

PALESTINE

ICLARM REPORT 1987



ICLARM REPORT
1987

ICLARM STATEMENT OF PURPOSE

ICLARM is organized exclusively for charitable, educational, and scientific purposes; and in furtherance of these purposes, ICLARM is to establish, maintain, and operate an international aquatic resources center designed to pursue ... the following objectives:

To conduct directly and to assist others in conducting research on fish and other aquatic organisms, on all phases of fish production, management, preservation, distribution, and utilization with a view to assisting the peoples of the world in rationally developing their aquatic resources to meet their nutritive and economic needs;

To improve the efficiency and productivity of culture and capture fisheries through coordinated research, education and training, development and extension programs;

To upgrade the social, economic, and nutritional status of peoples in the less-developed areas of the world through improvement of small-scale rural subsistence and market fisheries;

To work toward the development of labor-intensive systems to aid employment and of low energy systems to minimize capital and cost requirements;

To publish and disseminate research findings and recommendations of the Center; and

To organize or hold periodic conferences, forums, and seminars, whether international, regional, local, or otherwise, for the purposes of discussing current problems.

ICLARM Articles of Incorporation
1977, Manila, Philippines

ICLARM REPORT 1987

Edited by

**Jay L. Maclean
and
Leticia B. Dizon**

1988

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Cover: Cockle farming community and mangrove forest, Kuala Juru, Penang,
Malaysia. ICLARM is involved in an ASEAN-wide integrated coastal
resources management project (see p. 30). Photo by I.R. Smith.

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PREFACE

In 1986 ICLARM marked its tenth anniversary as an international nongovernmental organization concerned with fisheries research and development. In my preface to the ICLARM Report for 1986 I pointed out the magnitude and importance of ICLARM's hands-on research, aimed at helping to restore and maintain the stocks of fish and other living aquatic resources in inland and coastal waters. One year later, my colleagues on the Board of Trustees having again chosen me as their chairman, I have the opportunity to preface, with pride, our Report for 1987.

The year 1987 was a year of contrasts. There was, as the Report demonstrates, marked and encouraging progress in ICLARM's programs of research and development in both aquaculture and capture fisheries. Awareness of the social and economic problems of fishery-dependent persons and communities continues to guide our research activities. Strengthening of ICLARM-supported networks of scientists and others in national institutions facilitates transfer of vital information between individuals and institutions. ICLARM's admirable information and publication program continues to make available vital data on research methods and results.

Funding of our work by a growing number of national and international entities has increased. The Board of Trustees is grateful for the steady growth in material support. Nevertheless, we recognize that the scale of ICLARM's work is still far from adequate, given the diversity and urgency of the fisheries resource problems facing the nations of the third world. Our search for increased research support was continued vigorously in 1987. As this Report describes, particular efforts have been made to increase support for ICLARM's programs of research in freshwater aquaculture in tropical and subtropical areas. Specific proposals have been developed for consideration by the Consultative Group on International Agricultural Research (CGIAR). Discussion, study and consideration of our proposals are continuing.

On behalf of the Board of Trustees, I wish to offer sincere appreciation to ICLARM's hosts, the Government and people of the Philippines. Our thanks go also to the growing number of institutions and governments who support and provide funds for our programs. And finally, to the Director General and his colleagues on our staff, our compliments and thanks. Their outstanding skills and commitment are both vital and greatly appreciated.

Roy I. Jackson
Chairman
Board of Trustees

INTRODUCTION

The past year has been an exciting period at ICLARM not only because completion of a Five-Year Plan and growing donor interest hold forth much promise for future growth and stability for the Center, but also because of successful program activities in Asia, Africa, the South Pacific and Latin America. For the first time a fully global range of interactions and collaboration has been achieved. Certainly there is much more to do in this respect - further interaction with institutions in French-speaking West Africa, for example - but there need no longer be any doubt about ICLARM's global nature and programs.

The need for such an international program of research, training and information is reinforced at every turn. In my travels around the world, I am always struck by the eagerness of researchers for linkages with ICLARM. No longer necessary are detailed explanatory introductions about ICLARM's purpose and program (and name!). *Naga*, the ICLARM Quarterly, and other ICLARM publications are visible on shelves of research institute libraries worldwide, as are technical publications on results of research in cooperation with national institutions. Conversations during visits with research groups quickly become technical as they should and involve detailed discussions of methodologies, research results and possibilities for greater interaction.

It is clearly not possible for ICLARM to have intensive research collaboration with every fisheries and aquaculture research institution worldwide, but our international networks provide a very constructive avenue for exchange of ideas amongst large numbers of researchers. For example, the Network of Tropical Fisheries Scientists (NTFS) now has 773 members in 85 different countries. The Asian Fisheries Social Science Research Network (AFSSRN) has 8 member institutions in four countries, involving approximately 65 individuals. The ASEAN/USAID Coastal Resources Management Project, implemented by ICLARM, involves all six ASEAN nations in Southeast Asia (one of the few such regional projects to do so) and over 200 national researchers and planners. The newly announced Network of Tropical Aquaculture Scientists (NTAS) already has 88 members from 32 countries. These combinations of active research, networking and information exchange are as effective as they are exciting.

One might think that the only ingredient missing from these linkages is training. In fact, ICLARM undertakes much more training than is generally acknowledged, and I would like to highlight here these activities (Table 1). ICLARM's Resource Assessment and Management Program has undertaken considerable one-on-one training over the years, and 1987 saw a continuation of these activities. During 1987, the

Table 1. Training activities by ICLARM staff during 1987.

