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ICLARM PROGRESS REPORT

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international center for living aquatic resources management

17th floor, metrobank plaza, buendia ave. ext., makati, metro manila

CONTENTS

INTRODUCTION

In introducing this Progress Report an effort has been made to address a question asked by development planners too frequently. That is, "What benefits can be expected from research on aquatic resource management?" In responding to this question the close relationship between various forms of aquatic resource utilization is also explored in an effort to help fisheries development planners identify potential benefits.

When development planners view the fisheries situation in the tropics they are often discouraged about the potential for increased production and increased employment in the sector. There are valid reasons for this discouragement when the many problems facing the fishing industry are considered. The common property fisheries have been broadly overexploited; the catches of many developing countries are increasing only slowly, if at all, and in some cases decreasing; harvesting costs have risen dramatically with fuel prices; most fisheries already have too many vessels and too many fishermen and serious damage to the resources from pollution and destructive fishing practices is occurring.

Although the potential for increased production from aquaculture is not as discouraging, several authors have quite seriously (though erroneously) pointed out that the potential for aquacultural production is limited by the available coastal land well-suited for ponds and by competition with agriculture for space for freshwater aquaculture.

The development planner may logically ask, "Are tropical fisheries research and development worthwhile?" And if so, what are the benefits that can realistically be expected in the long term?

To answer this question completely, an in-depth look at several forms of fisheries production is necessary. It is useful to view fishing and aquaculture not as different activities, but as two closely related means for utilizing available aquatic resources. There is no clear distinction between fishing and aquaculture from the resource utilization viewpoint, and there are numerous examples where intensive management of fisheries merges with aquaculture in a way that defies separation. In the discussion below, marine resources and freshwater resources are considered separately but for each a continuum of resource uses from large-scale commercial fishing through intensive aquaculture is examined with respect to potential for increased production.

Marine Resource Utilization

Marine resources include the total ocean and brackishwater environment and the plant and animal life therein. The most highly developed form of utilization of marine resources for food production is fishing. Fishing has a long and complicated history including many failures to utilize resources wisely. Examples of fisheries that have collapsed because of overexploitation

are many (Atlantic salmon, sturgeons, king crabs, Peruvian anchoveta, California sardine, whales, etc.). The problems of the common property nature of marine fisheries are beginning to be dealt with, e.g., through new 200-mile national fisheries jurisdictions and through a glimmer of recognition by some resource managers that property rights should be assigned to user groups to ensure more rational utilization.

Total landings from marine fisheries are presently increasing at roughly 1% per year and if present practices are continued this rate of increase will not be sustained for long. At present catches from new fisheries and utilization of new products approximately balance losses due to overexploitation. The important point here that has greatest significance in tropical developing countries is that the world (or individual countries) does not have to settle for this scenario. Biologists and fishery managers know how to increase landings and they know how to increase the net economic value of the landings. To accomplish these objectives however will require political willpower to place long-term benefits ahead of short-term gain; to provide effective law enforcement in place of present graft-ridden "non-enforcement" agencies; and to stand firm against large commercial interests that wish to rape resources or damage the environment for quick profits. In several of the major fish-consuming countries of the tropics the supply of lower-priced fishery products is not keeping pace with rapidly increasing demand and recent rapid price increases for these commodities have been the consequence. These may be sufficient incentive to force managers and politicians to reconsider fishery management policies. Marine fish landings can be increased substantially over the long-haul if proper management steps are taken but will likely not increase much longer if present practices are followed. The value and extent of such gains are extremely hard to predict as they may or may not occur in any given country depending upon a variety of factors.

Two additional types of gains are possible from improved tropical marine fishery management. The first is related to overcapitalization which is the universal curse of open-access, common property fisheries. The poorly managed developing-country marine fisheries (as well as other fisheries) are characterized by excess fishing capacity, i.e., too many boats and too much gear. Consequently, investments are excessive, fuel consumption is too high and other operational and maintenance costs are also too high resulting in generally low profits. Reduction of these excess expenditures is a potential benefit of improved fishery management. The fuel, equipment and materials presently wasted in fishing could be directed toward other more productive uses. Again the magnitude of the potential gains is difficult to quantify but huge savings are possible for most tropical fisheries.

The second additional gain from better fishery management is improved equity in income distribution. This objective is commonly voiced as a goal of development activities but is not always recognized as a beneficial output of development-oriented projects. The small-scale fishermen of the tropics are one of the world's most disadvantaged groups from the standpoint of income distribution. The most common type of fisheries development projects, those that improve gear, engines and vessels, tend to exacerbate the problem, especially where stocks are already overfished. Nevertheless, if fisheries are managed specifically to improve income distribution, this can be accomplished. Because few fishery managers are presently actually working toward

this goal (in spite of their stated objectives) rather large gains are still possible in this area.

As marine resource management is intensified, it overlaps with aquaculture. Oyster or clam fishing becomes shellfish farming, holding in cages becomes culture in cages, stocking becomes sea ranching, trapping in coastal ponds becomes rearing in these ponds and intensive management procedures of many types move closer to husbandry. The marine resources can be used in a variety of ways but we are using an increasing share of them for aquaculture as our technical ability to do so improves.

This is the area with the greatest potential for increases in tropical marine fish and shellfish production. Controlled use of marine resources for a set of activities that are slowly shifting from intensive management to extensive aquaculture to intensive aquaculture has potential that is limited only by economic factors. As a form of animal husbandry comparable to chicken or pig production, space is not a limiting factor. The economic profitability of production will determine whether more or less production occurs. This is not belittle the problems of resource ownership, conflicts related to multiple use or the many possible external effects on users of marine resources. Yet a tremendous potential is apparent in the long run based on a wide variety of resource uses that are continuously becoming more intensive.

Freshwater Resource Utilization

In most respects freshwater resource utilization has potential parallel to that for marine resources. In small bodies of water greater control is possible and in general freshwater aquaculture has progressed farther technically than saltwater culture. No clear distinction between fishing and aquaculture exists in freshwater and considerable overlap is apparent, e.g., in stocking and management of reservoirs. Again there is a rapid shift toward intensification of culture technology and an increased use of natural waters for fish farming.

Several distinctions between freshwater and marine resources are worth noting. The first of these is that freshwater is a much more valuable commodity. Freshwater aquaculturists must compete with agriculture, industry and domestic users for supplies. On the other hand aquaculture is not necessarily a consumptive use of water and effluents from aquaculture can be used advantageously for irrigation. Water moving from storage reservoirs to agricultural sites for use in irrigation and water stored in reservoirs offer special opportunities for increasing production through aquaculture and fisheries development.

Another distinction is that freshwater often exists in remote inland areas that do not have ready access to ocean fish. Under these conditions special emphasis on appropriate utilization of freshwater resources may be particularly rewarding in supplementing local animal protein production.

Cage culture of fish is best developed for freshwater although the technology for marine cage culture is improving rapidly as well. The potential for increasing production of the rural poor through use of cages in natural waters is interesting in that land ownership is not required and investments

may be small. The technology is comparable to cage culture of chickens in many ways.

Tropical freshwater aquaculture is more readily integrated into the small farm of multipurpose community ponds than in saltwater culture. For this reason very small-scale aquaculture has been more successful in freshwater. Also freshwater fishes are better adapted to live in extremely nutrient-rich environments than commonly reared marine fishes. Therefore, waste recycling through aquaculture is better developed for freshwater systems.

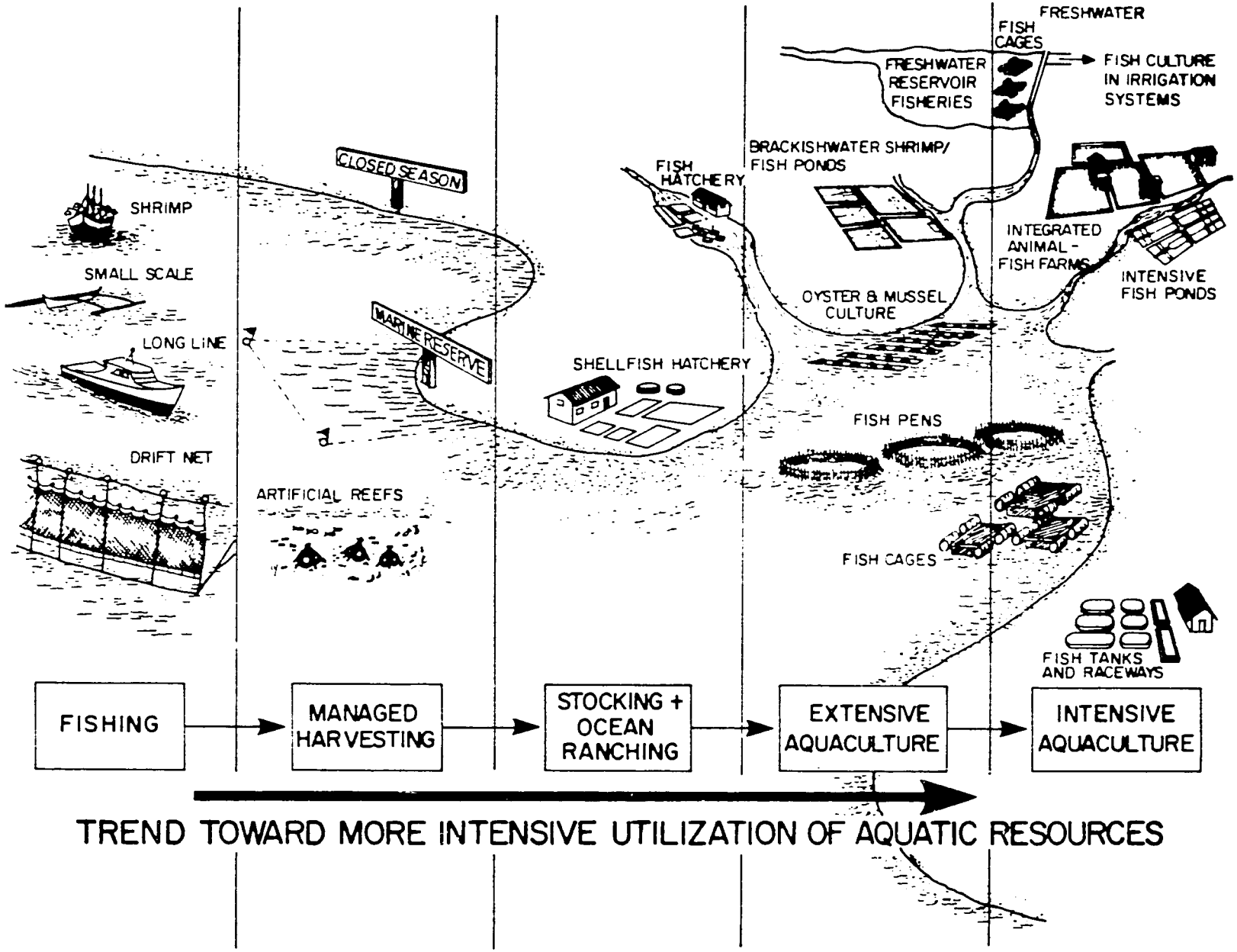
Conclusions

The distinctions between marine and freshwater resources are relatively unimportant for this discussion except in pointing out the many opportunities for increasing and improving aquatic resource utilization generally. For both marine and freshwater fishing, yield increases will be slow and dependent upon implementation of improved management measures. Other benefits related to reduction of harvesting costs and to more equitable distribution of benefits from tropical aquatic resource uses are important, are attainable, and pertain to both areas.

The greatest potential for deriving greater long-term benefits from both marine and freshwater resources will come as the transition from hunting to farming is realized. Intensive management and aquaculture may be indistinguishable and there is no need to attempt to distinguish the two. An important conclusion is that improved aquatic resource use does not face limitations related to the present harvest from fishing or any special other limitations of any kind. However, the research on tropical aquatic farming is lagging many decades behind that for terrestrial systems. As researchers improve our knowledge of tropical aquatic systems and our ability to manipulate them, the economic viability of such manipulation and control will increase significantly.

It is realistic to anticipate that the present rate of increase for aquacultural production, 7% per year, can at least be sustained for some time to come, and probably can be increased substantially in the upcoming years.

It is impossible to make an accurate estimate of the potential benefits from more intensive management and use of aquatic resources. As with animal husbandry of poultry and livestock the potential is large and is dependent upon the economics of input costs versus value of outputs. Unlike other animal husbandry, large research inputs are still required to utilize fully the extensive aquatic resources of the tropics.


FRESHWATER
FISH CAGES
FRESHWATER RESERVOIR FISHERIES
FISH CULTURE IN IRRIGATION SYSTEMS
BRACKISHWATER SHRIMP/ FISH PONDS
FISH HATCHERY
INTEGRATED ANIMAL - FISH FARMS
INTENSIVE FISH PONDS
CLOSED SEASON
SHRIMP
SMALL SCALE
LONG LINE
MARINE RESERVE
OYSTER & MUSSEL CULTURE
SHELLFISH HATCHERY
FISH PENS
DRIFT NET
ARTIFICIAL REEFS
FISH CAGES
FISH TANKS AND RACEWAYS
FISHING
MANAGED HARVESTING
STOCKING + OCEAN RANCHING
EXTENSIVE AQUACULTURE
INTENSIVE AQUACULTURE
TREND TOWARD MORE INTENSIVE UTILIZATION OF AQUATIC RESOURCES

TRADITIONAL FISHERIES PROGRAM

Background

Despite considerable attention in recent years to the resource management and poverty problems of tropical small-scale fisheries, the search continues for generalized approaches with high possibilities of positive impact. The low levels of incomes and standards of living in communities of small-scale fishermen are well documented. Less is known about the underlying causes of this poverty and even less about the best approaches or combination of approaches that would have high likelihood of successfully managing the fishery resources and raising standards of living in these communities.

These gaps in knowledge are not due to lack of efforts of concerned individuals and institutions to bring about improvements in fishing community welfare. The fact that success has been so often fleeting and confined to few communities at best is indicative of serious shortcomings in our thinking about the nature and complexity of the problems faced by such communities and in our approaches to planning alternative interventions and management institutions and anticipating their impacts.

Too often in the past, research on small-scale fisheries has been conducted as an end in itself rather than as a necessary ingredient of planning for and management of the sector. Researchers have had to demonstrate to skeptical planners and managers that research had a valid contribution to make. However, the seriousness and complexity of small-scale fisheries problems, the increasing need for their resolution to avoid serious socio-political problems, and recent demonstrations by researchers of the relevance of their work have brough about a situation where the potential for fruitful collaboration between fisheries planners, researchers and managers is greater than ever before.

Successful collaboration among these groups to evaluate management options for a select number of tropical fisheries would do much to demonstrate the wisdom and effectiveness of an integrated planning-research-management approach to small-scale fisheries throughout the tropics. To undertake this task on a wide geographical basis requires the contributions of committed researchers in several countries and various disciplines, including biology/stock assessment, economics, sociology and political science. While ICLARM staff can contribute to such an undertaking, it is clear that major contributions are required from national researchers. ICLARM's Traditional Fisheries Program is designed, therefore, to accomplish two major objectives:

(1) To strengthen selected national research institutions through networks and facilitate their long-term commitment to research on traditional small-scale fisheries; and

(2) To clarify management options for traditional small-scale fisheries, through in-house and commissioned reviews, workshops, improvements in multi-disciplinary research methodologies and selected case studies.

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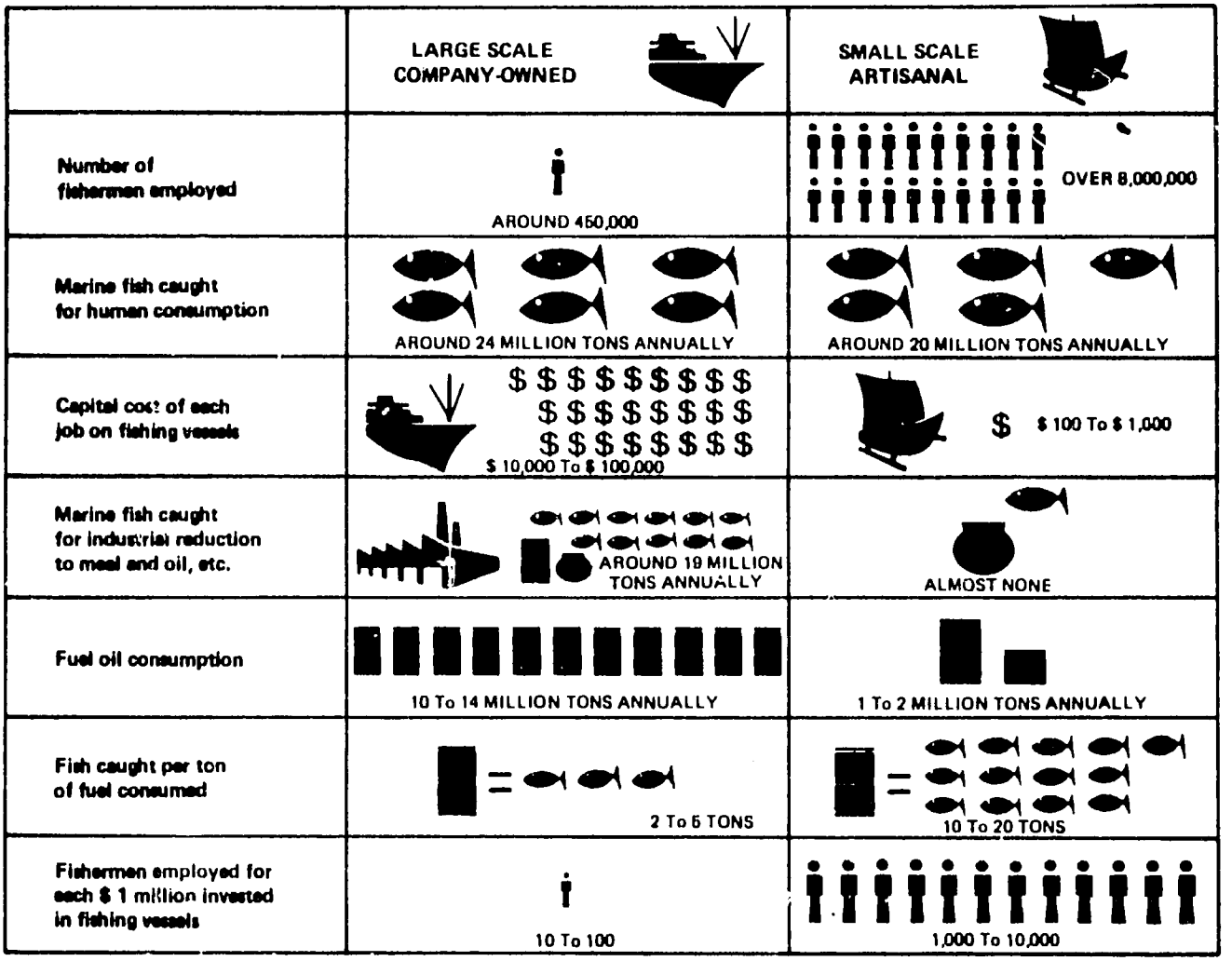
THE WORLD'S TWO MARINE FISHING INDUSTRIES - HOW THEY COMPARE



Progress of Work

In 1983, a Fisheries Social Science Research Network (FSSRN) was launched with an initial geographical focus on Southeast Asia and disciplinary focus on economics. The FSSRN is a long-term professional and institutional development program in Asia which aims to build national research capacity to address important socioeconomic issues in the management and development of the fishery resources of Asian countries. The task is to overcome two serious constraints that have limited social science including economic research related to fisheries resources in the past: (1) the lack of social scientists with training in the applications of their disciplines to fisheries research, and (2) weak institutional support for long-term research on fishery problems.

The Network seeks to achieve its objectives through a combination of formal and informal training, scholarships, research activities, information exchange, seminars, workshops and staff interchange. ICLARM plays a unique and crucial role as facilitator and catalyzer, provider of technical and information services backstopping and network coordination. ICLARM's non-governmental, international status and its own active research program in fisheries

social sciences makes it ideally suited for this role of assisting the network institutions develop their national training and research programs.

The Network was established in April 1983 with support from the International Development Research Centre of Canada (IDRC) and ICLARM covering an initial two-year period. The member institutions during this initial phase of the network are (1) Faculty of Resource Economics and Agribusiness, Universiti Pertanian Malaysia, (2) Faculty of Economics and Business Administration, Kasetsart University in Thailand, and (3) College of Arts and Sciences, University of the Philippines in the Visayas. The Network has assisted each institution develop training courses in fishery and aquacultural economics, has provided training fellowships to staff members who will take a leading role in the training and research programs in the future, and has made grants for social science research on fisheries and aquaculture.

During 1982-1983 IDRC and ICLARM assisted Universiti Pertanian Malaysia establish a new post-graduate training program in fisheries and aquacultural economics leading to the degree of Master of Science in Resource Economics with a specialization in fisheries and aquaculture. In addition the program offered a one-semester non-degree course with the same subject matter for qualified economists who wished to add fisheries and aquacultural economics to their basic training. These two courses form the backbone of the FSSRN professional training program and five lecturers from Network institutions have been awarded FSSRN Fellowships for the M.Sc. course and four have been similarly supported through the non-degree course.

