plan, however, to significantly expand and broaden our educational activities and would like to encourage students from throughout the Intra-Americas region to participate in our summer university courses.

For further information contact:

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Program Summary
Florida Sea Grant College

Jim Cato

Overview

Florida Sea Grant is the only university-based program of statewide coastal research, education and extension in Florida. It encompasses both traditional marine science and engineering subjects as well as complementary disciplines in law, economics, seafood technology, policy, biotechnology and others. Its network of extension faculty around the state conducts as many as 150 workshops annually to transfer information and technology. Florida Sea Grant program areas are conducted around the themes of living marine resources, coastal processes and development, marine industries and education.

FSG is part of the national network of Sea Grant Programs and participates with other Sea Grant programs in the southeastern U.S. and Caribbean to organize cooperative marine science research and information transfer.

Current and Pending Research Projects (Selected)

R/LR-E-14	Coping Strategies of Fishing Families in Response to Perceived Impacts of Changes in Marine Regulations.
R/LR-Q-18	Evaluation of Lactic Acid Treatment, Cryogenic Freezing and Depuration of *Salmonella* in Oysters of the Suwannee Region.
R/LR-B-29	The Gulf Stream Front, Its Role in Larval Fish Survival and Recruitment in Florida.
R/LR-B-30	Limits to Recruitment of Spiny Lobster in Florida: Assessment of Artificial Enhancement Techniques.
R/LR-B-24	Stock Assessment and Population Dynamic Models for Management Guidance of the Stone Crab Fishery.
R/LR-B-25	Toward Forecasting Stone Crab Recruitment and Environmentally Induced Year-Class Strength.
R/LR-B-32	Temporal Aspects of Recruitment and Spawning of the Gag Grouper in the Gulf of Mexico.
R/LR-A-15	Development of Technology for the Nursery and Field Cultivation of the Angel Wing Clam.
R/LR-A-12	Peptide Hormone Control of Reproduction in a Marine Shrimp.
R/LR-A-16	Regulation of Yolk Production in a Marine Shrimp, *Penaeus vannamei.*
R/C-S-29	Field Experiment Evaluation of the Effects of Beach Restoration on Stony Corals of Southeast Florida.

R/C-S-30 Coastal Turbidity Associated with Natural and Man-Induced Phenomena.

R/C-E-29 Regulation of Estuarine Phytoplankton Dynamic: The Interaction of Reduced Salinity, Enhanced N:P Ratios and Pulsed Nutrient Inputs.

R/LR-A-13 Plant Tissue Culture Technology for Marine Angiosperms Used in Habitat Restoration.

R/C-E-28 Macrobenthic Production in Natural and Restored Seagrass Beds.

R/C-P-17 A Computer-Directed Geographic Coastal Use Classification System for Ecologic Planning: The Case of the Florida Keys.

E/M-9 Techniques for Dealing with Uncertainty in Fisheries Management Information.

Demonstration and Technology Transfer Projects (Selected)

R/FDER-1,2,3 5,6,7 Seafood Composting Projects (seven studies, various titles).

E/GOV-1 Environmental News Video Stories.

R/SK-4 Enhanced Artificial Reef Database for Florida.

Additional Information

1. "Fathom." A quarterly magazine about the coast, available by subscription.
2. "Top 50," most frequently requested FSG publications.
3. "Directory" of FSG research, extension, education and administration.

Summary of Activities and Capabilities
Florida Institute of Technology

Lee E. Harris

FIT Facilities

R/V *Osprey*, 95 ft. oceanographic research vessel, Atlantic Oceanfront Research Lab., Vero Beach, FL, Melbourne, FL, Campus Laboratories and Facilities.

Research Projects

Great Guana Cay, Abacos, Bahamas. Physical oceanography study of tides and currents related to ship navigation for Premier Cruise Lines (Port Canaveral, FL). Researchers: Lee Harris and Geoffrey Swain, Dept. of Oceanography and Ocean Engineering. Status: ongoing.

Various Bahamian Waters. Annual summer six-week cruises to and within the Bahamas for undergraduate and graduate student research and education in biological, chemical, geological, and physical oceanography and ocean engineering. (Marine Field Projects) Researchers: John Windsor, Lee Harris, Jack Morton, Dept. of Oceanography and Ocean Engineering. Status: ongoing.

Exuma Sound, Bahamas. Fisheries recruitment research, including larval transport, feeding biology, and predation as related to meteorological/oceanographic processes and anthropogenic stress. Researcher: John Shenker, Dept. of Biological Sciences. Status: ongoing.

Shelf and Gulf Stream Waters between Florida and the Bahamas. Research cruises and instrument deployment for various groups including the Caribbean Marine Research Center, Corps of Engineers, and FIT faculty. Status: ongoing.

Trinidad and Tobago. United Nations Mission sponsored by the IOC for the T&T Institute of Marine Affairs, to advise on their research in physical oceanography. Researcher: Lee Harris. Status: ongoing.

Cozumel and Playa Carmen Areas, Mexico. Consulting on the development and environmental impacts of port and marina facilities. Researcher: Lee Harris. Status: ongoing.

Netherlands Antilles, Curacao and Aruba. Preparation of fisheries development plan including exploratory fishing vessel, gear, operations for tuna. Researcher: John Sainsbury. Status: completed.

Cayman Islands, BWI. Natural resources survey of the marine environment to establish environmental baseline data, to identify areas for development and siting of marine parks, and to quantify commercial fisheries. Researcher: Geoffrey Swain. Status: completed.

Research Programs in the Caribbean Sea and Adjacent Waters
Florida Institute of Oceanography

Karen Steidinger and Carmelo R. Tomas

The Florida Institute of Oceanography (FIO) is an administrative umbrella organization of the State University System of Florida representing the geographically dispersed marine science research and education community. The consortium members are the nine public universities, the private University of Miami, the Florida Marine Research Institute (FMRI) of the Department of Natural Resources, and the Florida Sea Grant College. As part of its mission, the FIO operates two ships, the 71 ft. R/V *Bellows* and the 110 ft. R/V *Suncoaster* from the St. Petersburg campus of the University of South Florida. It also operates the Keys Marine Laboratory (KML) on Long Key jointly with FMRI as a full service marine research and education facility. The FIO is charged with the development, implementation, and management of oceanographic research and education programs. The FIO presently has two programs with direct involvement in the Caribbean Sea.