Date(s)	Title	Location	Number of participants
Aquaculture Program			
25 Mar-2 Apr	Study Tours of Aquaculture Research Institutions and Farms in Thailand and the Philippines	Thailand, Philippines	14
21-25 Sep	An Awareness Program of Tropical Southeast Asian Aquaculture Technology for Senior Scientists in Malawi and Southern Africa	Malawi	39
28 Sep-2 Oct	Use of Standard Application Software in Research	Malawi	8
1-11 Dec	A Course of Training and Study on Aquaculture and Inland Fisheries Management	ICLARM HQ	2
Resource Assessment and Management Program			
19-30 Jan	Sampling Team Training in Small Pelagics Taxonomy and Data Collection Methods	Philippines	18
17-29 Jan	Acquisition of Fisheries Information: Methods, Problems and Solutions	Bangladesh	35
12 Jan-6 Feb	FAO DANIDA Follow-up Training Course in Stock Assessment in the Tropics	Philippines	20
14 Mar-14 Apr	Training on Stock Assessment, Abd. Halid Mohd. Salleh, Dept. Fisheries, Brunei Darussalam	ICLARM HQ	1
29 Aug-2 Sep	Introduction to the Compleat FLEETAN	Peru	22
7-11 Sep	Introduction to the Compleat FLEETAN	Mexico	16
14 Oct-4 Nov	Training on Stock Assessment, Beatrice Morales-Nin, Univ. of Hawaii	ICLARM HQ	1
19 Oct-13 Nov	Fisheries Management in Bangladesh: Theory, Policy, Problems and Solutions	Philippines, Indonesia, Thailand	8
7-21 Nov	Training on Stock Assessment, Melania Jabat, BEAR	ICLARM HQ	1
23-27 Nov	Inhouse Training on Data Analysis, Louela Dolar, Silliman Univ., Philippines	ICLARM HQ	1
Coastal Resources Management Project			
2-13 Mar	Principles of Coastal Resources Management (1st session)	Thailand	13
9-12 Aug	Principles of Coastal Resources Management (2nd session)	Malaysia	16
4-14 Nov	Methods for Socio-economic Analysis in Coastal Area Management	Singapore	16
Information Program			
3 Feb-13 Mar	Fisheries Information Management for Sri Lankan Librarian	ICLARM HQ	1
26 Feb	Lecture-Demonstration of the Capabilities and Actual Operation of a Computerized Information Retrieval System	ICLARM HQ	30
8 Apr	Practical on Accessing Scientific Information	ICLARM HQ	1
6 Apr-29 May	Indexing and Scientific Information Retrieval	ICLARM HQ	1
7 Aug	Lecture-Demonstration of Computer Database Management	UP Los Baños	20
11 Aug-27 Nov	Basic Library Methodologies and Database Management	ICLARM HQ	1
24 Aug	Lecture-Demonstration of Computerized Library Operations and Database Management System	ICLARM HQ	6
1 Sep-30 Oct	Training on Database Management	ICLARM HQ	1
11-13 Nov	Training on the Use and Application of UNESCO's CES, ISIS Software	ICLARM HQ	2
21 Dec-31 Mar	Interaship Training on Different Aspects of Library Operation	ICLARM HQ	1
Asian Fisheries Social Science Research Network			
6 Jan	Lecture on Fisheries Economics	Indonesia	30
12-16 Feb	Course on Research Issues in Fisheries Economics	Indonesia	24
19-23 Feb	Course on Microcomputers in Research	Indonesia	14
1-22 Apr	Course on Fisheries Economics Theory and Research	Malaysia	25
11-22 May	Course on Introduction to Microcomputers	Thailand	25
22-27 Jun	Course on Microcomputers in Research	Thailand	8
29 Jul-4 Aug	Course on Microcomputers in Research	Philippines	10
2 Oct	Lecture on Fisheries Economics Research	Philippines	30
11-13 Nov	Lecture on Economics and Social Research	Indonesia	19
16-25 Nov	Course on Microcomputers in Research	Indonesia	12

"Compleat ELEFAN" software package, developed by ICLARM scientists, was readied for distribution and introduced through courses to scientists in Southeast Asia, Peru and Mexico. These techniques are now in use in almost 50 countries around the world and have become an integral part of much fisheries stock assessment research and training. Much of the time of the Coordinator of the AFSSRN was spent conducting short courses and individualized training for Network members. Three training courses were offered during 1987 by the ASEAN/US Coastal Resources Management Project and another two by ICLARM's small-scale fisheries staff. Aquaculture program staff conducted four courses, including one in Malawi on aquaculture awareness for aquaculturists and fisheries scientists from four African countries. This course was taught in part by Asian aquaculture researchers and began what ICLARM expects will be a long-term role for the institution of encouraging exchange between Asian and African scientists.

Eight interns and other trainees worked during 1987 at our headquarter's library, now generally acknowledged as one of the world's best libraries on tropical aquatic resources and certainly amongst the forefront of those using computerized information systems to serve researchers internationally.

ICLARM's activities in Africa, the South Pacific and Latin America expanded during the past year. Our first African staff member arrived in Malawi to lead a cooperative program of applied research in integrated farming. This integrated farming theme also received strengthening in Asia with an ICLARM staff member leading the introduction of aquaculture to the 13 member countries of the Asian Rice Farming Systems Network, coordinated by the International Rice Research Institute (IRRI), also based in the Philippines. Research commenced on giant clams at ICLARM's new Coastal Aquaculture Centre, a joint activity with the Government of the Solomon Islands in the South Pacific. During 1987, we also copublished a significant review of the anchoveta fishery of Peru, at times the world's largest. This book and an associated workshop held in Peru in August 1987 were the culmination of six years of cooperative research with the Instituto del Mar del Peru (IMARPE) and the project of the Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ) based at IMARPE and set the stage for a next phase of cooperative work. Formal linkages for collaborative work were also established elsewhere in South America and in Mexico with a research group based at the Universidad Nacional Autónoma de México, for a modelling exercise on data from the fish resources of the southern Gulf of Mexico.

ICLARM's linkages also increased with institutions in developed countries. For example, Simon Fraser University in Canada became a cooperator for the AFSSRN; several individuals from network institutions are being trained there. ICLARM signed in 1987 an agreement with the Ecole Nationale Supérieure Agronomique de Toulouse (ENSAAT) in Toulouse, France, formalizing a relationship that has both training and cooperative research components in fisheries stock assessment and management. Also in March 1987, ICLARM commenced, through a Workshop on Tilapia Genetic Resources for Aquaculture, an international

program of research on documentation, conservation and utilization to produce improved breeds of tilapias. This workshop built on presentations and discussions the previous week at ICLARM's largest-ever conference - the Second International Symposium on Tilapias in Aquaculture - coconvened with the Thai Department of Fisheries.

