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ICLARM PROGRESS REPORT

1981-1982

October 1982

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Introduction

During the year ending 30 September 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 reputation, through its scientific contributions and accomplishment of its goals and objectives, is the strongest ever. As nearly every institution, local 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.

ICLARM's increasing strength is evident in both the quality and quantity of publications. Presentations and lectures by staff members at conferences, workshops, training courses have had a significant impact in ICLARM's areas of expertise. Details of these accomplishments are discussed later in the report. 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.

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

- Several economic studies of aquacultural production methods.
- Socioeconomic appraisal of the impact of milk fish farming extension activities.
- Stock assessment as related to studies of traditional fishing communities.
- Interaction of fishery management and clam cultivation in reef fisheries 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 all 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 Thailand (December 1981), Kuwait (January 1982) and Taiwan (July 1982), 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 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.

Recognition is difficult to measure or document. However, many aspects of our relationships with other institutions and scientists reflect growing recognition of the work of ICLARM. ICLARM scientists are invited to participate in an increasing number of conferences and workshops, more than time and funds will permit. A large number of spontaneous compliments have been received on our newsletter, publications, conferences and other initiatives. 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 on the basis of the review team's report is planning to contribute substantially to the ICLARM budget over the next 5 years. Also, the Australian Development Assistance Bureau is planning to increase the size of its annual contributions to ICLARM. Additional donors are being approached for short- and long-term support.

The outlook for ICLARM is not all encouraging, however. At the end of August ICLARM received word that the Rockefeller Foundation is reorganizing its programs as a result of its financial problems and that its core funding for ICLARM would be phased out over the next few years. This poses serious problems for ICLARM, particularly for the concept of ICLARM as a unique organization with the freedom, independence and flexibility to design and conduct its own research, and to attack research problems that are not within the reach of existing organizations. This loss of core support, if not replaced, could destroy the essence of ICLARM, the vital difference from other organizations that has been responsible for its rapid success. This problem and the future course for ICLARM will be the principal topics of discussion during the upcoming meetings of the Program Advisory Committee and Board of Directors.

The last 12 months have been 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.

A fault in the strategy of international donors regarding fisheries development is becoming particularly apparent to the ICLARM staff. This fault is that donors are willing to continue to contribute large sums to demonstration and extension projects even though they have only a mediocre record of success. The logic followed is that short-term technology transfer is so urgently needed that research cannot be afforded. Donors do not seem to recognize that, in fisheries as opposed to agriculture, this mediocre record is often due specifically to the absence of the required knowledge base, because of inadequate research. Outstanding examples are: (1) fisheries "management" without knowledge of the size of stocks; (2) aquaculture without adequate seed production methods, disease control or suitable strains and species; (3) continual "development" of fishing communities using superficial methods such as loan programs and cooperatives that have been consistently unsuccessful because of insufficient understanding of local socioeconomic circumstances.

The typical fisheries situation observed is one of a continually deteriorating resource base, maintenance of yields by shifting to smaller fishes (lower on the food chain), decreasing profits for fishermen, conflicting management goals, and growing conflicts among fishermen competing for limited resources. Aquaculture is in only a slightly better position as evidenced by agreement at a recent SEAFDEC meeting that seed supply for aquaculture on a regional basis was inadequate for expansion being planned.

Research is still an essential component of fisheries development. ICLARM seems, thus far, to have failed to convey this message to the fisheries world. Increasing awareness of research needs for tropical fisheries development will be a specific goal for 1983.

Overall 1982 has been a year of progress and accomplishment for ICLARM as is revealed in the following pages. Organizations that are responsive to needs of a changing world must be dynamic themselves, and the Center has clearly demonstrated the importance of its flexibility, scientific versatility and independence in 1982.

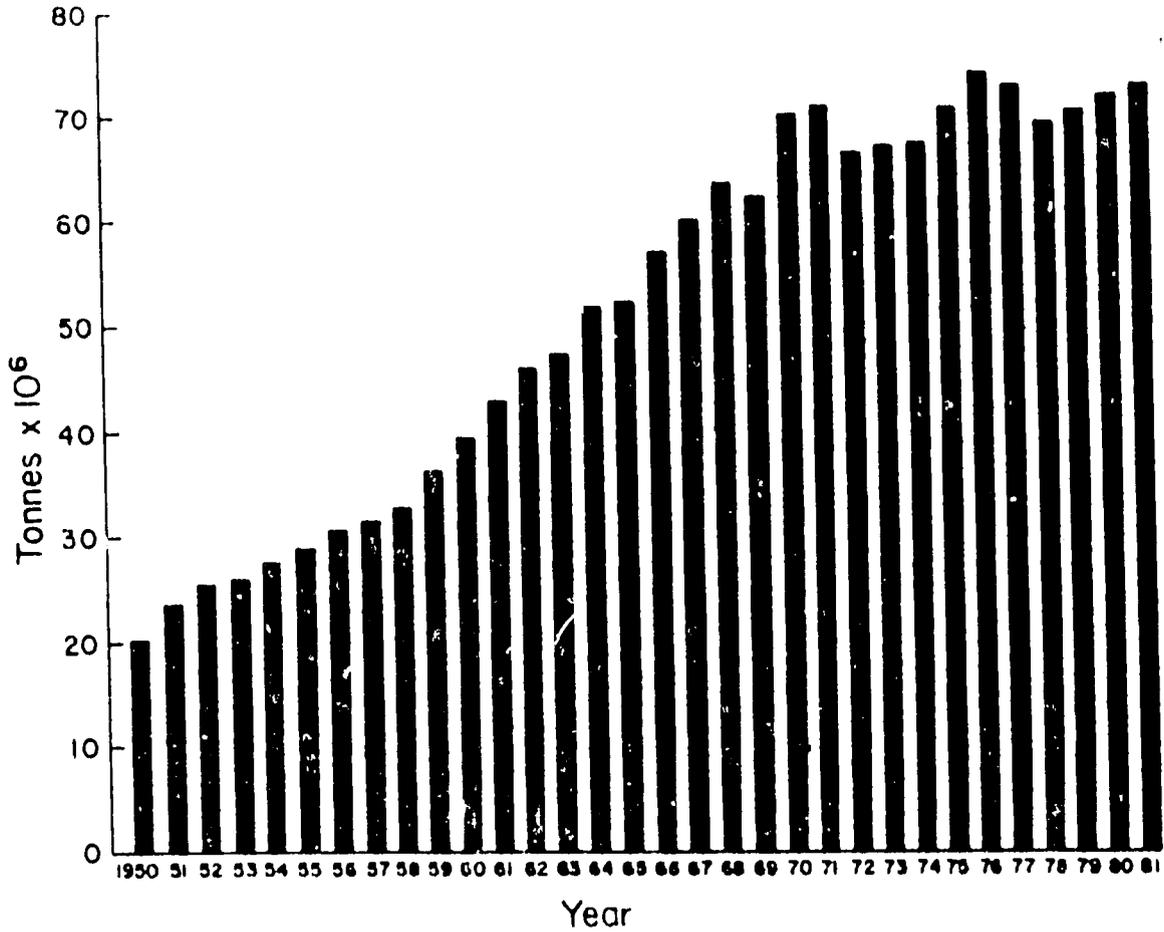


Fig. 1. Annual world fish production since 1950, showing the "70 million tonne plateau".

