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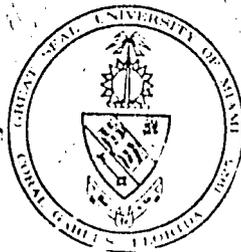
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UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL OF MARINE AND ATMOSPHERIC SCIENCES

REPORT TO THE TINKER FOUNDATION
ON THE 1978-1979 POSTDOCTORAL GRANT
"STRENGTHENING OF MARINE CAPABILITIES
IN CENTRAL AMERICA"

Francisco J. Palacio

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"I hold to the opinion that, although humanity can reach an advanced stage of culture only by battling with the inclemencies of nature in higher latitudes, it is under the equator alone that the perfect race of the future will attain to complete fruition of man's beautiful heritage, the earth."

Henry Walter Bates, "The Naturalist on the River Amazons", 1863.

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I. INTRODUCTION.

The purpose of the project was to obtain basic information on the status of marine affairs in Central American countries which could lead to the possible establishment of cooperative links with U.S. institutions, particularly the University of Miami's Rosenstiel School of Marine and Atmospheric Science, as a means for improving their scientific and technological capabilities in dealing with coastal resources and problems. Improved capabilities would ultimately strengthen the entire region's potential for ocean management.

It became clear at the early stages of the project that Central American countries shared with other South American and Caribbean island countries a renewed interest in their marine resources, and an increasing concern over incipient or growing problems of their coastal zones. These have come into focus in the least few years as a result of the United Nations Conference on the Law of the Sea, and of widespread alarm over environmental degradation. Extended territorial sea jurisdictions and definitions of exclusive economic zones have underlined the countries' interest in existing and potential resources of the continental shelf, margin and seabed, and have stressed the vulnerability of coastal ecosystems (and their bioproductivity) to various forms of coastal development.

A realization of the above situation prompted the planning, within the Rosenstiel School, of a center for coastal studies in the region whereby specific problems could be gauged, and cooperative research and training programs could be developed. The concept of a center was submitted for consideration to the Tinker Foundation for an initial 3-year project early in 1979. It was approved by the Board of Directors and subsequently became operational as of July 1st, 1979, as the Tinker Center for Tropical Marine Coastal Studies in Latin America. Thus, the Central American project has rendered fruit by the establishment of a mechanism to achieve the ultimate objective of cooperative programs through the Center.

A second step, the development of a marine science extension program, is being planned as complementary to the assessment of coastal problems.

Consideration of the possibility of developing interinstitutional ties with Central American universities requires a basic understanding of some of their characteristics and these must be discussed briefly. There are two types of universities in Central America: national and private. These correspond to the binomial character of Central American societies: a large majority of the population, which is afflicted by most of the problems of underdevelopment and is politically inactive; and a small, economically powerful and politically influential elite which exercises control over the rest of the population. Apparent dissatisfaction with the operation of underfinanced, politically restless, often leftist and sometimes unsatisfactory national universities, resulted in the foundation of private elitist institutions. They were developed from private schools often linked to religious organizations with strong "anticommunist" undertones as opposed to the seemingly "promarxist" influences observed in some national universities.

Almost all of the private universities were founded during the 1960's following the impetus of 'development' prompted by United Nations agencies, the creation of the Interamerican Development Bank, the Alliance for Progress, the Central American Common Market, the Economic Commission for Latin America, and similar programs. Naturally, technological professions, economics, business administration and other areas aimed at increasing and optimizing production were emphasized at the new private institutions. And although their foundation objectives specified the pursuit of social development, their educational role, in practice, has not done much to alleviate important social injustices, and often appears to strengthen the interests of ruling elites.

There are two important organizations of Central American universities which promote educational integration and improvement, cooperation and ultimately, social

change. These are:

1. The Confederación Universitaria Centroamericana constituting the Consejo Superior Universitario Centroamericano, CSUCA, founded in 1948. Members of the national universities, represented by their rectors and by the presidents of student federations are: Universidad de San Carlos de Guatemala, Universidad de El Salvador, Universidad Nacional Autónoma de Nicaragua, Universidad Nacional Autónoma de Honduras, Universidad de Costa Rica, Universidad Nacional de Costa Rica, and Universidad Nacional de Panamá.

2. The Federación de Universidades de América Central y Panamá, FUPAC. Its private members are: Universidad Mariano Gálvez in Guatemala, Universidad Centroamericana José Simeón Cañas in El Salvador, Universidad Politécnica and Universidad Centroamericana in Nicaragua, Universidad Autónoma de Centro América in Costa Rica, Universidad Santa María La Antigua in Panamá, and St. John's College in Belize.

Both national and private universities entered the 1970's with a number of common problems. The former, with financial constraints, faculty limitations with frequent turnover, and increased political activism, which has become a common feature of university life. Although student activism has been generally leftist, it has lacked strong ideological foundations and exists, by and large, because of misconceptions, lack of information and most importantly, government neglect and hopelessness before the power of ruling civilian or military minorities. Private universities also exhibited financial difficulties in facing the many needs of growing educational institutions including adequate facilities, full-time faculty in order to develop modest research efforts, and several administrative problems.

It is within this state of affairs that interest in marine resources began to develop in Central America. During the 1960's there was visible interest only in developing and expanding shrimping operations, and a Central American FAO (Food and Agriculture Organization of the United Nations) fisheries project was, at best, moderately successful in creating a minor awareness of the scientific foundations

of the exploitation of marine resources. During the period (1968-1976) of the Cooperative investigations of the Caribbean Sea and Adjacent Regions (CICAR), the Central American countries had little to contribute essentially due to the absence of an investigative capability or clear understanding of research needs. In fact, fisheries departments were the Cinderellas of most governments, and there was little interest in Caribbean projects, the center of international activities, because of underpopulated and often inaccessible Caribbean coastlines. Subsequently, there has been a new Central American awareness of the value of coastal resources produced by the combined effect of the United Nations Law of the Sea Conference negotiations, the creation in 1976 of the Intergovernmental Oceanographic Commission's Association for the Caribbean and Adjacent Regions, IOCARIBE, and the establishment in 1977 of FAO's Western Central Atlantic fisheries project (FAO/WECAF).

In the following sections an attempt is made to identify the role of academic institutions and government agencies in marine affairs, to define some of the most relevant problems of the coastal areas, to summarize information on legislation affecting marine resources, and to offer a few comments on these matters. All of the basic information was obtained during visits to Guatemala, Belize, Honduras, El Salvador, Nicaragua, Costa Rica, and Panamá, in the spring of 1979.

I am deeply indebted to numerous individuals in each country who made this survey possible. The names and addresses of most of these kind and generous people, some of whom helped me during difficult political moments, are listed in the Appendix.

II. MARINE CAPABILITIES.

A. GUATEMALA

1. Academic sector

a. The Universidad de San Carlos de Guatemala, founded in 1676, has a total student population of 37,249, of which 31,529 study in the capital city, the remainder in regional centers. In 1978, the university created CEMA (Centro de Estudios del Mar y Acuicultura), a regional center for marine studies and aquaculture in southern Santa Rosa state. In practice, CEMA has become the site for a 3-year undergraduate program leading to a degree as Aquaculture Technician, which is being implemented with a staff of 5, for 15 students. The role of CEMA is being reevaluated and its future is uncertain. The current university Coordinator for Regional Centers feels that CEMA was created without adequate planning as regards teachers, facilities, adequate technical expertise, and assessment of job opportunities for its graduates. There is a general feeling that CEMA should be redefined as a Center for the study of coastal resources and ecological problems. At this stage it is difficult to assess the merits of the current CEMA program; although the aquaculture curriculum is ambitious, the feasibility of its implementation is questionable. The university has expressed interest in securing the services of an experienced aquaculturist to develop a program aimed at satisfying some of the country's needs, perhaps through the assistance of FAO/WECAF and IOCARIBE.

Evidently, there is uncertainty about the most appropriate orientation that should be given to CEMA, and the Center exhibits many of the problems of a budding program, which is sustained by the enthusiasm of a few idealists. The university, perhaps without much planning, has realized the need for a marine program and has taken an initial and important step. If the university receives assistance in focusing on some of the problems of the Pacific coastline, CEMA can become an important instrument for the training of Guatemalans and for the unfolding of needed research programs. The possibility of a marine station in Bahía de Amatique is, as yet, remote.

b. The other important academic institution in Guatemala is Universidad del Valle, a private university not affiliated with FUPAC. The university, with some 350 students, is supported by La Fundación de la Universidad del Valle de Guatemala, and its U.S. counterpart, the Foundation of the Valle of Guatemala, a Delaware Corporation located in Princeton, New Jersey. Although the university does not have a marine program, it has a Center for Studies on Environment, Population and Natural Resources which deals indirectly with ecological problems in coastal areas, for example deforestation and soil erosion, cotton farming and pesticides reaching humans and fishes. A major project in the Center is a study of the biological characteristics of the pine-bark beetle which is destroying large areas of pine forests in the highlands. This project, conducted in cooperation with the Guatemalan National Forestry Institute and with financial assistance from Canada's International Development Research Center, is a fine example of interinstitutional cooperation in addressing important problems. This type of cooperative efforts could also be undertaken when addressing marine issues. The faculty and students of Universidad del Valle could strongly benefit from an integration of research activities which included marine questions, particularly in view of the good working relationships between Valle and San Carlos universities. The development of extension courses, and the improvement and expansion of CEMA capabilities could be utilized for the implementation of research efforts by the government and academic institutions in addressing relevant coastal problems.

2. Government role.

a. INSIVUMEH. As a result of the earthquake of 1976 the government created in 1977, within the ministry of public works, the Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología, INSIVUMEH. Its department of Hydrology has responsibilities over marine affairs and as such it has been identified as the IOCARIBE national contact. Actual work on marine questions appears to be limited to the preparation of tide tables; there is concern over malfunctioning gauges. INSIVUMEH has

numerous responsibilities but its effectiveness is hampered by an austere budget. Available resources are utilized essentially for inland problems and coastal waters are neglected; this is also the result of little exposure to education in the marine sciences. Most of the engineers that work within the department of Hydrology are graduates of a recent Master in Hydraulics, and Sanitary engineering programs at Universidad de San Carlos. It was suggested that the development of extension courses on coastal engineering and marine ecology/geology for the university and for personnel at INSIMUVEH, would expose the engineers charged with responsibilities over coastal waters to some basic concepts useful to their needs, and hopefully this could promote the formal training of coastal engineers and marine geologists.

b. DIRENARE. The ministry of agriculture's department of natural resources, DIRENARE (Dirección de Recursos Naturales Renovables) has a fisheries division in charge of aquaculture, artisanal and industrial fishing, the latter currently being assisted by a U.N. Development Program project. The fundamental problems are the absence of an adequate assessment of Guatemala's living marine resources, and the lack of information on the biology and dynamics of species being exploited. Diminishing catches suggest the possibility of overfishing or of environmental impairment. Industrial fishing, centered around Champerico and San José, is concentrated on shrimps, where 35 vessels capture some 5 million pounds per year. A critical need, thus, is the development of a resource assessment project and a research program on currently exploited and shrimp by-catch species. DIRENARE is preparing a national plan for fisheries development which will update legislation and redefine institutional responsibilities within the ministry of agriculture.

