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INTERNATIONAL CENTER FOR MARINE RESOURCE DEVELOPMENT

UNIVERSITY OF RHODE ISLAND



## 211(d) Annual Report

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211(d) Annual Report

Title: 1973-74 Annual Report -- AID/csd-2455

Grantee: The International Center for Marine Resource Development  
at the University of Rhode Island

A. Statistical Summary

Report Period:	July 1, 1973 to June 30, 1974
Amount of Grant:	\$750,000.00*
Expenditures for Report Year:	\$249,919.13
Accumulated:	\$706,421.36
Anticipated for Next Year:	\$218,579.00

B. Narrative Summary

The International Center for Marine Resource Development at the University of Rhode Island (URI) has focused its efforts on assisting the low-income artisan engaged in fishing and coastal aquaculture throughout the developing world. The Center sustains its capability for response to AID needs through task- and problem-oriented, multi-disciplinary programs designed to feed into pilot and full-scale development efforts. Principal accomplishments during the year have included:

1. an eight-nation conference at the University of Dar es Salaam in Tanzania on marine resources development in Eastern Africa, expected to lead to a substantial inter-institutional program;
2. initial planning for a seminar-workshop on coastal aquaculture and artisan fishing in Central America and Panama to be conducted during the current year;

\*Subsequent to the above date, the contract was supplemented by \$175,000 for an additional year.

3. development of technical assistance projects regarding assessment of marine productivity in Peru and various marine food technical assistance and institutional improvement efforts in Chile and Ecuador;
4. improved research into marine foods of the Less Developed Countries (LDC) including studies of under-utilized species as well as new preparation and preservation techniques;
5. publication of a report on prospects for international fisheries development assistance.

In addition, complementary research included the Consortium for the Development of Technology's (CODOT) teaching and research in Guatemala, Brazil and Chile as well as NSF-sponsored studies of artisan fishing and mariculture in Puerto Rico.

### C. Detailed Report

#### C.I. General Background and Purpose of the Grant

In the spring of 1969, the University of Rhode Island, with the help of a 211(d) grant from the United States Agency for International Development, established its International Center for Marine Resource Development (ICMRD). The premises on which ICMRD was founded are indicated by the following excerpts from the original proposal.

"The University of Rhode Island proposes to strengthen its research, teaching, consultation, and service capabilities in marine resources, especially to expand current university marine resources capabilities to an international dimension.

"This Center will allow the University to direct to the problems of less developed nations its existing, planned and proposed integrated strength in development economics, marine resource economics, marine biology, oceanography, ocean engineering, fisherman training, fishing gear research, food technology, marine resource extension work and supporting social science interest.

"Funds requested in this proposal will be used to engage present faculty to enlarge on their interests in international studies, to hire new faculty with these interests, to support domestic and foreign graduate and special students while they pursue their education or training in programs relevant to the purposes of the grant, to improve library holdings, to help finance visiting lecturers for seminars, courses and symposia and to provide for necessary supplies and travel related to this program.

"The result will be an integrated multi-discipline Center with capabilities for identification of and consultation on the solution of economic, biological, technological, social and institutional problems and constraints and the development and attainment of opportunities related to the role of marine resources in less developed countries. The work of the Center will be coordinated and integrated with and supported by the existing and expanding University activities in these subject areas on the state and national level."

In 1960 the University first established its broad, comprehensive, integrated approach to the study of marine resource problems, which led in 1969 to the establishment of ICMRD. The Center focused on an international and integrated approach to serve other countries facing problems in developing their marine resources through four general techniques:

Degree programs, short courses and other specialized offerings suited to the needs of foreign students interested in marine resources and marine affairs offered at the University.

Research, education and technical assistance carried out in foreign countries.

Research on problems of concern to foreign countries, sponsored by the University.

Advising and consulting services for interest in foreign countries.

## C.II. Objectives of the Grant

### 1. Objectives Restated

In addition to the general objectives described, the grant's specific objectives included: conducting a series of multi-disciplinary studies dealing with the role of marine resources in less developed countries; organizing courses of studies and seminars in degree programs; increasing the capacity to provide advanced, general and specialized education for LDC administrators and researchers; providing training for U.S. professional staff; and providing URI involvement in technical consultation and assistance in research on marine matters.

## 2. Review of Objectives

While these objectives did not change significantly until the past year, there were organizational changes growing out of the experience of the first year's effort, and an internal reassessment study was undertaken during 1971-72, midway in the 211(d) five-year grant period.

Originally guidance was given to the director by a planning and advisory committee. Effective July 1, 1972, a newly appointed director (Nelson Marshall) began to report directly to the Provost for Marine Affairs and to chair an Executive Committee of rotating personnel. A body of Center Associates, consisting of faculty and staff committed to the achievement of the program goals, was selected.

While these Associates have their academic homes in appropriate departments, they relate to ICMRD in much the same way as graduate faculty members who, while attached primarily to diverse departments, serve collectively as members of a graduate school. Of the 30 Associates, 25 were active in international programs in 1973-74. Those not so involved were linked to the Center through administrative and teaching roles. On an average, the 25 active Associates probably devote about 25 percent of their time to international work. Typically, each has one to three graduate students working with him in this area. Moreover, the list of foreign students pursuing marine studies at URI extends far beyond those on ICMRD assistance assignments (see table D).

Following this mid-grant reassessment, the support base was deliberately broadened. While AID 211(d) continued to be the largest element of support, funds were procured for projects sponsored by AID, ROCAP, the National Science Foundation, Resources for the Future, and by some developing countries. The University, in addition to its backing in faculty cooperation and space and facilities, has provided the Center up to \$25,000 annually.

Proposals were prepared and submitted which reflect the University's view of further AID-oriented effort in marine resource development appropriate for 211(d) grant extension beyond the initial five-year period. With priorities, concepts and approaches changing both at URI and AID, these proposed activities were not accepted for follow-on funding. The grant, which was originally targeted for completion in May 1974, was extended to August 1974, in order to, among other things, allow an inter-agency review team to meet with officials and faculty of the University to conduct a comprehensive review of the grant, its objectives and extension possibilities. As a result of this meeting held at URI May 30-31, 1974, a one-year extension to the existing grant was approved.

The extension is made to provide the necessary time for AID's assessment and definition of policy to be firmed up in the areas of fisheries and coastal aquaculture and for the University to develop the institutional strategy to properly support a new two- or three-year proposed effort responsive to program needs within the focused purpose defined in the review session.

The objective of the new program grant, and consequently the focus of the one-year extension, as stated, is "to develop and utilize a task-and-problem oriented multi-disciplinary competence by providing a sustained response capability serving the artisan fisheries and coastal aquaculture area--including mariculture and brackish water aquaculture (inshore and estuarine); handling, processing and marketing; socio-economic aspects; nutrition; training; guidance; and development of LDC technical and administrative competence."

The program being developed in accordance with this objective should help upgrade subsistence marine operations to artisan levels, thereby increasing LDC protein resources and uplifting local economies. It is being designed to provide multi-disciplinary input to problem definition and solution in both technical and socio-economic areas.

Among the grant's defined task objectives are the following:

1. Participate in program activities with an end purpose of upgrading the artisan fisherman's operations, including specific planning, project identification, program design and operation, technical assistance and institution-building projects, to the point where separately funded activities, such as the basic ordering agreement (No. AID/ta-BOA-1079, 11 June 1974), or research funding can provide the necessary support.
2. Establish priorities for accomplishment and solicit support from AID/Washington and the mission and regional bureaus.
3. Collaborate on a consortium or other functional basis with universities, centers, and government and international organizations.
4. Maintain appropriate services such as information and advisory systems, specialized education programs, conducting of conferences and workshops, publication of proceedings and other information of general interest, as well as responses to AID advisory requests.

A basic premise of the revised mode of operation is to maintain a competent, motivated and trained corps of investigators and managers in activities appropriate to serve AID needs.

While the Center primarily plans to maintain its AID-sponsored impetus within the focus described, it does not consider itself solely limited by that focus and indeed does encourage international support from other sources in complementary interest areas.

In addition the University will reaffirm and reassess its commitment and support to the Center both at the management and policy level and through strengthened faculty/staff support.

## Center Associates (at the end of the reporting period)

*Lewis M. Alexander	Prof. of Geography Director, Master of Marine Affairs Program
Fred G. Burke	Commissioner of Education Rhode Island Department of Education
*Clinton O. Chichester	Prof. of Food and Resource Chemistry Executive Chairman, Consortium for the Development of Technology (CODOT)
James W. Cobble	Prof. of Animal Science
**Spiros M. Constantinides	Prof. of Food and Nutritional Science and Biochemistry
Ronald G. Cummings	Prof. of Resource Economics, Chairman of Department
Joel B. Dirlam	Prof. of Economics
Howard H. Foster, Jr.	Asst. Prof. of Community Planning and Area Development
John K. Gamble	Asst. Prof. of Resource Economics Director, Law of the Sea Institute
John M. Gates	Asst. Prof. of Resource Economics
James J. Griffin	Executive Assistant, ICMRD
Andreas M. Holmsen	Prof. of Resource Economics
John A. Knauss	Prof. of Oceanography, Provost for Marine Affairs
Harlan C. Lampe	Prof. of Resource Economics
Tung-Ching Lee	Asst. Prof. of Food and Resource Chemistry
*Nelson Marshall	Prof. of Oceanography, Director ICMRD
James F. McFarland	Asst. Prof. of Resource Economics
Aloys A. Michel	Prof. of Geography, Acting Vice President for Academic Affairs
Foster H. Middleton	Prof. of Ocean Engineering
Virgil J. Norton	Prof. of Resource Economics
Candace Oviatt	Research Associate, Graduate School of Oceanography
John J. Poggie	Assoc. Prof. of Anthropology Chairman, Department of Sociology and Anthropology
Richard B. Pollnac	Asst. Prof. of Anthropology
William R. Rosengren	Prof. of Sociology
Saul B. Saila	Prof. of Oceanography and Zoology Director, Marine Experiment Station
John C. Sainsbury	Assoc. Prof. of Fisheries and Marine Technology Chairman of Department
Milton Salomon	Prof. of Food and Resource Chemistry
C. Robert Shoop	Assoc. Prof. of Zoology
Irving A. Spaulding	Prof. of Resource Economics and Sociology
Thomas F. Weaver	Asst. Prof. of Resource Economics

---

\*ICMRD Executive Committee

\*\*Replaces C.O. Chichester in the upcoming fiscal year

C.III. Accomplishments

Topic: International Conference on Marine Resource Development in Eastern Africa

Investigators: Spiros M. Constantinides  
James J. Griffin  
Harlan C. Lampe  
Nelson Marshall  
Richard B. Pollnac  
Saul B. Salla

Funded by: 211(d) \$35,521  
URI 3,852

Summary

The University of Rhode Island and the University of Dar es Salaam (Tanzania), sharing an interest in the transfer of technology through marine resource development workshops with downstream research, development, education and other aid activities, have jointly conducted an international conference during the past year. The concept of the Eastern African area meeting evolved over a considerable length of time through extended discussions on the part of both universities and grew to include a widening circle of interested individuals and organizations from many nations.

The "International Conference on Marine Resources Development in Eastern Africa" convened on April 4, 1974, in Dar es Salaam, and brought to bear the interdisciplinary marine interests of 56 people from eight nations on the task of assessing the needs and capabilities for marine resources development in Eastern Africa. Table A lists the participants of the conference.

The conference recommended establishment of a center in Tanzania to serve as a base of knowledge for conservation and rational uses of natural resources, both human and material, for national and regional purposes. Application to regional needs would be accomplished through strong cooperative ties with sister universities in Kenya and Uganda and with the East African Marine Fisheries Research Organization (EAMFRO) and other East African national and international universities, foundations and programs. The grant provided for URI participatory organizational activities and the publication of Proceedings.

**Table A. Participants, International Conference on Marine Resources Development in Eastern Africa**

Dr. S.A.H. Abidi, Kunduchi Fisheries Institute, Tanzania  
 Mr. J.E. Abura, East African Harbors Corporation, Dar es Salaam, Tanzania  
 Dr. W.H.L. Allsopp, International Development Research Bureau, Vancouver, Canada  
 Mr. C. Barnes, Economic Research Bureau, University of Dar es Salaam, Tanzania  
 Mr. K.H. Bain, FAO, Dar es Salaam, Tanzania  
 Prof. P. Bomboe, Geology Department, University of Dar es Salaam, Tanzania  
 Mr. D. Bryceson, Director of National Parks, Dar es Salaam, Tanzania  
 Mr. I. Bryceson, Zoology Department, University of Dar es Salaam, Tanzania  
 Prof. S.M. Constantinides, University of Rhode Island, U.S.A.  
 Mr. K. Curry-Lindahl, UN Environment Program, Nairobi, Kenya  
 Prof. R. Geigy, Swiss Tropical Institute, Basle, Switzerland  
 Mr. J.J. Griffin, University of Rhode Island, U.S.A.  
 Mr. J.J. Gwahaba, Makerere University, Kampala, Uganda  
 Dr. K.N. Hirji, Zoology Department, University of Dar es Salaam, Tanzania  
 Mr. K.M. Howell, Zoology Department, University of Dar es Salaam, Tanzania  
 Prof. M. Hyder, Zoology Department, University of Nairobi, Kenya  
 Dr. R.L. Jackowski, University of Nairobi, Kenya  
 Mr. J.J. Kambona, Ministry of Information, Dar es Salaam, Tanzania  
 Dr. F.K. Kasule, Zoology Department, University of Dar es Salaam, Tanzania  
 Mr. M.G. Kayura, UNESCO National Commission, Dar es Salaam, Tanzania  
 Dr. D. Krause, UNESCO, Paris, France  
 Prof. H.C. Lampe, University of Rhode Island, U.S.A.  
 Mr. G. Libaba, Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania  
 Mr. T. Maembe, Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania  
 The Hon. H. Makame, Minister of Natural Resources and Tourism, Dar es Salaam, Tanzania  
 Dr. L. Marine-Li, USAID, Arusha, Tanzania  
 Prof. N. Marshall, University of Rhode Island, U.S.A.  
 Dr. A. Mascarenhas, BRALUP, University of Dar es Salaam, Tanzania  
 Mr. H. Matthes, Kunduchi Fisheries Institute, Tanzania  
 Mr. W.N. Mbote, Ministry of Tourism and Wildlife, Nairobi, Kenya  
 Mr. J. Meyer, Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania  
 Dr. T. Mcharo, Serengeti Research Institute, Arusha, Tanzania  
 Mr. R.E. Morris, EAMFRO, Zanzibar, Tanzania  
 Mr. J.F. Mpelumbe, Kunduchi Fisheries Institute, Tanzania  
 Prof. A.S. Msangi, Zoology Department, University of Dar es Salaam, Tanzania  
 Mr. P. Msekwa, Vice Chancellor, University of Dar es Salaam, Tanzania  
 The Hon. D. Mwakawago, Minister of Information, Dar es Salaam, Tanzania  
 Mr. I. Mwakipesile, Kunduchi Fisheries Institute, Tanzania  
 Mr. P. Mwombela, National Scientific Research Council, Dar es Salaam, Tanzania  
 Mr. M.O. Mzee, EAMFRO, Zanzibar, Tanzania  
 Mr. S. Ndawula-Kajumba, Sociology Department, University of Dar es Salaam, Tanzania  
 Dr. A.M. Nikundiwe, Zoology Department, University of Dar es Salaam, Tanzania  
 Dr. F. Nyahoza, Dean, Faculty of Science, University of Dar es Salaam, Tanzania  
 Dr. D.M. Pearson, Zoology Department, University of Dar es Salaam, Tanzania  
 Prof. R. Pollnac, University of Rhode Island, U.S.A.  
 Mr. N.S. Rembe, Law Department, University of Dar es Salaam, Tanzania  
 Dr. W.B. Rudman, Zoology Department, University of Dar es Salaam, Tanzania  
 Dr. C. Sankarankutty, Zoology Department, University of Dar es Salaam, Tanzania  
 Prof. S.B. Saila, University of Rhode Island, U.S.A.  
 Mr. W.A.M. Sichone, Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania  
 Mr. S.B. Singh, Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania  
 Prof. S. Tedla, Haile Selassie University, Addis Ababa, Ethiopia  
 Dr. W.L.N. Tickell, Zoology Department, University of Nairobi, Kenya  
 Prof. D. Wasawo, ECA, Addis Ababa, Ethiopia  
 Mr. U.N. Wijkstrom, Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania

The Conference

The core of the conference consisted of discussions between Tanzanian representatives and advisors led by Prof. A. S. Msangi, head of the department of zoology at the University of Dar es Salaam, and representatives from the University of Rhode Island, led by Prof. Nelson Marshall, director of ICMRD. These discussions concerned the application of the experience and expertise of the University of Rhode Island to evaluation of Tanzanian resources and problems and to recommendations for a center to meet those problems.

The conference also provided a forum for representatives from other East African universities and governments; from the Economic Commission for Africa (ECA); from United Nations specialized agencies, such as the Food and Agriculture Organization (FAO), Educational, Scientific and Cultural Organization (UNESCO), and the Environmental Program (UNEP); and from funding organizations of Canada and the United States.

The first day of the conference (Table B, conference program) consisted of presentations of the status of Tanzanian marine resources. Statements and discussions reflected development needs and opportunities in artisanal reef, estuary, delta and offshore fisheries as well as coastal mangrove, estuary, lagoon and bay aquaculture. Data were supplied on a variety of different organisms such as oysters, mussels, lobster, prawn and other shellfish; sea turtles, sea cucumbers, and some brackish-water fishes (mullet and catfish); and also algae--all of which are either presently being exploited or could be.

The implications of other forms of coastal resource development and use, harbors, beaches, sand and gravel, oil and minerals and building sites, and pollution from petroleum, sewage and dredge-dumping were also addressed. Infrastructure, ocean engineering, and educational needs were brought out. Conservation and rational utilization of natural resources provided a recurrent theme.

On the second day of the conference, the marine resources programs at the University of Rhode Island were presented in a series of papers.

Marine Resource Programs at the University of  
Rhode Island--History and Composite View  
Fisherman Training, Fisheries Biology and  
Aquaculture  
Ocean and Environmental Engineering  
Marine Resource Economics  
The Structure of Fisheries Economics  
Marine Affairs Programs: Coastal Management,  
Coastal Resources Center, Marine Affairs  
Curriculum and the Law of the Sea Institute  
Marine Food Science and Technology  
Sociology and Anthropology Applied to  
Coastal Communities

Nelson Marshall

Saul B. Saila  
Saul B. Saila  
Harlan C. Lampe  
Harlan C. Lampe

James J. Griffin  
Spiros M. Constantinides

Richard B. Pollnac

Parts of the URI model were deemed relevant to the University of Dar es Salaam. The incorporation of academic disciplines relating to resource development might be incorporated in an integrated framework, for example. Or cooperative relationships and mutually beneficial links might be developed with friendly institutions and universities worldwide. Interest was expressed in participating in URI's marine affairs curriculum as a basis for management development. A special concern was voiced on the subject of food--distribution, quality, waste, and improper utilization, as well as research on the use of under-utilized species, waste processing and other food technology areas.