This outline of selected activities is evidence of ICLARM's growing international character. Our hope is obviously that such a range of global activities can be sustained in the years ahead.

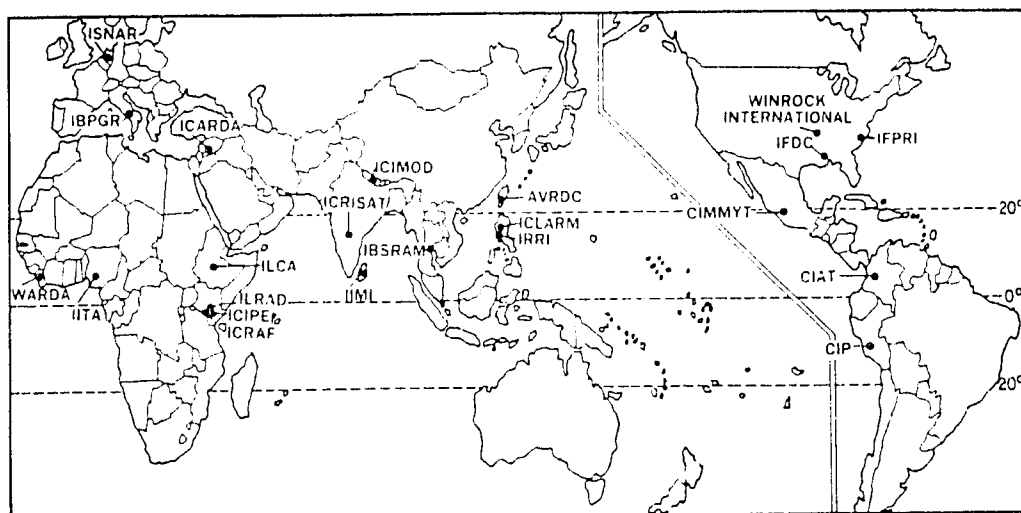
It is not widely known that ICLARM is one of over 20 International Agricultural Research Centers (IARCs) scattered around the globe, thirteen of which are members of the Consultative Group on International Agricultural Research (CGIAR). ICLARM and some of the others are currently seeking membership in this CGIAR group. Fig. 1 shows the headquarters' sites of these international centers.

Each of these international centers was established with a particular goal; some with a commodity focus, others with a resource management focus. ICLARM's Statement of Purpose, shown on page (ii), spans both kinds of goals, resulting in a focus on tilapias, carps and bivalve molluscs as commodities and rational management of capture fisheries, the coastal zone and aquaculture as resource systems.

Membership in the IARC group requires each center to undertake research of an international nature; in effect each member is expected to be a center of excellence in its field, working on basic research topics of broad international impact. This fact places ICLARM on the horns of a dilemma.

Small, with few facilities of its own, the Center to date has carried out its research in a cooperative mode with national and regional institutions. In its Five-Year Plan, ICLARM has identified certain priority research areas for its future program, some of which require facilities for long-term basic research. The most important criterion for conduct of such research is *independence*. The core program must be free from pressures and constraints that might deflect its activities towards the narrower and changeable objectives of host institutions or governments. National centers involved in cooperative activities with ICLARM, many of which are in resource-poor countries, must also be assured that they are not directly or indirectly subsidizing an international program of research.

The dilemma for ICLARM is whether to pursue its basic research areas of broad international concern solely through collaboration with national institutions, or to develop new centralized facilities for the work or to seek some compromise between these extremes. Given ICLARM's conceptual leadership in selected fields and the fact that the Center is the only aquatic-resource IARC, long-term management and control of facilities for basic research is the most logical. However, if pursued to the exclusion of cooperation, it would also be the most "nationally" unpopular choice. It would represent a change in ICLARM's research strategy which very correctly has always included components of institutional cooperation and development of national expertise in the Center's fields of endeavor.



Asian Vegetable Research and Development Center (AVRDC)
 Centro Internacional de Agricultura Tropical (CIAT)
 Centro Internacional de la Papa (CIP)
 Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)
 International Board for Plant Genetic Resources (IBPGR)
 International Board for Soil Research and Management (IBSRAM)
 International Center for Agricultural Research in the Dry Areas (ICARDA)
 International Centre of Insect Physiology and Ecology (ICIPE)
 International Centre for Integrated Mountain Development (ICIMOD)
 International Center for Living Aquatic Resources Management (ICLARM)
 International Council for Research in Agroforestry (ICRAF)
 International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
 International Fertilizer Development Center (IFDC)
 International Food Policy Research Institute (IFPRI)
 International Institute of Tropical Agriculture (IITA)
 International Irrigation Management Institute (IIMI)
 International Laboratory for Research on Animal Diseases (ILRAD)
 International Livestock Centre for Africa (ILCA)
 International Rice Research Institute (IRRI)
 International Service for National Agricultural Research (ISNAR)
 West Africa Rice Development Association (WARDA)
 Winrock International Institute for Agricultural Development (WINROCK INTERNATIONAL)

Fig. 1. International Agricultural Research Centers (IARCs). Reproduced through courtesy of AVRDC.

I would like to assure ICLARM's colleagues everywhere that ICLARM will continue in its "traditional" role of collaborative research, and trust that they will understand our additional obligations within the IARC group. The solution to this seeming dilemma, I believe, will be found through networking approaches involving national institutions with ICLARM providing the network hub, that is, the modest research units (e.g., to keep necessary germplasm) described in the aquaculture section of this Report and in related documents¹.