3. Coastal problems.

a. Water pollution by intense pesticide and fertilizer use, mainly in extensive cotton plantations of the northern Pacific states: Quezaltenango, Retahuleu,

and Escuintla, and to a lesser extent in southern Santa Rosa state which has narrower coastal plains. There are preliminary reports indicating extremely high values of DDT and methyl parathion in mullet and juveniles fishes whose survival is being jeopardized. Shrimp appear to be less susceptible to these pesticides but they are concentrating the chemicals and moving them through the food chain. Although the government, in principle, has agreed to a progressive reduction in the use of DDT, private individuals continue to use it intensely, and apparently, the existing laws are not obeyed or are difficult to enforce. Indiscriminate spraying has resulted in a recommendation by Central America's Institute for Nutrition (INCAP) that mothers abstain from breast feeding due to a high value of pesticides in the blood samples of poor inhabitants of areas in the vicinity of cotton plantations.

b. Unregulated coastal alteration and development, including mangrove deforestation for cotton farming and cattle grazing in the south (Escuintla and Santa Rosa). There is a preliminary report showing that from 1964 to 1974 there has been up to a 50% removal of mangroves causing ecological disequilibrium and reducing coastal bioproductivity. This is probably one of the reasons for declining fishery landings.

c. Oil pollution in Bahía de Amatique, Golfo de Honduras, by growing shipping operations in Puerto Barrios and Santo Tomás de Castilla, the main ports of Caribbean commerce, also being used by El Salvador. Minor oil spills have already taken place.

d. Pollution of Lake Izabal as a result of unregulated mining operations, mainly nickel extraction by EXMIBEL, a concession to a Canadian nickel company. High fish mortalities have been reported in the Lake and in the channel to Río Dulce which drains into Bahía de Amatique.

e. The social impact of all of the above on local fishery resources. Biological productivity is being reduced through change of habitat and bio-accumulation of chemicals.

particularly in estuarine areas. This affects not only the fishing industry and a related network of interests, but more importantly, it affects the livelihood of coastal inhabitants, artisanal and small-scale fishermen who survive on inshore species.

4. Legislation.

All fisheries-related legislation has been compiled in a single document by the department of agricultural services (DIGESA: Dirección General de Servicios Agrícolas), and the department of natural resources, DIRENARE (Legislación Pesquera de la República de Guatemala).

The fishing laws that are currently in effect were decreed in 1932 (Decreto Gubernativo 1235), and various modifications have been introduced subsequently to regulate licensing, gear, and the fishery for various species, particularly Decreto Legislativo 1470 of 1961. New legislation is being studied as part of a new fisheries development plan.

A 12-mile territorial sea was established in 1941. On June 9th, 1976 (Decreto No. 20-76) Congress confirmed the limit and also defined a new 200-mile economic zone, thereby reserving sovereignty for exploration, exploitation, conservation and management of natural resources of the continental shelf and the seabed. This legislation confers authority to appropriate agencies to regulate fishing, conservation, pollution control and other activities, but until new legislation is issued the economic zone is subjected to legislation previously applicable to the territorial sea. Specific legislation based on the 200-mile economic zone law have been, a) a 1978 decree limiting the number of vessels in the Pacific allowed to fish shrimps (36), and scalefish (50), and in the Atlantic for scalefish (25); and b) a February 28th, 1979 decree maintaining the number of Pacific shrimpers to 36, allowing 10 vessels in the Caribbean; 10 and 5 tuna boats are allowed, respectively, for Pacific and Atlantic waters. All are limited to a 100-ton maximum. Fishing enterprises are required to

sell 60% of the fish locally as well as 10% of shrimp captures. The fishing by national and foreign vessels is further discussed in detail. Article 46 of the latest decree allows the fisheries department to use funds obtained from various fees to support fisheries research.

5. Discussion.

The overall problem in dealing with marine affairs in Guatemala is the shortage of trained manpower. CEMA, as a young project is at this stage only oriented towards the training of aquaculture technicians, which, although needed, will not be prepared to tackle some of the more relevant and immediate marine problems. Developing aquaculture in an impaired coastal environment is a complex problem. As an undergraduate program, CEMA tends towards very early specialization therefore preventing graduates from being exposed to a wider appreciation of natural sciences. An important problem lies in the fact that if for one reason or another CFMA is not successful in its current objectives and this discourages further support, the major role it could play as a national center for the study of marine problems is jeopardized and a negative precedent on marine programs is established.

Possible international assistance in the marine sciences should attempt to address the immediate and long-term needs of the country. The immediate ones can be tackled by the regional implementation of extension courses which could convey critical information; this should, ideally, be accomplished parallel to research programs, for instance, fisheries resource assessment. The long-term needs could be addressed by graduate training of people in areas like coastal engineering, ecology, marine geology and chemistry, coastal circulation and meteorology; initially this could be done at the Master's level with thesis work on local problems.

There is a general feeling that Caribbean-based programs like IOCARIBE and FAO/WECAF have little impact on Guatemala's marine problems because of its narrow eastern coast, and their main problems occur in the Pacific side. Furthermore, some

people feel that if Guatemala participates in an intergovernmental program, high reliance on its success will be placed by officials at senior political levels who will be inclined to weaken national programs seeking self-sufficiency. While there may be, in fact, some merit to such views, the WECAF project is currently considering the possibility of including Central America's Pacific coast within its area of mandate, therefore being able to provide more adequate assistance.

Although thorough studies have not been published, the preliminary information obtained by several individuals on some pollution problems are alarming, and this situation should promote the development of research programs. One or more marine institutions could provide important assistance in this respect. An initial extension program could allow government officials and university personnel to focus more clearly on the nature and extent of some of the more critical situations like pesticide pollution and mangrove deforestation. This in turn could provide the basis for future work leading to appropriate regulation and legislation. The presence in Ciudad de Guatemala of Central America's institute for industrial research, ICAITI, is an advantage and their capabilities could be used and complemented to develop joint efforts.

There is great emphasis on aquaculture but this question should be studied more clearly. Are the existing resources being adequately exploited? Or is there a biased view since effort is concentrated on shrimps? Are there underutilized species that could be made available under current practices but with minor changes? Is it a question of inadequate management or of inadequate technology? Is industrial fishing, mostly for export, operating in detriment to small-scale fishermen? If, as current evidence suggests, the coastal productivity is being reduced by various factors, will these also affect any aquacultural enterprise? Indeed many coastal inhabitants could benefit from aquaculture, especially with low-technology and labor-intensive practices, but social questions must be asked. Do these people own the coastal land for aquaculture? Can the quality of the water be assured? Can a vertical enterprise

be organized? What changes will this bring about? It would seem that too great an emphasis is placed on the technology needed for the culture of high valued species for export markets without a critical consideration of many marginal and by no means less important social factors.

There is little doubt that the intense farming of cotton has brought with it the indiscriminate use, abuse and spraying of pesticides, and although some legislation exists to regulate these practices, enforcement is difficult and individual compliance is rare. Indiscriminate deforestation for farming and cattle grazing is undoubtedly resulting in a dramatic disruption of the ecological equilibrium. Indeed, there may be economic justifications according to some, but are the overall consequences being realistically weighed? Data from the Economic Commission for Latin America (ECLA, 1978 annual report) indicate that cotton exports have grown from \$75 million dollars in 1975, to \$ 83.7 million in 1976, to \$ 146 million in 1977, and increase of 74.3% in the 1976-77 period. Judicious use of pesticides can not be assured under these circumstances, particularly in the absence of a proper appreciation of ecological damage. Clearly, what is needed is a public awareness campaign, perhaps through the cotton grower's association if they perceive long-term difficulties, on the deleterious effects of pesticide misuse. Studies should be undertaken not only on the ecological but on the social impacts of current practices.

Finally, the definition of an exclusive economic zone requires a much greater understanding of living, mineral and non-extractive marine resources than is currently at hand in Guatemala. Marine institutions and international agencies can provide some catalytic assistance but it is ultimately up to concerned Guatemalans to undertake the steps needed to utilize and manage their marine potential wisely.

B. BELIZE

1. Education and government.

a. Higher education in Belize is given at St. John's College, a junior college-level institution founded in 1887. Instruction is given in Arts, Science and Business to some 1,0 students in Belize City, of which almost 90 come from other districts. Education in business has an important impact on local communities. Since the College follows Cambridge University's syllabus it does not have much academic flexibility and has no courses in the marine sciences despite the overall importance of the sea to Belizeans. Some elements of marine ecology are given in basic science courses. The College would benefit immensely from summer seminars or extension courses for teachers in various aspects of the marine sciences. The College's facilities are being expanded, and a new laboratory is being equipped, thus allowing for future investigations.

b. Government.- Fisheries management and research are centered in the Ministry of Trade and Industry's Fisheries Unit Laboratory in Belize City. The Laboratory includes 3 trained biologists and, at the present time, 2 Peace Corps working on several projects. Emphasis is given to monitoring the important conch, shrimp and lobster fisheries, which are being exploited by five well-organized and strong cooperatives which play an important social role in Belize. Almost 95 % of the fishery landings are exported for a total value of close to \$ 3 million dollars (about 9% of the government's budget); and price differences between export and local markets range from 500 to 700%. The Fisheries Laboratory has required that 10% of the fish and 5% of the lobster be retained in Belize for local consumption, an ordinance strongly opposed by the cooperatives.

2. Coastal problems.

a. Exploration for oil in Chetumal Bay, off Sartenejo in northern Corozal district.

b. Need for coastal resource assessment with identification of critical areas, and a study of the effect of fishing on reef ecology. Need for protection of the Barrier Reef.

c. Expanded tourism industry which has caused significant beach pollution in areas like San Pedro, Ambergris Caye. Need for tourism development management.

c. Disposal of raw sewage and solid waste. Need for legislation and enforcement mechanisms.

e. Beach erosion, particularly in southern Belize, between Belize City and Punta Gorda, Toledo District. This problem is strongly accentuated by hurricanes.

f. Need for expansion of Stan Creek Town (or Dendriga) port to handle exports of fruit and lumber, and imports of goods in support of local industry and agriculture. Unstable substrates make it too costly to build a road to Belize City.

g. Expansion of Belize City's port. Need for Port Authority regulations (being developed), and trained manpower to manage port operations.

3. Legislation.

Current legislation in force regulates the manner in which fishing is to be conducted including Licensing and Processing (Chapter 133 of the Laws, Statutory Instruments No. 66 of 1977, known as Fisheries Regulation No. 1977, and No 71 of 1978, the Fisheries Amendment Regulation). There are no marine environmental provisions.