The FSSRN has helped each university establish special reference collections of academic and topical literature related to social science aspects of fisheries and aquaculture and, in addition, has instituted a Reprint Series of important academic journal articles which are provided free to lecturers and students.

The Research program carried out during the first phase of the Network (1983-1985) consists of major and minor projects in each affiliated university. A major study of the Malaysian fish marketing system is being undertaken by the FSSRN research team at Universiti Pertanian Malaysia, a major study of the marketing system for shellfish products is being conducted by the Kasetsart University team, and a socioeconomic evaluation of fishery institutions affecting small-scale fishermen in Iloilo Province is the major study of the University of the Philippines team.

The FSSRN Coordinator, Dr. Brian Lockwood, transferred from UPM to ICLARM, Manila in mid-1984, a change which allows him to devote more time to network management now that the UPM graduate program has become self-sustaining by full-time and visiting faculty there. Since arriving in Manila, his major responsibility has been the development of an FSSRN Phase II proposal and report on Phase I results which will be submitted in October 1984 to IDRC and the Ford Foundation. The Phase II proposal includes an expansion of the FSSRN from four member institutions (including ICLARM) to nine.

Aside from the FSSRN, ICLARM's major Traditional Fisheries Program activity is the Management Options for Tropical Small-Scale Fisheries project. This project is an ongoing activity undertaken by ICLARM staff, often working

in collaboration with researchers from other institutions. ICLARM staff involved are Dr. Ian R. Smith and to a lesser extent Dr. Daniel Pauly with assistance from other temporary staff members such as post-doctoral and senior fellows. The work is multidisciplinary and has a strong policy focus. ICLARM particularly encourages the involvement of traditional small-scale fishing communities in the management of those resources which they use.

Progress in this activity during 1984 has been disappointing, though not unexpected given ICLARM's financial crisis. A reduced budget has brought about staff shortages; most staff time has been devoted to completion of various activities still incomplete at the end of 1983 (such as the final San Miguel Bay reports and the Indonesian and Malaysian Reviews) and to preparation of proposals. The only new initiative was the commissioning of a review of the Economics and Management of Thai fisheries by Dr. Theodore Panayotou and Mr. Songpol Jetanavanich which will round out ICLARM's fisheries reviews and synthesis manuscripts for Southeast Asia.

The major goals of the Program Leader (Dr. Smith) during 1984 were to secure funding for the coordinator position for the FSSRN and to attract external financial support for the Management Options project, including Program Leader costs. We can report partial success to date. If IDRC approves funding for Phase II (1985-1987) of the FSSRN, the Ford Foundation Southeast Asia Program Office in Jakarta has agreed to contribute an additional US$60,000 for each of these three years; with ICLARM's own contribution, this will be sufficient to cover coordination costs. The New York office of the Ford Foundation has also indicated interest in supporting the Management Options project and a proposal has been submitted (earlier attempts to gain support from several other donors were unsuccessful). It is hoped that a favorable response will be received soon and that a three-year support for Program Leader costs and a small working budget will be assured. Even with this support, the Traditional Fisheries Program remains only partially staffed (one of two permanent staff positions filled) with the added necessity for seeking funds on a case-by-case basis for any major collaborative research.

Advisory Services

Three consultancies were undertaken during the year. First, ICLARM provided the services of Dr. Smith, Dr. John Munro and Mr. David Thomson (consultant) to USAID-Philippines for the planning phase of their small-scale fisheries energy project with the Farm Systems Development Corporation. Second, Dr. Smith joined Dr. Pullin for a two-week consultancy in Malaysia to prepare a project document for the Dept. of Fisheries and the Bay of Bengal Fisheries Programme on the development and management of the Malaysian cockle (Anadara granosa) industry. This industry employs large numbers of part-time fishermen, particularly on the West Coast of the Malaysian Peninsular. Third, Dr. Lockwood will spend one month at FAO, Rome to prepare a manual on socioeconomic information systems for small-scale fisheries management and development. This consultancy is an extension of his consultancy for FAO in late 1983 during which he assessed the socioeconomic information systems for fisheries in Thailand, Malaysia and the Philippines.

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Training

The formal training activity of the Traditional Fisheries Program in 1984 was support for the M.Sc. and module programs in fisheries economics offered by Universiti Pertanian Malaysia. Dr. Lockwood taught a seminar course on fisheries policy and management as part of this program.

Publications and Consultancy Reports

Lockwood, B.A. 1984. Social science information systems for small-scale fisheries management and development in Malaysia, Philippines and Thailand. Prepared for the Fishery Development Planning Service of FAO, Rome. 13 p. + appendices.

Munro, J.L. 1984. Fishery resource data. Annex J. In Project paper: energy technology for fisheries. United States Agency for International Development (USAID), Manila, Philippines.

Munro, J.L. and I.R. Smith. 1984. Management strategies in artisanal multispecies fishery complexes. Proc. Gulf Caribb. Institute, Miami.

Pullin, R.S.V. and I.R. Smith. 1984. Development and management of cockle (Anadara granosa) culture in Malaysia. Project description and work plan prepared for the Bay of Bengal Programme and the Malaysian Dept. of Fisheries. 37 p. + appendices.

Smith, I.R., J.L. Munro and D. Thomson. 1984. Fishery site assessment methodology. Annex F. In Project paper: energy technology for fisheries. United States Agency for International Development (USAID), Manila, Philippines. 27 p.

Smith, I.R., D. Pauly and A.N. Mines. 1983. Small-scale fisheries of San Miguel Bay: options for management and research. ICLARM Technical Reports 11, 80 p. Institute of Fisheries Development and Research, University of the Philippines in the Visayas, Quezon City, Philippines; International Center for Living Aquatic Resources Management, Manila, Philippines; and the United Nations University, Tokyo, Japan.

Smith, I.R. and T. Panayotou. 1984. Territorial use rights and economic efficiency: the case of the Philippine fishing concessions. FAO Fish. Tech. Pap. 245. FAO, Rome.

Smith, I.R. and D. Pauly. 1984. Book review - A guide for the small-scale fishery administrator: information from the harvest sector. Mar. Resour. Econ. 1(2):225-231.

Smith, I.R. and D. Pauly. 1983. Resolving multigear competition in nearshore fisheries. ICLARM Newsletter 6(4):11-18.

Smith, I.R. and J.A. Maclean. 1984. ICLARM: unique fisheries organization, unique role. Fish. Econ. Newsl. (October 1984; keynote article).

Meetings Attended, Papers Presented

Philippine Agricultural Economics and Development Association: 30th Annual Convention, Manila, Philippines, 15 June 1984. (E. Escover)

Philippine Fisheries Research Society 7th Annual Convention and First PCARRD Fisheries Forum. Quezon City, Philippines, 16-17 March 1984. (O. Salon)

Small-Scale Fishermen Consultation Seminar. Sponsored by the University of the Philippines Institute of Social Work and Community Development, Quezon City, Philippines, 3-6 August 1984. (O. Salon)

Statistics Workshop. Institute of Biological Sciences, University of the Philippines at Los Baños, 7-9 May 1984. (O. Salon)

Monthly Seminar Series, College of Development Economics and Management, University of the Philippines at Los Baños, 6 July 1984. (I.R. Smith and E. Escover)

I.R. Smith. Resolving multigear competition in tropical small-scale fisheries.

Program Plans for 1985

ICLARM has continued to hold discussions with IDRC and has initiated discussions with the Ford Foundation (Southeast Asian Regional Office) with respect to continued funding for a second three-year phase of Fisheries Social Science Research Network development to begin in 1985. It is expected that the Network will expand considerably during its second phase to include, in addition to the three original members, Diponegoro University in Indonesia, University of the Philippines at Los Baños, the Fishery Economics Section of the Thai Department of Fisheries, the Aquaculture Department of the Southeast Asian Fisheries Development Center in the Philippines, and the Center for Agro Economic Research of the Agency for Agricultural Research and Development in Indonesia. The Network will continue to support the development of training programs in the universities and will expand considerably the scope and size of its research program through institution-based projects and through increasing cooperation in research between FSSRN institutions and research teams. A workshop on methodologies for economic analysis of aquaculture is scheduled for early 1985. This will be sponsored by Kasetsart University and the FSSRN and will be the first of a series of such workshops to take place in the FSSRN's Phase II.

Continuation and expansion of ICLARM's research on management options for tropical small-scale fisheries depends critically upon external funding. After major disappointments in 1983-1984 on the fund raising front with respect to this activity, there is now some promise of support from the New York office of the Ford Foundation to which a proposal has been submitted. The level of funding likely to be available will support one headquarters staff position plus a small working budget. With this support, further work on the methodologies of multidisciplinary analysis of traditional small-scale fisheries in the tropics is planned. For example, headquarters staff will continue their work on a conceptual level to address issues related to the costs and benefits of alternative management interventions and the trade-offs among competing objectives. The dilemma of efficiency vs. equity and employment in tropical

fisheries will receive particular attention. Research to date has barely scratched the surface with respect to alternative institutional arrangements for small-scale fisheries management and the potential for more decentralized community-based management schemes. In-house studies, cooperative research with other institutions and workshops will be undertaken to address these and related issues as funding permits. Any major new case studies will be undertaken only on a cooperative basis with other national institutions and will require funding from sources which have not as yet been identified.

Traditional Fisheries Project Summaries

Active

Upcoming

Project Title		:	Fisheries Social Science Research Network (Phase I)
Cooperating Institutions (First Phase only; to be expanded in Phase II)		:	Universiti Pertanian Malaysia (UPM), Serdang, Selangor, Malaysia; University of the Philippines in the Visayas (UPV), Iloilo; Kasetsart University, Bangkok, Thailand; International Development Research Centre (IDRC), Canada and ICLARM
Duration		:	1983 to 1985 (First phase)
Key Personnel	UPM	:	Prof. Ishak Hj. Omar
	UPV	:	Prof. Ma. Luisa Mabunay
	Kasetsart University	:	Drs. Ruangrai Tokrisna and Chamnien Boonma
	ICLARM	:	Dr. Brian A. Lockwood (Network Coordinator) Drs. Ian Smith and Edward McCoy
	IDRC	:	Drs. Elwood Pye and David King Dr. Brian Davy and Mr. Christopher MacCormac

Objectives

The underlying objectives of this social science 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.

The Network has three broad program areas:

1. THE DEVELOPMENT OF NATIONAL PROGRAMS OF PROFESSIONAL TRAINING IN FISHERIES AND AQUACULTURAL ECONOMICS.

The Network is assisting a university in each major fishing nation in Southeast Asia become the national leader in this specialized scientific field of study. Particular attention is given to the development of training material related to the special management problems associated with tropical multispecies multigear marine fisheries and the special conditions under which aquaculture operates in Asia. The Network provides affiliated universities with professional and technical assistance in designing fisheries and aquacultural economics courses and programs of study, assistance with teaching and research materials and literature, and opportunities for staff training and professional exchange.

2. THE DEVELOPMENT OF MEDIUM TO LONG-TERM PROGRAMS OF SOCIAL SCIENCE RESEARCH ON MANAGEMENT AND DEVELOPMENT ISSUES OF NATIONAL IMPORTANCE TO THE FISHERY SECTORS.

The Network assists socioeconomics researchers in affiliated universities and research institutions develop and implement programs of research. It provides grants for high priority projects, partly as a means of ensuring continuity in the research programs at the early stages of implementation. Network research teams can draw on experienced scientists from ICLARM, other Network institutions and elsewhere for technical and professional inputs where needed and the Network organizes special workshops to develop and evaluate appropriate methodologies for socioeconomic and multidisciplinary research on fisheries and aquaculture in Asia.

3. THE FORGING OF STRONG PROFESSIONAL WORKING RELATIONSHIPS (LINKAGES) BETWEEN FISHERIES SOCIAL SCIENCE TEACHERS AND RESEARCHERS AND AGENCIES RESPONSIBLE FOR FISHERIES AND AQUACULTURE PLANNING, MANAGEMENT AND DEVELOPMENT.

4. THE FORMATION OF AN ASIAN ASSOCIATION OF SOCIAL SCIENTISTS SPECIALIZING IN FISHERIES AND AQUACULTURE.

The obvious, but necessary, precondition for this longer-term objective is the existence of a core of active professional fisheries social scientists in each major Asian fishing country, and the whole Network program of professional development and support of research and training programs is designed to bring this about.

Training Results

There are very few social scientists in Asia who have had special training in the applications of economics to fisheries and aquaculture, particularly tropical fisheries and aquaculture. Until recently fisheries and aquacultural economics have not been taught in Asian universities. The first priority of the Network is to break the vicious circle whereby the lack of trained teachers has meant minimal development of training programs and vice versa. This lack of trained socioeconomists in fisheries/aquaculture has also limited severely the quality and quantity of past socioeconomic research on fishery problems and the ability of the social sciences to exercise an effective voice on matters of fishery policy in Asia.

The UPM Postgraduate Degree and Module Programs

In 1983, the Faculty of Resource Economics and Agribusiness, Universiti Pertanian Malaysia (UPM), introduced the first postgraduate training program in fisheries and aquacultural economics in Asia. It requires candidates to take the core courses of the M.Sc. (Resource Economics), three special courses in fisheries and aquacultural economics, and undertake thesis research on a fisheries/aquacultural economics problem. On completion of the program the candidate is awarded the degree of Master of Science (Resource Economics).

In addition, the Faculty offers the three special courses, plus an optional course in economics or fisheries science as a one-semester non-degree module for economists or fisheries scientists who require such training. The teaching is in English and non-Malaysian students are eligible for admission.

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With these professional training programs UPM has became the core training institution for the Network and each affiliated university, including UPM itself, has enrolled staff and/or future staff members in one or other of the two programs.

The Non-Degree Module was offered for the first time in 1983. The FSSRN provided fellowships for two lecturers from Network universities to participate in this program - Prof. Nida R. Ty (College of Arts and Sciences, UPV) and Mr. Thanwa Jitsanguan (Department of Agricultural Economics, KU). The module was offered for the second time in 1984 and the FSSRN provided fellowships for two lecturers from UPV to participate - Miss Ebonia B. Seraspe and Mr. Benedict C. Posadas (both from the College of Arts and Sciences). Each of the Network participants held Master's degrees but lacked exposure to the special subject matter of fisheries and aquacultural economics.

The Masters Degree Program at UPM admitted its first candidates in 1983. Of the eight students who enrolled in the fisheries economics specialization three were supported by Network fellowships: Miss Penporn Janekarnkij and Miss Ratana Sungsitthisawad of the Department of Agricultural Economics, Kasetsart University, Thailand, and Drs. Mudiantono from the Department of Economics, Diponegoro University, Indonesia. The FSSRN fellowships included participation in the Summer Program in Los Baños during April and May and a special course in aquaculture organized by ICLARM during June prior to enrollment at UPM in July. The Network fellows successfully completed their UPM coursework in May 1984 and are now engaged in the collection of data for their M.Sc. theses in their home countries. ICLARM awarded two fellowships for the M.Sc. program beginning in July 1984: Mr. Kamaruzzaman Abu Samah from UPM and Drs. Hamrolie from Diponegoro University. Mr. Piti Kantangkul from the Department of Agricultural Economics, Kasetsart University also started his M.Sc. studies in fisheries economics at UPM on an Agricultural Development Council fellowship.

Other Fisheries Economics Courses in Network Universities

The Department of Agricultural Economics at Kasetsart University, the College of Arts and Sciences of the University of the Philippines in the Visayas and the Department of Natural Resource Economics at Universiti Pertanian Malaysia offer courses in fisheries economics at the undergraduate level in their regular programs and, in addition, provide special courses in economics to undergraduates in fisheries and marine sciences programs. Most of these courses were established before the Network came into being, but the course at UPV was introduced in 1984 as a Network activity. KU will introduce a new undergraduate course in aquacultural economics in 1985 and a postgraduate course in fisheries management in 1985-86, and UPV plans a new undergraduate course in aquacultural economics for 1985. These new courses will be taught, mainly, by staff members who have studied at UPM on Network fellowships.

Related Training Activities

During May-June 1984, the Faculty of Resource Economics and Agribusiness at UPM gave a special five-week course in economics for fisheries biologists from Malaysia, Philippines, Indonesia, Thailand and Bangladesh. This course was funded by the International Development Research Centre of Canada which also supported the participation of ten fisheries biologists involved

in IDRC funded research projects in Asia. It is expected that the course will be offered again in 1985.

Research Results

Much of the past socioeconomic research on problems of the fisheries and aquaculture sectors in Asia has been somewhat ad hoc, that is, various single unrelated studies conducted by researchers or institutions without long-run commitments to fisheries and aquaculture research. The Network's primary objective with respect to research is to encourage and help affiliated institutions develop and/or strengthen their professional capacity to effectively plan and implement long-run programs of research on important national and regional issues of fisheries and aquaculture. There are a number of ways that the Network can achieve this objective but the following are probably the most important at this stage:

(1) the training of new researchers (mainly in the UPM programs, and particularly through supervision of M.Sc. thesis research);

(2) funding and technical support for research projects undertaken by individuals and departments or faculties affiliated with the Network;

(3) preparation of research programs in each affiliated institution; that is, statements of long-term research goals and the means (projects) of achieving them and

(4) the development of professional working relationships or linkages with agencies responsible for policy, management and development of marine fisheries and aquaculture research institutions and policymaking bodies.

The fisheries economics team in each affiliated university has received Network funds for research projects in spanning the first two years (1983-1984). A report on these projects is presented below.

Both UPM and KU have developed close working linkages with government agencies responsible for fisheries and aquaculture policy, management and development, particularly with respect to their current Network funded research projects. The UPM approach to this was highly successful and will form a model for the other teams. The UPM team organized a weekend workshop on priorities for social science (economics) research on the fisheries sector of Malaysia and obtained active participation from the Directors General and senior officers of the two government agencies responsible for fisheries policy and development. High priority was given to studies of the fish market system and this became the main thrust of the UPM Network team's 1983-1984 research. During the course of this study (still ongoing) both agencies have been involved in data gathering and as consultants and in addition the team obtained a substantial research grant from one of the agencies to supplement the Network funding. By taking this approach the UPM team is certain that (a) it is working on a problem of high priority to fishery sector management and (b) its findings will be used in developing fishery policy.

1. Universiti Pertanian Malaysia

Network Team Leader: Assoc. Prof. Ishak Hj. Omar

Department of Natural Resource Economics,
Faculty of Resource Economics & Agribusiness,
Universiti Pertanian Malaysia,
Serdang, Selangor, Malaysia.

Project 1: The fish marketing system of Peninsular Malaysia

Participants: UPM Network Team, Faculty of Economics and Business Administration, Universiti Malaya, Department of Fisheries Ministry of Agriculture and Cooperatives, and the Malaysian Fisheries Development Authority

UPM Network Study Team: Assoc. Prof. Ishak Hj. Omar, Dr. Mohd Ariff Hussein, Mr. Nik Mustapha Raja Abdullah, Prof. Eric Gibbons, Mr. Abu Hassan Md. Isa, Dr. Fatimah Mohd Arshad, Mr. Kuperan and Mr. Tai Shzee Yew

The study began in August 1983 after an extended period of planning in close association with the Malaysian Fisheries Development Authority and is expected to be completed in January 1985. Data are being collected over a survey period of 12 months from the major fish landings and through the market channels and wholesale markets thus covering all types of fish distribution and marketing participants in the long and complex chain connecting fishermen with consumers.

Closely related to the fish marketing system study is an analysis of times series data on fish prices and quantities traded in all wholesale markets in Peninsular Malaysia. The first paper in this study is available from the Faculty: Mohd Ariff Hussein and Samuel M. Strong "A bivariate time series analysis of wholesale fish price and quantity". The summary of this paper reads: "A bivariate time series model was investigated to detect price responsiveness to changes in quantities of fish traded in the Johor Bahru wholesale market. The estimated model shows that the negative relationship between price and quantity was significant and that the approach to the modelling of a wholesale fish market is appropriate and encouraging for further work." Work is continuing.

Project 2: Fish consumption patterns in a multi-racial society: a case study of urban households in Kuala Lumpur and Petaling Jaya

Participants: Mr. Nik Mustapha Raja Abdullah, Assoc. Prof. Ishak Hj. Omar, Dr. Brian Lockwood, and three final year B.Sc. (Resource Economics) Students, Miss Ann Sheren Sathishia Kumari, Noor Liah Hj. Allapitchay and Tan Mui Hong

This study described consumption patterns for fish and related food items in Malay, Indian and Chinese households from low, middle and upper income groups in the Kuala Lumpur urban area. A paper by Ishak Hj. Omar, Brian Lockwood and Nik Mustapha Raja Abdullah entitled "Fish Consumption Patterns

in a Multi-racial Society: a case study in Kuala Lumpur and Petaling Jaya, Malaysia" was presented at the International Conference on Development and Management of Tropical Living Aquatic Resources, UPM, 2-5 August 1983. Copies are available from the Faculty and from ICLARM.