Aquaculture Program

PROGRESS OF WORK

Because of the limits to production from capture fisheries many countries are increasingly turning to aquaculture as a supplementary source of supply of much needed protein. The present status of aquaculture varies tremendously. For example, in Southeast Asia there are only 7,000 hectares under production, in Malaysia (excluding extensive cockle beds), but several hundred thousand hectares in Indonesia and the Philippines. Consequently, the development requirements for aquaculture also vary from country to country. New systems are being introduced in some environments by farmers with little entrepreneurial experience in aquaculture; in others, refinements in existing systems are sought. In both cases, however, it is envisioned that aquaculture will remain predominantly in the hands of private producers.

If a single word were used to describe the activities related to aquacultural development in Southeast Asia during the last year 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 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 does benefit 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, milk fish and molluscan shellfish).

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 on the project level, but serve to join the program elements in a useful and functional way.

Tilapia

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 and genetic typing.

The potential of salinity-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 the Taiwan experiments. An ICLARM scientist, seconded to the Kuwait Institute for Scientific Research in early 1982, 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, a variety of 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 which was 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 1980. The first is entitled "Azolla in Tilapia Nutrition." *Azolla* is a nitrogen-fixing aquatic fern, which is commanding great interest as an organic fertilizer for aquatic ecosystems, including ricefields. In discussions with the International Rice Research Institute (IRRI), it became clear to ICLARM 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. However, such trials are proceeding in the absence of any information on the nutritional value of *Azolla* to fish. In this project, fresh and dried *Azolla* diets are being tested on *O. niloticus* 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 the growing awareness among planners and policy makers 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, feed, fertilizer and capital) in the production process and with other protein sources in markets. Because aquacultural systems are primarily in the hands of private producers, within certain sociocultural bounds 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 *O. niloticus*.

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 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 country (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, feed supply, 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 the

August 1983 workshop of PCARRD and ICLARM.

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 workshop will be held in November 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 at the end of 1982.

Stock Improvement

The fourth aquaculture program theme is stock improvement or genetics and although most of our present related studies are preparatory to long-term genetic studies, they are nevertheless of importance. Broodstock improvement work at Central Luzon State University will be completed in December 1982. However, genetic typing will be continued through 1983 at the University of the Philippines, Marine Science 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 even 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 fresh water. 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. The research emphasis, in the initial phase of the program, is placed on the development of saline-tolerant species and hybrids, followed by consideration of temperature tolerance and disease resistance.

Other Activities

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 wild seed stock 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 and is in the experimental-design stage.

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 has 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.

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.

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 textbook

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 Thailand.

ICLARM also took the opportunity to publish a very comprehensive bibliography of culturable tilapias, which was offered by a German biologist. ICLARM authors have also published articles unrelated to project activities in outside journals. A list of aquaculture publications other than those related to projects described earlier is given following the section on special activities.

SPECIAL ACTIVITIES

Advisory Services

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 will be 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 will be implemented in the last quarter of 1982.

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.

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.

ICLARM has established a close working relationship with AARD in Indonesia and has provided assistance of several types through IADS. 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.

Meetings Attended, Papers Presented

Coastal Zone Management Seminar-Workshop sponsored by USAID Manila, November 5-6, 1981. (C. Bailey, R.A. Neal, D. Pauly, I.R. Smith).

9th Conference of the International Society of Comparative Endocrinology, December 7-11, 1981, Hong Kong. (C.M. Kuo).

Annual Convention, Philippine Federation of Aquaculturists, Manila. December 11-12, 1981. (K-C. Chong).

Roundtable Discussion on the Reproduction of Warmwater Fishes. Aquaculture Department, SEAFDEC, Iloilo City, Philippines, December 13-14, 1981. (C-M. Kuo).

International Symposium on Hormone Application to Fish Culture, Taipei, Taiwan, December 16-17, 1981. (C-M. Kuo).

Paper presented:

Kuo, C.M. Endocrinological control on fish reproduction.

- 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).

Publications

- Lee, C.S. Production and marketing of milkfish in Taiwan: an economic analysis. ICLARM Technical Reports 6. National Chung Hsing University, Taichung, Taiwan and International Center for Living Aquatic Resources Management, Manila, Philippines. (In press)
- 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. *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. 1982. Book Review. Water quality management for pond fish culture by Claude E. Boyd. ICLARM Newsletter 5(3): 15.
- Pullin, R.S.V. 1982. Genetics undervalued—a report of the International Symposium on Genetics in Aquaculture, University College, Galway, Ireland, 29 March-2 April 1981. (In press, Marine Policy).
- 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.
- Schoenen, P. 1982. A bibliography of important tilapias (Pisces: Cichlidae) for aquaculture. ICLARM Bibliographies 3, 336 p.
- Smith, I.R. 1982. Book Review. Aquaculture economics: basic concepts and methods of analysis by Y.C. Shang. Marine Policy 6(2): 158-159.

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Project Title : Mass Production of Tilapia Fry

Cooperating Institution : The Freshwater Aquaculture Center of 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 cross ($N_p \times N_p$), ($N_p \times N_i$)* and ($A_a \times A_s$) were more successful in the wet season than in the dry season: 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 3-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. At the end of 60-day fry-rearing period, these fish ranged from 403.1 to 785.1 mg in weight and 29.1 to 36.7 mm in length under outdoor conditions. These variations are apparently due to genetic differences rather than environmental influences. The fry from the cross ($N_p \times N_p$) grew fastest followed by the fry of the $N_i \times N_p$ cross.

Differences in growth rates between dry and wet seasons were also highly significant especially from fish reared under outdoor conditions (Table 1). This is 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 among the crosses examined up to 3 months, but differences became evident from the fourth month. The $N_p N_p$ fingerlings showed the best growth (39.1 g body weight, 121.7 mm in body length) after three 3-month fingerling growth period. ($N_i \times N_i$) fingerlings were the slowest growing.