Currently, the central focus of the IARC group is the CGIAR. During 1987, we were consulted twice by Dr. Clarence Idyll, consultant to the Technical Advisory Committee (TAC) of the CGIAR. The result of these consultations, and others held with Asian and African scientists by Dr. Idyll, was his recommendation to the TAC that ICLARM be asked to implement an international research program in aquaculture (genetics and integrated farming systems). By the end of 1987, TAC debate was continuing on this possibility and ICLARM remains optimistic that 1988 will see progress on this issue and closer linkages with the CGIAR system at least for part, if not all, of our program.

The preparation of a Five-Year Plan during 1987, to cover the years 1988-1992, was a time-consuming yet rewarding task. Most importantly, efforts for this plan helped crystallize for the staff and Board of Trustees ICLARM's future long-term emphasis and program execution. The Center's *modus operandi* on collaborative research with national institutions and scientists was strongly endorsed and will remain an important element of our approach. The thinking that went into this Five-Year Plan is reflected in the individual program sections of this Annual Report. The Plan is available free on request.

The Center's expanded activities have been made possible because the number of organizations that support ICLARM increased over 1986 levels from 14 to 19, while total grants increased 41% to US\$3.1 million. We are extremely grateful for this support for the ICLARM program. Most gratifying has been expansion in organizations which provide unrestricted core support; these are USAID (USA), AIDAB (Australia), DANIDA (Denmark), GTZ (Federal Republic of Germany) and as of the end of 1987, the World Bank.

In closing I would like to give a word of thanks to the professional and support staff of ICLARM. It is hard to imagine an organization with a better group of individuals. The past year, which contained its fair share of program opportunities and financial constraints, has produced work of which I and ICLARM's Board of Trustees are extremely proud. This would not have been possible without the level of dedication and input that ICLARM's staff provide.

Ian R. Smith
 Director General
 Manila, May 1988

¹See, for example, ICLARM 1988. Research for the development of tropical aquaculture: a proposed new venture for the Consultative Group on International Agricultural Research (CGIAR). Submitted to the Technical Advisory Committee (TAC) of the CGIAR.

RESOURCE ASSESSMENT AND MANAGEMENT PROGRAM

Background

Fresh water and table salt are the only products consumed by people which are not derived from the earth's biosphere. All other things that we drink and eat were either parts of plants or of animals which themselves directly or indirectly relied on plants. A similar situation exists for textiles and paper, essential elements of our material well-being and of our literacy, respectively, and for the various compounds that form the basis of the pharmaceutical industries. Thus, whether we live in countries that are industrialized or not, developed or not, we still depend totally, to meet our bodily and cultural needs, on photosynthetic processes and biological production.

This undisputable fact, one may think, should be reason enough for a major part of human activities and material research to be directed, worldwide, toward the management and improvement of the earth's productive capacity - especially in view of the rapid increases of the world's population. However, one does not need to be an alarmist to note that it is precisely the opposite which is happening. Worldwide, and particularly in tropical third-world countries, where population growth is most rapid, the very basis of the earth's biological production is being gradually and quite literally eroded away.

The major causes for this degradation, as far as terrestrial habitats are concerned, are large-scale monoculture, the resulting losses and/or impoverishment of top soil, overgrazing of rangeland and other marginal habitats, and deforestation and the resulting erosion. All of these processes directly or indirectly affect aquatic habitats and their biotic production, the areas of concern of ICLAPM's Resource Assessment and Management Program.

The open-access nature of most aquatic resources and their increasing overexploitation, particularly in the last decades, has turned much of the debate between conservationists and resource managers over rates of use into a sterile exercise. The point here is that "tapping of aquatic resources" is usually followed by a rapid, totally uncontrolled expansion of "harvesters" leading to overexploitation and overcapitalization of the fisheries, past any rationally definable optimum.

This situation is documentable for the majority of fisheries throughout the world, tropical and otherwise, as well as for mangrove coastal zone areas. The prevention of further environmental degradation,

the rehabilitation of productive systems and habitats and the rebuilding of exploited resources and animal populations are commonly shared goals for these systems. The task for ICLARM and its cooperators is how research, and associated training and information activities, can contribute to progress in the right direction.

Most fisheries of the world, whether temperate or tropical, inshore or offshore, small-scale or commercial, may be described as "overcapitalized": there are too many fishermen and too many boats chasing too few fishes. However, politicians are often unable to acknowledge constraints resulting from resource limitations, and usually comply with the demands of the most vociferous segments of the fishing industry. This usually prevents long-term solutions to the overexploitation problem; rather, "short-term" solutions, such as further subsidies and/or inconsequential legislation are implemented. Indeed, it is still rare for the overfishing problem to be generally recognized in tropical countries; more often views of "limitless" resources are maintained even in the face of declining annual national catches and scientific evidence to the contrary.

The widespread failure to address economic and social conflicts within the fishing industry, and even to organize fishing to provide a stable supply of fish, most often stems from the failure to fully understand the consequences of three interacting features of fisheries:

- *fisheries resources although often bountiful, are always finite; they do not respond, past a certain level, to further increase of fishing effort by a corresponding increase in yield;*
- *entry into fishing is usually open, with the fish belonging to whomever catches them; fishery resources are "common property" and fishing, unlike farming, is an "open-access" activity; and*
- *demand for fish, for positive economic returns on boats and other capital investments and (in most third-world countries at least) for jobs in the fishing sector are steadily increasing; if left on its own, this demand will always produce levels of fishing effort far beyond that needed to exploit a stock optimally.*

Recent interdisciplinary studies conducted in various parts of the world strongly support the suggestion that small-scale fisheries throughout most of the third world are economically more efficient than large-scale fisheries, besides usually exploiting resources in a way that guarantees their renewal. However, insufficient comprehensive interdisciplinary research has been carried out on small-scale fisheries. For example, a number of comprehensive studies exist on the (large-scale) demersal trawl fisheries of Thailand and the (large-scale) fishery for Peruvian anchovies, both by local (Thai and Peruvian) and by foreign researchers, but few exists on the small-scale sector of these two countries, although they employ far more people (in the case of Thailand) or provide the bulk of the fish for human consumption (in the case of Peru).