4. Discussion.

Exploration for oil in Chetumal Bay underlines the reality of conflicting interests. As yet, there is no comprehensive evaluation of coastal resources in Belize and the impact of oil exploration can not be readily assessed. Further, Chetumal Bay falls under the joint jurisdiction of México and Belize and this represents a vivid example of mutual interests and conflicts between a richer and

a poorer nation. For instance, for Belize, 38% of 1978's conch production and 8% of its lobster landings came from off Sarteneja, for a combined export value of about \$ 300,000 dollars, that is, 10% of the total fisheries exports. To what extent will exploration affect these fisheries? And at what social cost? The impact will undoubtedly be of a much greater scale for Belize than for México. The fact that PEMEX (Mexican oil company) officials indicated that the impact of the current vast release of oil from a damaged well in southern Bahía de Campeche (where very important fisheries are located) could not be assessed due to the absence of baseline ecological information is not encouraging. The Fisheries Unit Laboratory in Belize has no authority nor the current means to make environmental impact statements, and furthermore, is not being considered for recommendations concerning the protection of important nursery grounds. No responsibilities can be assigned should exploration result in environmental alteration or damage due to the lack of basic ecological data.

As regards living resources, international assistance could be in the form of a joint program combining a) extension courses to train people in various areas, such as deep-sea (off reef) fishing for the 100-150 fathom snapper fishery, and b) research aimed at establishing a comprehensive framework for protection of critical areas of biological productivity, and for preservation of Belize's beautiful coastline and unique Barrier Reef.

The problems of beach erosion, sewage disposal, pollution and port expansion require the training of coastal engineers and marine ecologists/geologists. Ultimately, it is the responsibility of local authorities to strengthen the existing agencies and facilities, to develop research projects and sound environmental legislation and to establish the groundwork for a coastal zone management plan.

C. HONDURAS

1. Academic sector.

The Universidad Nacional Autónoma de Honduras, UNAH, had in 1978 a student population of 18,562 in 3 campuses; the main campus in Tegucigalpa (Ciudad Universitaria) with 14,205; Centro Universitario Regional Norte, CURN, with 3,145 in San Pedro Sula; and Centro Universitario Litoral Atlántico, CURLA, in La Ceiba with 1,212 students. In Tegucigalpa, 28 professional areas of study are offered with most enrollment for medicine, civil engineering, law, business administration, economics and accounting. Almost all the same areas are offered in San Pedro Sula; the majority of students in La Ceiba study Agronomy and Forestry.

There are 82 students in the department of biology in Tegucigalpa and 2 in San Pedro Sula. The curriculum in biology appears to be good: a comprehensive four year program for the bachelor's degree and two more years for a "Licenciatura", perhaps and equivalent to a Master's level program. There is one American Ph.D. faculty member in this department, and as the fall of 1979, there will be a faculty member just returning from a Master's program in marine biology at Oregon State University.

The possibility of a third regional center, which could include a marine biology program in southern Choluteca state, is being considered by the university. At the present time there is no formal instruction in the marine sciences but university authorities are seriously interested in developing one either in the Pacific or the Caribbean coasts.

2. Government role.

DIGERENARE. The department of natural resources (Dirección General de Recursos Naturales Renovables) was created on April 29th, 1974, to formulate Honduras' policies and to regulate the utilization of renewable resources. DIGERENARE has two main departments: Wildlife and Environmental Resources, and Fisheries.

The main problem that concerns senior DIGERENARE personnel is the absence of

legislation requiring environmental impact statements for development projects, which often favor special interests. This, in their opinion, is the source of ecological perturbation of far-reaching consequences. Moreover, although the Interamerican Development Bank (IDB) requires impact statements for the projects they fund, DIRIGENARE people feel that, at least in Honduras, such statements have been made lightly and without adequate consideration of relevant factors. Because of the impossibility of controlling environmental degradation they feel that their efforts are rendered fruitless in critical issues and that their position is one of helplessness before important interests. At best, they can suggest alternatives, make recommendations and attempt to minimize damage, usually without much success.

There is an important 1979 project being sponsored by the World Wildlife Fund, called "Reserve of the Biosphere", in which 500,000 hectares in eastern Honduras are being defined as a national wildlife preserve. There is hope that this project will promote an awareness of the need for rational management of natural resources. The project encompasses coastal lands in Colón, Gracias a Dios and northern Olancho states, roughly between the Negro (Sico Tinto) and Patuca rivers. Also, within the province, along the Río Platano, are two indian tribes that are being protected from cruel extermination: the Payas and the Misquitos.

DIRIGENARE is developing a small marine station in La Ceiba, with a limited budget. Its objectives are: culture of marine and freshwater crustaceans, study of the local fauna, protection of manatees and turtles, and the gathering of basic ecological data.

3. Coastal problems.

a. Honduras has tremendous potential for a Caribbean tourist industry. Areas like Bahía de Trujillo (Puerto Castilla), La Ceiba, Bahía de Tela, Puerto Cortés, Bahía de Omoa (site of old Maya commerce), and in general, any point along the lush coastline, are immensely alluring. Environmental degradation, evident in rapidly

growing population centers, jeopardizes the realization of such potential, and there is critical need for a coastal zone management plan.

b. Deforestation: 1) inland, upsetting hydrological cycles which result in erosion and severe floods; 2) coastal, where removal of mangroves, particularly in southern Golfo de Fonseca and eastern Laguna de Catarasca, can drastically affect fishery productivity, sedimentation and beach stability.

c. Need for a comprehensive evaluation of fishery resources, particularly in the Caribbean area, with full utilization of available species. Current emphasis is on high-priced crustaceans, and other species are being underutilized or discarded. The biology of exploited species is not well understood although there is indication that Laguna de Catarasca plays an important role as nursery grounds for Caribbean resources. Fishing in Golfo de Fonseca is based mostly in San Lorenzo; it is essentially an artisan fishery by gillnetting during tidal changes. A United Kingdom team is reported to be assessing the potential for industrial fishing, but conflicts exist due to the preference given by the government to Henecan (near San Lorenzo) rather than Amapala island as a major fishing port.

d. High pesticide use in southern Valle de Choluteca states in connection with cotton farming; pesticides are being drained into Golfo de Fonseca by the Nacaome and Choluteca rivers. High concentrations in fish and humans have been reported.

e. Coastal pollution from numerous urban and industrial discharges, particularly along the Caribbean coast: Puerto Cortéz, Bahía de Tela, La Ceiba, Bahía de Trujillo and Puerto Lempira.

4. Legislation.

Congressional Decree 154 of May 29th, 1959 put into effect the current fishery laws. The decree regulates licensing, aquaculture, exploitation, industrialization and commercialization. Its enforcement became the responsibility of DIGERENARE in 1974,

and there is a common feeling that such legislation requires updating.

Article 3 of 1965's Constitution establishes a 12-mile territorial sea, and Article 5 refers to a "zone for the control and protection of natural resources in continental and insular waters". But no specific legislation applicable to the marine environment has been issued.

Legislative Decree No. 25 of 1951 defines Honduras' sovereignty over the continental shelf, and claims authority to protect and control a 200-mile zone in the Atlantic Ocean, without reference to Golfo de Fonseca. Decree No. 4 of 1962 states in its Article No.1 that the State owns deposits of oil and hydrocarbons in its territory including those of the seabed down to 200 meters or beyond, in adjacent waters where exploitation is possible.

5. Discussion.

Data by the Economic Commission for Latin America (ECLA, 1978) indicate that Honduras has a high rate of economic growth in 1976, 8%, and in 1977, 7.5%, compared to an average of 3.3% for the 1970-1974 period. The recent growth is attributed mostly to increases in industrial and agricultural production; cotton exports grew 155% for a value of \$ 11.1 million dollars, and shrimp and lobster exports increased 30% for a value of \$ 15.6 million dollars. However, coffee and banana exports are still the most important export products (\$ 168 and \$ 125 million dollars, respectively, followed by lumber, \$ 42.5 million dollars, all figures for 1977).

Rapid economic growth has been achieved regardless of environmental considerations and concerned government and academic sectors agree that such growth has had a significant ecological impact, particularly the cotton and lumber industries. For the future, the problems seem to be compounded by the absence of, and implicit neglect in developing, mechanisms for a rational balancing of natural resource exploitation.

The elements of a plan for coastal management are critically needed if coastal resources are to be utilized wisely. Such a plan should take into consideration the

value and social implications of fisheries versus land clearing for agriculture as is the case in the vicinity of Puerto Lempira, Laguna de Catarasca, and in Golfo de Fonseca. Economically and socially important fisheries are concentrated around Catarasca and the Gulf, and continued alteration of their ecology can have drastic consequences. The importance and value of a well-structured tourist industry, which can also benefit from interesting archaeological sites and recreational fisheries, must be weighed against the cost of building sewage treatment plants, and of controlling and curtailing the disposal of industrial residues. In general, the situation is one of explicit interest in marine resources and the potential of the coastal zone, but of lack of appreciation of interrelationships and of adequate understanding of coastal ecology.

A possible course of action aimed at a better appreciation of the nature of some critical problems could be the development, with the national university, UNAH, of extension courses on coastal ecology. These can focus on specific situations with the cooperation of DIREGENARE and several individual development corporations, and such efforts could lead to a) creating an awareness, b) obtaining and disseminating information, and c) recommending appropriate legislative and government action.

D. EL SALVADOR

1. Academic sector.

The Universidad de El Salvador has a strong program in Biology, with a current enrollment of about 150 students. After four years of study and one year of thesis research the degree of "Licenciado en Biología" is awarded. The department of biology is being reorganized, and one of the sections deals specifically with natural resources. Their main concern at this time is the ecological impact of intense cotton cultivation on coastal areas, with particular emphasis on Bahía de Jiquilisco, which has the largest artisanal fishery in the country. Numerous families obtain their protein and income from fishing in the lagoon. Apparently, excessive use of pesticides in cotton farming results in high fish and bird mortalities in Jiquilisco, especially from September to January with a peak in October. As a public health problem, high values of pesticides have been reported from blood samples of local inhabitants. As regards soils, the continuous farming of cotton has resulted in soil impoverishment, which then requires intense fertilization, and in high rates of erosion.

The university is interested in developing a marine program and is considering building a laboratory in Estero de Jaltepeque, at the mouth of the Río Lempa, in central El Salvador, or in Barra de Santiago, in western Ahuachapan state. But university plans and projects are quite uncertain due to the prevailing political difficulties of the country. Furthermore, student activism in demonstrations and riots discourages increased government support. An important difficulty in undertaking research projects is that faculty and students are afraid to work in the field because assaults and shootings are commonplace. My visit to the university system in El Salvador was affected, in two occasions, one, by the killing of students, and the establishment of martial law, and the other by the killing of the Minister of Education. But despite problems of this nature, the university is seriously committed to develop programs aimed at marine resources in the future.

2. Government role.

The government places great importance on the development and exploitation of aquatic resources. This is due to the country's small area, its high population density and intense agriculture.

The ministry of agriculture's division of natural resources has a fisheries department with four units: a) fishculture, with four regional centers which promote aquaculture in rural areas; and two experimental stations; b) marine fisheries, which oversees fishing cooperatives and communal efforts, and supports two research stations: Puerto El Triunfo, Bahía de Jiquilisco, where fisheries technicians are trained, with AID and Auburn University assistance; and 2) Playa El Tamarindo, in eastern Golfo de Fonseca; c) inland fisheries, concentrating efforts in Lago Ilopango, Lago Coatepeque, and other minor lakes; and d) engineering support for the above.