* Female parent given first throughout.

A comparison of all-male postfingerling growth performance of $N_p N_p$, $N_s N_s$, $N_i A_a$, $N_p A_a$ and $A_a N_p$ stocks is also in progress and will terminate November 1982. The results of these experiments will be 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.

Efforts have been made to develop an efficient fry collection method. The fry production experiment was conducted in 100-m² concrete raceways and the N_p strain was chosen as the main species to be examined. The best fry production was again obtained with a sex ratio of 1:1 at a stocking density of five fish/m². Fry collection systems incorporating net partitions have been tested with environmental or olfactory attractants as stimuli. Preliminary observation 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.

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 male dehydrogenase are anticipated before the end of the year.

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

Cross† (♀ x ♂)	Condition*	0	15	30	45	60	Season
$N_p \times A_a$	0	13.5 (11.6)**	63.4 (17.5)	193.2 (24.0)	391.92 (29.0)	515.3 (33.1)	Wet season
	1		28.7 (14.1)	72.9 (17.9)	162.95 (22.5)	204.3 (24.7)	
$N_p \times A_a$	0	11.3 (11.0)	90.4 (19.1)	267.9 (27.7)	728.93 (38.6)	1,544.2 (44.7)	Dry season
	1		43.1 (15.2)	118.7 (21.3)	199.67 (24.9)	352.1 (29.4)	
$N_i \times A_a$	0	11.5 (11.1)	76.0 (17.4)	168.9 (22.5)	328.33 (28.4)	465.3 (31.7)	Wet season
	1		30.7 (14.1)	60.6 (15.5)	128.33 (19.9)	221.4 (25.0)	
$N_i \times A_a$	0	10.7 (11.2)	54.2 (18.5)	290.1 (28.0)	818.41 (37.1)	2,165.9 (51.4)	Dry season
	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 body length in mm (body length in mm).

† N_p - Philippine strain, *O. niloticus*

N_i - Israel strain, *O. niloticus*

A_a - Auburn University strain, *O. aureus*

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 variety (*Sarotherodon* sp.) 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 red tilapia (*Sarotherodon* sp.) and blue tilapia (*Oreochromis aureus*) 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.

During the winter season, when 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)			Wintering (130 days)			Post-wintering (variable)			Days cultured	
	Initial wt. (g)	Survival (%)	Growth rate (g/day)	Initial wt (g)	Survival (%)	Growth rate (g/day)	Initial wt. (g)	Survival (%)	Growth rate (g/day)		Final wt. (g)
Red tilapia (<i>Sarotherodon</i> sp.)											
FW*	46.7	85.1	0.75	107.9	98.2	0.37	141.7	99.0	1.23	348.4	384
BW*	44.4	**	**	63.9	84.7	0.28	100.0	94.0	0.72	201.7	326
SW*	40.1	86.6	0.69	95.3	79.0	0.12	103.9	87.4	0.86	231.0	376
Blue tilapia (<i>Sarotherodon aureus</i>)											
FW*	28.8	97.0	0.58	76.0	99.8	0.11	91.1	99.1	1.38	273.7	372
BW*	25.5	**	**	64.7	97.4	0.15	73.8	99.4	0.59	172.4	366
SW*	32.3	98.6	0.48	70.8	77.3	0.09	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 (CLSU) Muñoz, Nueva Ecija, Philippines

Duration : 7 months, November 1981-June 1982

Key Personnel CLSU : Mr. Ruben Sevilleja

Objectives: A 3-year cooperative research project (1978-81) on integrated animal-fish farming systems has been conducted by the Freshwater Aquaculture Center (FAC), Central Luzon State University (CLSU), Philippines and ICLARM. This cooperative project was initiated with the principal objective of developing technically and economically viable animal-fish systems. Economic analyses on the 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 and pig raising and to develop enterprise budgets for these systems.

Results: The internal rate of return (IRR) of the fish operation is 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 will not allow further expansion or if the farmer wishes to reduce risk by diversification, the fish operation is still 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.

The number of chickens required to maximize IRR of the integrated chicken-fish operation is a function of pond size, because as pond size increases, the manure loading rate should decrease. The reason for this is that the fish operation is 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 is optimal in theory. However, there is considerable variability of fish yields at such low loading rates, so we recommend that 500 chickens/ha be considered the minimal loading rate in practice. The density that maximizes IRR for a given pond size is 4,400 chickens/ha.

Duck raising is more profitable than a backyard piggery or a combined breeding and growing pig farm. Both pig operations are more profitable than a broiler chicken operation. Capital costs for the three systems integrated with 1,000-1,500 m² ponds range from P15,000-20,000, with pig-fish being the lowest, possibly within the reach of small 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 this project, which will be published before the end of the year.

Project Title : Controlled Reproduction of Commercially Important Marine Fishes

Cooperating Institutions : New Jersey Marine Science Consortium; U.S. 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 and develop mullet (*Mugil cephalus*) hatcheries, especially at sites with unusual water quality, 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 research. The basic problems as related to endocrinology 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 hormone-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. The second phase of 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 quality seedings.

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's 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 mentioned 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.

The accomplishments of the project during the first year of the project operation were reported in "1981 Annual Report on Cooperative Marine Technology Program for the Middle East" submitted to the U.S. AID, and a proposal for program continuation (1983-1986) was recently submitted.

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. Chaur-Shyan Lee, 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 by the end of 1982.

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 : 18 months, 15 July 1981-15 January 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 productivity 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 productivity 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 prepare training materials for extension officers based upon the results of this project's and earlier surveys of producers.

Results: A survey of 447 producers in 7 provinces was undertaken to collect data to test hypotheses related to the effect of 56 explanatory variables on levels of fertilizer use. Of these 56 variables (which cover a variety of demographic, managerial, physical, socio-economic and institutional parameters), only 8 were demonstrated to have a significant effect on levels of fertilizer use. These variables, which explain 73% of the variations in fertilizer use, 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.

Publications

- 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. The United Nations University, Tokyo.

- 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 comprehensive surveys.

In November, an in-country workshop on Technical and Economic Aspects of Mollusc Culture will be conducted. Conflicts in Use of Common Property Resources will be the topic of an international workshop in early 1983. This problem appears to be a major constraint to increased shellfish production in Thailand and possibly elsewhere. Social factors will also be considered in the study through this workshop.

Project Title : Intensive Mariculture of Tilapia
Cooperating Institution : Mariculture and Fisheries Department, Kuwait Institute for Scientific Research (KISR)
Duration : 1 year, beginning January 1982
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 of Kuwait.
- To develop suitable methods for the mass production of tilapia fry under conditions existing in Kuwait.
- To evaluate intensive growout systems for tilapia including cages and raceways.

