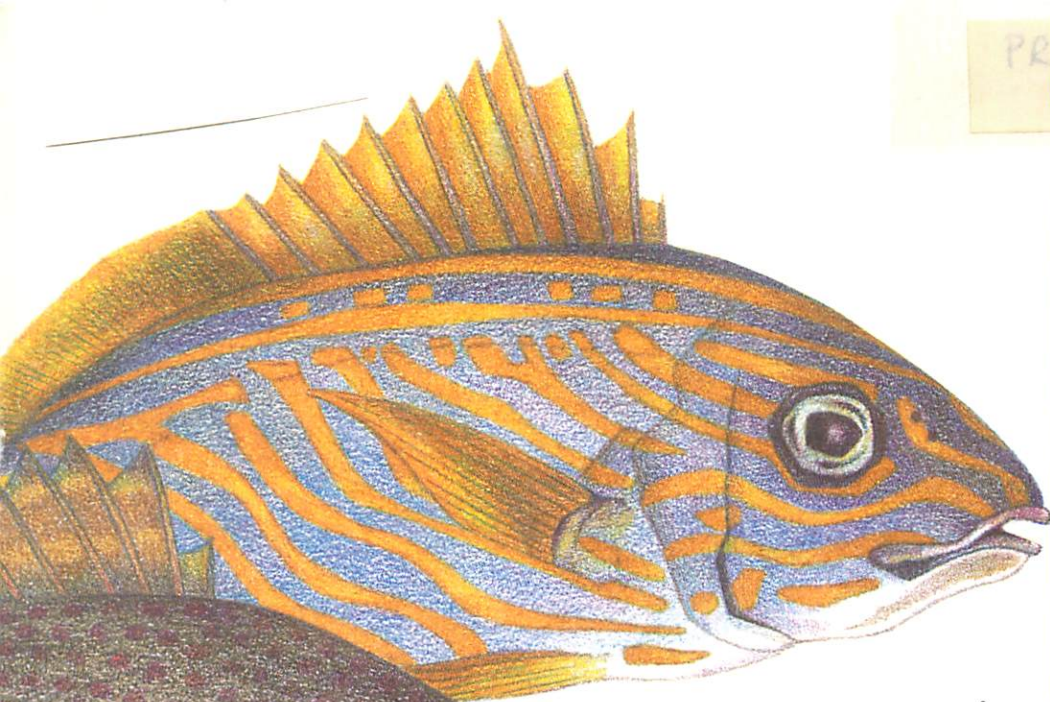
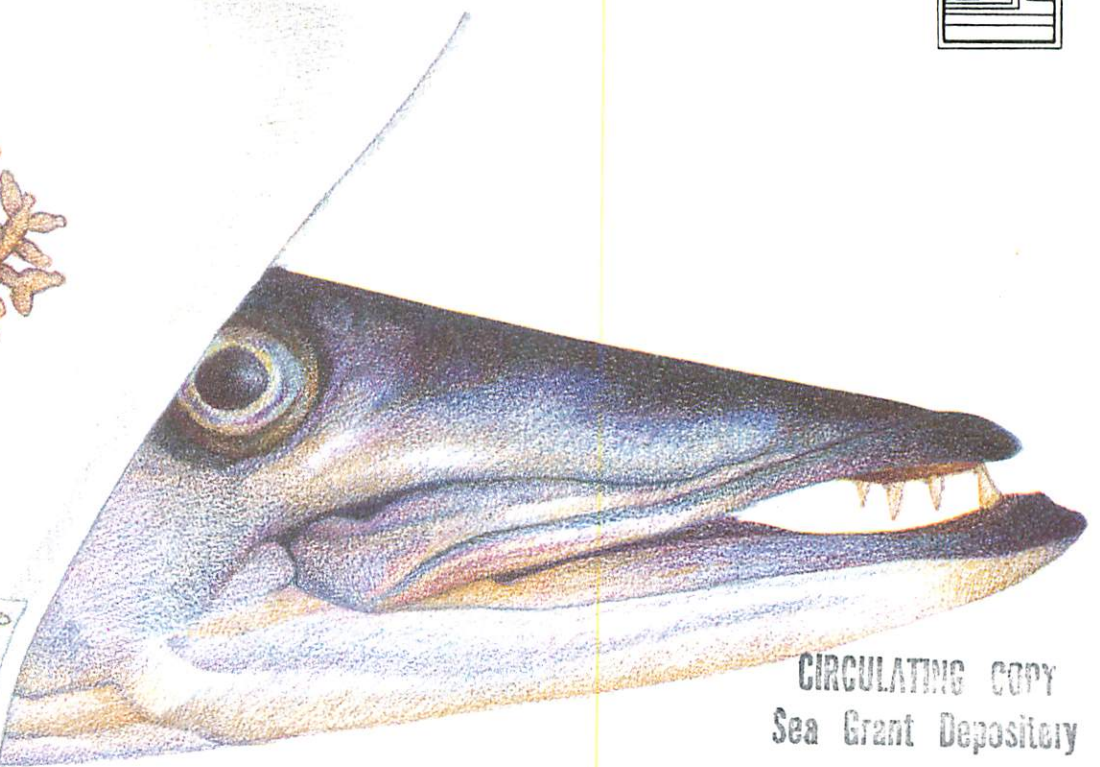


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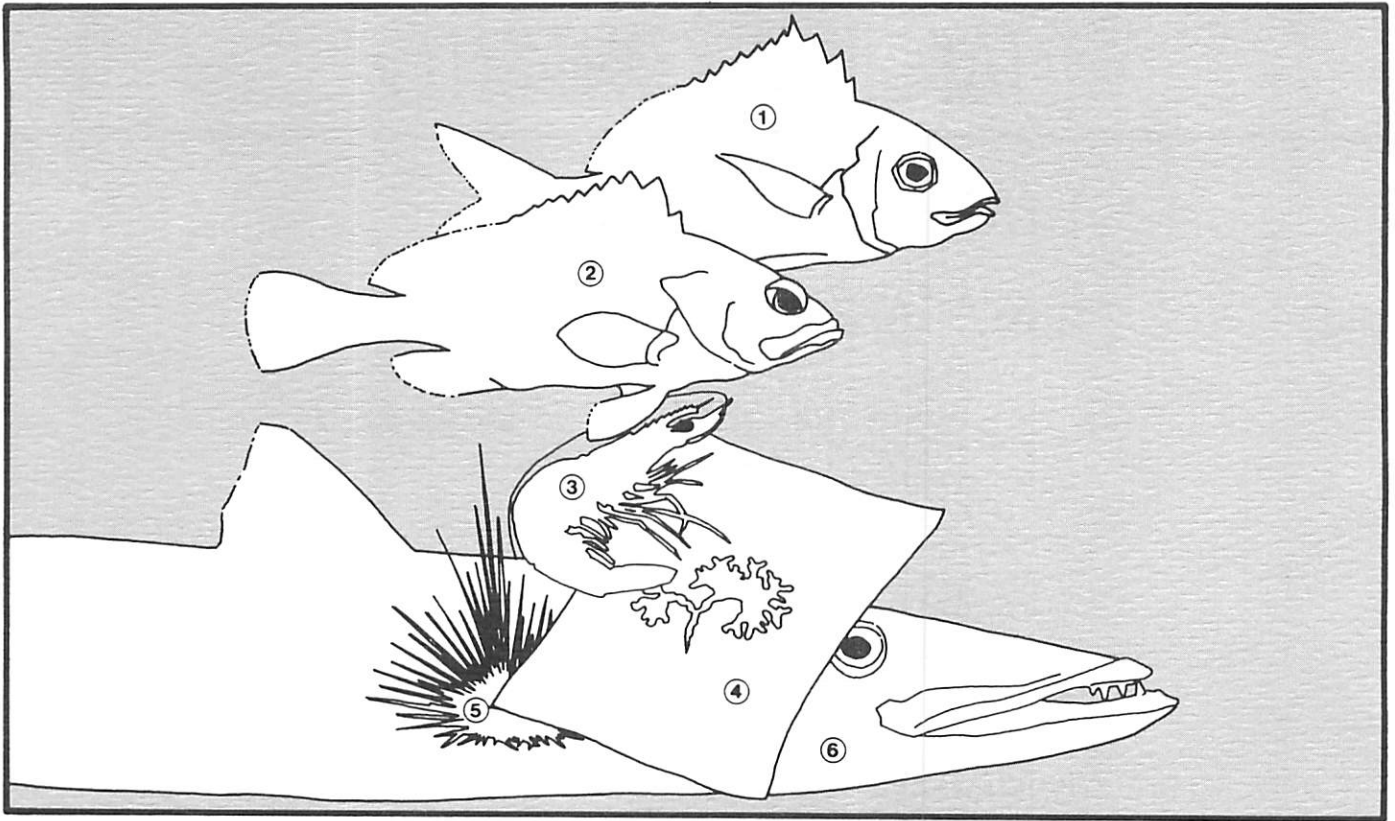


University of Puerto Rico  
SEA GRANT PROGRAM  
1985-1986 Annual Report



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- ABOUT THE COVER:**
1. French Grunt - Haemulon flavolineatum - R. Appeldoorn
  2. Red Hind - Epinephelus guttatus - D. Shapiro
  3. Penaeus Shrimp - Penaeus subtilis - A. Stoner
  4. Marine Algae - Coelarthrum albertisii - D. Ballantine
  5. Sea Urchin - Diadema antillarum - R. Carpenter
  6. Barracuda - Sphyraena barracuda - T. Tosteson



## University of Puerto Rico Sea Grant Program

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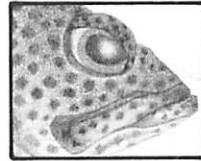
# TABLE of CONTENTS

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1 FROM THE DIRECTOR

3 RESEARCH

3 TOSTESON  
5 CORREDOR  
7 SHAPIRO  
9 STONER  
11 CARPENTER  
13 APPELDOORN  
15 GIESE  
17 BALLANTINE



18 PROGRAM DEVELOPMENT FUNDS

21 MARINE ADVISORY

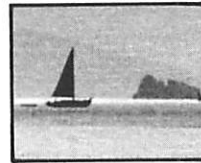
22 THE FISHERMAN  
23 SEAFOOD PROMOTION AND TECHNOLOGY  
24 EDUCATION  
25 RECREATION  
26 LINKAGES

27 SUMMER CAMP

29 EDUCATION

31 COMMUNICATIONS

36 ADMINISTRATION



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## FROM THE DIRECTOR



The University of Puerto Rico Sea Grant Program (UPRSGP) is effectively serving Puerto Rico, its University and the U.S. Virgin Islands (USVI). UPRSGP has upheld the MISSION of the National Sea Grant College Program (NSGCP), which is to accelerate, augment, and promote the development, conservation, proper management and maximum social and economic utilization of the nation's marine resources. It has promoted the CONCEPT of fostering a working partnership between the university, industry, government, and the community. It has succeeded in engaging the knowledge, talents, and skills of the universities in multidisciplinary research aimed at practical solutions to the socio-economic problems which beset our island in the marine resources realm. It has provided opportunities of funding not previously available for applied research and extension services. It has opened channels of communication through its potential to disseminate information person to person; it has unified the efforts of past decades by bridging the gap for information transfer between government agencies, industry, and the coastal communities. But, most

of all, UPRSGP has created new challenges, changed attitudes, generated incentives, and increased the awareness of the importance of marine resources development and marine affairs in Puerto Rico, the Virgin Islands, and in many of the Caribbean Basin countries.

Our goal is to spread Sea Grant's philosophy and mission throughout the Caribbean because we firmly believe that just as it has proven to be a highly needed and beneficial program for Puerto Rico, so it will be of significant value for the whole region. Sea Grant's education and extension services are essential and actually in great demand throughout the Caribbean. This is a challenge for the UPRSGP; thus, the reason why we entitled our first report: A SEA GRANT PROGRAM FOR THE CARIBBEAN and the USVI.

This, our second comprehensive report, intended for publication and distribution to government agencies, the academic community, the public throughout the island, and the national Sea Grant network, demonstrates the commitment of the University of Puerto Rico to the maximum realization of the goals and objectives of the National Sea Grant Col-



lege Program (NSGCP). It demonstrates that in spite of funding constraints and personnel limitations, the achievements have been significant and meaningful.

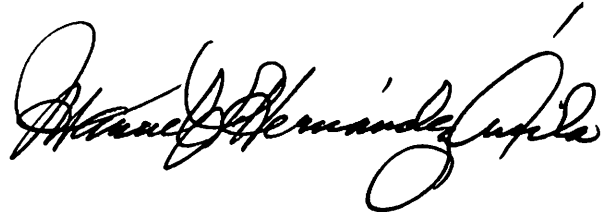
The main objectives of the UPRSGP address and focus on those critical issues which can bring the greatest benefits in the shortest length of time. Efforts are intended to bring some relief to the needs and problems of the islands and to help government agencies and industry to manage marine resources. Research emphasis has been and continues to be in five major areas:

- Feasibility studies in aquaculture-mariculture as a source of food and employment.
- Improvement of artisanal fisheries and development of a deep water fisheries industry through fishery biology and socio-economic studies of fishing villages and coastal communities.
- Tropical marine pharmacology and natural products; their potentialities and resources.

- Environmental and coastal processes studies related to major problems of coastal engineering and pollution of estuaries, bays, and coastal waters.
- Basic educational and information programs for professionals, school teachers, students, and the public in general.

Although the main problems and needs that have been identified in Puerto Rico through the program pertain to the above areas, the UPRSGP maintains an attitude and readiness for diversification, flexibility, and adjustment to necessities and demands as they arise. Our philosophy is to follow the trends, change direction when necessary, and adjust to the idiosyncracies and social behavior of the communities (including the research community) which we intend to serve.

We are proud to publish this general report of our concerns, achievements and future trends and hope that through it, you will learn more about our program.

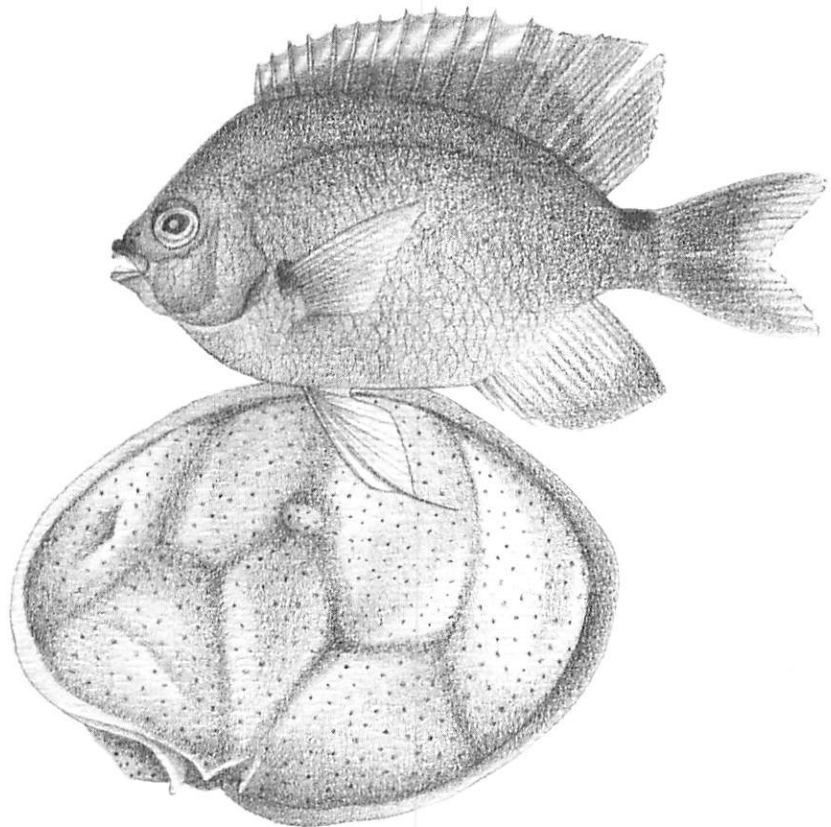




# Ciguatera in the Caribbean..... A Tropical Hazard!

Ciguateric fish poisoning is an urgent public health problem. In Puerto Rico and the U.S Virgin Islands alone, it may be as high as 20,000 estimated cases per year. Distinctive symptoms include severe itching, tingling and numbness in the extremities, and neurological symptoms such as temperature sensory reversal. The condition may persist for months and recur with stress, alcohol consumption or ingestion of non-toxic fish. Treatment is symptomatic, with no antidote presently known. While not usually fatal, ciguatera is traumatic and can be incapacitating for a period of a year. Until recently, ciguatera was limited to tropical regions. However, increased commercial fishing of tropical reefs has increased its frequency in temperate areas.

Ciguatera has a long history, dating back to 17th and 18th century explorers in the Indian and Pacific Oceans and the Caribbean Sea. Human activities in the marine environment, pollution, dredging, and degradation of coral reefs have been suggested as causes of the recent dramatic increase in the number of ciguateric fish.



### *Stegastes planifrons*

*A coral reef fish being utilized in the development of a dockside assay for ciguatera.*

### *Gambierdiscus toxicus* (X 1,000)

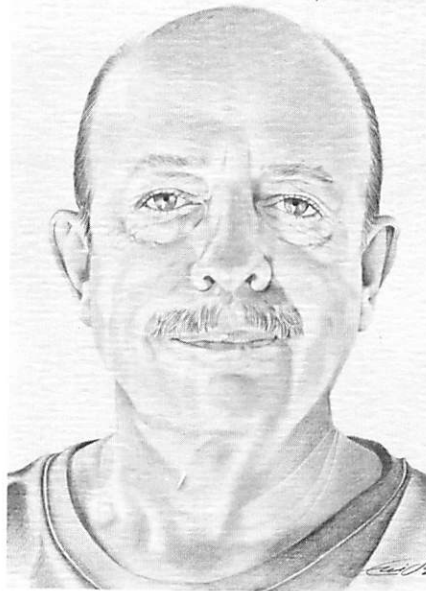
*A benthic dinoflagellate implicated as one of the vectors of ciguatera fish poisoning.*

It has been suggested by Japanese researchers that toxic dinoflagellates are the source of ciguatera poisoning in fish. Toxins produced by marine dinoflagellates are indeed among the most potent, known. One species of dinoflagellate, Gambierdiscus toxicus, initially discovered in French Polynesia has been suggested to be directly related to occurrence of ciguateric fish in the Pacific Ocean. Both G. toxicus and ecologically associated ostreopsis are present in southwest Puerto Rico.