Project 3: Economic studies of small-scale fish processing in Peninsular Malaysia

Participants: Final year B.Sc. students supervised by the FSSRN Team

During 1983-1984, studies were made of the following small-scale fish processing industries: Ikan bilis (dried anchovy), keropok (fish crackers), cincaluk (prawn paste), and trash fish.

Project 4: Miscellaneous studies

Participants: Final year B.Sc. students supervised by the Network Team

Economic studies were conducted on the following: prawn production and marketing in Sabah, production and marketing of cockles, utilization of trawler by-catch, and factors affecting the success of small-scale freshwater fishfarming.

2. Kasetsart University

Network Team Leader: Dr. Ruangrai Tokrisna

Department of Agricultural Economics,
Faculty of Economics & Business Administration
Kasetsart University,
Bangkok 9, Thailand

Project 1: The shellfish marketing system of Thailand

Participants: Dr. Ruangrai Tokrisna, Dr. Chamnien Boonma, Mr. Somkit Tugsinavisutti, Mr. Piti Kantangkul, Mr. Sanit Kao-ian, Dr. Sarun Wattanutchariya, Mr. Bunlu Ruttikorn, Dr. Edward McCoy (ICLARM), and Mr. Kachornsak Wetchagarun (Dept. of Fisheries, Ministry of Agriculture & Cooperatives)

In June 1983, the Network research team at Kasetsart University began a national study of the marketing system of shellfish products. The first phase of this study examined the production of, and market structure developed to distribute the many varieties of molluscs. As the sources of molluscs are widely scattered and harvesting and production are highly seasonal, this proved to be a difficult study to design and carry out. Surveys of producers and participants in the marketing chains are now complete and the draft report will be available in late 1984.

Project 2: The marketing system for squid, octopus and cuttlefish

Participants: as for Project 1

This study follows directly from the work done on the marketing system of molluscs extending this to the "other-than-mollusc shellfish." This component of the overall shellfish marketing systems study will be completed in December 1984.

Project 3: Economic evaluation of the shellfish processing industry

Participants: as for Project 1

As the team developed new knowledge and expertise on shellfish production and marketing in Thailand, it attracted funding from IDRC for an additional study of the shellfish processing industry. This study was started in March 1984 and will continue for 12 months.

In addition to the main team reports of the above studies, several KU graduate students who worked in the survey teams are preparing M.Sc. theses from the survey data. Thesis topics are as follows:

1. An analysis of the marketing system for small oyster (Crassostrea commercialis) in Thailand;

2. Price analysis and marketing system of short-necked clam (Paphia undulata) in Thailand;

3. Marketing system of cockle (Anadara granosa) in Thailand; and

4. Costs and returns in processing dried green mussel (Mytilus smaragdinus).

3. University of the Philippines in the Visayas

Network Team Leader: Prof. Ma. Luisa E. Mabunay

College of Arts and Sciences,
U.P. in the Visayas,
Iloilo City, 5901,
Philippines

Project 1: Socioeconomic benchmark household survey of six fishing villages in Iloilo Province

Participants: Prof. Ma. Luisa E. Mabunay, Prof. Nida R. Ty, Prof. Nuria B. Catells, Prof. Tomas S. Sajo, Prof. Perla D. de los Santos, Prof. Antonina R. Baldevia, Miss Ebonia B. Seraspe, Miss Cynthia J. Ticao

During 1983, the UPV Network team carried out a detailed household survey (enumeration) in two selected fishing villages in each of three municipalities in Iloilo Province. The survey was planned to provide information that would be used in drawing appropriate household samples for the special studies (projects 2-5) that followed. The baseline survey was completed in October 1983.

Project 2: Fish consumption in Iloilo: a consumer profile and behavior study

Participants: Nida R. Ty and Ebonia B. Seraspe

The broad objectives of this study are (1) to describe the socioeconomic and demographic characteristics of fish consumers in selected coastal areas, (2) to describe various purchasing habits and preferences of consumers, and (3) to measure and analyse the relationships between socioeconomic, demographic and other qualitative variables and fish consumption. This study will be completed in December 1984.

Project 3: Selected psychological characteristics of fishing communities

Participants: Nuria B. Catells and Cynthia J. Ticao

The study seeks to identify attitudes and motivations of fishermen and their wives that affect their ability to improve their social and economic conditions. Specifically the study will answer the following questions: (1) what are their perceptions of themselves, of their importance and role in the community? (2) what are their attitudes to and perceptions of their way of life? (3) what are their attitudes towards the introduction of new technology and other income earning activities? (4) what are their attitudes towards change in general in their occupation and in their geographic location? and (5) what are their aspirations for themselves, their children and their community? The study will be completed in December 1984.

Project 4: An evaluation of management of production and processing in municipal fisheries activities

Participants: Tomas S. Sajo and Perla D. de los Santos

The study will determine the relative technical and economic feasibility of production and processing of various marine products by municipal fishermen. The study will be completed in March 1985.

Project 5: Socioeconomics of marketing practices of small-scale fisheries

Participants: Ma. Luisa E. Mabunay and Antonina R. Baldevia

The study investigates in detail the working relationships between sellers and buyers of the marine production of small-scale capture fishermen, the marketing/exchange activities that take place, the sequence and costs of these activities, and the contribution of marketing activities to the income and lifestyle of municipal fishermen. The study will be completed in March 1985.

Research by Network M.Sc. Fellows at UPM

In May 1984, three Network fellows successfully completed the coursework component of their M.Sc. studies in Resource Economics (Fisheries and Aquacul-

ture) at UPM and returned to their home institutions to begin the data collection for their theses. Their thesis topics are as follows:

1. Miss Penporn Janekarnkij (KU), "Effects of fishery regulation on the trawler industry: a case study of trash fish production in Thailand"

2. Miss Ratana Sungsitthisawad (KU), "An economic analysis of the export market for Thai squid"

3. Drs. Mudiantono (Universitas Diponegoro, Indonesia), "An economic analysis of the milkfish marketing system in Semarang Regency, Central Java, Indonesia"

Other M.Sc. Thesis Research

Three Agricultural Development Council fellows also enrolled in the first group of students undertaking the M.Sc. program in Resource Economics (Fisheries and Aquaculture) and they also successfully completed their coursework. Like their Network colleagues they have also returned to their home bases for thesis research. The thesis topics are:

1. Mr. Jose Padilla (Philippines), is investigating the recent phenomenon of aquaculturalists shifting from the culture of milkfish to tilapia in brackishwater ponds and the comparison of the resulting "cropping patterns" with traditional milkfish monoculture in the Philippines

2. Mr. A.K.M. Mahfuzuddin Ahmed (Chittagong Univ. Bangladesh) is conducting an economic analysis of prawn culture in the farming system of coastal area farmers of Bangladesh

3. Ir. Kusumo Djoko Kuntjoro (Gadja Madha Univ. Indonesia) is conducting a study entitled "Maximum-economic-yield assessment for the marine fisheries of the north coast of Central Java"

Expansion of the Network (Phase II : 1985-1987)

During the first half of 1984 discussions were held with two universities and three research institutions in Southeast Asia regarding their interest in the objectives of the Network and eventual affiliation with it. These institutions are:

1. Aquaculture Department, South East Asian Fisheries Development Center (SEAFDEC AQD), Philippines.

2. Center for Agro-Economic Research (CAER) of the Agency for Agricultural Research and Development (AARD), Indonesia. CAER works closely with the Central Research Institute for Fisheries (CRIFI).

3. Fisheries Economics Section, Department of Fisheries, Ministry of Agriculture and Cooperatives, Thailand.

4. Faculty of Economics, Diponegoro University (UNDIP), Semarang, Central Java, Indonesia, and,

5. Center for Policy Development Studies, University of the Philippines at Los Baños (UPLB), Philippines.

Even though the Network is young in age and experience, it has made a start on the important task of providing the means for a stronger professional socioeconomics input into fishery policy formulation, management and/or development program design, and program monitoring and evaluation. The Network objective of encouraging and supporting institutions which are willing to develop and sustain long-term programs of socioeconomic research and/or training related to problems of fisheries and aquaculture has received strong endorsement in each country. The expected expansion of the Network from 1985 will add diversity to the research program, particularly from the non-university institutions, and it will add significantly to the group of socioeconomists working on common problems of fisheries management and aquacultural development in Southeast Asia.

The funding picture for the Network is very bright. During the first phase (1983-1984) the Network was funded by ICLARM and the Social Science Division of IDRC. During the second phase (1985-1987), we confidently expect to be funded by ICLARM, IDRC (Social Science Division and Agriculture, Food and Nutrition Sciences Division) and the Ford Foundation. Not only can the Network expect to continue the present program but it should also be able to expand the number of member institutions and range of Network activities.

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Project Title : Management Options for Tropical Small-Scale Fisheries

Cooperating Institutions : Various university and government institutions and individuals. This is an ongoing ICLARM activity with numerous linkages over time

Duration : First activities began in 1979

Key Personnel : Dr. Ian R. Smith, ICLARM

Background

Traditional or small-scale fishermen make up the majority of all fishermen, yet they are among the poorest sectors of most countries. Poverty in marine and inland fishing communities around the world is caused not only by their frequent geographic or socioeconomic isolation from the economic mainstream, but also by the underlying characteristics of the capture fisheries resources upon which they depend, including:

- biological limits to the annual sustainable production from marine and inland resources;
- open-access nature of the capture fishery with intense competition among gear types resulting;

Steady population growth onshore (which leads to new entrants in the fishery), rising operating costs (especially for fuel), increased pressure from more capital-intensive gears such as trawlers, and declining catch per day have made it impossible for most traditional small-scale fishermen to rise above the poverty level.

Historical development programs to assist this group have often been based on technological 'fixes' designed to make individual fishermen more efficient. However, when biological limits to resource exploitation have been reached, such approaches in isolation are counter-productive because they contribute to overfishing and exacerbate income inequality. Because of repeated poor experience with purely technological approaches, it is now becoming recognized that the most promising short-term solutions to problems of low income among traditional fishermen lie in fisheries management approaches that address the key issues of access to and allocation of the benefits from the fishery resources.

Thus, while long-term solutions to poverty in the fishing sector will certainly entail generation of alternative or supplementary income through non-fishery employment, much can be done in the short term within the fishery sector.

Objectives

ICLARM's work has a strong policy focus and is designed to:

- clarify management options for traditional small-scale fisheries;

- evaluate the likely impact of alternative interventions on resource use, employment and equity;

- evaluate alternative institutional arrangements under which management might proceed;

- develop multidisciplinary research methodologies appropriate for providing the information needs of these management institutions; and

- offer training in the above areas to others.

ICLARM particularly encourages the involvement of traditional small-scale fishing communities in the management of those resources which they use and works closely with national research institutions or researchers whenever appropriate.

The above objectives are achieved through a combination of in-house studies, commissioned reviews, workshops and cooperative research activities with national research instituions. ICLARM staff involved in this traditional fisheries project work closely with ICLARM staff in other program areas and disciplines and national institutions involved in the Fisheries Social Science Research Network.

Results

ICLARM's work to date under the management options project falls into two major categories: (1) research reviews and conceptual studies; and (2) case studies. In the first category are a broad range of research activities designed to address the need for small-scale fisheries management:

- a research framework published in 1979. This manuscript identified management interventions as a priority ICLARM research focus rather than the more traditional areas of interventions such as technical, marketing and post-harvest improvements, all of which are (or can be) pursued by other development agencies. One reviewer, writing in an international journal, stated that this manuscript "should contribute to a fundamental revision of (fisheries) concepts and policies."

- national research reviews and synthesis. These studies - of which there have been three to date in the Philippines, Malaysia and Indonesia - are designed to consolidate and synthesize from previous biological, economic and sociological research in the belief that much can be learned about policy needs by taking stock of what is already known. A review of Thai fisheries was commissioned in 1984; this is being prepared by Dr. Theodore Panayotou, a Visiting Professor at Kasetsart University and Mr. Songpol Jetanavanich of the Bangkok Bank. Reviews which have been published have not only had a significant impact on the thinking regarding resource limitations and management needs but they have also brought together research results which had been widely scattered and underutilized. The Philippine review has been reprinted three times.

- audio-visuals. The Philippine review and synthesis (above) has also been prepared as a 17-minute slide/tape presentation, which has been used by Philippine universities and government agencies to illustrate the need for fisheries management.

- numerous in-house staff publications and conference papers that analyze management needs and options.

The second categroy of work to date consists of case studies of particular small-scale fisheries undertaken in collaboration with other national research organizations:

- San Miguel Bay, Philippines. A major three-year multidisciplinary study of this important fishery was conducted between 1980 and 1983 in cooperation with the University of the Philippines in the Visayas, College of Fisheries. Results documented the full exploitation of the resource and the highly skewed distribution of catch, catch value and incomes between the small-scale gears (e.g., gillnetters and fixed gears) and the small trawlers with which they compete. Alternative management approaches were analyzed and legislative change with respect to trawler activities has already resulted from this study.

This was the first of its kind in Asia. A total of 26 papers in five technical reports were produced (the final project paper on management and research options was published in 1984) and the study is being used as a model for other similar studies elsewhere in the Philippines and in Indonesia and Thailand. Summary papers on this project were translated in 1984 into two Philippine languages (Tagalog and Bicol).

Future Work

Further work on the methodologies for multidisciplinary analysis of traditional small-scale fisheries in the tropics is planned. For example, headquarters staff will continue their work on a conceptual and applied level to address issues related to the costs and benefits of alternative management interventions and the trade-offs among competing objectives. The dilemma of efficiency vs. equity and employment in tropical fisheries management will receive particular attention. Research to date has barely scratched the surface with respect to alternative institutional arrangements for small-scale fisheries management and the potential for more decentralized community-based management schemes. In-house studies, cooperative research with other institutions and workshops will be undertaken to address these and related issues as funds permit. A proposal for three-year funding for this activity has been submitted to the Ford Foundation.

The Ford Foundation grant, if approved, will permit ICLARM to broaden its traditional fisheries research and contacts to regions outside Southeast Asia and in particular to address a major weakness of much traditional fisheries research to date. Too often in the past, research on conditions of small-scale fisheries has been conducted as an end in itself rather than as a necessary ingredient of planning for and management of small-scale fisheries. For fisheries management programs to result in beneficial impact on

small-scale fishing communities in terms of increased employment, redistributed income or community involvement in management schemes, an integrated planning-research-management approach is necessary. A major goal of ICLARM's Traditional Fisheries Program over the next few years is to demonstrate the usefulness of this integration through case studies in selected countries worldwide.

AQUACULTURE PROGRAM

Background

ICLARM's Aquaculture Program maintains a focus on three research areas chosen for their importance and relevance to warmwater aquaculture development in developing countries: stock improvement of cultured fish, waste-fed aquaculture (including integrated farming) and aquacultural economics of important commodities. In addition, the Program has a highly flexible modus operandi which allows it to address other research, information and training needs for the expansion of warmwater aquaculture production of key finfish and shellfish commodities. Program activities are selected which have broad international implications for warmwater aquaculture development, rather than, for example, location-specific development of hatcheries and farms.

With minor exceptions, the Program concentrates on species which can be grown in low-cost systems; for example, tilapias, carps and bivalve molluscs. ICLARM has long taken the view that the scope for growth in production of such commodities in tropical developing countries is vast and merits a large research and development effort to hasten its realization. The combination of high water temperatures, which permit fast growth and the ability of such organisms to feed on bacteria, plankton, vegetation and organic detritus means that cultured finfish and shellfish production can be achieved without high expenditure on fertilizers and formulated feeds. ICLARM has also recognized the high level of interest in intensive culture of penaeid prawns and freshwater prawns (Macrobrachium) in the tropics, but has chosen to exclude projects on these crustaceans from the Program, since numerous other agencies and the private sector are already providing the necessary research initiatives and support.

The Program works mainly through cooperative research projects with developing country institutions, usually with a single institution to address a particular problem for a fixed duration. However, plans are also being made for the establishment of long-term networks, coordinated by ICLARM, to facilitate research cooperation in aquaculture, following the examples set in other ICLARM Programs. Networks are an excellent and cost-effective means of achieving rapid progress in research and for spreading research cooperation and information exchange across the tropics and between developing countries, rather than the North-South linkages for cooperative research assistance which have been the usual pattern in the past.

In the Aquaculture Program, perhaps more than in any other of ICLARM's Programs, the concept of ICLARM and developing country institutions working together as research partners is most clearly seen, since aquacultural research requires considerable laboratory, hatchery and growout facilities, which ICLARM can help to establish or strengthen and (for the duration of the project) share with cooperating institutions.

In addition to such 'hands-on' cooperative research, the Program encompasses a wide range of other activities such as advisory services to government agencies and development banks, publication of commissioned reviews and bibliographies on topics of special interest and relevance to the main Program themes, participation in training courses and organization of workshops and conferences. Throughout all Program activities, a multidisciplinary approach is maintained, so that biological, economic and socioeconomic factors are considered together. In summary, the Program endeavors to address constraints to the expansion of cost-effective warmwater aquaculture through research, working in the developing countries where such expansion can best be undertaken.

Progress of Work

Stock Improvement

ICLARM's genetics/economics project with the Marine Sciences Center of the University of the Philippines (UPMSC) received generous support from the International Development Research Centre (IDRC) of Canada during 1984 and has made substantial progress. Characterization of cultured tilapia stocks in the Philippines has shown that all the so-called Nile tilapia (Oreochromis niloticus) populations examined contain introgressed hybrids with O. mossambicus. In addition to checking the identity of experimental and commercial tilapia stocks from the Philippines, Taiwan and Thailand, ICLARM has imported Taiwanese O. niloticus and O. aureus into the Philippines for use in research and development work by universities and government agencies.

The work of the ICLARM-UPMSC project has been extended beyond laboratory studies and information gathering from cooperator hatcheryman and farmers to actual on-farm culture trials. A comparison is being made of the cage culture performance of Israeli, local Philippine and Taiwanese O. niloticus. The project is linking electrophoretic studies in the laboratory, economic and socioeconomic analyses in the field and on-farm trials - probably a unique combination in aquacultural research in a tropical developing country.

Plans for an International Network for Stock Improvement in Warmwater Aquaculture have also made significant progress in 1984, with the development of proposals which are now under consideration by donor agencies. The ICLARM-UPMSC project affords a good example of a 'module' involving international cooperation of the type which can be used as blocks to build such a Network. In November 1983, the project was visited by Dr. Nobuhiko Taniguchi, Kochi University, Japan, who joined the ICLARM-UPMSC team for several weeks in further studies on the identity of cultured Philippine tilapia stocks. Much of the original equipment in the UPMSC laboratory was provided by the Japanese International Cooperation Agency (JICA). The UPMSC principal investigator, Mrs. Julie M. Macaranas will take up an 18-month Japanese Ministry of Education and Culture (Mombusho) training scholarship at Tohuku University, Sendai Prefecture, Japan in November 1984. Thus, activities associated with the current ICLARM-UPMSC project involve a developing country university (UPMSC), two Japanese universities (Kochi and Tohoku), three supporting agencies (JICA, Mombusho and IDRC) and ICLARM. Within the Philippines, the ICLARM-UPMSC researchers have maintained close contact with other research groups, notably

those at the Freshwater Aquaculture Center (FAC) of Central Luzon State University (CLSU) and the Aquaculture Department of SEAFDEC. A joint seminar on Philippine tilapia stock improvement was held at FAC/CLSU in September 1984.

Throughout 1984 ICLARM has also been developing linkages with other groups interested in genetics research in tropical aquaculture including Dalhousie University, Canada, and the Institute of Aquaculture, University of Stirling, for overseas training and research cooperation and Victoria University, Canada, for the development of proposals for gene banks, including cryopreserved fish semen.

Waste-fed Aquaculture

Organic waste-fed aquaculture, including integrated farming is practised throughout Asia and Central Europe. ICLARM's cooperative research project with the Asian Institute of Technology (AIT) Bangkok concentrates on the basis of fish production in waste-fed ponds and has been focused initially on conversion efficiency of algae to fish (Nile tilapia, Oreochromis niloticus). An intriguing discrepancy exists between published food conversion ratios (FCR) for feeding harvested algae to fish and those obtained with fish cropping algae grown in situ in the ponds. FCRs of about two have been obtained for the former (measured on a dry weight algae to fresh weight fish basis) as compared to 10-40 for the latter.

The central problem is measuring a correct net algal productivity rate based on in situ photosynthesis. The removal of algae by fish and zooplankton grazing and autolysis occur simultaneously in experimental tanks. An approach has been developed to quantify oxygen gains and losses in fertilized tank systems during daytime and nighttime and to convert the data to a carbon budget. A computer program is being developed to handle the data.