Results: During 1982, a 12-tank raceway system and a 120 m² tilapia hatchery were constructed. The hatchery includes eight 2m x 2m brood tanks, 27 400-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 Persian 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 50 kg/m³ and 25 kg/liter-minute water flow have been achieved. Projected annual yields exceed 50 kg/liter-minute. Such systems could possibly be scaled-up to use the brackish groundwater resources found in Kuwait and other arid lands.

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. Ed 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.

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 and dried *Azolla* diets are now being compared with this control diet and the digestion and assimilation of *Azolla* by the tilapia gut are being studied.

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 first examines 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 will then be designed 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 acclimated to outdoor plastic pools at IFDR. They are now producing 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.

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 as follows:

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

ICLARM personnel are interacting in a diverse set of ongoing research activities at several institutions to work toward these objectives.

Lack of standardization of induced-spawning techniques among scientists 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 under the recommendations from the participants at 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 of the physiological processes associated with the gonadal development, and endocrine control of the gonadal development. Included are research on hypophysial gonadotropin synthesis and release, serum gonadotropin and gonadal steroidogenesis profiles throughout gametogenesis; response of gonadal tissues to exogenous hormones; stimulatory effects of exogenous LH-RH on gonadotropin synthesis in the hypophysis, and gonadotropin-surge in blood serum and its consequences on the initiation and regulation of gametogenesis. Moreover, stimulatory effects of hormones and steroids on vitellogenin synthesis and incorporation into oocytes at varying developmental stages will be investigated. The stimulation of gonadal maturation by maturation of photoperiod and temperature regimes and by dietary control will also be studied.

Other studies include: description of the stimulatory pathways of exogenous hormones on gonadal tissues via receptor, adenylation system, messenger, and protein kinase axis;

gonadal steroid biosynthesis and metabolic pathways; osmotic regulation of gonadal tissues during the preovulatory period; involvements of prostaglandins and steroids in final maturation including ovulation and oviposition, and ovulatory mechanism. This research will lead to more reliable and efficient methods of controlling reproduction.

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 : Cooperative Tilapia Research Project

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

Duration : 3 years, beginning July 1982

Key Personnel ICLARM : Dr. C-M. Kuo
Dr. W. 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.

Reliable, efficient seed production systems and procedures will be developed through improved knowledge of tilapia reproductive physiology and behavior. The conditions for maximizing fry and fingerling production will be described to provide the basic information needed for designing hatcheries and nurseries. Species and hybrids will be screened and selected for intensive culture in coastal waters, and intensive systems, such as cages and raceways. Parallel to the work on growth in saline waters, a program of basic research on osmoregulation will be undertaken to provide basic information on, for example, the effects of dietary ionic components on improved salinity tolerance.

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.

Any disease conditions affecting growth or reproductive performance will be thoroughly investigated, including identification of pathogens and parasites, and development of prevention and treatment methods.

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 : 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. Chaur-Shyan Lee

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* : Economics of the Philippine Tilapia Industry
- Cooperating Institutions* : Philippine Council for Agriculture and Resources Research and Development (PCARRD) and several other research groups
- Duration* : 1 year, beginning August 1982
- Key Personnel ICLARM* : Dr. Ian Smith, Dr. Roger Pullin, Dr. Kee-Chai Chong, Ms. Luz Yater
: Researchers from various Philippine institutions

Objectives: The Philippine tilapia industry has clear potential for providing income to small-scale producers and protein to consumers. However, an economic analysis is needed to document its current structure, the response of producers to potential profits and the response of markets to recent increases in production. Possible constraints to further expansion of the industry need to be identified, whether they be in the form of input (feed and seed) supply limitations and costs, overcrowding of available production areas, distribution bottlenecks or limited market absorptive capacity. Both the Bureau of Fisheries and Aquatic Resources (BFAR) and the Philippine Fish Development Authority (PFDA) collect secondary data on production and prices that are useful as background to an economic analysis of the industry. However, for full documentation, an in-depth analysis of selected production and marketing systems based on data provided by private input suppliers, producers and middlemen is necessary. This information is especially important to guide government agencies such as Ministry of Human Settlements which, through its Kilusang Kabuhayan at Kauniaran (KKK) Program, is encouraging private investment by small-scale producers in tilapia production particularly in cage-culture systems.

PCARRD and ICLARM are providing small grants to about one dozen researchers throughout the country, each of whom will conduct research on a selected topic related to the tilapia industry. Studies include those on hatcheries, feed supply, cage and pond culture, rice-fish culture, backyard fishponds, marketing and community case studies. The results of these research projects will be presented and discussed at a PCARRD-ICLARM workshop in August 1983. The published proceedings are expected to provide the first comprehensive analysis and overview of the Philippine tilapia industry.

Project Title : Genetic Characteristics of Food Fishes

Cooperating Institution : The Marine Science 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: The Marine Science Center of the University of the Philippines (UP-MSC) and ICLARM recognize the importance of determining the genetic characteristics of commercially important food fishes.

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. 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*.

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*.

Publication

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.

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 and herbivorous 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. This conference will also give an opportunity for presentation of some of the results of ICLARM's tilapia projects. 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 hopes to 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, ICLARM staff 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).

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 toward obtaining such a facility has been found.

Traditional Fisheries Program

PROGRESS OF WORK

ICLARM's research in traditional fisheries continues its primary socioeconomic 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.

Throughout the Southeast Asian region, where much of ICLARM's research to date has been concentrated, the condition of renewable resources including capture fisheries is deteriorating due to lack of management. While a few isolated areas remain underexploited, the open-access nature of most fisheries, their biological limits and limited alternative employment opportunities together perpetuate poverty in fishing communities. Through competition, both within the small-scale fisheries sector and between this sector and the large-scale fishing units, returns to labor in most traditional fisheries are pushed down to the low levels of the opportunity wage. In very few cases are the attempts at limited entry adequately enforced to the benefit of small-scale fishermen.

The overfishing problem and the resulting economic waste are compounded by environmental degradation in many coastal zones, including coral reefs, due to pollution and to siltation from over-farmed and over-forested upland areas. Remedial action of a resource management nature is needed immediately in most countries if this major source of animal protein is to be maintained.

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.

ICLARM's research program in traditional fisheries is guided by three primary considerations. The first is the goal of clarifying alternative development and management choices available to decisionmakers. This leads us into 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 our 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, we strive to achieve interdisciplinary rigor in our research through close cooperation among biologists, economists and sociologists.

