ICLARM REPORT 1982

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Edited by

Jay L. Maclean

and

Leticia B. Dizon

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ICLARM

INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
MANILA, PHILIPPINES

ICLARM Report 1982

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Front cover: Children in Thailand with small tilapias *(Oreochromis mossambicus)* used for feeding seabass *(Lates calcarifer)*. Photo: Roger Pullin. *Back cover:* Fish dealer's "jeepney", Philippines. An important element in the economics of the tilapia industry. Photo: Noel Morales.

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CONTENTS

INTRODUCTION

During 1982, ICLARM has grown stronger, expanded its activities slightly and has continued to gain recognition as an established part of the scientific community working to support and strengthen tropical fisheries management and development. ICLARM's scientific contributions and accomplishments have included a wide variety of specific, carefully targeted research activities conducted in cooperation with other institutions and planned to complement and supplement the work of development organizations. Research results from the "first generation" of studies conducted by ICLARM together with cooperating institutions are now largely available. The increasing flow of ICLARM publications reflects the importance placed on the Center's primary means of communicating research results to user groups. Demand for ICLARM publications is strong from all parts of the developing world and sales are brisk.

To an increasing extent fisheries scientists are looking to ICLARM for guidance, assistance and ideas. The flow of visiting scientists through ICLARM's office continues to increase. Presentations and lectures by staff members at conferences, workshops and training courses have increased in number and have had a significant impact in ICLARM's areas of expertise.

As nearly every institution, national and international, interacting with ICLARM has received budget cuts, demands for ICLARM to step forward in a stronger role have come from many directions. ICLARM's funding limitations have prevented rapid expansion but opportunities and needs for such expansion are abundant, and the Center is responding positively within its capabilities.

The integration of ICLARM's various research activities continues to be a distinctive feature which enhances the effectiveness and the applicability of its work. Small staff size permits a high level of interaction and cooperation, and individual projects in one program are often designed to utilize expertise of scientists in other programs. Examples of these linkages in 1982 are:

- Socioeconomic appraisal of the constraints to increased productivity of milkfish farms.
- Stock assessment as related to studies of traditional fishing communities.
- Planning for interaction of fishery management and clam cultivation in reef resources utilization.
- Role of aquaculture as an employment alternative for low-income fishermen.

- Marketing studies as a part of the molluscan bivalve production project.
- Possible stocking-fishery interactions for mullet and other migratory species.
- Interaction of economics and biology on fishery management options.

Activities expanded during 1982 include the Resource Development and Management Program with the hiring of Dr. John Munro in February as Program Director. New aquaculture projects have been initiated in Kuwait (January) and Taiwan (July), with one or two ICLARM staff members stationed in each country. A Fisheries Social Sciences Network is rapidly taking shape involving key universities in Malaysia, Thailand, Indonesia and the Philippines and funding from IDRC of Canada. A differently designed network, the Management-Oriented Tropical Fisheries Research Network has begun to function. New cooperative agreements have been signed during the year with the Department of Fisheries in Sabah, the University of the Philippines in the Visayas, Universiti Pertanian Malaysia, the National Inland Fisheries Institute in Thailand and the Council for Agricultural Planning and Development in Taiwan. ICLARM has taken initial exploratory steps toward establishment of a fisheries forum in Southeast Asia. The level of interest in this activity is high.

Interaction with other institutions is both the primary mode of operation and the key to ICLARM's research-catalyzing and stimulating role. Relationships with other institutions and scientists reflect expansion of this mode of operation. ICLARM scientists are also invited to participate in an increasing number of conferences and workshops, and a large number of spontaneous compliments have been received on our newsletter, scientific publications, conferences and other initiatives, reflecting broad interest in ICLARM's work. Requests for assistance or collaboration on research projects also are increasing and far exceed our capacity to participate. The U.S. Agency for International Development reviewed ICLARM's program in March 1982, and the review team was highly complimentary.

The 12 months of 1982 were eventful ones for developing-country fisheries. Passage of a new Law of the Sea treaty offers to stabilize many aspects of international fisheries relations. Continuation of the world fisheries catch at the "70 million tonne plateau" is an ominous knell that should be recognized as a major "event" (Fig. 1). Tuna fishing is undergoing changes involving fish-attraction devices, purse seining and the harvest of juveniles that will certainly have far-reaching, albeit presently unknown, effects. Rapidly expanding bans on trawling in Southeast Asian countries are recognition both of the competition between modern, efficient harvesting methods and small-scale fishermen and of the conflicting goals of fishery management. The year 1982 may be remembered as the year many developing-country fishery managers first recognized that their country's fish harvests had levelled off or were declining and that increases projected to satisfy needs of growing populations would not be met from capture fisheries.

by the declaration of exclusive economic zones and the implicit expectation that the resources in those zones will be managed on a rational scientific basis. This has, in turn, brought into focus the urgent need for skilled scientific personnel able to generate management options on the basis of fishery investigations.

The Management-Oriented Fisheries Research Project addresses this problem. It is designed to augment the number of fisheries personnel, skilled in the assessment of tropical fish stocks, in the context of management-oriented fisheries research and training programs for selected countries. This is seen as a key step in the process of strengthening the capabilities of developing countries to manage their own fisheries. The approach proposed here differs from conventional fisheries development projects in that, rather than generate a large body of new data, the projects will normally concentrate upon in-depth analysis of data presently available and/or routinely collected by the participating countries. Where no previous database exists, methodologies for data acquisition will be investigated.

In the Management-Oriented Fisheries Research Project, two country modules, the Philippines and Peruvian modules are operational. The necessary groundwork for the Indonesian module has been completed and the project should get underway early in 1983. The Program Director visited a number of countries in Oceania and attended the Regional Fisheries Technical Meeting of the South Pacific Commission in July and August with a view to ascertaining the possibilities of developing modules within various South Pacific countries. He also visited Zimbabwe in December to investigate the possibility of a module focussed upon reservoir fisheries.

A visit of Dr. Pauly to the Instituto del Mar del Peru in November/December 1981 provided the opportunity to initiate a Peruvian module of the Management-Oriented Fisheries Research Project. This module concentrates on the analysis, using ELEFAN I, II and III, of 20 years' detailed catch-at-length data for Peruvian anchovy. The data, which are currently being analyzed at ICLARM, allow for precise estimation of the growth, mortality and recruitment rates of one of the most important fish stocks in the world.

Advisory Services

Dr. Pauly visited FAO, Rome and the Danish Institute for Fisheries and Marine Research from 28 September to 10 October 1982 for consultations on development of materials for the FAO/DANIDA training courses in fish stock assessment in which Dr. Pauly will participate in 1983.

Training

Drs. D. Pauly and J. Munro contributed to the teaching program of the Fishery Resources Assessment Training Course which was held at the Ateneo

de Manila University, 3-15 May 1982. Dr. Pauly took a major part in the organization of the course which was jointly sponsored by BFAR, ICLARM, PCARRD and the SCSP/FAO. Thirty young scientists employed by BFAR were given basic training in the elements of stock assessment during the course.

Additionally, Dr. Pauly held a 10-day training course at Silliman University in which he taught a selection of staff and graduate students the basics of stock assessment, based upon his "Selection of Simple Methods for the Assessment of Tropical Fish Stocks".

Dr. Pauly taught a one-semester course on "Aquatic Resource Management" from October 1981 to March 1982, at the Zoology Department, University of the Philippines. Two of the participating students successfully defended MS theses in Marine Biology. One of the theses was on the biology of the pomfret, *Formio niger*, while the other, using data on the croaker, *Otolithes ruber*, from San Miguel Bay, was the first thesis in fish population dynamics ever presented at a Philippine university.

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Pauly, D. and J. Ingles. 1981. Aspects of the growth and mortality of coral reef fishes. Proc. Fourth International Coral Reef Symposium 1: 89-98.

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Resources Research and Development. Sydney, Australia. April-May 1982. FAO Fish Rep. 275. 135 p.

Pauly, D. and G.I. Murphy, Editors. 1982. Theory and management of tropical fisheries. ICLARM Conference Proceedings 9, 360 p. International Center for Living Aquatic Resources Management, Manila, Philippines and Division of Fisheries Research, Commonwealth Scientific and Industrial Research Organisation, Cronulla, Australia.

Venema, S. and D. Pauly. 1982. Training courses in fish stock assessment: the past and the future. ICLARM Newsletter 5(4): 13-14.

Meetings Attended, Papers Presented

Third Session of the Indo-Pacific Fishery Commission's (IPFC) Standing Committee on Resources Research and Development (SCORRAD), Sydney, Australia, 28 April-4 May 1982 (J.L. Munro and D. Pauly).

Paper presented:

D. Pauly and J.L. Munro. The development and dissemination of new methodologies in fish stock assessment.

14th Regional Fisheries Technical Meeting of the South Pacific Commission (SPC), Noumea, New Caledonia, 2-6 August 1982 (J.L. Munro).

International Council for the Exploration of the Sea. 70th meeting. Copenhagen, 11-14 October 1982 (D. Pauly).

35th Annual Gulf and Caribbean Fisheries Institute, Nassau, Bahamas, 7-12 November 1982 (J.L. Munro).

Papers presented:

J.L. Munro and G. Heslinga. Prospects for the commercial cultivation of giant clams (Bivalvia: Tridacnidae).

J.L. Munro. Some advances and developments in coral reef fisheries research; 1973-1982.

Program Plans for 1983

It is planned that the Network, the Management-Oriented Fisheries Research modules and the in-house Tropical Fish Stock Assessment Research Program will continue in 1983 and beyond.

The emphasis in the Network will be on the acquisition of members, the dissemination of new simplified approaches to stock assessment and management (via the proposed newsletter) and the identification of possible participants in various workshops. The last-mentioned aspect will depend very much upon the acquisition of external support. The Network will, of itself, generate possibilities for identification and development of country modules.

We will have operational country modules in the Philippines, Indonesia and Peru in 1983. There are prospects, not yet developed, for modules in elsewhere in Asia, Africa and the South Pacific. The full development of country modules will depend very much upon the identification of specific

objectives for each module, tailored to the needs of each country, and the acquisition of suitable levels of bilateral funding.

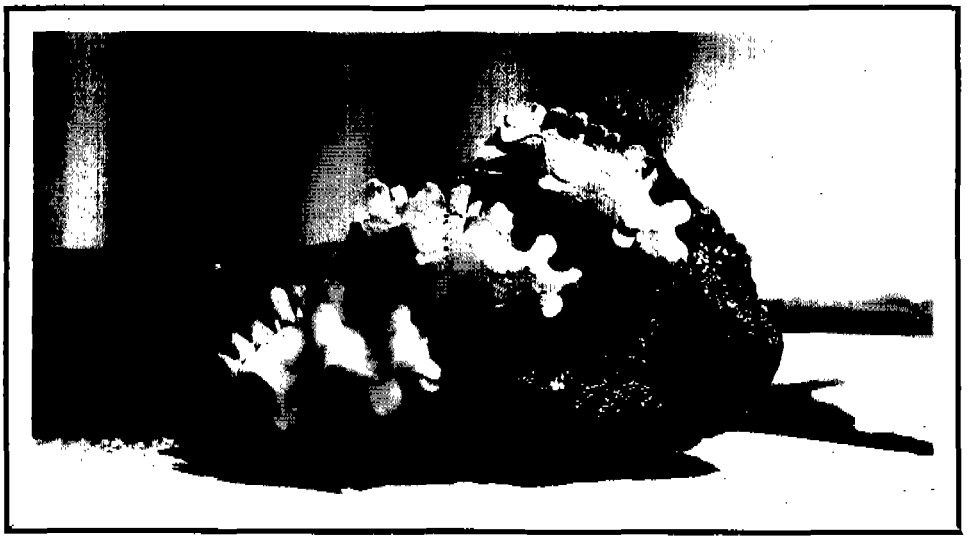
Present plans call for commitment of funds to the Philippine module to support an investigation of climatic and oceanographic features in relation to recruitment and an investigation of the operating characteristics and possible use of portable fish traps in the western Pacific environment. The Indonesian module centers upon the analysis of length-frequency and catch data on file at the Marine Fisheries Research Institute, Jakarta.

The Peruvian module will sponsor attendance of two scientists from the Instituto del Mar del Perú (IMARPE) at the FAO consultation on neritic fish stocks to be held in Costa Rica in April 1983, at which meeting the results of analysis of data on the northern stock of anchoveta will be presented.

The major new initiative proposed in the program for 1983 is the development of a project for rehabilitation of fisheries for giant clams (Tridacnidae) through a program of support of research on hatchery techniques and juvenile rearing, reef restocking or extensive mariculture, biological and socioeconomic studies. The tridacnid clams are a major traditional food resource throughout the Indo-Pacific, particularly in Oceania. The stocks have been decimated by the combined effects of increasing human populations and the attentions of fishermen from Southeast Asia operating under the incentive of the high value of the dried adductor muscle (US$120/kg). There is ample evidence that these animals form a significant component of the undisturbed reef ecosystem. They constitute one of the few harvestable resources for which the exploitation and/or cultivation for export markets and local consumption is largely compatible with the life style and aspirations of the people of Oceania. The project as envisaged would cut across the entire range of ICLARM's programs including socioeconomic aspects, aquaculture and conventional reef fisheries.

Resource Development and Management Project Summaries

Active



Juvenile giant clams *(Tridacna squamosa)* attached to a gravel substrate at the Micronesian Mariculture Demonstration Center, Palau. ICLARM is developing a broad project on giant clam research (see p. 10). Photo: John Munro.

Project Title	:	Tropical Fish Stock Assessment Research Project
Cooperating Institutions	:	Predominantly in-house study, with informal linkages with various research institutions
Duration	:	Continuous from July 1979
Key Personnel ICLARM	:	Dr. Daniel Pauly Dr. John L. Munro Mr. Noel David

Objectives

This project has as its principal objective the understanding of the dynamics of exploited tropical fish communities. However, the dearth of information is such that it is also necessary to direct considerable attention to the development of stock assessment methods which are straightforward, are readily applicable to tropical stocks and which do not require costly hardware for their implementation.

Results

Dr. Pauly has developed three integrated approaches based, in increasing order of sophistication, on the use of "paper and pencil methods", the use of programmable calculators and the use of microcomputers. The "paper and pencil methods", which include mainly methods for the analysis of growth and mortality and of catch and effort data, were packaged in 1980 in the form of a FAO circular entitled "A Selection of Simple Methods for the Assessment of Tropical Fish Stocks." This document, which has now been reprinted several times, has also recently been translated into French and Spanish by FAO for distribution in West Africa and Latin America, respectively.

The methods for use with programmable calculators have been incorporated into the manual, presently being edited, entitled "Fish Population Dynamics in Tropical Waters: A Manual for Use of Programmable Calculators". This manual, which covers the whole field of fish population dynamics, and which includes a number of new methods is built around 30 pro-

grams for HP 67/97 calculators, for which program listings and user's instructions are provided in an appendix. It is expected that this manual will meet considerable demand, given that it is a tropical text, and as a calculator-based text, the first of its kind.

The microcomputer-based methods include three ELEFAN programs, early versions of which have been requested from and distributed to colleagues throughout the world. It is intended that a set of microcomputer programs will be published in 1983.

A review of progress in coral reef fisheries research in the past decade has been completed by Dr. Munro. The objective of the review is to re-evaluate previous estimates of stock assessment parameters in coral reef fisheries using recently-developed techniques, identify areas where progress has been made and review some of the more controversial aspects of growth, mortality and recruitment of reef fish stocks. The review forms the basis of the final chapter of the work on Caribbean reef fish biology edited by J.L. Munro, which ICLARM contracted to reprint and which will be published in 1983.

Additionally, Dr. Munro completed two papers on giant clams (Tridacnidae), covering their phototrophic characteristics and a review of extant information on their biology.

In addition to the applied aspects of developing and disseminating appropriate stock assessment methods, basic research has been continued on aspects of the biology and ecology of fishes, notably their growth, mortality and recruitment.

Research assistant Deng Palomares at computer analyzing data for Tropical Fish Stock Assessment Project and Management-Oriented Fisheries Research Project—Peru module.

Project Title : Network of Tropical Fisheries Scientists

Cooperating Institutions : Project based on individual membership of fisheries scientists in institutions throughout the tropics

Duration : Continuous from April 1982

Key Personnel ICLARM : Dr. John L. Munro
Dr. Daniel Pauly

Objectives

The Network of Tropical Fisheries Scientists is intended to enhance communication between fisheries scientists working on scientific aspects of assessment, conservation and management of tropical stocks. The estimation of biological, fishery and socioeconomic parameters which determine the magnitude of harvests, and the application of those parameters to models to arrive at scientifically sound management measures for tropical stocks illustrate the technical focus of this work.

Results

The Network was formally launched by way of a presentation at the Third Session of the IPFC's Standing Committee on Resources Research and Development in Sydney, Australia, in April 1982. The Committee recorded its interest in the Network and passed a formal recommendation that the program be strongly supported.

A description of the Network and its objectives appeared in the October issue of the ICLARM Newsletter, and also in the proceedings of the SCORRAD meeting, but even in the absence of major publicity, membership is growing rapidly and stood at 60 members by the end of the year.

The first Network member to avail himself of ICLARM's facilities and expertise was Mr. Paul J. Dalzell of the Research and Surveys Branch of the Papua New Guinea Fisheries Division, who spent four weeks at ICLARM utilizing the computer facilities and the ELEFAN programs to analyze a large series of data sets on the tuna bait-fishes, *Stolephorus heterolobus, S. devisii* and *Spratelloides gracilis.* He was able to estimate growth, mortality and recruitment of two cohorts per year over periods of up to six years.