Social considerations were developed. These ranged widely from the broad topic of technology transfer over a wide gap to other topics--the relationships and implementation of economic improvements and sociological changes in the ujamaa village cooperative scheme and the problem of increasing consumer desire for fish to name two.

The remainder of the conference was devoted to workshops concerned with the specific approaches required to establishing the proposed center.

#### Post-conference Activity

University of Dar es Salaam officials, in cooperation with the Tanzanian government, are taking the necessary steps to establish the marine resources development center. This will be patterned after the URI model but adapted to East African needs. It will take shape through appropriate legislative and five-year program planning inputs. Recommendations have been made regarding the selection of a director.

UNESCO funding may be available to the director for travel to potential aid sites in Europe and North America. Using these visits and the considerable store of information contained in the conference papers now being published for the University of Dar es Salaam with the assistance of the University of Rhode Island (funded by AID), firm proposals can be established for specific research and aid projects--in fisheries and aquaculture technology and management, ocean engineering, marine resource economics, food technology, marine information, fisheries training and marine affairs education as well as technology transfer--to be integrated into Tanzanian national planning.

**Opening Address--The Honourable S. E. Chiwanga**

**Session One: Marine Resource Potential and Needs of Eastern Africa**  
Chairman: Abdul S. Msangi

- Shore and Reef Fisheries--John J. Kambona  
Supplementary Comments--Nelson Marshall
- Tanzanian National Parks and the Marine National Parks--Derek N. Bryceson  
Supplementary Comments--S. B. Saila
- Coastal and Estuarine Aquaculture: A Case for Introducing Prawn  
Culture in Tanzania--C. Sankarankutty
- Coastal and Estuarine Aquaculture--H. Matthes  
Supplementary Comments--W. H. L. Allsopp
- Priorities in Development of the Shelf Fisheries--Robert Morris  
Supplementary Comments--S. B. Saila
- Fishing Boats and Equipment--Jomar Meyer  
Supplementary Comments--Harlan C. Lampe
- Other Uses and Problems of the Coastal Area, Including Pollution  
and Port Development--J. E. Abura  
Supplementary Comments--K. Curry-Lindahl
- Processing and Marketing Marine Fish: Possible Guidelines for  
Development in Tanzania during the 1975-1979 Period--U. N. Wijkstrom  
Supplementary Comments--Harlan C. Lampe

**Session Two: Marine Resource Programs at the University of Rhode Island  
and Possible Applicability to Program Development at the  
University of Dar es Salaam and to the Eastern African  
Region**  
Chairman: Nelson Marshall

- Marine Resource Programs at the University of Rhode Island:  
History and Composite View--Nelson Marshall  
Response--Abdul S. Msangi
- Fisherman Training, Fisheries Biology and Aquaculture--S. B. Saila  
Response--Abdul S. Msangi
- Ocean and Environmental Engineering--S. B. Saila  
Response--P. Bomboe
- Marine Resource Economics--Harlan C. Lampe
- The Structure of Fisheries Economics--Harlan C. Lampe  
Response--A. Mascarenhas
- Marine Affairs Programs: Coastal Management, Coastal Resources  
Center, Marine Affairs Curriculum and the Law of the Sea Institute--  
James J. Griffin  
Response--G. Libaba
- Marine Food Science and Technology--Spiros M. Constantinides  
Response--T. Maembe
- Sociology and Anthropology Applied to Coastal Communities--  
Richard B. Pollnac  
Response--S. Ndawula-Kajumba
- Program Synthesis--Nelson Marshall

**Session Three: Planning an Institute for Marine Sciences for Eastern  
Africa**  
Chairman: The Honourable H. Makame

- Address to Delegates--The Honourable H. Makame
- The Role of the University of Dar es Salaam and the Relationship  
of the Institute of Marine Sciences to the United Republic of  
Tanzania and to the Region--Pius Msekwa
- Major Points of Discussion in Support of Establishing a Center for  
Marine Resources at the University of Dar es Salaam

Topic Title: Seminar-Workshop on Coastal Artisan Fisheries and Aquaculture  
in Central America and Panama

Principal Investigator: Nelson Marshall

Participants: James J. Griffin  
Harlan C. Lampe  
Richard B. Pollnac

Funded by: 211(d) \$9,931

### Need

Throughout Central America and Panama, close to 17,000 artisan fishermen, who with their dependents number about 100,000, rely to some extent on fishing for their livelihood. Together they form an important socio-economic group within the region, and they provide most of the fish consumed locally.

As a group they generally lack education and the economic means to rise above their present difficult existence. They are trapped by a situation where low incomes, often at subsistence levels, stifle the hope of significant improvement without outside help. Efforts to alleviate this situation have had only limited success.

### The Seminar-Workshop

The University, funded under the present grant, has, after considerable exploration and background research into the region's artisan marine needs, recommended conducting a seminar-workshop on coastal artisan fisheries and aquaculture. This seminar-workshop, approved by AID as a part of the extension grant, has as its objectives the exploration of the character, status and potential of the subsistence harvest fishery and coastal aquaculture activities of Central America and Panama and the advancement of concrete, upgrading suggestions to increase protein supply and employment. The event will bring together top government, university and fishing industry representatives in a workshop format to review the status, concerns, needs and options. It will rely on the combined input of representatives of these countries as well as regional and international subject-area experts. Additionally the seminar-workshop will provide an opportunity for observers from other greater Caribbean countries to sense the potential of such a technique.

A bilingual seminar-workshop proceedings will be published as a vehicle to perpetuate the impact of the deliberations, the data collected, and recommended action.

URI will be responsible for the following elements: identifying appropriate individuals, organizations and interests within the area; assessing their willingness to participate and contribute to the conference; releasing announcements; extending invitations; handling travel and per diem reimbursements for approximately 21 Central American-Panamanian representatives, for three observers from the Caribbean and for nine resource persons, and honoraria for four resource persons not on the URI faculty; providing instantaneous bilingual (Spanish-English) translation; arranging for a rapporteur; and providing for seminar facilities and events.

To date, Professors Marshall and Pollnac from the University have travelled in the area to define specific opportunities and program possibilities, have identified and held discussions with a significant number of national government, university and fishing industry personnel as well as international organization counterparts regarding the objectives of and potential contributions to the conference. Tentative plans are to hold the conference, con permiso, in early 1975 in San Jose, Costa Rica.

The seminar-workshop will be organized into three basic sessions:

1. presentations by the individual nations from the region on the current state of their aquaculture and artisan fisheries programs, their technology, institutional structure, and successes, failures and plans;
2. presentations by outside experts in artisan fisheries and aquaculture programs on present trends, experiences and fishing interests worldwide; and
3. workshops on new directions in marine resource development in the area based on assessment of critical demand.

Specific topics planned for discussion in these sessions are listed in table C. Output should include definition of specific aid projects as well as information exchange, linkage establishment and extension of knowledge.

Table C. Seminar-Workshop Topic Areas

<u>Harvest fishery</u>	<u>Coastal, estuarine and freshwater aquaculture</u>
finfish	shellfish
crustaceans	crustaceans
shellfish	other
other	
freshwater	
<u>Marketing and distribution</u>	
processing and handling	
cooperatives and other institutional practices	
investment needs	
overall economy and interrelations with other sectors of the economy	
<u>Equipment</u>	<u>Training of fishermen</u>
<u>Research</u>	<u>Administration</u>
<u>Extension and advisory services</u>	<u>Country, regional programs</u>

Topic Title: Technical Assistance Project for Instituto del Mar, Peru

Principal Investigator: Nelson Marshall

Funded by: 211(d) \$1,105

### Summary

At the request of the AID mission in Peru and AID/Washington, the University, as part of the current grant, has contributed to the generation of a proposed technical assistance project aimed at "increasing knowledge of the factors that govern productivity of the sea off Ilo, Peru, in order to relate effective those factors to commercial fishing."

Dr. Oscar Guillen, Director of the Instituto del Mar, worked with URI oceanographic scientists Nelson Marshall, Scott Nixon and James Kramer and with resource economist Jon Sutinen to design the first phase of the program which will be presented by Dr. Guillen to the AID mission in Peru for funding.

### The Project

Development of an Ilo Ecosystem Model first involves testing and evaluating two or more existing ecosystem models with data from the area. After establishing the degree of applicability of these models, the URI investigators will suggest requirements for an Instituto del Mar cruise program for data collection to supplement available area information and, thus, to improve or replace the model. Ultimately, re-testing will lead to selection of an appropriate model configuration that can be used to assess and predict area productivity.

An associated resource economics study will involve planning with the staff of the Instituto del Mar for an economic review of the Ilo area fisheries pointed especially to the artisan fisherman. Review of production, distribution and marketing of fish for human consumption as well as an assessment of the possibility of constructing an economic model capable of being interfaced with the ecosystem model will also be included.

The program plan for the 14-week effort has been established and, if approved, is expected to start in June 1975. The program, which will be partially conducted on site, could serve as a building block for future specific research tasks with the Instituto del Mar.

**Topic Title:** Technical Assistance for Escuela Pesquerias y Alimentos,  
Universidad Catolica de Valparaiso

**Principal Investigator:** Spiros M. Constantinides

**Participating Faculty:** Harlan C. Lampe  
Nelson Marshall

**Participating Student:** Luis A. Adriasola (Chile)

Funded by:	211(d)	\$ 6,005
	CODOT	10,000
	Diakonia	60,000

### Background

During a six-month stay in Chile in 1972, Professor Constantinides of URI assisted in the development of the academic program at the School of Fisheries and Marine Food Science (Escuela Pesquerias y Alimentos) at the Universidad Catolica de Valparaiso. The school recently has been selected by the Organization of American States (OAS) to be a multi-national Center for Marine Food Science and Technology offering its own graduate program. Professor Constantinides is continuing to advise the school on matters pertaining to academic programs, research and extension.

Professor Constantinides helped obtain \$60,000 for the school from Diakonia, a German Worldwide Council of Churches organization, and, as of January 1974, these funds were being used for artisan fisheries development. The project's primary objective is improvement of the handling, processing and distribution of artisan-caught fisheries products. A multi-disciplinary approach is being used. Professor Constantinides is coordinating the program with Professor Pablo Herrera of Chile.

In the spring of 1973, the parent Universidad Catolica de Valparaiso approached ICMRD with suggestions for establishing closer links between the two institutions. This concept was further explored by Professor Andres Couve, representing the central administration of the Universidad, during planning visits to URI in March and July of 1973. Further developments were set back by the coup of September 1973. However, in March, Sergio Gonzales, the Director of the Universidad's Escuela Pesquerias y Alimentos, spent a week at the University of Rhode Island conferring about on-going plans, and Professor Marshall, Director of ICMRD, spent a follow-up week in Chile to explore further the feasibility of such work.

The Technical Assistance Program

The first specific move made toward a cooperative effort centered around a research plan entitled "New Approaches toward the Utilization of Artisanal Fish Catch in Chile" which was developed jointly by Professors Constantinides and Lampe of URI and Professor Herrera of the Universidad Catolica.

This plan, in keeping with the view of the Universidad that the optimum development of its faculty competence means becoming involved in a series of meaningful research efforts, will be presented by the Universidad to the USAID mission in Chile in the early fall. Development of this proposal was materially assisted by the presence of the on-going Diakonia program.

The new three-year proposed program has as its overall objective to promote higher consumption of marine food in Chile based on products of good quality, low cost and consumer acceptability, and at the same time to increase the employment and income of the artisan fishermen who provide the majority of marine food for human consumption.

The processes to be developed will be simple with low capital investment and high labor demand and should benefit the country socially, nutritionally and economically. Specific objectives include the following:

Conduct a technical and economic feasibility study of developing fish food production and establishing plants in specific areas along the coast.

Evaluate the quality of marine food reaching the consumer and make the necessary recommendations to improve or modify handling, preservation and distribution practices.

Experimentally study new techniques of preservation to extend the shelf life of the edible marine species and expand the market by allowing quality products to reach more distant areas.

Carry out a marketing study with products developed in the previous stage.

Train the personnel actually involved in handling, preservation and distribution of marine foods to improve quality.

Improve methods of utilizing more of the total catch.

The investigation, if funded, will consist of the following stages:

A thorough study of the economic feasibility and convenience of expanding the production of fish food for domestic human consumption.

An analysis and evaluation of the current situation in handling,

preservation, distribution and consumption of marine food including (1) the supply of different species, (2) channels of distribution, and (3) quality and sanitary condition of the fish as they reach the consumer.

Development of new techniques of utilization of marine species. Simple techniques of preservation to extend the shelf life at room temperature of marine species will be studied, such as the use of ice or rapid salting.

A study of the possibility of introducing the technology of minced flesh preparation and the development of related products such as fish sticks, portions, cakes, and fishburgers incorporating potatoes and legumes, etc. Variables of the process will be studied, the yields for each process determined, and packaging materials, shelf life and storage conditions evaluated.

A marketing study will be carried out with products demonstrating high acceptability.

An analysis will be carried out to determine the optimal number and location of the facilities required to process the new products. Necessary equipment will be selected for the operation of these facilities.

Training will be conducted of artisan fishermen capable of collaborating in the program.

#### Other Activity

Professor Marshall, as a result of his visit in May, has suggested that the Universidad develop a comprehensive plan of development in its fisheries-marine sciences program. With this plan it should seek consortium-type support from universities in the United States interested in helping develop a marine resources center of excellence in this region.

Other universities in the United States that have been involved with the Universidad and are particularly interested include the Universities of Washington, Oregon State, Auburn, and Hawaii. Professor Marshall wrote to these universities and the State Department stating his impressions of the conditions and goals of the Universidad Catolica de Valparaiso and of other groups in Chile interested in marine work.

Topic Title: Technical Assistance to Port Harcourt College of Science and Technology, Nigeria

Principal Investigator: Nelson Marshall

Funded by: 211(d) \$1,195

The Port Harcourt College of Science and Technology is in the Rivers State, the most endowed region of Nigeria, which has considerable oil and other valued resources. As part of the effort to incorporate income from royalties and other sources into its culture and economy, the state plans to upgrade its educational system, particularly in the technological fields. The capstone is the further development of the College.

At present the College of Science and Technology has ample acreage but only a few wooden buildings and little more than the start of a faculty. The immediate building plan, which is elaborate, is to be matched by an equally elaborate plan for curriculum, faculty and student program development. For advice on the latter goals, the College has called upon the Education Development Center of Boston, which is assembling a consortium of universities in the United States to help with planning and with expatriate faculty input, etc. The University of Rhode Island has provisionally agreed to work in the marine aspects of this, particularly in the fisheries area.

The Director of ICMRD visited the college enroute to Tanzania early this past spring.

Topic Title: Escuela Politecnica de Litoral, Guayaquil, Ecuador

Principal Investigator: John C. Sainsbury

Participating Student: Miguel Fierro (Ecuador)

Funded by:	211(d)	\$3,707
	URI	270

Contacts with this school date back to the fall of 1972 when Professor Sainsbury provided advice on the development of a curriculum for training fishermen. Continuous contact has been maintained with respect to this kind of training, exploring possible broadening of the curriculum.

Ing. Wilmo Jara, Director of the School of Fisheries, Escuela Superior Politecnica de Litoral, Ecuador, spent three months with the URI Department of Fisheries and Marine Technology (February-May 1974) to study its laboratories, curricular matters, instructional methods and techniques, equipment, etc. During his visit he worked with all the faculty of the department and was most active in assembling materials for use in his own program in Ecuador.

Miguel Fierro, who will be an instructor in the program in Ecuador, completed the first year of his preparation in the URI two-year Commercial Fisheries Program. He expects to combine the second year of the fisheries program with initial activities toward a master of science degree in ocean engineering during 1974-75.

The Director of ICMRD visited the school briefly in May to get a first-hand appraisal of their needs. Additionally, Professor Albert Hillier of the URI Department of Fisheries and Marine Technology visited the school during the course of his AID-requested trip to Guayaquil to participate in a U.S. government-sponsored catalog exhibition and seminar on ocean fishing and fish processing.

**Topic Title:** Improved Utilization, Handling and Preservation of Marine Food

**Principal Investigator:** Spiros M. Constantinides

**Participating Students:** L. Yeh (China)  
J. Figueroa (Peru)  
G. Chang (R/China)  
H. Kaplan (U.S.)  
P. Karakoltsides (Greece)  
B. Gold (U.S.)

**Funded by:** 211(d) \$9,801  
URI 1,796

### General

The University of Rhode Island, with its interest and participation in marine food science activities relating to developing nations, continues to investigate the utilization, handling and preservation of marine foods. The projects listed below, partially funded under AID 211(d), are of great interest to LDCs with rich marine food resources. With preliminary work done at URI, information and guidance are being supplied to other institutions in developing countries initiating similar research programs. Graduate students working on these projects at URI return home to apply their knowledge in developing marine food science programs to meet the needs of their countries.

#### Sub-topic: Improved Utilization of the Crab for Human Consumption

Rich crab resources exist in many parts of the world. Simple and efficient methods of processing are needed to make utilization more widespread. A method has been developed to extract a higher proportion of the edible portion of the crab and utilize it in various ways for direct human consumption.

The fresh or frozen crab is sliced and, while still cold, is subjected to hydraulic pressure. The edible portion, which includes meat and other components, is pressed out and collected. A total yield of about 58 percent of the crab's waste is obtained, more than three times that realized by hand or machine picking.

The product obtained is further treated, producing either a paste that may be frozen or a dried homogenous fine powder. The crab paste or powder is of very high nutritional value judged by amino-acid analysis. Various products have been prepared from it during the report period, such as soups, snacks, crackers, dips and extrusions. The powder, which can be used both as a flavoring compound and as a protein-fortifying agent, can also provide feed for aquaculture.

Advantages of the processing method include: (1) the use of fresh or frozen crabs formerly considered unusable due to size, transportation deformation, or inadequate meat content; (2) the use of crab wastes remaining after normal hand or machine picking processes; (3) the use of the edible liquid portion, dried or frozen, for fortification of low protein foods; (4) the use of dried or milled shells as a source of minerals in animal feed; (5) the addition of the crab flavor derived from extracted meat juices to minced blocks of fish or crabmeat to improve flavor; (6) the processing of large quantities quickly; and (7) the possible extension of the method to other crustaceans, such as shrimp or crayfish.