Our 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 we have been involved in three major projects. First, we have continued the preparation of the five technical reports (containing 25 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. The first study of its kind in Asia, this project addresses the major issues of 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 policy making 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, since October 1981, Dr. Bailey and two counterparts have been conducting 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 October 1982, 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 is also organizing a seminar on small-scale fisheries for Indonesian social scientists in follow-up to the review.

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. Major activities of the network are curriculum development, training and research with an initial focus on fisheries economics. 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 International Development Research Centre, Agricultural Development Council and ICLARM, has 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, Kasetsart University (Thailand), and Universitas Diponegoro and Institut Pertanian Bogor (IPB) both in Indonesia. Each of these institutions 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 4 years, 1983 to 1986.

Two previous projects, completed in 1981, deserve mention because the manuscripts related to them are being published this year. They are the ADB-ICLARM "Workshop on Appropriate Technology for Alternative Energy Sources in Fisheries" and "Skipjack and Traditional Fisheries: A Solomon Islands Case Study." Both have involved a substantial editing effort by ICLARM during 1982. The manuscript of a third project completed in 1982, the "Malaysian Small-Scale Fisheries Review" is being revised by the authors.

SPECIAL ACTIVITIES

Advisory Services

During 1982, Dr. Pauly and Dr. 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 curriculum 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 IPB in Indonesia and assisted the Agency for Agricultural Research and Development (AARD), USAID-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 USAID (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 their 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

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.

Meetings Attended, Papers Presented

Coastal Zone Management Seminar-Workshop. USAID. Manila, November 5-6, 1981. (R.A. Neal, C. Bailey, D. Pauly, I.R. Smith).

National Conference on the Conservation of Natural Resources. Natural Resources Management Center and Fishery Industry Development Council, Manila. November 26-28, 1981 (L.R. Yater).

18-21 January 1982. Seminar Perikanan Lemuru, Banyuwangi. C. Bailey.
 Paper presented:
 In press. 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, March 15-24, 1982 (C. Bailey, D. Pauly, I.R. Smith, L. Yater).

Sea Grant Seminar and Workshop on Coastal Living Resources in Malaysia, Kuala Trengganu, Malaysia. May 25-28, 1982 (I.R. Smith).
 Paper presented:
 Smith, I.R. and D. Pauly. Simple methods for the multidisciplinary investigation of tropical multi-species multi-gear 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, June 21-24, 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. August 2-6, 1982. (R.A. Neal and I.R. Smith).
 Paper presented:
 Smith, I.R. 1982. Mismanagement of inland fisheries and some corrective measures. Rural Sociology Society Annual meeting, San Francisco. September 1-4, 1982 (C. Bailey).

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

PROJECT SUMMARIES

Completed

Small-Scale Fisheries of San Miguel Bay, Philippines: A Multidisciplinary Analysis.	40
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Active

Indonesian Small-Scale Fisheries Review.	42
Fisheries Social Science Research Network.	43

- Project Title* : Small-Scale Fisheries of San Miguel Bay, Philippines:
A Multidisciplinary Analysis
- Cooperating Institutions* : Institute of Fisheries Development and Research, 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)

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 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 5,600 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.

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.

- Bailey, C. Small-Scale Fisheries of San Miguel Bay, Philippines: Occupational and Geographic Mobility. ICLARM Technical Reports 10. UPV, Quezon City; ICLARM, Manila; and UNU, Tokyo. (In press)
- Bailey, C., Editor. (In press) Small-Scale Fisheries of San Miguel Bay, Philippines: Social Aspects. ICLARM Technical Reports 9. UPV, Quezon City; ICLARM, Manila; and UNU, Tokyo. Contains the following papers:
- Yater, L.R. The study area, field research methodologies and general characteristics of fishing families.
 - Esporlas, A.E. The seasonality of fishing, marketing and processing.
 - Villafuerte, E.D. and C. Bailey. Systems of sharing and patterns of ownership.
 - Yater, L.R. The fisherman's family: economic roles of women and children.
 - Yater, L.R. Problems in the fishery as perceived by the fishermen.
- Pauly, D. and A. Mines, Editors. (In press) Small-Scale Fisheries of San Miguel Bay, Philippines: Biology and Stock Assessment. ICLARM Technical Reports 7. UPV Quezon City; ICLARM, Manila; and UNU, Tokyo. Contains the following papers:
- Mines, A. The assessment of the San Miguel Bay fisheries: objectives and methodology.
 - Mines, A., D. Pauly, N. Navaluna and M. Vakily. San Miguel Bay: the physical environment.
 - Pauly, D. The fishes of San Miguel Bay and their ecological affinities.
 - Cinco, E. Length-weight relationships of San Miguel Bay fishes.
 - Navaluna, N. Morphometrics, biology and population dynamics of the croaker *Otolithes ruber* in San Miguel Bay.
 - Pauly, D., A. Mines and N. Navaluna. Catch and effort of the small-scale fisheries of San Miguel Bay.
 - Vakily, M. Catch and effort of the trawl fishery of San Miguel Bay.
 - Pauly, D. History and present status of the San Miguel Bay fisheries.
- Smith, I.R. and A. Mines, Editors. (In press) Small-Scale Fisheries of San Miguel Bay, Philippines: Economics of Production and Marketing. ICLARM Technical Reports 8. UPV, Quezon City; ICLARM, Manila; and UNU, Tokyo. Contains the following papers:
- Smith, I.R., A. Mines and G. Beñacia. The research site, data collection and methods of analysis.
 - Yater, F. Gillnetters: costs, returns and sharing systems.
 - Supanga, N. and I.R. Smith. Costs and returns of stationary gears.
 - Supanga, N. Costs and earnings of Cabusao pushnets.
 - Tulay, E. and I.R. Smith. Costs and earnings of mini-trawlers.
 - Navaluna, N.A. and E. Tulay. Costs and returns of small and medium trawlers.
 - Cruz, W. Institutional and technological aspects of access to municipal fishery resources.
 - Yater, F., E. Esporlas and I.R. Smith. Economic aspects of processing and marketing.
 - Smith, I.R. and A. Mines. Implications for equity and management.

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

Cooperating Institutions : Directorate General of Fisheries (DGF) and Marine Fisheries Research Institute (LPPL), Jakarta

Duration : October 1981 to September 1982

Key Personnel

- ICLARM : Dr. Conner Bailey (Sociology)
- DGF : Ir. Firial Marahudin (Economics)
- LPPL : Mr. A. Dwiponggo (Biology)

Objectives: The project is a multidisciplinary review of Indonesian small scale fisheries by scientists from the Indonesian Fisheries Directorate and Dr. Conner Bailey, who is based in Bogor. It brings together information from the scattered published and unpublished reports, mostly in Bahasa Indonesia, of the considerable research previously carried out on Indonesian traditional 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 Bahasa Indonesia in 1983.