Project Title : Management-Oriented Fisheries Research Project

Cooperating Institutions : Departments of Fisheries, Universities and Research Institutes in participating countries (currently including Philippines, Indonesia and Peru)

Duration : Continuous from 1982

Key Personnel ICLARM : Dr. John L. Munro
Dr. Daniel Pauly

Objectives

The project aims at strengthening the capabilities of the participating countries to manage their fisheries. Specifically, the project will:

1. train young fishery scientists in the interpretation of fishery data (especially in extracting a maximum of information from available data) and in formulating implementable management options
2. help determine, in the countries involved in the project, the basic information requirements for stock assessment and fisheries management
3. produce well-documented reviews of the various fisheries investigated and original studies on tropical fish population dynamics
4. help establish a dialogue between the fishery managers and the fishery biologists, and between the fisheries departments and the universities of the project's host countries.

Country modules will aim at developing a small, well-trained nucleus of researchers capable of utilizing up-to-date stock assessment techniques and of interpreting results. This core of trained researchers will be the basis for future in-country training of additional workers, for improvement of university curricula and for interaction with administrators setting policies and regulations affecting fisheries.

Results

There were two modules operational at the end of 1982, in the Philippines and Peru; a third module has been proposed in Indonesia.

Philippines

The Philippine module is unique in two aspects:

- It offers a framework for ICLARM interns from the Philippines, and
- It offers an opportunity for a limited amount of field work by Headquarters staff members.

The Philippine module has as its main accomplishment the completion and preparation for publication of an "Atlas of the Growth, Mortality and Recruitment of Philippine Fishes" in which data on 112 stocks belonging to 57 species are presented. The atlas resulted from the application of the ELEFAN I and ELEFAN II programs to approximately 0.9 million previously unanalyzed length-frequency measurements obtained from the Bureau of Fisheries and Aquatic Resources (BFAR) and other institutions within the Philippines.

The bulk of the work on the atlas was done by Mr. José Ingles, an ICLARM intern from the College of Fisheries, University of the Philippines. It is anticipated that the atlas will serve as a model for reduction and interpretation of available length-frequency data, and thus acquisition at low cost of maximum information from expensive field data.

Another set of Philippine data, namely, catch-per-effort data from trawl surveys, has been reduced by Mr. Ranin Regalado, an ICLARM intern from BFAR. The data, which pertain to all parts of the country and cover the period from 1947 to the present, provide the basis for the first comprehensive assessment of the status of Philippine demersal resources.

In addition, the report of the "stock assessment module" of the interdisciplinary "San Miguel Bay Project" has been completed. This report, which contains eight papers covering different aspects of the Bay and its fisheries, is the first in-depth analysis of any fishing ground of the Philippines. With its sister volumes on the economics and the sociology of the fisheries, the reports represent a model for multidisciplinary study of any tropical fishery.

Peru

The main aim, from ICLARM's side, of the Peruvian module is to demonstrate how the application of the ELEFAN programs, developed at the Center, can be used to accelerate the estimation of reliable fishery-related parameters from suitable sets of data.

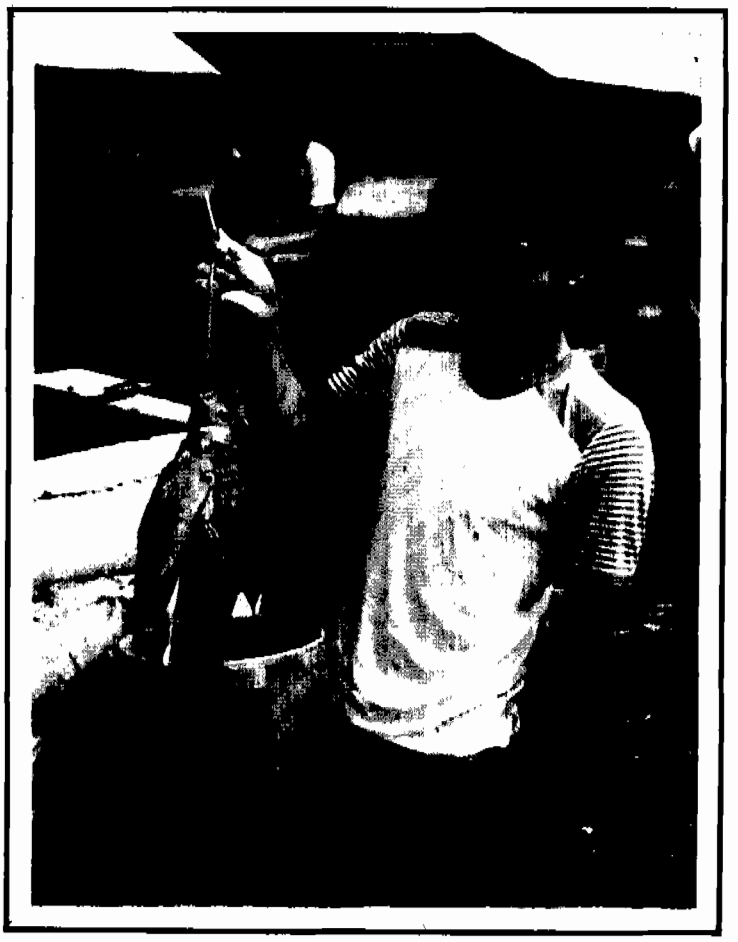
This is being demonstrated through the detailed analysis of a comprehensive set of monthly catch-at-length data covering the period 1961 to 1979 pertaining to the northern stock of the Peruvian anchovy; these data have been entrusted to ICLARM with the explicit request for their analysis by the ELEFAN methods. The results of the analysis are expected to provide a firm understanding of the growth of the Peruvian anchovy, including its

seasonality and degree of density-dependence. The estimates of recruitment obtained in this analysis will allow for the first time the rigorous testing of the various hypotheses that have been formulated with regard to the 1972 collapse of the fishery.

Indonesia

This module has recently been formulated as a proposal presented to a potential Indonesian counterpart agency. Proposed was that the set of ELEFAN programs developed at ICLARM be used on microcomputers at the Research Institute for Marine Fisheries, Jakarta (BPPL) and that ICLARM assist with the application of these programs to the numerous sets of length-frequency data available in Indonesia. Participants in the module also will analyze the data that have been collected in various trawl surveys conducted in Indonesian waters, notably in the Java Sea, using another set of programs developed for ICLARM.

A positive response to the proposal was received and a formal agreement is expected in early 1983.



Nile tilapia cultured in the Philippines. The tilapias are fast becoming a major international fish commodity and tilapia research is a major thrust of ICLARM's aquaculture program.

AQUACULTURE PROGRAM

Background

If a single word were used to describe the activities related to aquacultural development in Southeast Asia during 1982 that word would be "commercialization". For both high-priced species, such as shrimp and groupers, and lower-priced fishes, such as tilapia and carps, the obvious trend is toward commercialization of hatcheries, feed production, fry and fingerling supply, improvement of stocks and sale of improved varieties and even presentation of short courses on methodology. Southeast Asia, which realizes 10% of its fishery tonnage and 17% of its value from aquaculture, leads the developing world in applied aquaculture technology. This development trend has important implications for other regions of the world since it forecasts the likely course of events elsewhere. As with agriculture, the progressive, more efficient farmers are the first to adopt new technology; nevertheless, as with agriculture, the small farmer also benefits from improved seed, new practices and technical innovations.

ICLARM's orientation toward assisting poor producers and fishermen in improving their incomes, their opportunities for employment and their nutrition has not changed. The rationale that improvement of aquacultural technology generally will benefit the poor as well as the affluent farmer is still held. As in previous years, particular emphasis has been placed on lower-priced fish that can be produced efficiently (tilapia, mullet, carp, milkfish and molluscan shellfish).

Progress of Work

By design ICLARM has not conducted comprehensive research studies incorporating, for example, work on all aspects of the culture of a given species. Rather it has selected key research topics that will provide results to bridge critical gaps in knowledge that are inhibiting development or wise use of resources. Although this approach results in projects on a variety of topics giving the appearance of a scattered effort, several underlying themes exist that often overlap at the project level, but serve to join the program elements in a useful and functional way.

Commodities

The aquaculture program's commodity focus provides the first of these themes. Major emphasis has been placed on tilapia. Rapid acceptance of superior strains and steady increases in production have confirmed views that this group of fish will be the "chicken" of the aquaculture world. ICLARM's research on tilapias includes studies on salinity tolerance, broodstock selection, hatchery methods, intensive culture, nutrition, genetic typing and economics.

The potential of salt-tolerant tilapias is of great interest in coastal desert areas. In Kuwait, through a project entitled "Intensive Mariculture of Tilapia" this aspect is being addressed in cooperation with similar experiments in Taiwan (see below). An ICLARM scientist, seconded in early 1982 to the Kuwait Institute for Scientific Research where appropriate facilities exist, has constructed a raceway system there and acclimatized several strains of tilapia to seawater. Growth experiments are underway.

Despite their reputation for uncontrolled breeding at early ages in ponds, tilapia are fish with low fecundity, and the production of large numbers of fry requires spawning of many adults. As tilapia production has expanded and become more intensive, the failure of hatcheries to produce adequate numbers of fry at optimum times has become a major constraint to production.

A cooperative project, "Mass Production of Tilapia Fry," with the Freshwater Aquaculture Center of Central Luzon State University (CLSU), Philippines, was initiated in July 1980 to address this problem. In this project, several tilapia strains, species and hybrids with culture potential are being assessed for reproductive and growth performance. The culture collection for this work was assembled previously during the CLSU-ICLARM tilapia broodstock improvement project completed in August 1981. Nineteen intra- and interspecific breeding experiments involving seven strains of two tilapia species were performed initially. Follow-up work on promising stocks is being carried out to compare all-male postfingerling growth performance. Optimum sex ratios, stocking densities and fry collection methods are also being investigated, while electrophoretic analysis of tissues of the various strains is in progress to identify genetic "markers."

New thrusts in key tilapia research areas have commenced in two one-year cooperative projects with the College of Fisheries of the University of the Philippines, beginning in May 1982. The first is entitled "*Azolla* in Tilapia Nutrition." *Azolla* is a nitrogen-fixing aquatic fern, which is commanding great interest as an organic fetilizer for aquatic ecosystems, including ricefields. In discussions with the International Rice Research Institute (IRRI), it was learned that *Azolla* is also being tried in parts of the Philippines as a fish food, particularly for tilapias in rice-fish and other integrated farming systems, in the absence of information on the nutritional value of *Azolla* to fish. In this project, fresh and dried *Azolla* diets are being tested on Nile tilapia fingerlings.

The other new research direction is in "Tilapia Incubation Systems." Artificial incubation systems for tilapia eggs have been used experimentally in Africa, Israel, Taiwan, the United Kingdom and the U.S.A. A few commercial Taiwanese hatcheries are now starting to use them on a large scale. The attraction of such systems is that they can increase the productivity of hatcheries by increasing the frequency of spawning of broodstock. However, the factors affecting egg and larval survival in incubation systems have been little investigated and their true potential in fry and fingerling production is unknown. Experiments at the U.P. College of Fisheries using *O. niloticus* are underway.

Integrated Farming

The second unifying theme in the aquaculture program is integrated farming. A three-year cooperative animal-fish research project with Central Luzon State University, Philippines, was completed in December 1981. However, integrated farming includes all aspects of the integration of agriculture with aquaculture. Studies of the nutritional value of *Azolla* to tilapia (noted above) and plans for a detritus conference in 1983 as related to use of compost and agricultural by-products as pond fertilizers are a part of ICLARM's integrated farming activities. Plans are being made to begin a new project on utilization of composted wastes in aquaculture.

Economics

The third aquaculture program theme is economics. Recent economic studies of aquaculture systems indicate that there are wide variations in productivity and profitability among farmers raising given species. It is not uncommon to find a relatively small number of large farms that are highly profitable and a large number of small farms that are marginally so. Because of the apparent advantages of size and the corporate know-how of the larger private firms and aqua-businesses, much of the current growth in aquacultural production is coming from this relatively small number of farms. This trend is particularly pronounced in the case of high-value exportable products.

Increasingly, non-biological issues are becoming important and there is growing awareness among planners and policymakers that the potential for development of aquaculture must be viewed in the context of national and international economies. This is because aquaculture must compete with other land-based activities for its basic inputs (e.g., land, water, labor and capital) in the production process and with other protein sources in markets. Because aquacultural systems are primarily in the hands of private producers, their production decisions are based primarily upon the relative economics of the various options open to them.

ICLARM has seven aquaculture projects primarily concerned with economic aspects. The first, a seven-month study on the "Economics of Integrated Farming," has shown the profitability of poultry-fish integrated systems in the Philippines, based on data from the previous CLSU-ICLARM integrated farming research project. Economics of pig-fish farming were also described in the previous project. The major fish species involved was Nile tilapia. The second economics project, a one-year study which began in July 1982, is an "Economic Analysis of the Taiwanese Tilapia Industry." Tilapia rearing is the fastest growing segment of Taiwan's aquaculture industry. Its high yields per unit area have produced high profits which have stimulated fish farmers to change from other species to tilapia and rice farmers to convert their farms into fishponds. This dynamic industry now supplies 27% of the total pond culture production in Taiwan and even exports tilapia to Japan.

A related one-year study on the "Economics of the Philippine Tilapia Industry" began in August 1982. Tilapia are becoming increasingly important as food fish in the Philippines. In response to increased acceptance by consumers, the industry is in a dynamic growth phase wherein rapid changes in production techniques and organizational structure of production and marketing are occurring. Tilapia production systems are well-suited to adoption by small-scale producers because the initial capital investment, especially for cage culture, is not high. Because of declining catch and catch per effort of numerous inland fisheries, large numbers of small-scale fishermen have been attracted to cage culture systems and even operate small onshore hatcheries where the investment required is comparable to that of a motorized boat and gear. Larger-scale producers are also increasingly drawn to the industry and several 100+ hectare ponds are under development. The impact of this potential production upon market prices is not at all clear, nor is it known to what extent the small-scale systems, such as cages, can compete over the long term with the larger-scale pond systems. Even in lakes where cages are suitable, there is a tendency for numbers to proliferate to the eventual detriment of all producers as overcrowding occurs. Several small lakes in the Philippines (e.g., San Pablo Lakes) have passed through several cycles of profits, overcrowding, withdrawal by marginal producers, profits and overcrowding again. Twelve universities and government groups are working on this project and are analyzing economic aspects of hatcheries, cage and pond culture, rice-fish culture, backyard fishponds, marketing and the impact of the industry on selected fishing and agricultural communities. Each of these studies will result in a paper to be presented at a workshop sponsored by the Philippine Council for Agriculture and Resources Research and Development (PCARRD) and ICLARM in August 1983.

The Philippine milkfish industry has been the subject of a cooperative socioeconomic study by ICLARM, the Bureau of Agricultural Economics and the Bureau of Fisheries and Aquatic Resources. Researchers have considered why the majority of the country's milkfish farmers have such low

productivity despite the availability of simple new technologies. The results of an extensive survey indicate that major constraints are capital limitations, prevalence of higher risks, poor information dissemination and lack of motivation. The second phase of this project, now underway, is to prepare training materials for extension officers.

The fifth aquaculture economics project concerns snakehead *(Channa striata)*, the second most important cultured freshwater fish, after catfish, in Thailand. In recent years, catfish farmers have been beset by disease problems that have significantly reduced profits and many have switched to snakehead culture. No economic analysis of this culture system has been conducted, however, to determine input and output relationships and efficiency of resource use. Because this and other cultured species depend upon trash fish for feed, expansion in Thai freshwater aquaculture may be constrained by trash fish supply. ICLARM and the Thai National Inland Fisheries Institute have begun a cooperative study of snakehead production economics, as well as an investigation of the competitive markets for trash fish.

At the end of 1981, ICLARM and the Thailand Department of Fisheries began a broad study of the mollusc culture industry in Thailand, dealing with all aspects from production to marketing. Economics form an important element. Supported by the German Agency for Technical Cooperation, the project, entitled "Applied Research on Coastal Aquaculture," seeks to identify and help eliminate constraints to expansion of bivalve mollusc culture. Surveys of marketing, postharvest handling and levels of pollution are underway, and a national workshop is planned for January 1983 on technical and economic aspects of the industry. The project duration is 18 months, with possible extension into a second 18-month phase.

The last of ICLARM's primarily economics-oriented aquaculture projects, entitled "Aquaculture Trends and Development Prospects: Country Case Studies," consists of a series of studies that provide broad economic and institutional overviews of aquaculture's role in various countries. Two which were commissioned in mid-1981 for Taiwan and Israel, countries already facing aquacultural development constraints, are completed; final manuscripts are expected in early 1983.

Stock Improvement

The fourth aquaculture program theme is stock improvement or genetics and although most of the present related studies are preparatory to long-term genetic studies, they are nevertheless of importance. Broodstock improvement work at Central Luzon State University was completed in December 1982. Genetic typing will be continued through 1983 at the University of the Philippines, Marine Sciences Center, in a cooperative project called "Genetic Characteristics of Food Fishes." For capture fisheries, information on the genetic characteristics of exploited stocks is important in

stock identification and, therefore, population dynamics; for aquaculture, genetic improvement of cultured stocks is clearly a major route to increased production as it has been for other forms of animal husbandry.