Preliminary data indicate that FCRs for organic matter (greater than one half of algal origin) to fish are close to two, indicating a very efficient fish production system. The ICLARM-AIT project team has also joined with the National Inland Fisheries Institute, Bangkok in studying the beneficial effects of sulfide control in intensive culture of airbreathing fishes, notably Clarias batrachus. These are widely cultured in Thailand on waste animal protein in intensive pond systems. The team has studied whether additional iron, added during the culture period, prevents sulfide from increasing in the ponds. Ten weeks into the culture period no mortality has been found in either control or iron-treated ponds. Water quality data collected during the growout period show the exceptional tolerance of Clarias for low (even zero) concentration of dissolved oxygen and extremely high ammonia levels. Only very low levels of sulfide have been found thus far.

Commodities/Economics

Tilapias

Tilapias have figured prominently in stock improvement and waste-fed aquaculture projects (see above). In addition, information gathering has proceeded throughout 1984 towards the preparation of a major review on tilapias as an aquacultural commodity. Reviews of the scale and scope of tilapia

culture were published in Infofish Marketing Digest and in a special issue of the ICLARM newsletter, focused on "Tilapia - the Aquatic Chicken." A substantial supplement (191 pages) to ICLARM's bibliography on the important species of cultured tilapias was also published in 1984.

In Taiwan, a multidisciplinary project on the development of technology for saltwater tilapia culture has made outstanding progress in the development of methods for improving the salinity tolerance of fry by spawning and early development (in artificial incubators) in controlled salinities. This work was carried out by Dr. C-M. Kuo, based in Taipei, by Dr. W.O. Watanabe at National Sun Yat Sen University, Kaohsiung and at other Taiwanese institutions, coordinated through Dr. Kuo and Dr. J-C. Lee of the Council for Agricultural Planning and Development (CAPD). A substantial Technical Report containing some of the project's major findings has been co-published by ICLARM and CAPD, and publication plans for other research papers are well-advanced.

In Kuwait, Dr. K.D. Hopkins maintained ICLARM's cooperative research effort on the development of technology for saltwater culture of tilapias in arid lands with the Kuwait Institute for Scientific Research (KISR). As a result of the success of this project, saltwater culture of tilapias in Kuwait is now moving from a research and development phase towards commercial production. ICLARM's choice of Oreochromis spilurus from among several tilapias tested in Kuwait has proven successful and marketing trials have continued to demonstrate the high demand for good quality live fish of this species. O. spilurus can spawn in full seawater. A major product of the ICLARM-KISR research cooperation in 1984 has been the completion of a detailed feasibility study for a 100-tonne/year tilapia farm by ICLARM, KISR and the Kuwait Technology Investment Company. ICLARM is currently seeking sponsorship for an international conference on saltwater tilapia culture to bring together researchers and would-be developers from all interested countries.

Carps

Dr. R.S.V. Pullin worked with Asian Development Bank (ADB) co-consultants Drs. V.G. Jhingran and S.V. Goswami, Department of Zoology, University of Delhi and C. May (ADB) in convening a Regional Workshop on Carp Hatchery and Nursery Technology in Manila, February, 1984. The workshop was attended by carp hatcherymen and researchers from 13 Asian countries: Bangladesh, Burma, Indonesia, Nepal, Pakistan and Sri Lanka (which were participating nations in the 1983 ADB Regional Technical Assistance (TA) Project for Research and Training in Aquaculture and which all received missions by Drs. Jhingran and Pullin) and India, Malaysia, Singapore, Taiwan, Thailand and Vietnam. All the countries represented gave papers on the status of their carp culture industries (common, Chinese and Indian major carps) and recent research findings. The workshop noted the important research contributions to controlled breeding of carps by the late Dr. B.I. Sundararaj, who worked on the TA project with Drs. Jhingran and Pullin in 1983 before his tragic death in October. A summary report of this highly successful workshop was co-published by ADB and ICLARM. Drs. Jhingran and Pullin have also completed the preparation of a detailed manual on carp hatchery and nursery technology for publication early in 1985. The regional TA project will terminate in December 1984 with a mission to Sri Lankan hatcheries by Dr. Pullin.

Dr. Pullin has also been compiling a world status report on carp culture for presentation in 1985 and has agreed to collaborate with Dr. J. Moreau, University of Toulouse, on a study to analyze successes and failures in warm-water culture of carps in Africa and Asia.

Milkfish

The final results of several earlier research projects on economic aspects of milkfish were published in 1984. These included a report for FAO (published as ICLARM Technical Reports 15) regarding the dualistic nature of the Philippine milkfish industry and the need for strengthened extension and information systems to support this important industry. This work was also extended to examine current milkfish economics in Taiwan and Indonesia and several papers documenting emerging milkfish marketing constraints throughout Southeast Asia were published.

Other finfish

Drs. C-M. Kuo and W.O. Watanabe maintained ICLARM's interests in a number of other commercial brackishwater and marine finfish species such as seabass (Lates calcarifer), eels (Anguilla japonica) and black seabream (Mylio macrocephalus), through ongoing projects, advisory services and training activities in Taiwan. The main thrusts of this work have been on development of controlled reproduction techniques through a better understanding of reproductive physiology and improvement of larval and postlarval survival through to fingerlings.

Bivalve molluscs

The cooperative project between ICLARM and the Brackishwater Fisheries Division, Department of Fisheries (DOF), Ministry of Agriculture and Cooperatives of the Government of Thailand, entitled "Applied Research on Coastal Aquaculture," funded through the German Agency for Technical Cooperation (GTZ) will complete its second 18-month phase in November 1984. The project involves multidisciplinary studies on the economics and biology of culture and harvesting of Thai commercial bivalve molluscs, principally the green mussel (Perna viridis), the cockle (Anadara granosa), oyster species (Crassostrea spp.) and the short-necked clam (Paphia undulata).

One of the highlights of 1984 was the Workshop on Hatchery Techniques for Bivalve Molluscs at the Brackishwater Fisheries Station, Prachuap Khirikhan, Thailand in February. This workshop was convened to assist DOF personnel actively engaged in bivalve hatchery work. Over 30 DOF staff participated. The workshop organizer was ICLARM consultant Mr. Charles Angell, a mollusc culture expert from Seattle, Washington. Mr. Angell gave a course with practical demonstrations on phytoplankton culture, broodstock conditioning, induced spawning, larval rearing, setting technology and nursery rearing and detailed information on hatchery design and equipment. Course notes were co-published in Thai and English by the DOF and ICLARM for distribution throughout Thailand and in other interested countries. The workshop participants successfully spawned a wide variety of Thai bivalves, including the oyster species, Crassostrea lugubris, for which there is good potential for hatchery seed production. DOF staff have since implemented some of the techniques at other

provincial stations and at Prachuap Khirikhan the staff have spawned the bloody cockle (Anadara granosa) and reared the larvae through early development.

These larval rearing successes have confirmed that the Prachuap Khirikhan station (ICLARM's recommendation as a bivalve research center for Thailand) has the good quality water supplies and facilities needed for bivalve hatchery work. Mr. Angell also designed a new hatchery building for the station and conducted further on-the-job training for DOF personnel.

A new stock culture of the alga Isochrysis galbana, donated by the Centre Océanologique du Pacifique, Tahiti, at ICLARM's request, was sent to the DOF for mollusc rearing purposes. The project also made substantial progress in economics studies on bivalve production and marketing. Biological and economics studies are continuing through 1985 as the project moves to a third and final phase.

Economics

In addition to the economics activities mentioned above, ICLARM concluded two country case studies of Aquaculture Trends and Development Prospects in Taiwan and Israel during the year. These two studies were commissioned reviews in each case and involved contributions from numerous authors. Both reviews are currently being peer-reviewed externally and edited prior to publication. Other aquaculture economics projects with which ICLARM has been involved during the past year have been conducted by cooperating institutions under the auspices of the Fisheries Social Science Research Network (see p. 14).

ICLARM's interest in the social science aspects of aquaculture extends beyond economics. Institutional arrangements for and feasibility of small-scale operations often require a sociological perspective. In late 1984, Dr. Smith began preparation of a seminar paper on Social Feasibility of Aquaculture which is to be presented as the keynote address at an expert consultation of the Bay of Bengal Fisheries Programme in Madras, India. Workshop participants will endeavor to design approaches to small-scale aquaculture systems that will ensure their success in the face of expected competition from the large-scale private sector and other competing users of the coastal zone and inland waters.

Training

Dr. R.S.V. Pullin participated again in the course for senior aquaculturists from Asia and the Pacific, organized by the UNDP/FAO Network of Aquaculture Centers in Asia (NACA), offering a series of lectures on warm-water aquaculture research and development priorities. Dr. J.A. Colman, an ICLARM researcher on a Rockefeller Foundation postdoctoral research fellowship, was appointed an Affiliate Faculty Member of the Agricultural and Food Engineering Division, Asian Institute of Technology, Bangkok, Thailand and assisted with graduate teaching and research supervision in waste-fed aquaculture. Dr. C-M. Kuo continued his work as visiting professor to the Department of Zoology, National Taiwan University, Taipei and the Institute of Marine Biology, National Sun Yat Sen University, Kaohsiung, Taiwan assisting with

teaching and research advice on fish reproductive biology. Drs. Kuo and W.O. Watanabe (who completed in 1984 his two-year Rockefeller Foundation postdoctoral fellowship with the ICLARM-CAPD tilapia project in Taiwan) also helped the Agricultural University, Wageningen, the Netherlands by providing in-service training for their Master's students in Taiwan. Dr. E.W. McCoy assisted the Faculty of Agricultural Economics and Business Administration of Kasetsart University, Bangkok with graduate training and supervision in aquacultural economics.

Dr. K.D. Hopkins and Mrs. M.L. Hopkins gave a training seminar on tilapia culture to staff of the Philippine Bureau of Fisheries and Aquatic Resources and the Bureau of Agricultural Extension, Cagayan de Oro city, Philippines in August 1984.

Advisory Services

Dr. C-M. Kuo visited the People's Republic of China in March at the joint invitation of the Institute of Oceanology and the South China Sea Institute of Oceanology, Academia Sinica. His visit included seminars, lectures and discussions on research planning and on prospects for aquaculture development.

Drs. R.S.V. Pullin and I.R. Smith assisted the Bay of Bengal Programme (BOBP) of FAO and the Department of Fisheries (DOF), Malaysia in preparing a detailed project document for a BOBP/DOF program of cockle (Anadara granosa) culture development in Malaysia. Drs. Pullin and Smith spent two weeks in July-August, visiting Penang and Perak States, West Malaysia.

Dr. R.S.V. Pullin continued work with the Asian Development Bank (ADB), Manila with aquaculture development-related activities and is expected to undertake a mission to ADB-supported carp hatcheries in Sri Lanka in late 1984, to try out new induced spawning techniques.

Dr. E.W. McCoy continued to assist the Fisheries Economics Subsection, Department of Fisheries, Government of Thailand on broad issues relating to fisheries and aquaculture economics and also conducted economic analyses for a feasibility study on integrated duck-fish farming at the family level in rural Thailand: a project of the Asian Institute of Technology (AIT).* All Aquaculture Program staff have been active throughout 1984 in helping with enquiries from students, researchers, development agencies and the private sector on planning and development matters. The greatest demand for help and information has been in tilapia culture research and development, especially on where to obtain good broodstocks of Nile and red tilapias.

Dr. J.A. Colman, based at AIT, Bangkok and Dr. R.S.V. Pullin have joined with staff of the Marine Sciences Department of Chulalongkorn University, Bangkok to make some preliminary studies on biomass production in the

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* Edwards, P., Kaewpaitoon, K., Meewan, A., Harnprasitkam, A. and C. Chantachaeng. 1983. Final report on a feasibility study of fish/duck integrated farming at the family level in central and northeast Thailand. AIT Research Report No. 163. Environmental Sanitation Information Center, Asian Institute for Technology, Bangkok. 48 + ii p.

Gulf of Thailand. At present a great deal of the organic industrial and domestic waste from the Bangkok metropolitan area is deposited in the Upper Gulf of Thailand. From the fisheries point of view, even the most basic result of this input - its effect on primary production - has not been quantified. Should these wastes be collected and disposed of elsewhere (waste-fed aquaculture for instance) or are they useful in the Upper Gulf, fertilizing algae, the basis of fish production there?

Corals have been collected at the University's Sichang Marine Research and Training Station at Ko Sichong, off Sri Racha, Cholburi Province. These will be analyzed for trace-bioactive elements such as Ba. If primary production has increased because of nutrient additions to the Gulf, Ba, which is taken up and transported to the sediments by algae, should have decreased in the water. Since the Ca:Ba ratio in coral depends on their ratio in ambient water, any changes should be reflected in the Ca:Ba ratio in both coral and water. Coral is particularly useful for documenting changes because of annual rings present in sectioned samples. The Porites sp. samples collected show very clear rings. Samples have been sent to Skidaway Institute of Oceanography in Georgia for 210 Pb dating to confirm that the rings are annual.

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Meetings Attended, Papers Presented

Ocean Sciences Meeting of the American Geophysical Union, New Orleans, January 1984. (J.A. Colman)

J.A. Colman and C.L. Schelske. A model of Si-P interactions in large lakes and its application to Lake Michigan.

Asian Regional Workshop on Carp Hatchery and Nursery Technology, Asian Development Bank, Manila, 1-3 February 1984. (R.S.V. Pullin)

R.S.V. Pullin. Consultant's report to the Asian Development Bank Regional Technical Assistance Project for Research and Training in Aquaculture.

Seminar on Tilapia Production, Technology Resource Center, Makati, Metro Manila, 30-31 March 1984. (E. Escover)

Monthly Seminar Series, Bureau of Fisheries and Aquatic Resources, Manila, Philippines, 4 April 1984. (E. Escover and I.R. Smith)

I.R. Smith. Economic status and future potential of milkfish production in Southeast Asia.

Genetic Resources Conservation for California: a Symposium and Workshop. University of California, Davis, 5-7 April 1984. (R.A. Neal)

R.A. Neal. Aquatic animal genetic resources - strategies for conservation.

World Conference on Fisheries Management and Development, FAO, Rome, 25 June-6 July 1984. (R.A. Neal, R.S.V. Pullin)

Seminar on Tilapia Production, Center for Research and Communication, Manila, Philippines, 14 August 1984. (E. Escover)

Seventh SEAFDEC Program Committee Meeting, Singapore, 14-17 August 1984. (C-M. Kuo)

Program Plans for 1985

In 1985, the concept of an International Network for Stock Improvement in Warmwater Aquaculture will be further developed. In the Philippines, Dr. R.S.V. Pullin and Ms. J.B. Capili will continue to work on tilapia genetics with the University of the Philippines Marine Sciences Center (UPMSC). The work will encompass electrophoretic studies in the laboratory and culture trials with cooperator farmers in the field. Dr. I.R. Smith, Ms. E. Escover and Mr. O. Salon will continue, through parallel studies with cooperator farmers and hatchery operators, the multidisciplinary economics-genetics studies which have proved so successful in 1984. Mrs. J.M. Macaranas will start an 18-month study period at Tohoku University, Japan in November 1984 and the strong links for research cooperation between the ICLARM-UPMSC project and Japanese fish geneticists will be further developed. Dr. L.J. Lester, University of Houston at Clear Lake City, will spend sabbatical leave in the Philippines working through ICLA at Central Luzon State University on the heritability of growth traits in tilapias. He will also visit and advise on the ICLARM-UPMSC project. Mrs. Macaranas and Ms. Escover will attend the International Conference on Warmwater Aquaculture of Finfish at Brigham Young University, Hawaii to present papers on the results of the ICLARM-UPMSC project.

On a wider front, Dr. Pullin is expected to participate in an IDRC-sponsored training workshop for fish geneticists from Asian developing countries, to be held in Singapore in April 1985 and to present a paper at the Second International Symposium on Aquaculture Genetics, at the University of California, Davis in June 1985. These opportunities will be used to make further progress towards an International Network.

In its broadest sense, stock improvement also includes the development of tilapias for saltwater culture and this will be continued in 1985 by Dr. Kuo in Taiwan, Dr. Hopkins in Kuwait and by other ICLARM researchers as appropriate to requests. A proposal to hold an international workshop on saltwater tilapia culture, probably in Saudi Arabia, will be further pursued. These efforts to increase international cooperation in cultured fish genetics research will involve increasing exchanges of material such as tissue samples for electrophoresis and live fish for broodstock improvement. It is hoped that substantial funding for the proposed International Network will be secured in 1985 with clear indications as to where stock improvement centers can be established in the tropics and an assured future for Network coordination by ICLARM, Manila.

In waste-fed aquaculture/integrated farming, current research cooperation with the Asian Institute of Technology (AIT), Bangkok will be continued through Dr. Colman. The development of integrated small ruminant-fish farming systems will also be pursued. The Asian Development Bank (ADB) has expressed an interest in technical assistance projects for these systems in Asia, and ICLARM is also developing a major proposal for the development of waste-fed aquaculture in Africa.

An international conference on "Detrital Systems for Aquaculture" will be held in August 1985 at the Rockefeller Foundation's Study and Conference Center, Bellagio with sponsorship from GTZ. Major ICLARM publications in this field will include the proceedings of this conference, a review of the utilization of sewage wastes and waste-water in fish culture and a comprehensive bibliography on integrated agriculture-aquaculture systems.

Work will also be continued on the major cultured fish commodities, chosen by ICLARM because of their suitability for low-cost aquaculture and their advantages for implementation in tropical developing countries. For the tilapias, in addition to the stock improvement work mentioned above, ICLARM will publish a world review on tilapia as a cultured fish commodity and will assist research and development efforts in support of tilapia culture worldwide, including the development of a project in the People's Republic of China. For the carps, Dr. Pullin has been invited to keynote a major international symposium on the aquaculture of carps and related species to be convened by the Institute National de la Recherche Agronomique, at Evry, Paris in September 1985. Publication of a detailed carp hatchery/nursery manual by ADB and ICLARM is expected early in 1985. Dr. Kuo will continue to assist with work in Taiwan on the controlled reproduction of important marine and brackishwater finfish species. For the bivalves, the ICLARM - DOF, Thailand-GTZ project on bivalve culture will likely be extended for a further year with continued funding from GTZ. Drs. Smith and Pullin will assist the Department of Fisheries, Malaysia and the Bay of Bengal Programme of FAO in project reviews for work to develop cockle (Anadara granosa) culture in Malaysia.

ICLARM's aquaculture economics work in 1985 will be conducted almost exclusively under the auspices of the Fisheries Social Science Research Network. Major activities planned include a workshop on aquaculture economics methodologies and several commodity studies in Thailand, Malaysia and Indonesia.

Aquaculture Project Summaries

Active

Stock Improvement

Waste-fed Aquaculture

Commodities/Economics

Upcoming

Bellagio Conference: Detrital Systems for Aquaculture

International Network for Stock Improvement in Warmwater Aquaculture

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*Formerly listed as two projects - Genetic Characteristics of Food Fishes and Tilapia Seed Supply and Management in the Philippines (see 1983 ICLARM Annual Report).

Project Title		:	Economics of Philippine Tilapia Hatcheries and Evaluation of Farmed Stocks and Species
Cooperating Institutions		:	Marine Sciences Center, University of the Philippines (UPMSC), Diliman, Quezon City, Philippines with support from the International Development Research Centre (IDRC) Canada
Duration		:	1 year beginning April 1984 (with provision for extension)
Key Personnel	ICLARM	:	Drs. Ian R. Smith and Roger S.V. Pullin; Ms. Emma Escover; Mr. Orestes Salon and Ms. Josephine B. Capili
	UPMSC	:	Mrs. Julie M. Macaranas Ms. Ma. Josefa R. Pante

Objective

1. Genetics module:

   - To investigate the genetic characteristics of cultured tilapia stocks in the Philippines.
   - To identify electrophoretic and other genetic markers for diagnostic monitoring of experimental and commercial stocks.
   - To provide information for the initiation of stock improvement projects in Philippine tilapia culture.

2. Economics module

   - To determine the costs and earnings of alternative hatchery systems, including various land-based and water-based designs.
   - To determine average production costs for each of these systems to uncover possible economies of scale.
   - To determine fingerling marketing channels, costs and technical efficiency.
   - To analyze various policy issues related to government incentives for the industry, including possible need for and role of centralized government-run hatcheries.

Results

This project resulted from the combined activities of two projects reported in the 1983 ICLARM Annual Report: Genetic Characteristics of Food

Fishes and Tilapia Seed Supply and Management in the Philippines. The project received generous support from IDRC commencing April 1984. The results of the genetic and economics modules follow.

Genetics module

The project team has established a reliable routine for detecting introgression by Oreochromis mossambicus into O. niloticus populations. From 20 loci investigated as biochemical genetic markers, aspartate aminotransferase (Aat-1), glucose phosphate isomerase (Gpi-1), sorbitol dehydrogenase (Sdh), superoxide dismutase (Sod) and the sarcoplasmic proteins Sp-2 and Sp-3 were chosen as the most reliable. Table 1 compares some of the results obtained from this project with other published values on allele frequencies for these markers. In 1984 some progress was also made on the identification of serum markers which, with further development, will allow fish to be sampled without killing them for tissue specimens.