Sub-topic: Alternate Use of Fish Flesh for Human Consumption

Preparation of flavorless and odorless fish paste, similar to the Japanese gels, with spice or flavoring added can be used to improve protein-deficient diets while adding variety to suit consumer tastes.

The homogenous fish paste, with characteristics quite different from the original raw material, can be incorporated into the dietary patterns of non-traditional fish-eating countries such as Peru. Fish flesh from under-utilized species as well as trimmings from fish filleting processes may be used. Tests of the product to date have revealed that fish flavor can be satisfactorily removed, and the paste can be tailored for flavor, color and texture. The preparation process has proven to be simple and inexpensive.

Sub-topic: Comprehensive Review of the Edible Mussel

Large resources of mussels, an excellent source of protein, exist in various LDCs, yet their exploitation is minimal. Because there is no collected information on utilization of the mussel, an under-utilized species, a comprehensive review of the available information is necessary before studies are initiated. Professor Constantinides' students have been collecting this information and are presently in the process of assembling a review paper.

Sub-topic: Utilization of Under-Utilized Species

Many parts of the world have large sources of small shrimp and other crustaceans that have not been effectively or economically used. Preliminary studies (similar to those conducted on the utilization of crab) conducted during the report period were designed to demonstrate that various products suitable for human consumption can be produced. The method in the crab study can be adapted for other crustaceans, such as small-sized shrimp or krill. The product can also be used as feed in aquaculture. In addition, preliminary studies were carried out concerning the use of species such as the shark, ocean pout, skate, etc. Tests are being run using deboning machines to process mixed species with the objective of attaining a uniform product acceptable to the consumer.

Topic Title: International Marine Food Problems

Principal Co-Investigators: Clinton O. Chichester  
Tung-Ching Lee

Funded by:	211(d)	\$20,910
	NIH	}
	ITAL	
Nutrition Foundation		

The University of Rhode Island's program in research related to international marine food problems has expanded rapidly, and one of its food laboratories is currently working in the following research areas:

1. the development of high-protein foodstuffs (particularly infant foods) based on the use of Central American shrimp and trash fish,
2. the development of textured protein products obtained from marine rather than vegetable sources,
3. the development of protein foods from squid and other under-utilized marine resources,
4. the utilization of marine waste products (e.g., red crab waste) as feed for aquaculture,
5. the development of technology in small scale operations for the preservation of marine foods to be used for artisan fishermen and fishing villages in the developing countries.

Efforts to develop expertise in the marine food area have continued over the last three years, and competence has improved for international needs. Funds from the ICMRD 211(d) grant have been provided over a period of two and one-half years in recognition of the importance and need for research and development in this area. These funds were supplemental for projects funded by outside agencies and were directed to the support of research in the marine food area with an international view.

During the fiscal year 1973-74, the supplemental research support was used by Professor Tung-Ching Lee to teach and supervise the varied laboratory research activities (covered here and in Section VI) and to coordinate these with respect to international marine food interests. Funds were also used to purchase some chemicals and supplies needed for the research projects.

Professor Lee was appointed Assistant Professor in the Department of Food and Resource Chemistry and has served as the faculty member responsible for on-site supervision of Professor Chichester's research grants and other projects, as well as his own, during Professor Chichester's official leave

of absence from the University to serve as Vice President for Science and Research at the Nutrition Foundation, Inc., New York City.

Sub-topic: The Development of Protein Foods from Squid and Other Under-Utilized Marine Resources

Investigator: Clinton O. Chichester

Participating Student: C. Lee (Korea)

A new effort based on background studies conducted during the year and entitled Evaluation Factors Limiting the Establishment of Artisan Prawn Aquaculture is currently being considered by the ICMRD. This study outlines the possibility of raising prawn on small farms for human consumption and export marketing. The protein diet needed for prawn should contain a relatively high level of basic amino acids, and it has been shown that squid is the best source of this type of protein. Prawn culture could make a very significant contribution to the world's need for protein that is low in cost and relatively easy to obtain. The project is designed to encourage artisan aquaculture, especially in those areas of the world where squid or other economically feasible species are readily available.

Two papers have been prepared to date as a result of concern with the overall subject of under-utilized marine resources: (1) "The Potential Use of Squid as a Protein Resource" (C. M. Lee, T-C. Lee, and C. O. Chichester) was presented at the FAO Technical Conference on Fishery Products held in Tokyo, Japan, in December 1973 and will be published in the proceedings of the Conference; (2) "Process Requirements and Properties of Spray-Dried Squid Protein" (C. M. Lee, R. T. Toledo, T. O. M. Nakayama and C. O. Chichester) has been published in the Journal of Food Science, volume 39, 1974.

Topic Title: Prospects for International Fisheries Development Assistance

Principal Investigators: Harlan C. Lampe  
Nelson Marshall  
Jon Sutinen

Funded by: 211(d) \$5,679

A study entitled Prospects for Fisheries Development Assistance was published and submitted during the report year, at AID/Washington's request, with the prime objective of spelling out in a general sense the justifications, if any, for extending substantial assistance to developing countries in support of fishery and mariculture projects on a global basis. The report, prepared under the 211(d) grant, addressed itself to the following topics:

- fish and the world need for protein
- potential of the capture fisheries
- the potential of aquaculture
- socio-economic considerations affecting the fisheries potential.

In summary, the report concluded that there is a need to double the world protein supply before 1990, and this need is most acute in the developing countries. For a solution to the world's food problems, one must look not only to the more efficient use of all the known sources of food and protein, but to the development of new nutritional sources along with an assessment of the technical and economic feasibility of doing so. Stressing that the development and use of the world's fishery resources form part of the problem of assessment, the study noted the following:

1. With respect to capture fisheries, the present yield is about 65 million metric tons, while the potential is for a harvest almost double that amount. Geographically this potential exists largely in the waters of, or adjacent to, the developing countries.
2. With respect to aquaculture, the present yield is five to ten percent of the yield of the capture fisheries, but it has a greater potential for increase--in the order of a fivefold growth or perhaps substantially more. With supporting research and planning, the growth of aquaculture is often particularly well suited to developing countries.

3. Much of the development of capture fisheries and aquaculture in the LDCs can be handled best as labor intensive, relatively low capital undertakings. Such an approach increases employment and upgrades the living standards of large numbers of people, with fishermen progressing from subsistence or minimal artisan levels to economically more successful artisan fishery practices. Upgrading the economy and the nutrition of a nation or region must be treated as complementary goals since increased and improved supplies of foodstuffs and other goods require enhanced demand for them through increased income levels.
4. To the extent that these developing countries also move into more offshore ventures requiring more capital, they may run into competition, even conflict, with more developed nations that are continually expanding into new resource areas distant from their shores. Present Law of the Sea deliberations suggest that the developing countries will gain significant control over such fisheries off their coasts. Experience with such interactions indicate that unrestricted competitive pursuits in these fisheries can lead to over-fishing, but that well-conceived agreements between the investment interests of developed countries and the controlling interests of developing countries can be mutually beneficial.
5. Economically, the prospects for developing the fisheries are favorable in that (where subject to comparison) the cost per pound of producing fish protein, both in the capture fisheries and aquaculture, is often less than the cost for other protein sources of equivalent quality. While the prospects are good for producing fish protein more cheaply than other animal protein, development plans depending on such prospects must be considered on a case-by-case basis. Some relatively costly fishery products are in demand as exports; yet from the derived income, other protein may become more easily available to people involved in production.
6. To realize the foregoing benefits it will often be necessary to provide for expansion of present facilities and for new ones in the economic infrastructure. This need can usually be met through economic assistance programs once specific situations are analyzed.

The fisheries sector, the report added, having received relatively little attention, often lags behind other sectors of the economy in development and thus can respond more rapidly. As with any general resource that may be responsive to development, attention to a specific component of the fishery requires a detailed prior analysis of that component and the country or region under consideration. Furthermore,

each component must be considered in the broader context of the fisheries, agriculture and economy of which it is a part.

Assistance extended in behalf of fisheries development must be accompanied by the growth of in-country capability to foster and manage such resource development if benefits are to be maintained.

**Topic Title:** Surface Water Management for Irrigation and Lagoon  
Environmental Modification

**Principal Investigator:** Harlan C. Lampe

**Participating Faculty:** Ronald G. Cummings  
Darrell L. Hueth  
Candace Oviatt

<b>Funded by:</b> 211(d)	\$27,129
RFF	
URI	11,112

This study is designed to evaluate the economic impact on the artisanal lagoon fisheries of transfers of water to the agricultural sector in Mexico.

Lagoon environments are important as nursery grounds and as growing areas for shrimp in many parts of the world. The research in Mexico can be considered a pilot project for other areas in the world.

The principal investigator has spent about eight weeks in Mexico this year gathering data relating to production of shrimp, costs of lagoon modification and operations of fishermen's cooperatives on the lagoons. Dr. Oviatt visited the lagoons on the west coast of Mexico and obtained biological data relating to shrimp.

During the year a hydrologic computer model for use on lagoons was developed and debugged. A biological computer model is being developed to couple with the hydrologic model. A general theoretical economic model has been developed and reported on in meetings in Bogota and Santiago during the year. An operational optimal control model is being developed.

Production conditions and costs in the related agricultural sector have been assayed, and the agricultural sector system will be developed in the coming year.

Two papers are currently being prepared for publication during the next fiscal year.

**Topic Title:** Studies on the Culture of Green Sea Turtles

**Principal Investigator:** C. Robert Shoop

**Participating Student:** Philip Lemkau

**Funded by:** 211(d)        \$5,670  
                  URI                8,000

The value of the green sea turtle (Chelonia mydas) is based on its high quality meat, leather, and belly cartilage for soup (calipee), in addition to its liver for paté, fat for oil and shells for decoration and tortoise-shell items. The turtles, which are the only large edible marine animal in most tropical areas, contain about 40 percent edible, high protein, low cholesterol meat. Adults are essentially herbivorous. Their worth lies not only in quality and value of meat and other products but also in their role as grazers in tropical marine pastures not now being used for human food production.

Sub-topic: Rare Earth Tagging of Hatchlings

A major obstacle to turtle culture is the procuring of viable eggs without depleting endangered natural stocks. The protection of natural nesting beaches or nesting females might allow the harvesting of a percentage of eggs for mariculture projects, but survival in the wild is unknown. Before this method could be used commercially, natural survival, as well as the potential for augmented survival, must be understood.

One reason for the current lack of information is that a permanent method of marking hatchlings has yet to be developed. The enormous growth rate of sea turtles has made tagging by mutilation, identification plates and other attempted methods unsuccessful. Radioactive tagging of potential food items is prohibited.

The objective of the URI effort, partly supported by 211(d) funding, is to perfect a method of marking hatchling turtles in sufficient number to determine natural survival and movements. The assumption that nesting adults return to their hatching beach can be tested. If protective measures on nesting beaches could be shown to increase natural survival, establishment of captive breeding stock might be less critical in the culture of sea turtles.

One of the potential problems of sea turtle mariculture--identification of captive-raised stock in order to protect wild populations by allowing marketing of tagged animals only--could be eliminated by use of the following technique:

Hatchling turtles used, obtained from Costa Rica and Ascension Island, are injected with a europium chloride-citrate complex in varying concentrations. Europium deposited in liver and bone can be identified in extremely small amounts by neutron activation analysis. Progress to date has included establishment of suitable culture facilities, including large heated tanks, in the seawater aquarium building on the Narragansett Bay campus of the University. Turtles being reared, which are fed fresh fish, algae and trout food pellets, are experiencing normal rapid growth.

Neutron activation techniques have been perfected. Equipment required for analysis is available in the Rhode Island Nuclear Science Center reactor operated at two megawatts.

Preliminary studies on europium tolerance and permanence of the tag have been completed (Forbes, 1972). Procedures for injection and tissue changes associated with europium tagging are underway, with the cooperation of the Animal Pathology Laboratory at URI. Several animals tagged as hatchlings in 1972 and now approaching 70 pounds are being monitored through activation analysis for bone europium levels to confirm the validity of the technique.

Rapid injection methods are planned including development of a suitable gun injector for intraperitoneal injection with low potential for tissue damage and suitable for marking thousands of turtles in the field. Study of the physiological effects of europium, along with studies of normal sea turtle tissues, is planned and will provide basic information for use in mariculture operations. Field testing of the techniques in Costa Rica is planned.

#### Sub-topic: Design and Construction of Culture Cages

Planning has been completed for a proposed project designed to determine the feasibility of using small-scale cages for culture of the green sea turtle. There is considerable controversy on the advisability of culturing this endangered species. Therefore, research into the feasibility of small-scale culture by native tropical shore dwellers in developing countries merits thorough investigation prior to any decision concerning the implementation of culture programs.

Green sea turtles a few months old turn from a carnivorous to a herbivorous diet. At this time it should be possible to place animals into cages into which sea grasses (normal food) could protrude for grazing. During storms the caged animals could be kept on shore. Cages constructed

from locally available materials must be easily maintained and moved.

The purpose of this sub-project is to design a cage or set of cages useful for this type of culture and to experiment with different cage-bottom configurations that allow entry of sea grasses while preventing the captive animals' escape. Laboratory and field tests can be conducted in Rhode Island eel grass beds in the warm seawater in early autumn. Subsequent studies could involve comparison of tank- and cage-reared animal growth rates, effects of grazing, frequency of cage movement and supplemental feeding of caged animals by easily obtained vegetation, garbage or fisheries waste.

Topic Title: Hot Smoke Fish Curing in West Africa

Principal Investigator: Milton Salomon

Participating Faculty: Tung-Ching Lee  
Clinton O. Chichester

Participating Student: Matthew Caurie (Ghana)

Funded by:	211(d)	\$19,032
	URI	} 13,000
	NSF	
	Nutrition Foundation	

Under the direction of Professor Milton Salomon, assisted by Professors T-C. Lee and C. O. Chichester, Mr. Matthew Caurie is investigating fish smoking technology as a method of alleviating protein shortages under the 211(d) grant. Traditional West African systems of smoking fish in wood fires produce hot smoked fish of poor quality. Mr. Caurie's research involves fabrication of smoking ovens from existing barbecue machines and development of a method for fish smoking based on traditional West African wood-firing techniques. This new technique should produce smoked fish with higher nutritional and physical qualities.

The success of the project will be assessed by running Protein Efficiency Ratio (PER) tests, using fish smoked by methods developed in this study as the source of protein against a control.

A number of smoke-oven designs were fabricated and test run during the report year to determine the evenness of their smoke distribution within the chamber. One design has been found acceptable and is now being used to evaluate the factors known to be responsible for high quality hot smoke fish curing.

Initially a 2<sup>4</sup> factorial ABCD confounding experiment design is being used to study the effect of the following factors: humidity, smoke velocity, smoking temperature, and drying temperature (separately and in combination) on the physical and chemical quality of smoked fish.

Quality is being assessed with regard to physical factors--color of the smoked fish by extraction and colormetric estimation and fragility by estimation of free hydroxyproline content--and chemical factors--smoke deposition by phenol estimation, total protein estimation, and breakdown of protein during processing (presence of free-SH groups and hydroxyproline).

This initial study will permit the best factor or combination of factors to be selected for detailed nutritional investigation, including biological studies, in the coming year.

Topic Title: A Study of the Prospects of Marine Resources Development in the Caribbean Region

Principal Investigator: Lewis Alexander

Participating Students: Stella Vallejo (Argentina)  
Vincent Morgan (U.S.A.)

Funded by: 211(d) \$10,227  
Sea Grant 5,000

### Introduction

The Caribbean Region is a semi-enclosed sea surrounded by an array of independent and dependent countries, all of which are economically categorized as developing. The Region, therefore, constitutes a definable opportunity area for research concerning the problems and promises of development of marine resources. The International Center's Caribbean Marine Resource Development Study Project was designed to take advantage of this opportunity.

### Background

Research into marine-related development in the Caribbean by the Geography Department began in January 1973 with an investigative search of relevant literature. Bibliographical work, along with the formulation and evaluation of the structure and prospects of marine resource development schemes in the Caribbean, was continued during the summer and into the fall of 1973.

Initial inquiry was made to a group of organizations with interests in Caribbean and/or Third World development. Responses to these queries included information on the organizations themselves, suggestions for additions to the bibliography, factual and statistical data, analysis and opinion papers concerning Caribbean development, and the names and addresses of other organizations and individuals to contact for further input. Concurrently, preliminary analysis of the information was begun to form a reasonable estimate of the status of marine resource development in the Caribbean.

### The Study

The specific objectives of the on-going study are:

1. to assemble an enlarged bilingual bibliography of books, periodicals, papers, statistical summaries, etc., concerned with topics both generally and specifically related to marine resource development in the Caribbean Region by, with, or for the nations of that region;
2. to produce a generalized interpretation of the available information to provide an overview of the major problem areas confronting a coordinated, multi-national marine resource development program of the Caribbean;
3. to identify wherever possible those more specific factors (historical, existent and anticipated) which will either enhance or retard such development;
4. to assemble a directory of individuals, firms and institutions which are directly or significantly involved with marine resource development in the subject area; and
5. to specify topics or areas for further research, including recommendations for the methodology of such research.

Work to date has indicated an overwhelming disaggregation of marine-related activities and plans in the Caribbean area. This same phenomenon is also true of almost all other activities found there, leading the researchers to the conclusion that the Caribbean does not constitute a cohesive region in anything but the loosest geographical (i.e., physical) sense of the word.

The fact of essential non-regionality in the Caribbean leads to the recommendation that future marine-related aid, assistance or study projects of the U.S. Government in general and ICMRD specifically should not be directed at "the Caribbean" as a whole, but that such programs be designed to deal with those sub-regional bodies which have achieved some success and stability. These are, at present, primarily those organizations which deal in essentially economic matters: in Central America, the Central American Common Market (CACM); in South America, the Latin American Free Trade Association (LAFTA); and in the archipelago, the Caribbean Free Trade Association (CARIFTA) and its constituent sub-division in the Eastern Caribbean.

While these constitute the most viable integration movements in the area, attention should also be paid to the organizations of the still influential metropolitan powers: France, the Netherlands, the United Kingdom and the United States.

In sum, the area's history of failures to integrate provides the best argument against programs aimed at the entire Caribbean. History indicates that no "Caribbean Region" exists, and attempts to administer a program on that level would likely be frustrated. More recent history, however, identifies some viable economic sub-regions, and by working through and with these a marine-oriented program will be most likely to succeed.

Alone, the developing Caribbean economies can only compete for investment and aid; in groups, however, the divisive forces of that competition may be mitigated and a more stable situation allowed to develop. Assistance directed to the marine activities of these blocs would certainly contribute to their individual successes, and the resulting economically healthy groups would be in a better position to cooperate with one another for further development.