1. With the support of the John D. and Catherine T. MacArthur Foundation, the FIO implemented the SEAKEYS Program (sustained Ecological Research on the Florida Keys Seascape) in 1989. The SEAKEYS program is directed at a long term (five years), coordinated, interdisciplinary study of the ecosystems of the American tropics at geographic and temporal scales appropriate to the natural processes that influence the region. The SEAKEYS research is particularly directed at the influence of human populations on the coral reef tract from Fowey Rocks to the Dry Tortugas. The Program has four elements: (1) automated environmental monitoring at a series of five enhanced C-MAN stations under a cooperative agreement with the NOAA National Data Buoy Center (NDBC); (2) physical oceanography in cooperation with Dr. Ned Smith of Harbor Branch Oceanographic Institution; (3) nutrient dynamics with Dr. Alina Szmant of the Rosenstiel School of the University of Miami; and (4) coral community dynamics with Dr. James Porter of the University of Georgia and Mr. Walter Jaap of FMRI. SEAKEYS is also involved in the training of international tropical coastal managers.

2. The FIO is an administrative center of the CARICOMP (Caribbean Coastal Marine Productivity) Program which began at a workshop of Caribbean marine research institutions in 1985 when an eight-member Steering Committee was formed, chaired by Dr. Eric Jordan Dahlgren of UNAM, Mexico and Dr. John C. Ogden of FIO. This month, with the support of UNESCO and NSF, the CARICOMP program held a workshop to establish standardized methods for the monitoring of coastal ecosystems and to discuss data management and reporting protocols. A project of the UNESCO Coastal Marine (COMAR) Program, CARICOMP will begin in early 1991 with over 25 participating institutions in 20 countries, a Data Management Center (DMC) at the University of the West Indies, Kingston, and cooperative interactions with the established programs of UNEP/IOC in the region.

Research Conducted in Intra-Americas Sea by Florida Marine Research Institute Staff

Continuous Ongoing Programs:

- Population dynamics of stony and octocorals at the Dry Tortugas and eastern Sambo Reef areas. (W. Jaap and J. Wheaton)

- Taxonomy, distribution and life history of reef fishes and assemblages of toxic benthic dinoflagellates at the Dry Tortugas. (J. Kimmel and C. Tomas)

- Population biology, life history, feeding ecology and genetics of sea turtles from Panama (Bocas del Toro, Province, Caribbean and western Atlantic. (A. Meylen)

- Population dynamics of two spiny lobster species (*Panulirus argus* and *P. guttatus*) in Florida Keys with collaborations regarding settlement of puerulus larvae from Harbor Branch (Antigua), Bermuda Division of Fisheries, and Fundacion Cientifica (Venezuela). (J. Hunt)

- Population assessment and enhancement of queen conch in the Florida Keys (R. Glazer and J. Hunt)

Additional Interests (Ongoing and Proposed):

- Expansion of coral reef studies to include Carrie Bow Cay, Belize, C. A. and Lee Stocking Island Station, Bahamas, to allow comparative studies with less intensely use (human) reef areas.

- Comparison of information regarding the biology of fish species such as tarpon, bonefish, ladyfish, baitfish species, snook and grouper from Caribbean areas.

- Collaboration with research individuals and groups working on the effect of toxic phytoplankton species (benthic and pelagic) on natural populations and human health implications.

- Interest to establish a broader effort in synoptic observations of puerulus recruitment throughout the *P. argus* range including Brazil, which may be useful in establishment of a unified pan-Caribbean management effort.

- Collaborative efforts throughout the Caribbean regarding the genetic variability of queen conch required for accurate stock assessment and which will be useful for conch management.

- In all the research areas above there was an expression of having some means of increasing information transfer including a suggestion for one agency to collect, organize and disseminate Caribbean marine science research and fishery data.

In addition to the above comments, several members of the FMRI staff have been active in organizing and participating in international training courses, workshops and seminars in the Central American region and Europe. Given the need for sharing expertise in studying critical problems such as the spread of toxic phytoplankton blooms, loss of endangered species (turtles), decline of important fish stocks and the destruction of natural resources, it seems appropriate to suggest the formation of a Pan American/Caribbean Training Institute where specialized courses could be planned. This structure could make better use of the regional expertise that exists, provide a cost effective means for training research and technical scientists, and create the infrastructure required for organizing and holding such courses/workshops. Such an institute could be of an international agency charged with the mission of information transfer.

Summary of Research Activities in Intra-American Sea Region
Mote Marine Laboratory

Robert E. Hueter

Introduction

Mote Marine Laboratory (MML) is an independent, nonprofit research institution dedicated to excellence in the marine and environmental sciences. From its inception in 1955 as "a place where people can learn about the sea," the Laboratory has grown into an internationally recognized research and education institution with an annual research budget in excess of $2 million.

Research programs at MML reflect the diversity of the scientific staff, often working in cooperation with each other and with scientists from other institutions to accomplish the interdisciplinary approach required for complex marine and environmental studies. These programs emphasize: aquaculture and fisheries biology, biomedical studies, coastal resources, chemical fate and effects, environmental assessment and enhancement, protected and endangered species studies, and shark biology. Research projects are funded by grants and contracts from individuals, foundations, corporations, and government agencies. Operational costs are derived from these projects as well as from private contributions, gifts, and memberships. The Laboratory addresses pertinent applied research problems while maintaining basic research endeavors in marine and environmental sciences, and is heavily involved in science education at all levels.

Research Programs Relevant to Intra-American Sea Region

Marine research programs at MML with interests in the Gulf of Mexico, Caribbean Sea, and adjacent waters include the following:

Aquaculture and Fisheries Biology. A diverse research program that includes fishery habitat studies, environmental impacts on fish populations, finfish aquaculture and stock enhancement, ichthyoplankton surveys, fish tagging and migration, general fish biology, and commercial and recreational fisheries assessment. Specific topics of interest include effects of estuarine and near-shore ecological processes on coastal fishery resources; migration, stock structure, and fishing impacts for coastal pelagic and reef fishes; and fishery habitat identification, characterization, management, and enhancement.

Coastal Resources. Specific interest in research on the structure and function of tidal rivers affecting the Intra-American Sea region; primary and secondary productivity in relation to physical and chemical features, especially salinity; management and restoration of tidal rivers; and impacts of global change, including sea level rise, temperature and rainfall changes, and hurricanes.

Chemical Fate and Effects. Chemical analysis of water, sediment, and aquatic organisms to investigate the fate and effects of pollutants and natural biotoxins in coastal and marine environments. Interests include toxic chemicals and biotoxins in fishery products and protected marine species; networking of quality control and interlaboratory calibration among analytical labs throughout the region; alleviation of pollutant impact accompanying development in Caribbean nations.

Environmental Assessment. A multidisciplinary program that utilizes traditional and innovative procedures to assess the impacts of anthropogenic activities on marine systems. Includes impacts of power plant operations, oil field exploration, dredging, sewage effluents, and beach and seagrass restoration on

water quality, plankton, bottom communities, benthic infauna, ichthyofauna, and fisheries. Of special interest are: the community dynamics of patch reefs in the Gulf of Mexico and their susceptibility to anthropogenic activities; and the biodiversity of macroinvertebrate communities associated with estuaries and near-shore marine habitats in the Intra-American region.