Studies made during the visit of Dr. Nobuhiko Taniguchi, Faculty of Agriculture, Kochi University, in November 1983 showed evidence of introgressive hybridization with Oreochromis mossambicus in assumed Nile tilapia (O. niloticus) populations cultured in the Philippines. Five farm populations close to Manila and fish from one research center (SEAFDEC) were examined. Some of the results are shown in Table 2.

The project team also investigated assumed O. niloticus populations from elsewhere in the Philippines and from Taiwan and Thailand. Three assumed O. niloticus cultured populations from Mindanao (Maguindanao, Cotabato City and Davao del Norte) were analyzed and found to be introgressed with O. mossambicus. Results from six diagnostic loci showed that these fish from Mindanao have a higher degree of introgressive hybridization (0.260-0.300) than those examined from Luzon, particularly when compared to populations from Laguna and Rizal Provinces (average, 0.113). This is a clear reflection of differences in broodstock management.

Cage farms in San Pablo, Laguna, were sampled and the fish were also found to be O. niloticus introgressed with O. mossambicus genes to the same degree as the other Luzon stocks. Problems of poor documentation and management are widespread and are particularly discouraging for farmers who try to improve their broodstocks. By contrast, the project team analyzed fish marketed by Crust-Asian Resources Inc. of the Philippines, (which are said to be F_1 hybrids of pure O. aureus and O. niloticus founder stocks imported from Israel) and confirmed their identity.

Studies on a sample of 20 O. niloticus from Central Thailand, widely assumed to be a pure population, revealed alleles characteristic of O. mossambicus in three fishes at two loci. However, this does not definitely indicate introgression with wild O. mossambicus. These may be rare alleles present in the original population introduced to Thailand. No O. mossambicus genes were observed at other diagnostic loci.

Twenty O. niloticus from Taiwan were found to be relatively pure except for one fish that displayed patterns characteristic of an O. mossambicus X O. niloticus hybrid at two diagnostic loci. This population sample also

Table 1. Allele frequencies of species-specific isozyme and sarcoplasmic protein marker loci for Oreochromis niloticus and O. mossambicus: 1 = Auburn University, Alabama populations (Brummett 1982)*; 2 = Osaka population (Basiao and Taniguchi 1984)**; 3 = project results.

	Locus	Allele	Oreochromis niloticus		Oreochromis mossambicus	
Isozymes			1	2	1	3
	Aat-1	100	1.000	0.944	0.000	0.250
		46	0.000	0.056	1.000	0.750
	Gpi-1	100	1.000	1.000	0.000	0.000
		120	0.000	0.000	1.000	1.000
	Mdh-1	100	—	0.582	—	0.975
		80	—	0.418	—	0.025
	Sdh	100	—	0.982	—	0.000
		133	—	0.018	—	1.000
	Sod	100	1.000	1.000	0.000	0.000
		60	0.000	0.000	1.000	1.000
Sarcoplasmic proteins						
	Sp-2	100	—	1.000	—	0.000
		80	—	0.000	—	1.000
	Sp-3	100	—	1.000	—	0.000
		80	—	0.000	—	1.000

* Brummett, R.E. 1982. Isozymic variability within and among populations of Tilapia aurea, T. hornorum, T. mossambica and T. nilotica. M. Sc. Thesis. Auburn University, Auburn, Alabama.

** Basiao, Z.U. and N. Taniguchi. 1984. An investigation of enzyme and other protein polymorphisms in Japanese stocks of the tilapias Oreochromis niloticus and Tilapia zillii. Aquaculture 38:335-345.

Table 2. Mean frequencies of alleles derived from Oreochromis mossambicus in samples of 16-20 fish taken from six populations (five farms and one research center (SEAFDEC)) of tilapias, assumed to be O. niloticus, in the Philippines.

		Frequencies of alleles derived from:	
	Locus	O. mossambicus	O. niloticus
Isozymes			
	Aat-1	0.082	0.918
	Gpi-1	0.179	0.821
	Mdh-1	0.171	0.829
	Sdh	0.136	0.864
	Sod	0.100	0.900
Sarcoplasmic proteins			
	Sp-2	0.110	0.890
	Sp-3	0.120	0.880
	Grand mean frequency	0.136	0.864

displayed an unusual polymorphism for alcohol dehydrogenase (ADH) which may have been established only in Taiwan populations. ADH is monomorphic in pure tilapia species analyzed by the project team and by other workers. Likewise, 20 O. aureus from Taiwan were found to display unusual polymorphic patterns for ADH. All other loci were characteristic of pure O. aureus.

The most significant new work in 1984 was the initiation of on-farm culture trials with a cooperator farmer in Pililla, Rizal, Philippines. A three-way comparative growth performance trial of Israeli, Taiwanese and local Philippine O. niloticus is being carried out in cages in Laguna de Bay. The first results are expected by December 1984. The project team's activities now combine genetical laboratory studies, field investigations and on-farm trials with cooperator farmers - probably a unique combination in tropical aquacultural research.

In connection with this project, ICLARM and the United States Agency for International Development (USAID) cosponsored in 1984 shipments of proven commercial strains of O. aureus and O. niloticus from Taiwan to the Philippines, as new founder stocks from which Philippine universities and government agencies will be able to establish broodstock for future research work and stock improvement studies. Most of the fish are being held at the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) hatchery at Muñoz, Nueva Ecija, which was established with USAID support and is now the principal BFAR hatchery, distributing an average of 100,000 tilapia fingerlings each week.

Economics module

The information being analyzed includes three data sets: 1. record keeping data of selected hatchery cooperators in 1982-1983; 2. survey data of 78 hatchery farms in Luzon and Mindanao, 1983-1984; and 3. tilapia fingerling production records of 45 BFAR-managed farms for 1983.

Some of the initial findings from the survey of 78 private hatcheries are shown in Table 3. Tilapia hatcheries are usually relatively small. The average areas for lake-based and land-based hatcheries were 484 and 6,939 m^2, respectively. A large majority of tilapia hatchery operators (92%) spend only half of their time on hatchery work, irrespective of whether it is their primary or secondary occupation. Only six operators (8%) reported that they worked full-time on their hatcheries.

The lake-based hatcheries were established earlier than the land-based hatcheries. Most hatchery operators lack formal training in hatchery management: only 12 had attended seminars or undergone some training. Most of their information on tilapia breeding was gained through personal observation of existing farms in their neighborhood, contact with BFAR or SEAFDEC personnel and/or from relatives with relevant experience.

Most hatchery operators buy their broodstocks directly from BFAR or SEAFDEC or grow them on from progeny derived from introductions of BFAR or SEAFDEC fish, made several years ago. Twenty percent of the respondents reported that they obtained their broodstocks from other hatchery operators, while 7% reported that they took present broodstocks from lakes or rivers.

Analysis of the data is continuing and the results will be considered together with those of the genetics module to illustrate the possible consequences of poor broodstock management on the genetic characteristics and growth performance of the fish.

Table 3. Some selected information from a survey of 78 private tilapia hatcheries in selected provinces, Philippines, 1984.

1. Average farm size (m^2)		Average farm area	
Type	No. reporting	Initial	Present
Lake-based	31	200	484
Land-based	30	3,489	6,939
Combined hatchery/growout farm	12	11,123	19,282
Combined land/lake hatcheries	4	7,924	5,261
Rice/fish farm	1	1,500	18,928

2. Years in operation		Average
Lake-based	31	3.71
Land-based	30	3.21
Combined hatchery/growout farm	12	3.54
Others	5	2.60
All	78	3.38

3. Operator's involvement in hatchery operation	No.	%
Full-time/sole occupation	6	8
Part-time/primary occupation	30	38
Part-time/secondary occupation	42	54
Total	78	100

4. Source of operator's information on hatchery management		
Personal observation	6	33
BFAR/SEAFDEC personnel	25	32
Other family members	11	14
Other hatchery operators	9	12
Others	7	9
Total	78	100

5. Operator's attendance in seminar/training on hatchery operation and management		
Did not attend	66	85
Attended	12	15
Seminar (1-4) days – 5 Training (14-120 days) – 5 On the job training – 2 (Working with SEAFDEC)		

6. Source of broodstock		
BFAR	29	35
SEAFDEC	21	26
Other hatchery operators	23	28
Lake/river	6	7
Others	3	4
Total	82*	100

*Some operators reported more than one source of broodstock.

Project Title		:	Food Webs in Waste-fed Aquaculture
Main Cooperating Institutions		:	The Asian Institute of Technology (AIT), Bangkok, Thailand; The Rockefeller Foundation
Duration		:	2 years beginning October 1983
Key Personnel	ICLARM	:	Dr. John A. Colman Dr. Roger S.V. Pullin
	AIT	:	Dr. Peter Edwards

Objectives

- To investigate the chemical and biological basis of fish production in waste-fed aquaculture systems, concentrating on microphagous species (principally tilapias) dependent on plankton and the detrital food-web.

- To determine the effects of water quality factors on fish yields in a variety of waste-fed aquaculture systems (manured ponds, compost-fed ponds, sewage-fed systems and waste vegetation-fed systems, including the use of aquatic macrophytes).

This project has been retitled from the project 'Water Quality in Waste-fed Aquaculture' (see ICLARM 1983 Annual Report) to reflect a change in the scope of work. A brief rationale follows, before a description of the results and project activities.

Organic waste-fed aquaculture, including integrated farming, has now spread throughout Asia and to other warm temperate, subtropical and tropical regions. With the expansion, the importance of determining feeding mechanisms in waste-fed systems has also increased. This information is necessary to fix optimal combinations of organic waste inputs and fish species for new farm locations without experimenting by trial and error in every case.

This project has been focused initially on food conversion efficiency, algae to fish (Oreochromis niloticus) biomass, in chemical and organic waste fertilized culture tanks. The central problem is measuring a correct net algal productivity rate based on in situ photosynthesis. The removal of algae by fish and zooplankton grazing and autolysis occur simultaneously.

Results

Oxygen transformation in sun-lit fertilized culture tanks has been studied, including exchange at the air-water interface, concentration changes during light and dark periods, and oxygen consumption by fish. These data have been used to draw up a carbon budget. The approach is analogous to the familiar light-dark bottle methods, but includes carbon changes throughout the culture tanks and on a 24-hour rather than on only a daylight basis. A computer program is being developed to convert the large amounts of data generated by the daily oxygen measurements into culture-tank gross production, net algal production and net organic carbon presentation to the fish.

Preliminary data indicate that conversion ratios for organic matter (greater than one-half of algal origin) to fish are close to two. In contrast to previous published studies, this indicates that algal feeding is active and efficient. The results were obtained at high fish stocking levels (5 fish/m^2) and rapid individual growth rates (>1.5 g/day). Assuming confirmation of these initial results, the heterotrophic-autotrophic balance in waste-fed systems will be further investigated.

During 1984, plans have also been made and equipment assembled for testing for limiting nutrients in waste-fed systems. Because of the importance of algal production in waste-fed systems, a simple test indicating which nutrient is limiting algal growth would be useful. Monitoring nutrient ratios in fertilizer or waste input is not enough, because the availability to algae of nutrients contained in wastes after introduction to the pond is unknown. In agronomy, the analogous problem is found in predicting soil fertility on the basis of fertilizer added. It is addressed by plant tissue nutrient concentration analysis. When adapted to phytoplankton growth, this technique could reveal a great deal about pond nutrient cycling and phytoplankton growth limitation with relatively little research effort.

The project team has also joined with the National Inland Fisheries Institute, Bangkok in its program of investigating the occasional mass mortalities in intensive Thai catfish (Clarias batrachus) and snakehead (Channa striata) farms. In these farms, fish at very high densities are fed on waste animal protein. Past studies have shown that sulfide from uneaten food builds up in the culture ponds after iron, naturally present from the soil, has been exhausted through iron sulfide precipitation. Therefore, sulfide control by adding iron could be beneficial. The project team is investigating this. Ten weeks into the present culture trial no mortality has been found in either control or iron-treated ponds. Water quality data has confirmed the exceptional tolerance of Clarias to low (even zero) concentrations of dissolved oxygen and extremely high ammonia levels.

Project Title : Applied Research on Coastal Aquaculture: Phase II

Cooperating Institutions : Department of Fisheries (DOF), Ministry of Agriculture and Cooperatives, Government of Thailand and the German Agency for Technical Cooperation (GTZ)

Duration : 3 years, December 1982-November 1984

Key Personnel

ICLARM : Drs. R.A. Neal, R.S.V. Pullin and E.W. McCoy, Mr. J.M. Vakily

Thailand : Pairoj Brohmanonda, Kosol Mutarasint, Kachornsak Wetchagarun, Pongpen Rattagool, Songchai Sahavatcharint, Somying Rientriratana, Yuhd Hansopa, Taworn Tammasavate, Sunan Tuaycharoen, Thanittha Chongpeepien, Pongpat Boonchuwong, Sabaithip Amornjaruchit

Objectives

- To identify technical, biological and economic constraints hindering successful expansion of bivalve mollusc culture in the coastal zone of Thailand.
- To assist the DOF to initiate applied research aimed at eliminating identified constraints.
- To provide technical advice on mollusc culture, product handling and marketing.
- To assist the DOF in developing a lead station for research and development work in mollusc culture.
- To assist the DOF to initiate work on introduction and/or improvement of appropriate technologies for mollusc culture.

Results

The second 18-month phase of the project was initiated in June 1983. Based on constraints identified in Phase I, the project placed major emphasis on enhancement of seed supply for the cockle industry.

During the past seven years, the primary areas of cockle production moved from Satun Province on the Andaman Sea coast to Surat Thani and Nakorn Sri Thammarat Provinces in the lower Gulf of Thailand. The major production provinces are listed in Table 1. Petchaburi and Samut Songkram Provinces in the inner Gulf of Thailand are dependent on natural seed supplies. The remaining provinces utilize seed cockles imported from Malaysia. Prior to 1980, no production was reported from the lower Gulf (Table 2). In 1981 the lower Gulf was the primary production area. The Andaman Sea coast production decline

Table 1. Primary cockle production provinces in Thailand in tonnes, 1976-1982.

Province	1976	1977	1978	1979	1980	1981	1982
Samut Songkram	745	681	479	1,698	153	5,455	608
Petchaburi	2,448	2,112	1,823	3,240	1,296	1,806	1,281
Surat Thani	-	-	-	-	4,800	12,150	654
Nakorn Sri Thammarat	-	-	-	-	900	1,520	1,368
Satun	8,900	13,200	13,467	13,440	6,256	426	527
Total	12,093	15,993	15,769	18,378	13,405	21,457	4,428

Source: Fisheries Economics Section, Department of Fisheries, Thailand.

Table 2. Cockle production by area, Thailand in tonnes, 1976-1982.

Area	1976	1977	1978	1979	1980	1981	1982
Inner Gulf of Thailand	3,193	2,793	2,302	4,938	1,449	7,471	4,467
Lower Gulf of Thailand	-	-	-	-	5,700	13,930	2,202
Andaman Sea Coast	9,599	13,853	14,024	14,325	6,575	1,952	1,967
Total	12,792	16,646	16,326	19,263	13,724	23,353	8,636

Source: Fisheries Economics Section, Department of Fisheries, Thailand.

was attributed to production problems and not lack of seed supply. Following 5-7 years of production in the area, the rate of growth and survival of seed declined to uneconomic levels.

In 1984, Malaysia imposed restrictions on export of cockle seed which effectively prevented seed supplies reaching Thailand. If maintained these restrictions could eliminate Thai cockle production from the lower Gulf and Andaman Sea coast. Natural seed supply in commercial quantities exists only in the heavily industrialized inner Gulf. This seed supply is vulnerable to environmental deterioration and overharvesting of parent stocks. One long-term approach to safeguard the future of cockle culture is to establish parent stocks and to improve seed supplies in suitable natural conservation areas, while developing systems that will allow production to persist in culture areas. Two subprojects were initiated toward these goals.

Subproject 1. Enhancement of natural seed supplies:

Field survey data indicated that cockle seed settlement had occurred in Nakorn Bay, Nakorn Sri Thammarat Province, following two years of culture

activities by private business. A research project was initiated to monitor biological conditions in the bay, to determine the magnitude of spatfall and to test culture systems for optimum growth. Seed survival from stocking to harvest was also monitored. Nakorn Bay is heavily exploited and cockle culture is one aquacultural activity that may be suitable for low-income fishermen. Initially, however, collection of cockle seed for resale to commercial growers will be the primary goal for coastal villagers.

Sawee Bay, Chumporn Province, does not have commercial cockle production and is not heavily exploited. Seed and mature cockles were stocked in guarded experimental plots. Survival of mature cockles was relatively low after one month. Laboratory trials indicated that most losses occurred on stocking immediately after transport. After initial losses the population stabilized and losses were low. Further work is needed on methods of transport to increase survival. The seed cockles were tested for viability before stocking. Approximately 75% of the total weight stock represented viable seed. The cockles were stocked at different densities and growth and survival are being monitored monthly.

Subproject 2. Hatchery technology:

The project hired a short-term consultant, Mr. Charles Angell, to give a short course in hatchery technology, to assist in designing a mollusc hatchery at the lead station and to advise on mollusc culture and hatchery research. Following Mr. Angell's consultancy, the staff at Prachuap Khirikhan Station succeeded in spawning cockles and monitoring early larval development.

Two additional constraints, identified in Phase I were given emphasis in Phase II: product quality and product standardization. Product quality represents a major constraint in expanding demand for green mussels. Although heavy metal levels in marketed shellfish were found to be well within accepted limits, the production areas for green mussel suffer from bacterial contamination. In some product forms bacteria proliferate rapidly and shelf-life is very short. At present no depuration is conducted. A seminar on export potential for shellfish was held in August 1984. Quality factors were stressed. In addition, the DOF has given increased priority on research in product quality.

ICLARM is assisting the DOF in assessing spoilage and waste in marketing and methods to extend shelf-life of mollusc products. If green mussel production is moved south from the traditional areas a different processing and marketing system must be instituted. Under current transport and transfer conditions, viable in-shell green mussels cannot reach the retail market in Bangkok. Companion studies indicate that shucked green mussels receive a much lower price.

A 12-month bioeconomic study of green mussel was designed to relate production and marketing. Following three months of data collection, several standard assumptions regarding market margins have been modified. In addition the very large ancillary employment in green mussel processing is becoming apparent. Employment is heavily weighted towards low-income coastal villagers, primarily women. In one sample area, over 80% of the households derive their major source of income from green mussel processing.

Two additional subprojects have been initiated. At the request of the Fisheries Economics Section, DOF, ICLARM is assisting in a special study on marketing dried green mussels. The study is coodinated with the bioeconomics study reported above and with the mollusc processing study reported under the activities of the Fisheries Social Science Research Network (p. 14). The study has particular significance because reports indicate that approximately 50% of green mussel production is processed.

The second study has been initiated by the Brackishwater Fisheries Division, DOF, to identify all commercially important molluscan shellfish in Thailand. The number of species captured for food is relatively large. Some may have culture possibilities, especially the scallop (Amusium pleuronestes), and short-necked clam (Paphia undulata).

Project Title		:	Cooperative Tilapia Research Project
Cooperating Institutions		:	Council for Agricultural Planning and Development (CAPD), Taiwan and National Sun Yat-Sen University, Kaohsiung
Duration		:	3 years, beginning July 1982
Key Personnel	ICLARM	:	Drs. Ching-Ming Kuo and Wade O. Watanabe and Ms. Mei-Chan Huang
	CAPD	:	Dr. Jen-Chyuan Lee

Objectives

- Development of saline-tolerant tilapia strains and hybrids suitable for culture in coastal regions and associated technology packages for mass seed production and growout.
- Evaluation of survival, growth and reproductive performance of tilapias with potential for saline water culture in Taiwan.
- Improvement of salinity tolerance of cultured tilapias through genetic methods, such as hybridization and selective breeding, and also through physiological acclimatization.
- Development of efficient feeds for growth and maturation of tilapias cultured in seawater, through studies on their nutritional requirements in varying salinities.

Results

The salinity tolerance of tilapia species and hybrids was investigated using the following indices: (1) Mean Survival Time (MST), (2) Median Survival Time (ST-50) and (3) Median Lethal Salinity at 96 hours (MLS-96). These indices were also employed as practical measures to evaluate possible improvements in the salinity tolerance of tilapias through hybridization and selective breeding and through physiological acclimatization. The species under investigation included the most promising tilapias cultured in Taiwan: Oreochromis niloticus, O. aureus, hybrids (of O. niloticus, O. aureus and O. mossambicus) and red tilapias.

The salinity tolerance of freshwater-spawned and reared tilapias generally increased with the age/size of the fry, and notable increases were observed at 60-days and 90-days post-hatching for O. niloticus and O. aureus, respectively (Table 1). A significant improvement in salinity tolerance was observed when O. niloticus was hybridized with O. mossambicus (well-known as a euryhaline species). Studies are continuing on other interspecific hybrids.

The spawning performances of O. niloticus and O. aureus were investigated at varying salinities. Analysis of the data is not yet completed and only results for O. niloticus are considered here. Both species were found capable

Table 1. Mean Survival Time (MST), Median Survival Time (ST-50) and Median Lethal Salinity at 96 hours (MLS-96) of freshwater-spawned and reared Oreochromis niloticus (N), O. aureus (A) and O. niloticus X O. mossambicus (NXM) hybrids at various ages.