There are a number of obvious sociological and other reasons why research on small-scale fisheries is usually neglected. One of them is the simple fact that it is usually far more difficult to study small-scale than large-scale fishermen. In the tropics, small-scale fisherman, operating a

variety of gears which often change between seasons and are often modified as new construction materials become available, usually land their catches at the most unpredictable hours (to nonfishermen at least!), in faraway, inaccessible places. Catches may in part be earmarked for consumption by their own families, with the rest sold in small batches to processors or middlemen with whom the fishermen are linked through complex ties of mutual dependence.

The gathering and analysis of catch and biological data for use in managing small or large-scale fisheries, including that required for the more straightforward practice of stock assessment, are necessary because it is only through analysis of the performance of a fishery, of its catches and their trends that rational decisions can be taken. For example, when analyzed, such data, coupled with data on fleet economic performance, can help determine whether fleet expansion should be encouraged (the rarer case), or discouraged, or whether attention should be given to the development and deployment of new gears or to gear restrictions. One important role for an international center such as ICLARM, devoted to research to improve decisionmaking, should thus be to reduce the costs involved in routine stock assessment, and to make such assessments feasible where previously, as in the case of tropical small-scale fisheries, they were thought to be impractical. This involves concentrating on the development of appropriate methodologies, the area to which ICLARM has devoted its stock assessment research in the last decade.

Fisheries economics research, long seen by many as only complementary to management schemes that were structured around the biology of fish stocks, is also extremely important in tropical fisheries, since fisheries economists, rather than fisheries biologists, are the ones most qualified to assess and compare the direct and indirect costs and benefits of various management schemes. In small-scale fisheries, economists also can help by quantifying the costs and benefits of alternative employment schemes (including aquaculture), evaluating management options, and assessing the indirect costs incurred by developing economies when large segments of populations are kept outside the mainstream of society. Here again, methodologies need to be developed, tested, modified and disseminated.

Another important area, where resource economics can usefully intervene as far as fisheries in third-world countries are concerned, is the marketing aspect. Examples of relevant issues here are the cost/benefits of production for export vs domestic consumption, the competition of developed vs third-world countries on the international fish markets and related issues. Finally, the analysis of resource economics increasingly will be needed to help formulate strategy and tactics of negotiations involving access by foreign nations to their Exclusive Economic Zones (EEZ), as regulated by the new Law of the Sea.

Active programs of management of living aquatic resources in third-world countries are only now being considered by governments because seemingly irreparable damage to coastal ecosystems, of which such resources are a part, is occurring at an alarming rate. Traditional resource management measures by coastal communities in conserving their resources/ecosystems have been abandoned as a result of

economic, political and population pressures, especially since World War II, and can no longer be counted upon to ensure that these resources are available for future generations. New approaches are desperately needed.

Existing management schemes in most nations, including those for fisheries, are unisectoral in approach and mainly directed towards conservation of the resources through various laws and regulations governing their use. However, these laws and regulations in most cases have not been effectively implemented or enforced and illegal exploitation, such as the use of explosives and destructive gears for fish and coralline resources, continues unabated. In fact, it is extremely difficult to find a good example among third-world countries of living aquatic resources that are effectively and scientifically managed.

The complexity and diversity in coastal resource use in the tropics call for integrated coastal resources management strategies involving various relevant economic sectors, the regulation of which requires the understanding and support of those affected. Despite their frequent inability to make hard decisions towards resource management, most governments have become more aware recently of the need for rational, sustainable utilization of their nation's living resources. The problem is that these policymakers are confronted with national economic development priorities that may conflict with long-term resource management, and the absence of or insufficient relevant databases for policy decisions and management options.

One good example of this problem is the large-scale development of mangrove swamps for fish and shrimp ponds. While ecologists have strongly voiced the need to conserve mangrove swamps to help sustain the nursery grounds of certain species of shrimp and fish, they have failed to provide substantiated quantitative data on the potential loss of shrimp or fish stocks in the inshore waters, and of other relevant activities such as nipa palm production, if the mangroves were cut. Consequently, voices in favor of longer-term management have been drowned out by those favoring short-term expediency; the race to develop coastal shrimp farms thus continues unabated.

Sound management of aquatic living resources should be based on scientific databases containing basic resource information which is analyzed and synthesized for formulating management strategies. It is essential, if the management plan is to be workable, to adopt a holistic, integrated approach in resource management plan formulation. This approach must also be interdisciplinary in perspective. Not only regulatory measures are needed to form the basis for environment protection and resource conservation; possible enhancement measures, such as artificial reefs, that potentially rehabilitate resources and restore the environment, should receive equal attention.

ICLARM's activities in this field include a decade of development of appropriate methodologies for the assessment of tropical, multispecies fisheries stocks, as well as a number of economic and sociological studies, which continue to contribute significantly to management approaches for multispecies fisheries. The recent embarkation on a four-year ASEAN/US Coastal Resources Management Project executed by ICLARM and national groups in the six ASEAN nations is providing

further opportunities to broaden the focus of the Center's program and acquire expertise in the development of methodologies for integrated coastal resources management planning.

Progress of Work

One significant achievement of the year 1987 was the completion of ICLARM's Five-Year Plan, from which the above "Background" is adopted and which presents our medium-term plan for tackling the above-mentioned issues.

Apart from training and educational activities, featured in the Introduction to this report, the following major achievements and activities occurred in 1987:

- integration of Brunei Darussalam and Malaysia as 5th and 6th countries participating fully in the ASEAN/US Coastal Resources Management Project; completion of field work by most national teams; and publication of the Brunei Darussalam Coastal Environmental Profile;
- finalization and distribution of a test version of the Compleat ELEFAN software package for detailed analysis of length-frequency data;
- publication of three major texts, i.e., "Ecology of Tropical Oceans" by A. Longhurst and D. Pauly (Academic Press); "The Peruvian Anchoveta and its Upwelling Ecosystem", ed. by D. Pauly and I. Tsukayama and "Length-based Methods in Fisheries Research", ed. by D. Pauly and G. R. Morgan, with the last two produced in cooperation with partner institutions in Peru and Kuwait, respectively; and
- publication of a large number of scientific contributions, documenting the progress of ongoing, or the achievements of recently completed projects of the RAMP Program.