Phytoplankton Ecology. A new research area at MML emphasizing primary productivity of phytoplankton in the upper mixed layer and regional and global effects of bloom-forming species. Ecology and impacts of phytoplankton and zooxanthellae species on coral reefs and coastal environments.

Protected and Endangered Species. Includes two major programs devoted to marine mammals and sea turtles. Marine mammal stranding response, population ecology of marine mammals, monitoring of sea turtle nests, tagging of migratory turtles, and enhancement of survival of protected species are primary research interests.

Shark Biology. Basic research (biochemistry, anatomy, physiology, and behavior), biomedical studies, and applied fisheries research on sharks, skates, and rays. Of special interest for the Intra-American Sea region is the proposed Center for Shark Research at MML, to facilitate research on Gulf and Caribbean species impacted by current fishery operations. Fishery-related research interests include: population biology, life history, and ecology of sharks; shark fisheries and stock assessments; and socio-economic factors relating to sharks and shark fisheries.

MML Institutional/International Affiliations

Institutional Affiliations. Include Southern Association of Marine Laboratories, Association of Marine Laboratories of the Caribbean, National Marine Fisheries Service, Pesca, Office of Naval Research, Environmental Protection Agency, Minerals Management Service, Gulf of Mexico Program, Coastal Oceans Program, Harbor Branch Foundation, Florida Keys Land and Sea Trust, University of Miami, University of Puerto Rico, and University of Santo Domingo.

Gulf and Caribbean International Affiliations. Include research affiliations with Mexico, Cuba, Puerto Rico, Dominican Republic, Virgin Islands, Cayman Islands, Costa Rica, and Colombia.

International Marine Science Cooperation Program
Woods Hole Oceanographic Institution

David A. Ross and Judith Fenwick

The International Marine Science Cooperation Program was begun in 1985 to enhance international cooperation between the U.S. and foreign marine science communities. The program's broad objectives are: (1) to provide access for coastal countries to U.S. marine science expertise; (2) to improve opportunities for collaborative research between U.S. and foreign scientists (information exchange, outreach); (3) to increase opportunities for U.S. scientists to work in foreign waters; and (4) to strengthen the global approach to ocean studies.

Projects applicable to the region of the Intra-American Sea include:

- Funding sources for marine scientists. An active database of funding sources for scientists to do international marine science research (MSR). The database was published in 1990 as Fenwick, Ross and Schramm, *International Marine Science Funding Guide*. We are negotiating with OMNET to place the database as a SCIENCEnet electronic bulletin board for active access.

- International jurisdiction over marine scientific research. Databases have been created which profile 145 coastal countries on their maritime boundaries and offshore zone claims, jurisdiction over maritime zones, jurisdiction over MSR, and annotated history of U.S. research clearances to work in their waters. Portions of these databases will eventually become SCIENCEnet electronic bulletin boards. In addition, from database information we will be publishing in early 1991 a second edition of the worldwide map showing maritime boundaries and MSR jurisdiction.

- Caribbean/Latin America marine science institutions and research areas. Database in development for institutions and individuals which will tie-in with Sea Grant institutions to enhance information exchange, match colleagues and mutual areas of research.

The Viability of Establishing a Caribbean Regional Center for Marine Industrial Technology

Woods Hole Oceanographic Institution

David A. Ross, Judith Fenwick and Frank Gable

We have completed a recent study (July 1990) for the United Nations Industrial Development Organization on the viability of establishing a Caribbean Regional Center for Marine Industrial Technology. To help identify needed technologies we have produced individual country resource and economic profiles and a listing of wider Caribbean institutions with marine technology interests.

It is evident that the States of the Wider Caribbean have three important common denominators in the area of marine industrial technology: (1) major economic difficulties; (2) the opportunity available to these states under the new Law of the Sea regime; and (3) the coastal zone and ocean as vast and prominent sites in their future economic development. The meshing of these common denominators: economic problems and economic opportunity, yields a positive outlook. This positive trend relies on the appropriate development and management of marine resources in the Caribbean Region and on technological cooperation between developed and developing countries. The Insular Caribbean has the highest density of developing countries in the smallest geographic area. In such a region, ocean and shoreline development opportunities are pivotal to overall economic growth and development and yet development cannot proceed at any substantial rate without strong regional cooperation.

One of the key motivators for marine industrial development in the Caribbean is the fact that the 1982 Law of the Sea treaty encourages countries, particularly island nations, to declare 200-nautical-mile Exclusive Economic Zones (EEZ). These new areas under national jurisdiction will open up opportunities to exploit certain marine resources such as oil and gas, offshore fishing and possibly innovative technologies such as OTEC and marine biotechnology. This new jurisdiction is accompanied by serious challenges such as managing, monitoring, and enforcing jurisdictions within these new zones.

Success will depend on how well the countries can cooperate with each other. This is especially true since the costs for new industries, or expansion of present ones, will be high and beyond the resources of most individual countries. There will also be manpower and technical training needs that will require close cooperation and the formation of consortia between countries.

The keywords for technology development in the Caribbean are "appropriate" and "sustainable." The actual functions and objectives of a Caribbean Marine Industrial Technology Center should be defined after the needs and viable opportunities, and the relevant technologies and their uses, are fully identified for the region. A key goal of the Caribbean Regional Center certainly should be to sustain and increase economic growth without damaging environmental impact. Simply said, the Caribbean, especially the Insular Caribbean, is an extremely vulnerable marine environment.

We have identified eight technological subject areas for consideration by the proposed Caribbean Regional Center for Marine Industrial Technology (order of the listing does not reflect ranking or priority):

- desalination technology;
- pollution-control and waste-disposal technologies;
- non-polluting renewable energy technologies;
- marine biotechnology;

- technologies for the exploration and exploitation of non-living resources;
- technologies for shore protection and development, with emphasis on coastal erosion and beach protection;
- offshore technologies, including ocean engineering and marine mining technologies;
- fisheries, aquaculture, and mariculture.

We recommend these activities as follow-up actions after approval of our study:

1. The next step after approval of this report by UNIDO should involve dissemination of the completed viability study to set the stage for a workshop of marine experts from the Caribbean States, drawn from government, industry, and academia, along with participants from UNIDO, UNEP, UNDP, and other appropriate regional and international agencies. The workshop should begin the process of national studies on activities of institutions and industries involved or interested in the development of marine technologies in selected Caribbean island countries.