Survival and reproduction of a few tilapia species in seawater and even in hypersaline conditions have been recorded, but growth of most species is unsatisfactory. A selection of tilapia species and hybrids which are fast-growing in saline waters is essential, not only for further expansion of tilapia culture in coastal waters, but also to reduce conflicts with agricultural users of land and freshwater. A project based in Taiwan, "Evaluation of Mariculture Potential of Tilapia," was initiated in May 1981 to examine the growth and survival of two tilapia species in brackishwater and seawater. So far, growth and survival rates have been promising. That project was coalesced in July 1982 with a broader "Cooperative Tilapia Research Project," which will continue for three years. Two ICLARM staff have been placed in Taiwan for this project. The main thrust of the project is a comprehensive study of the reproductive and growth performances of tilapia species and hybrids under specific environmental conditions. Selection of species and hybrids will be based initially on their tolerance to specified environments. Continued improvement of species/hybrids will be undertaken through genetic improvement and selection, and through acclimatization. Research emphasis in the initial phase of the program is placed on the development of euryhaline species and hybrids, followed by consideration of temperature tolerance and disease resistance.

Two projects are designed to increase understanding of reproductive processes in fish. One of these is a long-term participation in "Controlled Reproduction of Commercially Important Marine Fishes," in Egypt with the mullet *Mugil cephalus* and in Israel with the seabream *Sparus aurata.* Culture of such marine fishes is rapidly becoming feasible both in ponds and in floating cages in a variety of locations, but most production has been done with fry collected from natural waters. The major obstacle to marine fish culture is how to control reproduction of culturable species. Associated problems include a lack of refined techniques for inducing maturation and triggering spawning on demand in captivity, and for mass rearing of fry.

The other project on reproduction consists of a set of cooperative studies with several Taiwanese institutions through the Taiwan Council for Agricultural Planning and Development, on "Controlled Reproduction and Mass Fry Production of Commercially Important Fishes." These studies differ from the first project in their broader application. They deal with establishing pituitary banks, broodstock collections, and developing routine procedures for inducing maturation and spawning of important fish species. The project began in July 1982.

There are four commissioned reviews by external authors in progress: on sewage and wastewater utilization in aquaculture; on tilapia nutrition; on tilapia genetics; and on the Japanese fisheries restocking program.

Advisory Services

Activities that are not discussed under individual project descriptions include ICLARM's provision of scholarships for graduate research on living aquatic resources through PCARRD which continued through 1982 with Drs. Pullin, Pauly and Smith advising on a variety of studies, including marine fungal proteins, environmental physiology of milkfish fry and fingerlings during transportation and acclimatization, and growth patterns in wild and cultured *Siganus* spp. with observations of daily otolith rings.

Throughout the report year, Drs. Pullin and Kuo have been working with an inter-agency research group in Northern Luzon, Philippines, on attempts to breed the migratory mullet, *Cestraeus plicatilis* (locally called "ludong"). The research group includes personnel from the Philippines Bureau of Fisheries and Aquatic Resources and the Ministry of Natural Resources, the Cagayan Integrated Agricultural Development Project and the Aparri Institute of Technology, Cagayan State University. This species is one of the most valuable in the rivers of Northern Luzon which used to support a large ludong fishery, now in decline through mismanagement. This is the only fishery in the world for a *Cestraeus* species known to ICLARM. The research group has recognized the potential for aquaranching and aquaculture of ludong once captive breeding is achieved.

In January, Drs. Neal and Pullin travelled to Kota Kinabalu, Sabah for discussions and to sign a cooperative research agreement with the Ministry of Agriculture and Fisheries Development (MAFD). The first project under this agreement was an advisory mission to assist MAFD to select a site for and to design a marine hatchery for research on the controlled breeding of marine fish. This project was implemented in December 1982 in a 2-week consultancy by Dr. Pullin with Dr. Jacques Fuchs of France-Aquaculture, the advisory arm of the French Centre National pour l'Exploitation des Océans (CNEXO). A site was selected and a complete hatchery design drawn up. The hatchery will be used initially for research and pilot production of sea bass and grouper fingerlings.

In May, Drs. Kuo and Pullin undertook a 3-week consultancy on aquaculture research and development planning for the Agency of Agricultural Research and Development (AARD), Ministry of Agriculture, Government of Indonesia. This consultancy was organized and administered by Resources Management International, Jakarta, and involved field visits to research and development facilities in West Java, Central Java and South Sulawesi.

ICLARM has established a close working relationship with AARD in Indonesia and has provided assistance of several types through the International Agricultural Development Service (IADS).

Dr. Pullin visited the Department of Fisheries, Ministry of Tourism and Wildlife, Kenya in August 1982 and advised their staff on research and development work in integrated farming, tilapia culture and trout culture in the Central and Eastern Provinces.

Dr. Pullin has continued to advise the Instituto Nacional de Investigaciones sobre Recursos Bioticos (INIREB), Xalapa, Vera Cruz, Mexico on identification methods for their tilapia stocks.

Throughout the year, ICLARM has handled an increasing number of requests from Asia, Africa, Europe and the Pacific for information on tilapia culture (particularly sources of pure strains and species to initiate research and development programs) and integrated farming.

Publications

Several ICLARM publications related to aquaculture projects which finished in 1981 or earlier appeared during the report period. They include the proceedings of the September 1980 conference on "The Biology and Culture of Tilapias," now being used as a text book by the University of the Philippines, and for courses in the University of Hawaii and Auburn University; the first of several reports on input-output relationships in Philippine milkfish farming, and another on the economics of catfish farming in Thailand.

ICLARM also took the opportunity to publish a very comprehensive bibliography of culturable tilapias, which was offered by Mr. Peter Schoenen. ICLARM authors have also published articles unrelated to project activities in outside journals. A list of these and aquaculture publications related to the projects described earlier is given below.

Chong, K-C., M.S. Lizarondo, V.F. Holazo and I.R. Smith. 1982. Inputs as related to output in milkfish production in the Philippines. ICLARM Technical Reports 3, 82 p. Bureau of Agricultural Economics, Quezon City; Fishery Industry Development Council; and International Center for Living Aquatic Resources Management, Manila, Philippines.

Chong, K-C., I.R. Smith and M.S. Lizarondo. 1982. Economics of the Philippine milkfish resource system. Resource Systems Theory and Methodology Series, No. 4. 66 p. The United Nations University, Tokyo.

Cruz, T.A., J.A. Thorpe and R.S.V. Pullin. 1982. Enzyme electrophoresis in *Tilapia zillii*: a pattern for determining biochemical genetic markers for use in tilapia stock identification. Aquaculture 29: 311-329.

Neal, R.A. and I.R. Smith. 1982. Key problem areas in world aquaculture development. ICLARM Newsletter 5(1): 3-5.

Panayotou, T., S. Wattanutchariya, S. Isvilanonda and R. Tokrisna. 1982. The economics of catfish farming in central Thailand. ICLARM Technical Reports 4, 60 p. Kasetsart University Research and Development Institute, Bangkok, Thailand and International Center for Living Aquatic Resources Management, Manila, Philippines.

Pullin, R.S.V. 1982. Genetics undervalued. Conference Report on the International Symposium on Genetics in Aquaculture, Galway, Ireland, 29 March-2 April 1982. Mar. Pol. 6(4): 345-347.

Pullin, R.S.V. 1982. *Tilapia, Sarotherodon* or *Oreochromis?* ICLARM Newsletter 5(1): 19.

Pullin, R.S.V. 1982. Experimental integrated farming systems in Mexico. ICLARM Newsletter 5(3): 11.

Pullin, R.S.V. and R.H. Lowe-McConnell, Editors. 1982. The biology and culture of tilapias. ICLARM Conference Proceedings 7, 432 p. International Center for Living Aquatic Resources Management, Manila, Philippines.

Schoenen, P. 1982. A bibliography of important tilapias (Pisces: Cichlidae) for aquaculture. ICLARM Bibliographies 3, 336 p. International Center for Living Aquatic Resources Management, Manila, Philippines.

Meetings Attended, Papers Presented

International Symposium on Genetics in Aquaculture, University College, Galway, Ireland, 29 March-2 April 1982 (R.S.V. Pullin).

International Meeting of the Fisheries Society of the British Isles on Fish Reproduction: Strategies and Tactics, Plymouth Polytechnic, Plymouth, U.K., 19-23 July 1982 (R.S.V. Pullin).

International Symposium on Reproductive Physiology of Fish, Wageningen, Netherlands, 2-6 August 1982 (C-M. Kuo).

Paper presented:

Kuo, C.M. Induced breeding of grey mullet, *Mugil cephalus* L.

FAO-IPFC Inland Fisheries Workshop, 2-6 August 1982 (R.A. Neal, I.R. Smith).

Seminar on Growing the Giant Tilapia; Aquatic Biosystems, Inc., Los Baños, Laguna, Philippines, 7 August 1982 (I.R. Smith, L.R. Yater).

Network of Aquaculture Centres in Asia, Second Advisory Meeting, Bangkok, December 1982 (R.S.V. Pullin).

Program Plans for 1983

The 1983 program will continue to be commodity-oriented with major emphasis on tilapias. The ongoing projects on saltwater culture of tilapias in Taiwan and Kuwait will be strengthened. The development of tilapia strains and hybrids which show good growth performance in brackishwater, seawater and hypersaline conditions is considered a high priority for the expansion of aquaculture in the tropics.

Research on tilapia culture in 1983 will include development of artificial egg and larval incubation systems and transportation methods in the Philippines; fry and fingerling production systems in Taiwan and low cost inputs as feed and fertilizers for tilapia culture. *Azolla* will be further assessed as a protein source in tilapia diets and the relative importance of plankton feeding, detritivory, herbivory and supplemental feeding in tilapia culture will be investigated in a variety of systems. A joint research initiative between the Asian Institute of Technology and ICLARM on chemical and biological factors affecting fish production in aquaculture systems receiving organic wastes is planned for 1983. The main species used will be microphagous tilapias. Thus, the existing network of ICLARM cooperative projects

on tilapia culture, with institutions in Kuwait, the Philippines and Taiwan, will be expanded to include Thailand.

Drs. Neal and Pullin have accepted invitations to act as co-chairmen at a major international conference on tilapia culture in Israel in May 1983. The possibility of a genetics workshop to formulate a practical plan of action for the documentation, conservation and establishment of type collections of important species and strains of tilapias is also under consideration. Further review publications on tilapia nutrition and the worldwide importance of tilapia as a food commodity are planned for 1983.

ICLARM is planning a larger involvement in research for the development of carp culture. The carps, including Chinese, Indian major carps and the common carp, are an extremely important commodity group throughout Asia. Discussions with the Asian Development Bank (ADB) have been in progress through 1982 to formulate a strategy for a research approach to the problems of seed supply in carp culture. ICLARM will assist ADB in 1983 with carp hatchery/nursery research in Bangladesh, Burma, Indonesia, Nepal, Pakistan and Sri Lanka and in the organization of a training workshop in 1984.

New aquaculture economics research will be initiated with institutions in the fisheries social science research network, especially Kasetsart University in Thailand. Likely topics are related to use rights in coastal aquaculture, competition with small-scale fisheries, multiple use of trash fish and the fish meal industry. Also in early 1983, Dr. K-C. Chong of ICLARM will be teaching the aquaculture economics component of the Masters in Aquaculture course offered at SEAFDEC by the UNDP/FAO Network of Aquaculture Centers in Asia (NACA). Dr. R.S.V. Pullin will also contribute lectures to this course.

On an extended time scale several areas of work with potential for important aquacultural research contributions stand out. The first of these is the genetic improvement of tilapias for culture including both genetic studies and selective breeding. This topic probably offers the single greatest potential contribution to aquaculture of any research area. It will require long-term research in a large research facility with strong scientific support. The second important topic is the broad area of utilization of organic wastes through detrital systems for fish culture. Most agricultural and organic wastes and residues have potential use as fertilizers/feeds in fish production systems incorporating composting, special microbial treatment or simple handling as pond detritus.

Two additional broader areas of research, general nutritional and disease research, are, as with other animal husbandry, the basic means for increasing production. Research has only begun in these areas with reference to tropical culture species. Nearly every tropical aquaculture effort could be improved through better basic knowledge of nutrition and disease control.

Because of funding limitations ICLARM has not pursued efforts to establish an aquacultural research facility of its own. The need stands but no clear path towards obtaining such a facility has been found.

Aquaculture Project Summaries

Completed

Active

COMMODITIES

ECONOMICS

STOCK IMPROVEMENT

Upcoming

Project Title : Mass Production of Tilapia Fry

Cooperating Institution : Freshwater Aquaculture Center, Central Luzon State University, Philippines

Duration : 2.5 years, beginning July 1980

Key Personnel ICLARM : Drs. Ching-Ming Kuo and Roger S.V. Pullin
CLSU : Renato Recometa

Objectives

The objectives of the project are to document the culture performance of broodstocks and progeny of the tilapias currently available in the Philippines.

Results

During 1982, the project consolidated its stocks of promising strains and hybrids such as *Oreochromis niloticus* from Israel (N_i), the Philippines (N_p), and Singapore (N_s), *O. aureus* from Auburn, U.S.A. (A_a), Taiwan (A_t) and Singapore (A_s) and various hybrids.

Intraspecific and interspecific cross-breeding compatibility was examined at the sex ratio of 1:1 in both the dry and wet seasons. Success of inter- and intraspecific cross-breeding was generally higher in the dry season which is the warmer season of the year in the Philippines. However the crosses (N_p x N_p),* (N_p x N_i) and (A_a x A_s) were more successful in the wet season than in the dry season, with mostly 100% success in the wet season.

The survival and growth performance of the progenies produced from inter- and intraspecific crosses of N_p, N_i and A_a fry were examined in five replicates both under indoor and outdoor conditions for 60 days. The fingerlings were then raised for a further three-month period in net enclosures suspended in earth ponds. The initial body weights of the inter- and intraspecific crosses examined varied between 8.2 and 13.5 mg but differences were not statistically significant between experiments. At the end of 60-day fry-rearing period, these fish ranged from 403.1 to 785.1 mg in weight and

*Female parent given first throughout.

29.1 to 36.7 mm in length under outdoor conditions. These variations were apparently due to genetic differences rather than environmental influences. The fry from the (N_p x N_p) cross grew fastest followed by the fry of the (N_i x N_p) cross.

Differences in growth rates between dry and wet seasons were also highly significant especially from fish reared under outdoor conditions (Table 1). This was attributed primarily to temperature differences. The survival and growth performance of fry produced from aforementioned inter- and intraspecific crosses have been monitored for both seasons. Due to facility limitations, the experiments have been conducted over a two-year period, and data processing is still in progress.

The growth rates of fry produced from the inter- and intraspecific crosses were very similar up to three months, but differences became evident from the fourth month. The (N_p x N_p) fingerlings showed the best growth (averaging 39.1 g body weight, 121.7 mm in length) after the three-3-month fingerling growth period. (N_i x N_i) fingerlings were the slowest growing.

A comparison of all-male postfingerling growth performance of different genotypes was completed in November 1982. These experiments were used to look for evidence of heterosis in hybrids and to isolate such effects from the well-known phenomenon of superior growth performance of males over females. The results showed that (A_a x N_i) hybrids performed best (Fig. 1).

Efforts have been made to develop an efficient fry collection method. The fry production experiment was conducted in 100-m^2 concrete raceways and the N_p strain was chosen as the main species to be examined. The best fry production was obtained with a sex ratio of 1:1 at a stocking density of five fish/m^2. Fry collection systems incorporating net partitions have been tested with environmental or olfactory attractants as stimuli. Preliminary observations have indicated that feeding under lighting is an effective means for concentrating fry for collection, particularly at early stages. However, attractants such as patis, a Philippine fish sauce, were not successful. Continued efforts will be made to refine the fry production methods and systems for N_p and other promising species and strains.

Table 1. Growth performance of tilapia species and hybrids in two different growth seasons.

Cross† (♀ x ♂)	Condition*	Season	Days from commencement of experiment							
			0	15		30		45		60	
N_p x A_a	0	Wet season	13.5** (11.6)	63.4	(17.5)	193.2	(24.0)	391.92	(29.9)	515.3	(33.1)
	1			28.7	(14.1)	72.9	(17.9)	162.95	(22.5)	204.3	(24.7)
N_p x A_a	0	Dry season	11.3 (11.0)	90.4	(19.1)	267.9	(27.7)	728.93	(36.6)	1,544.2	(44.7)
	1			43.1	(15.2)	118.7	(21.3)	199.67	(24.9)	352.1	(29.4)
N_i x A_a	0	Wet season	11.5 (11.1)	76.9	(17.4)	158.9	(22.5)	328.33	(28.4)	465.3	(31.7)
	1			30.7	(14.1)	50.6	(15.5)	128.33	(19.9)	221.4	(25.0)
N_i x A_a	0	Dry season	10.7 (11.2)	54.2	(16.5)	290.1	(28.0)	816.41	(37.1)	2,165.9	(51.4)
	1			44.9	(14.9)	120.9	(21.6)	198.21	(24.7)	333.2	(29.2)

*Condition: 0—outdoor, 1—indoor.
**Body weight in mg and length (in mm).
† N_p = Philippine strain, *O. niloticus*
N_i = Israel strain, *O. niloticus*
A_a = Auburn University strain, *O. aureus*

Progress on identification of electrophoretic genetic markers for the stock collection has been hampered by logistic problems at CLSU, principally lack of a reliable electrical supply for running electropherograms and cooling apparatus. However, determination and analysis of some useful isozyme polymorphisms, such as serum esterase, lactate dehydrogenase and malate dehydrogenase, are anticipated before the end of the year.