The government has prepared a National Plan for General Well-being, with 50 strategic programs. Program No. 6 concerns the exploitation of fisheries resources which includes, a) increased services by the fisheries department, with a 1979 budget of over \$ 1 million dollars; b) a marine fisheries and aquaculture development project financed by the Interamerican Development Bank; and c) a \$ 50 million dollar project to develop a fishing port in eastern La Unión, Bahía La Unión, Golfo de Fonseca, with assistance from the government of France.

3. Coastal problems.

a. High pesticide pollution from cotton farming; soil erosion resulting from unrotated crops; high fertilizer use causing eutrophication. Some persistent herbicides appear to be teratogenic, carcinogenic and produce abortions; public health problems are growing.

b. Mangrove deforestation in critical estuarine areas like Bahía de Jiquilisco, Estero de Jaltepeque (in the vicinity of Costa del Sol tourist resorts), Barra de Santiago, and Golfo de Fonseca.

c. Unregulated and indiscriminate fishing of young shrimp and other species in

estuarine areas, including fishing with dynamite and with the roots of some poisonous plants. There are important socio-economic problems associated with these artisanal fisheries.

d. Discarding and underutilization of shrimp by-catches.

e. Inadequate understanding of biology of molluscs, crustaceans and fishes of commercial importance.

4. Legislation.

El Salvador defined its territory in Article 8 of the Constitution of 1962 (as Article 7 of the one of 1950), as comprising 200 miles of the adjacent sea. Golfo de Fonseca, shared with Honduras and Nicaragua, is considered an historical bay subject to a special regime.

The current Fishery Law was established by Legislative Decree No. 1961 of 1955. It defines inshore fishing within 12 miles and offshore fishing between 12 and 200 miles. Legislative Decree No. 97 of 1970 regulates offshore fishing between 60 and 200 miles.

Decree No. 86 of 1974 regulates concessions for the exploration and exploitation of oil within the 200-mile territorial sea. A new fisheries legislation is being completed and will be issued probably in early 1980.

I was informed at the Ministry of Agriculture that there are regulations for the farming of cotton but that it has not been possible to enforce them.

There is no specific marine environmental legislation.

5. Discussion.

El Salvador's economy grew 5.5% in 1977, with a total value of exports of \$ 976 million dollars (Economic Commission for Latin America, 1978). This represents an increase of 31% from 1976; however, such an increase was due to the raise in prices since, in fact, the total volume of exports fell by 4%. The four main exports are

coffee (\$ 612 million dollars, 62.7% of total), cotton (\$ 84 million, 8.6%), sugar (\$ 33 million, 3.4%), and shrimp (\$ 9 million, 0.9%).

The decline in the production of cotton and coffee is related to an irregular cycle of rainfall which caused an initial drought affecting the former in the early part of the season, and later, excessive rains affecting the latter. In an attempt to increase production of these products, as well as basic grains, the farmers intensified the use of pesticides and fertilizers without success but with soaring production costs. Moreover, cotton farmers tried to compensate by increasing the farmed area by 8.5%.

The above mentioned circumstances are imposed by economic policies which also have a significant impact on the balance of nature, particularly in the coastal plains where cotton is grown. The crucial point is that ecological factors are not taken into consideration and the use of agricultural chemicals is intensified without an evaluation of side effects.

The intense spraying of pesticides has caused important fish mortalities and exposed humans to high levels of some reputedly dangerous compounds. The clearing of mangrove areas reduces the total productivity and the sources of food and income of many poor coastal inhabitants. Furthermore, shrimp catches have been declining according to reports from the Ministry of Economy. This is undoubtedly related to lower bioproductivity as well as to inadequately regulated fishing operations, to an impaired environment through the use of explosives, and to the fishing of juveniles. Shrimp exports grew from a value of \$ 8 million dollars in 1974, to \$ 12 million in 1976, and have decreased to a value of \$ 9 million in 1977. Actual landings have declined more significantly than export values since the price per unit has been raised over the last few years.

Evidently, the government is giving aquaculture a high priority as a means of supplementing the protein intake of densely populated areas, but on the other hand, the quality of the bodies of water that are supposed to support such production is being impaired. Furthermore, as is the case of the fishing port development in La Unión,

important investments are being made to increase the exploitation of fisheries resources but it is evident that mechanisms responsible for coastal bioproductivity are being affected by several factors.

The need for wise management of the coastal zone is quite evident, and a cadre of people trained in marine chemistry, ecology, fisheries, geology, ocean engineering and coastal oceanography is required. El Salvador has some serious social problems and the mismanagement of coastal resources could possibly lead to further economic and public health difficulties, as is already evident at the present time.

Important assistance could be provided through extension courses in cooperation with universities and government agencies; these could lead to the development of research projects to identify various aspects of ecological problems. Subsequently, public awareness of interrelated factors should be achieved and legislative action could follow. Unfortunately, the current political difficulties of the country make the development of scientific projects an uncertain possibility, despite the concern and interest of university and government personnel.

E. NICARAGUA

1. Academic sector.

Nicaraguan universities have been in recess in the course of the current civil war and it was not possible to meet with anyone in the university system. There is, however, an active Department of Ecology and Natural Resources at the Universidad Centroamericana in Managua, and a Department of Biology at the Universidad Nacional in León. Apparently, no marine programs are being offered.

2. Government role.

The Instituto de Fomento Nacional, INFONAC (Institute of National Development), was created in 1953 and reorganized in 1978 to increase, diversify and rationalize national production in all aspects. INFONAC's 1978 budget was \$ 18 million dollars, \$ 8.2 million for operations, and \$ 9.7 million for economic and social development.

A program for fisheries development was established in 1963 and during 1966 to 1971 they cooperated with the regional FAO fisheries project; a subsequent program for resource evaluation in the Pacific coast was undertaken with Universidad Católica de Valparaíso, Chile. The program with FAO fell short of expectations but some important progress was made. Trained fisheries personnel is concentrated in INFONAC and the institute has the capabilities of undertaking research projects. A new fisheries law is being prepared and a program to improve fisheries infrastructure with an Interamerican Development Bank loan has been negotiated.

There are several problems associated with current fishery practices. Artisanal fishermen are capturing migratory shrimp juveniles as a source of protein, and this is affecting adult shrimp stocks. Industrial shrimp operations, of which 70% are concentrated along the Caribbean coastline, are attempting to compensate for reduced captures by fishing in marginal areas and in doing so they are apparently damaging productive bottom communities with their trawls. Thus current efforts by INFONAC are

aimed at diversifying the fishing industry, currently centered around penacid shrimps and spiny lobster, and in creating new employment. In fact, fishery officials indicate that fish processing plants are operating at only 20% of their potential. There is interest in developing an offshore fishery for snapper, for langostino (Pleuroncodes), cigala or rock lobster, gamba or royal red shrimp, and other unexploited or underutilized species, including those being discarded by the shrimp boats. As an effort to reduce the impact of artisanal fishermen on juveniles, particularly in coastal lagoons, INFONAC is seeking to promote low-technology, integrated aquaculture, which would also provide opportunities for family employment. There are two aquaculture stations run by INFONAC, one for shrimp in Estero Padre Ramos (northwest of Chinandega), and a small Tilapia station in Managua. There is further interest in promoting the culture of oysters in the Caribbean lagoons, like Laguna de Perlas, which could lead to the establishment of small industries.

3. Coastal problems.

a. Pesticide pollution from cotton farming along the "cotton belt" comprising the Pacific states of Chinandega, León and Managua, in the coastal plains west of Cordillera de los Marrabios.

b. Mangrove deforestation in the Pacific affecting important estuarine areas like Estero Real (Golfo de Fonseca), Estero Padre Ramos, Estero de Aserraderos, Estero Pasacaballo, the bay of Corinto, PoneLOYA and Puerto Somoza.

c. Lack of information on the biology of species commercially exploited, particularly in relation to the ecological role of coastal lagoons along the Caribbean coast.

d. A project to link Caribbean coastal lagoons via an intracoastal waterway; if this project is undertaken to promote coastal communication by the Ministry of Public works, it may result in a drastic alteration of coastal ecosystems.

e. A projected construction of a main port in Laguna de Perlas, in what is

considered to be one of the most productive and important lagoons of the eastern shoreline.

f. Urban and industrial pollution in the Pacific: Corinto, Poneloya-León (Río Chiquito), and Masachapa; in the Caribbean: Bahía de Bluefields and Río Bambana-Prinzapolka.

g. Although not directly affecting the marine environment, there is great concern over the high degree of pollution, and the high salinity and turbidity of Lago Managua. The water quality in Lago de Nicaragua is good and it is anticipated that it will play an important role in supplying water to the Pacific coastal areas; developments having an impact on the lake such as the effluents from Granada and Rivas, should be closely examined. The same can be said about Laguna de Masaya, which can supply water to the Carazo plateau.

h. Protection of endangered species like manatees in the Caribbean and turtles on both coasts.

4. Legislation.

Article 3 of the Constitution of 1974 (following Article 5 of the Constitution of 1950) considers the national territory as comprising islands, cays, banks, submarine areas, the territorial sea (previously understood as 3 miles), and the continental shelf. However, a precise extension was not defined. The law regulating the exploration and exploitation of natural resources (Legislative Decree No. 316 of 1958), and of oil (Legislative Decree No. 372 of 1958) refers to the continental shelf on both sides, without specifying areas of jurisdiction. Legislative Decree No. 1-L of 1965 established in Article 1 a "national fishing zone" of 200 miles, and in Article 2 reiterates the validity of Legislative Decree No. 316 of 1958, known as the General Law for the Exploitation of Natural Resources. A Special Fishery Law created by Legislative Decree No. 557 of 1961, later modified by Executive Decree No. 11 of 1961, regulates fishing within "supradjacent waters above submarine areas", and is applicable to

territorial waters and to fishing in open ocean waters by Nicaraguan vessels. The Special Fishery Law regulates licensing under the Ministry of Economy, Industry and Commerce, rather than under the Ministry of Agriculture which is in charge of fisheries development. New fisheries legislation has been in preparation but it is not clear if environmental provisions will be included.

5. Discussion.

Nicaragua's economy grew 5.5% in 1977 (Economic Commission for Latin America, 1978), with exports totalling \$ 655.5 million dollars. The six major export products are: coffee (\$ 206 million, 31.5% of total); cotton (\$ 153.4 million, 23.4%); chemicals (\$ 54.2 million, 8.3%); beef (\$ 32.8 million, 5.0%); sugar (\$ 32.5 million, 5.0%), and shrimp and lobster (\$ 22.1 million, 3.3%). In general, agricultural production showed a relative decrease from a rate of growth of 3.5% for 1976 to 1.4% in 1974, which was somewhat compensated by a rise in the market value of cotton. Imports grew 21%, and this, coupled with the fleeing of private capital, led to an economic deficit.

Cotton production declined by about 4%, in spite of a 7% expansion of the farmed land, due to droughts in the northwestern part of the country. Coffee production fell below that of 1976 apparently due to strong winds. In both cases, the use of pesticides and fertilizers was intensified. As regards coffee, the struggle to control its pests cost \$ 11 million dollars.

Although INFONAC did not have specific data on the impact of high use of fertilizers and pesticides on the Pacific coastal region it is presumed to be significant, based on unofficial reports.