2. The study and a report of the workshop (step 1 above) should be circulated to those states and territories, with particular attention to industries, in the Wider Caribbean who may become "partners" in Center projects. Early focus should perhaps be on the insular Caribbean.

3. As in any well run public relations program, participants at the proposed workshop should use public forums and personal contacts to promote the feasibility and substance of the proposed Caribbean Regional Center, including developing contacts with industry, government officials, and researchers in their respective Member States.

4. As the proposal evolves and reaches closure, potential funders should be kept informed of progress.

5. Establishment of the Caribbean Regional Center should be dependent on official approval by five Caribbean states, and when core funding is in hand for a minimum of five years.

A Brief Summary of Programmatic Goals and Present Research Activities
Marine Environmental Sciences Consortium

William W. Schroeder

Background

Founded in 1971, the Marine Environmental Sciences Consortium (MESC) operates the Dauphin Island Sea Lab, located on Dauphin Island in coastal Alabama. The Lab is presently staffed with ten year-round faculty and three post doctoral research associates. In addition, numerous faculty from member institutions of MESC maintain active research involvement at the Lab.

Research Goals and Programs

The long-term research goals of the MESC are: (1) to develop new theory and improved understanding of the mechanisms (biological, physical, chemical and geological) structuring nearshore ecosystems; and (2) to apply this knowledge to the management of the nation's aquatic and coastal resources through multidisciplinary studies of coastal waters and their adjoining landscapes. Historically, research activities have concentrated on descriptive studies of salt marshes, soft bottom community structure, and hydrographic-circulation processes in and around the Mobile Bay estuary. Similarly, studies on the continental shelves of the northern Gulf of Mexico have established benchmark information on biological community structure, hydrography and circulation, and geologic framework. These studies have provided a substantial database from which a more process-oriented research program has evolved.

As an outgrowth of the historical research emphasis of the MESC, the present programmatic focus is on (1) the dynamics of production in estuarine environments with emphasis on the marsh, submerged aquatic vegetation (SAV), and open water ecosystems, and (2) shelf processes, emphasizing recruitment, secondary production and community structure in benthic communities associated with "hard bottom" environments as a "vehicle" for understanding the essentials of population dynamics and energy coupling between the shelf and the estuary.

In the area of estuarine productivity, we are concentrating on the processing and transfer of energy through the dominant types of local nearshore habitats. This work involves measurements of both primary and secondary production and nutrient regeneration, studies of predator-prey and plant-animal interactions, and the physical, chemical and biological factors influencing the recruitment dynamics of planktonic and sessile fauna and flora in a variety of localities. Included here are laboratory studies designed to evaluate the interacting roles of chemical cues and hydrodynamic factors as they influence the behavior of marine and estuarine organisms. In addition, the populations biology of several commercially important species is being investigated. A central theme in this work is an attempt to understand how variation in physical, chemical and biological processes interact to regulate the structure and function of estuarine ecosystems.

Studies on the shelf are similarly examining the processing of biological and physical energy through a variety of benthic habitats extending from the outer shelf shoreward to the mouths of the coastal estuaries. This work primarily involves seasonal and episodic reproductive and recruitment cycles, predator-prey interactions and the dynamics of differing habitats' community structure as a means of addressing the larger picture of ecosystem function. This highly interdisciplinary effort relies on concomitant investigations of the dynamics of water movement, sediment transport and the effects of episodic cold air masses on biological communities. A major thrust of these studies is to understand how the westerly-moving turbid, nutrient-rich plume exiting Mobile Bay affects larval transport and re-invasion

of the estuary, and also how productivities in areas receiving the plume might be affected by this large supply of nutrient-rich water.

Another area of interest centers on the reconstruction of paleoenvironments during the last Pleistocene regression and the Pleistocene-Holocene transgression (ca. 35,000 years B.P. to the present). This work entails examination of relic estuarine sediment and oyster shell deposits on the shelf as well as relic carbonate structures (e.g., drowned reef-like mounds and coastal barriers) relative to global sea level changes. Of particular interest is the linkage between global warming-cooling cycles and sea level response to features on the outer continental shelf that appear to reflect very short term sea level changes during the Younger Dryas period (ca. 11,000-10,000 years B.P.).

University of Puerto Rico

Manuel Hernandez-Avila, Jorge E. Corredor and Julio M. Morrell

With a complex mixture of Hispanic heritage and U.S. influence in science and technology, Puerto Rico is uniquely suited to carry out its traditional and ongoing role in international affairs. The University of Puerto Rico Sea Grant Program (UPRSGP) is continuing this important role in the realm of marine affairs, and specifically the export of Sea Grant's conceptual philosophy of research, education, and extension.

In 1977, the University system added a Sea Grant marine advisory service project to its rapidly growing role in marine affairs. By 1980, the Sea Grant advisory service project was expanded to include education and research. And in 1989, UPR's successful Sea Grant Program was elevated to college status. The ideal combination of a strong Department of Marine Sciences and a vigorous Sea Grant College Program, as well as support from other university departments and specialized agencies of the Commonwealth government, provides Puerto Rico and its University the necessary strength and resources to continue and even increase its leadership position and involvement in marine science development in Latin America and the Caribbean. This position of regional leadership is even further reinforced by Puerto Rico's rather unique history and position in the region. On one hand, the island, its people and its institutions reflect a strong background of Hispanic traditions, culture, and language. On the other hand, its political and economic ties to the U.S. provide Puerto Ricans with ready access to the latest developments in science and technology. It is an ideal set of circumstances which has built the north-south bridge in marine affairs.

Contributions by the University of Puerto Rico

The growing involvement of the University of Puerto Rico system in the marine affairs of the Caribbean and Latin America has developed or evolved along certain specific lines which were considered appropriate both to Puerto Rico and to the region, education from K-12 to Ph.D., both basic and applied research, and a broad spectrum of advisory, participatory and service functions. The following is a brief overview of these activities.

Education

UPR educational activities in marine affairs cover several distinct facets and objectives. Most are concentrated in the Department of Marine Sciences and the UPR Sea Grant College Programs. Other departments such as biology, chemistry, sociology, engineering and several institutes of the UPR Medical Campus also have important educational degree programs related to the ocean sciences and marine resources.

On a less structured level, there is a continuing non-degree program which was established several years ago with the marine science institute, CIBIMA, of the University of Santo Domingo in the Dominican Republic. Here UPR marine science professors have conducted short courses in specialized topics in marine biology, ecology, and coastal dynamics. Recently, the Department has been requested by the Santo Domingo government to provide specialized training courses in seafood science and technology, emphasizing product handling and processing, and quality standards and evaluation. These training courses are now in the organizational stage.