One theory of how fish contract ciguatera poisoning is that the toxin is passed through the "food-chain" when small toxic herbivorous fish, poisoned by toxic dinoflagellates they ingest, are consumed by larger carnivorous fish.

The toxin believed to cause ciguatera poisoning in human beings is known as ciguatoxin. Little is known of its chemical structure or specific pharmacological activity. Absence of a clear understanding of the toxin has hampered the design of an adequate system for detection of ciguateric fish.

There are, world-wide, approximately forty researchers studying ciguatera, and many theories have been advanced and tested. Dr. Thomas Tosteson and Dr. David



*Thomas R. Tosteson, Ph.D.*

Ballantine (assisted by Dr. Dupont Durst of the applied chemistry branch, U.S. Army Chemical Research, Development and Engineering Center, Aberdeen Proving Grounds, Maryland) at the Department of Marine Sciences Laboratory at La Parguera are now looking for a "dockside" test based on the hypothesis that the automatic nervous system of ciguateric fish may be affected by the presence of ciguatoxin, and this may affect color adaptation and color responses in these animals. Poisoned reef fish, stabilized in laboratory tanks, will be examined for confirmation of this hypothesis. Confirmation could lead to a dockside test since some of the effects would be observable in

the fish's scales.

The detection of poisonous fish prior to their consumption would be an important step in preventing ciguatera poisoning in humans and in protecting commercial sources from inadvertently distributing these fish.

Dr. Tosteson and his colleagues are working with barracuda, a fish known to have a high incidence of toxicity in this region of the Caribbean. These investigators have observed that ciguatera in the barracuda is seasonal in its frequency in this area. High percentage (60-70%) of the samples were found to be toxic in October and November, and again in February, March and April; the latter period correlating with increased reports of human toxification.

The fact that ciguatera is seasonal in these fish suggests that barracuda do not accumulate toxins in their tissues. The factors that may cause these seasonal fluctuations in barracuda ciguatoxicity are: (1) seasonal change in rainfall and stormy weather, (2) seasonal fluctuations in toxic benthic dinoflagellates and, (3) changes in the ability of these fish to detoxify ingested poisons, which are presently being investigated.



# Nature's Own Sewage Treatment Plant

Is a mangrove/seagrass ecosystem a natural sewage-treatment plant?

Three things made La Parguera, a fishing village on Puerto Rico's southwestern coast, an ideal spot for Dr. Jorge Corredor's search for an answer to this question. First, it is located within one of the most extensive mangrove forests on the Island. Second, it is a couple of minutes' boat ride from the Department of Marine Sciences Laboratories on Isla Magueyes. Third, although houses in La Parguera are usually equipped with a septic system, stilt-houses and houseboats along its shore discharge solid sewage directly into the protected channel formed by a mangrove fringe landward and a series of mangrove-covered keys seaward.

In La Parguera, pollution is of more than academic interest, for while discharge of raw sewage into the adjacent waters poses a serious public-health problem, the new sewage-treatment plant presently being installed by the Puerto Rico Aqueduct and Sewer Authority may pose just as serious a threat to the marine environment on which the village depends. The problem is that human waste tends to produce an excess of consumable nitrogen and hence a scarcity of the available oxygen essential to animal life.

Mangrove ecosystems have, in the past, been widely viewed as natural buffers to excessive build-up of nitrogenous nutrients (eutrophication), but little was known of their capacity

to cope with human waste specifically. Dr. Corredor therefore proposed "to determine the response of the mangrove/seagrass communities ... off La Parguera to anthropogenic nitrogen sources."

Essential to the project was the determination of the type,



Jorge E. Corredor, Ph.D.

distribution, and variation of nitrogen compounds in the water, in the sediment, and in the exchange between the two. To this end, a number of stations were established along the La Parguera channel, within a mangrove inlet (to measure conditions unique to water in the mangrove root complex), another to monitor conditions to seaward of the keys and, as control stations, two more well removed from the source of pollution.

Using these stations, Dr. Corredor conducted environmental monitoring of temporal and spatial variations in the concentration of the four major dissolved components of the nitrogen cycle, ammonium, ni-

trate, nitrite, and organic nitrogen, in the water column and in the sediment pore waters, as well as temperature, salinity, and dissolved oxygen content. He also conducted flux and metabolism assays which revealed, among other things, the key role played by Microcoleus lyngbyaceus, a ubiquitous cyanophyte, in the maintenance of nitrogen balance.

Dr. Corredor's results, while not proving that this is the best of all possible worlds (sediments in some of the deeper basins have been driven to total anoxia, with consequent exclusion of bottom-dwelling fauna from those areas) are on the whole optimistic. In his own words, "Although the discharge of raw sewage poses a serious problem for public health, impact upon the ecosystem is less dramatic." Scavengers which quickly consume excess organic matter assure that sewage enters the system in a form amenable to rapid bacterial decomposition, thus maintaining the biological demand for dissolved oxygen at manageable levels. Nutrient enrichment, and hence environmental degradation, is limited to the immediate area of discharge through rapid uptake by phytoplankton and by mangroves and seagrasses. Currents are remarkably effective in expelling nitrogen from the channel, although their effectiveness varies with wind conditions and therefore, with the season. Microcoleus lyngbyaceus, proliferated by the dumping of raw sewage, is a major exporter of nitrogen, and while it is a public nuisance, it seems

to be less toxic than previously reported. The consistent decrease in dissolved nitrogen content downstream of the affected area attests to the efficiency of the ecosystem in absorbing excess nitrogen.

Dr. Corredor has reservations, however, about the environmental impact of ASA's sewage treatment plant, since it will change the discharge of anthropogenic nutrients from a diffuse, long-channel source to a point source, and since the discharge will be greatly increased due to the inclusion of some 3000 persons now on septic systems. He foresees that the plant "will very probably cause serious environmental degrada-

tion, at least in the channel areas immediately adjacent to the sewage treatment plant."

While Dr. Corredor has concentrated on the La Parguera area, it is not the only place affected. This work clarifies the biogeochemical cycle of nitrogen in near-shore tropical waters, especially the carrying capacity of ecosystems in these environments.

Dr. Corredor presented a report of his findings to the Twelfth Symposium on Natural Resources, in San Juan, Puerto Rico, December 11-12, 1985 and at the AIMLC meeting at St. Croix, Virgin Islands in 1986.



*Stilt-houses at La Parguera*

# The Sex Life of Groupers

The grouper has never before had the in-depth look that Dr. Douglas Shapiro is giving it. The overall purpose of his large, on-going project is to determine the effect of intensive fishing over annual spawning aggregations on the reproductive potential and hence future abundance of this commercially important fish. As Dr. Shapiro analyzes the problem, the extent of this effort depends on the answers to four questions: (1) whether fishing over the aggregation tends to be disproportionately selective of particular sizes or sexes; (2) how much of total spawning occurs in and during the aggregation; (3) how the sexes are dispersed within the grouper's social structure; and (4) whether sex change (all groupers are born females, some of them later changing sex) is socially controlled — *i.e.*, whether males are produced as needed.

Dr. Shapiro believes that he has answered the first two of these questions. Commercial hook-and-line fishing is not selective of sizes or sexes. Thus, commercial catches adequately sample sex and size ratios in the spawning aggregation, with the highly desirable consequences that future fisheries studies may utilize commercial samples. And spawning is restricted, by physiology, to the time of the annual aggregation (locally, the latter half of January) and most probably occurs only within the aggregation. Fishing over aggregations, therefore, has a greater impact on reproduction and future abundance than if spawn-



*Douglas Y. Shapiro, Ph.D.*

ing were spaced more broadly throughout the year.

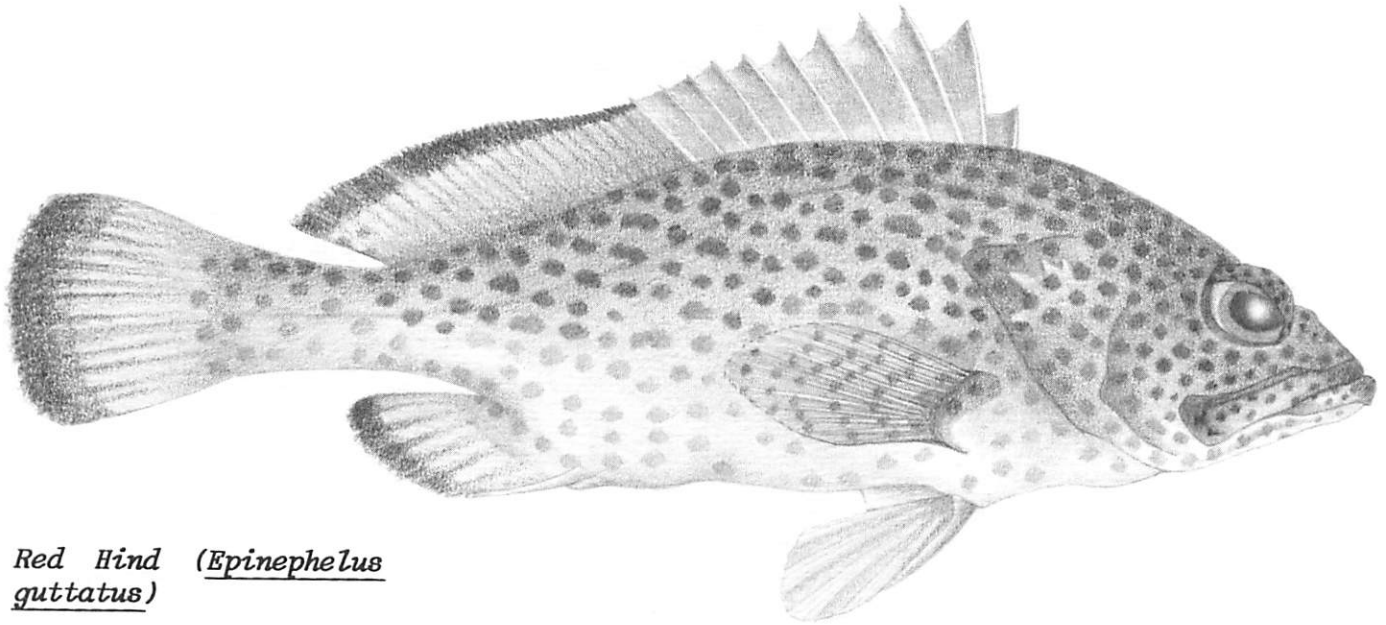
Groupers aggregate only once a year and the spawning itself seems to occur during a period as short as a single night. Work on the third of Dr. Shapiro's questions, concerning the social structure of the aggregation, has been delayed by difficulty in locating an aggregation of suitable size, every time this small, once-a-year window comes around. In the course of his investigations, however, Dr. Shapiro turned up a fact which surprised him: grouper society outside the annual aggregations is apparently sexually segregated. The in-shore, shallow-reef population is entirely female while the males are ... well, where are the males for eleven and a half months? Thus, one scientific answer leads to another question? Dr. Shapiro is assuming that they must be in deep water off the shelf, where females who change sex join

them, but only anticipated new gear will make possible the confirmation of this assumption.

The fact that the all-female, shallow-reef society is consistent and definable over periods averaging at least three months, suggests that sex change occurs only when a female has been in contact with a male on the spawning ground, although the change itself does not occur until the contact has ceased. If this is correct, then the internal organization of the spawning ground plays at least two roles in reproduction. Heavy fishing of the aggregation would not only reduce the number of spawners, but would also disrupt sex change, hence future sex ratios, hence later reproductive potential.

Dr. Shapiro's fourth question was whether sex change is controlled socially, by the need for a male, or developmentally, by the age or size or other developmental characteristic of the female alone. The discovery that hook-caught fish can be brought to the surface alive and in fairly good condition led Dr. Shapiro to the development of fish cages in which this question can be studied under laboratory conditions. If sex change is socially induced, the segregation of females (from the spawning aggregations) in cages, isolated from males, should induce sex change. The occurrence of sex change in control cages containing a male, on the other hand, would suggest that the change is developmental, initiated perhaps by cessation of spawning. In 1987, using this refined captivity technique, Dr. Shapiro determined that females held in





*Red Hind (Epinephelus guttatus)*

cages were more likely to initiate the earliest stages of sex change than females in the population. However, there was no difference between females isolated from males and females kept in contact with males. Additional studies, including measurement of the endocrine changes in these individuals, are now being done in an attempt to explain these unexpected findings.

A further question raised in

Dr. Shapiro's study is the origin of juvenile groupers settling into the adult population. From where had they come? Dr. Shapiro believes that he has found a way of measuring the ages of such juveniles and that by comparing their ages with the dates of spawning aggregations, he will be able to circumscribe their places of origin.

Besides his findings on the effects of fishing over grouper

spawning aggregations, Dr. Shapiro has developed improved research techniques for the study of sex change, has provided information which can be the basis of new yield models for related research, and has contributed to initial discussion of new fishery-management guidelines for Puerto Rico. Should he discover that juvenile recruits are voyaging from one island to another, these discussions may have to become international!

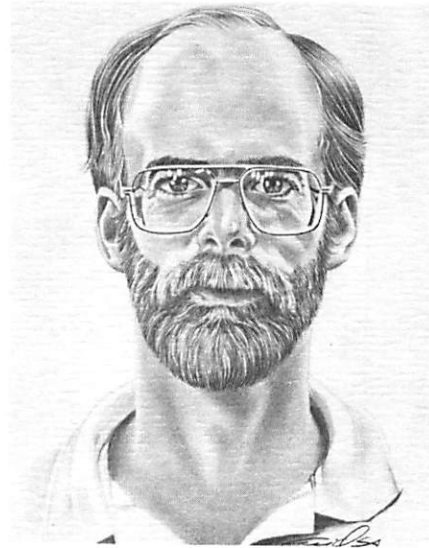
# Joyuda Lagoon.....Δ Natural Treasure?

Although hardly as spectacular as the promise of pirate treasures or sunken galleons, Joyuda Lagoon on Puerto Rico's west coast has long been recognized as a natural treasure by the artisanal fishermen of the region - as well as by the connoisseurs of freshly caught shrimp. Although not a large producer of shrimp, there are occasional night-time catches of up to 100 pounds, taken mainly in the one narrow inlet which connects Joyuda with the adjacent sea. Local fishermen report little seasonality in their catch, but do recognize a pronounced lunar periodicity in shrimp abundance.

The lagoon itself is small and shallow—1.37 square kilometers in area and averages 1.5 meters in depth. It is fringed by dense stands of mangroves and is surrounded by rolling pasture land which is free of agricultural, industrial, and urban development. The lagoon bottom consists of sediments, which are highly organic and rich in nutrients, materials derived mainly from the mangrove litterfall and lagoon plankton. This situation has produced a rich and productive benthic environment, one which promotes a high yield of commercial shrimp. Joyuda Lagoon, being small in size, relatively unimpacted by human activities and possessing a highly productive environment, consequently has the characteristics of a nearly ideal model system for investigating recruitment, immigration, and standing stock relationships.

The Joyuda Lagoon system, with its single, narrow inlet and adjacent shallow marine habitats, constitutes a relatively narrow zone within which the entire life history of the local shrimp species can be studied. Of the four penaeid species which occur in the lagoon (*Penaeus brasiliensis*, *P. notialis*, *P. schmitti* and *P. subtilis*), *P. schmitti* is already an important aquaculture species in other regions of the Caribbean and Gulf of Mexico. A major obstacle to further development, however, is the present lack of knowledge of the biology and potential yield of tropical Atlantic and Caribbean penaeid shrimp.

Dr. Allan Stoner's project has sought to determine temporal immigration and emigra-



Allan W. Stoner, Ph.D.

tion patterns of Joyuda shrimp. Sampling stations were established in the lagoon, the inlet, and on the adjacent insular shelf to determine seasonal abundance of juvenile and adult shrimp, the results being supplemented by fisher-

men's catch statistics.

Dr. Stoner has determined that shrimp are most abundant during the last quarter of the lunar cycle; that *P. notialis* and *P. subtilis* are numerically co-dominant in the lagoon; and that juvenile shrimp are the most abundant organisms. The researchers also found that stock recruitment appears to occur year-round in all four species, but in the case of *P. subtilis*, recruitment was more pronounced during the rainy season. It is clear from the first year study that the high production of Joyuda Lagoon shrimp is partially related to year-round recruitment and growth, and partially to the high organic productivity encountered in the lagoon nursery area. As a research spin-off, it was also noted that the traditional cast nests and weirs used by local shrimpers were less effective in capturing adults than the otter trawl employed by Dr. Stoner and his associates.

A second aspect of the research is to conduct growth studies using *P. notialis* and *P. subtilis* juveniles. Experiments are being conducted for four weeks in April-May, when juveniles are particularly abundant, and again in August-September, when water temperatures are highest. Since tagging of juveniles is difficult, species samples are placed in special enclosures in the lagoon which provide an environment for natural growth, protection from predators, and prevention of escape, thus facilitating specimen collection and

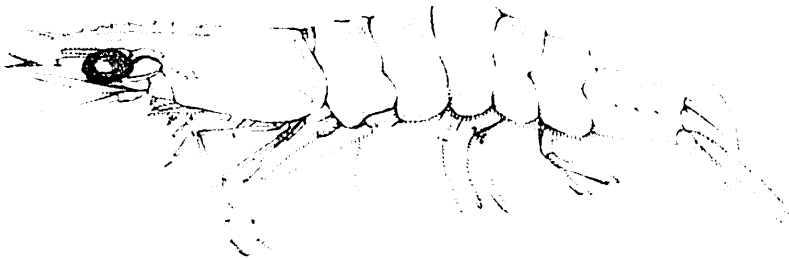
growth measurements at the end of experiments.