Details on these and related items may be found in the project summaries following this overview.

Work by J.L. Munro within this Program was concentrated in four areas; the editing of Fishbyte, the newsletter of the Network of Tropical Fisheries Scientists; the preparation of a report to the Government of Tonga on the implementation of a cost-effective assessment and monitoring program for the shallow-water fisheries of the island of Tongatapu; an assessment of the status of the spiny lobster fisheries of Tonga; and the development of the sampling and assessment protocol and provision of advice on species introductions in the aquaculture and fisheries management of the Saguling and Cirata reservoirs in Indonesia.

Three issues of Fishbyte were produced and were well received. The newsletter has been notably successful in filling the information gap on resource assessment methods and microcomputer software developments.

Advisory Services

Technical assistance from Drs. M. Agüero and J.L. Munro was requested from the Asian Development Bank (ADB) for the "Fisheries Research and Development Project in Malaysia". The objectives of this project are to help the Government of Malaysia to enhance research and managerial capabilities for their coastal fisheries and develop their offshore fisheries resources.

The consultancy covered the various aspects of the project through a one-month fact-finding mission from April to May to Malaysia, the analysis of its economic feasibility, including a two-week Appraisal Mission in July-August to various sites of the country and a desk study from April to October of alternative designs for artificial reefs.

At the request of the Government of Tonga Dr. J.L. Munro visited Tonga from September 11-27 to advise on the development of a permanent monitoring system for the shelf fisheries of the main island of Tongatapu. The system appears to be operating successfully and is the first real test of what is referred to in the South Pacific region as "the ICLARM system"-essentially a length-frequency based approach combined with routine fishing using standardized fishing gears.

Program Plans

New activities which will be initiated in 1988 are:

- development and implementation of multispecies models as tools for integrating knowledge on fisheries resource systems;
- development of an interactive database on tropical fisheries resources management;
- economics as if people mattered: application to small-scale fisheries management;
- coastal zone management planning; and
- a review of the future of tropical aquatic resources.

In 1988, several trips to Latin America will be undertaken by RAMP staff to identify potential activities, sources of funding, location and cooperating institutions for an ICLARM Latin American Office.

Development and implementation of multispecies models

The fisheries resources exploited in tropical third-world countries are usually multispecific, and may include several dozens or even hundreds of species. Such multispecies systems usually consist of a large biomass of small prey species (which may include valuable shrimp) and a smaller biomass of larger predators. These systems are commonly analyzed on a per-species basis, and usually treated in assessment as if consisting of a single species. Improved models which do not require large numbers of

biological parameters have recently become available and need to be further modified and more widely disseminated.

It is proposed to implement such cost-effective models in various locations over the next five years; selection criteria are: availability of research group(s) interested in a joint activity with ICLARM on this topic; and availability of suitable data sets.

Sites under active consideration with potential cooperating organizations include the Peruvian upwelling ecosystem, the southern Gulf of Mexico and various areas in Southeast Asia (e.g., southern Samar Sea, Philippines, Brunei Shelf, western Indonesian waters).

The research effort itself will be conducted by a small group of ICLARM scientists working in close cooperation with national groups.

Interactive database on tropical fisheries resources management

The information gap discussed earlier in conjunction with tropical fisheries probably cannot be bridged using classical means, such as maintaining extensive libraries, encouraging interlibrary loans and electronic data exchange. Rather, it can be expected that shortage of funds for such classical activities will become increasingly problematical, and hence increase the isolation of scientists working on tropical resources from the mainstream of their science and from reference materials.

We propose to alleviate this problem by developing a self-sufficient database implemented on standard microcomputers (and at first limited to tropical capture fisheries) which would provide key facts and information extracted from the literature. The database would constitute an "expert system" (an artificial-intelligence-type information system in which commands or queries can be made in simple English)

Included will be species identification keys, morphometric data, a summary of growth and mortality information for each species and a summary of biological data on each species. Initially, data on about 200 major species will be provided on diskettes, with the ultimate goal of covering 2,500 species.

Economics as if people mattered and its application to small-scale fisheries management

At excessive levels of effort, resources abundance as well as genetic and faunal diversity are very much reduced. System oscillations and major ecosystem changes are induced also and these may lead to extinction of local fish populations or of endemic species. Fishermen, at least in most third-world countries, are then driven by their need for daily subsistence to destructive fishing practices, such as use of dynamite and poison and in the process destroy the very system upon which their long-term survival relies.

Almost every day, choices are made by governments concerning investments, development schemes and other economic activities which can contribute directly or indirectly to widening the gap between rich and poor. Such actions include subsidized loans being made available for building large trawlers that will operate in waters exploited by small-scale fishermen, or removal of mangrove stands to implement an export-oriented shrimp aquaculture scheme.

ICLARM should continue to address these issues as it has for the past decade and complete the analyses of the planners and consultants who propose such practices by pointing out their hidden (and not so hidden) social costs. This activity will include areas neglected by planners and consultants, such as the cost to society of "policing" poor people; the costs of not educating their children; the costs of not providing adequate preventive health care; and the cost of excessive population growth.

ICLARM's activities in this small-scale fisheries area over the coming years will consist of the following, among other things:

- continued case studies, as currently underway, e.g., in the inland fishery of Bangladesh and in other selected areas of the Bay of Bengal;
- continued training courses and workshops on Management of Marine Fisheries in cooperation with ICLARM's fisheries scientists, with emphasis on research methodologies; and
- exploration of program expansion possibilities in Latin America.

Coastal zone management and planning

Coastal areas of tropical countries are characterized by highly productive ecosystems which support a broad range of economic activities. Possibly no other region in the world is more dependent on the utilization of such coastal resources than the Association of Southeast Asian Nations (ASEAN) region comprising Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore and Thailand.