Age (days)	MST (min) N	A	NxM	ST-50 (min) N	A	NxM	MLS-96 (ppt) N	A	NxM
7	51	44	53	51	44	55	19	19	22
15	30	52	139	29	54	132	17	18	24
30	38	42	129	37	42	120	17	19	17
45	42	54	157	39	51	152	19	20	25
60	85	64	217	79	62	195	19	20	27
90	93	123		89	128		18	19	
120	103	136		96	130		20	20	
180	154	151		155	148				
210	185			178					

of spawning at salinities ranging from 5 to 32 parts per thousand (ppt) but embryonic development and hatching were unsuccessful with eggs spawned at 32 ppt. For broodstock of the same age the average numbers of eggs spawned from individuals acclimatized to various salinities were not different statistically. Details of the spawning performance of O. niloticus are given in Table 2.

Freshwater-spawned eggs were removed from the buccal cavity and incubated artificially at various salinities. Hatching success was similar from incubation at 10 and 15 ppt, but significantly greater at 5 ppt, which compared favorably with results obtained in freshwater. Survival declined with increasing post-hatching salinity, but similar survivals (51.6-54.2%) were observed in freshwater, 5 and 10 ppt. Survival in 5 ppt was 56.3%, six days post-hatching.

These results indicate that control of salinity during spawning, egg incubation and acclimation of early tilapia fry is a possible means of improving salinity tolerance. The impact of early exposure to saline water on the subsequent salinity tolerance of fry was clearly demonstrated. Salinity control during three developmental phases (spawning, artificial incubation and post-hatching) was next investigated and the results of fry salinity tolerance (represented by MST, ST-50 and MLS-96) are summarized in Table 3. Improvement in fry salinity tolerance depended upon the extent of elevated salinity exposure during development from spawning through post-hatching. For freshwater-spawned eggs, salinity tolerance increased when the fry were exposed to the elevated salinities during post-hatching period and further improved when both incubation and post-hatching salinities were elevated. An elevated spawning salinity was a most significant factor in producing comparatively salinity-tolerant progeny: 15 ppt or higher was found to be the most effective.

Table 2. Reproductive performance and hatching success of Nile tilapia (Oreochromis niloticus) broodstock at various salinities.*

Salinity at spawning (ppt)	No. of spawnings	Females: Body wt (g)	Females: Body length (cm)	Females: Mean no. of eggs per g body weight	Females: No. eggs per spawnings	Hatching success (%): Mean ± S.E.	Hatching success (%): Range (%)
0 (yearling tilapia)	3	29.3 ± 1.5	11.4 ± 0.8	9.6 ± 2.9	272.3 ± 70.4	52.3 ± 27.4	0-92.8
0 (2-3 year old broodstock)	60	203.9 ± 19.7	21.5 ± 1.3	5.2 ± 0.3	961.3 ± 61.8	54.2 ± 7.3	0-99.9
5	15	26.7 ± 1.4	11.5 ± 0.2	8.3 ± 0.9	226.9 ± 22.9	51.6 ± 8.6	0-93.1
10	15	25.4 ± 3.7	11.4 ± 0.7	11.8 ± 0.5	295.9 ± 22.5	32.7 ± 10.2	0-99.0
15	20	18.1 ± 3.3	10.3 ± 0.6	11.3 ± 1.3	180.8 ± 21.8	36.9 ± 9.5	0-99.0
32	7	34.3 ± 4.1	11.9 ± 0.4	9.2 ± 1.4	-	0.7 ± 0.7	0- 5.0

* Eggs were artificially incubated at equivalent spawning salinities.

Table 3. The salinity tolerance of Nile tilapia fry (Oreochromis niloticus) exposed to elevated salinities during spawning, artificial incubation and post-hatching.

Spawning salinity (ppt)	Incubation salinity (ppt)	Post-hatching salinity (ppt)	MST (min) ± S.E.	ST-50 (min)	MSL-96 (ppt)
0	0	0	51.1 + 5.3	51	19.2
0	0	5	62.1 + 15.3	58	
0	0	10	116.0 + 47.6	103	
0	0	15	1,966.4 ± 1,608	270	
0	5	5	86.2 ± 27.5	59	21.2
0	10	10	1,097 ± 934.5	90	25.0
0	15	15	3,411.2 ± 1,073.8	4,320	30.2
0	20	20	4,089.5 ± 847.6	>5,760	>32
0	25	25	5,760	>5,760	>32
5	5	5	970.2 ± 270.4	600	28.1
10	10	10	2,218 ± 639.4	3,600	>32
15	15	15	5,226.4 ± 199.6	>5,760	>32

MST = Mean survival time
ST-50 = Median survival time
MLS-96 = Median lethal salinity 96 hours

Project Title		:	Controlled Reproduction and Mass Fry Production of Commercially Important Fishes
Main Cooperating Institution		:	Council for Agricultural Planning and Development (CAPD), Taiwan
Other Cooperating Institutions		:	National Taiwan Normal University (NTNU), Taipei; Institute of Zoology, Academia Sinica (ASIZ), Taipei; Taiwan Fisheries Research Institute (TFRI), Tainan
Duration		:	3 years beginning July 1982
Key Personnel	ICLARM	:	Drs. Ching-Ming Kuo and Wade O. Watanabe
	CAPD	:	Dr. Jen-Chyuan Lee
	NTNU	:	Dr. Stephen H. Shih
	ASIZ	:	Dr. Y-L. Yu
	TFRI	:	Mr. Y-Y. Ting

Objectives

- To develop improved methods for the controlled reproduction and mass fry production of commercially important cultured fishes in Taiwan.
- To establish pituitary banks; high quality broodstock of key species; techniques for induced maturation and induced spawning on demand, egg incubation, larval rearing, nursery procedures and defined nutritional and environmental conditions for optimal fry production.

Results

ICLARM's role in the project is to coordinate and advise on research activities and also to take responsibility for research on final oocyte maturation and ovulation.

Methods for purification and bioassay of fish pituitary gonadotropins (GTH) have been refined. GTH preparations were extracted from Chinese carp pituitaries, which are readily available in quantity, and the potency of preparations was increased ten-fold over those prepared previously. The effect of injecting GTH preparations on gonadal maturation and ovulation is currently under investigation, with particular attention to species- and higher taxa-specificity.

The gonadotropin bioassay based on teleostean testicular response in androgen production has been greatly improved with respect to sensitivity. The dose response of common carp testis to gonadotropin preparations from various species are shown in Fig. 1 and Table 1. Furthermore, the applicability of a bioassay method based on estrogen production in carp ovarian tissue has been examined. The results often vary with the developmental stage of the tissue employed.

Table 1. Comparisons of sensitivity and potency of gonadotropins in promoting the androgen accumulation in rooster and common carp testis.

Hormone	Source	Sensitivity (μg) Testis		Relative sensitivity (%) Testis		Relative potency** (%) Testis	
		Rooster	Carp	Rooster	Carp	Rooster	Carp
Silver carp GTH*	Project	7.2	0.2	7,200	0.4	1.39	25,000.0
Common carp GTH	Project	41.0	1.2	41,000	2.4	0.28	4,166.7
Salmon GTH	West Vancouver, DFO	62.0	3.6	62,000	7.2	0.14	1,388.9
Salmon GTH	Syndel	91.0	6.1	91,000	12.2	0.096	819.7
Ovine LH	NIHS-22	0.10	50.0	100	100.0	100.00	100.0
PMSG	Sigma (2,090 IU/mg)	–	610.0	–	1,220.0	–	8.2
HCG	Sigma (3,360 IU/mg)	–	4,200.0	–	8,400.0	–	1.2

* GTH : Pituitary gonadotropin
LH : Luteinizing hormone
PMSG : Pregnant mare serum gonadotropin
HCG : Human chorionic gonadotropin
** Effective dose for 50% of dose-response

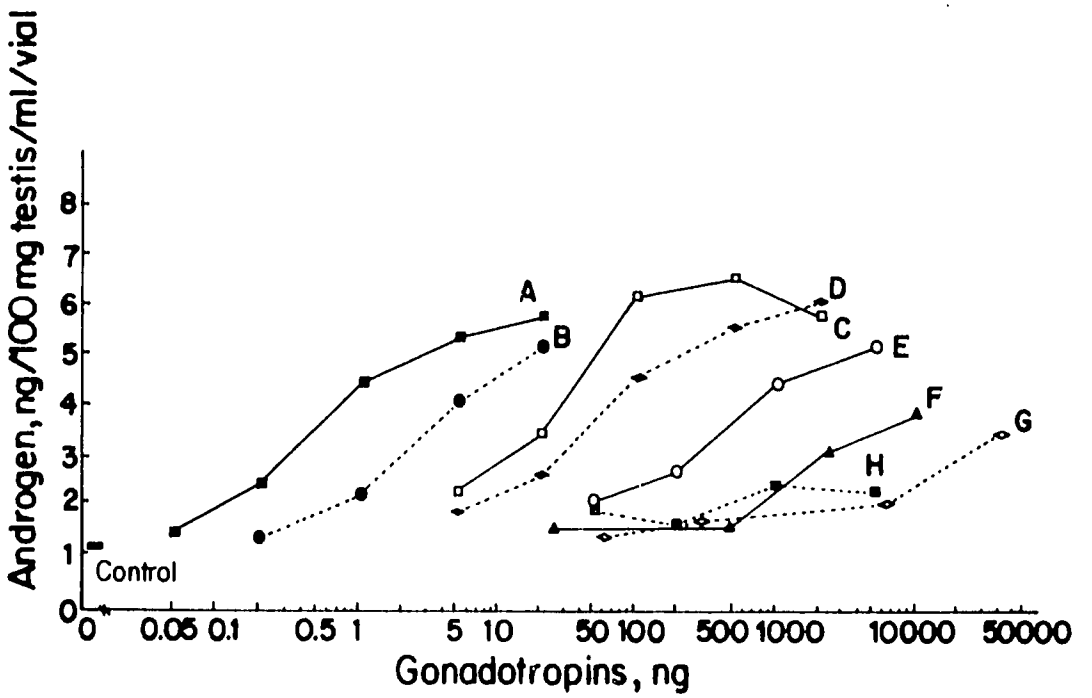

Fig. 1. Bioassay response curves for a series of vertebrate gonadotropins utilizing the androgen production response in carp testis. A–Silver carp GTH (ASIZ-HM-G1), B–Carp GTH (ASIZ-CC-G1), C–Salmon GTH (SG-G100), D–Salmon GTH (Syndel), E–Ovine LH (NIH S22), F–PMSG (2,390 IU/mg), G–hCG (3,360 IU/mg), H–Ovine FSH (NIH 13).

Work on induced maturation and spawning of the Pacific eel, Anguilla japonica has been continued and the results indicated that injections of estradiol (30 μg per kg body weight) and GTH preparation or gonadotropin-releasing hormone analogue are effective in the stimulatng gonadal development (particularly for testis) and in inducing subsequent spawning of pond-reared eels. However, the problems of larval rearing still remain.

A reliable method for controlling ovulation in the common carp, Cyprinus carpio through precise determination of the maturity of recipients has been

developed and the changes in ionic composition and steroid levels of the oocytes were followed during the preovulatory period. The results of this study have been presented in an ICLARM-CAPD progress report. Circadian rhythmic changes in estrogen content in serum and oocytes (Fig. 2) and the oocyte response to exogenous gonadotropin stimulation were further examined. The results provide baseline information for refinement of induced-breeding techniques.

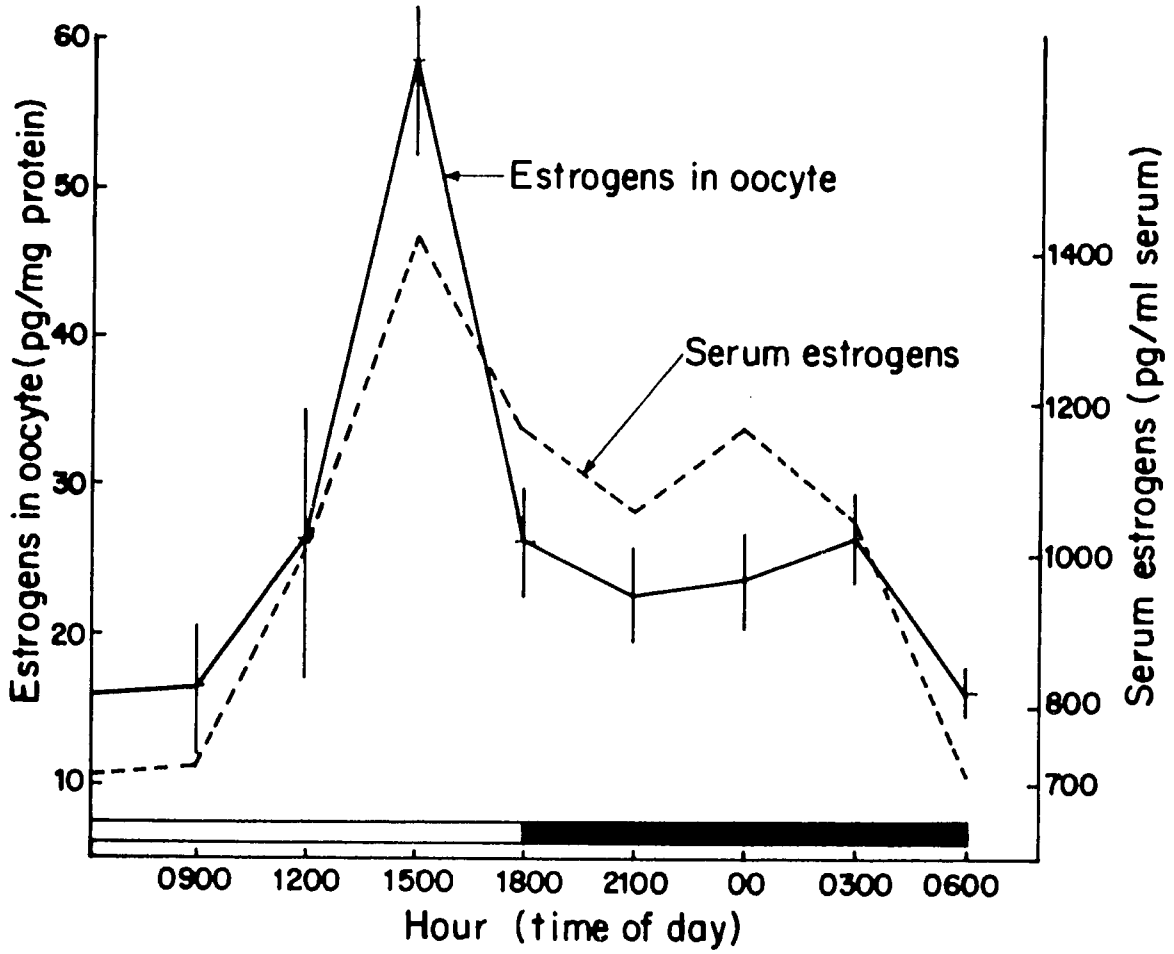

Fig. 2. Circadian changes in estrogen content in serum and oocytes of *Cyprinus carpio* L.

Other work in progress has included studies on the physiology and endocrinology of the seabass (Lates calcarifer) during gonadal maturation and on investigation of factors affecting final maturation in the mud-skipper (Boleophthalmus chinensis). Furthermore, work was done on the development of hatchery technology for the mass production of black seabream (Mylio macrocephalus) fry. The use of Isochrysis as a first larval food has greatly improved larval survival through to the fingerling stage. Mass culture techniques for Isochrysis have therefore been established.

The project provided a training opportunity for Mr. Roel Bakkar, a Masters student from the Agricultural University, Wageningen, the Netherlands during his six-month study/training visit to Taiwan. His work included artificial induction of spawning, measurement of changes in serum steroids and precise determination of oocyte development during the preovulatory period.

The scope for further improvement of fry salinity tolerance will be examined by acclimatization of broodstock to higher salinities. It is probable that a combination of genetic (hybridization) and non-genetic (spawning, incubation and post-hatching acclimatization at elevated salinities) methods will be necessary to optimize the salinity tolerance of tilapias for culture in saline waters.

The survival and growth performance of the saline water-acclimatized O. niloticus, O. aureus and red tilapia fingerlings cultured at various salinities were further monitored during growout in 9 m^2 floating cages. Efforts to develop efficient and economical formulated feeds, particularly those suitable for tilapia culture in seawater, have also been continued through studies on the mineral and other nutritional requirements of tilapias cultured in various salinities. For monosex fingerlings, (O. niloticus x O. aureus hybrids), feeds with an energy content below 3,100 Kcal/kg and crude protein between 24% and 40% are preferred. In seawater, however, a higher energy content of 3,500 Kcal/kg with a crude protein content of 32% gave good results.

This project provided opportunities for a 6-month overseas training visit by Mr. Anne V. Van Dam, a Master's student from the Agricultural University, Wageningen, the Netherlands and for graduate studies by Mr. Wen-Tsun Lo, National Sun Yat Sen University. They worked closely with the ICLARM-CAPD project, learning all the techniques used in the research and making further studies on the processes and mechanisms involved in osmoregulation in O. niloticus and O. aureus.

Project Title		:	Intensive Mariculture of Tilapia
Cooperating Institution		:	Mariculture and Fisheries Department, Kuwait Institute for Scientific Research
Duration		:	3 years beginning January 1982; to be extended for 6 months starting January 1985
Key personnel	ICLARM	:	Dr. Kevin D. Hopkins
	KISR	:	Dr. Thani Al-Ahmad

Objectives

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

Results

A 9-month long experiment to measure the growth rates of five groups of tilapia in seawater (38-41 ppt) was completed and the data is now undergoing analysis. A tentative ranking (in decreasing order) of growth performance of the species and hybrids cultured follows:

1. Taiwanese red tilapia, sex-reversed males
2. Oreochromis spilurus, sex-reversed males
3. O. spilurus, both sexes
4. O. aureus (♀) X O. spilurus (♂) hybrids, both sexes
5. O. aureus, sex-reversed males

The sex-reversed fish were fed 100mg ethynyl testosterone/kg feed for six weeks during the fry/fingerling stage before the yield trials started. Exact sex ratios have not yet been determined. All of the fish, particularly the red tilapia and O. aureus, became highly susceptible to diseases when water temperatures dropped below 21-23°C.

Development of tilapia hatchery methods for use in Kuwait has continued. O. spilurus has been successfully spawned and eggs artificially incubated in seawater. Eggs have been obtained from red tilapia and O. aureus females in seawater but have either not survived or have been unfertilized. Additional work on egg production, hatching and fry survival, is ongoing and will be completed in October 1984.

An experiment was conducted to test the hypothesis that increasing the number of feedings per day and duration of feeding using automatic feeders, would increase survival and growth of tilapia (Oreochromis spilurus) fry. Fry

Ranking of 16 hypothetical tilapia grow-out systems in Kuwait for a production capacity 100-200 tonnes of tilapia per annum. Costs in Kuwaiti Dinars (KD).

Systems	Water type	Capital cost[a] KD/tonne	Operating cost[b] KD/tonne	Profit loss KD/kg
Simple recirculating system, with shallow well	Brackishwater[c]	1,950	770	0.491
Unlined pond with shallow well	Brackishwater	1,980	890	0.361
Simple recirculating system with deep well	Brackishwater	4,910	790	0.179
Simple recirculating system	Seawater	1,860	1,180	0.097
Cage without breakwater	Seawater	1,230	1,300	(0.117)
Unlined pond with deep well	Brackishwater	6,590	915	(0.123)
Pond, tidal khor (inlet)	Seawater	3,340	1,250	(0.137)
Cage with breakwater	Seawater	1,940	1,330	(0.293)
Lined pond with shallow well	Brackishwater	6,940	890	(0.630)
Raceways[d] (glass-reinforced concrete)	Seawater	8,570	1,440	(0.834)
Pools[d] (plastic)	Seawater	8,270	1,440	(0.838)
Tanks[d] (fiberglass)	Seawater	8,630	1,400	(0.840)
Raceways[d] (rubber)	Seawater	8,330	1,440	(0.850)
Excavated tidal pond	Seawater	12,300	1,250	(1.032)
Lined pond	Seawater	7,930	125	(1.044)
Lined pond with deep well	Brackishwater	11,550	915	(1.114)

[a] Grow-out facilities only. Hatchery, preproduction expenses, interest not included.
[b] Variable costs plus salaries, benefits and insurance.
[c] 3-5 ppt salinity.
[d] Types of flowing water systems.

US$1.00 = KD 0.289

survival was higher when the fry were fed continuously than when they were fed only three times per day. No difference in survival was noted between fry fed continuously and those fed five times per day. Increasing the feeding period from 7 to 12 hours did not increase survival. No difference in growth was noted.