It is hypothesized that immigration into the lagoon may occur in the form of very small juveniles rather than in the form of post-larvae, but confirmation will require an additional station outside the lagoon and routine sampling of spawning-ground activity. Uncertainty about the relationships among reproductive stock size, recruitment strength, and production of commercial marine shrimp are questions still to be addressed. The close working relationships between the research team and Joyuda fishermen has had mutual benefits. On one hand, Dr. Stoner has obtained valuable data pertaining to catch, to emigration periodicity and fishing pressure effects. On the other hand, the fishermen have gained insight and a broader understanding of external factors which do or may affect

their livelihood — factors which impact the environment such as mangrove cutting, land fill, industrial and urban pollution, etc. As a group, they now better appreciate the importance of wetland regulations.

Dr. Stoner's multifaceted research, involving benthic and plankton collection, examination of diets, and growth experiments, has already attracted support from the National Science Foundation for further study which will include principal investigators from various institutions and from the United States Geological Survey.

Research efforts with the four species of Penaeus in Joyuda Lagoon will be valuable for the fishery and aquaculture industries in Puerto Rico and the Caribbean, ultimately impacting fishery-management practices.



Penaeus schmitti

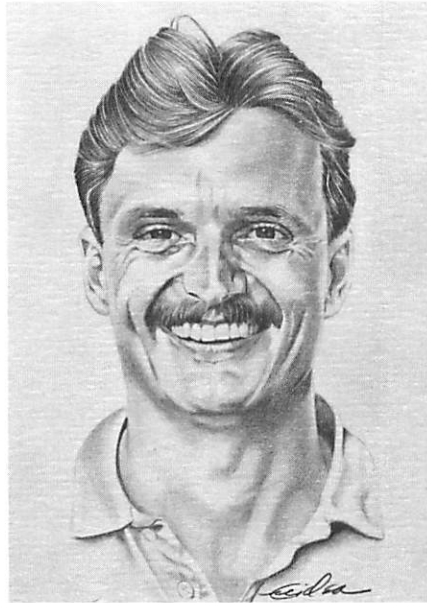


# Where Has the Spiny Sea Urchin Gone?

The spiny urchin (*Diadema antillarum*) was until recently, one of the most abundant organisms on Caribbean coral reefs, with a recognized impact on reef algae and on reef-building corals.

Dr. Robert Carpenter and Dr. John Ogden of Fairleigh Dickinson University's West Indies Laboratory on St. Croix had been studying this spiny character for ten years, when nature unexpectedly presented them with every scientist's dream, a natural experiment. A die-off of the species throughout the Caribbean, suddenly reduced the sea urchin population by an estimated 95-99% (more than 99% in the Virgin Islands).

Grazing sea urchins partially control the abundance and composition of the reef's algal community, as well as the number of algal species and their rates of primary productivity. Changes in the sea urchin population might, therefore, be expected to impact herbivorous fish species that also graze on the same algal community. Previous experimental work had suggested that fish species which comprise a significant proportion of the Caribbean fish catch, compete with the sea urchin for food. However, fishes are less efficient than the sea urchin at exploiting the available food resources. It was suggested that where sea urchins were abundant, fish populations might be lowered due to lack of food. It was reasonable to suppose that removal of the sea urchin would have major ramifications af-



*Robert C. Carpenter, Ph.D*

fecting both plant and animal inhabitants of the reef. And now nature had removed the sea urchin!

Dr. Carpenter and Dr. Ogden were quick to grasp the opportunity. Supported by Sea Grant seed money, they obtained data almost immediately following the February 1984 die-off from sites which they had previously studied between 1980 and 1983. Initial data showed that the removal of sea urchins led to a significant decrease in algal primary productivity (hypothesized to be the result of lack of nutrient input formerly provided by the sea urchins) and that, due to increased food resources, herbivorous fishes were grazing more intensively.

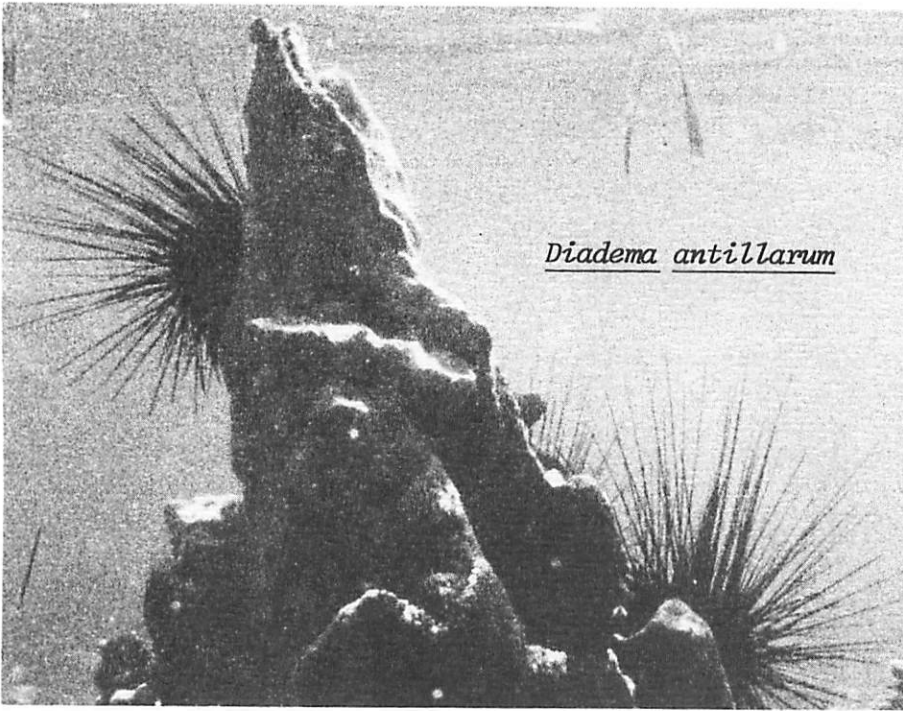
Provided with further Sea Grant support, Dr. Carpenter and Dr. Ogden spent the next year in a more detailed study of the sea urchin's impact on algae (standing stock, species composition, morphology, primary productivity), on herbiv-

orous reef fishes and on coral-reef component abundance.

Within five days of the die-off, algal biomass increased by 20%. It continued to increase until it was 5-6 times higher than before the die-off. Consistent with previous experimental results, algal primary productivity, both per unit area and per unit plant biomass, decreased following the die-off. Productivity per unit plant biomass remained low for 22 subsequent months. The productivity per unit chlorophylla, for example, decreased and remained at levels characteristic of communities grazed only by fishes. Macroalgal species which were rare before the die-off now dominate many shallow-reef areas, and large plants of green, brown and red algae are common in areas previously inhabited by diminutive algal turfs.

These algal changes have persisted despite increased grazing by herbivorous fishes and documented increases in the population sizes of surgeonfishes and parrotfishes over reef sites. Although estimates of total herbivorous-fish populations have been variable, they are consistently higher than pre-mortality estimates. Continued monitoring will be required to determine if this will lead to increased catches by fishermen.

Although there has been an increase in the populations of herbivorous fishes, macroalgae have become dominant in many areas. Much of the macroalgal biomass is dislodged by wave action and may be utilized by detritivores such as conch in the lagoon, although there is



*Diadema antillarum*

no evidence so far of an increased population of detritivores. Most of the algal biomass is exported from the reef system. The transition from a reef dominated by corals and algal turfs, to one dominated by macroalgae, may result in a functional change in the whole reef system from a grazing based to a detritus-based food web.

A recent comparative study of reefs throughout the Caribbean suggested that high sea urchin populations may result from intense fishing of their competitors and/or predators. The

present study suggests that the removal of the sea urchin leads to short term increases in some fish species, but that the structure and function of the reef community is altered considerably.

In the short term, from the point of view of fishery management, the catastrophic die-off of 1984 was ideal natural management. However, the long-term consequences of an altered reef ecosystem are unclear and may result in reefs of considerably less value, both aesthetically and economically.

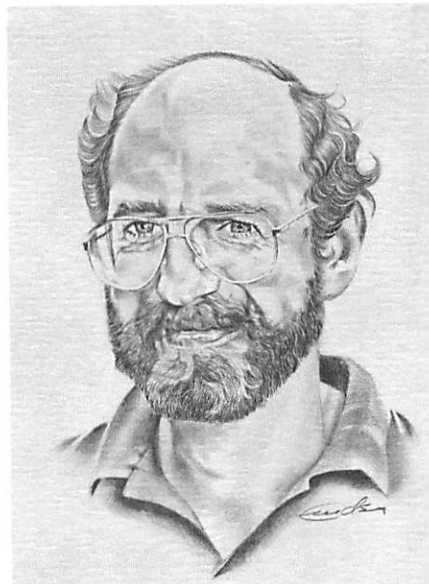
# Assessing Tropical Artisanal Fisheries.....

## A Practical Approach

The yield of a fishery is predicted by means of a "yield model" based on such life history variables as rates of natural increase, mortality, and growth. Traditional models are derived from, and apply to, single species. However, application of such models to tropical coral-reef systems, with their multi-species populations, is difficult, due to the immense body of data required and to the fact that available statistics for these fisheries are often on the family, not the species, level. What is needed is a yield model which will use these data and which will be of practical use in stock assessment of multi-species fisheries. Dr. Richard Appeldoorn's objectives are to develop such a yield model, to validate the model on a "cluster" of related species, and to test the underlying ecological assumption of the model. In the first year of his 3-year project, Dr. Appeldoorn has accomplished the first of his objectives.

The project involves using taxonomic groupings above the species level as the unit of stock assessment. This is based in turn on the premise that the larger group can be treated in important respects as a single species. Dr. Appeldoorn believes that two lines of argument support the plausibility of this premise. First, empirical studies have shown that critical growth parameters for related species cluster ac-

ording to a particular relationship and that mortality can in turn be estimated using these parameters. Thus, variation in life histories among related species, particularly variation in important population parameters, is contained within a common pattern.



*Richard S. Appeldoorn, Ph.D.*

The second line of argument is based on guild theory in ecology. Guilds (clusters) of coral-reef fish often show taxonomic affinities at the family level. Work on one such guild—damsel-fish—showed that members of different species had similar requirements for habitat and space and that they defended territories against other guild members without distinction of species. The work also showed that recruitment to the guild was essentially non-specific. Functionally, then, one species could be substituted for another without great ecological change.

A higher taxonomic unit will, Dr. Appeldoorn acknowledges, involve a loss of information as compared with a species unit, but the primary purpose of his approach, he says, "is not to model the fine details of the system, but to generate useful assessment information from existing lumped-species data." In addition to employing existing data, Dr. Appeldoorn's approach, unlike the traditional single-species approach, will account for species interactions, since these are integrated within the structure of the ecological guild.

The guild of haemulids (grunts) was chosen to test the model because of the commercial importance of this family in Puerto Rico; because a considerable amount of ecological work has already been reported on the family and on certain of its species; because members of the family have been shown to have significantly similar life histories, and because all fishery statistics on grunts from Puerto Rico are lumped into a single category. Thus, the family is a prime example of the kind of situation in which assessment in multi-species units would be recommended.

Field work is now in progress to generate the parameters necessary for running the model and comparing results with the sum of single-species models for each species within the cluster. Length-frequency curves will be generated for



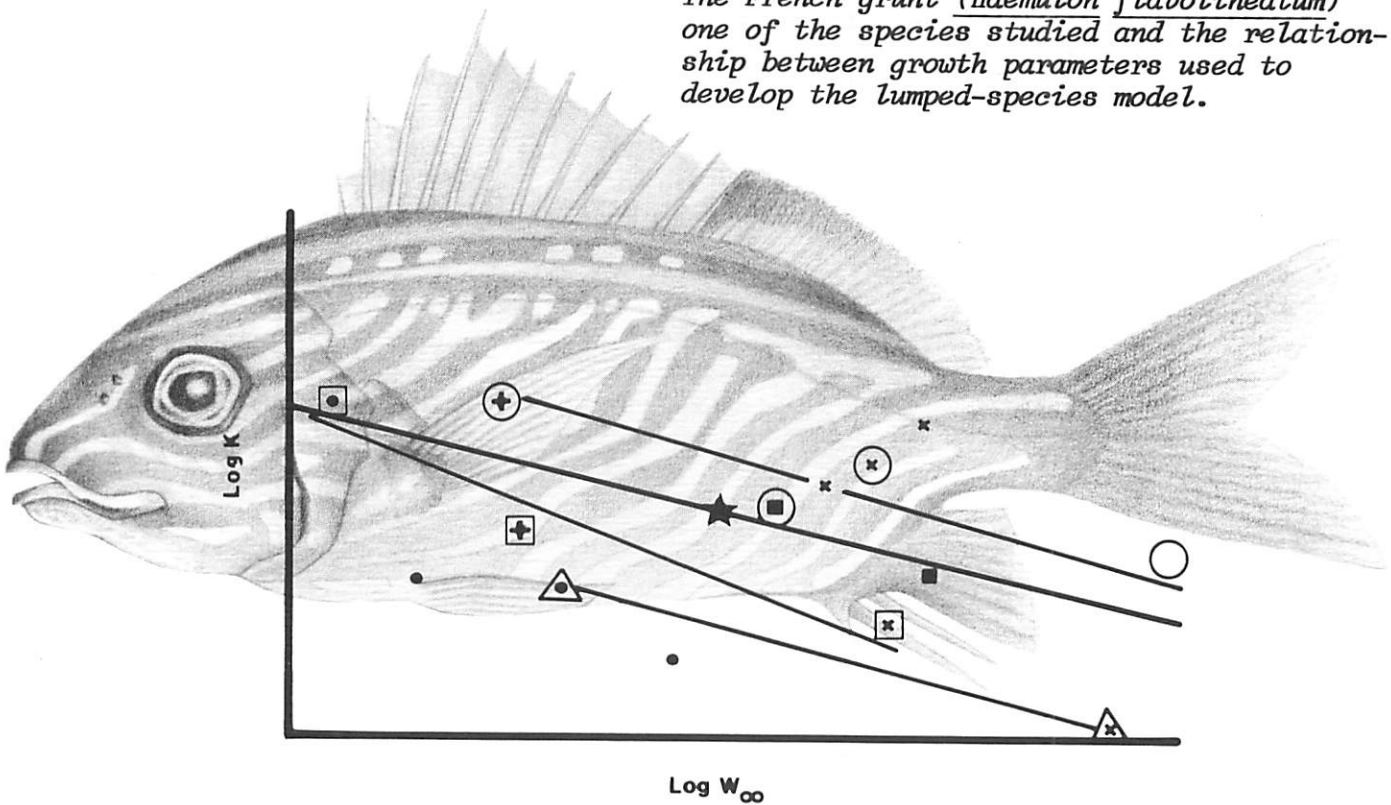
at least the three primary species in the guild—French, blue-striped, and white grunts—and these will be analyzed by length-frequency techniques for growth and mortality. Visual census is being used to determine abundance. These procedures will provide the information necessary for pooling individual species assessments for comparison with the lumped-species model. As a

corroborative step, similar data from the Puerto Rican Commercial Fishery Laboratory are being collated and analyzed.

A successful model for lumped species will provide stock assessment of grunts for La Parguera and the Puerto Rican Fishery at Joyuda. It will also provide a basic model for lumped species in other parts

of the world, requiring fewer data and therefore easier and less costly data collection. Dr. Appeldoorn believes that the role of the researcher in fishery management is to obtain and disseminate knowledge crucial to maintaining the productivity of the resource and developing policy that maximizes the benefits to fishermen, retailers, and consumers.

*The French grunt (Haemulon flavolineatum) one of the species studied and the relationship between growth parameters used to develop the lumped-species model.*

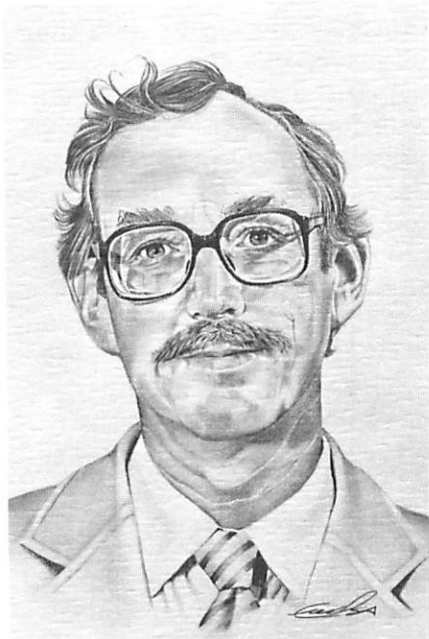


# The Seiche Phenomenon

**"S**eiche: stationary wave oscillation with a period varying from a few minutes to an hour or more (somewhat less than tidal periods) being dependent upon dimensions of basins in which it occurs. Seiches usually are attributed to strong winds, atmospheric pressure changes or seismic disturbances and are found in enclosed bodies of water or superimposed upon tidal waves of open ocean." (Ocean and Marine Dictionary).

Coastal seiches have been the subject of Dr. Graham Giese's research, much of it sponsored by the UPR Sea Grant Program, since he first noted their presence along the broad shelf off Isla Magueyes in 1968. Also in 1968, local fishermen were reporting encounters, on the shelf, with erratic currents which seemed unrelated to tides or winds.