Coastal resources have contributed significantly to economic development in these countries. However, because the resources have been exploited through extraction, environmental degradation and conflicts in resource use due to lack of coordination between sectors have resulted. Lack of an adequate information base on these resources has been a further complication. Exploitation of such resources must be based on their sustainable utilization in order to meet present and future development opportunities and for this a long-term management perspective is needed. It is against this background that the Integrated Coastal Resources Management Project (CRMP) was formulated. It was initiated in 1986 and is now ICLARM'S largest single project.

The goal of the project is to increase capabilities within the ASEAN region to develop and implement coastal resources management strategies that are comprehensive, multidisciplinary and environmentally sustainable.

The project is funded by the United States Agency for International Development (USAID) for an initial period of four years (1986-1989) and is being executed by ICLARM. As executing agency, ICLARM provides technical and administrative support to national teams as well as facilitates overall project implementation. The CRMP's Project Steering Committee composed of representatives from each of the ASEAN nations is responsible for establishing overall project policy direction and oversees and evaluates project activities and performance.

This major activity will provide ICLARM with extremely valuable experience in the coastal zone management field. At this time it is premature to say exactly what the Center's long-term future involvement will take, but certainly key elements will be in the areas of interdisciplinary research, training and development of educational materials, all of which are part of ICLARM's mandate.

A review of the future of tropical aquatic living resources

Careful reading of published works including projections into the future of major trends in population, agricultural production, energy needs and supply usually reveals that the available information on the fisheries and aquaculture sectors and on the coastal zone in tropical countries is woefully inadequate for any useful projection. ICLARM has the flexibility and the contacts within the scientific community that would be needed to conduct research and publish a comprehensive document which would remedy this situation.

The product envisaged is a set of topical reviews by leading experts in their fields, arranged by issues and regions, which could serve as a reference for national planning agencies, international institutions, government and private donor organizations, NGOs, private investors, banks and other entities. Global issues would include:

- world population growth and its impact on fish demand;
- world fish markets and the role of third-world countries;
- fisheries and aquaculture development and resource conservation;
- the role of tropical fisheries and aquaculture research;
- aquaculture and other uses of resources such as land, water and fertilizers;
- coastal zone management in tropical third-world countries,
- information and training needs for improved fish supply, etc.; and
- constraints to effective management.

The expected product should, more than any of the Center's previous written output make obvious the interdisciplinary research orientation of ICLARM, and the fact that it can play a role that no other organization can assume. The advice of the Worldwatch Institute in Washington, D.C. will be sought so that ICLARM can benefit from that group's highly successful *State of the World* series. The document will also serve as a major planning document for ICLARM's future work in Resource Assessment and Management.

Further details on these plans, and on their implementation may be found in the ICLARM Five-Year Plan (1988-1992) (Parts 1 and 2).

Meetings Attended, Papers Presented

- ASEAN/US CRMP Philippines Sub-Project National Technical Meeting, Manila, 12-13 January. (Chua Thia-Eng, A. White, F. Guarin)
- ASEAN/US CRMP Philippines Second National Steering Committee Meeting, Quezon City, Philippines, 14 January. (Chua Thia-Eng)
- ASEAN/US Coastal Resources Management Project (CRMP) Project Steering Committee Meeting, Singapore, 20-22 January (Chua Thia-Eng, A. White)
- Symposium on the Exploitation of Management of Marine Fishery Resources in Southeast Asia/Twenty Second Session of the Indo-Pacific Fisheries Commission, Darwin, Australia 16-19 February. (M. Agüero, D. Pauly)
- Papers presented:
- Agüero, M. Economic consequences of excessive effort.
- Calvelo, R. and P. Dalzell. A review of the recent status of exploited stock of roundscads in the Philippines.
- Dalzell, P. and R. Ganaden. The overfishing of small pelagic fishes in the Philippines.
- Pauly, D. Theory and practice of overfishing: a Southeast Asian perspective.
- Silvestre, G.T., R. Federzon, J. Muñoz and D. Pauly. Overexploitation of the demersal resources of Manila Bay and adjacent areas.
- Fifth Meeting of the Committee on Resource and Development of the Indo-Pacific Fishery Commission, Darwin, Australia, 20-21 February. (D. Pauly)
- Second International Symposium on Tilapia in Aquaculture (ISTA II), Bangkok, Thailand 16-20 March. (D. Pauly)
- Paper presented:
- Pauly, D., J. Moreau and M. Frein. Comparison of growth performance of tilapia in open waters and aquaculture.
- Hopkins K.D., M.L. Hopkins and D. Pauly. A multivariate model of fish growth, applied to tilapia seawater culture in Kuwait.
- National Conference on Fishery Policy and Planning, Baguio, Philippines, 16-20 March. (P. Dalzell)
- Paper presented:
- Dalzell, P. and R. Ganaden. The status of Philippine small pelagic fish stocks.
- Haribon Foundation/World Bank Forum on Sustainable Development in Forestry, Fisheries and Agriculture, Manila, Philippines. 30-31 March. (Chua Thia-Eng, A. White, J. Paw and F. Guarin)
- ASEAN/US CRMP Philippines Third National Steering Committee Meeting, Lingayen, Philippines, 23 April. (Chua Thia-Eng, A. White, F. Guarin)
- Bay of Bengal Programme. Consultation on People's Participation in Small-Scale Fisheries Projects, Bangalore, India, 5-9 May. (M. Agüero)
- Paper presented:
- Agüero, M. and E. Gonzalez. Self-regulatory mechanisms in small-scale fisheries.
- 5th Asian Fisheries Society Council Meeting, Tokyo, Japan, 13-15 May. (Chua Thia-Eng)

Asian Fisheries Society Fisheries Education Workshop, Kitasato, Japan, 16-18 May. (Chua Thia-Eng)

Paper presented:

Chua, T.E. Fisheries education and training in developing Asia: new challenges to meet development needs.