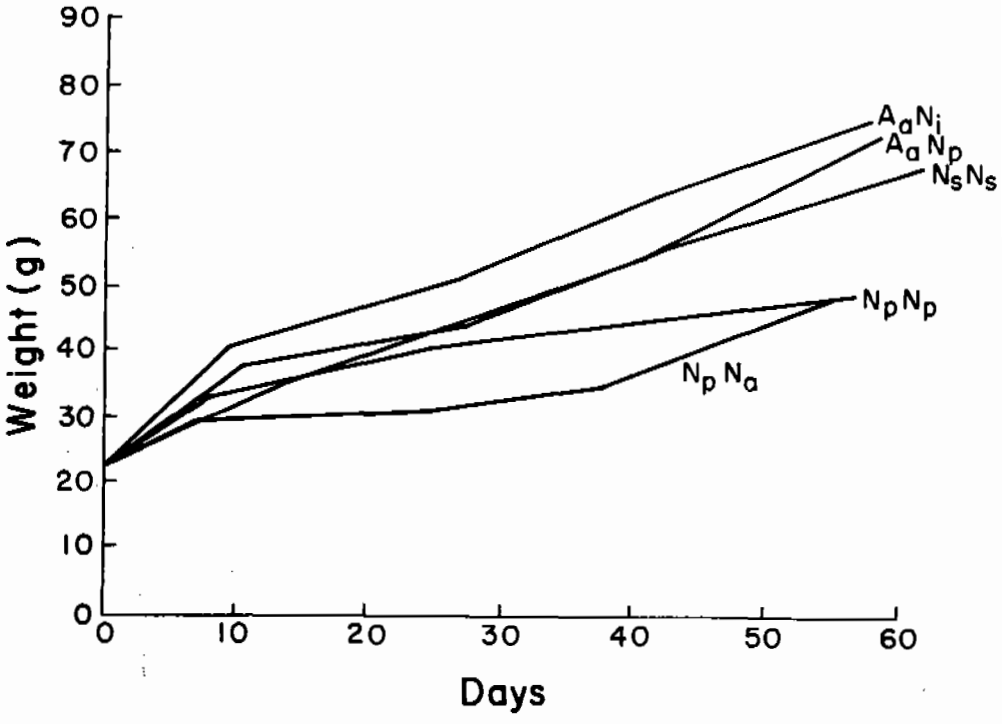


Fig. 1. Comparative growth of all-male postfingerlings of various tilapia strains and hybrids produced at CLSU in 1981 and 1982: mean values from growth curves shifted to a common origin.

Project Title : Evaluation of Mariculture Potential of Tilapia

Cooperating Institution : Council for Agricultural Planning and Development (CAPD), Taiwan

Duration : May 1981-June 1982 (merged with new Cooperative Tilapia Research Project)

Key Personnel ICLARM : Dr. Ching-Ming Kuo
CAPD : Dr. J-C. Lee

Objectives

This project is aimed at evaluating the culture potential of tilapias in brackish and marine waters by determining their growth performance, feed conversion, survival and reproductive capacity. A red tilapia (probably a three-way *Oreochromis* hybrid) and blue tilapia *(Oreochromis aureus)* were selected initially for their tolerance of salinity and cold temperatures, respectively, and a continuing search for other candidate species and improved hybrids is underway.

Results

The culture suitability of the red tilapia and blue tilapia in coastal waters was examined from their survival and growth performances in various salinity conditions over three consecutive growing periods, i.e., pre-wintering, wintering and post-wintering. Cage culture experiments were performed in triplicate under three salinity environments, freshwater, brackishwater (18-20 ppt) and seawater (32-34 ppt).

Survival and growth rates of the blue tilapias under these three salinity conditions were similar, except for an elevated mortality (22.7%) recorded in seawater during the wintering period (Table 1). Red tilapia grew better in freshwater, although the differences in growth and survival between freshwater and seawater conditions were not significant during the pre-wintering growing period. Nile tilapia *(O. niloticus)* have been observed to spawn in full seawater.

During winter, when water temperatures ranged between 12 and 18°C, growth was notably suppressed, ranging between 0.09 and 0.15 g/day

for blue tilapia and between 0.12 and 0.37 g/day for the red tilapia. The environmental influences on the growth were most pronounced when the cold temperature was combined with higher salinity. The survival of red tilapia was directly related to salinity at low temperatures.

Table 1. Survival and growth of tilapias at three different salinities.

Species	Pre-wintering (80 days) Initial wt (g)	Survival (%)	Growth rate (g/day)	Wintering (130 days) Initial wt (g)	Survival (%)	Growth rate (g/day)
Red tilapia						
FW*	46.7	85.1	0.75	107.9	98.2	0.37
BW	44.4	**	**	63.9	84.7	0.28
SW	40.1	86.6	0.69	95.3	79.0	0.12
Blue tilapia *(Oreochromis aureus)*						
FW	28.8	97.0	0.58	76.0	99.8	0.11
BW	25.5	**	**	64.7	97.4	0.15
SW	32.3	98.6	0.48	70.8	77.3	0.09

Species	Post-wintering (variable) Initial wt (g)	Survival (%)	Growth rate (g/day)	Final wt (g)	Days cultured
Red tilapia					
FW*	141.7	99.0	1.23	348.4	384
BW	100.0	94.0	0.72	201.7	326
SW	103.9	87.4	0.86	231.0	376
Blue tilapia *(Oreochromis aureus)*					
FW	91.1	99.1	1.38	273.7	372
BW	73.8	99.4	0.59	172.4	366
SW	82.3	98.0	1.26	212.1	312

*FW = freshwater, BW = brackishwater (18-20 ppt) and SW = seawater (32-34 ppt).
**Experiments incomplete; fish escaped from enclosures damaged by crabs.

Project Title : Economics of Integrated Poultry-Fish Farming

Cooperating Institution : Freshwater Aquaculture Center, Central Luzon State University, Philippines

Duration : 7 months, November 1981-June 1982

Key Personnel CLSU : Mr. Ruben Sevilleja

Objectives

A three-year cooperative research project (1978-81) on integrated animal-fish farming systems has been conducted by the Freshwater Aquaculture Center and ICLARM. This cooperative project was initiated with the principal objective of developing technically and economically viable animal-fish systems. Economic analyses on the poultry-fish data gathered during this work and from related studies on working farms continued until June 1982.

Specific objectives of these economic studies were to determine the profitability of integrating fish production with chicken, duck or pig raising and to develop enterprise budgets for these systems.

Results

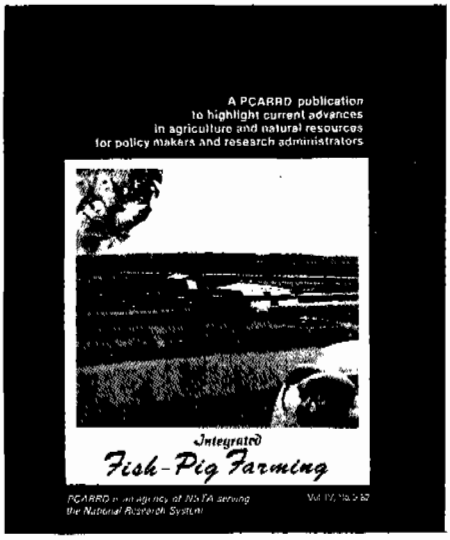
In duck-fish systems it was found that the internal rate of return (IRR) of the fish operation was less than the IRR of the duck operation. Therefore, if it is possible to expand the duck operations, the farmer should do this rather than integrate with fish culture. However, if the duck-egg market would not allow further expansion or if the farmer wished to reduce risk by diversification, the fish operation would still be a good investment because its IRR is considerably higher than the 15% opportunity cost of capital. The IRR for an integrated duck-fish combination would be about 40% per annum.

In chicken-fish systems it was found that for maximum IRR, manure loading rate should decrease with increasing pond size. The reason for this is that the fish operation was found to be more profitable at large pond sizes than the chicken operation. Therefore, the manure loading rate should be minimized at large pond sizes in order to minimize "losses" from the chickens and to maximize IRR. When the number of chickens is limited (but pond size is not) the densities which maximize IRR increase as pond size increases.

With a low number of chickens, manure loading from less than 250 chickens/ha of pond should be optimal. However, there is considerable variability of fish yields at such low loading rates, so it is recommended that 500 chickens/ha be considered the minimal loading rate in practice. The density that maximizes IRR for a given pond size was determined to be 4,400 chickens/ha.

Duck raising was found more profitable than a backyard piggery or a combined pig-breeding and growing farm. Both pig operations are more profitable than a broiler chicken operation. Capital costs for the three systems integrated with 1,000-1,500 m^2 ponds range from ₱15,000-20,000, with pig-fish being the lowest, possibly within the reach of small-scale farmers. However, the positive change in net income for the farmer is probably more significant for small producers than the IRR consideration.

These results are incorporated in the final Technical Report of the CLSU-ICLARM Project, "Applied Research on Integrated Animal-Fish Farming", which will be published early in 1983.



Results of the ICLARM-CLSU integrated animal-fish farming project have been used in various ways. They formed the basis of an extension booklet by the Philippine Council for Agriculture and Resources Research and Development *(upper)* while the International Institute for Rural Reconstruction near Manila used the technology in promoting small-scale integrated farms in the Philippines *(lower)*.

Project Title : Intensive Mariculture of Tilapia

Cooperating Institution : Mariculture and Fisheries Department, Kuwait Institute for Scientific Research (KISR)

Duration : 1 year, beginning January 1982 with possible extension of 1 year

Key Personnel ICLARM : Dr. Kevin D. Hopkins
KISR : Dr. Teng Seng Keh

Objectives

There are three broad objectives of the project:

- To screen and select species and hybrids of tilapias suitable for intensive culture in the coastal zone.
- To develop suitable methods for the mass production of tilapia fry under conditions existing in arid lands.
- To evaluate intensive growout systems for tilapia including cages and raceways.

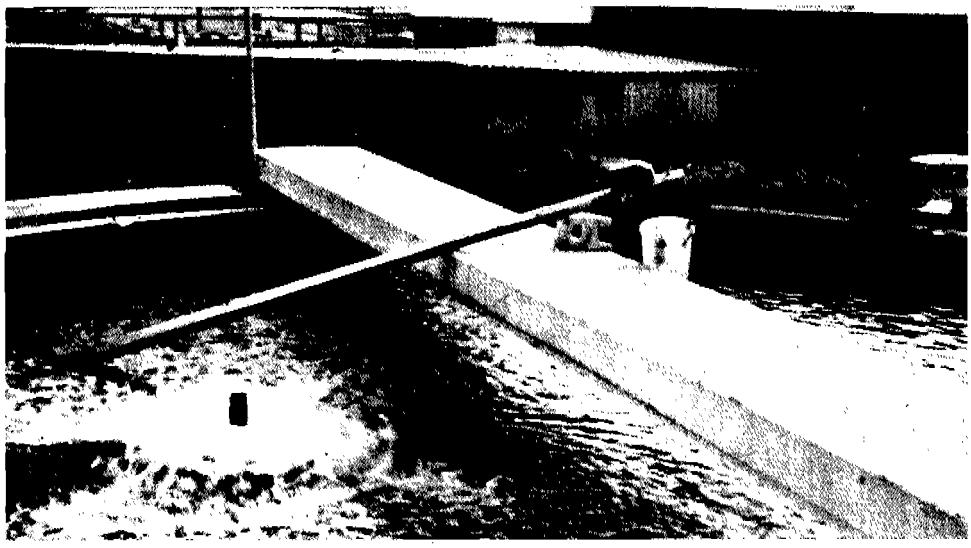
Results

A 12-tank raceway system and a 120-m^2 tilapia hatchery were constructed. The hatchery includes eight 2m x 2m brood tanks, twenty seven 400-liter conical fry rearing tanks and ten 500-liter holding tanks. The brood tanks were stocked and *Oreochromis aureus* fry were produced and acclimatized to seawater. The *O. aureus* fry were subsequently stocked into the fiberglass raceways which use seawater pumped from the nearby Gulf. Ten thousand *O. spilurus* fry have been imported from Kenya and acclimatized to seawater and stocked into raceways. These ongoing experiments will determine the growth potential of the two species when cultured in seawater. Red tilapia fingerlings from Taiwan were also imported but the initial stock died through poor water quality conditions during their acclimatization to seawater.

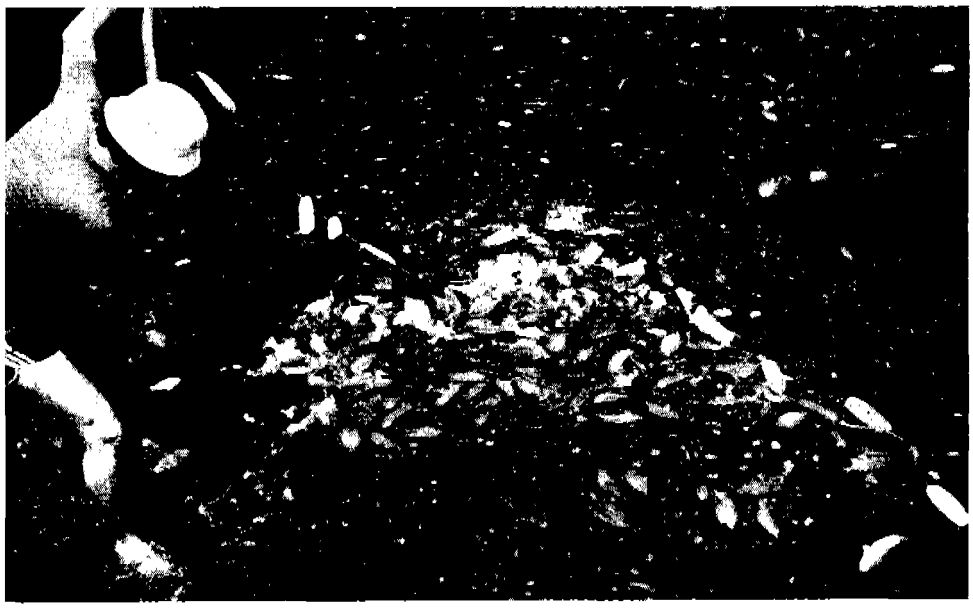
Additional small-scale experiments have been conducted in lower salinities using heavily-aerated silos. Tilapia densities in excess of 70 kg/m^3 or 35 kg/liter-minute water flow have been achieved with monthly yields greater

than 10 kg/m^3 or 2.5 kg/liter-minute. These yields are an order of magnitude higher than those attained in trout raceways.

Live tilapia have been successfully test-marketed in Kuwait at prices exceeding US$6/kg. Further research should reduce production costs and prices. Such systems could possibly be scaled-up to use the brackish groundwater resources found in Kuwait and other arid lands.



A 250-m^3 tank used in the Kuwait intensive tilapia mariculture project, showing an agitator for aeration *(upper)* and tilapia being harvested *(lower)*.



Project Title : *Azolla* in Tilapia Nutrition

Cooperating Institution : The College of Fisheries of the University of the Philippines in the Visayas (UPVCF), through its research arm, the Institute of Fisheries Development and Research (IFDR)

Duration : May 1982-April 1983, with provision for extension

Key Personnel ICLARM : Dr. Roger S.V. Pullin
UPVCF/IFDR : Dr. Gaudiosa Almazan

Objectives

UPVCF/IFDR and ICLARM have agreed to cooperate on some basic nutritional studies using *Azolla* in diets fed to Nile tilapia *(Oreochromis niloticus).* The objective of this research is to determine the value of *Azolla* as a source of dietary nitrogen both in systems where it is available as fresh vegetation and in compounded diets. *Azolla* is readily grown in mass cultures using soil and water mixtures, with the addition of phosphate where necessary. Fish-feed manufacturers have expressed interest in the potential of *Azolla* as a nitrogen source in pelleted foods.

Results

Stocks of a high-temperature tolerant strain of *Azolla pinnata,* known as "Bangkok strain" were obtained from the International Rice Research Institute and mass cultures have been grown in outdoor plastic pools. *O. niloticus* stocks described as "SEAFDEC strain" were obtained from the Philippine Bureau of Fisheries and Aquatic Resources tilapia hatchery at the Freshwater Aquaculture Center of Central Luzon State University. A 28-day nutritional bioassay has been developed using fingerlings in aquaria receiving a control diet of 40% rice bran/40% fish meal/10% corn meal/9% corn starch and 1% afsillin (a vitamin and mineral premix) at a rate of 5% body weight/day, split between two feedings. Fresh *Azolla* diets were tested first. Nile tilapia tested for as long as seven weeks on even *ad libitum* feeding with fresh *Azolla* failed to gain weight. Dry diets are now being compared with the control diet and the digestion and assimilation of *Azolla* by the tilapia gut are being studied.

Solar drier used for drying *Azolla* for inclusion in test diets for Nile tilapia.

Plastic pools are used for keeping tilapia and maintaining *Azolla* cultures at the Institute of Fisheries Development and Research, College of Fisheries, University of the Philippines in the Visayas.

Project Title : Tilapia Incubation Systems

Cooperating Institution : The College of Fisheries of the University of the Philippines in the Visayas (UPVCF), through its research arm, the Institute of Fisheries Development and Research (IFDR)

Duration : May 1982-April 1983, with provision for extension

Key Personnel ICLARM : Dr. Roger S.V. Pullin
UPVCF/IFDR : Dr. Gaudiosa Almazan

Objectives

This project was conceived to investigate the various options for tilapia incubation systems, such as water movement around the eggs achieved by aeration and/or water flow and a variety of incubator designs with and without rotation or shaking devices. Incubators are needed to maximize egg and larval survival. The sensitivity to handling of different stages of eggs and larvae will be investigated using artificially fertilized eggs. The project will also assess the possibility of shipping disinfected eggs in insulated containers under various conditions of temperature and water quality.