Dr. Giese's earliest investigations disclosed that coastal seiches came in fortnightly groups, with greatest activity seven days after new full moons. He discovered that variation in activity from one fortnight to another was dependent on the amplitude of the preceding spring tide, while seasonal variations were correlated with surface water temperatures in the sea south of Isla Magueyes. By 1984, he was able to report that "it has been amply demonstrated during the course of this study that the approximately hourly current and sea level oscillations observed in the coastal waters of southwestern Puerto Rico are the result of fundamental shelf seiching." Dr. Giese now had



*Graham S. Giese, Ph.D.*

sufficient understanding of the seiche phenomenon to estimate the extent of its contribution to sea levels and currents and to construct curves of seiche activity enabling prediction of the probability of such activity on any given day.

Concurrently, Dr. Giese had been speculating about the causes of coastal seiches. Why the correlation of seiche activity with lunar phase (which suggests a relationship to the semidiurnal tide), since the local tide is strongly diurnal? And why the seven-day phase lag?

The first question led Dr. Giese to wonder whether there might exist an internal (deep water, hence invisible) tide. In 1972, with existing experimental evidence for the arrival of such tides at the slope of the Isla Magueyes shelf, he suggested "a causative relationship" of seiche activity to internal tides. By 1983, Dr. Giese had obtained evidence that the

seiches were not caused by tides directly, but rather by internal waves produced, in turn, by tides. In his words, he had "strong circumstantial evidence that the seiching is initiated by incoming tide-generated internal solitary waves and there is good evidence that such internal waves exist in the Caribbean Sea."

But where in the Caribbean Sea do such waves originate? It seemed reasonable to suspect the southeastern part of the Sea, where semidiurnal tide ranges are the greatest. Accordingly, Dr. Giese prepared scatter diagrams of daily seiche activity at Isla Magueyes and plotted these against maximum falling-tide ranges at Punta Gorda, Venezuela, where tidal records were available from the National Ocean Service. Magueyes seiche-activity followed Punta Gorda tide-range maxima by six days, close to the seven-day phase lag previously noted and presumably the time required for the internal waves to reach Puerto Rico!

Dr. Giese now sought field confirmation in the form of direct comparison of seiche activity with internal waves arriving at the shelf. A current meter was moored deep on the slope where the characteristics of arriving internal waves were measured with a thermistor string and a tide recorder located on Magueyes. Two additional meters were placed sub-surface on the shelf's edge. Measurements were made during the fortnight following the perigeon new moon, when seiche activity should be at its greatest and covering as much of the period

of maximum activity as possible. These data were analyzed and compared with measurements of seiche activity during the same period.

Alas, the course of true science, like the course of true love, is not always smooth; the results failed to confirm the causal relationship so strongly suggested by his earlier investigations. Why? Indeed, why had his earlier scatter diagrams shown that a large tidal range at Punta Gorda, while necessary, was not a sufficient condition for the occurrence of high seiche activity at Magueyes six days later? What factor or factors besides internal tides were influencing his results? Season? Transit? Coupling with coastal water, with consequent dissipation? Variable physical conditions in the area of internal wave generation? Were variations in currents and/or water density at the point of origin responsible?

Using airborne radar data, Dr.

Giese and Dr. Peter Black of NOAA identified the generation site of internal waves arriving on the Puerto Rican shelf off Isla Magueyes as two seamounts, 63 kilometers apart with peak depths of less than 400 meters, on the southern part of the Aves Ridge. Making use of Aves Ridge current-meter data from the Navy and Isla Magueyes tidal information from NOAA, Dr. Giese will compare expected-to-actual seiche activity, and then compare the differences to current patterns over the seamounts. Dr. Giese believes that when adequate data become available, water density will also be shown to be connected with seiche activity.

Through this Sea Grant funded project, Dr. Giese has been able to arrive at methods and technology which have been applied in an important study, in the Philippine Islands, which supported the hypothesis that seiches are indeed excited by internal waves. Additionally,

Dr. Giese has been in contact with researchers in Spain and in China where conditions appear to be similar to those of his own study.

Dr. Giese's study interacts with two other research projects sponsored by Sea Grant: Dr. Jorge Corredor's study of nitrogen loading from sewage discharge can be compared to natural nutrient enrichment resulting from mixing on the upper slope due to internal-wave activity; and Dr. Douglas Shapiro's grouper work, in particular, the effect that seiche-produced currents may have on the dispersion of fish eggs and larvae.

In the longer run, Dr. Giese's work will help professionals to predict seiches and currents, thus reducing the impact of coastal floodings, alerting the shipping and fishing industries to potential navigational hazards, and protecting offshore engineering projects from unexpected disasters.



*Isla Magueyes, La Parguera, Lajas, Puerto Rico*

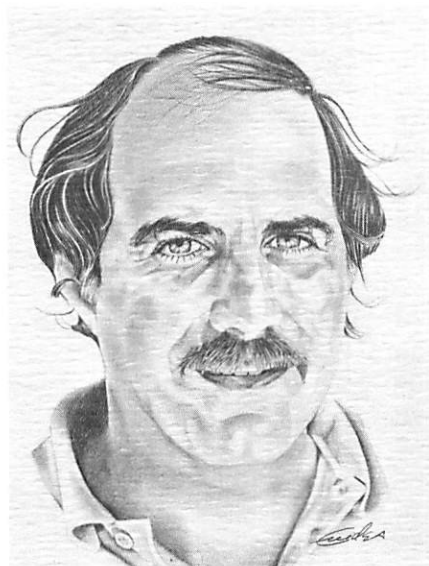


# Tropical Algae Species..... A Future Cure for Cancer?

Could blue-green algae be an answer for thousands of cancer patients? The National Cancer Institute is interested enough to take a serious look at the possibility. Marine algae have topical cleansing, anti-fungal, anti-neoplastic, anti-fertility, and anti-viral properties, as well as a long history in folk medicine. Blue-green, green, brown, and red algae are represented by hundreds of species in Puerto Rican waters. The University of Puerto Rico's high-quality facilities and rich marine environment have already fostered five studies which have shown Puerto Rican seaweeds to be rich in antibiotics and cell toxins.

The previous studies, however, have concentrated on the biological properties of water-soluble algal compounds. The properties of lipid-soluble extracts were known only to a lesser degree. The need to identify, isolate, and biologically characterize the active lipid-soluble compounds in Puerto Rican seaweed as potential biomedicinals is apparent.

Dr. David Ballantine and Dr. William Gerwick, whose research interests were complementary, made up the team for an in-depth study of biologically active Puerto Rican seaweed. Dr. Ballantine, working in the laboratories of the UPR Department of Marine Science, identified and studied the biological activity of seaweed extracts. Dr. Gerwick, who previously worked in Puerto Rico collecting and testing crude



David L. Ballantine, Ph.D.

extracts and who is currently at Oregon State University, was responsible for chemical analysis of the bioactive compounds.

Primary objectives of the project were to produce crude extracts of Puerto Rican seaweeds having pharmaceutical promise, to isolate the bioactive principals and to describe the chemistry structurally using spectro-chemical techniques. Compounds were made available to researchers, government agencies, and pharmaceutical and agrichemical companies.

Working over a two-year period, a variety of marine habitats were sampled and specimens of 122 species were collected. Of the species assayed, 65 showed at least minimal biological activity. The majority were red algae, although greens, browns, and blue-greens were represented.

From these collections, sixteen algal species were targeted as having interesting chemistry or high bioactivity in their crude extracts. Of these compounds, eight were previously unknown natural products. Two of these have been identified as potentially useful antibiotics and two others showed a high level of toxicity to cultured cells, a necessary characteristic of anti-cancer drugs. An interesting side result was the recognition of high variability in biological activity of some algal species at different times of the year and variability in activity between different localities.

Dr. Gerwick's chemical analysis of a Puerto Rican blue-green algae disclosed a new natural product which he has named hormothamnione. In laboratory experiments, hormothamnione has shown itself "an exceptionally potent toxin to cancer cells." It is now being tested by a pharmaceutical company.

This Sea Grant sponsored study has provided background data for future research in the field. Increasing public pressure and medical concern for effective, reliable treatment of numerous illnesses, including cancer, lead to subsequent stages of development. Future work will include the further chemical characterization of active algal secondary metabolites and, ultimately, research into their biosynthesis.

*Cottoniella filamentosa*  
A deep red algal species  
with antibiotic activity



# PROGRAM DEVELOPMENT FUNDS



In a world of ever-changing environmental conditions, the UPR Sea Grant Program has the ability to respond quickly and effectively to new research needs and to educational and community needs. Most projects require a minimal investment for a long-term benefit, while others are to determine the feasibility of more in-depth research and programming. Although the Program Development Funds or fund-

ing is limited, over the years the Director and his Special Advisory Committee have selected projects that meet both the needs of the community and Sea Grant program priorities, thus increasing public awareness while enhancing program credibility.

Projects, some of them collaborative efforts, cover a broad spectrum of activities. These range from investigations of potential research topics in the marine, social, and economic sciences, to testing new fishing gear,

education and training, and assistance to public awareness programs; always emphasizing new trends and developments in the marine world. All projects are carefully monitored for effectiveness and responsiveness to identified needs.

Program Development funds used for these new and innovative projects enable UPR Sea Grant Program to stay in the mainstream of scientific research, education, and extension.

R. Andrew Cameron, Ph.D.

Department of Marine Sciences - UPR

The influence of the recruitment process on the population structure of ecologically and commercially important sea-urchin species in seagrass beds.

José M. López, Ph.D.

Center for Energy and Environment Research - UPR

Testing, demonstrating, and establishing the use of Fish Attracting/Aggregating Devices (FADS) in Puerto Rico.

Richard Appeldoorn, Ph.D.

Department of Marine Sciences - UPR

Investigation of deep-water shrimp resources in the channel between Puerto Rico and Mona Island. Identification of deep-water shrimp species, estimation of abundance and population characteristics.

John C. Ogden, Ph.D.

West Indies Laboratory

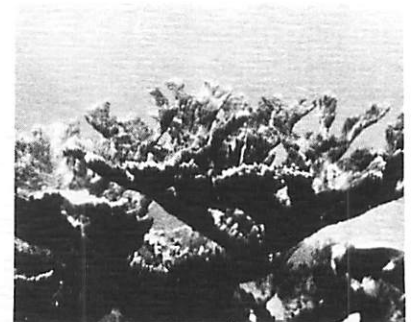
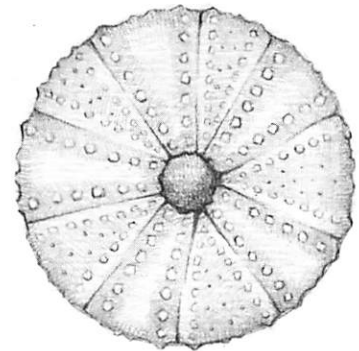
Fairleigh Dickinson University

Initial study of recent mass mortality of the sea-urchin, Diadema antillarum, establishing baseline post-mortality information.

Gladys Escalona de Motta, Ph.D.

Medical Sciences Campus - UPR

Survey of Ciguatera cases in Puerto Rico, determining the causes of the increase in reported incidence since June 1981. Review of symptomatology and possible seasonality.



Manuel L. Hernández-Avila, Ph.D.  
Department of Marine Sciences - UPR  
Development and printing of, Needed: An Educational Program in Tropical Fisheries concerning the need for a School of Tropical Fisheries.

Idelisa Bonnelly de Calventi, Ph.D.  
Centro de Investigaciones de Biología Marina (CIBIMA) de la República Dominicana  
Development of a methodology for the integrated study of ecosystems and their interaction with seagrass, determining appropriate limits of National Marine Parks.

Richard S. Appeldoorn, Ph.D.  
Department of Marine Sciences - UPR  
Assessment of deep-water resources and evaluation of passive gear around Puerto Rico and the Virgin Islands, using the deep-submersible Johnson Sea-Link. Joint research project of UPRDMS, Sea Grant, and National Marine Fisheries Service.

Dr. Douglas Shapiro, Ph.D.  
Department of Marine Sciences - UPR  
Study of egg dispersal and water movement for coral-reef fish.

Luis R. Almodovar, Ph.D.  
Department of Marine Sciences - UPR  
Study of the potential enhancement and aggregation of fishery resources from data gathered through the placement of Fish Attracting Devices (FADs).

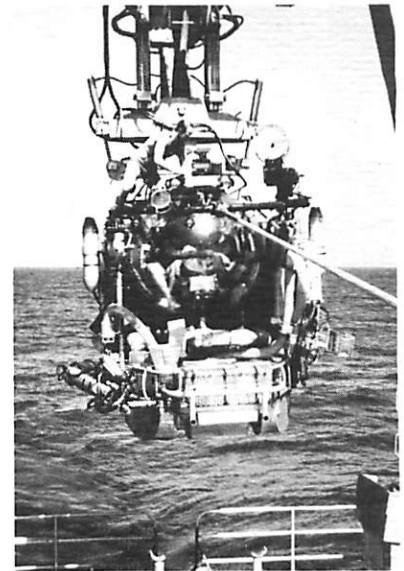
Herminio R. Rodríguez Morales  
Colegio Regional de Aguadilla - UPR  
Location of 19th-century maritime ports on the northern coast of Puerto Rico, determining their historical and archeological importance.

Thomas R. Tosteson, Ph.D.  
Department of Marine Sciences - UPR  
Study of the role of microbial adhesion-enhancing macro-molecules in the sedimentation of organics in reef-front environments.

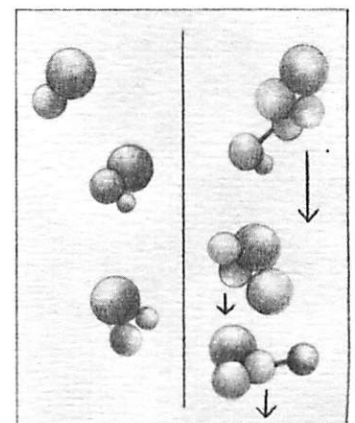
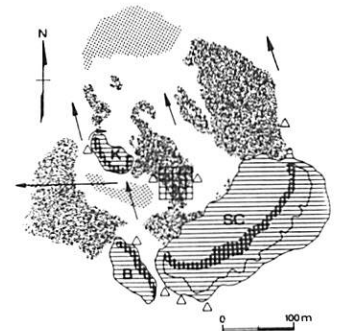
William N. McFarland, Ph.D.  
West Indies Laboratory  
Determination of causes and significance to the Caribbean fishery of the periodic recruitment of "grunts" from the zoo-plankton.

Gustavo V. Barbosa Cánovas, Ph.D.  
Department of Chemical Engineering - UPR  
Study of processes to improve the acceptance and utilization of locally harvested tilapia.

Mark Hixon, Ph.D.  
College of the Virgin Islands  
Testing of the assumption that population sizes of resident reef fishes are determined by availability of shelter sites.



SAN CRISTOBAL REEF



David Ballantine, Ph.D.

Department of Marine Sciences - UPR

Preparing a color guide to marine plants of Puerto Rico, photographing local algal species with emphasis on the more common representatives.

Dallas Alston, Ph.D.

Department of Marine Sciences - UPR

Study and evaluation of aquaculture technology by commercial shrimp producers in Ecuador and Panama and the identification of technology transferable to Puerto Rico.

Andrew S. McGinty, Ph.D.

Department of Marine Sciences - UPR

Determining whether a multiple stocking and harvesting system is viable for producing marketable prawns and tilapia on a sustained basis.

Ricardo Cortés, Ph.D.

Department of Marine Sciences - UPR

Economic evaluation of overall production potential and dollar value of fish-poultry-shrimp polyculture and determination of desirable species combinations for non-intensive aquaculture practices.

Manuel L. Hernández-Avila, Ph.D.

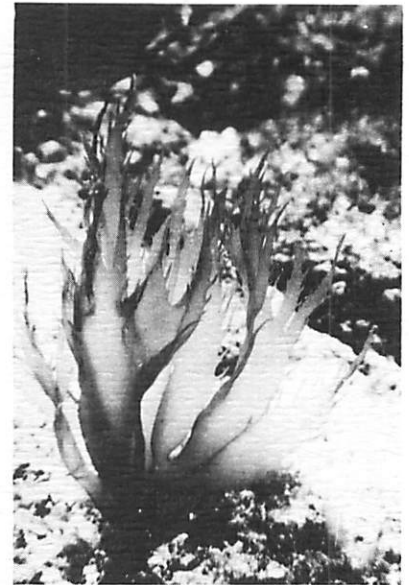
Department of Marine Sciences - UPR

Cooperation of professors of the Department of Marine Sciences in the teaching of courses at the Universidad Autónoma de Santo Domingo and in development of a master's program for the Marine Biology Center (CIBIMA). International initiative: Dominican Republic

Marine Advisory Services

Sea Grant - UPR

Outside evaluation of Marine Advisory Services with recommendation for improving the quality of the extension services.