Topic Title: Commercial Fisheries Education/Training Program at the  
University of the South Pacific, Fiji

Principal Investigator: John C. Sainsbury

Participating Student: Robert Stone (Fiji)

Funded by:	211(d)	\$ 350
	URI	6,000

Robert Stone, Fisheries Officer in the government of Fiji, completed the first year of the URI Commercial Fisheries Program and will be continuing for his second year.

As a part of a Special Problems course, Stone undertook the development of a three-year commercial fisheries/education training program to be based at the University of the South Pacific, Fiji.

The final technical document will be completed shortly after some follow-up work in Fiji.

Topic Title: District of Sao Miguel, Azores

Principal Investigators: Nelson Marshall

Participating Faculty: James Cobble  
Andreas Holmsen  
Harlan Lampe

Funded by: 211(d) \$3,147

A plan is being formulated to offer to this district in the Azores a close linkage for developing extension activity in both agriculture and fisheries. The plan would help meet the most obvious need to upgrade and modernize the rural economy of the province. It would involve visits of both staff and students from the Azores to the University of Rhode Island and a flow of people from the University of Rhode Island to the Azores for the expertise most needed.

During the course of the past year, a team of two men, Professors Lampe and Cobble of the University of Rhode Island, spent two weeks in Sao Miguel formulating the desired plan. Shorter visits were made by Professor Holmsen, who specializes in fisheries, and the ICMRD Director.

Topic Title: Water Resources Management

Principal Investigator: Ronald G. Cummings

Participating Faculty: Darrell L. Hueth  
Harlan C. Lampe  
James W. McFarland

Participating Officials and Faculty: J. Millan (Colombia)  
J. Saldariagga (Colombia)  
F. Martinez (Chile)  
J. Poblete (Chile)  
A. Durojeanni (Peru)  
J. Rocha (Mexico)

Funded by:	211(d)	\$13,362
	URI	8,000

During the past year efforts have been concentrated on two research projects, Lagoon Management and Irrigation Activities in Northwest Mexico and Groundwater Management and Salinity Control for Coastal Irrigation Areas in Northwest Mexico, funded partially by 211(d) and partially by a Resources for the Future (RFF) grant. Interim progress reports on this research were presented at RFF-sponsored seminars on water resources research in Latin America held in Bogota, Colombia, in November 1973, and Santiago, Chile, in June 1974. Two visits, also sponsored by RFF, were made to Mexico City and Hermosillo, Mexico for the purpose of data collection.

The Groundwater Management and Salinity Control Study attempts to provide an inter-temporal management scheme for a coastal irrigation district in northwest Mexico. The only source of irrigation water in the area is a ground aquifer which is currently being mined. But as it is mined, salt water intrudes, and the aquifer is gradually destroying. Irrigated agriculture is at present the primary source of resident income, and the study provides information regarding the value of agriculture in terms of incomes generated. It also provides information useful for comparison to marine-related activities presently being considered, e.g., rearing shrimp in local lagoons. In analyzing these marine activities, information relating returns and costs in alternative forms of economic activity is required. Thus, primary criteria for study success are the usefulness of the results to Mexican officials in managing the irrigation area, and the use of the results as input in the evaluation of marine-related area activities.

Professor Cummings has been working with Latin American colleagues in the above areas providing constructive criticism on their in-country projects. In general these efforts have provided an unquantifiable increase in expertise gained by the Latins as a result of these integrated research efforts and the published reports listed in the publications section of this report. Additionally, two faculty members, Professors Hueth and McFarland, have gained experience in developing-country work here.

Topic Title: Coral Reef and Reef Lagoon Studies

Principal Investigator: Nelson Marshall

Participating Student: Thierry G. Jacques (Belgium)

Funded by:	211(d)	\$15,650
	URI	2,000

A fundamental question exists about the productivity of coral reef communities, both normally and stressed with silt, freshwater runoff and pollution resulting from land utilization and development of tropical coastal areas. The sustenance of this productivity is inseparable from the sustenance of the fisheries harvests and related food returns to the people inhabiting these areas.

The effort of the past year focused on testing applicable techniques of production measurement; rate of carbonate formation as assayed by alkalinity changes, and rate of productivity as assayed both by oxygen and carbon dioxide changes. Reassuring results were obtained on the application of the methods and the extent to which they can be used to discriminate ecological differences. With this information, coupled with field observations on test sites in Puerto Rico, a plan for the next phase of the study was formulated.

The 211(d) base-grant support has served as seed money to plan for a larger AEC-funded cooperative program with the Puerto Rico Nuclear Center of the University of Puerto Rico which would be of worldwide applicability.

Topic Title: Economic Demand Relationships of Fisheries Resources under  
Extended National Jurisdiction

Principal Investigator: Harlan C. Lampe

Participating Student: Lars O. Vidaeus (Sweden)

Funded by: 211(d) \$9,144

Decision making relating to the utilization and development of fishery resources under conditions of extended national fishery jurisdiction requires as one essential input information on the demand relationships at various market levels. Determining the significance and nature of such relationships, including analysis of market structure, is the objective of a planned study developed during the past year--to obtain information on the herring reserves of the U.S. east coast and on European demand--to establish the significant evaluation parameters. This technique, which has general applicability, appears to be of substantial value in decision-making in the Third World as developing countries' fishery jurisdictions expand. A small ICMRD funding contribution to the study is designed to insure evaluation of implications for the developing countries and application to future specific assessment tasks in areas of Center interest.

Topic Title: Education

Funded by:	211(d)	\$3,699
	URI	5,000

Various elements of the University's educational programs have relevance to Center and LDC needs. While limited support to participants in research is described elsewhere in the report, the educational development effort is assuming increased importance as a Center activity of major importance and as such is accumulated here.

Sub-topic: Master of Marine Affairs Program

Investigator: Lewis Alexander

In the Master of Marine Affairs Program, a highpoint was reached in terms of inquiries and applications from both national and international students. Of the 29 students enrolled, there were ten unsponsored civilian students; three employees of NOAA; seven senior military officers from the Naval War College; four military officers on sabbatical leave or functioning with military staffs; one staff member from the Office of the Oceanographer of the Navy; and four international students. The latter group consisted of a female oceanographer from France, a zoologist from New Zealand, a professor of marine engineering from Ghana, and a professor of marine biology and oceanography from Chile. The Chilean professor, who studied in the Fisheries and Marine Technology Department as well as the Marine Affairs Program, was supported by the Center, a fact which triggered complementary funding from UNESCO for the Ghanaian professor.

The entire class of 1973 is currently employed with all but one graduate working in a marine-related field. More than 80 percent of the graduates of the four previous classes are employed in marine-related fields.

Steps were taken to develop a doctoral program in marine affairs, and a Marine Affairs Journal was initiated to promote widespread distribution of the students' papers and reports.

Sub-topic: Resource Economics (Marine Resource Option)

Investigator: Ronald G. Cummings

Five students were graduated with the Ph.D. in Resource Economics (Marine Resource option) and nine were enrolled in the program. Positions taken by the graduates were: economist for the Canadian Department of the Environment, economist with the Atomic Energy Commission, research associate with the URI Department of Resource Economics, economist with the National Marine Fisheries Service, and instructor at Connecticut College. Some of the research specified in prior reports was accomplished by these individuals.

Sub-topic: Commercial Fisheries

Investigator: John C. Sainsbury

In the two-year Associate Degree program in Commercial Fisheries, 11 of the 14 students who were graduated in 1973 are now employed in the commercial fishing industry and three are continuing their studies in the Marine Resources option of the bachelor's curriculum in natural resources. The September entry of freshmen totalled 33. There were two foreign students from Ecuador and one from Fiji. Interest in the program by LDCs continues to grow.

Sub-topic: Ocean and Mechanical Engineering

Investigator: Herman E. Sheets

Eleven students were graduated from the graduate program in ocean engineering and all have found employment in government or industry. In the joint program in ocean and mechanical engineering, seven students were graduated in 1973. A survey of the incoming College of Engineering freshman class indicates that 14 students intend to enroll in the joint program. Projects in this area--aquaculture systems and artisan fishing facility design--while presently not funded by the Center, are of increased interest in LDCs like Tanzania. Three foreign students are enrolled in the graduate program, two from the Republic of China and one from Japan.

Topic Title: ICMRD Technical Library

Principal Investigator: Jacqueline P. Alexander

Funded by: 211(d) \$15,289

The ICMRD Library material consists principally of reports, technical papers, and up-to-date statistical material relating to marine resources in developing countries--predominantly material not available in normal library collections in the U.S. or internationally. In addition to such specific information, holdings also include publications relative to such broad topics as technology transfer, general works on mariculture/aquaculture, and nutritional information relating to protein needs in developing countries and the use of fish products to satisfy such basic needs. These various publications have been organized into a working collection making the material accessible to the staff and researchers of the Center and also to graduate students and faculty in related marine disciplines throughout the University.

Because of the non-book format of much of the material, it was necessary to devise a form of cataloging and classification which would lead to efficient organization with a minimum of expensive and time-consuming input. After investigating and experimenting with various techniques, it was decided that an adaptation of the computerized classification, already in use for the Sea Grant collection, would be most efficient. This decision was based on several factors: the type of material, the ease of classification, the existence and successful use of the computer program, and the possibility for integration of the various University marine-related collections into a combined print-out. Final details of this computerization are now being completed; the system will allow "on-line" input and also produce library cards in standard format. Once all holdings have been entered into the system, it will be possible to produce print-outs of whole collections or portions for interested parties.

The acquisition of material for the collection is a daily activity requiring familiarity with current literature and knowledge of sources. Many of the documents are available only directly from foreign governments, agencies within countries, or international groups. Personal contact and letters are important. Material must be acquired as soon after publication as possible because of the need for up-to-date information and because such material is often produced in limited quantity and once out of print impossible to acquire. No attempt is made to acquire materials for the

ICMRD Library which are already in the main University Library or the Pell Marine Library.

Close liaison is maintained with staff members and researchers to determine areas of investigation and direction of research. An attempt is made to develop material in fields where future interest is indicated as well as to maintain ongoing topics.

Where necessary, bibliographies are prepared and in-depth literature searches are undertaken for staff members and supporting groups, such as the University publications office.

Service function performance is difficult to measure; however, library use has increased in recent months reflecting improved collection and acquisition facilities and increased awareness of the Library. The organization and cataloging of the collection has improved accessibility. Frequent requests are received for easily retrieved information, principally statistical data. Requests for obscure or foreign citations require more time, and it is not unusual for such searches to take months. Because of this, staff members increasingly contact the Library while projects are in the planning stage so that material will be available during the active period of investigation.

**Topic Title: Seminars for Development of International Institutional Capabilities**

Funded by: 211(d)        \$1,000  
                   URI                2,000

An informative series of seminar-type reviews are conducted throughout the year at which on-campus investigators present to the Center Associates and other faculty, staff and visitors the international aspects of a research/educational topic with which they are intimately involved. The seminars provide a strongly interdisciplinary review of activities and a forum for different interests and approaches to international development to be aired, as well as enlarge the circle of interested faculty and students who may be needed in the future.

The topics of the current year's program are listed below.

28 November	James W. Cobble	"Cobble on Korea"
12 December	Harlan C. Lampe	"Fisheries in Vietnam Today"
23 January	Thomas S. Estes	"International Development Programs--U.S. Organization and Methods"
13 February	Spiros M. Constantinides	"Fish as Food in Japan"
6 March	Thomas A. Grigalunas	"The Economics of Offshore Petroleum Development"
25 April	John C. Sainsbury	"Fishermen's Training Overseas"
15 May	Richard B. Pollnac	"Sociology/Anthropology and Marine Resource Development"

#### C.IV. Impact of Grant-Supported Activities in Developing Institutional Capabilities

The overriding function of the various 211(d)-supported research efforts in Section III, as well as the Center's interests in many of the non-211(d)-funded studies in Section VI, is to sustain a response capability for the agency's needs while developing through utilization the knowledge, skill and interests generated in the academic community during the early phases of the grant. This transition is currently underway.

Within the past year, five persons at URI with advanced faculty status have been on assignment for AID/Washington, the USDA, FAO, FAO/IDB, and the Brazilian government. Four were full-time faculty who were required to take leave or reassignment status to carry out this work. The average duration of their assignment was in the order of four to five months. In addition, four junior professionals with recently completed Ph.D. or master's degrees and considerable field experience have been on overseas assignments.

Advisory effort from the Director of ICMRD and Resource Economics and Food Technology faculty being made in support of overseas interests includes, for example, the development of our role as publishers of an advisory report on developing a marine resources center for Tanzania. Additionally a number of research efforts in coastal artisan fisheries and aquaculture are underway on campus.

In that the 211(d) program has sustained only five full-time faculty positions and an average of seven graduate technical research assistants, the use of nine-plus persons overseas is impressive.

The research activity and pilot assistance efforts described in this report are geared to provide new information and techniques for technological and socio-economic needs for LDCs, as well as transfer of that knowledge, within the grant's focused objectives. The current thrust of this activity is pointed toward programs designed to be of sufficient value and interest to elicit LDC and overseas mission support as well as to encourage active interfacing with existing international and multi-national granting agencies and foundations.

The process of institutional involvement cannot be static, for people change and required disciplinary needs change both in technologies and applications. A continuing effort must be made to involve new people and interests within and between the universities involved. In order to make the maximum use of the limited non-program-peculiar funding available for this task, the Center approves partial contributions in many research areas within the academic community. The approximate equivalent of five full-time faculty salaries are spread as widely as possible in order that needed disciplines can be integrated as necessary into the development process.

Work under the Center's direction is becoming more sharply focused to the primary grant objectives while being tailored in organization to a problem/project type of arrangement. Specific goals, performance cost-schedule commitments and evaluations are being set for work performed.

The incorporation of the large number of Center interests into a workable, congruent whole that integrates research problems, geographic areas, academic disciplines and cooperating institutions continues to consume considerable planning effort. Some preliminary working documentation of this effort is included in the Future Plans section. A tool such as this allows better assessment of work value and priorities for Center and AID interests.

The University's management structure is being brought more frequently and specifically into problems and planning as interest by the Center and AID management is intensified. In the long term this management involvement at the state, the university and the college level raises the level of awareness and desire to participate on the part of the faculty and staff presently involved, or anticipating involvement, in Center activities, as well as providing impetus to tailoring programs and policies in the Center's interest. Other international and institutional linkages are forged or reinforced at these higher management levels.

In conformity with legal regulations including Executive Order 11246, as amended by Executive Order 11375, and Title VII of the Civil Rights Act of 1964, the University of Rhode Island has developed a comprehensive Affirmative Action Plan. The Plan encompasses organizations within the University community such as the International Center for Marine Resource Development.

The aim of the Affirmative Action Plan is to increase the number of minority group members and women in the labor force of the University and to provide them with equal opportunity to develop to their full potential. The University actively seeks out and hires minorities and women for all available positions, and all URI employment advertisements state "An Equal Opportunity/Affirmative Action employer. Minorities and women are encouraged to apply."

An Equal Employment Opportunity Committee, consisting of seven persons, has been established to consider complaints of discrimination in employment on grounds of race, color, religion, sex, or national origin. Committee members, appointed by the University president, include representatives from faculty, administration and other staff. It is required that minorities and women be represented on the committee.

During the report year, seven professional and administrative women were funded by 211(d). Professional: Jacqueline Alexander, Bettye Gold, Stella Vallejo. Administrative: Virginia Bowerman, Miriam Murray, Stephanie Pazis, Elizabeth Tefft.

### C.V. Utilization of Institutional Resources and Development

As the University of Rhode Island's 211(d) grant has matured, the escalating use of the Center, as a means of tapping the University's capabilities in disciplines related to marine resource development, reflects its changing role. While the initial grant objectives favored the building of international interest and capability among the faculty, staff and student body in the grant's focal arena, the achievement of current goals will be measured in a large sense by the amount and kind of institutional resources by LDCs, either under sponsorship by AID or others.

The Center's current policy reflects the AID 211(d) goals of sustaining its response capability for AID-congruent activity through use. In that the grant's clearer present focus--development of artisan fishing and coastal aquaculture--is still in the process of being defined in depth by the Center and in that the agency is likewise examining its role in the marine area, the bulk of our work has been concentrated in preparatory effort for downstream full-scale implementation.

However, even in this current status, much involvement and interest from LDCs is evident from a careful analysis of the detailed task reports noted in Sections III, V, and VIII, with funding as specified in Table II, Section IX.

The following topic areas extracted from those sections reflect to a substantial degree, directly or indirectly, requests for support from LDCs.

Requests for support from foreign countries received from:

Brazil (ITAL--CODOT)

Guatemala (ICAITI--CODOT)

University of Dar es Salaam,  
Tanzania

Instituto del Mar, Peru

Universidad Catolica de  
Valparaiso, Chile

Vietnam (USDA)

Port Harcourt College, Nigeria

Escuela Politecnica de Litoral, Ecuador

Guayaquil, Ecuador -- Catalog exhibition and seminar on ocean  
fishing and fish processing

University of the South Pacific, Fiji

District of Sao Miguel, Azores

Belize

Mexico (Artisan Fishing)

Mexico (Water Resources Management with Resources for the  
Future grant)

A review of some of the visitors to the Center during the report year provides another indication of the breadth, scope and potential for international interest and involvement, ranging, in addition to American institutions, from international aid organizations (UN, IDB), foundations, educational/research institutions, to foreign national governments and regional agencies. Establishment and reinforcement of linkages and development of interests with URI faculty and researchers has resulted.

A representative list of internationally-oriented visitors to ICMRD during the report year includes:

Roy Lee  
UN Office of Ocean Economics and Technology

Richard Meunier  
Graduate School of International Studies, University of  
Denver

Andres Couve  
International American Development Bank, FAO/IDB  
Cooperative Program

Dr. John Liston  
University of Washington (CODOT)

Barbara Summers  
Rhode Island World Affairs Council

Gov. Sabara  
Indonesia

Ricardo G. Castaneda  
Ministerio de Relaciones, San Salvador

George Hall  
LaSalle Foundation, Margarita Island, Venezuela

Dr. Patric M. Arnaud  
Station Marine d'Endoume, Marseille, France

Taylor Pryor  
formerly with Oceanic Foundation

Prof. Pablo Herrera  
Universidad Catolica de Valparaiso, Chile

Ricardo M. Moragas  
University of Barcelona, Spain

Dr. Sergio Gonzales  
Universidad Catolica de Valparaiso, Chile

Omar Mzee  
East African Marine Fisheries Research Organization, Tanzania

Dr. Jose Pastore  
Brazilian Director of Planning

Dr. Agric. Trygve Gjedrem  
Agricultural University of Norway, Institute of Genetics and  
Breeding

Motoyoshi Tanaka  
Kagoshima Fisheries High School, Kagoshima, Japan

Dr. Oscar Guillen  
Instituto del Mar, Lima, Peru

Dr. Craig B. Kensler  
University College, Galway, Ireland

Yet another indication of international involvement is in the foreign student activity in investigations oriented toward marine resources at the University of Rhode Island. A listing of the foreign graduate students and their areas of study appears on the following pages.