- Project Title* : Fisheries Social Science Research Network
- Cooperating Institutions* : International Development Research Centre (IDRC), Canada; Agricultural Development Council (ADC), Bangkok, Thailand; 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)
- Duration* : 1982 to 1986 (First phase)
- Key Personnel*
- | | |
|----------------------|--|
| ICLARM | : Drs. Ian Smith, Conner Bailey and Ed McCoy |
| IDRC | : Drs. 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 Chamniem Boonma |

Objectives: The underlying objective of this proposed 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. Prof. Ishak Omar of UPM is spending 5 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.

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 will last until the end of 1984 and will be implemented in close cooperation with the Malaysian fisheries development agency MAJUIKAN. MAJUIKAN will provide secondary wholesale and retail price and quantity data that have been collected daily (but not analyzed) from 8 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 eight 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, 8 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 8 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 (TURF's, to use Dr. Francis Christy's term). In particular, we plan through a series of case studies 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 Dr. Christy's invitation for ICLARM involvement in this subject area.

Resource Development and Management Program

PROGRESS OF WORK

The basic objective of the Resource Development and Management Program is to enhance the abilities of fisheries scientists in the tropics to assess the fisheries resources for which they are responsible and to translate the results of such assessments into recommendations for the management and conservation of the stocks.

Progress in stock assessment work on tropical fisheries has been very slow and there are still few examples of tropical fisheries which are managed on the basis of options formulated as a result of management-oriented research. The reasons for this situation relate to the biology of the fishes, the nature of the fisheries and the institutions responsible for research and management in the tropics, as well as to educational opportunities available to scientists.

The greatest constraint is that scientific personnel attached to tropical fisheries institutions are often not well versed in matters relating to stock assessment. The few universities teaching stock assessment techniques are mainly located in temperate countries; the training courses available through the offices of various international agencies are not always satisfactory and the number of possible participants is always limited. To this end the thrust of the program since its inception in 1979 has been towards the elaboration of theories relevant to the assessment and management of tropical multispecies, multigear fisheries, the development and dissemination of appropriate stock assessment methodologies, and the training of young fisheries scientists.

In March 1982, Dr. John L. Munro joined the program as its first formal Director, with a mandate to implement the existing strategies and formulate new directions and goals. For 1982, the program's activities were consolidated under four projects. These include the ongoing Tropical Fish Stock Assessment Research Project, the completed ICLARM/CSIRO Workshop on the Theory and Management of Tropical Multispecies Stocks, and two new "Network" projects aimed at improving fisheries management in tropical, developing countries.

Activities for the ICLARM/CSIRO workshop were the preparation for publication of the proceedings, of which Dr. Pauly is the senior editor.

Stock assessment in tropical waters is in many cases far more difficult than the same exercise undertaken in temperate regions, for reasons relating to the complex and little-understood interactions in multispecies, multigear fisheries and to the difficulties of ageing fishes. ICLARM's research efforts in this field are through the Tropical Fish Stock Assessment Research Project.

A variety of work has been carried out in this project, the most important of which has been the completion by Dr. Pauly of a manual entitled "Fish Population Dynamics in Tropical Waters: A Manual for Use with Programmable Calculators." This book is currently being refereed and will go to press early in 1983.

Investigations by Dr. Munro have covered the elaboration of a technique for estimating growth rates from mark and recapture data, analysis of data on the biology of tridacnid clams, reviews and data analyses of coral reef fisheries.

The skeletal draft of a textbook entitled "Tropical Fisheries Science" by J. Munro and D. Pauly has been completed.

The new projects are the Network of Tropical Fisheries Scientists and the Management-Oriented Fisheries Research Project. These two projects are closely integrated and much of

the work of the program is now centered around the Network of Tropical Fisheries Scientists—which was formally announced at the meeting of the IPFC's Standing Committee on Resources Research and Development (SCORRAD) in Sydney in April 1982.

The objective of the Network is to identify fisheries scientists who are working on stock assessment problems in relative isolation in tropical countries, enroll them as members and bring them into contact with fellow scientists with common or similar problems in management-oriented fisheries research. Membership of the network is on a personal basis and not institutionalized. The principal vehicle for communication will be a stock assessment newsletter which will contain exchanges of informal notes, news and views on tropical fish stock assessment and management. Members of the network are offered assistance in data analysis, including periods spent in Manila or visits by ICLARM staff to the institutions concerned to formulate plans and devise appropriate methodologies. The Network will organize training workshops on such topics as length-structured stock-assessment methods and of mesh-selection phenomena. ICLARM assistance will also include the development of data-acquisition strategies where no database exists. This is particularly important in circumstances where difficulties are encountered in identifying which data should be collected, when, how and in what quantities. Great expenditures of time and effort have quite often proven abortive because the scientists omitted certain vital observations.

The Network is presently funded internally by ICLARM but it is expected that it will attract outside support when its membership is sufficiently expanded. Membership of the Network is rapidly increasing (although it has not yet been publicized in the ICLARM Newsletter) and already stands at 40 members in 12 countries.

Throughout the tropics, and indeed throughout the world, the realization that fisheries need to be managed on a continuing basis has caught most nations almost totally unprepared. This has been forced upon many nations 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 data base 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 before the end of 1982. 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.

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 year's detailed catch-at-length data for Peruvian anchovy (northern stock). 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.

SPECIAL ACTIVITIES

Advisory services

For the report period, the only advisory work conducted was a consultancy in Peru by Dr. Pauly, 24 November to 13 December 1981, in which he advised the GTZ project "Programa Cooperativo Peruano-Aleman de Investigacion Pesquera" on multispecies modelling and methods for the estimation of growth and mortality parameters.

Training

Dr. D. Pauly and Dr. 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, PCARR 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 Fish Stock Assessment".

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 his graduate 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, is the first thesis in fish population dynamics ever presented at a Philippine university.

Meetings Attended, Papers Presented

Dates	Staff	Meeting
18 to 24 November 1981	D. Pauly	NOAA/FAO Workshop on the Scientific Basis for the Management of Penaeid Shrimps, Key West, Florida.
Paper presented:		
D. Pauly, J. Ingles and R.A. Neal. "Application to shrimp stocks of objective methods for the estimation of growth, mortality, and recruitment-related parameter from length-frequency data (ELEFAN I and II)."		
28 April - 4 May 1982	J.L. Munro D. Pauly	Third Session of the Indo-Pacific Fishery Commission's (IPFC) Standing Committee on Resources Research and Development (SCORRAD), Sydney, Australia.