# MARINE ADVISORY



## Marine Extension in Action!

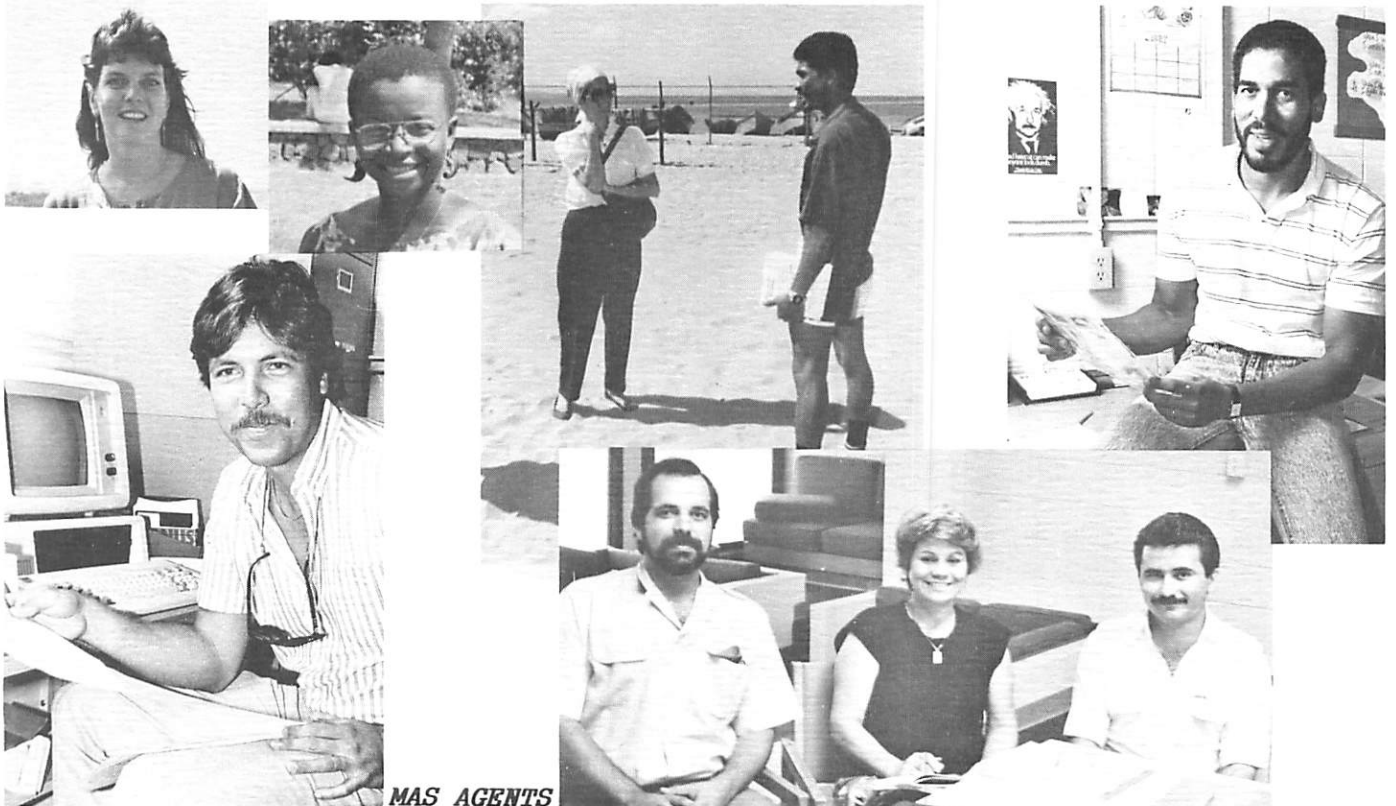
Puerto Rico and the U.S. Virgin Islands, as many other islands and nations in the Caribbean, are becoming increasingly dependent on tourism, industry, and commerce, sectors that rely on the space and landscape of the coastal environments. In the last decade, the sea and the coastal zone have turned into our vital environment. Our largest urban centers dwell in coastal areas, and the present and future growth of the construction industry and the real estate business lies in the coastal plains.



*Manuel Valdés-Pizzini, Ph.D.*

There is a need to stimulate the use of available but untapped coastal and marine resources, and solve the user's conflicts over those resources which are over-utilized. MAS is the arm of the UPRSGP providing the transfer of knowledge and technology to the marine resources users coping with the island's growth and changes.

Marine Advisory Services from the UPRSGP and VIMAS at the College of the Virgin Islands, provide the needed educational and extension services to the



**MAS AGENTS**

*Clockwise: Nathalie Peter, Laverne Ragster, María B. Riesco, Ruperto Chaparro, Jerry González, Saúl Wiscovich, Leonides Carrero, Santiago Arias*





users of a small archipelago of more than six populated islands and various islets. Our services are geared to serve almost 4 million people, and an additional 1.8 million tourists that use our coastal resources.

Dr. Manuel Valdés Pizzini is Coordinator of Sea Grant's Marine Advisory Services, a crucial component and the link between the community, the researcher and the problem.

*Maria Matos, MAS Secretary*

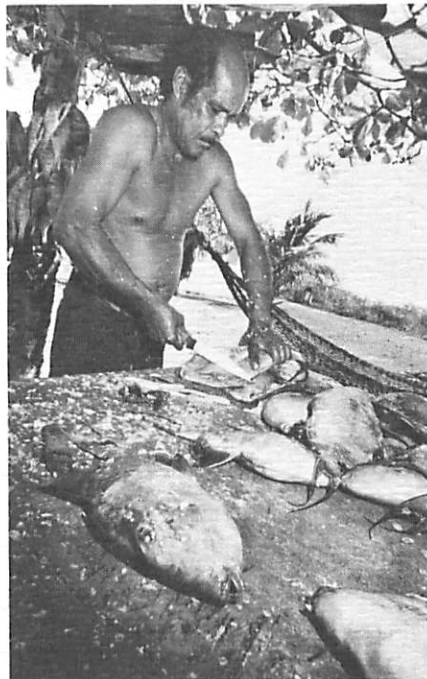
**W**hile modernization of Puerto Rico's industrial and agricultural sectors progresses, and tourism peaks on the Island, fishing remains an artisanal (small-scale) activity as it was under Spanish rule, when fishing was secondary to agricultural interests.

While a fisherman's profession is insecure and variable, he has knowledge and skills that are admired in folklore and legends, today, as traditional virtues. Fishing also provides an occupation to people who, by choice or necessity, have not been assimilated into industry.

The fishing communities of Puerto Rico, and especially those of the Virgin Islands, are in competition for space with recreational areas, vacation homes, and the burgeoning demands of tourism. It is difficult for the fisherman to maintain his trade in an economy that promotes modernization and development.

These artisanal fishermen are the target of Marine Advisory Services; educational, training, and assistance programs. MAS staff offers expertise in im-

## The Fisherman



proving the old and discovering the new. As an example: shark, a long-term resident of Caribbean waters has never been fully appreciated by consumers. MAS advisors have introduced this underutilized species through training sessions, work-

shops, pamphlets, TV, radio spots and demonstrations. Increased acceptance of shark is demonstrated by its utilization in fast-food and seafood restaurants and fish markets. The increased demand has created a need for new ways of fishing with up-to-date gear and fishing techniques. MAS workshops on longlining for shark and the use of vinyl-coated traps instead of the traditional wire ones have shown fishermen how to save a significant amount of money each year.

Other workshops have shown them the positive effects on the fish population that would result from the use of traps with a quarter-inch larger mesh.

Another underutilized species, tuna, is available on Puerto Rico's northwest coast and has had an increasing commercial market. However, lack of public acceptance had curtailed expansion of sales. The publication of Atun Fresco: Recetas (Fresh Tuna Recipes) produced increased sales, but fishermen are still selling a major portion of the tuna catch to local canneries under an agreement worked out with MAS assis-

tance. Is there another use for tuna? One that will be more lucrative? Tuna as a bait for commercially important snap-

pers and groupers? (A MAS needs assessment project, uncovered this latter possibility; and MAS is testing it on limited

basis as a potential market, not only in Puerto Rico and the Virgin Islands, but elsewhere in tropical waters.)

Nationwide seafood consumption has been increasing at a rate of 6% per year. That national trend is also reflected in the profile of the Puerto Rican consumers. Puerto Ricans consume, on the average, a total of 16 pounds a year, higher than the 12 pounds of the national average. Unsophisticated and uninformed consumers are leaving the way open to a new breed of well-informed seafood eaters who are constantly requesting information on technical, culinary, and health aspects of their potential food intake. Marketing research shows that consumers are more aware and interested in health related qualities of fish. New scientific data on nutritional value, control of cholesterol, Omega 3 fats, and the effect of ciguatoxins, are among the most significant health related issues that the new consumers are eager to know about. To a large extent, the development of "sophisticated consumers" has been a successful story of many Sea Grant Programs throughout the nation, including ours. MAS has devoted significant efforts in the development and enhancement of handling and marketing techniques, and consumption increase in Puerto Rico. During the past six years, our program educated consumers on the value of underutilized species. In coordination with other agencies and programs such as Cooperative Extension Service (CES) and CODREMAR, MAS turned these species into household words.

## Seafood Promotion and Technology



*Underutilized Species MAS Workshop*



As an integrated project, MAS's efforts with one sector of the community impacts on another, assisting fishermen with underutilized species, for example, while exposing the consumer to the benefits of shark and tuna. Fish festivals, boat shows, "Fisherman's Week" festivals, aquaculture extension services, shopping malls, and supermarkets all offer a forum for marine advisors to make personal contact with the public; answering questions and providing accurate information.

Consumer and retailers alike need to be educated. Improved market conditions will no doubt increase consumption and profits. Future "hoteliers" have benefited by the expert advice of MAS staff on the identification and purchasing of fish and shellfish. Proper handling of fish by restaurateurs, supermarket managers, health-department personnel and wholesalers is a major concern of MAS because of the potential impact on thousands of consumers; one has to experience only one tainted fish never to want to eat fish again. Proper hygienic handling can prevent this tragedy.

MAS's commitment to exchanging knowledge throughout the region has led to the sharing of its experience with shark and tuna with the United Nations Nutritionists in Trinidad and to the sharing of information about handling, preparing, and marketing with Caribbean Education Specialists in Jamaica.

MAS educational activities cover a broad spectrum. Through lectures, educational materials, training sessions, field trips, technical advice, and demonstrations, MAS has increased awareness and changed attitudes. Fishermen, the prime objective, have received assistance through workshops and activities aimed at improving safety standards, navigational skills, fish-handling techniques, and the use of better gear aboard fishing vessels. To increase awareness of the importance of fish management, MAS has prepared La Pesca Artesanal y las Asociaciones de Pescadores en Puerto Rico. (Small-Scale Fishing and Fishermen's Associations in Puerto Rico). This published report takes an

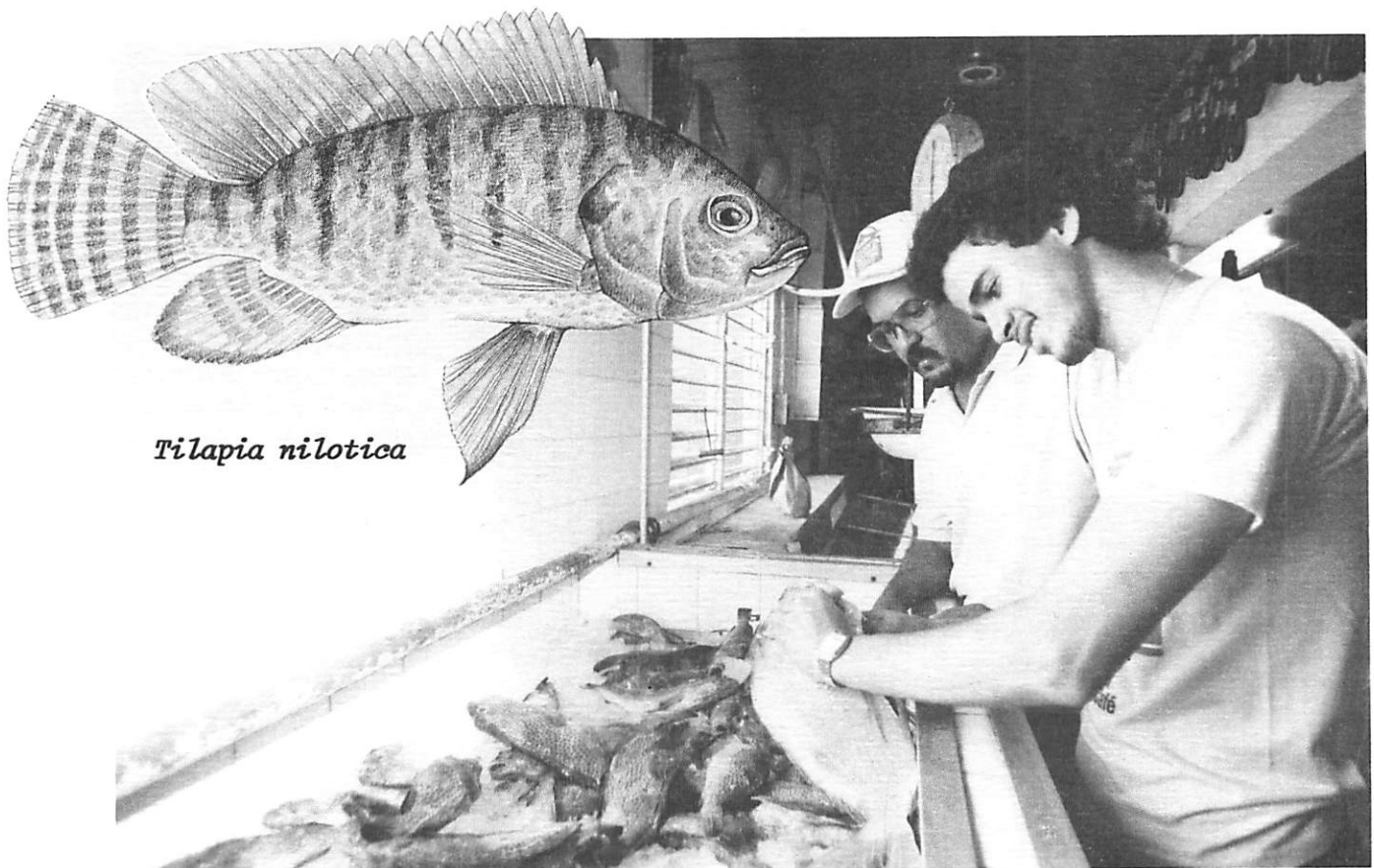
## Education

objective view of the social and economic structure of organized fishing associations and makes recommendations for improvement and continued existence.

Students at elementary, secondary, college, and technical schools in Puerto Rico and the U.S. Virgin Islands have received information on career opportunities in marine sciences, coastal zone management, science fairs, preparation of fish and shellfish, and nutritional values of fish. MAS believes in a hands-on approach to marine education. Advisors have visited dozens of schools in the past two

years. MAS has coordinated an architectural-design contest at the UPR School of Architecture to create interest in coastal engineering and it has issued a technical manual for Environmental Assessment Report analysis. Marine Advisory Service staff, as experts in the field, coordinate activities with the Coast Guard Auxiliary, CODREMAR, the Right to Work Administration, mayor's offices, fishermen's associations, and civic clubs.

Monthly aquaculture workshops at the Lajas Experimental Station, coordinated by MAS and the Department of Marine Sciences, assist potential growers of fresh water prawns and tilapia in meeting the increasing demand for seafood.



*Tilapia nilotica*

*Proper Fish Handling Techniques*

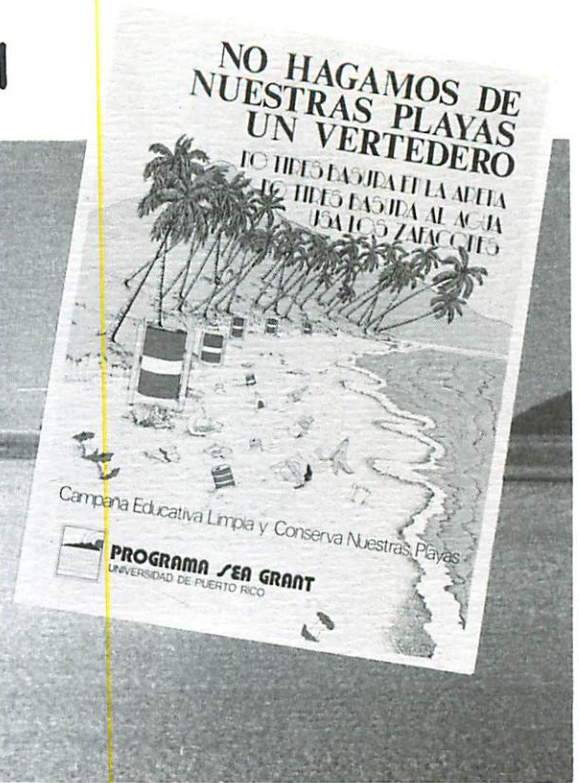
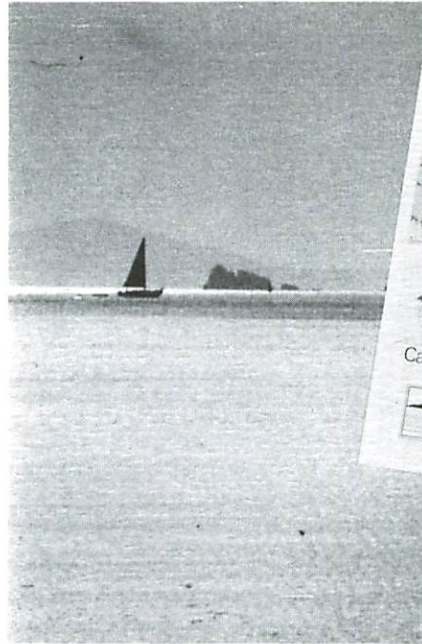


With almost guaranteed good weather year-round, Puerto Rico and the Virgin Islands are experiencing not only increased tourism, but increased use of recreational resources by residents. As marine recreation has become more popular as a year-round activity, we have seen a somewhat haphazard approach to the development of facilities for boaters, bathers, and fishermen. Piers and launching ramps appear overnight, small deserted beaches are accessed by boat or unpaved roads, recreational fishermen are catching the same fish that are the livelihood of artisanal fishermen. Coordinated planning of facilities, lodgings, and services is essential to good development.

The weekend boater, using anything from an outboard-powered *yola* to a cabin cruiser, is competing for the same waters with sailboaters and windsurfers and, in some cases, swimmers. Safety and navigation are crucial skills for all of them. Life-saving courses, installation of beach buoys, and navigation workshops have been available through MAS efforts. In the Virgin Islands, even SCUBA divers are cautioned on the importance of preserving their undersea world.