**Table D.**  
University of Rhode Island

INTERNATIONAL CENTER FOR MARINE  
RESOURCE DEVELOPMENT

<u>Department</u>	<u>Student Name and Country</u>	<u>Major Professor</u>	<u>Area of Work or Thesis Title</u>
Animal Science	F. Orach-Meza (Uganda)	T. L. Meade	Population dynamics study on selected marine specie
Chemistry	S. Y. Tang (R/China)	C. W. Brown	marine-related work, but not in connection with thesis
	P. Mukherji (India)	R. D. Gonzalez	working with silica surfaces--possible marine application
	S. C. R. Chen (R/China)	D. Rosie	gas chromatography--possible marine application
	A. Krstulovic (Yugoslavia)	D. Rosie	
	W. P. Leo (R/China)	C. W. Brown	marine related, no title yet
Food and Nutritional Science	J. Figueroa <sup>1</sup> (Peru) <sup>2</sup>	S. Constantinides	An Alternate Use of Fish Flesh for Human Consumption
	G. H. Horng (R/China)	H. Dymza	Dietary Variables in Rainbow Trout Fed a High Level of Oxytetracycline in a Closed System
	S. F. Ting (R/China)	H. Dymza	Intermediate Moisture Fish Preservation
	L. Yeh <sup>1</sup> (R/China)	S. Constantinides	Improved Utilization of Crabs for Human Consumption
Food and Resource Chemistry	M. M. Ali <sup>1</sup> (Bangladesh)	T. L. Meade	Thiol amino acids in quality control and nutritive value of fishery products
	J. Anaya (Colombia)	C. O. Chichester	Unavailable Peptides from the <i>in vivo</i> Digestion of Maillard Ova Albumen
	M. Quarie <sup>1</sup> (Ghana)	M. Salomon	Improvement in the Technology of Traditional Hot Fish Smoking
	A. Cheng (R/China)	C. O. Chichester	Effect of age on the utilization of protein (including marine protein)
	T. Chen (R/China)	T-C. Lee	Effect of Processing Variables on the Nutritive Quality of Food Products Produced by Extrusion Cooking (including marine food products)
	C. Lee (Korea)	C. O. Chichester	Physiological Consequences of Non-Enzymatically Browened Food
	H. Mayorga (Guatemala) <sup>2</sup>	C. O. Chichoster	The Use of Cottonseed Protein to Make a Cheese-Like Product
	M. Tanaka (Japan)	C. O. Chichester	Effect of the Browning Reaction on Quality, Digestion and Absorption of Protein
	D. Thananunkul (Thailand)	T-C. Lee	The Use of Indigenous Proteins of Thailand--including marine proteins--to develop new food products
	J. Kuo (R/China)	K. L. Simpson	Working on the utilization of crab waste as a protein and pigment source for trout and salmon
Master of Marine Affairs	E. A. Ayisi (Ghana) <sup>2</sup>	L. M. Alexander	Ocean Resource Development and Related Problems
	B. A. Deniaux (France) <sup>2</sup>	L. M. Alexander	The European Community and the Sea
	V. A. Gallardo (Chile)	L. M. Alexander	Chile's National Interest in the Oceans
	D. B. Gordon (New Zealand) <sup>2</sup>	J. K. Gamble	New Zealand's fisheries

<u>Department</u>	<u>Student Name and Country</u>	<u>Major Professor</u>	<u>Area of Work or Thesis Title</u>
	S. Professorsky (Israel)	L. M. Alexander	The Mediterranean Coast of Israel--A Planner's Approach
	S. A. Vallejo (Argentina)		not yet determined
Mechanical Engineering & Applied Mathematics	A. Faiz (Iran)	R. Lessman	Measurement of Turbulent Skin Friction in Straight, Divergent and Convergent Channels
	H-Y. Kuo (R/China)	M. Wilson	Flow Oscillations in Cryogenic Instrument Lines
Ocean Engineering	M. Inoue (Japan)	H. E. Sheets	
	S. J. Kuo (R/China)	F. W. White	
	Y. C. Lee (R/China)	T. Kowalski	
Oceanography	A. Ahmed (Sudan)	R. A. Duce	Trace metals in seawater
	M. Bhovichitra (Thailand)	E. Swift	Nitrogen metabolism in marine algae
	E. Durbin (New Zealand)	T. Smayda	Autecological studies of marine planktonic diatom <u>Thalassiosira nordenskioldii</u>
	T. Jacques <sup>1</sup> (Belgium)	N. Marshall	Coral reef communities
	D. Lai (Hong Kong)	P. Richardson	Search for Gulf Stream rings in the western Sargasso Sea using modern data listings
	Y. J. Liang	D. Kester	Chemical Oxidation-Reduction Processes in the Marine Environment
	M. Tapia (Spain)	J-G. Schilling	Geochemistry of Submarine and Subaerial Rocks from the Azores Region
	T-C. Teng (R/China)	T. Smayda	Ecological studies of marine planktonic diatom <u>Asterionella japonica</u>
	C. Unni (India)	J-G. Schilling	Geochemistry of Cl and Br in basalts from the Iceland-Reykjanes Ridge System and Hawaii
Pharmacognosy	F. M. Soliman (Egypt) <sup>2</sup>	H. W. Youngken	Microbiological Transformation of Marine Pucosterols
Resource Economics	J. Abgrall <sup>1</sup> (France)	T. Weaver	A Cost-Production Analysis of Trap and Hand Line Fishing in Puerto Rico
	P. Y. Liao (R/China)	H. Lampe	Recent Trends in Taiwan Fisheries with Reference to External Aid Programs
	A. Marchant (Chile)	A. Holmsen	The Present Status and Potential Utilization of the Southern New England Cancer Crab Resources
	L. Vidneus <sup>1</sup> (Sweden)	H. Lampe	Economic Considerations of Artisanal Fishermen
	L. Adriasola <sup>1</sup> (Chile)	H. Lampe	
Commercial Fisheries	M. Fierro <sup>1</sup> (Ecuador) <sup>3</sup>	J. Sainsbury	
	R. Stone <sup>1</sup> (Fiji)	J. Sainsbury	

<sup>1</sup>Study project supported fully or partially by 211(d) funds.

<sup>2</sup>Student has returned to native country.

<sup>3</sup>Except for Fierro and Stone, whose work in the Commercial Fisheries Program has obvious marine application, this list does not include undergraduate foreign students, many of whom are enrolled in marine-related courses.

The New England Marine Resources Information Program (NEMRIP), based at the Narragansett Bay Campus of the University of Rhode Island, which received 208 requests for specific publications from 22 countries, also reflects international interest.

Argentina	6
Australia	5
Brazil	6
Canada	75
Chile	5
Ecuador	2
England	10
France	4
Ghana	2
India	15
Italy (FAO)	15
Ireland	4
Japan	25
Mexico	7
Netherlands	1
New Zealand	6
Philippines	4
South Vietnam	2
Portugal	2
Venezuela	8
Wales	2
West Germany	2

This is in addition to a much wider circle of interested subscribers to the NEMRIP general newsletters and other publications. A definite upward trend in international interest in this information source has become apparent over the past several years.

C.VI. Other Resources for Grant-Related Activities

The topics reported in this section, while not supported in any way by the Center's 211(d) funding, have been closely related to the overall thrust of ICMRD activity because of their obvious potential relationship to our interests. Results from some of these comparatively heavily-funded research efforts could in the future be directed to tasks which are of sufficient interest to warrant full or partial coverage from ICMRD.

Costs associated with these tasks have been estimated and are included in Table I, Section IX.

Topic Title: The Consortium for the Development of Technology (CODOT)

Chairman: Clinton O. Chichester

Funded by: AID ROCAP \$179,915  
Location: Guatemala (ICAITI)  
Dates: November 1, 1972 - October 31, 1974

Funded by: Council of Science and Technology, Government of Sao Paulo,  
Brazil \$1,993,000  
Location: Brazil (ITAL)  
Dates: September 1, 1973 - September 30, 1975

The CODOT program is too broad in scope to present in this report except in brief overview.

It is a joint effort of five food science departments across the United States. They are located at the Universities of Washington, Wisconsin, California at Davis, Michigan State and Rhode Island. The program is administered at the University of Rhode Island. These universities were selected for their expertise in the following areas of food technology:

- teaching and research in food science and technology of fishery and other marine food resources;
- teaching and research related to better utilization of dairy products and the augmentation of programs of food safety, both of which are of extreme importance in the developing countries;
- teaching and research in the problems of the preservation of fruit and vegetable products and in the study and utilization of fermentation as a means of preservation in developing countries;
- teaching and research in the area of animal products (primarily meats) and of food engineering; and
- teaching and research on the utilization of marine products for human food and animal food supplements, the economic management and nutritional integration of marine products with agricultural products, and pesticide monitoring of marine foods.

Since fisheries and marine technology is incorporated in these five areas of food technology represented in the organization of CODOT, it is hoped that this organization will have a major and lasting impact on the development of commercial fisheries as well as training in fishery skills throughout the developing world.

Brazil The Consortium activity in Brazil involves a cooperative program with the Instituto de Tecnologia de Alimentos (ITAL). The program is divided into five projects, paralleling CODOT's major areas: meat technology and production, fisheries and marine technology, tropical fruits and vegetables, economics and marketing for processed foods, quality control and pesticide residues. To date six graduate students and four trainees have come to the United States to study in selected areas under the various projects. The graduate students are enrolled at Ohio State University, Louisiana State University, University of Wisconsin, University of Washington and the University of Rhode Island.

Consultants are also being sent to Brazil to train members of the ITAL staff, help select pilot plant equipment, do basic survey work, etc. Thus far one consultant (Professor Virgil Norton of the University of Rhode Island) is spending eight months in Brazil, and in addition five other short-term consultant trips have been made.

Guatemala In April the annual CODOT/ICAITI Short Courses offered in Central America were attended by over 160 persons.

Throughout the year seven persons served as consultants to ICAITI projects on a variety of topics including organoleptic analysis and import-export marketing. Three CODOT/ICAITI-sponsored Guatemalan students were enrolled in graduate programs in the U.S. Additionally, one American student has done graduate research on Guatemalan fisheries.

Although the ICAITI program will end in October of 1974, a new program is being proposed to AID/ROCAP for support to expand the CODOT/ICAITI relationship and effectiveness in the development of technology and its transfer in Central America. It is anticipated that CODOT will continue to offer support and personnel for the Annual Short Course presentations which have proved very successful and beneficial since their inception three years ago.

**Topic Title:** Development Program Directed toward the Development of Infant Foods Based upon Indigenous Proteins

**Principal Investigator:** Clinton O. Chichester

**Participating Student:** D. Thananunkul (Thailand)

**Funded by:** AID \$109,706

**Location:** Chile

**Dates:** July 1, 1972 - December 31, 1974

This project, concerned with the development of infant and weanling foods based upon oilseed proteins and fish protein concentrate (both available in southern Latin America), has been underway for a number of years. The project has not only made use of protein sources, previously unused, for the production of these types of food but has incorporated a multi-disciplined approach to a systematic investigation of the potential of food protein sources.

The chief accomplishments, thus far, outside of the attainment of purely scientific findings, include: (1) the establishment of an integrated program in applied nutrition which may serve as a model for other areas of the world; (2) the development of national programs for the supplementation of infant diets through the development of food products; and (3) the establishment of a research team in the country which has achieved substantial results that may be applied worldwide.

One Ph.D. candidate has been in Chile since February 1974 assisting in dietary studies and nutrition research. Financial support for this student is received from funds administered through the URI Agricultural Experiment Station.

Continuation of this project is expected with new funding from AID for an effort entitled Development Program Directed toward the Utilization of Milk and Meat-Extended Products Based upon Indigenous Plant Protein Sources in Chile. Under this program possible protein sources, as well as better use of those sources already known, will be investigated. This project is important to marine resource development in that it investigates the utilization of fish protein concentrate in the infant formula already developed (Leche Alim). Information obtained may be applied in the future to food use of other types of marine protein.

The primary function of the group at the University of Rhode Island will be consultation and administration of the financial aspects in the initial stages of the new project. In addition to the development of high protein,

low cost infant and weanling foods, it is hoped that programs for production, distribution, standardization, and food quality control will be developed. Training of Chilean nationals in protein processing problems, quality control, marketing and communications also will be emphasized.

**Topic Title: Food Technology**

In this section various food technology studies being conducted under the aegis of Professor Chichester and his cooperative investigators, Professors Tung-Ching Lee and Kenneth L. Simpson, is reported.

**Sub-topic: Carbonyl Accumulation During Browning of Fruit**

Principal Investigator: Clinton O. Chichester

Participating Students: M. Tanaka (Japan)  
C-M. Lee (Korea)  
A. Cheng (R/China)

Funded by: National Institutes of Health \$94,432  
Dates: September 1, 1972 - August 31, 1975

In the browning reaction occurring in foodstuffs, there is an accumulation of carbonyl compounds as well as the production of protein-carbohydrate complexes. Data accumulated previously indicate that animals have extreme difficulty in using these complexes. Attempts have been made to study the nature and the physiological effects of biologically active substances formed during the browning reaction in model systems and in a native food, the browned apricot.

The biological activities of browned products were measured by a comprehensive feeding study using Sprague-Dawley rats. The results showed that there were significant differences between test and control groups in body weight gain, feed efficiency, water consumption, serum GOT, GPT, glucose level, urine concentration ability, and the relative weight of the liver and kidney. Three Ph.D. candidates have been involved with this study and its ramifications.

The application of this research to marine foods could be significant in terms of the effect of browning reaction on the development of marine protein food products.

Future plans for the final grant year include further investigation of (1) characterization of browning products and identification of physiologically active compounds formed during browning; (2) elucidation of the mechanism of metabolism of browning products after being absorbed; (3) the insulin-glucose model system; (4) isolation and identification of micro-organisms responsible for the breakdown of the browning product; (5) the effect of browning products

on the activity of digestive enzymes; and (6) toxicity studies for each major compound found to be accumulated in a specific site.

Sub-topic: Essays in Toxicology

Principal Investigator: Clinton O. Chichester

Partially funded by: National Institutes of Health \$11,206  
Dates: December 1, 1972 - December 31, 1975

This grant offers clerical and administrative support for the publication of a yearly series entitled Essays in Toxicology. The office offers the editorial board of Essays an administrative base as well as literature search and compilation services. One part-time librarian is employed.

This publication offers scientific writings and research data in the overall area of toxicology. However, particular articles, such as "Metabolism of DDT in Man," are significant to the area of fisheries and the development and utilization of fisheries products.

Manuscripts for volume 6 are in the production process, and manuscripts for volumes 7 and 8 are assigned. The editorial board has approached the Society of Toxicology for financial support of this publication series after termination of its present NIH grant in 1975.

Sub-topic: Use of Cottonseed Protein to Make a Cheese-like Product

Principal Investigator: Clinton O. Chichester

Participating Student: H. Mayorga (Guatemala)

Procedures for making a cheese-like product from cottonseed protein are being evaluated at the research laboratory at the Instituto Centroamericano de Investigacion y Tecnologia Industrial (ICAITI) in Guatemala where the student involved with this project is doing his master's thesis research.

It is expected that the information derived from this research effort will be significant and perhaps indicate the possibility of using marine proteins to make similar cheese-like products.

The optimum conditions for the utilization and development of cottonseed protein products have been determined. Extraction methods to obtain the protein from cottonseed have been studied and further developed.

Sub-topic: Effect of Processing Variables on Nutritive Quality  
Produced by Extrusion Cooking

Principal Investigator: Tung-Ching Lee

Participating Student: T. Chen (R/China)

Funded by: The Nutrition Foundation \$30,000

Dates: January 1, 1974 - December 31, 1976

Each step in food processing may be regarded as nutritionally significant. This project offers insights into the kinetics and mechanisms of the effects of processing on nutritive quality. Better understanding of the role of components on the food system, and their relationship to nutritive quality is important for efficient use of world protein resources. Since the recent overwhelming use of extrusion cooking processing in products such as snack foods, cereals and marine products and by-products, the practical importance of the proposed investigation as it relates to human nutrition is obvious.

This project offers valuable data on the possible utilization of marine products and by-products in the growing market for extruded foodstuffs for human consumption.

One student at the master's level has been employed to assist the principal investigator with this research project. A Wenger X-5 Extruder has been installed to produce the products to be evaluated.

By varying the controllable parameters, a study of the kinetics and mechanisms of the effects of extrusion cooking on the quality of protein and vitamin content of foods will be made. Information on the effect of composition changes of the food system on nutritive quality as a result of extrusion processing will be obtained. Evaluations on protein quality and vitamin content after extrusion processing will be made using both in vivo and in vitro methods. And finally, a study will be made on the stability of carotenoids (pro-vitamins) during extrusion cooking.

Sub-topic: Removal of the Flatulence Factor from Soybean Milk  
by Enzymatic Techniques

Principal Investigator: Tung-Ching Lee

The eating of soybeans and other legumes presents some difficulty due to the problem of digestive upset caused by a decrease in passage time through

the gut. This is especially true in the case of young children. It has recently been shown that the oligosaccharide stachyose is the major factor in causing flatulence from legumes. The elimination of stachyose by siastase treatment significantly reduces this effect from soy milk and presumably from other leguminous products.

One master's level student is supported by funds through an AID International Training Program to work on this area for the master's thesis.

This project will further investigate the causes of flatulence and attempt to find solutions to allow greater utilization of soybean milk as well as other legumes.

Sub-topic: Research Project on Carotenoids

Principal Investigator: Kenneth L. Simpson

Participating Faculty: Clinton O. Chichester  
L. Lee  
Richard Wolke

Participating Student: J. Kuo (R/China)

Funded by: National Science Foundation \$125,562  
Three-year project

This project involves a cooperative effort by the University of Rhode Island and the Institute of Agronomy in Cluj, Romania.

Carotenoids are the major class of naturally occurring pigments which are found without exception in photosynthetic plants. In recent years carotenoids have been used as sources of pro-vitamin A and as natural colorants of food and feed. In the latter regard, the acceptability of some animals as food is partly based on proper coloration, as with salmon, trout, chicken, etc. The chemistry and biochemistry of carotenoids of the salmonids has thus far received little attention. In conjunction with our own interest in salmonid pigmentation, we plan to test in the trout a number of compounds that have been made or isolated in our laboratory or in Romania. These compounds will be tested for pigmentation and toxicity.