Results

Broodstocks of Nile tilapia *(Oreochromis niloticus)* termed "SEAFDEC strain" obtained from the Philippine Bureau of Fisheries and Aquatic Resources have been acclimatized to outdoor plastic pools at IFDR. They have produced large quantities of eggs for investigation. Incubators using aeration and/or water flow have been constructed and artificial fertilization attempts are in progress using anaesthetized fish. The initial results were difficult to interpret as mortalities of eggs and larvae were very variable, in part due to fungal infections. However it has now been established that mechanical movement of eggs, for example in a rotating drum, can give very high survival to hatching. This is in effect the principle of using the well-known shaker-table for fish egg incubation, but essentially 'rolling up' the table into a rotating cylindrical incubator. After hatching, continued strong movement tends to damage the larvae and best survival is obtained from static systems supplied with aeration. Further refinements to incubator design will be made in 1983.

Project Title : Economic Analysis of the Tilapia Industry of Taiwan

Cooperating Institution : National Chung Hsing University, Taichung, Taiwan

Duration : 1 year, beginning July 1982 (first phase)

Key Personnel

National Chung Hsing University : Dr. Lee Chaur-Shyan

Objectives

The general objective of this study is to analyze the economics of the Taiwanese tilapia industry. The one-year first phase will develop an overview of the industry in terms of (1) regional distribution of current production; (2) classification of different rearing systems by species; (3) numbers and locations of feed and fry suppliers; (4) markets, marketing practices and prices; and (5) major government policies and policy issues. A second phase of the project to be initiated in 1983, depending upon successful completion of the first, will consist of an in-depth analysis of selected input supply, rearing systems and marketing sectors of the industry.

Project Title : Milkfish Production Dualism: A Socioeconomic Perspective

Cooperating Institutions : Bureau of Agricultural Economics (BAEcon), Ministry of Agriculture, Philippines; Bureau of Fisheries and Aquatic Resources (BFAR), Ministry of Natural Resources, Philippines

Duration : 21 months, 15 July 1981-15 April 1983

Key Personnel ICLARM : Dr. Kee-Chai Chong
BAEcon : Ms. Maura Lizarondo
BFAR : Mr. Cesar Guerrero

Objectives

As part of its continuing effort to improve yields per unit area from Philippine milkfish farms, the Bureau of Fisheries and Aquatic Resources and UNDP/FAO have established four Brackishwater Aquaculture Demonstration and Training Centers in the four different climate zones of the country. One of the basic purposes of these Centers is to demonstrate that it is economically feasible to increase yields by intensifying the use of supplementary inputs, particularly fertilizers.

The majority of the country's milkfish farmers continue to rely on extensive methods. The purpose of this ICLARM/BAEcon/BFAR study is to examine why milkfish farmers have not been adopting the available technologies at a more rapid rate. The study hypothesizes that a mixture of physical, socioeconomic, technical and institutional factors constrain the majority of producers (but not all) and that as a result a dualistic structure exists in the industry.

The project has two phases. The first, which has been completed, was to prepare a report for FAO on the results of an extensive survey of producers in selected provinces in the Philippines conducted in late 1981 and early 1982. The second phase which has just begun, is to conduct a series of seminars for BFAR extension personnel, based upon the results of this project's and earlier surveys of producers.

Results

A survey of 447 producers in seven provinces was undertaken to collect data to test hypotheses related to the effect of 56 explanatory variables on levels of fertilizer expenditure. Of these 56 variables (which cover a variety of demographic, managerial, physical, socioeconomic and institutional parameters), only eight were demonstrated to have a significant effect on levels of fertilizer use. These variables, which explain 73% of the variations in fertilizer expenditure, are:

(1) Ratio of milkfish price to organic fertilizer price
(2) Ratio of milkfish price to inorganic fertilizer price
(3) Salinity of pond soil
(4) Family size
(5) Risk consideration
(6) Belief in the effect of fertilizers on milkfish taste
(7) Interest in working on others' farms
(8) Active seeking of advice from others

The major constraints to increased fertilizer use appear to be operating-capital limitations, the prevalence of higher risks, a weak information dissemination system, and a lack of motivation among producers to seek out information on the higher yielding (and more profitable) technologies. The report concludes with recommendations to overcome these difficulties, including consideration of fertilizer subsidies to encourage more intensive and widespread fertilizer use.

Part of the harvest of a farm in Negros Oriental, on its way to be packed in ice for shipment to Manila. The results of the ICLARM/BAEcon/BFAR study identified several major constraints to increased use of fertilizer by Philippine milkfish producers to enhance yields.

Project Title : Economics of Snakehead Culture in Thailand

Cooperating Institution : National Inland Fisheries Institute (NIFI), Bangkok, Thailand

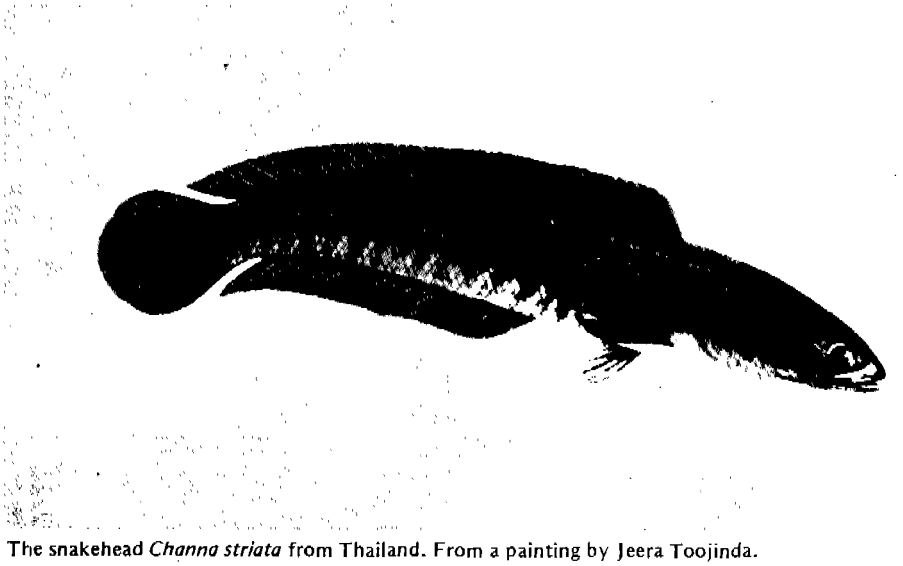
Duration : 10 months, March-December 1982

Key Personnel ICLARM : Dr. Edward W. McCoy
NIFI : Dr. Mali Boonyaratpalin

Objectives

This research project has two parts. The first is the study of the economics of aquacultural production of snakehead *(Channa striata),* an important freshwater fish in Thailand. The second is an analysis of the competitive structure of the market for trash fish, the most important food source for cultured fish in Thailand. Growth and changes in the industry will be analyzed from secondary data. Production functions and short- and long-run cost functions will be estimated from primary data. Producer response to varying changes in both demand and cost of inputs will be estimated. A descriptive analysis of the trash fish industry will be conducted.

The study is being conducted in six provinces of Thailand with data collected through a survey of randomly selected producers. Analysis of variance, multiple regression techniques and simultaneous-equation systems will be used in analyzing the data.



The snakehead *Channa striata* from Thailand. From a painting by Jeera Toojinda.

Project Title	:	Applied Research on Coastal Aquaculture Phase I: Mollusc Culture
Cooperating Institutions	:	Department of Fisheries, Ministry of Agriculture and Cooperatives, Government of Thailand and the German Agency for Technical Cooperation (GTZ)
Duration	:	18 months, beginning December 1981, with possible extension for 18 months
Key Personnel ICLARM	:	Drs. Edward W. McCoy, Ronald F. Ventilla, Richard A. Neal, Roger S.V. Pullin
Thailand	:	Piroj Lipikorn, Anant Saraya, Dr. Yont Musig

Objectives

This project deals with the shellfish industry as a continuum from production through marketing and includes technical aspects of culture, public health and pollution, postharvest handling and marketing. Special emphasis has been placed on an economic study of marketing in light of experience in other countries where production resulting from improved culture practices has outstripped market demand.

Project objectives during the initial 18-month period (Phase I) are as follows:

- To identify technical, biological and economic constraints hindering successful expansion of mollusc culture in the coastal zone, particularly of the mussel *(Perna viridis)* and cockle *(Anadara granosa).*
- To assist the Department of Fisheries to initiate applied research aimed at eliminating identified constraints.
- To provide technical advice on mollusc culture, product handling and marketing.
- To assist the Department of Fisheries select a lead station for research and development work on mollusc culture which will serve as a site for applied research activities of this project.
- To assist the Department of Fisheries to initiate work on introduction and/or improvement of appropriate technologies for mollusc farming.

- To increase seed production of cockles through development of hatchery and technology.
- To demonstrate and spread technical advances to coastal communities through the existing extension service of the Department of Fisheries.

Results

The Team Leader/Economist has been in place since December 1981 and the second member of the team, the Biologist, has been in Thailand since April 1982. Analysis of market structure and functions is underway, and biological experimentation designed to provide a technical base for seed collection, determination of environmental interactions and improved production methods have been initiated. A wide range of economic data has been collected on all aspects of production, processing and marketing.

A special survey of postharvest handling procedures is being conducted to determine the effect of handling on product quality and to aid in identification of means for improving market quality of shellfish. In addition, a pollution survey is underway to compare, through spot checks, present levels of enteric microorganisms and heavy metals with levels observed during previous surveys. An in-country workshop on Technical and Economic Aspects of Mollusc Culture has been scheduled for January 1983.

Project Title : Aquacultural Trends and Development Prospects: Country Case Studies

Cooperating Institution : Studies are individually commissioned

Duration : First country case studies began in mid-1981

Key Personnel Taiwan : Dr. Lee Chaur-Shyan, National Chung Hsing University

Israel : Dr. Dan Cohen, Aquaculture Production Technology Ltd. and Hebrew University

Objectives

There is an important role for research institutions such as ICLARM to play in clarifying the potential for and the impact of aquacultural development in developing countries. The major socioeconomic issues that need attention in this context are those related to technology transfer and constraints to its adoption, market potential, externalities and competition with other sectors, and equity and distribution of benefits from expanded aquaculture production. These can best be addressed at the national level. As an initial step, ICLARM is commissioning several case studies in countries where aquaculture is an important activity and where data are available to permit analysis without resorting to extensive field surveys.

Results

Studies in Taiwan and Israel were commissioned in 1981. In both countries, developmental constraints are already apparent. Competition for aquacultural inputs has increased from other sectors, such as for water in Israel. Industrial development has created rural labor shortages and pollution problems in Taiwan. Also, international market changes have resulted in species shifts in both countries. The final manuscripts for these two country studies are expected to be completed early in 1983.

Project Title : Cooperative Tilapia Research Project

Cooperating Institution : Council for Agricultural Planning and Development (CAPD), Taiwan

Duration : 3 years, beginning July 1982

Key Personnel ICLARM : Drs. Ching-Ming Kuo and Wade Watanabe
CAPD : Dr. J-C. Lee

Objectives

The objectives of this project are to evaluate and develop improved tilapia stocks for culture in various environments, including seawater, and to develop technology packages for mass seed production and growout of improved stocks.

Broodstocks of *Oreochromis aureus, O. mossambicus, O. niloticus, O. spilurus* and red tilapia will be first established. These broodstocks will be characterized by electrophoretic genetic markers and will provide the foundation stocks for the project.

The techniques used will include selection, hybridization and polyploidy. Improvements on survival, growth and reproductive performances of all the progenies produced will be evaluated, especially in saline waters. Marketability factors such as color and dressing weight will also be considered.

Work will be conducted to develop efficient and adequate feeds for growth and maturation, including research on nutritional requirements and digestive physiology. A major part of the study will focus on the formulation of cost efficient diets and development of feeding methods to maximize conversion.

Project research will be coordinated with ICLARM projects in other countries. This project will be one part of a network of tilapia research activities through which complementary research on tilapias is being conducted. Exchange of research results and stocks and comparisons with site-specific research from other localities will expedite progress.

Efforts are being made in the initial phase to establish project facilities and to develop detailed work plans for the project, which is being implemented in close cooperation with National Sun Yat-Sen University, Taiwan Fisheries Research Institute and Institute of Zoology, Academia Sinica.

Project Title : Controlled Reproduction of Commercially Important Marine Fishes

Cooperating Institutions : New Jersey Marine Science Consortium; United States Agency for International Development (AID) (Cooperative Marine Technology for the Middle East); Egyptian Academy of Scientific Research and Technology; Israel Oceanographic and Limnological Research Ltd.

Duration : 1980-1986

Key Personnel ICLARM : Dr. Ching-Ming Kuo
Egypt : Prof. A.R. El Bolock
Israel : Hillel Gordin

Objectives

Egyptian efforts to spawn mullet (principally *Mugil cephalus)* and develop hatcheries and Israeli research related to improvement in techniques for hormonally-induced maturation and spawning of gilthead seabream *(Sparus aurata)* are the parallel thrusts of this project. The basic problems, endocrinological and environmental influences on reproduction, are similar.

The principal objective of the project is to increase understanding of the reproductive processes of the gilthead seabream and the grey mullet. Specific studies are directed toward determination of the effects of given doses of luteinizing hormonone-releasing hormone on gonadal development and on definition of optimal injection schedules and dosages to achieve gonadal maturation and ovulation in gilthead seabream. With mullet, studies are designed to determine the effects of photoperiod and other environmental parameters on gonadal maturation. Research in Egypt will include propagation of mullet and controlled maturation and spawning using either environmental manipulation or hormonal injections of the types used for gilthead seabream. This will be followed by development of hatchery technology for mass production and stocking of high quality fingerlings.

Results

The cooperative work for the program is being conducted primarily in the Middle East region, with exchange visits by Israeli and Egyptian investigators to the participating American institutions. As ICLARM does not have facilities for conducting research on the controlled reproduction of marine fish, the ICLARM staff input has been advice on project development, establishment of working plans, follow-up on the progress of the project, and periodic participation in the research.

During the first year of the project's operation, efforts have been made to organize project teams, develop working plans, establish hatchery facilities, acquire equipment and laboratory supplies, train project personnel, and conduct the research for the project. The major difficulty, which hampered the progress of the project to date, was facility limitations. However, overall progress of the project is generally satisfactory.

In Israel, captive seabream and mullet stocks have been established. Gonadal maturation of seabream has been advanced by attenuation of the photoperiod under controlled conditions. Attenuation rates of one-half and one minute per day were most effective. Spontaneous spawning of seabream has been induced under these controlled environmental conditions.

Spawnings of seabream have been induced through injections of human chorionic gonadotropin and the gonadal cycle of seabream has been defined. Work is continuing on the improvement of incubation and larval rearing systems. In addition, efforts are underway to extract and purify seabream pituitary gonadotropin.

Histological sections of mullet gonad were monitored throughout the year to document the natural gonadal cycle. Also with mullet, steroid profiles (estradiol and testosterone) were monitored and correlated with gametogenesis in a captive mullet population.

Parallel investigations in Egypt focused on mullet. The annual gonadal cycle was monitored in Lake Qarun.

Project Title : Controlled Reproduction and Mass Fry Production of Commercially Important Fishes

Cooperating Institution : Council for Agricultural Planning and Development (CAPD), Taiwan

Duration : 3 years, beginning July 1982

Key Personnel ICLARM : Dr. Ching-Ming Kuo
CAPD : Dr. J-C. Lee

Objectives

This is a cooperative project with several Taiwanese institutions working through CAPD with ICLARM to develop effective methods for controlling reproduction and improving fry production methods of commercially important cultured fishes. Major objectives of the project are to:

- establish pituitary banks
- establish broodstocks of key species in captivity
- induce maturation of captive fishes on demand
- induce spawning of mature fishes on demand
- establish optimal egg-incubation systems and larval-rearing procedures
- improve fry production through studies of nutritional and environmental requirements

ICLARM personnel are interacting in research activities at several institutions.

The lack of standardization of induced-spawning techniques has resulted largely from unavailability of assayed hormones and incompatibility and species-specificity among the recipients and donors. Taiwanese scientists have agreed to take a leading role in establishing pituitary banks in accordance with recommendations from the International Conference on Endocrine Application to Animal Culture, held on 17-18 December 1981 in Taipei. Gonadotropins resulting from the work will become reference hormones for controlled reproduction. A sizable collection of brood fish of each commercially important fish identified will be established in captivity to provide the experimental material.

Plans to control gonadal maturation of captive broodstock cover description of the morphological changes in gonads and the physiological processes

associated with the gonadal development, and endocrine control of the gonadal development.

Experiments will also be conducted to determine larval-rearing techniques and other information necessary to scale up to a more practical level. Variations of environmental parameters will be evaluated to determine those conditions that ensure maximum larval survival with a consideration of the food requirements of the larvae.

Results

Efforts have been made in the initial phase of project operations to organize project staff from various participating institutions and to develop a work plan for the project. The project will be implemented with close cooperation of the National Taiwan University, National Taiwan Normal University, Institute of Zoology (Academia Sinica) and Taiwan Fisheries Research Institute.