Marine recreation benefits not only an estimated 100,000 sport fishermen, but also those who live in coastal communities. Despite the positive economic benefits of this, the lack of

## Recreation



comprehensive information is a problem. The U.S. Virgin Islands Marine Recreation Services and Facilities Directory, published by Sea Grant, will have a companion guide to Puerto Rico listing direct services such as guides, tournaments, fishing clubs, charter boats, marinas, suppliers, and launch ramps; and indirect services such as lodgings, transportation, campgrounds, and restaurants.

UPRSGP is presently working in two projects funded by the National Marine Fisheries Service (NMFS). These are: "Developing Marine Recreational Fishing (MRF) in PR/USVI" and "Evaluating Infrastructure Needs for MRF Development in PR/USVI", both

in collaboration with the Institute for Coastal and Marine Resources (ICMR), East Carolina University and North Carolina University Sea Grant Program (NCSGP).

Saving our shores from man-made pollution which many accept as normal, is a major component in the effort to protect and preserve our valuable marine environment and recreational resources. MAS advisors are increasing awareness of beach environment through a beach conservation project which includes publishing a conservation fact sheet, informing legislators and public officials of the importance of beach maintenance, and organizing community efforts through civic organizations.



Government agencies and private/civic organizations are an essential part of MAS's efforts to expand contact with the public. As advisors to the Environmental Quality and Natural Resources Committee on the Legislature, MAS staff have the opportunity to offer recommendations on potential legislation related to fisheries, marine recreation and conservation. At the same time, MAS is able to provide the Caribbean Fishery Management Council (CFMC) with current information on the needs of the fishing community and to inform the constituency about Council plans. Transfer

# Linkages

of knowledge and community education are successful where positive working relationships have been established. Over the years, MAS has developed strong ties with the Corporation for the Development and Administration of the Marine, Lacustrine, and Fluvial Resources (CODREMAR), the Cooperative Extension Service (CES), the U.S. National Weather Service, and the Department of Natural Resources (DNR). Workshops, fairs, and educational literature are only

a few of the joint efforts of MAS and those agencies.

MAS is part of the Southeast Sea Grant Marine Advisory Services (SESGMAS) Network. SESGMAS is one of five Sea Grant Networks that are used to pool regional expertise and resources to solve state, regional, and national problems. This particular network covers eight states from North Carolina through Texas and the Commonwealth of Puerto Rico. Through this network, publications, research personnel, and audio-visual materials are shared by each of the states in the network and/or with any other Sea Grant program.

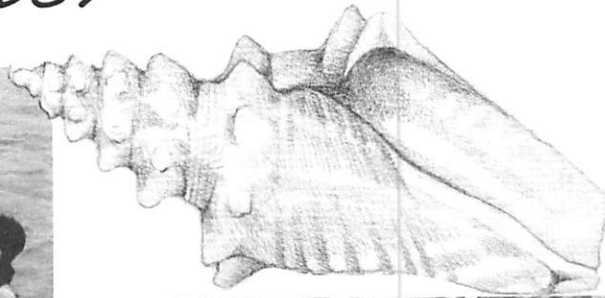
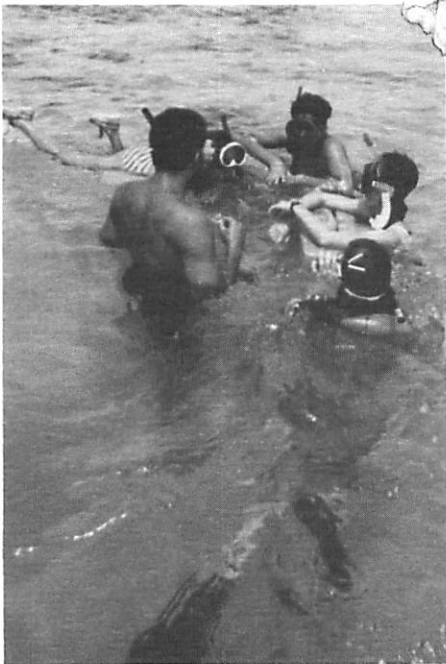


MAS ACTIVITIES	AUDIENCE
Agriculture, Fishing & Industry Promotions (3)	13,171
Commercial Fishing Methods Workshop (3)	25
Coastal Community Festival	4,000
First Shark Festival	2,000
Field Trips, Lectures Workshops On Marine Education For Teachers & Students (12)	310
Demonstrations/Promotions Of Underutilized Species For Health Specialists & Food Professionals (2)	420
Seafood Demonstrations (1)	800
Seafood Workshops (4)	125
Seminar & Contest On Marine Art & Literature	329
Marine Careers Seminars (3)	256
Aquaculture Demonstrations (2)	5,200
Aquaculture Open House (24)	400
Navigation Safety Workshops (3)	50
Nautical Rally	31
Science & Technology Workshop On Coastal Resources Management	23
Architectural Design For The Improvement Of The Coastal Zone (Seminar, Contest & Presentations At The UPR School Of Architecture)	85
Workshop On The Sea As An Art Resource	30
Diver's Day Symposium & Beach Clean-Up	20
Cajaya Marine Camp (2)	64
Workshop On Seafood Handling & Ciguatera Poisoning (4)	87
TV & Radio Programs (4) Estimated Audience Of:	8,000
<b>TOTAL</b>	<b>107,426</b>

# CAJAYA MARINE CAMP



## A Close Look at the Fascinating World of Marine Sciences



In the myriad of educational activities, summer camps and festivals in Puerto Rico, all year long, there is a lack of perspective and commitment towards the development of programs related to marine resources, conservation and utilization. The marine camp CAJAYA (which means shark in Arawak) provides the opportunity for 25 to 30 children to be exposed to the fascinating world of marine sciences.

During the last eight years, CAJAYA has been the instru-

ment through which approximately 285 students learned to appreciate, preserve, and protect marine resources. In the process, they also become spokespersons of acquired ideas and information by disseminating the learned materials in their schools and communities.

In the USVI, marine agent Nathalie Peter, has developed an offspring of CAJAYA, Kids and the Sea (KATS). KATS is a community affair, in which the Rotary Club, VIMAS and the UVI get involved in providing nearly 42 kids with basic maritime skills, and the apprecia-

tion of the value of sea related activities in the Virgin Islands.

### Summer School, who needs it?

At the CAJAYA summer camp, the competition to participate is fierce. This camp, the culmination of the year's efforts with students and teachers, is held at La Parguera for one week in early June.

A morning is devoted to learning about a marine species, the afternoon to observing it in its natural habitats, and evening game time. Using Conozcamos el Mar, a textbook written and published by UPR Sea Grant,

students learned about marine habitats, the dynamics of oceans, and the wise utilization of coastal and marine resources. Hands-on experience in the field rounds out formal learning activities while in the evening the staff organizes educational games and art work (knot-tying, nautical card games, spelling with international navigation flags, and mounting of marine algae). Not surprisingly, most kids want camp to last longer and most want to come back next year. But Friday ends the week!

New enthusiasm abounds, the excitement holds until school opens and summer experiences are shared. Classmates catch the enthusiasm for marine sciences and the wise teacher

uses this new interest in many areas of the curriculum. Science Fairs often show the result of this summer learning program and inspire other students to apply to the next summer CAJAYA Marine Festival.

The goal of CAJAYA is to create an atmosphere where 11-15 year olds gain new experiences and increase their knowledge and appreciation of marine resources. Here are our future marine enthusiasts!

The camp is restricted in size by available housing which can accommodate only 30 students. Since many more apply, candidates are interviewed and selected by Marine Advisors. Camp fees of \$140 cover food and lodging. Most campers

are self-paying. However, there is financial support from the private sector for those who cannot afford to pay.

The CAJAYA Marine Festival, coordinated by MAS, is supported by the Sea Grant network. Everyone is involved; from teachers who attend Sea Grant workshops during the year, to the program staff who send out applications, to MAS advisors who select the campers, to faculty, students, and researchers of the Department of Marine Science who participate and contribute to the curriculum, to the Communications staff who provide resource material, to the private sector which provides financial support.



*CAJAYA Marine Summer Camp*



## The Sea as a Classroom

The sea as a source of knowledge for science? for history? for literature? for mathematics? for poetry? for Puerto Rican culture? Dr. Alida Ortiz, Project Director of the Marine Education Center (MEC) believes that, "The inspiration the sea can provide for teachers and students is endless." Marine education activities are available to all Puerto Rican schools, including mountain areas where the sea is far from sight.

Sea Grant's Marine Education Center at Humacao University College offers workshops, conferences, lectures, audio-visual material, posters, video tapes, slides, textbooks, pamphlets, etc. to teachers and students who either come to the Center or ask Sea Grant to visit their schools. Professor Edgardo Ortiz, faculty member of the Marine Biology Program has trained work-study students from the College. These students staff the Center and can respond immediately to questions and requests for materials. Resource materials are available on loan or, in some cases, given as teaching aids to Puerto Rican elementary and secondary school teachers. Having identified the absence of relevant educational materials as an obstacle to marine education, MEC has undertaken the production of written and audio-visual mod-



*Alida Ortiz, Ph.D., Director of MEC with students*

ules, guides, and TV programs. In some cases, materials are totally indigenous, but recognizing the wealth of educational materials produced by the Sea Grant network, the Center has also translated relevant teaching materials from other Sea Grant programs. The creation of Costas de Puerto Rico and The Sea as a Source of Inspiration — Music and Poetry (original video tapes) was a collaborative effort with the Department of Communications at HUC. These tapes were dubbed to English and shown at Sea Grant Week 1987.

Marine education activities are developed in three differ-

ent aspects: in-service training for teachers, field trips for students and teachers and school lectures.

The Center has the materials for a multitude of marine activities, and teachers are constantly asking, "How can I use this in my classroom?" Teacher workshops meet the need. Dr. Juan González, Marine Education Coordinator - UPR-SGP at Mayaguez, knows that for each teacher who attends a weekend workshop at La Parguera, his efforts impact 25 to 30 students. Three years ago, 50 teachers applied for the workshops; now it is not uncommon to have 300 applicants.



Appreciation of the sea is too often limited to weekend recreation. Many adults and most children do not know about algae, seagrass, coral reefs, and mangroves. Marine education is the answer. By means of slides, lectures, and field trips, teachers and students are exposed to a new world. Hands-on experience promotes a learning atmosphere that cannot be recreated within the four walls of a classroom sitting on hard chairs and, it creates good feelings about the water.

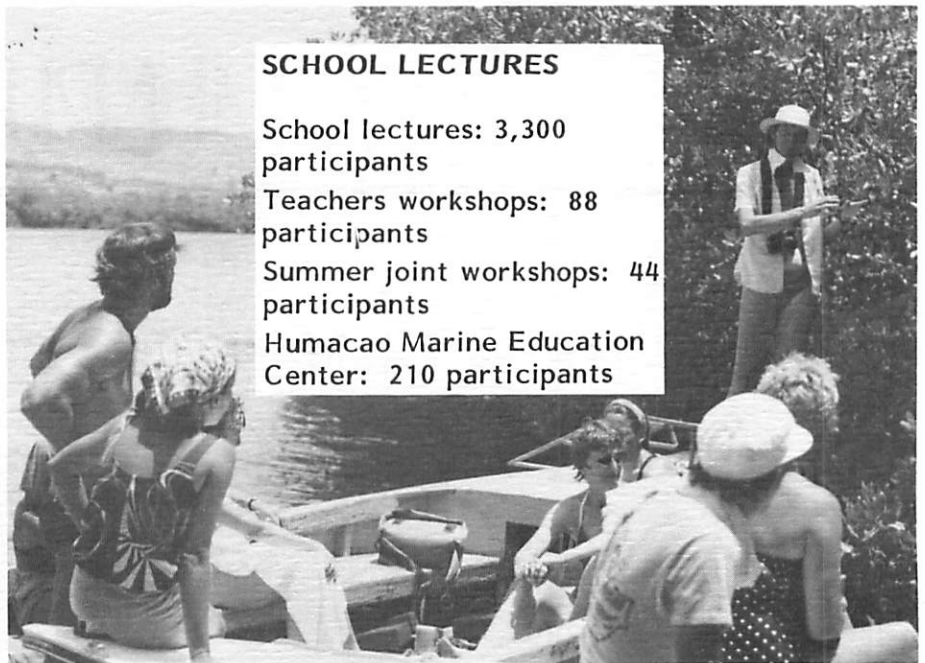
School lectures for third graders up to high school students followed up by field trips to the Marine Sciences Department Field Station at La Parguera have been conducted on weekdays, weekends, holidays, and in June, when school has closed. So committed is the staff to share their knowledge and appreciation of the sea that it seems they can't say "no" to any request.

Summer vacation provides time for more intensive educational activities. In addition to the CAJAYA Marine Camp, a week-long workshop for teachers from Puerto Rico and North Carolina was undertaken during the summer of 1985. According to Dr. Juan González, this workshop is especially rewarding. The interaction among teachers, the exchange and realization of common problems, and the meeting of cultures cannot be surpassed he reports. Both programs expect to repeat this activity in the near future.

A direct result of teacher workshops has been the development of a new public school course, "Inquiry into the Marine Environment." Teachers, Marine Education faculty and the Department of Public Education have designed this

### SCHOOL LECTURES

School lectures: 3,300 participants  
 Teachers workshops: 88 participants  
 Summer joint workshops: 44 participants  
 Humacao Marine Education Center: 210 participants



*Puerto Rico-North Carolina joint teacher's workshop*

multi-disciplinary elective course for 10th to 12th graders in the Río Piedras school district. In the fall of 1986, the class consisted of 38 students and 14 teachers from a variety of disciplines (Biology, Social studies, Chemistry, Mathematics, Physics, Spanish, English, Computer Science). Two biology teachers are responsible for the course but, often other teachers participate in an effective team-teaching strategy—classroom lectures, field trips and laboratory work. This innovative course design has received enthusiastic endorsement and support from

all participants. The interdisciplinary nature of the course is promoting interaction between teachers from different disciplines and students from different learning levels.

A general curriculum revision for grades K to 12 which requires the introduction of marine concepts, is in process. The required earth sciences course for 9th graders demands that teachers be knowledgeable about the basic concepts of oceanography, which is given during workshops and other marine education activities.

Sea Grant involvement in marine education since 1977 has been a motivating influence for change within educational systems. School officials, teachers, and students in all regions of the Island have been in contact with Sea Grant activities in one manner or another.

At the end of the fable, The Sea of Gold, the hero used his treasure from the sea "wisely and well, and he lived a long and happy life on the little island, where no one called him stupid..."



*Juan G. González, Ph.D.*



## A Vehicle for Marine Related Information

"Getting the word out" — Television, radio, publications, research abstracts, translations, educational material and a newsletter (*Boletín Marino*) are among the activities of this small, dedicated Communications/Publications staff. A coordinated communication program requires planning, organization and cooperation with all components of the University of Puerto Rico (UPR) Sea Grant Program. Vangie Hernández, Communications/Publications Coordinator, conceives her role as one of listening to all of the

various voices, interpreting one to another, and initiating and developing channels of communication. While the Communications/Publications project is specifically designed for Puerto Rico and the U.S. Virgin Islands, and is a bilingual project, information is shared with the international community (Dominican Republic, Chile, Argentina, Venezuela, and Costa Rica among other countries) where marine materials and information are often unavailable.

*Vangie F. Hernández,*  
*Communications Coordinator*



### How are publications generated and needs addressed?

Sea Grant's researchers who are working on the scientific problems of marine life depend on the Communicator to relay technical information to the public in a simple language. The current ciguatera research is a perfect example of pertinent research that is crucial for the fishermen and the consumer to understand... thus Ciguatera Fish Poisoning, Questions and Answers and Ciguatera in the Eastern Caribbean.

source cannot be underestimated, and in view of this, Sea Grant produced a bilingual publication on the potential and requirements of successful tilapia production, Tilapia Production in Ponds. As a direct result of this publication having been included in the World Mariculture Society Journal, we have had numerous requests from far away countries like Malaysia, Portugal, Germany, Saudi Arabia, Norway, Guam, Denmark, Canada, and British Columbia.

Marine advisors who are constantly interacting with the public, know what the commu-



*Enidsa Vázquez,*  
*Graphics Designer*

Tilapia is another, the future of aquaculture as a world food

nity is looking for and can anticipate needs. Sometimes they generate the idea for a publication, sometimes they author it while the communications staff sees to the development (graphics, editing, printing), but most of the time it is a collaborative effort.

Marine advisors utilize the communications staff as a resource for posters, literature, slides and video cassettes on the subject of their projects. Students, fishermen, educators, housewives and businessmen regularly request information on marine resources. Sea

Grant's extensive Marine Education and Information Center (MEIRC), not only provides available materials, but records unmet needs for future publications and refers them to concerned parties.