In addition, the Department of Marine Sciences provides less formal or ad hoc educational opportunities to visiting professors from various universities in the region. Often these visitors wish simply to upgrade or advance their scientific capabilities, normally in conjunction with a particular UPR professor or researcher in their field. In other cases, a visitor's purpose is, for example, to change a pure chemistry background to one of marine pollution chemistry. Many of the visiting professors, particularly those on a one-year sabbatical, have received supplementary financial support from the University to help defray travel or living expenses.

Finally, there is the UPR Sea Grant secondary school program which, at the present, has been developed mainly for Puerto Rican use but could, however, be readily exported to other countries in the region with relatively little modification. The basic goal of this program is to create national awareness of the sea and its potential value to society, an awareness which traditionally has been lacking not only in Puerto Rico but in all other countries in Latin America and the Caribbean as well. The aims of the programs are to provide additional training courses and field experience for K-12 teachers, develop curricula for classroom use in conjunction with public education officials, and to place supplementary texts, audio-visual aids and study materials in the hands of teachers. In view that similar efforts are under development only in Trinidad and Brazil, the Puerto Rican secondary school program has tremendous outreach potential in the region.

Research

Scientists of the University of Puerto Rico have long played a major role in marine affairs research in the greater Caribbean region. The spectrum of research not only includes the four traditional disciplines of oceanography but also has been expanded to cover topics in coastal engineering, seafood science and technology, mariculture, resource economics and management, sociology and law. Much of this research has addressed problems unique to Puerto Rico. A significant proportion, however, has been conducted in the Virgin Islands and elsewhere in the Caribbean Basin. Within the University of Puerto Rico system, most research programs in marine affairs involve graduate student participation, a significant number of which are degree candidates from Latin American countries. Additionally, there frequently is international collaboration at the PI level, often in bilateral institutional research projects or in arrangements with professors visiting the University. In several instances, the UPR Sea Grant College Program has supported research projects in other Caribbean countries, normally relatively modest funding of so-called "seed-money" grants. Unfortunately, the last 10 years of essentially level funding has severely limited this research support and, or course, many of our other international outreach initiatives.

The International Network

Although formalized, UPRSGP international activities have been limited, due in part to our relatively youthful status as a Sea Grant Institutional Program and also by our history of low-level funding. We continue to incorporate within our budget projects with international components. Simply put, we believe in an International Sea Grant outreach and we believe our operations are a significant part in the development of that outreach. Bicultural, as well as bilingual, our operations extend through VIMAS into the English-speaking islands of the Caribbean as well as into the Hispanic countries of Central and South America.

To date, we have established a cooperative program with the University of Santo Domingo in the Dominican Republic and we are now considering a seed money project with the University of the West Indies in Jamaica. Less formally, our research projects often incorporate Latin American graduate students and our researchers are in collaboration with many foreign scientists. The UPRSGP researchers, marine

advisors, and educators are also frequent participants in scientific conferences, symposia and workshops organized in Latin America and the Caribbean.

UPRSGP administered NOAA pass-through funds which supported WATS-II, the Second Western Atlantic Turtle Symposium which was convened in Mayaguez in October 1987. Some 37 countries from the western Atlantic, from Brazil on the south to the U.S. and Bermuda on the north, were involved. The Director of the UPRSGP, as well as research and administrative staff of the program, have long been active in programs of IOCARIBE, the Intergovernmental Oceanographic Commission (IOC) of UNESCO, as well as with regional activities of the UN Food and Agricultural Organization (FAO) and the UN Environment Program's (UNEP) Caribbean Action Plan.

Collaborative Research Activities of the UPR-Chemical Oceanography Group in the Caribbean Region

Currently, the Chemical Oceanography Group is involved in the following regional activities:

1. CARIPOL I. Monitoring and research on petroleum pollution (tar on beaches, floating tar and dissolved/dispersed petroleum hydrocarbons). Stations are routinely occupied off the southwest coast of Puerto Rico and at Mona Island. Other stations are occasionally occupied in the U.S. Virgin Islands.

2. CARIPOL II. Monitoring and research on petroleum pollution in organisms and sediments. Samples are refluxed, extracted in hexane, split into aromatic and aliphatic fractions and analyzed by fluorescence spectroscopy and gas chromatography. The group has participated in regional inter-calibration exercises and is currently participating in a second round of intercalibration between participating laboratories.

3. Development of a pilot program for the quantification and analysis of marine debris. J. Morell, at the direct request of the IOC Secretariat, is currently coordinating the development of strategies and methodologies for the assessment of the problem of marine debris in the Caribbean region in collaboration with CIOH (Cartagena, Colombia) and CINVESTAV (Merida, Yucatan, Mexico). The program thus developed will then be implemented by the full list of CEP POL participants.

Research Overview
Gulf Coast Research Laboratory

Thomas D. McIlwain

Research Programs and Plans

The Gulf Coast Research Laboratory has a variety of research expertise. The research staff conducts year-round, full-time applied and basic research in various fields that are reflected in the following research thrust areas. These research areas have been chosen after critical review of future research needs and expertise available within the Laboratory. Additional staff needs have been identified and will be added as funding becomes available. The research thrust areas include:

Fisheries Science

This group includes expertise in carcinology, ichthyoplankton, invertebrate zoology, fishery population dynamics, fishery development, and parasitology. The fisheries group currently conducts research into the biology of important recreational and commercial finfish and shellfish. Researchers are involved in the development of underutilized and latent fishery resources in the Gulf of Mexico. In carrying out its mission, the fisheries group interacts with state, regional, and national marine resource agencies, such as the Gulf of Mexico Fishery Management Council, the National Marine Fisheries Service, the Gulf States Marine Fisheries Commission, and the Mississippi Department of Wildlife, Fisheries and Parks in supplying, analyzing, and interpreting fishery management data.

Aquaculture

This group includes expertise in finfish and shellfish aquaculture with emphasis on parasites and diseases of cultured species and maturation and spawning. They are able to call on the expertise of the other research sections in problem-solving related to aquaculture. Additionally, this group can call on the engineering expertise available on the parent campus of the University in the Department of Engineering Technology. Their primary focus is directed toward solving problems that deter the orderly development of the aquaculture industry.

Environmental Fate and Effects

This group has expertise in analytical chemistry, environmental chemistry, microbiology, pathology, and toxicology. Currently, their research ranges from nutritional components of Gulf fishes to determination of chemical and physical properties of organotins under bioassay conditions. Inorganic pollutant levels in resident organisms are being investigated, and environments of anthropogenic wastes through the northern Gulf estuaries are being determined. Other research activities involve examination of various indigenous plants for ability to interact with polynuclear aromatic hydrocarbons, product quality and public health as affected by seafood microflora (especially related to aquaculture species), autochthonous estuarine pathogens, and indicator bacteria in the estuarine environment. The pathology focus of this group is on histological and environmental aspects of organs, tissues, and cells of marine and freshwater organisms and possible effects resulting from effects of carcinogens and environmental toxicants. They are integrated with the toxicologists who focus on the fate and disposition of xenobiotics in the natural environment, including assessment of degradation rate kinetics and effects on degradation

rate of environmental parameters. Geographic site comparisons of laboratory systems to field evaluation are made in predicting environmental fate of various chemicals and assessing the toxicity of degraded parent compounds using indigenous fish and crustaceans.