Project Title : Genetic Characteristics of Food Fishes

Cooperating Institution : The Marine Sciences Center, University of the Philippines (UP-MSC)

Duration : 1 year, beginning 1 January 1983, with provision for extension

Key Personnel ICLARM : Ms. Josephine Capili; Dr. Roger S.V. Pullin
UP-MSC : Ms. Julie Macaranas; Ms. Maria J. Josefa

Objectives

Tilapias are of major importance in aquaculture throughout tropical and subtropical regions and have been identified as the most important tropical species group for applied aquacultural research. The species of interest to culturists include representatives of the substrate-spawning genus *Tilapia* and the mouthbrooders *Sarotherodon* and *Oreochromis*. The purity of most of the Philippine tilapia stocks is in doubt; some experimental stocks are now acknowledged to be mixed: for example, *Oreochromis niloticus* mixed (hybridized?) with *O. mossambicus*.

In this project enzyme electrophoresis will be used to locate genetic markers for the identification of stocks or species useful in aquaculture. The project will concentrate initially on tilapias from both commercial farms and experimental collections.

It is also planned to study other species which are important or potentially important for aquaculture, including the mullets *(Mugilidae)*, catfishes *(Clariidae)*, snakehead *(Channa striata)* and miscellaneous marine species such as *Epinephelus tauvina* and *Lates calcarifer*.

TRADITIONAL FISHERIES PROGRAM

Background

ICLARM's research in traditional fisheries continues its primary socio-economic focus, because the major problems facing the sector in most parts of the world appear to be non-technical in nature. This is not to say that potential for gear improvement does not exist in selected locations; however in many traditional small-scale fisheries the limits to further expansion have been reached. This is especially true in coastal waters of Southeast Asia where small-scale fishermen compete with larger, more capital-intensive trawlers and purse seiners for the same resources.

The attitudes of government fisheries planners are strongly ingrained, and their attitudes on needs for vessel and gear upgrading continue to receive support from development banks and international development agencies. Because decisionmaking tends to be highly centralized at national levels, few location-specific refinements to solving the low income problem have developed. Programs tend to be national in scope, short-term in nature, and thus overlook local differences.

However, in the face of increasing evidence that technical approaches will not solve the overfishing and low income problems of the capture fisheries sector, these attitudes are slowly beginning to change. It is now recognized in some countries that potential solutions lie in approaches that limit fishing effort and thus potentially produce higher sustainable yields and incomes from capture fisheries. This shift from development to management leads, however, to some very sensitive topics that were ignored as long as technical (development) solutions were applicable. No longer is it possible to expand the pie to benefit all fishermen. It is now necessary to face the difficult decisions regarding allocation of a pie of given size among the various competing users. The problem is particularly complex when fisheries stocks are shared among nations. Very little previous experience with such approaches, especially in the tropics, is available to help guide decisionmakers in this new direction.

Progress of Work

ICLARM's research program in traditional fisheries is guided by three primary considerations. The first is the goal of clarifying alternative devel-

opment and management choices available to decisionmakers. This leads to research areas that are not being adequately addressed by other international development organizations which often take a short-term view, if they conduct research at all. The second is to involve as many national institutions as possible in cooperative research endeavors. ICLARM's own staff and financial resources are small and close working relationships with national research institutions have catalyzing and multiplier effects that are necessary conditions to successfully addressing the socioeconomic problems of small-scale fisheries. Finally, the program strives to achieve interdisciplinary rigor in research through close cooperation among biologists, economists and sociologists.

The program focuses on three subject areas:

1. marketing and potential for increasing efficiency
2. alternative fisheries management systems
3. alternative or supplementary-income opportunities (especially small-scale aquaculture)

Each in its own way is designed to explore means by which income levels and standards of living can be raised in traditional fishing communities.

During the year ICLARM has been involved in three major projects. First is the continuation of preparation of the five technical reports (containing 27 papers in all) that present the results of the Multidisciplinary Analysis of the Small-Scale Fisheries of San Miguel Bay, Philippines, a joint project with the University of the Philippines in the Visayas with partial funding from the United Nations University and the Philippine Council for Agriculture and Resources Research and Development (PCARRD). The first study of its kind in Asia, this project addresses the major issues of stock assessment, allocation of use rights, distribution of benefits, marketing efficiency and occupational and geographic mobility of fishermen to assess the need for managing this multispecies multigear fishery. Options that might be considered by local and national policymaking bodies are identified and discussed. The study's main side benefits have been the development of methodologies for low-cost data acquisition and analysis, and the integration of biological, economic and sociological perspectives into a clear statement of the need for management of fisheries of this type. Preliminary results and methodologies have been presented at several national and international workshops during 1982, and numerous other research groups have expressed interest in pursuing similar research in other locales.

Second, during 1982, Dr. Bailey and two counterparts conducted a review and synthesis of previous research on Indonesian small-scale fisheries. Patterned after a similar review of Philippine municipal fisheries that also had a multidisciplinary focus, this review will be completed by early 1983, and the resulting manuscript will be published in both English and Bahasa Indonesia. The review is timely because Indonesia imposed in 1980 a ban on trawling with small-scale fishermen the expected beneficiaries. With financial support from the Ford Foundation, Dr. Bailey also assisted with organizing a Novem-

ber 1982 workshop on socioeconomic aspects of small-scale fisheries in Indonesia, which was sponsored by the Central Fisheries Research Institute of Indonesia. Proceedings will be published in Bahasa Indonesia during 1983.

The third major project has been the initiation of a Social Science Research Network of selected universities in Southeast Asia. This project gets to the heart of the goals of ICLARM's traditional fisheries program in that it is long term in nature, focuses on applied research with management implications and involves several national research institutions. It has major elements of training, curriculum development and research. The initial focus is on fisheries economics spearheaded by the Universiti Pertanian Malaysia (UPM) which, with assistance from the International Development Research Centre of Canada, the Agricultural Development Council and ICLARM, initiated the first M.Sc. in Resource Economics (Fisheries Specialization) in Southeast Asia. Other institutions participating in the network are the University of the Philippines in the Visayas and Kasetsart University (Thailand). An Indonesian university is still to be identified. Each of these institutions, as well as Universitas Diponegoro in Indonesia, will be sending young faculty members to UPM from 1982 to 1985 supported by ICLARM fellowships funded by IDRC. Upon their return home after completion of their studies, these individuals will form the core of a research network devoted to fisheries and aquaculture economics. A key problem presently hampering social science research—that is, the extreme shortage of trained fisheries social scientists—is thus being addressed. The groundwork for extension of the network's activities beyond 1982 has been completed, and IDRC is currently considering an ICLARM proposal for financial support that would extend the network's activities for four years, 1983 to 1986. During 1982, ICLARM also hosted Prof. Ishak Omar of UPM for a five-month sabattical during which he prepared for his subsequent teaching assignments. Work continues on a Fisheries Economics Reader to be published in Bahasa Indonesia by the Obor Foundation.

A previous project completed in 1981, deserves mention because the manuscripts related to it were published this year; it is the ADB-ICLARM "Workshop on Appropriate Technology for Alternative Energy Sources in Fisheries" which involved a substantial editing effort by ICLARM during 1982. The manuscripts of two other projects completed in 1982, the "Malaysian Small-Scale Fisheries Review" and "Skipjack and Traditional Fisheries: A Solomon Islands Case Study" are being revised by the authors.

Advisory Services

During 1982, Drs. Pauly and Smith made two visits each to Indonesia to assist Dr. Bailey's Indonesian counterparts in the preparation of their sections of the Indonesian Small-Scale Fisheries Review. Dr. Smith also assisted the faculty of UPM with design of their fisheries economics curricu-

lum and selection of reading materials. Ms. Yater (Research Assistant) assisted Silliman University and the University of Nueva Caceres, both in the Philippines, with design and implementation of their fisheries socioeconomic surveys. Dr. Bailey advised several graduate students at Institut Pertanian Bogor in Indonesia and assisted the Agency for Agricultural Research and Development, AID-Indonesia and the UNDP with development of their programs in small-scale fisheries and aquaculture. Drs. Neal, Smith, Pauly and Bailey assisted with the organization of the AID (Philippines) Seminar and Workshop on Coastal Zone Management and the subsequent design of their follow-up program. Finally, Dr. Smith has advised the National Development Company in the Philippines on its alternative energy projects in rural fishing communities.

Training

In addition to the fisheries economics program and fellowships already discussed, Dr. Chong has been guest lecturer in fisheries economics at several courses at Manila universities. Other training activities, such as graduate student research and training of research assistants, have been conducted within various ICLARM projects, especially the San Miguel Bay project.

Publications

Bailey, C. 1982. Natural resource management: a basis for organization of small-scale fishermen. Rural Development Participation Review, Winter 1982: 19-22. Cornell University, New York.

May, R.C., I.R. Smith and D.B. Thomson, Editors. 1982. Appropriate technology for alternative energy sources in fisheries. ICLARM Conference Proceedings 8, 225 p. Asian Development Bank and International Center for Living Aquatic Resources Management, Manila, Philippines.

Meetings Attended, Papers Presented

Seminar Perikanan Lemuru, Banyuwangi, Indonesia, 18-21 January 1982 (C. Bailey).

Paper presented:

Bailey, C. Social science contribution to understanding the Bali Straits Lemuru *(Sardinella longiceps)* fishery.

Workshop on Rural Coastal Fisheries in the South China Sea Region. South China Sea Fisheries Development and Coordinating Programme, Manila, 15-24 March 1982 (C. Bailey, D. Pauly, I.R. Smith, L. Yater).

Sea Grant Seminar and Workshop on Coastal Living Resources in Malaysia, Kuala Trengganu, Malaysia, 25-28 May 1982 (I.R. Smith).
Paper presented:
Smith, I.R. and D. Pauly. Simple methods for the multidisciplinary investigation of tropical multispecies multigear fisheries.

Canadian Council for Southeast Asian Studies/Institute of Southeast Asian Studies (Singapore) joint seminar on Village-Level Modernization: Livelihoods, Resources and Cultural Continuity, Singapore, 21-24 June 1982 (C. Bailey).
Paper presented:
Bailey, C. Access to and management of coastal marine resources: The fishing communities of San Miguel Bay, Philippines.

FAO/IPFC Workshop on Inland Fisheries for Planners, Manila, 2-6 August 1982 (R.A. Neal and I.R. Smith).
Paper presented:
Smith, I.R. Mismanagement of inland fisheries and some corrective measures.

Rural Sociology Society Annual Meeting, San Francisco, 1-4 September 1982 (C. Bailey).

Fifteenth Meeting of the Council of the Southeast Asian Fisheries Development Center, Tokyo, 27 September-1 October 1982 (I.R. Smith, Observer).

Workshop Social Ekonomi Perikanan Indonesia (Workshop on the Socio-Economics of Indonesian Fisheries), Central Fisheries Research Institute, Cisarua, 2-4 November 1982 (C. Bailey and I.R. Smith).
Paper presented:
Bailey, C. Rethinking two assumptions regarding small-scale marine fisheries development problems in Indonesia: implications for government programs and socio-economic research (in Bahasa Indonesia).

FAO Workshop on Territorial Use Rights in Fisheries, Rome, 6-10 December 1982.
Paper presented:
Smith, I.R. and T. Panayotou. Territorial use rights and economic efficiency: the case of Philippine fishing concessions.

Program Plans for 1983

Further development of the fisheries social science research network will be the primary activity of the traditional fisheries program. National institutions participating in the network have been encouraged to establish priorities within the context of their own fisheries sectors and previous research experience. The tentative plans of each of the institutions reflect the current diversity of interests among the universities. We expect, however, that areas of common interest will emerge after the network is initiated.

Five research activities are presently planned in two categories below: country research (items 1-4) and pre-project research (item 5).

(1) *Malaysia (UPM):* In 1982, UPM initiated a three-part fisheries marketing study that was designed to illustrate ways in which the structure and

operation of the market can be changed for the benefit of small-scale fishermen. This project headed by Professor Ishak Omar will last until the end of 1984 and will be implemented in close cooperation with the Malaysian fisheries development agency MAJUIKAN and the Department of Fisheries. MAJUIKAN will provide secondary wholesale and retail price and quantity data that have been collected daily (but not analyzed) from eight major market centers since 1979. In addition to this price analysis study, UPM will also examine the structure of the marketing system and conduct extensive field surveys with fishermen and middlemen. Finally, consumer surveys will be conducted in Kuala Lumpur to determine preferences and per capita consumption of fish among the different racial groups of Malaysia.

(2) *Philippines (UPV):* The UPV team has proposed that their initial research project focus upon formal and informal institutions in fisheries production and marketing in the Western Visayas region of the Philippines. The study would be initiated in April 1983 upon the return to UPV of the first faculty member to receive training in the UPM non-degree module program. The focus on institutions was chosen for the project because it is a logical follow-up to a baseline multidisciplinary study undertaken by the same faculty during 1981 and 1982. The major components of the proposed UPV research project include: 1) evaluation of the management of production and processing by small-scale fishermen; 2) socioeconomics of marketing practices; 3) analysis of fish consumption patterns in Iloilo; and 4) psychological characteristics of fishing households. These studies will be initiated simultaneously.

(3) *Thailand (Kasetsart University):* The Kasetsart team has decided to focus its initial research activities on aquaculture economics, under the direction of Dr. Ruangrai Tokrisna, team leader. Marketing aspects will have the highest priority during 1983. Initially, the research will cover the shellfish, an important source of low-cost protein and of income to many fishing households in Thailand. Also the research will examine the question of property rights and access in coastal shellfish farming. Another area of interest is the multiple use of trash fish and the problems of the fish meal industry, a topic of importance to both capture fisheries and aquaculture. Later, studies of economies of scale in fish processing will be instituted.

(4) *Indonesia:* Indonesian research will be confined to student research at least until 1985. Further plans will be developed after selection of the Indonesian institution for the network.

(5) *Pre-project research:* Each of the ICLARM-IDRC fellowship awardees in the UPM M.Sc. program in fisheries economics will be required to write a thesis. With approval of the UPM faculty, these theses could be conducted in the scholar's home country. While it is too early to say what specific topics these scholars will choose, each will be encouraged to pursue a topic relevant to the research priorities which have been established by his or her network institution. By mid-1986, therefore up to eight thesis research projects should have been completed. Not included in this figure are the

theses that will be produced by those scholars who attend the UPM program on their own or on non-IDRC-ICLARM finances. The UPM program will undoubtedly attract students other than those which will be supported under the network funding.

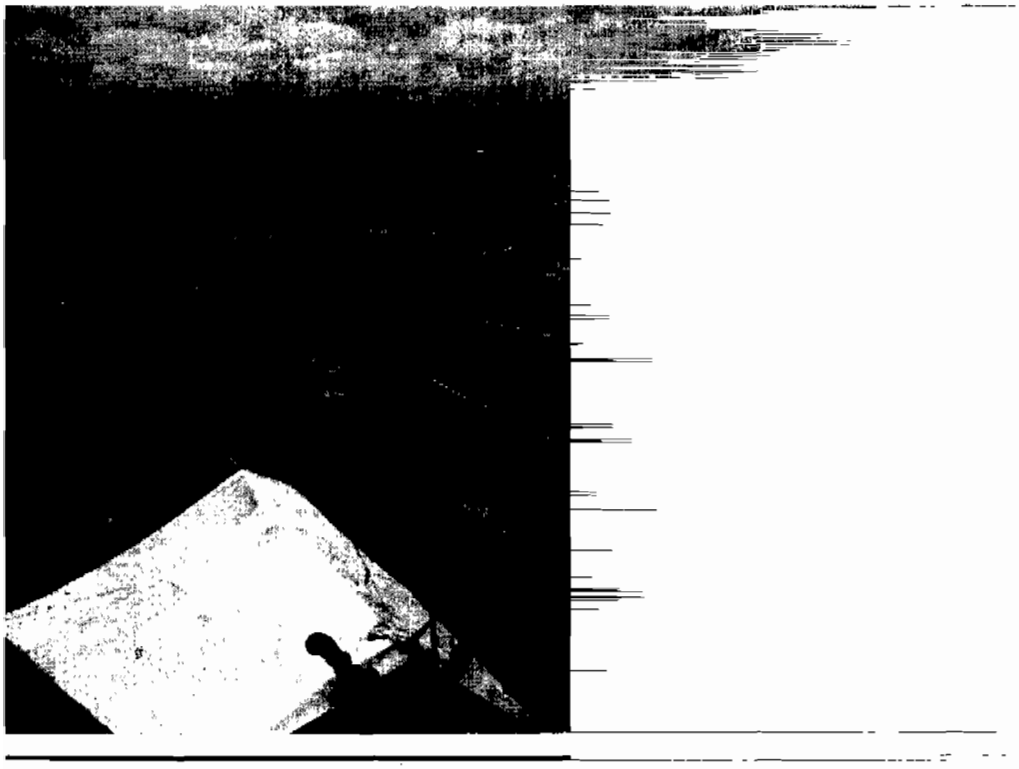
In addition to the above network activities, we will be exploring the possibilities of collaboration with FAO to study territorial use rights in fisheries. In particular, a series of case studies is planned to address questions of allocation of use rights, limitation of entry and transferability of use rights in tropical fisheries. Preliminary discussions have been held with FAO in response to their invitation for ICLARM involvement in this subject area. A final subject area being explored is an examination of the impact of trawling on nearshore resources and small-scale fishing communities.

Fishermen and buyers on the beach, San Miguel Bay, Philippines. The low incomes of small-scale fishermen in the Bay could be increased by reallocation of use rights.