### How does Sea Grant get the word out?

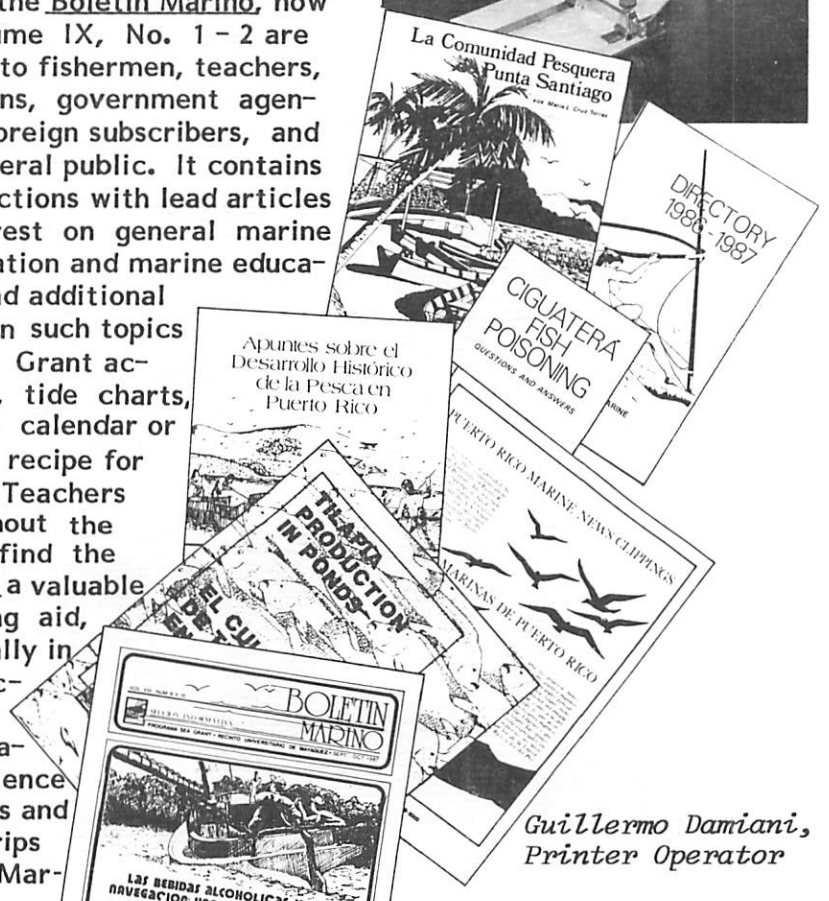
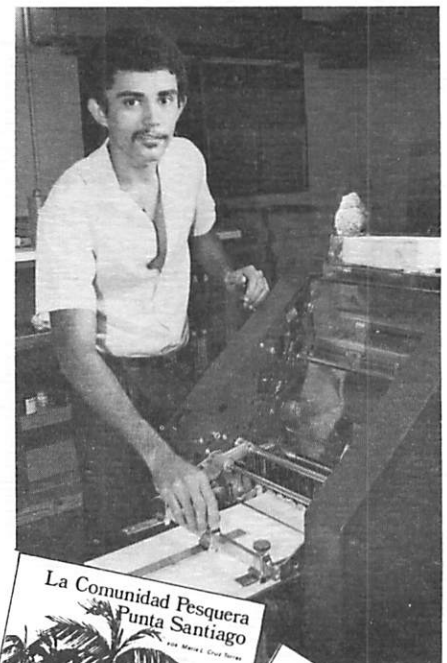
Puerto Rico and the U.S. Virgin Islands are media-oriented societies. Major newspapers are published in San Juan and St. Thomas, while small weeklies are distributed free to households. Many articles related to Sea Grant have been published over the years and often reporters will call the Communicator for news of interest. As part of the UPR family, Sea Grant has been featured in its newspaper, Diálogo on subjects such as marine ecology, beach conservation and marine education.

The Marine News Clippings Service, a selection of news issues related to marine resources in Puerto Rico and the U.S. Virgin Islands, is mailed to a select group of government agencies, legislators, university libraries, newspapers, and other interested groups. Pertinent articles are selected from daily newspapers by trained work-study students. Although this is a time-consuming project, it has received a positive feedback especially from government agencies and has proved to be a valuable service which is otherwise unavailable. Only two other Sea Grant Programs still offer this service.

The Communications staff has established strong relationships

with regional, and island-wide radio and television stations, which are utilized to reach the Islands' population. Radio spots, weekly talk shows, news items, documentaries, and educational programs on network and public radio and T.V. stations, keep the Communicator busy coordinating presentations, developing subjects and following up on requests for materials.

Over 1900 copies of UPR Sea Grant's own bimonthly newsletter, the Boletín Marino, now at volume IX, No. 1-2 are mailed to fishermen, teachers, librarians, government agencies, foreign subscribers, and the general public. It contains two sections with lead articles of interest on general marine information and marine education, and additional items on such topics as Sea Grant activities, tide charts, a lunar calendar or even a recipe for shark. Teachers throughout the Island find the Boletín a valuable teaching aid, especially in conjunction with marine science projects and field trips to the Mar-



*Guillermo Damiani,  
Printer Operator*



ine Sciences Department  
Field Station at Isla Magueyes.

Transfer of knowledge is accomplished in many ways and fact sheets are one of the most effective. Brief, to the point, accurate information that is easily remembered on topics of public interest, fact sheets are printed by the thousands at the Communications office. Recognition of the need to generate this type of communication quickly and at low cost, led the Director to approve the purchase of an off-set printer. Twelve fact sheets are available to all who request them and are used by teachers, students, and MAS advisors, as well as a new Recipe Series containing 15 recipes up to now which include shark, tuna, and other subutilized species.

In addition to five research reprints, four research reports and a Master's thesis, the Communications/Publications staff has produced, in 1985-86, six publications, ten issues of Marine News Clippings, six issues of the Boletín Marino, a list of publication abstracts, three posters, nine fact sheets, three one-pagers, five English/Spanish news releases and seventeen newspaper Sea Grant related articles.

When there is a need for marine related information, contact Sea Grant first! The Marine Education and Information Resources Center (MEIRC), a Communications/Publications sub-project, has the only comprehensive collection on the Island of marine related literature, audio-visual aids and information on and from other Sea Grant programs.

The UPR Sea Grant is one of the 21 Sea Grant programs in the nation which offers the marine education information included in the Marine Educa-



*María E. Font,  
Information Specialist*



*Mabel Suárez,  
C/P-1 Secretary*

tion Materials System (MEMS). The MEMS collection has 2200 microfiche related to marine science education, plus an equal number of research reprints. If the Center does not have the information at hand, it has the ability to borrow publications from the National Sea Grant Depository (NSGD) at the University of Rhode Island.

Audio-visual material and equipment can be borrowed by students, teachers, faculty,

and Sea Grant staff. Over thirty video cassettes, most of them produced or translated by the Communications staff, are available. The Information Specialist is also able to provide a tailor-made carousel of slides on a given topic.

One year's statistics are staggering: requests 1,262, library loans 116, audio-visual loans 2,523, publications disseminated 32,317. The year in question, 1985-86, brought activities such as Expo Chem 86 where our participation in the form of Sea Grant Publications/Communications booth gave our program added visibility, thus added demand of our services. The same year brought a heightened effort as to radio and T.V. broadcasting and even more interest in our publications and services, as did the fact that our new publication titles were included in the Sea Grant Abstract Service and some in the World Mariculture Society Journal.

A new project which is furthering appreciation of marine resources in a very special way is the development of a storybook, El Mar y sus Amiguitos (A Visit With the Ocean and her Friends). There are six characters of "friends" of the ocean ingeniously represented by a sea urchin, a sea-horse, an octopus, a damselfish, a pufferfish, and a gorgonian with colorful descriptive names. The ocean plays the main role in this story. And what is so special about this? Well — it is designed, illustrated and written for children who attend the Instituto Loaiza Cordero, a Commonwealth funded school for the blind and partially blind children. These children will be able to hear the story in Spanish and read it in Braille, and follow the specimen's outlines with their fingers as well.

## Research Reprints

PRU-R-85 (5) "Klebsiella pneumoniae in Orange Juice Concentrate"  
Project No. EN/P-45  
Authors: Francisco A. Fuentes  
Terry C. Hazen  
Arleen J. López-Torres  
Pio Rechani  
Reprinted from: Applied and Environmental Microbiology,  
June 1985, p. 1527-29

PRU-R-85 (6) "Survival and Enumeration of the Fecal Indicators Bifidobacterium adoles-

centis and Escherichia coli in a Tropical Rain Forest Watershed"  
Project No. EN/P-45  
Authors: Martha Carrillo  
Eddie Estrada  
Terry C. Hazen  
Reprinted from: Applied and Environmental Microbiology,  
Aug. 1985, p. 468-476

PRU-R-85 (7) "Sea Urchin Mass-Mortality: Effects on Reef Algal Abundance, Species Composition, and Metabolism

and Other Coral Reef Herbivores" (English and French)  
Project No. UPR-PD-21  
Author: R.C. Carpenter

PRU-R-85 (8) "Seasonal Abundance of Gambierdiscus toxicus and Ostreopsis sp. in Coastal Waters of Southwest Puerto Rico"  
Project No. R/LR-08-1  
Authors: D. L. Ballantine  
A. T. Bardales  
T. R. Tosteson  
H. Dupont-Durst

## Research Reports

PRU-T-85-001 "A Commented Bibliography on Fishing and Fishing Sites in Puerto Rico" (Bibliografía Comentada sobre la Pesca y las Localidades Pesqueras en Puerto Rico")  
Project No. R/SE-20-1  
Author: J. Gutiérrez Sánchez

PRU-T-85-002 "Personal and Job Problems of Puerto Rico

Fishermen" ("Características Personales y de Trabajo de los Pescadores en Puerto Rico")  
Project No. R/SE-20-1  
Author: J. Gutiérrez Sánchez

PRU-T-85-005 "Artisanal Fishing and Fishermen Associations in Puerto Rico" ("La Pesca Artesanal y las Asociaciones de Pescadores en Puerto Rico")

Project No. SE/D-20-1  
Authors: J. Gutiérrez Sánchez  
B. McCay  
M. Valdés Pizzini

PRU-T-87-001 "Reports from the Coastal Zone Management Scientific and Technical Workshop Series"

## Publications

UPR-G-24 "The Fishing Community of Punta Santiago" ("La Comunidad Pesquera de Punta Santiago") (Spanish only)  
The study shows how fisheries-development issues in Puerto Rico are reflected in the experience of small-scale fishermen.  
Project No. SE/D-20-1  
Author: María Cruz

UPR-G-25 "Tilapia Production in Ponds" ("El Cultivo de Tilapia en Charcas") (English and Spanish)  
The culture of tilapia in Puerto Rico is an excellent means of

producing fish on a local basis and decreasing the dependence on imported seafood. In Puerto Rico, many small ponds already exist, most of which are suitable for fish culture. This publication presents the potential for successful culture of tilapia in Puerto Rico and points out the difficulties, the risks, and the basic requirements for the success of this operation.  
Author: A. McGinty

UPR-H-26 "Publication Policy and Guidelines" (English only)  
These guidelines are intended to inform and assist our re-

searchers and consultants of the requirements and responsibilities involved in publishing the results of Sea Grant-sponsored work, thus complying with the Office of Sea Grant's: accomplishments and benefits and to promote an awareness of ocean issues as addressed in Sea Grant-supported projects.  
Editor: Vangie F. Hernández

UPR-G-27 "Ciguatera Fish Poisoning...Questions and Answers" (English only) U.S.V.I. MAS  
This publication was produced by the Virgin Islands Marine



Advisory Service in a simple question and answer, pocket-size format. It is meant to educate and orient the islanders on the human ailment called ciguatera caused by the consumption of tropical reef-associated fish which may contain ciguatoxin (CTX). Published by the UPR-SG Communications/Publications project. In English only. Author: J.P. McMillan

UPR-G-28 "Annotations on the Historic Development of Fisheries in Puerto Rico" ("Apuntes Sobre el Desarrollo

Histórico de la Pesca en Puerto Rico") (Spanish only) In recent years, social scientists have taken a new interest toward fisheries in Puerto Rico in order to be able to understand their role in our economy and our society. This study presents the more outstanding aspects of the historical development of fishing production in Puerto Rico. It also points out those aspects which are relevant for future studies.

Author: M. Valdés Pizzini

UPR-G-29 "U.S. Virgin Islands

Marine Recreation Service and Facilities Directory, 1986" This Directory is a public service provided as part of the continuing efforts of the national Sea Grant College Program to meet the needs of coastal communities. One purpose of the Directory is to serve as a handy guide for visiting boats in the Territory of the U.S. Virgin Islands. It is also a valuable source of information for marine business located here in the neighboring islands, and in the continental United States. Recopilations: Nathalie Peter

### Fact Sheets (Datos Marinos)

- |  |  |  |
|--|--|--|
| <p>No. 1 How to Fillet Fish (Instrucciones para Filetear Pescado)</p> <p>No. 2 How to Know if the Fish You are Buying is Fresh (Cómo Sabemos que el Pescado o el Marisco que Estamos Comprando está Verdaderamente Fresco?)</p> <p>No. 3 Storing Fish (Almacenaje del Pescado)</p> <p>No. 4 Nutritional Value of Various Foods (El Valor Nutritivo de los Alimentos)</p> <p>No. 5 Fish and Your Micro-</p> | <p>wave (El Pescado y su Microonda)</p> <p>No. 6 Beware of Jellyfish (Cuidado con las Aguavivas) (Spanish and English)</p> <p>No. 7a Ciguatera in the Eastern Caribbean</p> <p>No. 7b Ciguatera en el Mar Caribe Oriental) (Spanish and English)</p> <p>No. 8 Enjoy and Preserve Our Beaches (Disfruta y Conserva Nuestras Playas) (Spanish and English)</p> | <p>No. 9 Fresh Tuna in Puerto Rico (El Atún Fresco en Puerto Rico)</p> <p>No. 10 Huracán - Medidas de Precaución a Tomarse</p> <p>No.11a Tormentas Eléctricas y la Seguridad Marina (Spanish and English)</p> <p>No.11b Boating Safety—Thunderstorms (Spanish and English)</p> <p>No. 12 Are You a High Risk Diver? (Cuando es que se Toma el Mayor Riesgo en la Enfermedad por Descompresión) (Spanish and English)</p> |
|--|--|--|

### Research M.S. Thesis

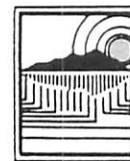
PRU-Y-85-A "Some Aspects of Fresh Fish Marketing at the Fisherman and Middleman Level in the Cabo Rojo Zone"

("Algunos Aspectos del Mercado de Pescado Fresco a Nivel del Pescador y de los Intermediarios en la Zona de Cabo

Rojo")  
Project No. SE/D-20-1  
Author: M. Corredor López



# ADMINISTRATION



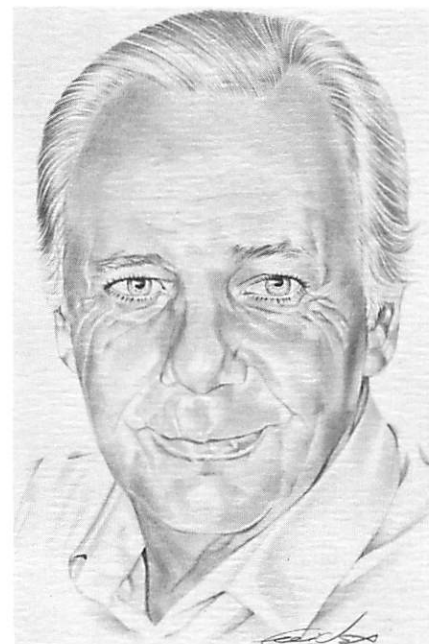
Overall program administration and management provide the structure for developing an integrated program that can unify the academic and marine communities, marine industry, business, and government efforts necessary to develop, conserve, enjoy, and utilize the marine resources of Puerto Rico and the nation.

## Accomplishments

Greater interest and cooperation with the Sea Grant Program has been generated

throughout the University system, government and federal agencies, and the community as a whole. There has been an increased interest and commitment of university researchers on all campuses to undertake studies consonant to the goals of the Sea Grant Program. Sea Grant has changed attitudes, improved skills and inspired greater aspirations in students, fishermen, households, industrialists, businessmen, and others in the community.

*Robert R. Lankford, Ph.D.*  
Assistant Administrator



### PROGRAM BUDGET BY OSG CATEGORIES

Extension: 1984-1985

	OSG GRANT FUNDS	UNIVERSITY MATCHING FUNDS
<b>MARINE RESOURCES DEVELOPMENT</b>		
Living Resources other than Aquaculture	\$ 16,200.00	\$ 16,800.00
<b>MARINE ENVIRONMENTAL RESEARCH</b>		
Pollution Studies	3,700.00	7,820.00
Applied Oceanography	2,100.00	1,500.00
<b>MARINE EDUCATION AND TRAINING</b>		
Marine Education	4,130.00	7,720.00
<b>MARINE ADVISORY SERVICES</b>		
Extension Programs	30,355.00	15,200.00
MAS-Sub Project (Virgin Islands)	11,440.00	8,500.00
Communications/Publications Project	30,545.00	12,600.00
<b>PROGRAM MANAGEMENT &amp; DEVELOPMENT</b>		
Program Administration	8,740.00	5,700.00
Program Development	<u>6,000.00</u>	<u>2,000.00</u>
<b>TOTALS:</b>	<b>\$113,210.00</b>	<b>\$ 77,840.00</b>
<b>ROUNDED TO:</b>	<b>\$113,200.00</b>	<b>\$ 77,800.00</b>
<b>TOTAL BUDGET:</b>	<b>\$191,000.00</b>	

### PROGRAM BUDGET 1985-1986

	OSG GRANT FUNDS	UNIVERSITY MATCHING FUNDS
<b>MARINE RESOURCES DEVELOPMENT</b>		
Living Resources other than Aquaculture	\$ 88,264.00	\$ 79,994.00
Marine Biomedicinals & Extracts	13,970.00	14,210.00
<b>MARINE ENVIRONMENTAL RESEARCH</b>		
Ecosystems Research	26,000.00	20,700.00
Pollution Studies	13,636.00	12,560.00
<b>MARINE EDUCATION AND TRAINING</b>		
Other Education	25,335.00	21,960.00
<b>MARINE ADVISORY SERVICES</b>		
Extension Programs	134,085.00	107,480.00
Communications/Publications Project	68,600.00	43,000.00
<b>PROGRAM MANAGEMENT &amp; DEVELOPMENT</b>		
Program Administration	35,100.00	32,255.00
Program Development	<u>30,000.00</u>	<u>10,000.00</u>
<b>TOTALS:</b>	<b>\$434,990.00</b>	<b>\$342,159.00</b>
<b>ROUNDED TO:</b>	<b>\$435,000.00</b>	<b>\$342,200.00</b>
<b>TOTAL BUDGET:</b>	<b>\$777,200.00</b>	

## Program Development

## 1984-1986 FUNDED PROJECTS STATUS

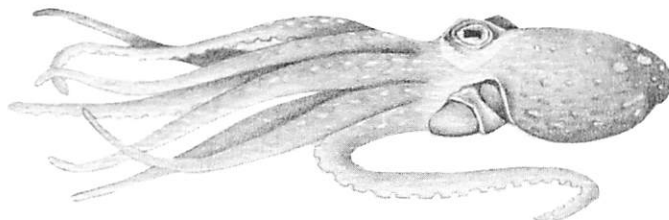
Quick and flexible response to research, educational, and community needs is one of the most important operational aspects of Sea Grant. This unique capability enhances credibility, prestige, and social utility of the program. Funds to support one-time needs, development of useful projects without waiting up to a year lead time, and immediate response to community problems provide a flexibility that increases the effectiveness of our mission.