Coastal Ecology

Expertise in this group includes ecology, geology, physical oceanography, and botany. Their current research is focused on the rate of photosynthesis by phytoplankton in relation to the concentration of chlorophyll and other plant pigments and benthic community structures. Additional research that they are considering involves interdisciplinary studies of bottom sediments of Mississippi coastal water bodies, field surveys of beach accretion-erosion cycles, and detailed investigations of the Pleistocene-Holocene geographical history of coastal plains of inshore and nearshore Gulf areas. This group teams with the USM Center for Marine Science located at Stennis Space Center in Bay St. Louis, Mississippi, to conduct joint research on estuarine hydrodynamic and physicochemical processes. Other studies include characterization of estuaries, air-sea interaction, hydrologic processes in marshes, dynamics of estuarine fronts, continental shelf circulation, and cross-shelf processes. Integrated into these studies are research activities on plant life of Mississippi's estuaries, marine ecosystems, sand beaches, and dune habitats, with concentration on the systematics, physiology, and ecology of tidal marsh plants, sea grasses, and sand dune species.

Biodiversity

Marine vertebrate and invertebrate zoology an marine botany are the areas of expertise found in this group. Current research highlights taxonomy systematics and distribution of subtropical and tropical marine and estuarine fishes and ecological surveys of local invertebrate flora and fauna. This includes extensive baseline studies of northern Gulf barrier islands and mainland beaches to document the impact of man's activities on these fragile environments.

In support of this extensive research effort, the Laboratory maintains the Gunter Library which contains 26,000 catalogued reprints, 10,000 books, and 1,000 journal titles. Additional research support facilities include the Ichthyology Research Collection that contains about 20,410 catalogued lots of fishes representing over 200,000 specimens from 251 families and 2,700 species. The Laboratory also maintains a Water Analysis Laboratory and the William M. Shoemaker Toxicology Laboratory to support its extensive research effort.

Additionally, the Laboratory operates a fleet of research vessels including the oceanographic ship *Tommy Munro*, which has an overall length of 98 ft., beam of 25 ft., and draft of 12 ft. This vessel carries an ABS certification for operation in all oceans.

Besides the extensive research effort outlined above, the Laboratory operates the J. L. Scott Marine Education Center and Aquarium located on the Biloxi, Mississippi, campus. The Center is the Laboratory's main public-use facility and provides living and static displays of flora and fauna in the aquarium room and lobby. The large public aquarium area is designed to inform the public of the diversity and importance of our estuarine and marine environment. Through this Center the Laboratory offers "Project Marine Discovery" (PMD), a unique field trip program for kindergarten through high school students during the academic year and summer months. Once a month throughout the year, a program called "An Evening at the Aquarium" is held. This is a family-oriented lecture program aimed at informing the public about current issues relating to the marine environment. Additional educational activities include plans for expanding course offerings into the Caribbean area at strategic locations.

Research Overview
Texas A&M University at Galveston

William E. Evans

Introduction

Texas A&M University at Galveston is the marine and maritime component of the Texas A&M University System. The University provides academic instruction in seven marine and maritime-related degree programs leading to the Bachelor of Science degree; there are cooperative graduate degree programs at both the master and doctoral level with the Departments of Oceanography, Biology, and Wildlife and Fisheries Sciences at Texas A&M University at College Station.

The University has two campuses: the 100 acre Mitchell Campus on Pelican Island and the three acre Ft. Crockett Campus on Galveston Island. An additional 15,200 sq. ft. of space is occupied by University researchers at the National Marine Fisheries Service Laboratory at Ft. Crockett. Galveston and Pelican Islands are located at the mouth of Galveston Bay with access to the Gulf of Mexico but minutes away.

Research Programs

Research at Texas A&M University at Galveston is housed under two administrative units, the Texas Institute of Oceanography and the Coastal Zone Laboratory. Although each unit has its own administrative responsibility (e.g., funding), there is some overlap among their constituent research programs. A brief description of these administrative units is given below.

The Texas Institute of Oceanography (TIO), established under the auspices of the Texas A&M University System, is directed by Dr. William J. Merrell, President of Texas A&M University at Galveston. TIO provides services for all research institutions in Texas. Its mission: (1) provides focus for research on the Gulf coast; (2) assures scientists at Texas universities of suitable multi-user facilities; (3) provides research and technological base for development of marine-related businesses in the State of Texas and Gulf of Mexico; (4) facilitates management and coordination of academic marine research programs of Texas; and (5) facilitates management of regional federal programs.

The Coastal Zone Laboratory (CZL) is a TAMUG-based administrative entity under the direction of Dr. C. S. Glam. The CZL has two main functions: (1) administer and coordinate all research at TAMUG; and (2) report on all TAMUG research activities and funding to the Texas Coordinating Board.

Research at TAMUG is housed in four major program areas. These program areas include: (1) Coastal Processes; (2) Texas Shelf Processes; (3) Marine Policies and Management; and (4) Climate Change in Texas. There is considerable variation in the degree of research development across these four program areas. Consequently, the primary focus of this presentation will be on research within the best established programs, Coastal Processes. However, a brief description of the other three research programs is warranted prior to discussion of Coastal Processes.

The Texas Shelf Studies Program incorporates research efforts concentrating on basic research in physical, biological, chemical and geological oceanography, geophysics, and ocean engineering in Gulf of Mexico offshore and other deepwater environments. The TIO plays a vital role in this program by providing researchers access to the latest technology for analyzing water, sediment and core samples and vessel time to collect these samples.

The Marine Policies and Management Program facilities research providing marine policy for coastal zone management, risk assessment from which seafood safety regulations may be developed, and environment/ecosystem educational outreach programs targeted to state and federal agencies and legislative bodies. Examples of research projects under this program include: factors affecting recreation/tourism in the coastal zone, impact of science on environmental policy and the economic consequences of this policy, oil prices and the U.S. economy, and humanities and life along the coast.

Research in the Climate Change and Texas Program is attempting to determine how human activities and natural forces are influencing climate. TAMUG is fortunate to have a MACSAT real-time satellite imaging computer system for monitoring weather and ocean temperatures. TIO is working with Texas A&M University at College Station to establish a university-wide Center for Advanced Climate Studies to provide a focus for systematic research on the physical basis of climate changes, its prediction, and related policy issues.