Traditional Fisheries Project Summaries

Completed

Active



Small-scale fishing boats near Indramayu, West Java, using a small river as a protected anchorage. ICLARM and the Indonesian government are cooperating in a multidisciplinary review of Indonesian small-scale fisheries.

Project Title : Small-Scale Fisheries of San Miguel Bay, Philippines: A Multidisciplinary Analysis

Cooperating Institutions : Institute of Fisheries Development and Research, College of Fisheries, University of the Philippines in the Visayas (UPV); the United Nations University (UNU), Japan; and Philippine Council for Agriculture and Resources Research and Development (PCARRD)

Duration : September 1979 to January 1982

Key Personnel UPV : Prof. Antonio Mines (Project Leader)
ICLARM : Dr. Ian Smith (Economics)
Dr. Daniel Pauly (Biology)
Dr. Conner Bailey (Sociology)
Ms. Luz Yater (Sociology)

Objectives

The primary objective was to conduct an in-depth study of the San Miguel Bay fisheries to facilitate this sector's inclusion in the Bicol integrated area development program, a plan from which fishing communities have generally been excluded. A second objective was to develop a multidisciplinary approach to tropical fisheries research for application elsewhere.

Results

The biological segment of this project involved estimation of fishing effort and catch per effort for all gear types, leading to reliable estimates of catch by month and by species groups.

Catches from the Bay were found to be 3 to 4 times higher than official statistics suggest. About 53% of the catch which totals 15,000 tonnes/year, is taken by some 5,100 small-scale fishermen, and the remainder by 95 trawlers of various sizes. Detailed assessments using surplus-production and yield-per-recruit models suggest that the Bay is overfished in the sense that

an increase in effort by either the trawl or the small-scale fishery would not result in an increased catch from the San Miguel Bay as a whole, but rather exacerbate the present allocation problems between the small-scale and trawl fisheries. This is confirmed by the economic analysis which shows that small trawlers, representing only 3% of the Bay's fishing units and employing 7% of the fishery's labor force, earn the largest share of catch value and 50% of the pure profits (resource rents). Serious consideration should be given to limiting effective fishing effort so as to maintain positive resource rents and to deal with the presently highly skewed distribution of benefits. The analysis of labor mobility showed that very limited alternative employment opportunities exist in the area, which explains the low opportunity costs of labor and the significant outmigration from the area. These complementary findings all argue for seeking solutions to the low incomes of the small-scale fishermen within rather than outside the fishery by reallocating use rights and catch in their favor.

Four technical reports are currently in press, dealing with biology and stock assessment, economics of production and marketing, social aspects, and occupational and geographical mobility. A fifth report, which synthesizes the results of the first four and discusses options for management and research, is in preparation.

Project Title : Indonesian Small-Scale Fisheries: Research Review and Synthesis

Cooperating Institutions : Directorate General of Fisheries (DGF) and Research Institute for Marine Fisheries (BPPL), Indonesia

Duration : October 1981 to September 1982

Key Personnel ICLARM : Dr. Conner Bailey (Sociology)
DGF : Ir. Firial Marahudin (Economics)
BPPL : Mr. A. Dwiponggo (Biology)

Objectives

The project is a multidisciplinary review of Indonesian small-scale fisheries by scientists from the Indonesian Directorate General of Fisheries, the Marine Fisheries Research Institute and Dr. Conner Bailey, who is based in Bogor. It brings together information from the scattered published and unpublished reports, mostly in the Indonesian language, of the considerable research previously carried out on Indonesian fisheries.

Results

The authors have spent 12 months reviewing the literature and preparing an English-language manuscript. Extensive field work, including interviewing fishermen and researchers was carried out to supplement the literature database. The review will be published in both English and Indonesian in 1983.

Project Title : Fisheries Social Science Research Network

Cooperating Institutions : Universiti Pertanian Malaysia (UPM), Serdang, Selangor, Malaysia; University of the Philippines in the Visayas (UPV), Iloilo; Kasetsart University, Bangkok, Thailand; One Indonesian University (yet to be identified); International Development Research Centre (IDRC), Canada; Agricultural Development Council (ADC), Bangkok, Thailand

Duration : 1982 to 1986 (First phase)

Key Personnel

ICLARM	:	Drs. Ian Smith, Conner Bailey and Ed McCoy
IDRC	:	Dr. Elwood Pye and David King
UPM	:	Dr. Brian Lockwood and Prof. Ishak Omar
UPV	:	Profs. Ida Siason and Ma. Luisa Mabunay
Kasetsart University	:	Drs. Ruangrai Tokrisna and Chamnien Boonma

Objectives

The underlying objective of this research network is to build national research capability. Only through sustained long-term involvement of national institutions can research have an impact on fisheries development and management policy. This project seeks to provide continuity and quality to fisheries social science research by addressing priority issues through a small network of affiliated institutions. Major purposes of the network are to strengthen selected national research institutions, facilitate their long-term commitment to fisheries social-science research, and forge links between the research community and policymakers.

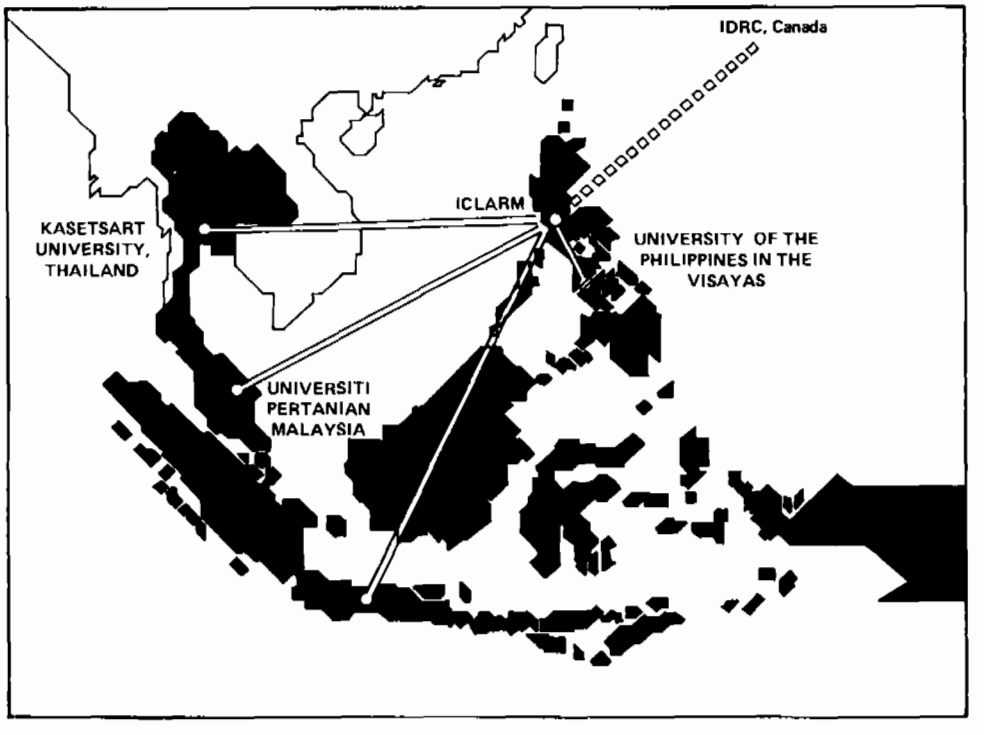
Results

The core of the program during 1982 to 1985 is the M.Sc. Program in Resource Economics (Fisheries Specialization) that has been initiated by UPM faculty in 1982. Young faculty members from UPV, Kasetsart and

several Indonesian institutions will be sent to this M.Sc. program which has been started with the assistance of Dr. Brian Lockwood, Visiting Specialist of the Agricultural Development Council. Professor Ishak Omar of UPM spent five months sabbatical at ICLARM (August to December 1982) to develop materials for his course in aquaculture economics. His sabbatical is partially supported by IDRC.

UPM has also developed a non-degree module program in the same subject matter. With a grant from IDRC, one faculty member from UPV and one from Kasetsart University will attend the first non-degree module which begins in November, 1982. Four fellowships will be awarded by ICLARM for the M.Sc. degree program beginning June 1983, again with funding from IDRC. These fellowships are designed to train a core group of fisheries economists who can carry on long-term quality research in Southeast Asia.

At the end of 1982, IDRC was considering a grant to ICLARM for the 1983-1985 research activities of the network and a favorable decision was expected.



The fisheries social sciences research network. Three universities are presently involved with a fourth to be identified in Indonesia.

EDUCATION AND TRAINING

ICLARM has been unable to staff the Education and Training Program this year for financial reasons. All activities have been handled by personnel from other programs and, in fact, most of the activities have been directly related to one of the programs. For this reason nearly all education and training activities are discussed under other program reports, and are not repeated here.

One exception is the survey of training opportunities that was initiated in response to a series of requests from scientists, from development project leaders and from development banks for information on both short-term training and long-term educational opportunities. A communication gap was identified between the institutions providing training and the users. Specific training plans and funding are being incorporated into development projects without knowledge of what training is available. On the other hand universities and others offering training cannot plan or sponsor courses (especially short courses) without a clear understanding of what training is needed, and who needs it.

A large number of institutions and agencies was approached for information on their educational and training programs. Many responded with useful information on both educational programs and short courses that has been compiled for publication in the October ICLARM Newsletter. This is a first step toward improving communication on the topic. Initial indications are that adequate opportunities exist for university degree programs. Specially tailored short courses are not available, however, to meet present needs.

Several institutions contacted indicated a willingness to arrange special courses on demand: Texas A & M University has taken a strong interest in the problem and is designing a response capability to meet needs. As the first step in this direction ICLARM has assisted Texas A & M in quantifying demand for special training.

INFORMATION SERVICE

Progress of Work

The Information Service has been functioning now for four years. Initiated as a support service for the scientific staff, the Service has a full-time staff of nine and another three persons on a part-time basis. There are currently five information activities.

- Newsletter. The quarterly Newsletter has evolved into a medium in which particular topics are pursued through invited articles. Its "information department" which is the result of scanning all incoming library material, has grown to become a well-used current awareness service. Readership is now 2,200.
- Technical Series. There are five technical series of publications as shown below with the number of titles produced to date.

Conference Proceedings	(8)	— reports of international meetings sponsored by ICLARM usually in cooperation with other organizations.
Studies and Reviews	(6)	— monographs on important issues, refereed and equivalent to other primary literature.
Technical Reports	(4)	— detailed results of ICLARM projects.
Bibliographies	(3)	subject matter of interest in tropical, developing countries.
Translations	(1)	

- Computer Terminal. For the past year, ICLARM has had the use of a teletype terminal which provides direct access to the major international computer databases, including ASFA, BIOSIS, and Oceanic Abstracts. No other fisheries organization in the region has this facility. In recent months the terminal has been used to handle external, as well as in-house, enquiries.
- Audiovisuals. Equipment is now on hand to make sophisticated sound-slide shows. So far this medium is being used in-house only.
- Library. Growth of the library is accelerating as more exchange agreements are made and retrospective collecting of some periodicals and monographs and especially reprints has been initiated. Currently 399 periodicals are received and there are about 3,000 catalogued monographs. The library concentrates on tropical, developing country fisheries. It also receives an excellent press clipping service from the Press Foundation of Asia. Apart from its collections, the library produces a monthly acquisitions list, distributed on request; directly answers many enquiries; takes an active role in

bibliography preparations; and keeps an eye on developments of interest to users. The librarian is currently President of the Agricultural Libraries Association of the Philippines.

Since ICLARM's publications are its primary source of visibility in the international community, promotion of the technical series is a special activity of the section. Techniques being used are advertisements, press releases, brochure distribution, copies to review journals and indexing services, use of distributors, membership of promotional organizations, and book exhibitions.

The last-mentioned item is seen as most important. During this report period, ICLARM publications have appeared at one national and two international book exhibitions in Manila; through membership in the Book Development Association of the Philippines, some ICLARM books went to international book fairs in Singapore and Germany. They will be displayed also at upcoming fisheries and aquaculture meetings in the U.S.A. All ICLARM publications are being exhibited in bookstores in major cities in China, on a rotational basis that began with a major exhibition held concurrently in three cities in May. This was the first International Agricultural Research Centers' book exhibition in China, at which 14 international centers, including ICLARM, participated.

Meetings Attended, Papers Presented

Philippine Library Association, Inc., 8th Annual Meeting of the House of Delegates, Manila, Philippines, 29 May 1982 (R.M. Temprosa).

Agricultural Libraries Association of the Philippines (ALAP), Seminar-Workshop, Cavite, Philippines, 3-5 June 1982 (J.L. Maclean, R.M. Temprosa, E. Barile and H. de Castro).

Association of Special Libraries of the Philippines (ASLP), Mid-year conference seminar on the "The Identification of User Needs and Problems," Thomas Jefferson Cultural Center, Philippines, 14 August 1982 (E. Barile and H. de Castro).

Seminar on Fishery Information Science in Southeast Asia, Bangkok, Thailand, 16-20 August 1982 (J.L. Maclean and R.M. Temprosa).

Papers presented:

J.L. Maclean. ICLARM's Information Service.

J.L. Maclean and A. Neelameghan. Reference services, current awareness and information analysis in Southeast Asian fisheries.

ALAP/AEOP Seminar-Workshop on Descriptive and Subject Cataloging, Cavite, Philippines, 11 October-6 November 1982 (R.M. Temprosa).

National Consultative Workshop on the Establishment of a National Fisheries and Marine Sciences Information Network, Iloilo, Philippines, 1-4 December 1982 (J.L. Maclean and R.M. Temprosa).

Paper presented:

J.L. Maclean. Fisheries and marine science information: a resource for development.

Program Plans for 1983

The Information Service activities are continuous. Plans for 1983 are to increase efficiency of operations. A microcomputer arrived in December which will handle mailing lists, sales and inventories initially. Its word-processing capability will speed up manuscript preparation since the secretarial staff will able to make use of the program. The library is expected to benefit greatly as well.

There are three special activities proposed for 1983. One is a joint proposal with SEARCA to upgrade the fisheries component of its agricultural database. The latter already includes 50-75% of fisheries literature generated in Southeast Asia. The proposal is for ICLARM to assist in identifying potential inputting institutions and in training workshops to orient existing and new inputters towards fisheries material. The objective is to improve bibliographic retrieval of literature in the region.

The second proposal is for a selective fisheries information service. There are two primary objectives of the proposed service, (i) to provide individual users with specific material in ICLARM's area of expertise, and (ii) to assist in strengthening the information capability of fisheries institutions in developing countries.

The first objective is a question/answer service. Trends in requests would be used as a basis for preparation of bibliographies and from them, state-of-the-art reviews. The second objective is an advisory role which requires appointment of an information scientist to act as a consultant to individual institutions and advise on improving regional capacities also.

A third proposal, to set up a Southeast Asian Fisheries Forum, was warmly endorsed by the Program Advisory Committee at its 1981 meeting and further endorsed by the AID review team in March 1982. The proposal seeks to promote contact between practicing fishery scientists to exchange ideas and information, to disseminate their knowledge and provide a stimulus for regional collaboration in research. ICLARM, while seeing its role merely as a catalytic one, has been reticent to pursue the idea in view of the probable problems of continuous funding for the forum. However, in the light of the strong endorsement by the PAC and AID review team, a proposal was sent in August to a number of institutions and colleagues within and beyond the region. Of 30 replies, 29 were favorable, and 28 of those could be described as highly enthusiastic. At this stage, it is apparent that there is sufficient interest to propose an organizational meeting in May 1983.

Awards for the best Philippine books of 1982 were presented at a ceremony in Manila last December. ICLARM had one entry, the 432-page "Biology and Culture of Tilapias," which topped the scientific category. Picture shows editor Maclean receiving the special award from Philippine Prime Minister Cesar Virata.

Arrival of a new microcomputer with a line printer capable of producing camera-ready copy will assist manuscript preparation. Here Elma Banilbo is checking entries on the computerized mailing list.

ICLARM offered free searching during 1982 of the computer databases available from DIALOG through the terminal facility.

ICLARM's publications were exhibited in several countries in 1982. Picture shows part of the ICLARM display in Beijing during an exhibition of publications of the International Agricultural Research Centers which toured China in May 1982.

CONTRIBUTION SERIES

Published contributions from ICLARM include the Center's five technical series—Conference Proceedings, Studies and Reviews, Technical Reports, Bibliographies and Translations—as well as ICLARM Newsletter articles, papers in scientific journals and published presentations at seminars and workshops.

The following list contains all numbered contributions, most of which have been published since 1979. Projections into 1983 have been included to allow citing of material approved for publication and already in the process of editing and/or printing by the end of 1982.