From the available information, it seems clear that the greatest potential for the future expansion in the exploitation of fisheries lies in the underpopulated and underdeveloped Caribbean coast. This does not diminish the important contribution that can be made by deeper water fishing in the Pacific, but it is exclusively industrial fishing, whereas in the Caribbean it can represent a combining of

aquaculture and enhanced multispecies exploitation with greater social benefits.

Current and potential production appears to be associated in the Caribbean side with important coastal lagoons: Bahía de Bluefields, Laguna de Perlas, Laguna de Wounta, Laguna Karatá, Laguna Páhara, and Laguna Wani. Thus, projects such as the possible construction of an intracoastal waterway linking the lagoons and the building of a new port in Laguna de Perlas should be weighed carefully against the value of coastal resources and their social and economic implications. A rational plan for coastal management will be needed.

INFONAC represents an important concentration of experienced personnel who, when peace is reestablished in the country, can play an important role in the management of Nicaragua's natural and marine resources. Recently developed scientific information can be brought to them through extension courses, and the preparation of projects aimed at studying the biology and the ecology of several species and areas can be achieved on a cooperative basis. Finally, Nicaragua has an important tourism potential in its Caribbean coast. Developments in the future should give particular thought to this potential.

F. COSTA RICA

1. Academic sector.

a. Universidad de Costa Rica.- The university has a student population of about 25,000, and has a strong undergraduate program at the School of Biological Sciences, with some 600 students. As of April, 1979, the university created under the Vice-rector for Research (a unit created in 1973 to foster scientific and technological investigations), the Centro de Ciencias del Mar y Limnologia (CCML). Its purpose is to study marine and freshwater systems and to utilize and conserve their resources. The CCML has an interdisciplinary research approach aimed at understanding the natural processes that support living resources, at obtaining the basic information that could lead to coastal management, at assisting national projects, and at establishing a graduate program. The latter would complement other graduate programs in the university in areas like chemistry, microbiology and natural resources. The CCML is developing parallel to an important joint project between the universities of Costa Rica and Delaware, with a \$ 300,000 dollar, 2-year grant from the International Sea Grant, which includes the use of a Delaware research vessel. This project, which began in late 1978, is designed to investigate the basic ecology of Golfo de Nicoya, and at assessing the potential of its living resources.

There is also an educational center in Alajuela (Centro Regional Universitario de Occidente), with a project, which will become operational in 1980, to train fishery technicians, with assistance from FAO and the Interamerican Development Bank.

b. Universidad Nacional, Heredia.- The university, with about 20,000 students, has two Faculties concerned with Costa Rica's marine environment: the Faculty of Exact and Natural Sciences, and the Faculty of Earth and Marine Sciences.

The Faculty of Exact and Natural Sciences includes the departments of Biology, Physics, Chemistry and Mathematics. As of mid-1979, the department of Biology will be offering a curriculum in Marine Biology, with a 5 year program (145 credits), leading to a Bachelor's degree, plus 2 more years (180 credits) for a "Licenciatura"

in Aquaculture. The department of Physics is also interested in marine geochemistry and meteorology.

The Faculty of Earth and Marine Sciences is considering the possible creation, within its department of Geography, of a future program in Physical Oceanography. Perhaps it will be incorporated to the Marine Biology program. The department of Environmental Sciences offers a basic curriculum on some of Costa Rica's and the region's problems, and it also trains primary and secondary school teachers to foster environmental awareness at early educational stages.

2. Government role.

a. Comisión Nacional de Pesca.- Costa Rica's commitment to promote the full utilization and conservation of its marine resources was reaffirmed by the current Administration when the former director of the University of Costa Rica's School of Biological Sciences, a marine scientist, was appointed to head a Presidential advisory commission for marine affairs, the Comisión Nacional de Pesca. Dr. Carlos Villalobos' appointment for such a post resulted in 1979 in a definition of the country's policy on marine resources. The National Plan for the Exploitation of Marine Resources involves artisanal, semi-industrial and industrial fisheries, aquaculture, and coastal management. The Plan is to be implemented by the Ministry of Agriculture's department of fisheries resources, and by several other agencies, including a new National Coastal Commission to be charged with the responsibility of managing the coastal zone.

Artisanal fisheries are concentrated mainly in the Pacific coast between Bahía Santa Elena and Puntarenas, involving an estimated 1,200 families that account for close to 60% of the captures for local consumption. The government's main thrust is to create an infrastructure for unloading, processing, distribution and marketing of fishery products. This is being accomplished through several programs which include the purchase of 50 boats (12 meters in length), and expansion of facilities in

Puntarenas and other minor ports, with a \$ 10 million dollar project mostly (65%) funded by an Interamerican Development Bank (IDB) loan.

Semi-industrial fisheries exploit shrimp, lobster, sardines and scalefish. Shrimp landings have decreased during the last 5 years at an average rate of 11.8% probably due to overfishing. Furthermore, the fleet is apparently becoming obsolete. The government has a \$ 3.6 million dollar project, with \$ 1.3 million from IDB, to strengthen the private shrimp industry, and such an effort is considered complementary to the artisanal development project. During 1979, the department of fishery resources will undertake a biological study to assess the status and dynamics of shrimp stocks. A second project, for \$ 3 million dollars, aimed at developing the lobster fishery of the Caribbean, is also being negotiated with the IDB.

The industrial tuna fisheries represent an important resource for Costa Rica. It seems that all captures within the country's 200-mile economic zone have exceeded an average of 35,000 tons per year. During 1977 Costa Rican vessels landed only 892 tons, with a tremendous increase in 1978 when an estimated 10,000 tons were captured. The government's efforts are centered on assuring the full utilization of tuna resources, which require an improvement of the fleet, its support facilities, and an expansion of their 2 processing plants, which can only handle 10,000 tons per year.

The potential for aquaculture in Costa Rica is significant and the government is promoting its practice, particularly at the communal level in inland bodies of water. Important areas are: the Tortuguero region in the Caribbean, Golfo de Nicoya and the estuarine system of the mouth of the Sierpe river in the Pacific. A \$ 5 million dollar loan is being negotiated with IDB to strengthen the capabilities of the Ministry of Agriculture's section for aquaculture, which also include the operation of training centers.

b. CONICIT.- The Consejo Nacional de Investigaciones Científicas y Tecnológicas, CONICIT, is the national organism responsible for promoting and funding scientific and technological projects, which include specialized training. CONICIT has taken particular interest in developing the country's marine scientific capabilities and began, in early 1979, the construction of a marine laboratory in Punta Morales, west of Puntarenas. The main area of interest will be Golfo de Nicoya and adjacent areas, and the laboratory will be made available to qualified investigators from various institutions. Furthermore, CONICIT is sponsoring the graduate training of 4 marine scientists at the University of Miami as of the fall of 1979, partly funded by a new program whereby contributions to a fellowship funds are requested from U.S. firms with interests in Costa Rica. This program has been the result of joint efforts between CONICIT and the University of Miami, and it is anticipated that future cooperation will develop for the implementation of research projects, which include adequate equipment of the Punta Morales facilities.

3. Coastal problems.

a. Need to study the biology of species of commercial importance. This includes the study of the role of mangroves in coastal productivity and estuaries as nursery grounds; such work should also include an understanding of the socio-economic value of coastal communities, and the subsequent development of conservation policies and appropriate environmental legislation.

b. Need to assess the resources of Golfo de Nicoya and the danger of pollution to this interesting cul-de-sac. The current University of Costa Rica-University of Delaware project should provide some basic information.

c. In the Pacific side, assessment of the ecology of Bahía Santa Elena, Golfo de Papagayo, Bahía de Coronado and Golfo Dulce.

d. In the Caribbean side, a study of the ecology of Canal del Tortuguero and Bahía Cahuita, both national parks, and the potential of lobster fishery expansion.

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e. There are two hydroelectric projects being developed by Costa Rica's institute for electrical power, ICE. One involves the Tempisque river which drains the rich agricultural region of Guanacaste state. The other involves the Rio Grande del Terraba in Valle del Diquis, in southern Puntarenas state, which drains the important banana producing region. There is concern over the impact of the hydroelectric projects and the alteration of water flow upon river deltas, estuaries, and on the transport of sediments and agricultural runoff.

f. Need to understand the sedimentary processes and the circulation of waters in both coasts. There is specific interest in the bay of Caldera where a new port is being built.

4. Legislation.

Costa Rica declared, through Decreto-Ley No. 116 of 1948, its national sovereignty over adjacent waters to control, protect, conserve and utilize its marine resources over a 200-mile limit. In Decreto-Ley No. 803 of 1949, "national sovereignty" was replaced by "rights and interests of Costa Rica", and "control" was replaced by "State protection" over the zone. Decree No. 2204-RE of 1972 established a patrimonial sea of 200 miles, which included the territorial sea, defined as 12 miles by Decree No. 2203-RE.

Article 6 of the Constitutional reform of 1975 declared that the State exercises complete sovereignty over its territorial waters of 12 miles and establishes a special jurisdiction over a 200-mile zone to protect, conserve and exploit the resources of the waters and the seabed. The "Ley sobre la Zona Maritimo Terrestre", of 1977 defines the boundaries and management regime of the coastal zone.

The first legislation on fisheries was issued by Law No. 190 of 1948, regulated by Decree No. 363 of 1949. Various subsequent modifications and regulations have been decreed, and these have all been compiled in 1976 by the Ministry of Agriculture's departments of fisheries resources and wildlife.

The current Comision Nacional de Pesca is planning new and comprehensive marine legislation.

5. Discussion.

Costa Rica has made an important commitment to develop its marine resources and rationalize their exploitation. Such a commitment has been particularly evident in 1979 with the creation of a presidential level ad hoc commission, the creation of a center for marine studies, the development of an interuniversity research project, the establishment of an undergraduate curriculum in marine biology, and the construction of facilities for a marine laboratory. These steps are being complemented by the training of students in several institutions abroad.

Evidently, the present stage of growth in marine activities may have its problems and limitations; but the important denominator is clear consciousness, at various levels, of the value and potential of the marine environment, and the need to conserve it through a long-range balanced weighing of conflicting interests. Moreover, social dimensions of marine affairs are being given considerable importance.

Both the National and Costa Rica universities are concerned with implementing their own programs and there seems to be little cooperation between them at this time. This temporary circumstance will probably change as their efforts mature and are integrated by the leadership assumed by CONICIT, and by the thrust of the projects sponsored by the Comisión Nacional de Pesca.

There are two important points that must be taken into consideration in the development of educational programs in the marine sciences. One is the level of instruction and the other is the potential employment and effective utilization of graduates. There is common agreement among marine scientists that their field of interest is essentially multidisciplinary and this requires a broad and strong background in basic sciences with further specialization in the marine field. Consequently, it has been recommended that marine science instruction be given at the graduate level, ideally by experienced marine scientists. The creation of an undergraduate program in Costa Rica has the danger of early specialization not only limiting the breadth of scope of the student, but also restricting their potential for employment. Furthermore,

the faculty has few scientists specialized in the marine sciences, and these few are mostly young professionals just returning to their home institutions, who will undoubtedly be engaged in heavy teaching loads thus depriving them of adequate time for research. Some will be driven to administrative duties. A further problem is that the majority of students interested in the marine sciences are concentrated in the area of biology. It was pointed out that some 100 students out of 600 of the University of Costa Rica's School of Biological Sciences are interested in marine biology, in addition to those at the National University. It is unrealistic to assume that there will be employment opportunities for a group of this size in the near future in Costa Rica. And this problem is compounded by the fact that most of the young, specialized, faculty returning to Costa Rica are trained in marine biology. It appears that for a country the size of Costa Rica, a careful analysis of potential demand for marine biologists should be undertaken and regulated in some way by the Comisión Nacional de Pesca, CONICIT or an interuniversity commission.