The application of this research to marine resources is quite significant. Factors affecting pigmentation of such species as trout and salmon are most important since the color of these types of marine food determines their commercial and nutritional value (pro-vitamin A level of fish meal) and acceptability as a food item. Small farm culture of these species must take into account these aspects of pigmentation level.

Sub-topic: Evaluation of Cooking Techniques in a Red Crab  
Processing Facility

Principal Investigator: Kenneth S. Simpson

Participating Faculty: Clinton O. Chichester  
Tung-Ching Lee

Participating Student: J. Kuo (R/China)

Funded by: New England Fisheries Steering Committee  
\$7,700

Dates: August 1, 1974 - August 31, 1975

The utilization of marine waste products for the development of marine food production is of importance on both a domestic and international level.

The objective of this project is to evaluate present techniques in the cooking of red crab as they affect subsequent processing. These techniques will be compared with alternate procedures and equipment in terms of effect on quality, yield and ease of extraction of the crab meat. All of these operations, except laboratory tests, will be conducted in the Galilee (Rhode Island) crab processing plant.

A grant has just recently been awarded to support research work in the area of evaluation of cooking techniques in a red crab processing facility.

Topic Title: Puerto Rico Fisheries-Mariculture Development Project

Principal Investigator: Dr. Kenneth W. Watters, Puerto Rico Nuclear Center

Participating Faculty: Irving A. Spaulding  
Thomas A. Weaver

Participating Students: Jean F. Abgrall (France)  
David K. Stevenson (U.S.)

On-site Coordinator: John K. Hutchinson

Funded by: National Science Foundation \$99,500

### General

The Puerto Rico Fisheries-Mariculture Development Project, funded by the National Science Foundation (Experimental Research and Development Incentives Division) and implemented on 15 June 1973, was conducted by the International Center for Marine Resource Development at the University of Rhode Island, the Puerto Rico Nuclear Center of the University of Puerto Rico, and the U.S. Atomic Energy Commission, Mayaguez, Puerto Rico. The specific long-range program goals set were to help upgrade the Puerto Rican capture fishery and to develop mariculture techniques for marine animals potentially culturable on a commercial scale.

During the year-long background study, funding for an interfacing mariculture technology research effort was provided jointly by the U. S. Department of Commerce (NOAA) and the Commonwealth of Puerto Rico Department of Agriculture.

The fundamental goal of the background study was to provide a preliminary estimate of the potential for Puerto Rican fisheries and mariculture development and to recommend levels of support for later stages of a cooperative research and development program by organizations other than the National Science Foundation. Detailed objectives of the background study were (1) to describe a typical major Puerto Rican fisheries industry in its current mode of operation, (2) to experiment with pre-selected and innovative technologies within a mariculture setting, (3) to conduct social science investigations to estimate the probable effects of implementing specific technological developments and to suggest optimum implementation methods, and (4) to identify barriers to development existing in the fisheries and mariculture industries and incentives to motivate fisheries-associated individuals and institutions (the infrastructure) to overcome these barriers.

An integral segment of the year-one activity was an in-depth review by an advisory committee to assess progress, direct the first-year activity to a successful conclusion and project follow-on approaches.

#### Advisory Committee

Dr. Nelson Marshall, ICMRD/URI  
Dr. F. R. Rosa-Franco, Regional College of Aguadilla, Puerto Rico  
Dr. Saul B. Saila, University of Rhode Island  
Mr. James J. Griffin, ICMRD/URI  
Dr. Frank Lowman, Puerto Rico Nuclear Center  
Dr. Jose Suarez-Caabro, Puerto Rico Department of Agriculture  
Dr. Ronald G. Cummings, University of Rhode Island  
Mr. Robert Taber, MAS/URI

#### The Study

Investigations were conducted primarily in the municipality of Cabo Rojo in the southwest corner of the island, the most productive single fisheries district of the 41 Puerto Rican municipalities. In 1972 the area produced over a million pounds of finfish and shellfish, approximately 30 percent of the island's capture fishery catch. Capture fishery for this study was defined to include resident fishing activity from small craft in the vicinity of the coast using traps, handlines, trawl lines, gill nets, turtle nets, trot lines and cast nets, etc., but excluding the more technologically advanced offshore tuna fishery.

#### Investigations

Fishery Technology. Because approximately 56 percent of the island's capture fishery production effort and 65 percent of Cabo Rojo's effort is devoted to use of the fish trap "nasa," efforts were concentrated on obtaining comparison of catch efficiency on three Caribbean designs with varied mesh sizes. A general review of island fishing techniques identified the two other productive methods, the monofilament gill net and the snapper reel.

Preliminary results derived from three months (September-October 1973 and May-June 1974) of field work aboard a 30 foot commercial vessel actively working traps in 25-30 fathoms can be grouped under two headings: (1) yield and trap design evaluations, and (2) length-frequency analysis and size selection.

##### 1. Yield and Trap Design Evaluation

A significant effect of location and depth on the performance of pots of identical volume, mesh size, entrance size and age was apparent. Differences were more obvious in terms of the numbers of fish captured than in the quantity (pounds) of fish captured. Fewer, but larger and more valuable, fish were caught in deeper water.

Design difference comparisons, made with data accumulated in the fall, proved insignificant. Partially successful experiments based on spring data indicated the superiority of Cuban S pots over Jamaican Z pots, and Z pots over pots of the traditional Puerto Rican design. Again, the parameters which revealed the most significant differences were, respectively, numbers of fish, pounds and value. These results tended to confirm similar pot design studies in Jamaica; however, the superiority of one pot design over another may depend on the availability of fish. Catch rates in the spring were about two-thirds the fall rates.

## 2. Length-Frequency Analysis and Size Selection

Length data was collected for over 6500 fish belonging to ten important commercial species captured in two different mesh sizes. General conclusions to date follow.

- a. For several of the smaller and/or more elongated species, a significant number of younger fish were retained in one-inch mesh pots but not in one-and-a-quarter-inch mesh pots fished in the same location and at the same time of year.
- b. Larger individuals of several species were selectively retained in one-and-a-quarter-inch mesh pots but not in one-inch mesh pots fished in the same location and time of year.
- c. At least for one species, larger entrances caught larger individuals than smaller entrances placed in otherwise identical pots fished under similar conditions.
- d. Modal analysis of data for several species caught in a given mesh size, location and season revealed the presence of two or more size groups. These may be age groups or sex groups with distinct growth rates. Many species spawn more than once a year.

Further analysis of length data should permit the estimation of annual mean size at capture by different mesh sizes and the calculation of mortality/growth rates. Comparison with values for exploited and unexploited stocks in Jamaica will allow an assessment of the relative degree of exploitation on the west coast of Puerto Rico. The combination of size selectivity information, mortality/growth ratios and yield information should also permit an evaluation of the effects of changes in fishing strategy (i.e., mesh size) on the yield of a number of species.

Future plans call for the completion of field work in Puerto Rico during September-October 1974. During this time, additional length data will be collected from one inch, one-and-a-quarter inch and one-and-a-half inch mesh traps and a brief oceanographic study of the effects of bottom

currents on capture rates will be carried out. Data analysis will continue throughout the year. Preliminary reports resulting from the study should be available later this year. Results of this evaluation work on equipment will be combined with the economic research.

Additionally the use of fathometers aboard traditional fishing vessels for optimum trap displacement is being evaluated.

Mariculture. Mariculture research concentrated on three oyster species, with emphasis on the mangrove oyster, Crassostrea rhizophorae. Among the several marine animals that could be cultured in Puerto Rico, the mangrove oyster shows, on the basis of a semi-commercial, small-scale pilot project, great potential for enhancing resident harvester earnings. The oysters cultured in this program grew to commercial size in three months, a remarkably high growth rate. A definition of the optimum cultch (surface on which oysters set) and rafting techniques will be available later this calendar year.

Economics. Resource economics investigators determined the degree to which existing fishery marketing structures could absorb significant increases in locally produced finfish and shellfish and reviewed credit and loan programs available to Puerto Rican fishermen. The researchers are now describing an econometric model, based on analysis of field data, of capital investment for optimum production by types of fisheries and level of effort. It is expected to be available by fall.

Sociology. Investigations into Cabo Rojo fishing villages (El Combate and Boqueron) defined sociological parameters relevant to technological development.

The fishing family firm was the most feasible social unit through which to introduce new technology. This unit has a high potential for withstanding social stress resulting from innovative adaptation. While other social units (particularly the fishing cooperatives) may also have viable avenues for introducing new methods, initial technology transfer attempts should target the family firm because of the slowness of group decision making, the difficulty in convincing the majority of cooperative members of the value of a change as well as some history of strained government-cooperative relationships. Social research also defined the need for a regional conceptualization of fisheries and mariculture development compatible with multiple uses of coastal resources. It also clarified the conceptualization of fisheries problems among artisan fishermen and the use of research in developing understanding of factors related to technology transfer while developing relationships with other institutions interested in fisheries development.

Barriers. Barriers to Puerto Rican fisheries and mariculture development revealed by the background study are listed below.

Fishery Barriers

Diversity of the fisheries  
Equipment losses  
Availability of materials  
Nearshore productivity

Mariculture Barriers

Availability of land  
Contamination of shellfish  
Resistance to change and to new techniques

Socio-Economic Barriers

Subsistence preference of some fishermen  
Young fishermen uninvolved  
Distrust of outsiders and government  
Social stress as a result of technological innovation  
Lack of reference and evaluation information  
Apparent lack of job market for fishermen

Incentives to overcoming these barriers and specific action recommendations are included in the Puerto Rico Year One "Background Study" Preliminary Report, pages 17 through 34, submitted to the National Science Foundation in 1974.

Topic Title: Belize Aquaculture Potential Survey

Principal Investigator: George Matthiessen

Participating Faculty: Harlan C. Lampe

Funded through the University of Illinois \$6,000

Because the inland and coastal waters of Belize, and the resources that these contain, have not been previously studied in depth, a brief survey was conducted under the auspices of the University of Illinois. This study outlined, from the limited data that does exist and a short field assessment, the physical and aquatic environments, currently exploited aquatic resources, and the fishing industry in relationship to the technical and economic feasibility of a local commercial aquaculture enterprise. The study and its major recommendations are summarized below.

#### The Study

Characteristics of Belize regarded as favorable for aquaculture included the following:

Extensive, varied and unspoiled aquatic environments, including freshwater rivers and streams, brackish water lagoons, and fully marine habitats (such as offshore cays and reefs).

Absence of significant sources of pollution detrimental to aquaculture.

A prevailing temperature conducive to sustaining year-round growth for many tropical and semi-tropical species.

Significant freshwater drainage to the coastal areas, with subsequent enrichment of the coastal waters.

Other characteristics of Belize, however, tend to reduce the economic potential for aquaculture:

The abundance and ready availability of aquatic foods to a large percentage of the country's predominantly coastal-dwelling population.

Lack of much of the infrastructure necessary for many forms of aquaculture, such as means for communication, transportation, and freezing and storage facilities, as well as technical experts.

Although no published facts are available, there is reason to suspect that the salinity of the coastal waters and lagoons may vary widely with season, resulting perhaps in intolerable stress upon some species that might otherwise be contained and cultured within these areas.

A potential sensitivity toward private appropriation and exploitation of marine resources by non-Belizeans.

In general, there are two areas in which commercial aquaculture might concentrate. The first would be to produce significant quantities of relatively low-cost food largely for domestic consumption. In many areas of the tropics and including Central America, where animal protein is in insufficient supply, such an endeavor would certainly be useful. In Belize, however, neither malnutrition nor hunger appears to be a problem for the majority of the populace. Malnutrition may exist in the inland areas, but the population is so sparse and scattered, and means of transportation so limited, that it is presently doubtful if efforts in this direction would be particularly realistic or rewarding.

The second area would be that of producing high-cost products, so-called "luxury" foods, that command a sufficiently high price in foreign markets to justify an export industry. Belize's present fishing industry is primarily of this nature and undoubtedly helps the country's unfavorable import-export ratio and balance of payments.

The science of culturing aquatic foods, particularly those of the luxury variety, is still in its infancy. Aquaculture, and particularly mariculture, is far behind contemporary poultry farming, and the number of successful enterprises are far outnumbered by those that have failed. Therefore, regardless of how favorable the social, legal, economic and environmental climate may appear to be, the assumption that an aquaculture enterprise may generate early profits is unrealistic.

The commercial fishing industry of Belize is focused on two major export products: spiny lobster and conch. The major operators are five cooperatives, two of which process and export almost all of the product. One major new processing facility is being built and another remodeled. Two cooperatives visited appear to be far better managed than most in Latin America.

The immediate market for conch and lobster is Miami, Florida. The conch fishery is composed of divers operating from small wooden sailboats or open outboard-powered skiffs. The lobsters are caught either by divers or traps.

In addition there is a short season for groupers which appear to migrate onto the shelf area along the reefs during early winter.

Both the conch and lobster fishery seem to be under considerable pressure. Lobster fishermen believe that output per unit of effort has been declining substantially. With this decline, more and more effort has been transferred to the conch fishery where there are observable increases in the proportion of small conch landed.

The shrimp fishery offshore is not participated in by Belizeans. Vessels from Guatemala operate in these waters, and there is no simple way to evaluate the production of shrimp off the Belizean shore since output appears in Guatemala's statistics.

Ten species or genera frequently considered for tropical culture in fresh and marine water were selected for review. The criteria employed for selection included food value and/or established marketability, tolerance to Belize environmental conditions, and evidence of some previous captive rearing.

Abundant, low price

Tilapia (Tilapia spp)  
Carp (Cyprinus carpio)  
Catfish (Ictalurus spp)  
Oyster (Crassostrea rhizophorae)

Luxury, for export

Conch (Strombus gigas)  
Spiny lobster (Panulirus argus)  
Freshwater prawn (Macrobrachium spp)  
Shrimp (Penaeus spp)  
Mullet (Mugil cephalus)  
Pompano (Trachinotus carolinus)

The tilapias, carp, catfish and mangrove oyster undoubtedly could be cultured successfully and perhaps in significant volume in Belize. In a country such as this, however, where seemingly more desirable sources of protein foods are readily at hand, at least along the coast at present, culture operation dependent upon local consumption would not appear to be profitable. Furthermore, market demand for these species in foreign countries presently would not appear to be sufficient to justify the costs of a culture operation for export purposes.

Recommendations

After evaluating other species including the luxury group, the freshwater prawn (Macrobrachium spp) appears to offer the greatest potential for aquaculture at present because a good deal is known of its culture biology

and requirements; a successful prawn culture operation is presently underway in Jamaica and in other parts of the Caribbean; its price in the market is comparable to other luxury foods such as lobster and shrimp; it is a hardy animal that apparently can tolerate rather wide variations in salinity and is generally omnivorous; it matures rapidly, permitting a harvest schedule of two crops per year; it has often been cultured in ponds simultaneously with other species, particularly finfish; and intensive yields, in excess of 3,000 pounds per acre per year, have been reported.

The penaeid shrimps also offer some prospect for development in lagoon environments, of which Belize has many, since shrimp are present in some lagoons at some times of the year. Prior to any consideration of shrimp production in lagoons, biological and physical needs must be established.

Recommendations were made for further detailed studies preparatory to development.

**Topic Title:** Demand and Supply Potentials for South Vietnam's Fishery Industry

**Principal Investigators:** Harlan C. Lampe  
Howard L. Steele (USDA)

**Funded by:** USDA \$8,000

The fishing industry of South Vietnam has expanded rapidly in the past ten years despite the war. Further expansion is desired to increase domestic protein supplies and to generate badly needed export earnings. The purpose of the mission was to evaluate:

- (a) resource availability,
- (b) fleet effectiveness and efficiency,
- (c) marketing and distribution systems, and
- (d) institutional capabilities.

The mission found:

- (a) While substantial underexploited pelagic and demersal resources exist in the region, it would be economically feasible to harvest perhaps half the available potential.
- (b) Vessels of 75 gross tons or more are not generally economically viable units.
- (c) Substantial overcapacity exists in shrimp processing and fish meal production.
- (d) The marketing and distribution system impedes collection of exportable products (e.g., shrimp, cuttlefish, etc.).
- (e) Port facilities everywhere are inadequate.

The mission recommended:

- (a) Cessation of subsidies and other financial aid for vessels greater than 75 tons.
- (b) Cessation of any subsidy or financial assistance for construction of shrimp and fish meal processing facilities.
- (c) Concentration of a major technical assistance program on 2,000 medium trawlers and gillnetters to improve technical

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efficiency and provide funds for improved instrumentation and gear.

- (d) Initiation of shrimp exploration in coastal waters immediately.
- (e) Beginning of careful exploration for pelagic stocks utilizing the air capabilities of the GVN and chartered vessels.
- (f) Development of port facilities at Rach Gia and Vung Tau.

It has been reported by USAID in Vietnam that the GVN is acting upon the recommendations of the mission.

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Topic Title: Marine Mineral Resource Management Issues

Principal Investigator: Thomas A. G. Galunas

Funded by: 211(d) \$1,500

The purpose of the investigator's visit to the major petroleum-producing countries on the North Sea was to identify and survey major economic and institutional issues associated with the exploitation of oil and gas on the North Sea. Based on this field research trip, a paper, Petroleum Activity in the North Sea, has been prepared.

A specific goal of the visit was to identify key international development issues associated with offshore oil and gas exploration and development. Interest in the international aspects of offshore petroleum exploitation represents an extension of URI's Sea Grant Program interest. This work is viewed as a step toward developing an institutional capability and involvement in research and teaching in the management of marine minerals, particularly oil and gas, in the context of UICs.

The investigator testified before the U.S. Senate on the economic impact of offshore oil and presented a paper, Investment, Production and Returns to Potential Petroleum Development on the Outer Continental Shelf, at the annual meeting of the American Agricultural Economic Association. Other accomplishments include several journal articles and testimony, public policy papers and professional consultations on energy and offshore petroleum issues.

Topic Title: Artisan Fishing Development in Mexico

Principal Investigator: Irving A. Spaulding

Funded by: URI           \$410

A planned research activity being pursued under a cooperative input relationship with the government of Mexico, the Ford Foundation and Resources for the Future, which deals with the development of artisan fisheries and its implications for reduction of rural poverty, should have considerable applicability to much of Central and Latin America.