The best developed research program area at TAMUG is the Coastal Processes Program. This program provides an umbrella of research focused primarily on Galveston Bay and vicinity. Specific research interests included in the Coastal Processes umbrella are: (1) marine chemistry and toxicology; (2) marine life sciences; (3) physical oceanographic processes and modeling; and (4) Galveston Bay Information Center.

TAMUG's endangered species research program is currently targeting marine mammal and sea turtle stocks. To this end, TAMUG has initiated a Marine Mammal Research Program consisting of a core of five researchers with expertise in various facets of marine mammal biology. Dr. Bernd Wursig, a behavioral ecologist, is Director of this program. Other core researchers include Drs. William Evans, an acoustician; Randy Davis, a physiologist; Graham Worthy, a physiological ecologist; and Raymond Tarpley, a veterinarian and anatomist. The other endangered component of the Marine Life Sciences area is sea turtle natural history. Research efforts involve collaborative efforts between Drs. Andre Landry and Ray Sis and the National Marine Fisheries Service, Galveston Laboratory.

Texas A&M University
College of Geosciences/Geochemical and Environmental Research Group

Dennis A. Wiesenburg

The Geochemical and Environmental Research Group (GERG) in the College of Geosciences at Texas A&M University conducts research in the fields of organic geochemistry, environmental chemistry and marine chemistry in the Gulf of Mexico, Caribbean Sea and throughout the world. GERG is staffed by 17 Ph.D. scientists and almost 100 technical support staff. GERG scientists are involved in numerous research projects in the Gulf of Mexico and Caribbean Sea, especially in the areas of environmental contamination studies, petroleum geochemistry studies and ecological monitoring. A summary of ongoing GERG projects is given below.

Studies Using Submersibles

Oil and gas seeping from deep reservoirs into surface sediments in the Gulf of Mexico has resulted in the formation of areas of lush chemosynthetic communities of mussels, clams and tube worms on many areas of the continental slope in the Gulf of Mexico. The continuing study of these seabed communities is undertaken by GERG scientists using various submersibles including the *Johnson Sea-Link*, the Navy's nuclear research submarine NR-1 and the DSV *Alvin*. Our goal in these studies is to determine the areal extent of the communities, to evaluate the geological conditions of seep areas, to understand the geochemical processes which support the existence of the communities and to examine the microbiology of the organisms to determine metabolic mechanisms.

Coral Reef Research

The study areas for our programs on coral reefs are the Flower Garden Banks in the Gulf of Mexico and the Florida Keys. We are conducting long-term monitoring at the East and West Flower Gardens to assess changes in coral cover, population levels, diversity, and accretionary and encrusting growth rates. Studies are also aimed at understanding coral bleaching which, for the first time, was considered to be severe this past summer on the banks. Our program in the Florida Keys is aimed at assessing coral damage and recovery rates at three ship grounding sites in the Key Largo National Marine Sanctuary and evaluating NOAA damage assessment procedures.

National Status and Trends Mussel Watch Program

GERG has been involved in the National Oceanic and Atmospheric Administration National Status and Trends (NS&T) Mussel Watch Program since 1986. The NS&T Program's goal is to assess the current status and long-term trends of selected environmental contaminants. In order to achieve these goals GERG collects and analyzes oysters and sediments from over 70 sites on the U.S. Gulf coast.

Environmental Monitoring and Assessment Program (EMAP)

GERG has just begun working on an environmental assessment program for EPA. The EMAP-Near Coastal Program is designed to assess change in ecological conditions over broad biographic regions--including the Gulf of Mexico.

Oil Spill Monitoring Program

GERG scientists continue to take an active role in oil spill studies both in the Gulf of Mexico and in Alaska. GERG is providing analytical support to NOAA, the U.S. Fish and Wildlife Service and the State of Alaska as part of their responsibilities to the Exxon Valdez Damage Assessment Trustees. Over 1,000 samples from the Exxon Valdez oil spill have been analyzed by the GERG analytical laboratory. When the supertanker *Mega Borg* exploded 57 off Galveston, Texas, on June 8, 1990, GERG scientists implemented a rapid field monitoring response. GERG intends to provide a rapid response team to evaluate the initial impact of other oil spills which may occur in the region.

Galveston Bay Research Activities

Several GERG environmental programs focus on Galveston Bay, Texas, under the auspices of the Galveston Bay National Estuary Program supported jointly by EPA and the State of Texas. Our Galveston Bay projects are designed to examine both the pollutants and their sources.

Aruba Environmental Baseline Study

In 1989, GERG scientists conducted a environmental study offshore Aruba. The objectives of this study were to document present day environmental conditions in two offshore areas that had been leased for oil and gas exploration. A physical oceanography survey was conducted as part of this study, along with five video transects of the sea bed, bottom sediment collection and analysis for trace metals and petroleum hydrocarbons and a beach tar survey. Part of the Aruba study consisted of collecting sediment samples using a 2,000 lb. piston corer for subsurface determination of petroleum hydrocarbons. During the last seven years, over 2,000 piston cores have been collected and analyzed from the Gulf of Mexico and Caribbean Sea. GERG will continue this active geochemical exploration research in coming years with several cruises already planned for 1991.

The University of Texas at Austin/Marine Science Institute

Robert S. Jones

The Institute is dedicated to the three primary functions of a major university (education, research, and service), as they apply to the Texas coastal zone. It is an organized research unit of The University of Texas at Austin and emphasizes both basic and applied research aimed at understanding the biological, chemical, and physical processes governing the coastal zone ecosystem.

The facility is located in Port Aransas, Texas, at the north end of a Gulf beach barrier island, Mustang Island. This sophisticated research laboratory and its modern physical plant resided on the Aransas pass ship channel which separates San Jose and Mustang Islands. The pass connects the Gulf of Mexico with an extensive system of estuarine lagoons and provides the navigational approach to the port city of Corpus Christi. This setting is ideal for a marine science facility. Ships and small boats from the Institute have access to both the open Gulf and bay environments of the Texas Coastal Zone. Scientists and students can easily reach a multitude of relatively pristine coastal habitats, including hypersaline lagoons, estuaries, mud flats, seagrass meadows, oyster reefs, barrier island ecosystems, and the vast environmental domain of the offshore continental shelf.