There has been a great deal of interest in Golfo de Nicoya, probably due to the concentration of population around the gulf, and to the closeness to San José, the capital city. And indeed, it appears that Golfo de Nicoya is a critical area for artisanal fisheries. However, southern Golfo Dulce and Peninsula Osa, as well as Golfo de Papagayo in the north, have not been studied and their contribution to coastal productivity of the Pacific coast remains unknown. It is expected that future developments in research capabilities will focus on these areas. In fact, it was suggested that the National University may build a marine station in southern Puntarenas state in the future.

The common concern throughout the Pacific coast in Central America has been the heavy use and impact of pesticides, particularly in the farming of cotton in coastal plains. This is not the case, as yet, in Costa Rica. Most of its agricultural production in the northwest is coffee (worth \$ 125.6 million and \$ 275.4 million dollars in exports for 1976 and 1977 respectively, representing a 31.6% and a 40.9% of the total

value of exports); in the southwest it is bananas (worth \$ 95.3 million dollars for 1976 and also for 1977, representing a 28.9% and a 14.2% of total exports). Most of the farmable land in Costa Rica is being cultivated already, and coffee remains the most important product. Future plans include the renovation and improvement of the existing farms. However, for bananas, the second most important export product, there are plans to diversify and there has been an initial program, undertaken by the main banana company, to plant Africal palm for oil. The tendency to diversify is also evident in the change from farming basic grains like rice and beans to growing cotton for export as of 1977. Thus, if practices follow the pattern observed in other areas of Central America, Costa Rica will be exposed to the problems resulting from the intense use of pesticides, particularly in Valle del Rio Tempisque draining into Golfo de Nicoya. But a realization of the potential problems may urge close regulation and supervision of farming practices.

The fact that Costa Rica has officially stated the need for coastal management as an integral part of the development of its marine resources, and is now in the process of creating a National Coastal Commission, is of high significance. Moreover, their keen interest in understanding the nature of coastal ecosystems suggests the possibility that Costa Rica could become in the near future an important regional center for such studies. Certainly the creation of a most favorable climate by various institutions for the promotion of marine science is a relatively unmatched asset.

G. PANAMA

1. Academic sector.

The Universidad de Panamá has a student population of some 30,000, 3,300 in the Faculty of Natural Sciences and Pharmacy, and about 150 in the Department of Biology.

During the month of May, 1979, some members of the Department of Biology submitted a plan to the Dean of the Faculty of Natural Sciences and Pharmacy, to create a new Department of Marine Sciences and Limnology. Previously, a department of marine sciences had been created in 1966 as a result of FAO's Central American fisheries project, and of a UNESCO/Universidad de Panamá technical assistance program. In 1975 the Faculty was reorganized and the department of marine sciences was transformed into a special research program and later restricted to a small working group. The individuals currently concerned with the need for a university-level program in the marine sciences, to respond to the country's needs and problems, have now prepared the recent project to fulfill such a role. The objectives of the new Department are: to develop training programs at the technical, undergraduate and graduate level; to undertake research programs in fisheries biology, aquaculture and environmental problems; and to create a public awareness through the publication of a journal, the operation of an aquarium and the creation of a marine museum. Specific programs are: a) study of the marine and freshwater environments of Panamá; b) assessment of fishery resources; c) study of the relationships between coastal ecosystems and biological productivity; d) assessment of the potential for aquaculture; and e) research on the impact of coastal developments, including the possible construction of a new sea-level canal. The total budget for 1980 is in the order of \$ 183,000 dollars. The projected new Department assumes that the facilities at Fuerte Amador, in the Canal Zone next to the Smithsonian Tropical Research Institute will be made available to the University, and that cooperation with the Smithsonian will also provide access to their research vessel. Furthermore, there are now 17 individuals within the university that have training and experience in marine research, and these can provide a critical nucleus

for the implementation of the Department's objectives. Under an agreement between the universities of La Habana, Cuba, and Panamá, the new Department is expected to cooperate with the Center for Marine Investigations of the Faculty of Biology in La Habana.

Past work by Panamanians since 1966 include studies on primary productivity, upwelling, sediments, pollutants, shrimps, estuaries, crustaceans, fishes, seagrasses, and the general ecology of Panamá with emphasis in Golfo de Panamá and to a lesser extent, Golfo de Chiriquí.

The private Universidad de Santa María La Antigua does not have a program in marine sciences but the Rector indicated that one could be established if the university is convinced that they can make an important contribution to the country's needs. Should Universidad de Panamá fail to undertake measures to develop a marine program, Universidad Santa María La Antigua could then proceed to assess their possible role in the field.

2. Government role.

a. Directorate of Marine Resources.- This department of the Ministry of Commerce and Industry is in charge of most of the affairs pertaining to the marine environment, with particular emphasis on fisheries development. However, authority over some aspects of the coastal zone, like mangrove forests, lie within the jurisdiction of the Ministry of Agriculture's Department of Natural Resources, RENARES, in Santiago de Veraguas; the national aquaculture program is also managed by RENARES.

The department of marine resources has four sections dealing with the following: a) biological investigations, b) fisheries statistics, c) artisanal and cooperative fisheries, and d) promoting the consumption of seafood.

There is significant concern over the landings of shrimp due to the size of the fleet. In 1961 there were 161 vessels with an average annual landing of 34 tons per vessel, in 1976 there were 254 with an average annual capture of 17 tons per boat,

a decrease in average production by vessel of about 50%. Although the landings have fluctuated around an average of some 5,500 metric tons per year over the last 6 years, the production by species is declining with increasing effort. The value of shrimp exports has grown from \$ 15.2 million dollars in 1974, to \$ 19 million in 1975, to \$ 33.5 million in 1976, and then decreased to \$ 27.6 million in 1976, representing 10% of total exports for the year. In view of the situation there is great emphasis within the department of marine resources in studying the biology and dynamics of shrimp stocks, and in understanding their relationships with coastal ecosystems, particularly in eastern Golfo de Panamá and Golfo de San Miguel.

The expansion of the fisheries industry has resulted in the construction of a new port in Vacamonte, near Panamá City. The port is expected to be completed in 1980, and will include facilities for a fisheries laboratory. In addition to the work on shrimp biology and the impact of coastal development on fisheries productivity there is new interest in the fisheries for anchovies and herrings. Panamá's total fishery landings increase from 76,000 metric tons (mt) in 1975, to 147,000 mt in 1976, and to 203,000 mt in 1977, the highest increase being in anchovies and herrings for fish meal and oil. The captures of these species grew from 67,000 mt in 1975 to 137,000 mt in 1976, to 193,000 mt in 1977. Corresponding exports of fish meals and oil represented \$1.7 million dollars in 1975, increased to \$ 8 million in 1976 and soared to \$ 15 million in 1977. The total value of exports for 1977 being \$ 271 million dollars.

Clearly, Panamá is especially interested in its fisheries resources and is committed to undertake the necessary scientific investigations for their rational and optimal exploitation, but on the other hand, the department of marine resources is short on qualified fishery scientists, and the universities do not have the appropriate educational programs.

b. Autoridad del Canal de Panamá. As a result of the Panamá Canal Treaties,

the office of the Director of Operations of the new Panamá Canal Authority, which is responsible for the implementation of treaty provisions, will have broad environmental responsibilities. These include coordinating the work done by several agencies, like the Ministry of Planning and Economic Policy, the department of marine resources of the Ministry of Economy and Industry, the department of natural resources of the Ministry of Agricultural Development, the Water and Sewage Authority, the Port Authority and other governmental agencies.

The Panamá Canal Authority is currently working on a major 1979-1983 project for the management of the Canal Basin, including Lago Gatún as well as problems of sedimentation, and reforestation of parks and reserves. The Authority is also concerned with the potential danger of oil pollution in the loading port of Puerto Armuelles, along the route to Balboa, the canal waterway and the Caribbean coastline. The Authority will be involved in the establishment of a joint Environmental Commission with the United States as understood in Article VI of the Canal Treaty; furthermore it will be assessing the possibility of constructing a new sea-level canal.

3. Coastal problems.

a. Danger of oil pollution in Puerto Armuelles where it is estimated that 500,000 barrels of Alaskan oil are being loaded every day. Areas exposed to oil pollution are: Bahía de Charco Azul, Golfo de Chiriquí, Bahía de Parita, Bahía de Panamá, the canal, Colón, Golfo de los Mosquitos, and Laguna de Chiriquí, Bocas del Toro. These are all important areas for fisheries resources, and particularly for artisanal fishermen.

b. Ecological impact of new hydroelectric projects affecting the flow of water to estuarine areas.

c. Urban and industrial pollution of Bahía de Panamá, Colón, the western

Golfo de Panamá, and along Chiriquí state.

- d. Water management in the Canal Zone.
- e. Potential pollution by the mining of copper in Cerro Colorado, by CODEMIN, Corporación de Desarrollo Minero, which could affect the important fisheries of Golfo de Chiriquí.
- f. Management of shrimp fisheries.
- g. Potential ecological impact on Panamá's ecology of a possible new sea-level canal.

4. Legislation.

Law No. 58 of 1958 defined Panamá's territorial sea as extending to 12 miles. Subsequently, Article No. 1 of Law 31 of 1967 established Panamá's sovereignty beyond its continental and insular territory to a territorial sea zone of 200 miles.

A number of decrees and laws have modified the basic fisheries law issued by Decree No. 17 of 1959. Shrimp fisheries have been regulated by Law 33 of 1961, Decree No. 49 of 1965, Decree No. 29 of 1971, and Executive Decree No. 50 of 1977. Other legal instruments regulate the tuna fishery (Decree No. 127 of 1964), licensing (Decree No. 42 of 1965), the anchovy fishery (Decrees No. 168 of 1966, No. 283 of 1966, No. 366 of 1967, and No. 77 of 1968). Other instruments ban fishing by 10-ton vessels within a 12-mile zone (Decree No. 202 of 1965), and prohibit fishing in nursery grounds (Decree No. 210 of 1965). Cabinet Decree No. 15 of 1972 discusses permits and taxes for navigation within Panamá's jurisdictional waters.

There is no specific marine environmental legislation. Decree 118 of 1909 prohibited the sale of intertidal areas, but this law has not been enforced; some intertidal areas are privately owned. Decree No. 399 of 1966 prohibits the private use of beaches, and this law is strictly enforced.