During a June 1974 research conference and fishing village site visit, the purpose of which was to establish feasibility and obtain background material for such a study, Professor Spaulding met in Mexico City with Jose Silos, Presidential Advisor in the Coordinating Commission for the Agricultural Sector; Santiago Friedman, Ford Foundation; and William Lord, Resources for the Future. Discussion centered on research status in the area of rural poverty and the relevance of new research of this type for Mexican artisan fishermen.

After the conference's conclusion, Professor Spaulding went to Hermosillo, Sonora, where he visited the Guaymas and Las Guasimas commercial and artisan fisheries operations.

Interest and concern shown in these contacts about artisan fishermen and poverty in rural coastal areas has set the stage for further potential development. Fishing operations have been surveyed sufficiently to establish firm impressions of several problems requiring clarification before specific research is undertaken.

Topic Title: Land Crab and Lobster Culture

Principal Investigator: J. Stanley Cobb

Funded by: Sea Grant (U.S. Dept. Commerce) \$4,450

Preliminary gathering of both published and field information has been undertaken to obtain background material suitable for establishing the technical feasibility of labor-intensive culture of the tropical land crab. Varieties of land crabs are found in many tropical LDCs.

The crustacean's single large claw contains a substantial amount of meat generally considered a delicacy. The crab that we have been investigating, Cardisoma guanhumi (blue land crab) of Florida, eats leaves, grasses, berries, nuts, carrion, pet foods, and possibly garbage. While normal cropping practices kill the animal (even though only the claw is eaten) and since these animals regenerate lost appendages, the harvesting of claws from large males selectively bred for large claws has been suggested for development. If, as with most crustaceans, the loss and subsequent regeneration of lost claws reduces the length of time between molts, harvesting in this manner may prove to be an efficient method of culture.

Organisms obtained from Florida are being studied at URI at the present time, and plans have been developed proposing the evaluation of the following in detail:

1. Mass culture in large pens, with emphasis on methods to reduce mortality due to aggression.
2. Individual culture in small containers to determine diet and space requirements, disease problems, and methods of accelerating molting by appendage removal.
3. Investigation of the feasibility of removing the claws for sale and allowing the animal to regenerate them.

A lobster pond culture proposal to Sea Grant being prepared and of interest to the Center regards the applicability of pond culture to the tropical lobster. Several ponds of two- to four-thousand square feet with differing flow rates, shelter and stocking density are to be constructed. The ponds, which will contain a partial seawater system covered by a geodesic dome, will be used for rearing and behavioral studies as well as studies of synchronization of molting time.

Topic Title: Lobster Habitat Design

Principal Investigator: Saul B. Saila

Funded by: Rhode Island Department of Natural Resources \$12,400

An ongoing study in optimization of lobster habitats for the highly territorial northern lobster Homarus americanus has implications for more efficient rearing of Panulirid lobsters in tropical areas of interest to the Center.

Studies to date have involved establishment of proper design parameters such as habitat weight as related to bottom sediment conditions, material strength, inertness and texture, as well as the influence of current speed and the stability of habitat shapes. Habitats installed in various sites in the Narragansett Bay area have been monitored for occupancy, stability and other criteria.

After evaluating various cinder-block configurations of habitats for these lobsters, a candidate design was selected, a streamlined dome with a horizontal semi-elliptical opening. The heavy-walled habitat is made of pumice. The design permits adjustment of the habitat's specific gravity for substrate configuration and loading.

In field experiments habitats were fully occupied within two weeks after emplacement, even when located in unoccupied sand areas up to one kilometer away from the nearest apparent source of stock.

A minimal spacing between habitats of approximately three meters was found optimal. In matrices of habitats where the distance was less than optimal, only the habitats at the edge were occupied. Larger lobsters required more space and larger openings. Opening sizes were based on elbow-to-elbow distances required to accommodate the extent of the chelapods, not on carapace dimensions. The test showed that habitats must be carefully designed and placed to minimize dispersal under strong storm surges; otherwise trawler (net) fishermen could suffer substantial net impedence from picking up mislocated habitats.

Design and installation parameters appropriate for similar evaluations of ocean farming possibilities for tropical farms in Tanzania and elsewhere have been suggested by these experiments.

Topic Title: Trophic Regimes in Coral Reef Atolls

Principal Investigator: Nelson Marshall

Participating Student: Ray P. Gerber

Funded by: National Science Foundation      \$26,300

The objective of the NSF-sponsored work, completed during the report period, was to better understand productivity pathways and thus strengthen our capability for assessing fisheries production around coral reefs and adjacent waters.

Little is known of the basic productivity and of the food chains in lagoon waters behind coral reefs. We are aware that primary production in typical coral atoll lagoons is very low, as indicated by low chlorophyll values, by approximations of phytoplankton abundance, and by data on carbonate-14 uptake. Recently various workers have stressed the potential of organic matter exported from the reef as an additional primary food source available in lagoons and affecting the low phytoplankton input.

The findings of the present study verify assumptions that reef detritus is consumed by certain lagoon fishes and by lagoon zooplankton, thereby adding to the food available for organisms of higher trophic levels. Efforts of the past year have focused on summarizing work to date and preparing for more quantitative work.

**Topic Title:** National Oceanographic Data Center (NODC)

**Principal Investigators:** Thomas F. Weaver  
James J. Griffin

**Funded by:** NODC \$1,000

The major objective of this segment of the NODC Oceanographic Data Training Program conducted at URI was to increase the breadth of experience of the selected multi-national and technologically-oriented group of oceanographic scientists, technicians, managers and government officials through exposure to socio-economic issues in fisheries development.

The central URI activity included a series of formal programs and disciplinary seminars to introduce the participants to staff members and their professional work, followed by individual visits with each participant-selected URI scientist to discuss specific research appropriate to national and academic interests. The week's schedule also gave participants an opportunity to observe major marine research projects at the University.

The overall response of the participants was positive, indicating success in achieving the objectives. The quality and interest of the participants was quite high, a reflection, no doubt, of a careful selection procedure. The input on the part of all members of the group was a very major ingredient in what was a rewarding experience for the majority. The expanding involvement of these people in their various nations' marine resources programs and with their brief background in interfacing disciplines involved in decision making provide a basis for improved understanding needed as development programs mature in their regions. Linkages were established or reinforced.

NODC Training Program Participants

Carlos Julio Lozano Lopez  
Ministerio de Defensa  
Armada Nacional CAN  
Bogota, Colombia

Omran E. Frihy  
Research Assistant  
Alexandria, Kayed Bey  
Institute of Oceanography  
and Fishes, Egypt

Abdul Gani Ilahude  
Chief, Oceanography Section  
National Institute of Oceanology  
Aquarium Pasar Ikan  
Jakarta Barat 580 DAK, Indonesia

Jae Kyung Bae  
Fisheries Biologist  
Fisheries Research and  
Development Agency  
Youngdo-Ku  
Busan, Korea

NODC Training Program Participants (cont'd.)

Saviour J. Sciberras  
Senior Technician  
Biology Department  
Royal University of Malta  
Msida, Malta

Juan Quispe Arce  
Assistant, Instituto del Mar del Peru  
Esq. Gamarra y Gral. Valle  
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Alexander Theocharis  
Researcher  
Institute of Oceanographic and  
Fishing Research  
Department of Physical Oceanography  
Agios Cosmas - Ellinikon  
Athens, Greece

Bamrung Piyawatin  
Chief, Marine Meteorology Section  
Meteorological Research Center  
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Zanzibar, Tanzania

The University's Sea Grant College Program, while focusing primarily on domestic problems, reflects very favorably on the 211(d) effort in that it generates considerable research capability and is applicable to 211(d) objectives. Many faculty members participate in both Sea Grant and ICMRD undertakings.

Topic Title: URI Sea Grant College Program

The University of Rhode Island's Sea Grant College Program is strongly reflected in the goals and commitments of several of the University's eight colleges. It has transcended traditional college and departmental lines through strong support of the URI president and governing board, through the administration of the Provost for Marine Affairs, and through faculty interest in the types of problems and potentials central to the program.

The program has education, research, and advisory service components in areas such as marine environmental problems, commercial fisheries, marine recreation, aquaculture, foods from the sea, and problems of mining in the sea.

For purposes of program management and coordination, Sea Grant activities can be grouped under five headings. The general objectives of these components are:

1. Education and Advisory Services

Education: To train needed manpower in ocean engineering, marine economics, marine resource management, and fisheries and marine technology.

Advisory Services: To provide information on all aspects of marine and coastal matters to individuals, groups and businesses; to enhance public understanding of issues involving the marine environment; and to determine user needs and convey these to the Sea Grant research community and other appropriate groups.

2. Research on coastal resources

To gain knowledge of and find solutions for those long-run or short-term problems which inhibit conflict resolution and optimum use of the coastal zone.

### 3. Research on natural fisheries

To determine and analyze means for increasing the efficiency, profitability and/or long-term economic and social viability of the Rhode Island and New England commercial fisheries.

### 4. Research on aquaculture

To identify and resolve those problems standing in the way of viable commercial, closed or semi-closed system aquaculture of appropriate species in a temperate climate.

### 5. Research on marine foods and drugs

To improve physical or economic utilization of foods and drugs from the sea and to investigate and test possible new biological or chemical products from the sea or new processes for present products.

Some of the activities conducted under the Sea Grant program have present or potential application to the Center's interests in developing marine resources. These have been integrated into topics reported elsewhere.

#### Sub-topic: Advisory Services

The two Sea Grant advisory projects, the URI Marine Advisory Service (MAS) and the New England Marine Resources Information Program (NEMRIP), are responsible for outward information transfer as well as feedback to university researchers of problems and opportunities in the marine community. Major areas of emphasis are commercial fisheries, coastal planning, marine recreation and marine science in education.

A major commercial fisheries project during the year was a demonstration of two-boat midwater trawling for herring managed by the MAS. Initiated during the previous year, the project was expanded from four to eight commercial fishing vessels and the catch nearly doubled, from about 5.2 million pounds to about 10 million pounds. The cost of the project to MAS was about \$5,000, and the added catch value was estimated to be nearly \$200,000.

Inquiries processed by NEMRIP from regional and national sources numbered 4,000. Foreign requests for information in 1973-74 totalled 208 from 22 countries. NEMRIP co-sponsored and planned two regional marine recreation conferences; published various materials for elementary and secondary school science teachers; published a study on The Use and Impact of Selected Marine Publications; and participated in the formation of the New England Marine Advisory Service.

**Sub-topic: Research on Coastal Resources**

In addition to the successful deterministic treatments of the tidal circulation in Narragansett Bay, Rhode Island, detailed data for the development of a statistical model relating the input river-water transport to the ambient and historical wind field has been collected and analyzed. The ecological model of the phytoplankton, zooplankton, benthos and nutrients in the Bay has been completed, and a detailed sensitivity analysis is underway to explore the consequences of the great range of data on the physiological constants involved that is available in the literature.

Much of the basic data, mathematical formulation, and approach of this model is being used in the development of a Marine Ecosystem Analysis (MESA) New York Bight Model and in refinements of an EPA watershed management model. Some aspects of this model form the base for the Ilo survey, the planned URI-Instituto del Mar, Peru, program reported elsewhere.

An input-output economic model relating both gross revenues and personal income to effluents generated by over 50 industrial sectors in the Narragansett Bay drainage basin has been completed, and attempts are now underway to extend this model to deal with specific sites in the Bay and with problems of optimization. Such economic cost/benefit analyses are felt to be significant in LDC considerations for implementation of any environmental protection constraints.

A method for the rapid identification of oil slicks using infrared spectroscopy has been developed and coupled to a computer data bank of the infrared absorption characteristics of 70 known petroleum compounds. The changing infrared "fingerprint" of No. 2 fuel oil, Ecuadoran crude oil and Zaire crude oil in the seawater during weathering has also been determined and included in the data bank.

Oil spill spreading and drift information was also coupled to the hydrodynamic model as a first step in developing an "on line" oil spill motion prediction capability. Preliminary results indicate good agreement between simulated spill movement and that observed in a very large spill in 1960. Additional studies have been carried out in the loads and shapes of oil spill barriers that might best be used with the current and wave actions found in the Bay.

The East African conference on marine resource development held in Dar es Salaam, Tanzania, expressed extreme concern with predicting, measuring and controlling the effects on beaches, coastal fisheries and agriculture of extensive and escalating oil spills from offshore tanker passage and terminals. Interest in other petroleum-oriented topics, such as those developed below, was expressed as well.

An analysis of the economic and technical features of offshore petroleum development has also been largely completed, and a study of its effect on the regional economy is underway. This study has had a substantial input to decisions regarding the development of a deepwater, "out-to-sea" terminal for Boston Harbor, as well as statewide and New England energy policy.

Chemical studies of the fulvic and humic acids extracted from Bay sediments have shown that these organic compounds can double or triple the solubility of petroleum hydrocarbons in sea water, and may increase the action exchange capacity of sediments as much as 50 percent over that of sediments with these compounds removed. As part of the modelling work, in situ measurements of the nutrient regeneration and oxygen flux rates by three estuarine bottom communities were also taken, along with measurements of total sediment weight, organic content, and organic carbon and nitrogen inputs to the bottom at three stations in the Bay.

The Coastal Resources Center, partially funded by Sea Grant, completed the natural resources phase of a state marine resources inventory and shoreline-use study. In addition, over 100 maps in a scale of 1:1000 were prepared for the entire shoreline to identify physiographic features, vegetation, and open space to a depth of one mile inland. Studies of the Tanzanian and Central American coastal areas would benefit from similar inventories.

In response to interest by several local boat and marina owners, a study of floating breakwaters was begun for application to the Bay. Preliminary tests showed that large, freshwater-filled plastic bags were not strong enough, but that simple mats made by scrap tires were effective in producing a 75 percent attenuation of two-to-three foot waves. A national tire and rubber manufacturing company is now sharing in the support of this project. A particular problem to be overcome is finding an effective material for lashing the tires together. Some LDC semi-exposed coastal area fishing operations could possibly be centralized around inexpensive coastal anchorages of this type, leading to economies of scale.

#### Sub-topic: Research on natural fisheries

In the commercial fisheries sector, technical, biological and socio-economic studies are carried out. In the gear development area, a bottom trawl performance study has been completed to determine which changes in gear components were most effective in influencing fishing capability. Additionally, the development of a new high-rise bottom trawl was undertaken this year, first through scale-model testing and later testing on commercial vessels. The trawl has had wide acceptance and is already being used on several local vessels and also on fishing vessels abroad. The University has so far had about 400 requests, many international, for drawings of the trawl.

In the biological area, the Schaefer method of calculating the equilibrium catch of a fishery was modified to permit calculations of annual recruitment. It was found that the variability of both sustainable yield and recruitment were explained by changes in environmental temperature (air and seawater temperature), possibly leading to better catch prediction. The size and age class catch data for the yellowtail flounder fishery are now being evaluated in order to assess the effect of environmental temperature on growth.

The subject of effective and inexpensive methods of stock assessment was suggested as a major step in development of Eastern African marine fisheries where requirements for scarce funds must compete on a quantitative basis with other needs. Studies such as those described below are applicable.

Data from the Rhode Island floating trap fishery was examined in order to assess the impact of Rhode Island Sound dredge spoil disposal, and experiments concerning the mechanisms and ecological significance of patch formations of the surf clam have been conducted with the aid of SCUBA. A management model for the surf clam industry was developed, and an economic evaluation of the various management alternatives for this resource was determined. It was found that the maximum sustainable yield for the fishery has not yet been reached, but that the effort is already beyond the point of maximum economic return.

#### Sub-topic: Research on aquaculture

Lobster culture studies have been directed toward physiological and behavioral problems during the juvenile development stages. Both flow-through and recirculating seawater juvenile culture systems are in use. Water quality studies have been carried out, and the effect of dissolved oxygen, pH, ammonia and temperature have been related to growth and development of juveniles. The technical feasibility of culturing juveniles has been established.

Salmonid culture in water re-use systems continues to look promising, and systems still under development have been scaled up and are being put into use by commercial concerns. No serious disease problems have been encountered. Fish thefts from our grow-out system, a major problem in LDC aquaculture, have negated studies on feed conversion; however, the stocks maintained have enabled continuation of studies designed to optimize the system. The majority of the research effort has been directed toward the study of methods for water treatment.

Marine pathology continues as an important and expanding part of the University's overall aquaculture research program. Survey and collection of normal and abnormal tissues from marine and freshwater fish provide a continuing activity. Such analyses are a necessary ingredient in any LDC aquaculture venture.

#### Sub-topic: Research on marine foods and drugs

Studies of a frozen fish emulsion, with added starch, showed that the final product maintained its water-holding capacity and that denaturation during freezing did not occur. The emulsion is considered an intermediate substance from which other products could be produced.

Enzyme studies to identify factors degrading edible portions of shellfish and red crab are continuing in tandem with the developmental aspects of fish-food processing.

Methods for utilizing the very large amount of red crab waste are being investigated. Presently, the waste is being dumped into land-fill operations. Complete analysis of the waste as a potential fish feed has been accomplished. Feeding trials with trout in large tanks and using diets containing 10 and 20 percent crab waste are currently underway. The trout are now being monitored for growth rate, color and taste.

C.VII. Next Year's Plan of Work and Anticipated Expenditures

The present extension of funding for the University of Rhode Island 211(d) program was granted with the understanding that the future plans of the program would be substantially revised in collaboration with (a) the unfolding interests of AID, (b) due regard to changes in policy relative to the 211(d) programs, and (c) attention to anticipated policies of AID with respect to supporting work in aquaculture and fisheries. Inasmuch as the latter policies have not been firmly established and communicated to us, we are planning on the basis of assumptions as to what the AID policy will be.

We are expressing our intended program, still in the talking stages, in the form of three matrices which are attached. The matrices show a coherent topical program in the artisan fisheries incorporating aquaculture and including closely related supporting marine resources work. Looking across the top of the matrix, one sees the project areas, first in terms of education and advisory services, then by areas. In the matrices one quickly sees the proposed work requiring AID support coupled with plans to support much of this activity with outside funding. Consortium and linkages also show quite vividly. The three matrices on the following pages are alike in terms of projects or activity areas but differ in that Matrix A refers to artisan fisheries and aquaculture input, B deals with functions and C relates this to the University organization. The matrices provide the skeleton of a future plan being elaborated in full in a 211(d) proposal. The proposal will follow the principle of decreasing reliance on 211(d) funds and phasing in more and more supported work. The proposal also will be inherently geared to transferring our capability into action efforts with definite achievement goals.