A preliminary economic analysis of possible tilapia production systems in Kuwait has been completed. This was used to select those production systems which warrant detailed analysis (see Table). 'Simple' recirculating systems, in which 'new' water is used to dilute metabolic by-products and supplementary aeration is provided, are attractive, but cannot be used in Kuwait because of government restrictions on the use of 'new' water. Detailed analyses performed subsequently indicate that certain more complex recirculating systems are appropriate for Kuwait. A detailed feasibility study of an intensive tilapia culture system inside greenhouses using physical and biological filtration was completed in September 1984. The design envisages integration with an irrigation scheme.

Project Title		:	Economics of Snakehead Fish Culture in Thailand
Cooperating Institution		:	National Inland Fisheries Institute (NIFI), Bangkok, Thailand
Duration		:	Initial 16 months March 1982-June 1983 Continued June 1983-December 1984
Key Personnel	ICLARM	:	Dr. Edward W. McCoy
	NIFI	:	Dr. Mali Boonyatapalin

Objectives

- To determine the production relationships of snakehead with special emphasis on the feed component.
- To determine the competitive relationship of trash fish for feed and trash fish for fish meal.

The feasibility of utilizing mollusc flesh as a feed ingredient either directly or as a component of formulated feed was included. In this objective the project was interrelated with the Project: Technical Assistance in Applied Research in Coastal Aquaculture which is listed on p. 49.

Results

Many fishfarmers shifted from catfish (Clarias sp.) to snakehead (Channa striatus Fowler) production following the occurrence of major disease problems with the former. The snakehead is an air breather and a voracious predator. Two major production systems are utilized: stocking of fry and stocking of fingerlings. The entire seed supply is captured from wild stock. No major disease problems had been reported prior to 1983.

Immediately following data collection from producers, however, a country wide disease outbreak occurred with heavy mortality in most production units and in wild stock. The outbreak was attributed to environmental stress due to toxic substances.

Three exogenous factors dominate the snakehead production cycle. First, the availability and survival of fry determine the stocking rate. Survival rates range from 7 to 24% from 1.5 cm (2,300/kg) to fingerling size of 10-15 g each. Survival from fingerling to maturity is about 85%. Second, the availability and price of trash fish determine feeding rates and feed composition. No manufactured ration is available. Third, market demand, both in price and quantity, after the fish reach maturity influences the production cycle. The culture period ranges from 7 to 11 months. Fish are fed a maintenance diet after reaching market size (300 g). Fish are harvested in small quantities based on favorable market price and are marketed live. Dead fish price is only 60 to 65% of live fish price.

The study results have been prepared in draft. Additional data collection was necessary to clarify the practices after the disease outbreak.

RESOURCE DEVELOPMENT AND MANAGEMENT PROGRAM

Background

The basic objectives of the Resource Development and Management Program are now well established and are directed principally towards the enhancement of the abilities of fisheries scientists working in tropical, mainly developing countries, to undertake stock assessment investigations, to develop methodologies appropriate to their situations and to provide fisheries management advice to the responsible authorities in their countries. An important adjunct to these objectives has been the development of appropriate methods for assessing tropical fisheries. Much emphasis has also been placed on the social and economic aspects of management programs.

Since 1983 the operations of the Program have been grouped around four basic projects: the Tropical Fish Stock Assessment Research Project, the Network of Tropical Fisheries Scientists, the Management-oriented Fisheries Research Project and the International Giant Clam Mariculture Project. Each of these projects, in keeping with the basic Program objectives, has a substantial component of training activities in fish stock assessment techniques, involving collaboration with other international agencies in conducting courses, intensive in-house training of limited numbers of highly motivated scientists from developing countries and the regular publication of Fishbyte, the newsletter of the Network of Tropical Fisheries Scientists. Additionally, a substantial part of the consulting work undertaken by the Program's staff has involved teaching at regional courses and the preparation of materials for such courses.

Initial emphasis in the Resource Development and Management Program was directed towards the development of relatively inexpensive microcomputer and calculator-based stock assessment techniques and methodologies, with particular emphasis on the use of length-frequency data. Results of this initial thrust have now been published or are in press and are available in widely distributed texts and computer programs. These activities have all been a part of the Tropical Fish Stock Assessment Research Project culminating in the completion of five length-frequency based stock assessment programs for microcomputers, several major works on the "Theory and Management of Tropical Fisheries" and on "Caribbean Coral Reef Fishery Resources" and numerous scientific contributions. More recently, attention has been directed towards questions of natural variation in recruitment in stocks of fish and bivalves and on methods for stabilizing these resources.

The Network of Tropical Fishery Scientists, initiated in April 1982 was firmly established by the start of 1984, with a global membership of 370 in over 63 countries. Members of the Network receive, at no cost, regular issues of Fishbyte and, when requested, free reprints, stock assessment manuals and database searches. Additionally, members have access to advisory services provided by the Program and may also be accorded financial support to work at ICLARM as Visiting Scientists on subjects of their own choosing.

The Management-oriented Fisheries Research Project consists of stock assessment and management modules which are built around nucleii of members of the Network of Tropical Fisheries Scientists in particular countries or institutions. Each module is provided with training and scientific support and, if required, the use of a microcomputer (which might be donated to the institution at the end of the project). One module, based in the University of the Philippines, has been completed and two, in Peru and Indonesia were operational at the start of the year.

The International Giant Clam Mariculture Project was lauched in January 1983. This project arose as a result of previous experience and interest of Program staff in relation to the general question of recruitment to coral reef ecosystems, in growth and turnover rates of these unique phototrophic animals and the recognition that the Indo-Pacific stocks of clams are being decimated by the combined effects of systematic illegal pulse fishing by certain nations combined with heavy demand for giant clams in most of the island countries of the Indo-Pacific region. The recognition that giant clams exhibit relatively rapid growth rates, are theoretically capable of extremely high yields per unit area (around 60 mt/ha/yr) and are the only "self-feeding" potential farm animal known to humankind were the principal incentives for initiating the project.

The project aims at rehabilitation of giant clam fisheries through a program of support for research on hatchery and nursery techniques and the economic feasibility of reef restocking, extensive or intensive mariculture systems. As the scientific and technical facilities needed to execute the entire project, as designed at ICLARM, were beyond our resources, James Cook University of North Queensland, Australia, was invited to participate in the project and undertake the major biological research activities with ICLARM concentrating on stock assessment techniques, the development of a pilot-scale hatchery at a suitable equatorial Indo-Pacific location, socio-economic problems and processing, product development and marketing studies. The project design calls for the participation of numerous Indo-Pacific institutions in many aspects of research.

Progress of Work

The Tropical Fish Stock Assessment Research project continued at a somewhat reduced level during 1984, mostly as a result of expansion of other projects and an increase in consulting work with consequent constraints on staff time. Nevertheless some significant progress in stock assessment methodologies emerged and these were for the most part in Fishbyte. Dr. Pauly's book entitled "Fish Population Dynamics in Tropical Waters: A Manual for use with Programmable Calculators" was published in September and is expected to receive positive reviews. Additionally, the ELEFAN suite of microcomputer programs was finalized and the users' instructions have been readied for formal publication. The first three of the five programs have already been widely circulated and are in use in many institutions throughout the world.

The Network of Tropical Fishery Scientists is expected to greatly increase its membership during the course of the year and by September had a total of 370 members in 63 countries. Three issues of Fishbyte will be published in 1984 and the size of the newsletter is already much expanded

over what was originally envisaged, largely as a result of the enthusiasm of the membership and the abundance of information available for publication. The availability of free reprints selected for their immediate relevance has been the most popular of the facilities offered to members, highlighting the extent to which most tropical fisheries scientists have inadequate access to recent scientific literature. Three hundred copies of the manual by Dr. J. Gulland entitled "Fish Stock Assessment: A Manual of Basic Methods" were received from the FAO/DANIDA Training Project in Fish Stock Assessment and most were distributed to members working on tropical fisheries during the course of the year, as were numerous other manuals supplied by FAO. This too has been of great benefit to members. Seven members, sponsored from a variety of sources, visited ICLARM in 1984 for periods ranging from a few days to three months.

During the course of the year the Indonesian module of the Management-oriented Fishery Research Project drew to a close and a new module was initiated in Zambia. The Indonesian module produced growth and mortality estimates for 80 stocks of fishes and invertebrates and the availability of a microcomputer resulted in a substantial increase in activity and interest in stock assessment work. The basic results of the work were written up by module participants during the latter part of the year and the final report will be published in 1985. The Peruvian module continued to work on the analysis of a very large (1953-1982) time series of length-frequency and catch of anchoveta, and of bird abundance data and funding is assured for an expansion of this work in 1985. The Zambian module was initiated when a member of the staff of the Zambia Department of Fisheries arrived in Manila in June for a period of training in the use of microcomputers and stock assessment methodologies and then returned to Zambia carrying with him a TRS-80 model 4P portable microcomputer, a printer and a complete set of stock assessment and applications programs. The initial thrust of the module will be towards the analysis of a series of length-frequency data for fishes captured in gill nets in Lake Kariba during the period after impoundment and before commercial fishing was initiated. These data are expected to yield extremely valuable information on the natural mortality and growth rates prevailing in the fish populations at that time. Additionally, analyses will be made of the Zambian landings of the sardine fishery in Lake Kariba and of the demersal and pelagic stocks of Lake Tanganyika.

Early in the year the Australian Centre for International Agricultural Research (ACIAR) announced that it would support the Australian module of the International Giant Clam Mariculture Project through a three-year, $836,000 grant to James Cook University of North Queensland, in Townsville, Australia. None of this funding comes to ICLARM but it serves to place the entire project on a much sounder scientific footing. As a result of these developments, James Cook University invited ICLARM to base a staff member (Dr. J. L. Munro) in Townsville and undertook to provide office space, overheads and scientific support services for a period of two years in the first instance. This arrangement was put into effect at mid-year and has greatly enhanced the possibilities for further development of the project.

Work on the Giant Clam Project has concentrated upon proposal development, particularly for a pilot-scale hatchery situated in the equatorial region of the Indo-Pacific. A formal invitation was received from the

Government of the Solomon Islands to base the proposed hatchery on Guadalcanal Island and a preliminary investigation was made of the likely site for the hatchery. Additionally, expressions of interest have been received from the Government of Kiribati and of the Marshall Islands. Proposals are also being developed for social, economic, marketing studies and for work on product development. Scientific work has concentrated on the analysis of an eight year time series of growth data for giant clams and finalization of a manuscript on photosynthetic and respiration rates. It is expected that these manuscripts will be submitted for publication in late 1984.

Dr. D. Pauly was granted study leave for a total of six months in late 1984 and in the spring of 1985 at Kiel University in order to fulfill the requirements for award of a postdoctoral degree.

Advisory Services

Dr. D. Pauly lectured from 20 to 30 of June on tropical stock assessment at the FAO/DANIDA Training Course, held in Hirtshals, Denmark for the benefit of participants from West Africa and the West Indies. He also taught from 30 August to 6 September the use of the ELEFAN Programs to participants from six countries of the Bay of Bengal region at a course held in Colombo, Sri Lanka by the Marine Fishery Resources Management Project of the Bay of Bengal Programme.

Dr. J. Munro undertook several advisory projects totalling about 30 days of work for the Asian Development Bank (a review of the fisheries of Thailand and assessment of potential harvests and the potential of artificial reefs), for the U. S. Agency for International Development (assessment of the status of Philippine fishery resources) and for the U. S. Caribbean Fishery Management Council (assessment of sustainable yields for the neritic fisheries of Puerto Rico and the U. S. Virgin Islands). He also visited Sri Lanka to evaluate the possibilities for Sri Lankan participation in the Giant Clam Project.

Publications

Munro, J.L. 1984. Estimation of natural mortality rates from selectivity and catch length-frequency data. Fishbyte 2(1):11-14.

Munro, J.L. 1984. A systems approach to stock assessment in tropical, small-scale, multispecies, multigear fisheries. In Proc. International Conference on Development and Management of Tropical Living Aquatic Resources, Universiti Pertanian Malaysia, August 1983. (in press)

Munro, J.L., J.D. Parrish and F.H. Talbot. 1984. The biological effects of intensive fishing upon coral reef fish communities. In B. Salvat (ed.) Human activities causing damage to coral reefs: knowledge and recommendations. UNESCO, Paris. (in press)

Munro, J.L. and I.R. Smith. 1984. Management strategies for multispecies complexes in artisanal fisheries. Proc. Gulf Caribb. Fish. Inst. (in press)

Pauly, D. Length-converted catch curves: a powerful tool for fisheries research in the tropics (Part II). Fishbyte 2(1):17-19.

Pauly, D. and J.L. Munro. Once more on growth comparison in fish and invertebrates. Fishbyte 2(1):21.

Pauly, D. and H. Calumpong. Growth and mortality of the sea-hare Dolabella auricularia (Gastropoda: Aplysiidae) in the Central Visayas, Philippines. Mar. Biology 79:289-293.

Pauly, D. Who cites your publications when you work in the tropics? ICLARM Newsletter 7(2):6-7.

Pauly, D. Recent developments in the methodology available for the assessment of exploited fish stocks of reservoirs, p. 321-326. In J.M. Kapetzky and T. Petr (eds.) Status of African reservoir fisheries. Committee for Inland Fisheries of Africa. Tech. Pap. 10, 326 p.

Pauly, D. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Studies and Reviews 8, 325 p.

Pauly, D. Reply to comments on prerecruit mortality in Gulf of Thailand shrimp stocks. Trans. Amer. Fish. Soc. 113:404-406.

Pauly, D. A mechanism for the juvenile-to-adult transition in fishes. J. Cons. Int. Explor. Mer. (in press)

Pauly, D. and J. Caddy. A modification of Batthacharya's method for the separation of normal distributions. FAO Fish. Circ. (in press)

Ingles, J. and D. Pauly. An atlas of the growth, mortality and recruitment of Philippine fishes. ICLARM Technical Reports 13. (in press)

Pauly, D. and J.L. Munro. ICLARM's activities in tropical stock assessment 1979 to 1984, and beyond. ICLARM Newsletter 7(3):7-9.

Pauly, D., Sann Aung, L. Rijavec and Htun Htein. The marine living resources of Burma: a short review. In Report of the 4th Session of the Standing Committee on Resources Research and Development, of the Indo-Pacific Fishery Commission, Jakarta, 23-29 August 1984. FAO Fish. Rep. (in press)

Meetings Attended, Papers Presented

South Pacific Commission, Sixteenth Regional Technical Meeting on Fisheries, Noumea, New Caledonia. 13-17 August 1984. (J.L. Munro)

Australian Institute of Marine Science. Workshop on Current Topics in Ecology of Coral Reef Fishes, Townsville, Australia, 26-28 October 1984. (J.L. Munro)

Dahlem Konfenzen: "The exploitation of marine communities". Berlin-Dahlem, 2-7 April 1984. (D. Pauly)

University of British Columbia, Vancouver 3rd International Symposium on the Early Life History of Fishes/8th Annual Larval Fish Conference, 7-9 May 1984. (D. Pauly)

N.A. Navaluna and D. Pauly. Seasonality in the recruitment of Philippine fishes as related to wind patterns (in press).

IOC/UNESCO, Paris: First Session of the Guiding Group of Experts on the Program of Ocean Sciences in Relation to Living Resources, 16-20 July 1984. (D. Pauly)

Special Session of the Scientific Council of the Northwest Fisheries Organization, Dartmouth, Canada, 5-7 September 1984. (D. Pauly)

D. Pauly. The population dynamics of single species, with emphasis on squids. (in press) (paper presented in absentia)

Program Plans for 1985

Planning for 1985 has been somewhat constrained by uncertainties over funding and no major expansion of activities in stock assessment is planned at this stage. Instead every effort will be made to consolidate activities which are presently underway and ensure that completed works are published with the least possible delay. It is therefore expected that a substantial part of the budget will be devoted to publication expenses.

A major scientific conference on "The Theory and Application of Length-Based Stock Assessment Methods" will be held from 10-15 February 1985 at the Instituto di Technologia della Pesca e del Pescato, in Mazara del Vallo, Sicily, Italy, with cosponsorship from the Kuwait Institute of Scientific Research and FAO. The conference will investigate in detail the various length-based models proposed to date for the management of fisheries - notably the ELEFAN programs - propose improvements where need be, and consider the implications of such methodologies for sampling and research program. The proceedings of this conference, an ICLARM-KISR copublication, will be published in the ICLARM Conference Proceedings series.

The Network of Tropical Fisheries Scientists will be expanded and funding will be sought to place the publication of Fishbyte on a sounder footing, provide funds to enable members to make research visits to ICLARM and to expand the facilities available to members. The newsletter, Fishbyte, will be issued on a quarterly basis.

The activities of the Management-oriented Fisheries Research Project will focus upon the further development of the Peruvian and Zambian modules. Dr. Pauly will spend two months in Peru to finalize the data acquisition for this module, and prepare, with his Peruvian colleagues the first draft of papers based on the data analyzed so far. Dr. Munro will make at least one visit to Zambia to review the progress of that module. If funding permits, several small modules will be added to the project in response to expected requests from the Universiti Pertanian Malaysia and from a South Pacific island nation. Additionally, external support will continue to be sought for development of an African Fish Stock Assessment Research and Extension Unit, to be situated somewhere in East-Central Africa (preferably

Zambia for logistical reasons). It is envisaged that such a unit could form a base for future ICLARM operations in Africa.

The International Giant Clam Mariculture Project will be expanded to the greatest degree that internal and external funding permits. This will include an expansion of the Townsville-based research activities in collaboration with James Cook University, submission of proposals to a variety of funding agencies and seeking funding for increased participation by various Indo-Pacific institutions. The principal focus will be upon the proposed pilot-scale hatchery and the organization of the program of work of the collaborating institutions.

Resource Development and Management Project Summaries

Active

Project Title	:	Network of Tropical Fisheries Scientists
Cooperating Institutions	:	Fishery Resources and Environment Division, Fisheries Department, FAO, Rome, Italy. plus Individual member scientists in institutions throughout the world.
Duration	:	Continuous from April 1982
Key Personnel ICLARM	:	Dr. John L. Munro Dr. Daniel Pauly Ms. Ferdinandina Santos

Objectives

- To enhance communication between fisheries scientists working on the assessment, conservation and management of tropical stocks.

- To enhance the output of these scientists by improving access to literature, providing free database searches, distributing manuals and other literature and publishing a newsletter at regular intervals. The technical focus is on the estimation of the 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.

Results

During 1984 the Network was partially funded by the FAO/DANIDA Training Course in Fish Stock Assessment. This funding covered the services of the Network Secretary and some of the mailing, copying and publication costs. However, we were unable to secure a block grant to support the Visiting Scientist scheme and arrangements for visitors had to be made individually. Nevertheless, 11 scientists were able to secure sufficient support to visit Manila and avail themselves of ICLARM's facilities.

Membership of the Network rose from around 200 in 52 countries to over 370 in 63 countries by September and is expected to further increase before the end of 1984. Sixty percent of members are third world nationals, 26% are western scientists working in tropical developing countries and the remainder are western scientists with strong interests in tropical fish and fisheries.

Three issues of the newsletter Fishbyte were issued during 1984 and received a very enthusiastic response from members. In concentrating on the practicalities of fish stock assessment and management in developing countries the newsletter fills a basic need for sensible information about what scientists can practically expect to achieve, what others in similar

situations are currently achieving (or failing to achieve) and offers at least a modest degree of communication between scientists with very similar basic problems.

Over two hundred copies of J. Gulland's new book, "Fish Stock Assessment: A Manual of Basic Methods" were distributed gratis to members in tropical developing countries, together with many hundreds of reprints, FAO manuals and circulars and other items of interest. A number of database searches have been made at the request of members but not as many as might have been expected and steps will have to be taken to make members aware of the power and usefulness of this facility.

Project Title		:	International Giant Clam Mariculture Project
Principal Cooperating Institution		:	James Cook University of North Queensland
Other Cooperating Institutions		:	Department of Primary Industry, Fisheries Research Branch, Queensland, Australia
			University of Papua New Guinea
			De La Salle University, Manila, Philippines
			Silliman University, Dumaguete City, Philippines
			University of the Philippines, Quezon City, Philippines
			Fisheries Division, Ministry of Agriculture and Fisheries, Suva, Fiji
			Ministry of Lands, Energy and Natural Resources, Honiara, Solomon Islands and the IUCN/WWF Conservation for Development Programme in Indonesia
			National Aquatic Resources Agency, Colombo, Sri Lanka
Duration		:	1983-1988
Key Personnel	ICLARM	:	Dr. John L. Munro
	JCUNQ	:	Prof. C. Burdon-Jones
			Dr. J. Lucas

Objectives

- To create a foundation of scientific knowledge which will enable giant clams to be raised in sufficient numbers in hatcheries to make reef restocking or extensive mariculture feasible.
- To reverse the trend of the larger species towards extinction.
- To develop a new industry in the equatorial Indo-Pacific based upon the extensive cultivation of an esteemed traditional food resource, which will provide increased food supplies and exportable products.
- To ultimately create maricultural systems for the only phototrophic, and thus self-feeding potential farm animal known to humankind.