Paper presented:

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

2-6 August 1982	J.L. Munro	14th Regional Fisheries Technical Meeting of the South Pacific Commission (SPC), Noumea, New Caledonia.
7-12 November 1982	J.L. Munro	35th Annual Gulf and Caribbean Fisheries Institute, Nassau, Bahamas. †

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."

PROJECT SUMMARIES

Active

Tropical Fish Stock Assessment Research Project	50
Network of Tropical Fisheries Scientists	52
Management-Oriented Fisheries Research Project	53

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 communities. However, the dearth of information is such that it is also necessary to direct considerable attention to the development of 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 a manual, presently under review entitled "Fish Population Dynamics in Tropical Waters: A Manual for 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 programs 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 were first of the 3 ELEFAN programs, early versions of which have been requested from and distributed to colleagues throughout the world. It is intended that these three programs, along with three other useful programs, will be published in early 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 in 1980 and which is expected to be printed and released before the end of this year.

Additionally, Dr. Munro completed three papers on giant clams (Tridacnidae), covering their growth rates, autotrophic characteristics and a review of all extant information on their biology. These have been submitted for publication in appropriate journals.

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.

Publications (1982 or in press):

- Bakun, A., J. Beyer, D. Pauly, J.G. Pope and G.D. Sharp. 1982. Ocean sciences in relation to living resources. *Can. J. Fish. Aquat. Sci.* 39(7): 1059-1070.
- Gwyther, J. and J.L. Munro. (submitted) Photosynthetic and respiration rates of tridacnid clams and their zooxanthellae. *Coral Reefs*.
- Hopkins, K., D. Pauly, E.M. Cruz and J.H. van Weerd. Recruitment control: an alternative to predator-prey ratios. *Meeresforsch.* 29. (In press)
- Munro, J.L. Some advances and developments in coral reef fisheries research; 1973-1982. *Proc. Gulf Caribb. Fish. Inst.* 35. (In press)
- Munro, J.L. and G. Heslinga. Prospects for the commercial cultivation of giant clams (Bivalvia: Tridacnidae). *Proc. Gulf Caribb. Fish. Inst.* 35. (In press)
- Munro, J.L. and Gwyther, J. (submitted) Growth of tridacnid clams (Tridacnidae: Bivalvia). *Aquaculture*.
- Pauly, D. 1982. A method to estimate the stock-recruitment relationships of shrimps. *Trans. Amer. Fish. Soc.* 111(1): 13-20.
- Pauly, D. 1982. Reprints as a neglected resource. *ICLARM Newsletter* 5(2): 18-19.
- Pauly, D., J. Ingles and R.A. Neal. Application to shrimp stocks of objective methods for the estimation of growth, mortality and recruitment-related parameters from length-frequency data (ELEFAN I and II). *Proceedings of the NOAA/FAO Workshop on the Scientific Basis for the Management of Penaeid Shrimps, Florida, November 1981.* (In press)
- Pauly, D. Book Reviews: "Fisheries Management" (R.T. Lackey and L.A. Nielsen, eds.) and "Resource Management and Environmental Uncertainty" (M.H. Glantz and J.D. Thompson, eds.) *Meeresforsch.* (In press)
- Pauly, D. Fish population dynamics in tropical waters: a manual for use for programmable calculators. *ICLARM Studies and Reviews.* (In press)
- Pauly, D. Further evidence for a limiting effect of gill size on the growth of fish: the case of the Philippine goby (*Mistichthys luzonensis*). *Kalikasan, Philipp. J. Biol.* 11. (In press)
- Pauly, D. Notes on tropical multispecies fisheries, with a short bibliography on the food and feeding habits of tropical fish. *In Report of the regional training course on fisheries stock assessment, Samutprakarn, Thailand, 1 Sept.-9 Oct. 1981. South China Sea Fisheries Development and Coordinating Programme, Manila. SCS/GEN/82/83.* (In press)
- Pauly, D. Studying single-species dynamics in a multispecies context, p. 33-70. *In D. Pauly and G.I. Murphy (eds.) Theory and management of tropical fisheries. ICLARM Conference Proceedings 9.* (In press)
- Smith, I.R. and D. Pauly. Simple methods for the multidisciplinary investigation of tropical multispecies multi-gear fisheries. *Proceedings of the Sea Grant Seminar and Workshop on Coastal Living Resources in Malaysia, 25-28 May 1982. Universiti Pertanian Malaysia, Kuala Trengganu, Malaysia.* (In press)

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 March 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 will appear 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 is expected to exceed 100 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 our 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 6 years.

Several formal requests for assistance and information have also been received from other areas including Fiji, the Philippines, Papua New Guinea and Zimbabwe.

Publications:

- Pauly, D. and Munro, J.L. The development and dissemination of new methodologies for tropical stock assessments. Proc. 3rd Session Indo-Pacific Fish. Comm. Standing Comm. Resources Res. and Development, Sydney, 1982. 9 p. (In press)
- Munro, J.L. and Pauly, D. 1982. The ICLARM Network of Tropical Fisheries Scientists. ICLARM Newsletter 5(4): 1 p.

- 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* : Indefinite 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, and
- (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: The modules which are presently operational include the Philippines, Peru and Indonesia.

Philippines

The Philippine module differs from other country modules in two aspects:

- It offers a framework for ICLARM interns from the Philippines, and
- It offers a framework 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, will provide the first comprehensive assessment of the status of Philippine demersal resources. A report presenting these results is being prepared.

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 fishery, 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 fishery, the reports represent a model for multidisciplinary study of any tropical fishery.

Publications to date of the Philippine module are:

Pauly, D. and J. Ingles. Aspects of the growth and mortality of coral reef fishes. Proceedings of the Fourth International Coral Reef Symposium, Manila. (In press)

Ingles, J. and D. Pauly. Raw data and intermediate results for an atlas on the growth, mortality and recruitment of Philippine fishes. xv + 224 p. (mimeo)

Ingles, J. and D. Pauly. An atlas of the growth, mortality and recruitment of Philippine fishes. ICLARM Tech. Rep. (In press)

See also publications of the Traditional Fisheries project "A multidisciplinary analysis of the small-scale fisheries of San Miguel Bay, Philippines."

Peru

The main aim, from ICLARM's side, of the Peruvian model 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 and 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 regards to the 1972 collapse of the fishery.