The Director, with special advisory committees according to subject area and disciplines, determines the projects to be funded. The following criteria is employed: (1) the likelihood of success; (2) it offers a probable practical solution in the shortest length of time; (3) generates further ideas, methods, or a more specific project (proposal) to address the problem in an effective way; (4) provides information to attract support from other sources; (5) addresses the identified problems of users, scientific priorities and educational needs; (6) increases our capabilities to deal efficiently with identified needs, and (7) enhances the cooperative interaction of our program with government agencies, other institutions, industrial concerns, and the National Sea Grant programs network.

PROJECT NO.	SUBJECT OF PROJECT	INVESTIGATORS	INSTITUTION, DEPT., (Begin)	DEPEND. (End)
PD-18-R/RR-30	Fish Aggregating Device (FAD)	J. Capella J. López	UPR-Mayaguez CEER (Jan. 84)	(Mar.85)
PD-19-R/LR-06	Deep-Water Shrimp Trap Survey of SW P.R.	R. Appeldoorn	UPR-Mayaguez Dpt. Marine Sci. (Jan. 84)	(1986)
PD-20-R/OE-24	Engineering Properties of Coastal Sands	C. Rodríguez	UPR-Mayaguez Dpt. Marine Sci. (Jan. 84)	
PD-21-R/LR-07	Mass Mortality of Sea Urchins	J. Ogden R. Carpenter	FDU-St. Croix, W. Indies Lab (Mar. 84)	(1985)
PD-22-R/LR-08	Survey of Ciguatera Cases in Puerto Rico	G. Escalona	UPR-San Juan, Neurobio. Lab (July 84)	(1985)
PD-23-E-59	Development of a Tropical Fisheries School	M. Hernández	UPR-Mayaguez Dpt. Marine Sci. (Apr. 85)	(1986)
PD-24-E-56	Workshop on Ocean Science	I. Bonnelly	Univ. Santo Domingo CIBIMA (Apr. 85)	(1986)
PD-26-R/RR-30	Assessment of Passive Deep-Water Gear	R. Appeldoorn	UPR-Mayaguez Dpt. Marine Sci. (Sep. 85)	(1987)
PD-27-R/LR-06	Dispersal of Reef Fish Eggs	D. Shapiro	UPR-Mayaguez Dpt. Marine Sci. (Jan. 86)	(1987)
PD-28-R/MT-30	Fisheries Enhancement Using Floating FADS	L. Almodovar	UPR-Mayaguez Dpt. Marine Sci. (May 86)	(Cont.)
PD-29-R/MT-36	Locating Historic Ports/Facilities North of P.R.	H. Rodríguez	UPR-Aguadilla Dpt. Humanities (May 86)	(Cont.)
PD-30-R/ME-40	Sedimentation of Marine Macromolecules	T. Tosteson	UPR-Mayaguez Dpt. Marine Sci. (May 86)	(Apr. 88)
PD-31-R/LR-06	Fishery Recruitment From the Plankton	W. McFarland	FDU-St. Croix W. Indies Lab (May 86)	(1988)
PD-32-R/RR-35	Minced Fish from Tilapia	G. Barbosa N. Diaz	UPR-Mayaguez Dpt. Chem. Eng. (May 86)	(June 87)
PD-33-R/LR-06	Artificial Reefs for Fishery Enhancement	M. Hixon T. Turner	UVI-St. Thomas Dpt. Sci/Math (Sep. 86)	(1987)
PD-34-R/LR-07	Color Guide to Marine Algae of Puerto Rico	D. Ballantine	UPR-Mayaguez Dpt. Marine Sci. (Feb. 87)	(1988)
PD-35-R/A-01	Shrimp Culture Technology Transfer	D. Alston	UPR-Mayaguez Dpt. Marine Sci. (Sep. 86)	(1988)
PD-36-R/A-01 02	Multiple Stocking, Prawns and Tilapia	A. McGinty	UPR-Mayaguez Dpt. Marine Sci. (Sep. 86)	(1988)
PD-37-R/A-01 02 04	Economic Assessment of Polyculture	R. Cortes	UPR-Mayaguez Dpt. Marine Sci. (Sep. 86)	(1988)

### PERCENTAGES OF SEA GRANT FUNDS ALLOCATED TO EACH CATEGORY SINCE 1980

CATEGORY	80-81	81-82	82-83	83-84	84-85	85-86
Research	20	33	44	37	25	40
Education	8	5	4	6	4	6
MAS	40	32	25	33	37	30
Comm./Pub.	20	19	17	18	27	16
Management	<u>12</u>	<u>11</u>	<u>10</u>	<u>6</u>	<u>7</u>	<u>8</u>
<b>TOTALS</b>	100	100	100	100	100	100



PROJECT STATUS  
(1984-1986)

	<u>PROJECT NO.</u>	<u>PI/INVEST.</u>	<u>YEAR BEGUN</u>	<u>YEAR ENDED</u>
Marine Advisory Services	A/E-71	M.L. Hernández Avila+ M. Valdés-Pizzini	1984 1985	1985 Cont.
Marine Education	E/D-70	M. Cerame-Vivas* J.G. González+ A. Ortiz	Dec.1980 Dec.1983	1983 1984
Communications/ Publications Project	A/B-76 C/P-1	E.F. Hernández	Dec.1980	Cont.
Program Management	M/A-79	M.L. Hernández Avila	Jan.1980	Cont.
<b>RESEARCH</b>				
Detrimental Effects of Intensive Fishing Over Spawning Aggregations of a Commercially Important Grouper	R/LR-06-1	D. Shapiro	Dec.1982	Apr.1985
Origin, Detection and Chemical Nature of Ciguatoxin in the Northeastern Caribbean	R/B-08-1	T.R. Tosteson H.D. Durst D. Ballantine	Dec.1982	Apr.1985
Biomedicinals from Puerto Rican Seaweeds	R/MB-12-1	W.H. Gerwick	Dec.1982	Dec.1984
Cooperative Research on Fishing Communities of Puerto Rico	R/SP-20-1	J. Gutiérrez	Dec.1982	Dec.1984
Effects of Nitrogenous Loading Through Cultural Eutrophication of the Mangrove/Seagrass Ecosystem at La Parguera, Puerto Rico	R/P-45-2	J.E. Corredor	Dec.1983	Apr.1986
Measurement of Tide-generated Internal Solitary Waves on the Slope South of Puerto Rico	R/A0-50-1	G. Giese	Dec.1983	Apr.1986
Development & Testing of a New Methodology for Assessing Lumped Species Unit Stock in Tropical Fisheries	R/LR-06-2	R.S. Appeldoorn	1984	Apr.1988
Effects of the Mass Mortality of the Caribbean Echinoid <u>Diadema antillarum</u> on Commercially Important Coral Reef Resources	R/ES-40-2	R.C. Carpenter J.C. Ogden	1984	Apr.1986
Fisheries Biology of Four Penaeid Shrimp Species in a Tropical Lagoon	R/A-01-2	A.W. Stoner	1986	Apr.1988
Detrimental Effects of Intensive Fishing Over Spawning Aggregations of a Commercially Important Grouper	R/LR-06-1	D.Y. Shapiro	1986	Cont.
Proposal for the Design of a Dockside Test for Ciguateric Fish	R/LR-08-1	T.R. Tosteson D.L. Ballantine H.D. Durst	1986	Apr.1988

\* No longer with the program  
+ New coordinator



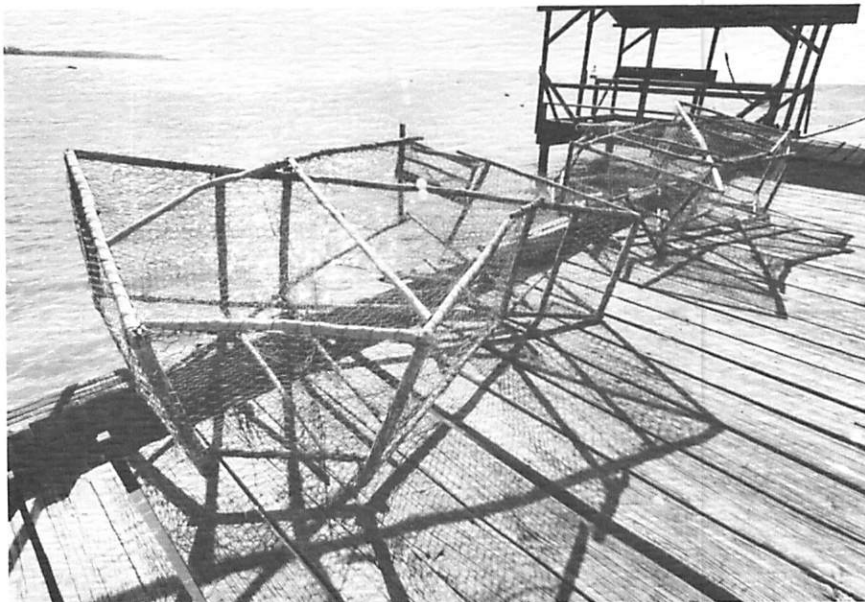
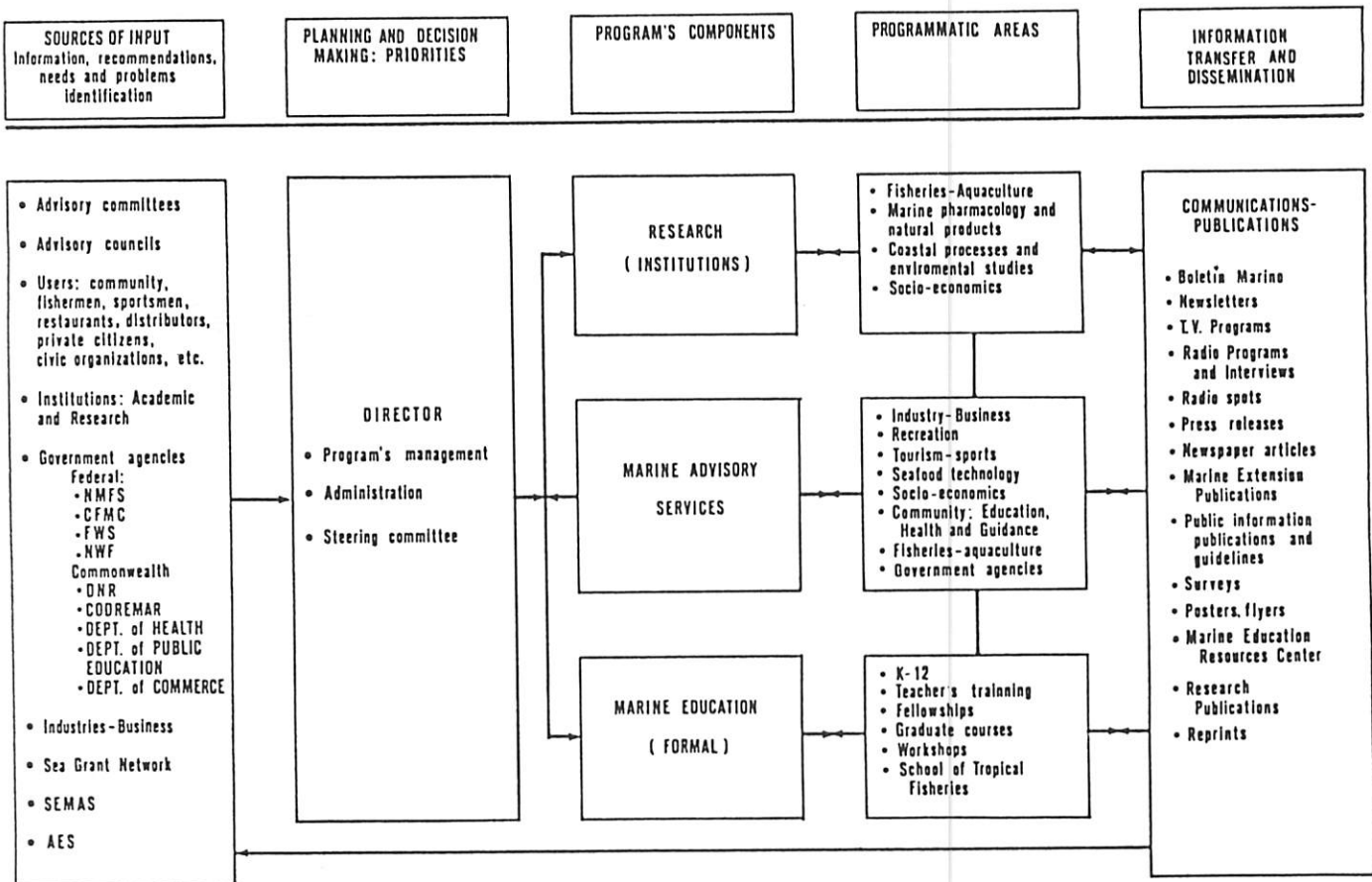
*Mariblanca Aguet,  
Administrative Secretary*

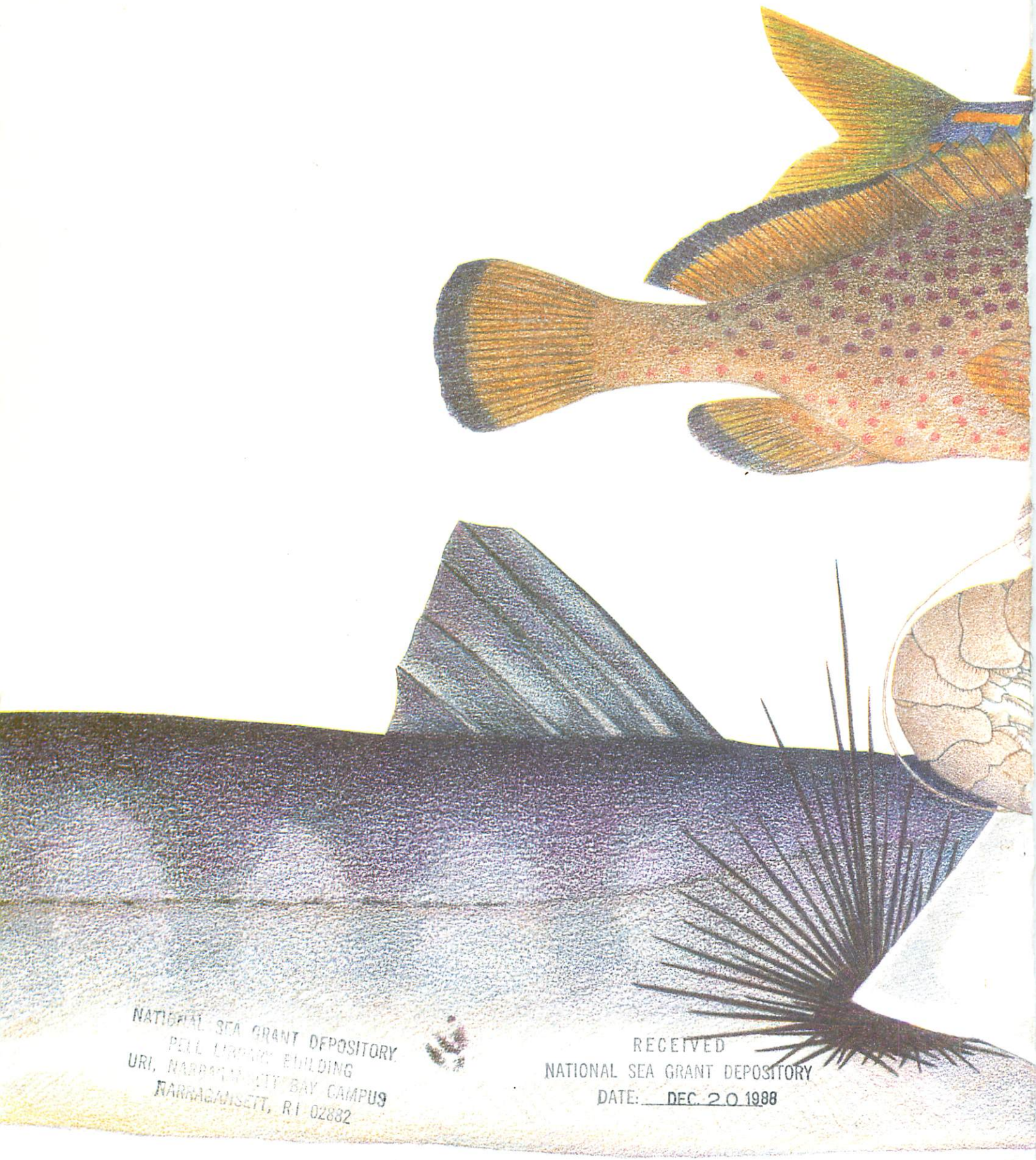


*Laura Acosta-Gregory,  
Executive Secretary*



## Decision Making Flow Chart and Structure of the UPRSGP





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