Active research programs in several marine science disciplines, including the physiology, biochemistry and ecology of marine plants and animals; biological, chemical, and physical oceanography; geochemistry; mariculture; biochemical toxicology; and environmental monitoring, have been established at the Institute for many years. Current programs include:

- Multidisciplinary research on marine ecosystems involving impact of freshwater inflow on estuarine systems, nutrient cycling, and mechanisms coupling estuaries and lagoons with the inshore continental shelf.
- Nutrient uptake dynamics and primary production in phytoplankton.
- Trophic dynamics in benthic organisms including bacteria, meiofauna and macrofauna.
- Microbial degradation of organic matter and recycling of nutrients in marine food webs.
- Studies on physiology and environmental toxicology, encompassing factors that control molting in invertebrate organisms and the reproductive biology of marine finfish.
- Investigations on recruitment and predator/prey dynamics of marine zooplankton and larval fishes using video/computer image analysis equipment.
- Ecology and adaptive value of bioluminescence in marine organisms.
- Evaluation of nutrition in natural and mariculture systems using stable isotope tracer methods.
- Mariculture research involving chemical and temperature/photoperiod spawning of finfishes, development of intensive raceway culture for year-round production of shrimp and fish, and the establishment of physico-chemical limits in larval fish growth and survival.

The Institute's 83,000 sq. ft. headquarters on 72 acres of beachfront land consists of a series of interconnected buildings containing laboratories, offices, library, museum exhibit halls, classrooms, a

visitors center, auditorium, seminar rooms, and workshops. A 10,000 sq. ft. wet laboratory is supplied with filtered, running seawater. There is an additional 7,000 sq. ft. of dormitories (70 beds), a cafeteria, physical plant complex, garages, greenhouses, walk-in freezers, and outdoor pool/habitat tanks. A pier laboratory affords direct access to measure fluxes in the Aransas Pass ship channel connecting the Gulf with the bays.

A mile west of the main building complex the Fisheries and Mariculture Laboratory occupies 26,000 sq. ft. of buildings adjacent to the ship channel. The facility contains extensive wet laboratories for spawning, larval development, and grow-out studies in fishes.

Library holdings include over 8,000 books and 37,000 bound volumes of journals. Remote-job-entry terminals in the Institute's computer laboratory provide direct access to the UT-Austin Computation Center's CDC, IBM, and DEC mainframe computers. The Institute publishes its own journal, *Contributions in Marine Science*.

The R/V *Longhorn* was modified in a major refit in 1986 to give her an overall length of 105 ft. The vessel is equipped with a trawl, hydrographic and conducting winches and modern electronic navigation and communication equipment. The *Katy*, a 57-ft. fiberglass trawler, is used in bay programs. Marine operations are augmented by a fleet of swift small boats.

APPENDIX B: BULLETIN BOARDS

The "Bulletin Board" Philosophy

Murray Brown, MMS

There is no more humbling experience for a marine scientist than to be present during a scientific talk by a meteorologist. Typically, they present charts indicating many tens--if not hundreds--of data stations used in their synoptic(!) analyses. This happy situation, of course, is made possible by the relative ease of making measurements on land, and the constant presence of a dedicated corps of observers (as well as some automated devices in remote locations). Unfortunately, for the oceanographer, all locations are remote, observers are few, and the measurements are costly and difficult to obtain. Toward some improvement in this area, the past decade has seen a great increase in the willingness of oceanographers to share information; in the past two years much discussion of an "operational oceanography" system has also taken place. Essential to the fabric of these successes and plans has been electronic messaging and electronic bulletin boards, particularly the services provided by the SCIENCENET System which is used by most U.S. oceanographers.

Although the theme of most bulletin boards is topical, such as "JOBS" or "TOGA" for example, the U.S. Minerals Management Service has enjoyed great success with a board aimed at aiding scientists in a particular geographic region, the Gulf of Mexico. The original announcement for the board (Attachment) speaks for itself, in that the board is to allow all kinds of information exchange, NOT JUST THE EXCHANGE OF ORIGINAL DATA. In fact, actual data exchange is probably handled more efficiently as individual-to-individual messaging. It is more valuable, in the MMS experience, just to let "the world" know the familiar journalistic watchwords: WHAT, WHEN and WHERE. Observing this simple concept facilitates a wealth of information exchange in the Gulf of Mexico community, ranging from coordinated cruises and data-swapping, to posting of near-real time data from ships, buoys and satellites.

In addition to setting up the GULF.MEX bulletin board (see attachment), the MMS tackled another long-standing problem: How to send graphics via electronic mail? Although text messaging is very much a standard way of doing business in the U.S. oceanic community, there has been much discussion of ways to send graphics, particularly charts. Although some graphics formats, such as Tektronix and Hewlett-Packard Graphics Language have been suggested, they typically require very large files. GULF.MEX has dealt with this by publishing a shareware program (GULFPLOT) that plots charts according to a simple ASCII data format that has now been published for several useful data types. The transmitted files are small, and the xW1 data--not graphics command instructions--are handled. This practice allows widespread use and sharing of "headline" information, such as satellite analyses and drifting buoy tracks, and easy graphic integration of data from many sources. The program is written in the Basic language included in nearly all DOS-compatible microcomputers, and no compiling or other software is needed.

Attachment:
[OMNET/SCIENCENET Announcement of October 1, 1990]

Effective November 1, 1989, a new bulletin board "GULF.MEX" will be established on OMNET, to serve the marine science community in the Gulf of Mexico. GULF.MEX is needed for the communication needs of several new MMS studies in the Gulf, but in the broader sense is a long-overdue mechanism for tying together many research groups who now recognize the benefits of emphasizing our regional resources and of seeking support and opportunities through cooperation. Therefore, GULF.MEX is "open to the public" and dedicated to the new spirit of cooperation seen in recent major conferences, particularly the Chapman Conference in St. Petersburg.

GULF.MEX BULLETIN BOARD
"The North Atlantic is our boundary condition."

The GULF.MEX Bulletin Board will provide a long-needed medium of information exchange among marine scientists in the Gulf of Mexico region. The following types of information are invited:

- News and comments from all Federal-, State-, academic-, or industry-sponsored marine research programs in the Gulf.
- Cruise plans and reports from the MMS-sponsored Louisiana/Texas Shelf Physical Oceanography Program (LATEX).
- Data availability announcements from LATEX.
- Ship-of-opportunity (SOOP) data from LATEX.
- Drifting buoy locations.
- Selected shareware related to SOOP data and buoy data.
- Information on cruises and data from the biological components of LATEX.
- News of note from regional marine science departments and laboratories.
- Contract awards and RFP availability announcements.
- Report availability announcements.
- Regional meeting announcements and agendas.
- Notes (and graphics!) on Loop Current behavior and eddy locations.
- Periodically updated research directory(ies).
- Pertinent references to the JOBS bulletin board.
- Birth announcements and other human news.

Your contributions to GULF.MEX will be welcomed. Please help in the efforts to build a stronger marine science community in the Gulf of Mexico.

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