A preliminary paper, authored by Ms. Tsukayama and Dr. Pauly will be presented at the planned consultation on neritic stocks, in San Jose, Costa Rica, in April 1983. Also, in view of the lack of contacts between scientists working in developing countries, and between scientists working in Latin America in particular, ICLARM has responded positively to a request by FAO to fund the participation of 2 Peruvian scientists at the consultation mentioned above.

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 Marine Fisheries Research Laboratory, Jakarta (LPPL) 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 is anticipated, and negotiations leading to a formal agreement are expected to begin in November.

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 Papua New Guinea, Fiji, Zimbabwe, Sierra Leone, Malaysia and Thailand. 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 files at the Marine Fisheries Research Institute, Jakarta.

In Papua New Guinea, plans will center around an advisory role related to upgrading their Fisheries Division's stock assessment capabilities and full utilization of their computing center. In Fiji, the opportunities appear to relate to the development of appropriate sampling strategies for monitoring fisheries development, with a view to accumulation of data suitable for assessment of the small-scale and subsistence fisheries. There are similar opportunities in Tonga where the fisheries are little developed but rapidly changing.

In Zimbabwe, there appear to be several data sets which are worth investigating and which possibly justify commencing new initiatives in collaboration with local counterparts. Several possibilities also exist in Sierra Leone.

The major new initiative proposed by 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 (about 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.

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 part-time or casual 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 our 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. Details are given in Table 1.

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 coun-
Translations (1) } tries.

- **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 we enter into more exchange agreements and are beginning retrospective collecting of some periodicals and monographs and especially reprints. Currently we receive 399 periodicals and have 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 on 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.

SPECIAL ACTIVITIES

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 our membership in the Book Development Association of the Philippines, some of our books went to international book fairs in Singapore and Germany. They will be displayed also at upcoming annual meetings of the American Fisheries Society and the World Mariculture Society. 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. Our first subsequent bulk order from China was for 82 items.

MEETINGS ATTENDED, PAPERS PRESENTED

- 3-5 June 1982 – Agricultural Libraries Association of the Philippines (ALAP), Seminar-Workshop, Covelandia Resort, Philippines. J.L. Maclean, R. Temprosa, E. Barile and H. de Castro.
- 14 August 1982 – 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. E. Barile and H. de Castro.
- 16-20 August 1982 – Seminar on Fishery Information Science in Southeast Asia, Bangkok, Thailand. J.L. Maclean and R. Temprosa.
- Papers Presented – ICLARM's Information Service. J.L. Maclean.
- Reference Services, Current Awareness and Information Analysis in Southeast Asian Fisheries. J.L. Maclean and A. Neelameghan.

PROGRAM PLANS FOR 1983

The Information Service activities are continuous. Plans for 1983 are to increase efficiency of operations. A microcomputer has been ordered which will handle mailing lists, sales and inventories initially. Also, its word-processing capability will speed up manuscript preparation since the secretarial staff will be able to make use of the program. The computer will be shared with the accounting section.

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, for a selective fisheries information service, has already been submitted and is outlined below. A decision is expected from the proposed donor, IDRC, in January 1983.

A third proposal, to set up a Southeast Asian Fisheries Forum, was warmly endorsed by the PAC at its 1981 meeting and further endorsed by the USAID 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. A visiting representative of the Gulf and Caribbean Fisheries Institute reinforced this attitude by describing the constant struggle for funds to keep that forum alive.

However, in the light of the strong endorsement by the PAC and the AID review team, a proposal was sent in August to a number of institutions and colleagues within and beyond the region. Of 16 replies to date, 15 were favorable, and 13 of those could be described as highly enthusiastic. At this stage, it is apparent that there is sufficient interest for us to propose an organizational meeting early in 1983. Our feeling is that universities rather than government fisheries agencies seem to be the appropriate bodies to be the focus of development of such a forum.

Table 1. Numbers of ICLARM publications distributed in the 12 months to 31 August 1982.

(a) Numbers sold

Series

Conference Proceedings	1	72	Studies and Reviews	1	112	Technical Reports	1	88
	2	58		2	103		2	104
	4	269		3	142	Translation	1	41
	5	215		4	71	Bibliographies	1	50
	7	228		5	94		2	8
Newsletter (subscription)	:	112		6	197			

(b) Revenue (including postage, which is 50-60% of total): \$10,055

(c) Free Distribution:	Airmail copies, all publications	:	155
	Library exchange (surface), all publications	:	140
	Free Newsletters	:	2,100

Project Title : A Selective Fisheries Information Service

Cooperating Institution : International Development Research Centre (IDRC), Canada

Duration : 2 years initially, from early 1983

Key Personnel ICLARM : Jay L. Maclean
Information Scientist to be appointed for two years.

Objectives: 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 in which the information scientist appointed will act as a consultant to individual institutions and advise on improving regional capacities also.

The subject matter will be limited to ICLARM program areas. The proposal further requests that a trainee information worker be appointed to the service to take over after the initial two years.

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¹Resigned effective 15 January 1982

²From 15 January 1982

³Fixed term appointment

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⁴Commenced March 1982⁵Commenced 2 April 1982⁶Resigned 1 August 1982⁷Promotion effective 16 September 1982

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⁹April 1980-March 1982

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INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT, INC.
Statement of Sources and Application of Funds

	1981	1982 (tentative)
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)	22,000	
2. Restricted		
German Agency for Technical Cooperation (GTZ)	55,234	71,114
Rockefeller Foundation	32,947	-
Central Luzon State University (CLSU)	35,362	
United Nations University (UNU)	20,000	
United Nations Development Programme (UNDP)	15,292	35,956
USAID	6,425	
New Jersey Marine Science Consortium (NJMSC)	6,000	20,000
Philippine Council for Agriculture and Resources Research and Development (PCARRD)	2,850	-
Kuwait Institute for Scientific Research (KISR)		51,860
Others: Consultancy Fees	18,472	15,000
Publication Income	6,215	17,000
Miscellaneous	55,936	13,650
	<u>1,508,797</u>	<u>1,558,097</u>
Application of Funds		
Administration	397,817	262,882
Information Service	190,830	201,509
Capital Investment	42,936	14,873
Programs -- Program Advisory Committee	17,475	28,433
Program Development Fund	49,431	6,506
Aquaculture	408,503	572,934
Traditional Fisheries	124,921	170,291
Resource Development and Management	102,482	192,703
Education and Training	10,885	
	<u>1,345,280</u>	<u>1,450,131</u>
Fund Balance, End of Year	<u>163,517</u>	<u>107,966</u>

* August 1982 - July 1983