5. Discussion.

Panamá is a sparsely populated country, with a total population of about 2 million, and a density of 24 per square kilometer. At the present time, and more so in the future, the country's economic life is closely linked to the two oceans it separates, not only because of the Canal, but because of its natural regions. The major features of the provinces are their marine areas: Laguna de Chiriquí, Bocas del Toro, Colón; Golfo de San Blas and Archipiélago de las Mulatas, San Blas; Golfo de San Miguel and Ensenada de Garachiné, Darién; Bahía de Panamá, Bahía de Parita, Cocle and Herrera; Península de Azuero; Golfo de Montijo, Veraguas; and Golfo de Chiriquí and Bahía de Charco Azul, Chiriquí. All of these represent major ecological systems with individual characteristics and immense actual and potential value for living and non-living marine resources. All of the economically significant fisheries are associated with these coastal ecosystems, and artisanal fisheries of social importance are centered around Golfo de Chiriquí, Bocas del Toro, Golfo de Panama, and to a lesser extent, in San Blas. Oceanographic and meteorological factors have a tremendous direct impact upon this relatively small branch of land dividing a once continuous ocean, and the marine ecological importance of Panamá has been recognized for many years by the Smithsonian Institution and by other scientific organizations.

In view of all of the above, it is surprising that Panama has given so little consideration to the maritime nature of the country, and that Universidad de Panamá, a distinguished educational institution unfortunately affected by student political activism, has played only a marginal role in the training of people to address the country's marine potential and resources. Perhaps the important role played by the Smithsonian Tropical Research Institution has not encouraged the development of Panamá's own marine capabilities, but certainly the future offer a new challenge. Panamá's passiveness in the past was demonstrated by the support given to a marine department during the course of United Nations missions, later dwindling at the

expiration of those projects. But the realities of the present and the years to come place a new responsibility upon the nation's leaders. The new Panamá Canal Authority has clearly expressed the need for qualified scientists and technicians to face the responsibilities implied by the implementation of the Panamá Canal Treaties. The government has become increasingly aware of the importance of their marine resources and in 1980 it will expand its fishery-resource research facilities. But the research required by the fisheries department is focused on specific projects, further constrained by personnel shortages. On the other hand, there are numerous problem-areas that should become the focus of comprehensive long-term research programs, ideally within a graduate level university curriculum. The particular physical morphology of Panamá should encourage a great deal of research efforts, more so in view of the possibility of a new canal. In any event, the narrow strip of land that separates the Caribbean and the Pacific suggests that terrestrial activities have a direct impact on coastal phenomena which should be closely examined.

Indeed the Smithsonian Tropical Research Institute has given consideration to potential ecological problems of a new canal, like the spread of the coral-eating Acanthaster equinoderm into the Caribbean, the danger of the poisonous Pelamis Pacific sea-snake entering the Caribbean, and the problems of speciation when competing faunas come into contact. But apparently the Smithsonian has not given sufficient consideration to problems relevant to Panamá, such as the impact upon significant shrimp fisheries, also the impact on coastal ecosystems, and the socio-economic consequences of an altered marine environment. In fact, there is concern about the Smithsonian's apparent neglect of Panama's needs and problems and this has not had a positive effect among local academic circles. But on the other hand, the responsibility for addressing Panama's problems lie within the Panamanians themselves. As mentioned above, the Universidad de Panamá, with an important nucleus of people with experience in the marine sciences is considering the possibility of creating a new Center for Marine Sciences and Limnology. The weight of today's realities and the prospects for

the future are enough to assure the University's full endorsement and increased support for a Center that would focus on the country's immediate and potential marine problems; it would be most unfortunate if a short-sighted vision would prevent the Center's creation. There is reason for optimism in view of the University's efforts to create a national research capability with the recent establishment of an ad hoc center known as CEDECANI, and a Division for research and graduate studies.

Panamá's particular characteristics makes it a natural region for the development of cooperative research and training programs, and the current personnel of government and university departments could benefit from the creation of extension courses covering a wide variety of areas. Furthermore, the specific interest expressed by the Canal Authority in meeting the needs posed by the transfer of management responsibilities, are a favorable circumstance for the strengthening of Panamá's marine capabilities.

III. GENERAL DISCUSSION.

1. This report is not exhaustive and only attempts to present a broad view of the main features of marine affairs in Central American countries that would allow the University of Miami's Rosenstiel School of Marine and Atmospheric Science, and other institutions and organizations, to understand in a general way how they could be responsive to the needs of those countries. A comprehensive assessment of individual countries requires in-depth analyses beyond the scope of the report.

2. The information presented in the preceding pages indicates that most of the marine environmental problems in Central America have very important economic and social implications. Failure to address them adequately will undoubtedly result in greater difficulties in the immediate future, as well as in the long-term development of the countries.

There seems to be a general feeling among some government circles that the subject of the marine sciences is of limited value and importance to relatively small developing countries. Relevant information is expected to be delivered by some form of international assistance and thus, there would appear to be little need to invest in the development of indigenous marine capabilities. This short-sighted view operates in detriment to the understanding of local situations and the search for realistic approaches to their unravelment, as well as to the planning for the future. In practice, marine activities are restricted to the work of fisheries offices, with limited funds, generally only expected to gather statistics, more or less control the fishing effort to maximize exports, and find quick and easy methods for aquacultural production to satisfy nutritional needs, and to reduce pressure from fishery stocks in inshore areas. In spite of the inadequacies in quality and quantity of the support for those fisheries offices, it is encouraging to see the achievements in some areas when one considers cumbersome administrations and scarce funds.

The reality of the substance of the marine sciences is quite different. Marine scientific research has the potential for understanding the essence of marine environ-

mental problems thus providing the basic information needed to adopt sound development policies and legislation, and to optimize the utilization of living, mineral and non-extractive resources of the coastal regions. Unfortunately, throughout most of Latin America, interest in the oceans is limited to some aspects of living resources, and the potential of the coastal region is not fully appreciated.

The central issue in assuring effective government support for marine programs in the region is the underlining of the socio-economic dimensions of ecological problems. This is a difficult task since interrelationships of factors are not well understood, or are overlooked, and because social justice is often disregarded. In the past, marine environmental problems have been viewed mostly as marginally affecting politically inactive artisanal fishermen, and in general, environmental degradation has been seen as an unavoidable effect of economic development. These views have not been a motivating force for action in countries where the private economic interests of small elites are known to prevail in the actual exploitation of natural resources. But efforts aimed at identifying the interrelationships between certain courses of action and environmental problems and their economic implications will probably assure government interest and action in a manner that will hopefully also give greater attention to critical social aspects including public health. For instance, the fact that mangrove removal reduces the bioproductivity of a coastal lagoon thus affecting small scale fishing activities, in turn promoting urban migration, increasing unemployment and creating the opportunities for crime in cities, should be taken into consideration most seriously. The partial collapse or substantial decline in fishery landings from areas exposed to ecological degradation should be closely examined for social and economic trade-offs.

The management of natural resources is a political issue rather than a technical one, and the situation in individual countries can not be discussed here. However, it can be pointed out that Costa Rica, a politically stable and democratic country, has given the management of its marine affairs a high priority through the

creation of a presidential-level advisory commission, and that a scientist was appointed to head it. Moreover, it is not surprising that it is also in Costa Rica where there is a concerted effort on the part of the scientific funding agency, universities and government departments, to study, utilize, develop and manage their marine resources.

The responsibility for addressing marine issues lies also in academic institutions. Whereas government departments are constrained by the pursuit of specific objectives, the universities have a wide range of alternatives. If student involvement in national affairs were at least as active in creative activities as it is in protests and other destructive investments of energy, important progress would be made in examining local situations. Unfortunately, the scarcity of adequate direction in marine affairs usually limits the work of someone interested in the sea to the listing of species of one or several groups that are reported in the literature to exist in that country. This level of efforts are commonplace.

As a result of the need to identify the nature of coastal problems immediate assistance from advanced marine institutions could be in two stages: a) the creation of a mechanism for assessing and qualifying situations which seem to be most critical and with a wider range of implications; an initial step in this direction has been the establishment at the Rosenstiel School of the Tinker Center for Tropical Coastal Marine Studies for Latin America, and there is hope that other institutions will be willing and able to cooperate with the Center; and b) the creation of extension courses in the marine sciences for bringing updated information and scientific experience that could not be readily obtained otherwise, to university and government personnel. Long term needs involve the graduate training of scientists in the various disciplines of the marine sciences, hopefully through a first phase of studying in advanced institutions to prepare a basic nucleus of specialists, and a second phase involving the settling of this nucleus as a self-sustaining scientific community that applies itself to national problems.

3. The strengthening of marine scientific capabilities in Central America can not be considered separately from the general problem of the development of science in the region. This is an extremely important and extensive subject that can not be examined here, but two relevant questions can be raised. First, what is the general scientific organizational structure in the region? Second, what role can the international scientific community play specifically in reference to the marine sciences?

a. I am deeply indebted to Dr. Carlos Tünnerman Berheim, Director of the Central American Program for Science and Technology of the Consejo Superior Universitario Centroamericano, CSUCA, for allowing me to examine a special 1978 report to UNESCO on the organizational efforts for science in the region.

Early steps in the area of science and technology (S&T), were the creation of the Nutritional Institute for Central America and Panamá, INCAP, in 1945 (effective in 1949), and the Central American Industrial Research Institute, ICAITI, in 1952 (operational in 1956 with emphasis on food technology), both in Guatemala; and the Permanent Commission for Agricultural Research in Central America in 1967.

A UNESCO mission to discuss scientific planning visited Central America in the spring of 1970 and recommended several courses of action. Only Costa Rica followed the suggestion of creating an organism in charge of promoting S&T development, and in 1972 the Consejo Nacional de Investigaciones Científicas y Tecnológicas, CONICIT, was created. Other countries created only S&T units within their ministries of planning and economy. There has been some concern about the orientation of those units since they operate within narrow economic guidelines. In July of 1974, under the sponsorship of UNESCO/CONICIT, the first meeting on S&T policies for Central America took place in Costa Rica. The meeting, which brought together scientists, educators and planners, made various recommendations concerning the training of human resources, funding for S&T, transfer of technology and regional cooperation. The government S&T units began cooperating under a 1975 resolution by the Organization of American

States, OAS, to create a Commission for the Scientific and Technological Development of Central America, aimed at identifying common elements that would permit integration of national projects. The Commission met for the first time in San Salvador in January of 1976 and has then met twice a year. Several projects have been identified and distributed among the countries, for instance, marine science in Costa Rica, transfer of technology in Guatemala, Reforestation in Honduras. In the Commission's meeting of December, 1977, there was agreement that regional progress was very limited and in fact, most projects were considered as being at very preliminary stages. One of the problems in the Commission is that the scientific community is not represented in it; another is the fact that it is not a true intergovernmental body. The Commission receives technical assistance from the OAS regional S&T program.

An important step for the institutionalization of S&T policies is a project linked to the reorganization of the Central American Common Market, which has been under consideration by individual governments since March, 1976. However, emphasis in this project appears to be on applied technology rather than on science development. An additional project for the transfer of technology is being considered by the SIECA (Permanent Secretariat of the General Treaty of Central American Integration), with support from UNCTAD.

In 1978 the CSUCA prepared a plan for Central American Scientific and Technological Development. Its long-term goals are: to identify relations between science, technology and society within the context of developing countries; to promote the adoption of S&T policies aimed at overcoming dependency; to strengthen the S&T infrastructure by stimulating university activities; to inspire the spirit of science and creative activities by revising the teaching of the methods of science; to firmly establish applied and basic science in Central American universities; and to develop regional scientific autonomy within the context of Latin American efforts.