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2. ICLARM. 1976. Program development statement. International Center for Living Aquatic Resources Management, Manila, Philippines. 35 p.
3. Nash, C.E., T. Joyner and R.D. Mayo. 1976. Seeding the southern ocean with salmon. International Center for Living Aquatic Resources Management, Hawaii. 68 p.
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5. Christy, F.T., Jr. 1978. Changes in the law of the sea and effects on fisheries management. ICLARM Newsletter 1(1): 5-6.
6. Pauly, D. 1978. Management of multispecies stocks: a review of the theory. ICLARM Newsletter 1(2): 3.
7. Pauly, D. 1978. A discussion of the potential use in fish population dynamics of the interrelationships between natural mortality, growth parameters and mean environmental temperature in 122 fish stocks. International Council for the Exploration of the Sea, CM 1978/G:21 Demersal Fish Committee. 36 p.
8. Smith, I.R. 1978. Preliminary analysis of the performance of the fry industry of the milkfish *(Chanos chanos* Forskal) in the Philippines. Aquaculture 14(3): 199-219.
9. Christy, F.T., Jr. 1979. Fishery problems in Southeast Asia, p. 217-223. *In* D.M. Johnston (ed.) Regionalization of the Law of the Sea. Ballinger Publishing Co., Cambridge, Mass.
10. Pauly, D. and G. Gaschütz. 1979. A simple method for fitting oscillating length growth data, with a program for pocket calculators. International Council for the Exploration of the Sea, CM 1979/G:24 Demersal Fish Committee. 26 p.
11. Pauly, D. 1979. Biological overfishing of tropical stocks. ICLARM Newsletter 2(3): 3-4.
12. Pullin, R.S.V. 1979. Thailand's first technical seminar on marine resources. ICLARM Newsletter 2(3): 7, 14.

13. Shehadeh, Z.H. 1979. EIFAC workshop focuses on mass production of fish seed. ICLARM Newsletter 2(3): 8-9.
14. Marr, J.C. 1979. Fishery management problems in Southeast Asia, p. 211-215. *In* D.M. Johnston (ed.) Regionalization of the law of the sea. Ballinger Publishing Co., Cambridge, Mass.
15. Smith, I.R. 1979. Traditional fisheries development in the Philippines. ICLARM Newsletter 2(3): 16-18.
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17. Pullin, R.S.V. 1979. Seminar on research methodology. ICLARM Newsletter 2(4): 24.
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19. Pauly, D. 1979. Reprinted 1983. Theory and management of tropical multispecies stocks: a review with emphasis on the Southeast Asian demersal fisheries. ICLARM Studies and Reviews 1, 35 p.
20. Smith, I.R. 1979. A research framework for traditional fisheries. ICLARM Studies and Reviews 2, 40 p.
21. Christy, F.T., Jr., Editor. 1980. Law of the sea: problems of conflict and management of fisheries in Southeast Asia. Proceedings of the ICLARM/ISEAS Workshop on the Law of the Sea. ICLARM Conference Proceedings 2, 68 p. International Center for Living Aquatic Resources Management, Manila and the Institute of Southeast Asian Studies, Singapore.
22. Christy, F.T., Jr. 1980. Summary report of the ICLARM/ISEAS workshop on the law of the sea. ICLARM Conference Proceedings 3, 11 p. International Center for Living Aquatic Resources Management, Manila and the Institute of Southeast Asian Studies, Singapore.
23. Pauly, D. 1980. ICLARM's resource development and management program: the tropical stock assessment research project. ICLARM Newsletter 3(1): 3-4.
24. Chong, K-C. 1980. Philippine milkfish production economics study underway. ICLARM Newsletter 3(1): 6, 13.
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26. Pullin, R.S.V. 1980. Philippine tilapia broodstock project. ICLARM Newsletter 3(1): 8-9.
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28. Meltzoff, S.K. 1980. Anthropologist conducts study of skipjack tuna fisheries in Solomon Islands. ICLARM Newsletter 3(2): 14.
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30. Pullin, R.S.V. 1980. Coastal aquaculture—the Indian experience. Mar. Policy 4(3): 251-253.
31. Gaschütz, G., D. Pauly and N. David. 1980. A versatile program for fitting weight and seasonally oscillating length growth data. International Council for the Exploration of the Sea, CM 1980/D:6. Statistics Committee. 14 p.

32. Pauly, D. and N. David. 1980. A BASIC program for the objective extraction of growth parameters from length-frequency data. International Council for the Exploration of the Sea, CM 1980/D:7. Demersal Fish Committee. 14 p. Also as Meeresforsch. 28: 205-211.
33. Nash, C.E. and Z.H. Shehadeh, Editors. 1980. Review of breeding and propagation techniques for grey mullet, *Mugil cephalus* L. ICLARM Studies and Reviews 3, 87 p.
34. Chonchuenchob, P., K. Chalayondeja and K. Muttarasin. 1980. Hanging culture of the green mussel *(Mytilus smaragdinus* Chemnitz) in Thailand. ICLARM Translations 1, 12 p.
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36. Edwards, P. 1980. Food potential of aquatic macrophytes. ICLARM Studies and Reviews 5, 51 p.
37. Maclean, J.L., Editor. 1980. ICLARM Report 1977-1980. 168 p.
38. Smith, I.R. and R. Pestaño-Smith. 1980. A fishing community's response to seaweed farming. ICLARM Newsletter 3(3): 6-8.
39. Bailey, C. 1980. The road to Mangkok. ICLARM Newsletter 3(3): 10-12.
40. Pauly, D. and N. David. 1980. An objective method for determining fish growth from length-frequency data. ICLARM Newsletter 3(3): 13-15.
41. Bailey, C. 1980. Social and economic aspects of small-scale fisheries development: a case study from Malaysia. Proc. Indo-Pacific Fish. Comm. 19(III): 702-714.
42. Smith, I.R. and R. Pestaño-Smith. 1980. Seaweed farming as an alternative income for small-scale fishermen: a case study. Proc. Indo-Pacific Fish. Comm. 19(III): 715-729.
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45. Cruz, E.M. and Z.H. Shehadeh. 1980. Preliminary results of integrated pig-fish and duck-fish production tests, p. 225-238. *In* R.S.V. Pullin and Z.H. Shehadeh (eds.) Integrated agriculture-aquaculture farming systems. ICLARM Conference Proceedings 4, 258 p. See Contribution No. 44.
46. Hopkins, K.D. and E.M. Cruz. 1980. High yields but still questions: three years of animal-fish farming. ICLARM Newsletter 3(4): 12-13.
47. Pauly, D. 1981. The relationships between gill surface and growth performance in fishes: a generalization of von Bertalanffy's theory of growth. Meeresforsch. 28(4): 251-282.
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LINKAGES, AGREEMENTS

Axiomatic to the formulation and successful implementation of ICLARM's programs is the initiation and maintenance of institutional linkages through memoranda of agreement and understanding and the subsequent undertaking of cooperative projects with organizations operating with similar or related program thrusts.

During the report period, ICLARM maintained formal agreements with ten institutions. A further 29 donor and research organizations also cooperated with ICLARM in various activities. The formal agreements include:

- **Council for Agricultural Planning and Development, Government of Taiwan**

  A new cooperative research agreement between ICLARM and CAPD was signed in April 1982 for continuation of projects begun in 1981. These projects are now incorporated in the "Cooperative Tilapia Research Project" which will continue for three years.

- **Central Luzon State University, Philippines**

  A five-year cooperative program of research and training in aquaculture and inland fisheries began in 1979. Two projects under this agreement were completed in 1982, on tilapia fry production and economics of integrated farming.

- **Department of Technical and Economic Cooperation, Government of Thailand**

  ICLARM provides technical assistance to the Thai Department of Fisheries for applied research in coastal aquaculture. The program, in support of the Thai Government's national aquaculture development plan, deals specifically with shellfish farming. A cooperative project began in December 1981.

- **Kasetsart University Research and Development Institute (Thailand)**

  Under the continuing agreement signed in September 1979 to collaborate and assist each other in pursuit of research projects related to

fisheries and aquaculture development and management, was a study on catfish production economics in central Thailand. The analysis of data was completed in 1981 and a report published in mid-1982.

- **Ministry of Agriculture and Fisheries Development of Sabah, Malaysia**

  ICLARM and MAFD signed a cooperative research agreement in January 1982. Under this agreement an advisory mission was undertaken in December to assist in site selection and design of a research fish hatchery.

- **Ministry of Natural Resources (MNR), Government of the Philippines**

  A memorandum of agreement was signed in October 1979 for continuing collaboration and mutual assistance in projects or activities of mutual interest to ICLARM and MNR. During the report period, the results of a socioeconomic survey of milkfish producers were jointly published by ICLARM, the Bureau of Agricultural Economics and the Fishery Industry Development Council within that Ministry.

- **Research Institute of Agricultural Economics, National Chung Hsing University (Taiwan)**

  An agreement was signed in June 1980 to undertake joint projects related to fisheries and aquaculture development and management. An aquaculture trends study and an economic analysis of the tilapia industry in Taiwan are being carried out under this agreement.

- **Southeast Asian Regional Center for Graduate Study and Research in Agriculture (Philippines)**

  Agreement was reached in February 1978 for continuing collaboration on areas of mutual concern: 1) development and conduct of training courses, 2) pursuit of research, 3) promotion of transfer of technologies in fisheries and related fields, and 4) any other project or activity which is of mutual interest to ICLARM and SEARCA. During 1982, the two organizations had several discussions in the field of fisheries information.

- **Universiti Pertanian Malaysia**

  UPM and ICLARM signed an agreement for collaboration in July 1982. Under this agreement, Prof. Ishak Omar of UPM spent five months sabbatical at ICLARM in 1982. UPM is expected to take part in a Social Science Research Network presently in the planning stage.

- University of the Philippines in the Visayas

  ICLARM and UPV have agreed to collaborate and assist each other in research projects related to fisheries and aquaculture, through a memorandum signed in August 1982.

The following donor and research organizations also provided support for or cooperation with various projects:

Agricultural Development Council, Bangkok

Aquaculture Production Technology Ltd., Israel

Asian Development Bank

Australian Development Assistance Bureau

Bureau of Fisheries and Aquatic Resources, Philippines

Bureau of Agricultural Economics, Philippines

Commonwealth Scientific and Industrial Research Organisation, Australia

Egyptian Academy of Scientific Research and Technology

Food and Agriculture Organization

Fishery Industry Development Council, Philippines

German Agency for Technical Cooperation

Indonesian Directorate General of Fisheries

Research Institute for Marine Fisheries, Indonesia

Instituto del Mar, Peru

International Agricultural Development Service

International Development Research Centre, Canada

International Rice Research Institute

Israel Oceanographic and Limnological Research Ltd.

Kuwait Institute for Scientific Research

National Inland Fisheries Institute, Thailand

New Jersey Marine Science Consortium

Philippine Council for Agriculture and Resources Research and Development

Rockefeller Foundation, U.S.A.

Thailand Department of Fisheries

United Nations Development Programme

United Nations University, Japan

United States Agency for International Development

University of the Philippines Institute of Fisheries Development and Research

University of the Philippines, Marine Sciences Center

STAFF

ICLARM is a small Center. Its history consists largely of the individual achievements of its staff. However, it requires the departure of staff from ICLARM to allow their endeavors to be acclaimed without the opportunity for them to make deprecatory remarks. There were two departures in 1982. In January 1982, ICLARM's Director General, Ziad H. Shehadeh, resigned to take up an appointment at the Kuwait Institute for Scientific Research as Head of the Mariculture and Fisheries Department. December 1982 marked the completion of field assignments with ICLARM of rural sociologist Conner Bailey.

Of Ziad, the following appreciation was penned for the April 1982 Newsletter by James Storer, prominent member of ICLARM's Program Advisory Committee.

> All of those concerned with ICLARM are sorry, both individually and in a collective capacity, that Ziad Shehadeh has resigned from his post as Director General.
>
> The choice by ICLARM's Board in 1979 of Ziad as the Director General was very wise. Ziad had been with ICLARM almost from the very beginning, having joined the organization in 1976 when it was still located in Hawaii. He was thoroughly familiar with the programs and priorities that had been established by his predecessor, Jack Marr. There was much to be said, therefore, for having someone assume the leadership of ICLARM who understood both the potential and the problems of the fledgling institution. Now, after two and one-half years with Ziad as the Director General, it is clear that ICLARM has earned its wings and is accepted as a proven institution for carrying out its mandate in fisheries research and related activities.
>
> It is not surprising that Ziad should have maintained and sharpened the particular focus on fisheries research that had already been established. It was, and is, an appropriate one. Ziad has also maintained and strengthened the emphasis upon a small, but extremely competent, interdisciplinary staff and very wisely continued the practice of publishing excellent documents and reports, which have done much to enhance the awareness of ICLARM throughout the fisheries world.
>
> Two and one-half years is not a long time and surely not long enough for Ziad to have realized all the dreams and hopes he had for ICLARM, including those that would have brought the organization into a full global role. We are, however, grateful for all he has accomplished and we are pleased that Ziad will continue to make valuable contributions to ICLARM as a member of the Board of Trustees. With all possible warmth and sincerity, we wish Ziad well in his new career and in his new home.

Conner Bailey ended three years of field assignments with ICLARM in December, after 20 months with the San Miguel Bay project and 16 months

Dr. Ziad H. Shehadeh

Dr. Conner Bailey

as a member of a team reviewing and synthesizing previous research in marine fisheries of Indonesia.

Conner and his family went to Massachusetts, where he has a fellowship at the Woods Hole Oceanographic Institution. He retains his link with ICLARM as an affiliate scientist. During his assignments, Conner prepared a number of papers on fisheries management by coastal communities as well as major contributions from the field projects. ICLARM is happy to record that Conner's work during these three years has had considerable impact on the development of the Traditional Fisheries Program, and headquarters staff look forward to further association with him in the years ahead.

The staff roster for 1982 follows.

Director General

Richard A. Neal, Ph.D.

Previous Director General[1]

Ziad H. Shehadeh, Ph.D.

Scientific Programs

AQUACULTURE PROGRAM

Richard A. Neal, Ph.D.	Director, Aquaculture Program
James C-M. Kuo, Ph.D.	Senior Scientist

[1]Previous Director General, Dr. Ziad H. Shehadeh, resigned 15 January 1982; Dr. James C. Johnston was Acting Director General until the appointment of Dr. Neal on 1 November 1982.

Roger S.V. Pullin, Ph.D.	Senior Scientist
Kee-Chai Chong, Ph.D.	Senior Research Fellow[3]
Kevin D. Hopkins, Ph.D.	Senior Research Fellow[3]
Edward W. McCoy, Ph.D.	Team Leader, Thailand Project[3]
Ronald F. Ventilla, Ph.D.	Marine Biologist, Thailand Project[3]
Wade Watanabe, Ph.D.	Marine Biologist, Taiwan Project[3]
Ms. Felicidad Estrada, B.S.	Secretary, Aquaculture Program

TRADITIONAL FISHERIES PROGRAM

Ian R. Smith, Ph.D.	Senior Scientist and Director, Traditional Fisheries Program
Conner Bailey, Ph.D.	Senior Research Fellow[2]
Ms. Luz Yater, B.S.	Research Assistant[3]
Ms. Nenita Jimenez, B.S.	Secretary, Traditional Fisheries

RESOURCE DEVELOPMENT AND MANAGEMENT PROGRAM

John L. Munro, Ph.D.	Senior Scientist and Director, Resource Development and Management Program[4]
Daniel Pauly, Ph.D.	Associate Scientist
Noel C. David, B.Sc.	Affiliate Scientist
Ms. Ma. Lourdes Palomares, B.S.	Research Assistant[5]
Ms. Erlinda Miralles, B.S.	Secretary, Resource Development and Management Program

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[2] Appointment ended December 1982.
[3] Fixed term appointment.
[4] Commenced March 1982.
[5] Commenced 2 April 1982.

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Ms. Carmencita Carpio, B.S.	Secretary, Director General[10]
Ms. Ma. Concepcion Querubin, B.S.	Secretary, Deputy Director General

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[6] Resigned 1 August 1982.
[7] Promotion effective 16 September 1982.
[8] Resigned 5 October 1982.
[9] Commenced 1 November 1982.
[10] Resigned 31 July 1982.

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Mr. Espiridion Trafalgar	Driver

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Ranin Regalado, B.S. Bureau of Fisheries and Aquatic Resources, Philippines	Population Dynamics[12]

[11] April 1980-March 1982.
[12] September 1980-February 1982.

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*Appointed ICLARM Director General in November 1982.

STATEMENT OF SOURCES AND APPLICATION OF FUNDS
(US $)

		1981	1982*
SOURCES OF FUNDS:			
Carry over from Previous Years' Funds		120,064	163,517
Income			
Grant — 1. Unrestricted			
	Rockefeller Foundation	812,000	850,000
	United States Agency for International Development (USAID)	300,000	320,000**
	Australian Development Assistance Bureau (ADAB)		20,986
2. Restricted			
	German Agency for Technical Cooperation (GTZ)	55,234	269,597
	Rockefeller Foundation	32,947	
	Central Luzon State University (CLSU)	35,362	
	United Nations University (UNU)	20,000	
	United Nations Development Programme (UNDP)	15,292	23,638
	USAID	6,425	
	New Jersey Marine Science Consortium (NJMSC)	6,000	31,283
	Philippine Council for Agriculture and Resources Research Development (PCARRD)	2,850	10,723
	Kuwait Institute for Scientific Research (KISR)		51,856
Others:	Consultancy Fees	18,472	11,665
	Publication Income	6,215	18,478
	Miscellaneous	55,936	25,445
		1,486,797	1,775,188
APPLICATION OF FUNDS:			
Administration		397,817	281,698
Information Service		190,830	205,224
Capital Investment		42,936	20,738
Programs —	Program Advisory Committee	17,475	40,166
	Program Development Fund	49,431	7,317
	Aquaculture	408,503	597,554
	Traditional Fisheries	124,921	157,948
	Resource Development and Management	102,482	179,243
	Education and Training	10,885	
		1,345,280	1,489,888
FUND BALANCE, END OF YEAR		141,517	285,300

*Based on unaudited figures.
**August 1982-July 1983

INTERNATIONAL CENTER

FOR LIVING AQUATIC RESOURCES MANAGEMENT