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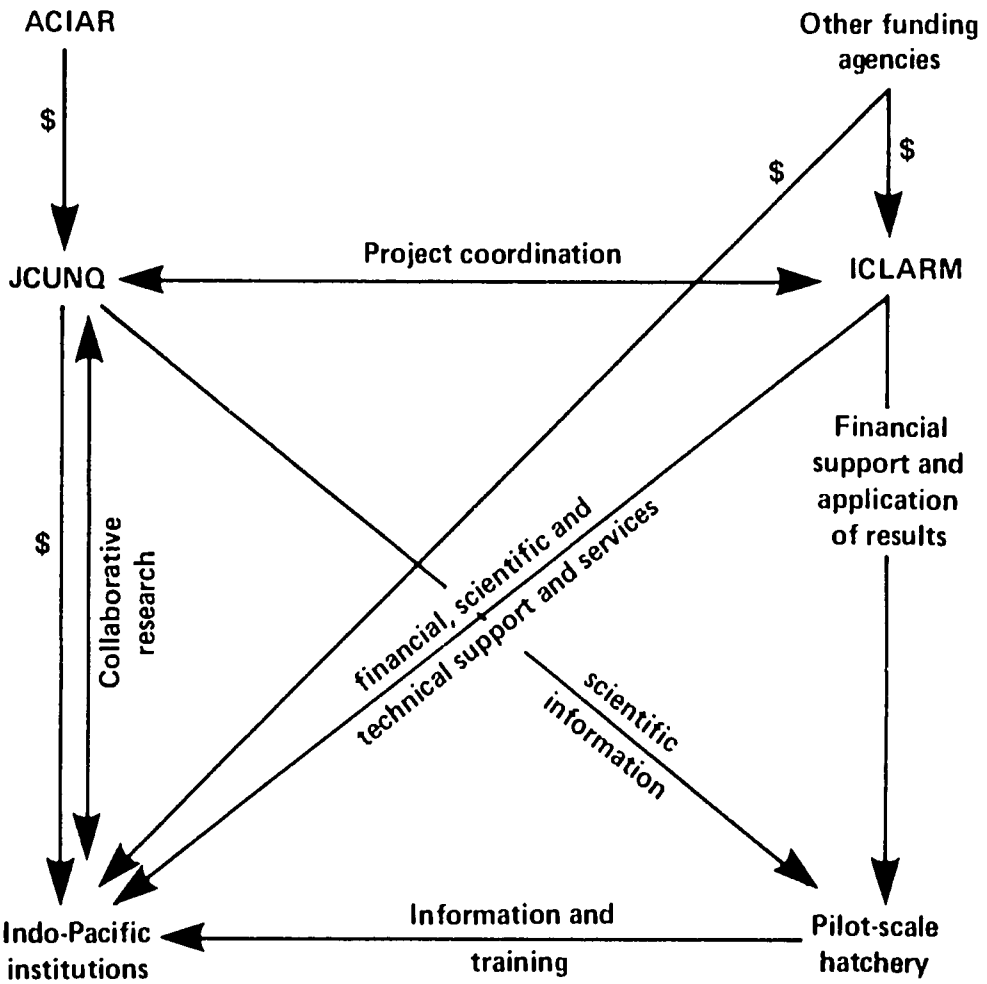
Results

During 1983 a close working relationship was established between ICLARM and scientists at James Cook University of North Queensland (JCUNQ) and in late 1983 a proposal for Australian participation in this project was submitted to the Australian Centre for International Agricultural Research (ACIAR). A grant of A$870,000 was made to JCUNQ early this year in respect of this proposal. These funds do not accrue to ICLARM but fund research at JCUNQ and at four of the participating institutions and thus create the basic scientific framework for developing giant clams into a cultivated crop. The organizational structure of the project is shown in the accompanying diagram.



The institutions which receive ACIAR funding via JCUNQ are the Motupore Island Research Centre of the University of Papua New Guinea, the Marine Sciences Center of the University of the Philippines, the Marine Laboratory of Silliman University at Dumaguete in the Philippines and the Fisheries Division of the Ministry of Agriculture and Fisheries in Suva, Fiji.

Research projects at these institutions are now underway on a variety of topics. Aquaculture facilities at the JCUNQ Orpheus Island laboratory have been greatly expanded with the installation of a high volume pumping system, holding tanks and raceways. Research will concentrate on the development of mass rearing techniques, specific ecological requirements of giant clams and problems in estimating growth rates.

Two manuscripts dealing with the growth of tridacnid clams and with photosynthetic and respiration rates will be completed and submitted for publication before the end of the year. A methodology for surveying reefs for giant clams and assessing the status of the stocks was developed and tested in collaboration with scientific staff of JCUNQ, the Queensland Department of Fisheries and the Great Barrier Reef Marine Park Authority. This methodology will enable a uniform system to be applied when areas throughout the Indo-Pacific are surveyed.

Attendance at the South Pacific Commission's Regional Technical Meeting of Fisheries, at which a full day was devoted to mariculture showed that the principal species of interest are the tridacnid clams and the top shell, Trochus. Many of the Pacific island countries are already taking steps to become involved in giant clam cultivation, hatcheries of various types are already in the planning stage and there are plans to attempt to introduce the larger species, Tridacna gigas and T. derasa to areas outside of their natural range or to reintroduce them to areas where they have become extinct.

A proposal for development of a pilot-scale hatchery has been developed and a visit made to the Solomon Islands to appraise a possible site which was suggested by the Fisheries Division of the Government of the Solomon Islands. Subsequently, a formal invitation to develop the hatchery on Guadalcanal Island was received from the Solomon Islands Government but no decision has yet been taken on this matter pending a visit to Kiribati to appraise the possibility of siting the hatchery there. Proposals for appraisal of the markets for tridacnid products, for social and economic studies and for product development will be prepared and submitted to appropriate funding agencies before the end of the year or in early 1985.

Project Title	:	Management-Oriented Fisheries Research Project
Cooperating Institutions	:	Research Institute for Marine Fisheries, Indonesia (BPPL); Instituto del Mar del Peru (IMARPE); Department of Fisheries, Zambia
Donor Institution	:	Skaggs Foundation (Indonesian module)
Duration	:	Continuous from 1982
Key Personnel ICLARM	:	Dr. Daniel Pauly Dr. John L. Munro
BPPL (Indonesia)	:	Mr. Dwiponggo
IMARPE (Peru)	:	Ms. I. Tsukayama
Zambia	:	Dr. S.P. Subramaniam Mr. R. Matipa

Objectives

- To strengthen the capabilities of the participating countries to manage their fisheries by creating stock assessment and management modules (SAMMs) in various countries and institutions. Each SAMM will develop a small nucleus of well-trained researchers.

- To train fishery scientists in the interpretation of fishery data (especially in extracting a maximum of information from available data) and in formulating implementable management options. 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 fisheries administration.

- To help determine, in the countries involved in the project, the basic information requirements for stock assessment and fisheries management.

- To produce well-documented reviews of the various fisheries investigated and original studies on tropical fish population dynamics.

- To 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.

Results

Three modules were operational in 1984 in Indonesia, Peru and Zambia. (The work of the Philippine module was completed in 1983.)

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Indonesia

The data acquisition and analysis phase of this module ended in August of this year, after 18 months spent working with length-frequency data on various Indonesian commercial fishes and invertebrates using a computer supplied by ICLARM and the ELEFAN programs. Results of analysis of data on shrimps, roundscads and miscellaneous demersal fishes have been presented in a PhD dissertation and two papers, respectively (see below), while work on the preparation of a comprehensive "Atlas of the growth, mortality and recruitment of Indonesian commercial fish and invertebrate" and a paper on the analysis of trawl data is continuing.

Peru

The acquisition and standardization of monthly time series data on the Peruvian anchoveta, its fishery and its ecosystem for the period 1953 to 1982 was continued. Data accumulated to date include detailed catch and catch composition data, and a number of climatic and oceanographic parameters; the remaining work involves mainly the compilation and standardization of data on the population of the three major species of fish-eating birds. When completed in mid-1985, these time series will be used to separate out, using length-based stock assessment techniques, the effects of excessive fishing from those due to El Niño events, and hence to help formulate management advice in a variable environment.

Zambia

This module commenced in mid-year when Mr. R. Matipa of the Zambia Department of Fisheries spent three weeks at ICLARM familiarizing himself with the TRS-80 Model 4P portable microcomputer purchased for this project and studying the use of various analytical and applications programs. At the end of the training period he returned to Zambia carrying the microcomputer, printer, programs and two programmable calculators, all of which are now in use in Zambia.

The objectives of this module are:

1. To appraise the catch and effort statistics which have been collected over the past decade and, if possible make initial stock assessments of the major fisheries.

2. To reduce and interpret the length-frequency data and catch composition data for Zambian fishes which are available in the Department of Fisheries and to compute estimates of growth, mortality and related parameters from these data.

3. To assess the commercial pelagic fisheries on the basis of catch statistics and biological data.

4. To estimate biological and fishing parameters of other Zambian fisheries.

5. To train Department of Fisheries staff in recent methodologies for quantitative approaches to fish stock assessment and the use of microcomputers.

Publications

Dwiponggo, A. Notes on the demersal fishery of the Java Sea and population parameters of some demersal fish species. In Report of the 4th Session of the Scientific Committee for Resources Research and Development of the Indo-Pacific Fishery Council. FAO Fish. Rep. (in press)

Naamin, N. 1984. [Population dynamics of white shrimps (Penaeus merguensis de Man) in the Arafura Sea, with an alternative management plan] in Indonesian. Doctoral Thesis, Bogor Agricultural Univ., Bogor, Indonesia.

Sadhotomo, B., Basuherman and S. Nurhakim. 1983. [Estimate of growth parameters, instantaneous mortality and yield per recruit of roundscad Decapterus marnadsi (Temminck and Schlegel) in the Java Sea] in Indonesian. Mar. Fish. Res. Rep. (Jakarta) No. 27:1-11.

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	:	Dr. Daniel Pauly Dr. John L. Munro Mr. Morfio Sumiran (until March 1984) Ms. Maria Lourdes Palomares

Objectives

- To understand the dynamics of exploited tropical fish communities.
- To develop stock assessment methods which are straightforward, are readily applicable to tropical stocks and which do not require costly hardware for their implementation.

Results

In-house research in 1984 was severely curtailed by a number of consultancies undertaken by both Drs. Munro and Pauly. What little time could be devoted to research was concentrated on further refinements of the length-based methodologies developed in the last years, and completing a number of reports and articles presenting application of these methodologies, notably of the ELEFAN programs. Several of these reports and articles will be published by FAO in late 1984 and 1985, while others have been published in Fishbyte.

A manual by D. Pauly titled "Fish Population Dynamics in Tropical Waters: a Manual for Use with Programmable Calculators" was issued as No. 8 in ICLARM's Studies and Reviews series.

The planning of a major conference on the "Theory and Application of Length-Based Methods in Stock Assessment" initiated by Dr. Munro was continued by D. Pauly after Dr. Munro moved to Australia. The conference, to be held 10-15 February 1985 in Mazaro del Vallo, Sicily, Italy, is expected to provide a scientific framework for the large-scale application of length-based methodologies in stock assessment, and to provide advice on the sampling and research programs that such transition entails, and thus to complement previous work on length-based methods done in this project.

The publication of a complete set of of the ELEFAN programs inclusive of listings (ELEFAN 0 to IV) will be held back until this conference is held, such that recent advances can be incorporated into the published versions.

Research on the theory of fish growth and mortality has been reinitiated, emphasis being given to the anatomical and physiological features of fish which are responsible for similarities in the vital statistics of different populations of the same species, different species of the same genus, etc. It is hoped that this work will lead to methods for the stock assessment in tropical, multispecies environments.

Fisheries biologists trained at ICLARM in the use of the ELEFAN programs and other methods for tropical stock assessment (April 1980 to June 1984).

Visitor	Institution	Dates of visit
Mr. J. Ingles	College of Fisheries, University of the Philippines	April 1980 to March 1982
Mr. R. Regalado	Bureau of Fisheries and Aquatic Resources, Research Division, Manila	Sept. 1980 to March 1982
Dr. Yap Siew-Yang	Dept. of Zoology, Universiti Malaya, Kuala Lumpur	May-June 1981
Mr. Paul Dalzell	Division of Fisheries, Kavieng, Papua New Guinea	September 1982
Dr. Sann Aung	Sea Fisheries Survey and Research Unit, Rangoon, Burma	June-Oct. 1983
Mr. Mohd Zaki Mohd Said	Faculty of Fisheries and Marine Science, Univ. Pertanian Malaysia, Kuala Lumpur	November 1983
Mr. Mohd Azmi Ambak	Faculty of Fisheries and Marine Science, Univ. Pertanian Malaysia, Kuala Lumpur	November 1983
Mr. G. Tampubolon	Balai Pengembangan Penangkapan, Ikan, Semarang, Indonesia	Nov.-Dec. 1983
Mr. L. Pinto	Department of Biology, De La Salle University, Manila	December 1983
Dr. K. Sivasubramaniam	Bay of Bengal Programme, Colombo, Sri Lanka	February 1984
Mr. Abdul Rehman Abdul Ghaffar	Kuwait Institute of Scientific Research, Kuwait	February-April 1984
Mr. Aye Pyo	Sea Fisheries Survey and Research Unit, Rangoon, Burma	April-May 1984
Ms. Anette Juinio	Marine Sciences Center, University of the Philippines, Manila	May 1984
Ms. Chan-Eng Heng	Faculty of Fisheries and Marine Science, Univ. Pertanian Malaysia, Kuala Lumpur	June 1984
Mr. Liew Hock Chark	Faculty of Fisheries and Marine Science, Univ. Pertanian Malaysia, Kuala Lumpur	June 1984
Mr. R. Matipa	Department of Fisheries, Chilanga, Zambia	June 1984
Ms. A.S. Cabanban Ms. E. Cortes-Zaragoza Mr. I.D. Manganang Mr. C.R. Pagdilao Mr. N.A. Navaluna and Ms. D.P. Tandog	M.Sc. students, University of the Philippines, Manila	Various dates

INFORMATION SERVICE

This year marked the beginning of the Service's first project to assist, in an active manner, researchers and institutions in tropical developing countries working in research areas similar to those of ICLARM. Details are given below.

Since the last progress report, formal contact was made with the International Agricultural Research Center (IARC) group, mostly CGIAR centers, by attendance at an IARC information officers meeting in October 1983. A second such meeting is planned for 1985.

In other respects, the Information Service has continued to pursue its duties to ICLARM staff through library activities and publications; it has also begun a more active public relations campaign that has borne considerable fruit over the last twelve months.

Publications

A total of 14 items in ICLARM's technical series was produced over the last 12 months, as well as 10 pamphlets and brochures. The major production was Daniel Pauly's "Fish stock assessment in tropical waters: a manual for use with programmable calculators". Apart from representing a new concept in simplifying the tasks of fisheries biologists, it represents ICLARM's first offering of "software"-pre-programmed calculator program cards are offered as an "optional extra" to this manual. Computer software may be offered with future publications.

Distribution. A second national distributor of ICLARM publications, Pioneer Publishers and Distributors in Bombay was appointed in 1984 for India; the other is International Scholarly Book Services (ISBS), Oregon, for the U.S.A., appointed in 1983. ISBS has sold 409 copies of ICLARM publications from August 1983 to July 1984.

From sales, library exchange and free issue, the total number of books in ICLARM's five technical series distributed since the first publication early in 1980 is 41,066 as of August 1984.

Distribution of quarterly ICLARM Newsletters from the first issue in July 1978 now totals around 90,000 copies.

Publicity/Reviews. Late in 1983, ICLARM appointed a journalist, Mr. Rudy Fernandez, to prepare press releases about the Center's activities. This was an area to which little time had previously been given. Some 20 releases have been made to the regional DepthNews service. All have appeared in a variety of Philippine national and provincial newspapers.

The releases are also sent to various, up to 40, fisheries-related publications around the world. The acceptance rate of these releases has been outstanding and articles based on them have appeared in magazines, journals

and newsletters in Australia, Southeast Asia, various countries in Europe and the U.S.A. Some have been aired on an internationally broadcasted program of the British Broadcasting Corporation. Some have also been published in secondary outlets, magazines and newspapers reporting or summarizing previously published articles.

A growing number of ICLARM publications are receiving reviews in the primary literature in American, European and international journals. Apart from endorsing the quality of the contents of the publications, reviews have proven to be prime means of publicizing them. Other fisheries related journals and magazines regularly note the availability and source of ICLARM publications sent to them.

Exhibitions. This year ICLARM books have been displayed in India at the New Delhi World Book Fair; the 16th Singapore Festival of Books; for the second time at the Frankfurt Book Fair, on the Philippine stand as well as that of the International Agricultural Research Centers; and various displays in Manila and Cebu in the Philippines.

Translations. Several reports by Dr. Daniel Pauly for FAO have been translated into French and Spanish over the past 18 months. A milestone occurred recently with the news that ICLARM's already best-selling book "The biology and culture of tilapias" has been translated into Chinese for distribution in the People's Republic of China. A second ICLARM report on "Applied genetics of tilapias" has been translated into Chinese and is awaiting publication.

Library

The library's holdings of books and monographs increased by 27.5% in the past 12 months; the number of serial titles received increased from 390 to 555 (483 of which are received in exchange or free); and the reprint collection increased from 2,330 titles in 1983 to 2,600 at the end of August 1984.

Some 660 visitors used the library in the eight months from January to August 1984. On an annual basis this indicates a 68% increase over external library usage in 1983. By comparison, there were about 150 external users in 1981.

Contribution Series

ICLARM's contribution series records all published articles by ICLARM staff and by external authors on commission. As of September 1984 the total number published or in press was 217. The full list is provided on p. 87. Many of these contributions are offered free and advertised in the ICLARM Newsletter.

External Information Services

The Selective Information Service, a project sponsored by the International Development Research Centre (IDRC) of Canada, became operational in 1984. It was advertised in the April 1984 Newsletter and through a pamphlet, as well as through visits to institutions in various countries. IDRC has provided an initial two-year grant for the project.

This service consolidates ICLARM's external information activities, allowing in-depth replies to requests for information on projects within ICLARM's areas of expertise. In common with most institutions, ICLARM staff are hard pressed to find time to respond to enquiries as fully as they would wish. The new project provides staff and time to handle enquiries more efficiently. It also provides avenues of assistance for other institutions wanting advice to improve their own information handling ability.

Asian Fisheries Forum

Last year, the enthusiasm of fisheries scientists of the Asian region for a regular forum and fisheries society was reported. ICLARM sponsored the first meeting of interested scientists in 1983, and distributed a questionnaire seeking the views of readers. Over 600 enthusiastic responses have now been received from around the globe.

A second meeting was held in May 1984, sponsored by IDRC, at which the Asian Fisheries Society was established in response to the views of questionnaire respondents. The Council of the new Society includes two ICLARM staff and ICLARM is continuing its catalytic role through assistance with publicity, publication of pamphlets and providing a temporary secretariat.

Major activities of the Asian Fisheries Society include the Asian Fisheries Forum, the first of which will be held in Manila in May 1986, and a regional fisheries journal.

Meetings, Courses Attended, Papers Presented

Seminar on the Fundamentals of Economic Publishing (International Department of the Frankfurt Book Fair), Cebu City, Philippines, 23-30 November 1983. (L.B. Dizon)

Publishing Seminar on Editorial and Marketing Management (Book Development Council-Publishers Association London and Book Development Association of the Philippines), Manila, 22 February-2 March 1984. (L.B. Dizon, R. Estarez, J.L. Maclean)

National Seminar on United Nations International Referral Network for Environmental Information, Manila, 26 March 1984. (R.M. Temprosa)

NSTA/IDRC MINISIS Seminar-Workshop, Manila, 24-26 April 1984. (R.M. Temprosa and N.I. Jhocson)

Second Meeting of the Foundation Council for the Asian Fisheries Forum and Asian Fisheries Society; First Meeting of the Council of the Asian Fisheries Society; and First General Assembly of the Asian Fisheries Society, Los Baños, Philippines, 30 April-2 May 1984. (J.L. Maclean, R.A. Neal)

Seminar on the Global Network of Science and Technology Information, Manila, 10 May 1984. (H.C. de Castro)

Seminar-Workshop on On-Line Searching Using DIALOG, Manila, 23-25 May 1984. (R.M. Temprosa, N.I. Jhocson, H.C. de Castro and L.B. Dizon)

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Regional Red Tide Workshop (IOC-CSIRC), Sydney, 18-20 June 1984. (J.L. Maclean)

J.L. Maclean. Red tides in Papua New Guinea waters.
The role of bacteria in dinoflagellate toxicity.

SEAFDEC-IDRC Workshop on Shellfish Toxicity, Singapore, 11-14 September 1984. (J.L. Maclean)

J.L. Maclean. Indo-Pacific toxic red tide occurrences, 1972-1984.

J.L. Maclean and R.M. Temprosa, compilers. A bibliography on toxic red fishes and shellfish poisoning related to the Indo-Pacific region.

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1 Fixed term appointment
2 Appointment ended July 1984
3 Resigned 11 March 1984