**COHERENT TOPICAL PROGRAM IN COASTAL AQUACULTURE AND ARTISAN FISHERIES**  
 With Related Marine Resource Activity

**Scientific Research**  
 Academic efforts, pilot projects,  
 assistance programs

**Technical Assistance**  
 Pilot projects & assistance programs

**Advisory**  
 Information programs, conferences  
 publications

**Education**  
 Course development, foreign student  
 training, tutorials & seminars

**Matrix B: Functions**

III - Initiative in advanced stages; .... early initiative;  
 [ ] - Administered either as a consortium or cooperative activity; [ ] - administered elsewhere as a consortium or cooperative activity.  
 x - Participation dependent on continued 211(d) funding; [ ] - combined 211(d) and project funding; [ ] - proposed for 211(d) fund-  
 . . . the bot suggested as outside AID source; [ ] - outside funding.

U. Far es Salann, Center for Marine Resources Coordinator: N. Marshall	[ ]		[ ]	
U. Catolica de Valparaiso, Cooperative Development with Escuela de Pesquerias y Alimentos Coordinator: .....	[ ]		[ ]	
Azores Program, Developing Extension Activity Coordinator: .....	[ ]	[ ]		
Puerto Rico Reef Study, Analyses of Development Stress P.I.: Nohemaiinen UN Contact: Nixon				[ ]
Port Harcourt College, Curriculum Development Director: Robins UN Contact: .....	[ ]			
Linkage with ICLARM Prime Director: Sellev UN Contact: ICLARM	[ ]	[ ]		
<b>IV. CODOT PROGRAMS, Food Technology, Linkages with U. Calif- ornia, U. Washington, U. Wisconsin &amp; Michigan State U.</b>				
Central America, ICAITI Coordinator: .....	[ ]	[ ]	[ ]	
Brazil, ITAL Coordinator: .....	[ ]	[ ]	[ ]	
Thailand, Kasetsart University Coordinator: .....	[ ]	[ ]	[ ]	
<b>V. INDIVIDUAL &amp; SMALLER PROGRAMS</b>				
Auburn University, Linkages in Aquaculture Programs UN Contact: .....	[ ]	[ ]		
Mexican Lagoon Study, Water Management for Mariculture Regions P.I.: Lampe				[ ]
Coral Tropic Study, Basic Information on Reef Fisheries Potential P.I.: Marshall				[ ]
Puerto Rico Fisheries-Mariculture Development Study P.I.: Marshall	[ ]	[ ]		[ ]
Central American Artisan Fisheries Seminar/Workshop Coordinator: Griffin		x	x	
Instituto del Mar, Peru, Joint Project, Production Potential off Southern Peru. Coordinator: Griffin				[ ]
<b>VI. OTHER</b>	---to be determined---			

**COHERENT TOPICAL PROGRAM IN COASTAL AQUACULTURE AND ARTISAN FISHERIES**  
with Related Marine Resource Activities

**Matrix C: University Organizations**

Total URI Faculty in Subject Area  
 B Approx. No. URI FTE in Development Work Overseas  
 C FTE to be Supported by Outside Funds for Development Work

	Food culture (Admin by collaboration)	Mariaculture (URI)	Aquaculture	Fisheries Training	Marine & Fisheries Biology	Ocean & Related Engineering	Food Technology	Resource Economics	Anthropology/Sociology	Marine Affairs	Other	Undetermined no outside support suggested
NA	5	14	1	1	1	1	1	1	1	1	1	1

**I. EDUCATION, LDC Professionals Studying at URI**

Coordination: Director, ICDD Student Adviser: _____	na	x	x	x	x	x	x	x	x	x	x	x
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**II. ADVISORY, Information Services on Artisan Fisheries and Aquaculture; Seminars organized by URI**

Director: M. Wiley Asst. for Int. Dev. Coordinator for advisory												
---	--	--	--	--	--	--	--	--	--	--	--	--

**III. AREA AND REGIONAL PROJECTS**

U. Iar es Salgan, Center for Marine Resources Coordinator: N. Marshall												
U. Catolica de Valparaiso, Cooperative Development with Escuela de Pesquerias y Alimentos Coordinator: _____								Δ	Δ			
Azores Program, Developing Extension Activity Coordinator: _____				○	○		○	○				Agri-culture
Puerto Rico Reef Study, Analysis of Development Stress P.I.: Adolphson					○			○	○			
Port Harcourt College, Curriculum Development Coordinator: _____				○	○		○	○				
Linkage with ICLARM P.I.: Director, Sellew	○			○	○			○				

**IV. CDDOT PROGRAMS, Food Technology, Linkages with U. California, U. Washington, U. Wisconsin & Michigan State U.**

Central America, ICAITI Coordinator: _____				○	○	○	○	○				
Brazil, ITAL Coordinator: _____				○	○	○	○	○				
Thailand, Kasetsart University Coordinator: _____				○	○	○	○	○				

**V. INDIVIDUAL & SMALLER PROGRAMS**

Auburn University, Linkages in Aquaculture Program P.I. Contact: _____	○	○	○	○		○	○	○	○			
Mexican Lagoon Study, Water Management for Mariculture Regions P.I.: Lampe				○				○				
Coral Trophic Study, Basic Information on Reef Fisheries Potential P.I.: Marshall					○							
Puerto Rico Fisheries-Mariculture Development Study P.I.: Marshall		○		○				○	○			
Central American Artisan Fisheries Seminar/Workshop Coordinator: Griffin	x	x	x	x		x	x	x				
Instituto del Mar, Peru, Joint Project, Production Potential of Southern Peru Coordinator: Griffin					Δ			Δ				
<b>VI. OTHER</b>												to be determined

/// = Initiative in advanced stages; ○ = early initiative.  
 □ = Administered at URI as a consortium or cooperative activity; □ = administered elsewhere as a consortium or cooperative activity.  
 Δ = Direct URI funding contributions (apportioned in faculty contributions).  
 - = Participation dependent on continued funding; ○ = combined funding; Δ = proposed for 2010.  
 Funding not suggested or outside URI scope; ○ = outside funding.

Tentative Initial Task Planning for 1974-75 -- 211(d)

<u>Project Title</u>	<u>P.I.</u>	<u>Student(s)</u>	<u>Funding Projection</u>
Ecology of tropical coastal ecosystems under development stress	Marshall	Jacques	\$ 3,100.
Technology transfer & innovation in artisan fishing traditions	Spaulding	---	5,070.
Studies on the artisan culture of green sea turtles	Shoop	Lemkau	1,800.
Socio-cultural change in artisan maritime communities	Pollnac	---	2,650.
Fishpot potential of the inshore tropical reef environment	Saila	Stevenson	3,850.
Low cost boat for artisan fishing in developing countries	Sainsbury	Stone (1/2)	9,200.
ICMRD Research Library	J. Alexander	---	2,000.
Hot smoke fish curing	Salomon	Caurie	200.
Evaluation of factors limiting the establishment of artisan prawn aquaculture	Lee & Chichester	Kamata	1,400.
Growth of algae, enteromorphs, for use as fertilizer in LDCs	Marshall	Parker	1,850.
Improved utilization, handling and preservation of capture fish resources	Constantinides	(various)	2,300
Socio-cultural study of Latin American fishing communities	Poggie	Bartee	<u>5,680.</u>
			<u>\$40,600.</u>

Tentative Initial Task Planning for 1974-75 -- non-211(d)

Supplemental research support for non-211(d)-funded projects in marine foods and nutrition	Lee		\$ 800.
Caribbean regional marine resources development in the Caribbean: the role of fisheries with emphasis on artisan interests	L. Alexander	S. Vallejo R. Brusconi	<u>1,820.</u>
			<u>\$ 2,620.</u>

Anticipated re . . . cs

Lampe	Vidaeus
Cummings	Adriasola

C.VIII. Other

Topics involving multi-national interests which have enhanced the linkages established between the University, governments and the world's scientific community are included in this section. In some cases these activities have led to the development of work relating to the grant's primary interest.

Efforts such as the Law of the Sea Institute and the Mid-Ocean Dynamics Experiment provide a basis for information exchange in priority areas in development of marine resources while establishing contacts in foreign areas, contact which in several instances has been pivotal in downstream program development (i.e., Tanzania, Central America, etc.).

Other activities describe the present contributions to national/international policy making and provide a University input to long-range planning which ultimately would affect our efforts in achieving our 211(d) goals.

Topic Title: Law of the Sea Institute

Principal Investigator: John K. Gamble, Jr.

Continued emphasis was placed on workshops focusing on specific marine problems conducted by the Law of the Sea Institute. The Institute also embarked on a bibliographic project which is expected to provide the most comprehensive bibliography yet developed on the social sciences of the oceans.

The eighth annual URI Law of the Sea Institute Conference was held in June with 215 attendees representing 40 nations who addressed themselves to the topic Law of the Sea: The Emerging Regime of the Oceans.

During the fall of 1974 a review of the outcome of the Caracas Law of the Sea Conference will be presented to government, institutions and industry at the MTS Conference in Washington, D.C., in lieu of the normal Institute.

Among other related activity undertaken by Professor Gamble relevant to ICMRD goals is the completion of a book entitled Global Marine Attributes which attempts to describe all of the independent countries of the world according to marine characteristics and also the beginning of research and eventually course development in the comparative analysis of marine policy formation. This effort will include an attempt to develop a theoretical model for analyzing the differing processes within countries that produce national marine policies.

**Topic Title: Mid-Ocean Dynamics Experiment (MODE)**

Seventy of the world's senior physical oceanographers gathered in mid-July at the University of Rhode Island's Narragansett Bay campus for a six-week institute to pool their knowledge gained in an international experiment on ocean eddies. The scientists from Britain, France, Germany, Sweden and the United States worked at the URI oceanography campus to collaborate and report on the latest understanding of ocean circulation gained from an ambitious experiment called MODE.

Scientists from the Soviet Union, who have been observers of the experiment, came to Rhode Island to learn more of its findings. Another delegation of Soviet scientists arrived in late August to study the results.

Only 15 years ago scientists thought that movement of ocean water consisted of enormous, slowly moving ocean currents. But with sketchy data gathered by research vessels in the late 1950s and with information obtained in the MODE study, it is now known that ocean eddies exist and are important to ocean circulation. The circulation pattern, scientists are finding out, is more like the complex, swirling "highs" and "lows" of weather systems.

Ocean eddies have been observed which are several hundred miles in diameter and take months to pass a given point. Current speeds in the eddies are typically 10 to 15 miles a day, but currents as high as 40 miles per day have been found.

A tremendous amount of energy is wrapped up in the eddies. Questions now being asked are how and where do they transfer energy and heat and how much? How do they interact with atmospheric circulations, affecting weather and climate and ultimately food supplies?

With funding from the National Science Foundation and the Office of Naval Research, an international experiment to monitor and measure ocean eddies was carried out in the spring of 1973. Scientists on six oceanographic research vessels (including URI's Trident) converged on a 100,000 square-mile area approximately midway between Bermuda and Miami, Florida. They tracked instrument packages which would stay submerged and travel freely with the eddy currents. Current meters moored in water thousands of feet deep, as well as other instruments, were also used to measure intensively, for the first time, the size, speed and nature of eddies.

Although a major part of the MODE field work has been completed, some of the instruments remain in the study area and will be monitored until 1977.

With the six-week meeting at URI, the scientists hoped to collaborate in producing three major reports on the MODE project. Scientists have had

a year to analyze and publish on their own and set the stage for a pooling of knowledge gained from the project. It is hoped that one group of MODE scientists will produce a synoptic atlas of the data. Another group will be responsible for drawing comparisons of data from different groups of scientists, and a third group will try to fit the MODE information into the context of the present understanding of ocean circulation.

Topic Title: Ocean Management

Principal Investigator: John A. Knauss

Provost Knauss became chairman of the Freedom of Ocean Science Task Group of the National Academy of Sciences, a group which is providing active advice to the State Department regarding the United Nations Law of the Sea Conference. The group has formally communicated with Ambassador John Stevenson, head of the U.S. delegation, outlining the Academy position. Additionally, the group prepared a report on the present status of negotiations which the National Academy of Sciences sent to other academies and which the U.S. National Committee to Scientific Committee on Oceanic Research (SCOR) sent to other national committees.

Provost Knauss was a member of the Law of the Sea Advisory Group to the U.S. State Department attending three weeks of preparatory meetings in Geneva during the summer of 1973 and the Caracas Law of the Sea Conference as a member of the U.S. delegation on the Sea Beds Committee in the summer of 1974.

In addition, Provost Knauss served as an advisor to the officers of the Sea Grant Program, assisting them in preparing a report to Congress on the possibilities of developing an international Sea Grant Program. Both he and Professor Marshall have worked with Professor Judith Kildow of MIT on an advisory committee reviewing this question. Some of their thoughts have been forwarded to AID for consideration in establishing the agency's position on this issue.

In addition, Provost Knauss has served on a program of technology transfer in Washington which met March 25-27, 1974. The program's results will be published very shortly.

A lead article in Science by Provost Knauss, written at the invitation of the editor, discussed marine science and the Law of the Sea negotiations.

**C. IX. Report of Expenditures**

Table I

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## Distribution of 211(d) Grant Funds and Contributions From Other Sources of Funding\*

Review Period 7/1/73 to 6/30/74

(List all grant-related activities) TOPIC TITLES	211(d) Expenditures				Non-211(d) Funding Amount
	Period Under Review	Cumulative Total	Projected Next Year	Projected to end of Grant	
International Conference on Marine Resources Development in Eastern Africa	\$ 35,521	\$ 45,277	\$12,000	\$ 57,277	URI \$ 3,852
Seminar and Workshop on Coastal Artisan Fisheries and Aquaculture in Central America and Panama	9,931	9,931	25,000	34,931	
Technical Assistance for Instituto del Mar, Peru	1,105	1,105	2,000	3,105	
Technical Assistance for Escuela Pesqueras y Alimentos, Universidad Catolica de Valparaiso	6,005	7,159	4,000	11,159	CODOT 10,000 Diakonia 60,000
Technical Assistance to Port Harcourt College of Science and Technology, Nigeria	1,195	1,195	1,000	2,195	
Escuela Politecnica de Litoral, Guayaquil, Ecuador	3,707	3,707	1,000	4,707	URI 270
Improved Utilization, Handling and Preserva- tion of Marine Food	9,801	16,251	5,000	21,251	URI 1,796
International Marine Food Problems	20,910	30,091	6,500	36,591	NutFdn, NIH, ITAL 10,500
Prospects for International Fisheries Development Assistance	5,679	5,679	--	5,679	
Surface Water Management for Irrigation and Lagoon Environmental Modification	27,129	31,245	15,500	46,745	RFF, URI 11,112
Studies on the Culture of Green Sea Turtles	5,670	10,602	7,579	18,181	URI 8,000
Hot Smoke Fish Curing in West Africa	19,032	23,128	23,000	46,128	URI, NSF, NutFdn 13,000
A Study on the Prospects of Marine Resource Development in the Caribbean Region	10,227	17,331	10,000	27,331	Sea Grant 5,000
Commercial Fisheries Education/Training Program at the University of the South Pacific, Fiji	350	350	11,100	11,450	URI 6,000
SUB-TOTAL (forwarded to next page)	\$156,262	\$203,051	\$123,679	\$326,730	\$129,530

\*These figures are your best estimates

Table I

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## Distribution of 211(d) Grant Funds and Contributions From Other Sources of Funding\*

Review Period 7/1/73 to 6/30/74

(List all grant-related activities) TOPIC TITLES	211(d) Expenditures				Non-211(d) Funding Amount
	Period Under Review	Cumulative Total	Projected Next Year	Projected to end of Grant	
sub-total fwd	\$156,262	\$203,051	\$123,679	\$326,730	\$129,530
District of Sao Miguel, Azores	\$ 3,147	\$ 3,147	\$ 5,000	\$ 8,147	
Water Resources Management	13,362	19,180	18,200	37,380	URI \$ 8,000
Marine Mineral Resource Management Issues	1,500	1,500	--	1,500	
Coral Reef and Reef Lagoon Studies	15,650	26,995	10,000	36,995	URI 2,000
Economic Demand Relationships of Fisheries Resources under Extended National Jurisdiction	9,144	16,788	9,800	26,588	
Education	3,699	3,699	--	3,699	URI 5,000
ICMRD Technical Library	15,289	15,289	15,000	30,289	
Seminars for Development of International Institutional Capabilities	1,000	1,000	1,000	2,000	URI 2,000
<b>Topic sub-total</b>	<b>\$219,053</b>	<b>\$290,649</b>	<b>\$182,679</b>	<b>\$473,328</b>	<b>\$146,530</b>
Director's Office, ICMRD: Other planning and Development in Period under Review	13,001	13,001	15,900	28,901	
Director's Office, ICMRD: Program and Grant Management	17,865	171,314	20,000	191,314	
Balance of Prior Year (6/30/73) tasks not included in above topics		231,457		231,457	
<b>TOTAL</b>	<b>\$249,919</b>	<b>\$706,421</b>	<b>\$218,579<sup>1</sup></b>	<b>\$925,000<sup>2</sup></b>	

<sup>1</sup>Includes increase of \$175,000 for 1974/75<sup>2</sup>New Grant Total

Table I

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## Distribution of 211(d) Grant Funds and Contributions From Other Sources of Funding\*

Review Period 7/1/73 to 6/30/74

(List all grant related activities)	211(d) Expenditures			Projected to End of Grant	Section C.VI. Non-211(d) Funding Amount
	Period under Review	Cumulative Total	Projected Next Year		
					CODOT--ICAITI (AID/ROCAP) \$ 179,915
					CODOT-ITAL (Council of Science & Technology, Govt. of Sao Paulo) 1,993,000
					Development of Infant Foods Based upon Indigenous Protein (AID) 109,706
					Food Technology
					NSF 125,562
					NIH 105,638
					Nutrition Foundation 30,000
					NE Fisheries Steering Comm. 7,700
					Puerto Rico (NSF) 99,500
					Belize (through Univ. of Illinois) 6,000
					Land Crab and Lobster Culture (Sea Grant--Dept. Commerce) 4,450
					Lobster Habitat Design (R.I. Dept. Natural Resources) 12,400
					Trophic Regimes in Coral Reef Atolls (NSF) 26,300
					National Oceanographic Data Center (NODC) 1,000
					Demand and Supply Potentials for South Vietnam's Fishery Industry 8,000
					Artisan Fishing Development in Mexico 410
					<u>\$2,709,581</u>

Table II

Expenditure Report

(Actual and Projected)

Under Institutional Grant #AID/ - 2455

Review Period 7/1/73 to 6/30/74

(Line Items to Conform to Budget in Grant Document)	Expenditures to Date		Projected Expenditures				Total
	Period under Review	Cumulative Total	Year				
			2	3	4	5	
Personnel	\$167,807.49	\$482,224.87					
Graduate Assistants	35,344.13	105,033.95					
Travel	24,890.27	59,894.50					
Other	21,877.24	59,266.04					
	\$249,919.13	\$706,421.36					

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