Over the last 16 years CSUCA activities have followed the "Plan for Regional Integration of Central American Higher Education", which resulted in the restructuring

of universities and an expansion of curricula. Several educational centers with good programs were strengthened and became Central American Schools, which permitted the initiation of graduate study programs. The regional graduate programs and Schools are: Master in Sanitary Engineering, Master in Hydraulics and Doctor of Veterinary Medicine, in Universidad San Carlos de Guatemala; Licenciatura in Sociology (requiring four semesters of study after the bachelor's degree), Master in Chemistry, Master in Microbiology, and Licenciatura in Geology; all of these at Universidad de Costa Rica.

In 1969 CSUCA created, as an interuniversity effort, the Editorial Universitaria Centroamericana (EDUCA), dedicated to publish educational books; it has already published over 180 titles with about 800,000 copies printed.

CSUCA promotes integrated research in member universities through four Central American Programs in a) Social Sciences; b) Health Sciences; c) Cultural Affairs; and d) Scientific and Technological Development. In support of the latter, the journal, "Revista Centroamericana de Ciencia y Tecnología", began publication in June of 1978, with two issues per year.

Although outdated, the only report on scientific and technological activities in Central America was prepared by Jorge Arias Blois, from ICALTI, in 1971 and later published in 1975 by OAS. The report gives a general idea of the distribution of effort: the survey of 171 regional institutions indicated that 43% of research and technical development was done at universities; of 3861 people that were surveyed, 2298 (59%) considered themselves as scientists, the remainder as technicians. Personnel distribution was as follows: Costa Rica, 14%; El Salvador, 27%; Guatemala, 21%, Honduras, 12%; Nicaragua, 7%; and Panamá, 17%. Research was conducted on the following: agriculture, 29%; social sciences, 25%; exact and natural sciences (including engineering), 17%; medicine, 10%; mining and industry, 7%. A new survey is being prepared by CSUCA in 1979.

In summary, during this decade there has been an important effort by Central

American educators, scientists and planners to create various mechanisms for the diffusion of science and technology, which are now being viewed as important development forces. The process of organization and formulation of science policies is continuing at the present time despite political, economic and social difficulties, and notwithstanding setbacks, there is reason for optimism for the future. The potential for the development of marine science, under the general circumstances described above, and in view of growing environmental problems, is highly encouraging.

b. The question of the role of the international scientific community should be viewed in two ways. First, as an international responsibility for the development of science, and second, as a self-interest in the understanding and utilization of the oceans on the part of marine scientists.

As an international undertaking, most efforts dedicated to the promotion of science and technology in developing countries are formally conducted by agencies such as UNESCO, the United Nations Development Programme, UNDP (which funds close to 70% of UNESCO's work in this area), the Organization of American States and the U.S. and Canada's agencies for international development. Despite their numerous achievements real effectiveness is often restricted by political considerations, by local governmental bureaucracies, and by limited success in reaching the academic, scientific and research communities. Moreover, the role of the agencies is only catalytic and the greatest share of the responsibility of developing science lies largely on local individuals. Since science is a collective and international undertaking it also follows that scientists in advanced countries (where more than 90% of the world's scientists live), have an unavoidable responsibility to promote or contribute to its development elsewhere, and to assist individuals and organizations that are building for the future in developing countries. Such efforts can enhance and complement the role of intergovernmental agencies. Although I admit to being biased, the generalization about an unavoidable responsibility is particularly true in the case of U.S. scientists in respect to Latin America, as a geographical and

historical imperative. But the sad reality is one of common indifference to the local problems in the region, including education, manpower development, scientific communication, research capabilities, scientific organization and science policies. I find such an indifference culturally short-sighted, politically negative, and economically unimaginative. For the limited number of realistic and concerned scientists interested in Latin America, it must be stressed that the aim of their assistance should be selective so that a small amount of help can stimulate the largest amount of indigenous activity in the proper direction. Efforts like those of the National Science Foundation Program for Latin America for cooperative research, and those of Interciencia, the interamerican federation of associations for the advancement of science, are well suited for increasing interactions between scientists, which should in turn produce stronger bonds than those being generated under governmental programs.

The preceding considerations are especially valid between the U.S. and Latin America in the field of marine sciences. The U.S. has played an important role in the region by shaping a number of official international marine projects, by supporting educational programs, and by sponsoring fishery development work (mainly through AID). The former have had limited success because they assumed the existence of effective marine scientific capabilities, which in reality have been generally lacking. U.S. universities have trained something in the order of 200 students in the marine sciences, about 25 at the Ph.D. level, but many have returned to countries lacking adequate marine scientific infrastructures. There have been recent efforts to strengthen capabilities by developing project-oriented programs, specifically in the case of the International Sea Grant Program, of which almost 75% of its \$ 912,000 dollar budget for 1978-79 has been awarded to Latin America. Fisheries programs have had some success and some failures, but overall, they have been hampered by failures on the part of local governments to take the necessary steps for basic scientific work. In turn, these government have placed a heavy burden on international organizations,

whose efforts can help, but not provide the key to solving core problems.

In my opinion, the key to future success in promoting the development of marine science in the region lies in addressing relevant problems which sometimes are not fully appreciated locally. On the part of the U.S. there appears to have been emphasis on international projects that have been viewed as having little bearing on local needs, and not an insignificant amount of graduate training of Latin American students has involved research on problems that are out of phase with national priorities and urgent needs.

Working for the future requires closer personal interaction between marine scientists at the incipient programs and growing institutions in Central America. Assistance at the present stage of growth is crucial and can have a tremendous impact in the development of marine science, its quality and its outlook, in exploiting resources, and conserving regional seas, directly and indirectly affecting the United States. The focus of the assistance should be relevant problems, some of which have been mentioned in this report and many have been probably overlooked. A critical aspect of the assistance needed is at the policy level since it is clear that most countries are presently concerned with the formulation of science policies. The difficulty here lies in the fact that many scientists in the U.S. already work within a scientific organizational structure and are not familiar with the difficulties of building for science in developing countries. But certainly, assistance on the implications of various courses of action will be extremely important in the formulation of policies.

4. Central America is, in general, at a young and promising stage of development, but the future requires more rational strategies. The agricultural economy of most countries has been based on a few intensely farmed products, but there is now a tendency to diversify agriculture and to improve the soils which have been impoverished by the abandonment of crop rotations and by deforestation and erosion. Most agriculture has been centered along the western ranges and coastal plains near main population centers, and the current pattern of the agribusiness has had an important social impact. Subsistence agriculture has disintegrated, minifundia peasants and landless workers have been impoverished, low nutritional patterns of consumption have become common among the poor, and these have caused massive emigration to the periphery of cities. Evidently, coastal agriculture is also having a significant impact on rural communities and on the marine environment. In fact, Central America's geographical characteristics create a close interrelationship between terrestrial activities and marine ecosystems. The future development of Central America requires a clear understanding of the role and value of those ecosystems and of the socio-economic implications of their alteration.

The impact of agricultural practices and coastal development, which usually affect estuarine areas, can be observed at the level of industrial fishing, but in reality marine ecological problems have a wider range of implications. Industrial fishing concentrates mostly on shrimps for export to the developed countries, but such emphasis not infrequently involves indiscriminate fishing by mechanized trawlers which destroy bottom communities and affect fish stocks (moreover, fishes caught along with the shrimp are usually discarded to maintain space for shrimps). These lead to a decline in local consumption of protein among those who have virtually no sources of protein other than fish. Furthermore, many of the fishes that are being captured in inshore areas are showing high levels of pesticides, which coupled with indiscriminate spraying constitute an important health problem. Coastal alteration or degradation also has an impact on the actual and potential utilization of the

environment for tourism, recreation and sport fishing, which alone and combined have an economic potential not yet fully appreciated.

The potential for aquaculture is also being jeopardized by actions affecting the bioproductivity of estuarine areas and the degradation of the water quality. Furthermore, aquaculture is often conceived as a practice that should concentrate on the culture of shrimp for export, and its potential for supplementing the nutritional needs of the rural poor is being disregarded. Also, there is a tendency to utilize imported species, which have been used successfully elsewhere, but which more often than not cause ecological problems, without a clear appreciation of the potential for indigenous species.

The absence of even basic information on the ecology of critical areas is an important issue. Quite often environmental damage is caused by those who claim that there is no information suggesting that a particular area has any value. On strictly legal grounds it is extremely difficult to refute such positions. As a result, there is urgent need to make baseline studies and to initiate a rational understanding, no matter how basic, of some ecologically critical areas. Concerned individuals must realize that there are other factors other than environmental concern that play a role in determining the fate of coastal lagoons, estuaries and other ecological niches.

All the current problems of the coastal regions and the potential for utilizing living, mineral and non-extractive marine resources, including their social consequences, require the early development of marine scientific and technological capabilities. All the Central American countries perceive the need and are making efforts to start, or have started, programs in that direction. But as young and inexperienced programs, trying to develop in areas where there is little tradition for science, and even less for marine issues, there is need for advice, orientation and practical assistance in focusing on relevant problems. All the stages in the development of a marine maturity need not be repeated; science is in fact, a cumulative undertaking, and thus the role

of scientists from advanced countries can be extremely useful.

There is reason for optimism in the immediate future. Whereas in the United States an appreciation of the need to regulate the coastal zones only became law recently with the Coastal Zone Management Act of 1976, all the Central American countries are already talking about such legislative need, and all are also concerned with the need to adopt the practice of environmental impact statements in the planning of development projects. Costa Rica is already in the process of creating during 1979 a National Coastal Commission to address the problems of coastal management. Furthermore, although mechanisms to study some of the problems do not exist yet, there is no question that most of the interplaying factors are fully recognized by government officials, educators, planners and scientists in Central America. The limitations are financial, political and of manpower, but the fact that the problems are recognized as such is a fundamental step.

In an age of interdependency, there is little doubt that the future of the oceans, in particular the regional seas, require the undertaking of joint efforts which should be underlined by a sense of common destiny in the Americas. It is hoped that in some way this general report, the funding for which came so kindly from the Tinker Foundation, will contribute to the establishment of such efforts and to further understanding between the peoples of the United States and Latin America. In the closing of this century there is a challenging opportunity to plan and work for a better future, and to preserve the oceans for future generations.

APPENDIX.

A D R E S S E S

1. University Organizations.

CSUCA. Consejo Superior Universitario Centroamericano
 Dr. Sergio Ramírez Mercado
 Apartado 37, Ciudad Universitaria "Rodrigo Facio"
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Also: Dr. Carlos Tünnermann Bernheim
 Director del Programa Centroamericano de
 Desarrollo Científico y Tecnológico
 (Currently Minister of Education, Managua, Nicaragua)

FUPAC. Federación de Universidades de América Central y Panamá
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 Ciudad Universitaria, Zona 12
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Director,
 Centro de Estudios del Mar y Acuicultura, CEMA
 Monterrico, Taxisco
 Santa Rosa

Director, Escuela Regional de Ingeniería Sanitaria y Recursos Hidráulicos
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