URI/USAID Coastal Resources Management Round table Meeting, Orcas Island, Puget Sound, USA, 22-24 May. (Chua Thia-Eng)

Coastal Area Management and Planning Network (CAMPNET), Seattle, USA, 25 May. (Chua Thia-Eng)

Paper presented:

Chua, T.E. Coastal resources management initiatives in Southeast Asia.

5th International Symposium on Coastal and Ocean Management, Seattle, USA, 26-28 May. (Chua Thia-Eng)

Papers presented:

Chua, T.E. and J.N. Paw. Aquaculture development and coastal zone management in Southeast Asia: conflicts and complementarity.

White, A.T. and G. Savina. Community-based marine reserves, a Philippine first.

International Conference on Ecology in Vietnam, New Paltz, New York, 28-30 May. (Chua Thia-Eng)

Paper presented:

Chua, T.E. Coastal area management in the Association of Southeast Asian Nations (ASEAN).

ASEAN/US CRMP Malaysian Sub-Project Technical Workshop on Coastal Profile of South Johore, Genting Highlands, Malaysia, 16-18 June. (A. White)

ASEAN/US CRMP Malaysian Sub-Project National Workshop on Coastal Resources Management, Kuala Lumpur, Malaysia, 30 July-3 August. (Chua Thia-Eng)

Pacific Science Congress, Seoul, South Korea, 20-30 August. (J.L. Munro)

Paper presented (*in absentia*):

White, A.T. The effect of community-managed marine reserves in the Philippines on their associated coral reef fish populations.

Segundo Congreso Latino Americano sobre Ciencias del Mar, Universidad Nacional Agraria La Molina, Lima, Peru, 17-21 August. (M. Aguero, M.L. Palomares and D. Pauly)

Invited Lecture:

Aguero, M. "Fundamentos teorico practicos del manejo pesquero en paises subdesarrollados".

Workshop on Models for Yield Predictions in the Peruvian Upwelling Ecosystem, Instituto del Mar del Peru, Callao, Peru, 24-28 August. (M. Aguero, D. Pauly and M.L. Palomares)

Presentation:

Pauly, D. and I. Tsukayama (eds.) The Peruvian anchoveta and its upwelling ecosystem: three decades of change.

Paper presented:

Aguero, M. A bioeconomic model of the Peruvian pelagic fishery.

FAO/IPTP (Indo-Pacific Tuna Programme). Second meeting of Tuna Research Groups in the Southeast Asian Region, University of the Philippines, Quezon City, Philippines, 25-28 August. (P. Dalzell).

Papers presented:

Cortez-Zaragoza, E., P. Dalzell and D. Pauly. Seasonal abundance, morphometrics and hook selectivity of yellowfin (*Thunnus albacares*) off Darigayos Cove, La Union, Philippines.

- Tandog-Edralin, D., E. Cortez-Zaragoza, P. Dalzell and D. Pauly. Some aspects of the biology and population dynamics of skipjack in Philippine waters.
- Planning Workshop on Determining the Socioeconomic Impact of Introducing Seaweed Production as Basis for Marine Aquaculture, Manila, 22-26 September. (Chua Thia-Eng and A. White)
- Seminar on the Current Projects of ICLARM's Resource Assessment and Management Program, 9 October. (all RAMP staff)
- Presentations:
- Gayantlo, F., Jr. The Compleat ELEFAN software package for analysis of length-frequency data for fish stock assessment.
- Palomares, M.L. Estimation of the food consumption of marine fish population.
- Pauly, D. Dynamics of the Peruvian anchoveta.
- ITROFIC Conference and Workshop, University of the Philippines, Quezon City, Philippines. 17-23 October. (P. Dalzell and D. Pauly)
- Paper presented:
- Dalzell, P. Philippine small pelagic fisheries: a review and assessment of present levels of exploitation.
- ASEAN Pacific Island Nations International Fisheries Conference, Manila, 26-29 October. (Chua Thia-Eng)
- Snellius II Symposium, Jakarta, Indonesia, 23-29 November. (D. Pauly)
- Paper presented:
- Dalzell, P. and D. Pauly. Assessment of the fish resources of Southeast Asia with emphasis on the Banda and Arafura Seas.
- First Indian Fisheries Forum, Mangalore, Karnataka, India, 4-8 December. (Chua Thia-Eng)
- Paper presented:
- Chua T.E. and J.L. Maclean. Has scientific research in Asia contributed to Asian fisheries development?
- 9th Shrimp and Finfish Management Workshop, Safat, Kuwait, 7-9 December. (D. Pauly)
- Paper presented:
- Pauly, D., M. Soriano and M.L. Palomares. On improving the construction, parametrization and interpretation of steady-state multispecies models.

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Resource Assessment and Management Program Project Summaries

- Project Title** : Tropical Fish Stock Assessment Project
- Cooperating Institutions** : Predominantly in-house studies, with informal linkages with various research institutions
- Duration** : Continuous from July 1979
- Key personnel** ICLARM : Dr. Daniel Pauly
Dr. John Munro
Ms. Ma. Lourdes Palomares
Ms. Mina Soriano

Objectives

- To increase our understanding of the dynamics of exploited tropical fish communities.
- To develop stock assessment methods which are straightforward and readily applicable to tropical stocks.

Results

In 1987, the emphasis of this project which had hitherto been concentrated on the development and dissemination of computer-based methods for the analysis of length-frequency data was gradually shifted toward multispecies modelling.

Here, three main lines of study were followed:

- development of multispecies yield-per-recruit and mesh size optimization models;
- refinement and large-scale application of methods for the estimation of food consumption of natural fish populations; and
- improvement of existing methods for the construction of multispecies food web models.

The first line of study, mainly by Ms. M. Soriano working in cooperation with Mr. G.T. Silvestre (University of the Philippines, College of Fisheries), led to the development of a set of versatile routines for multispecies yield-per-recruit analysis which explicitly incorporate selection ogives and length-specific "values" (biological or commercial). This package will be incorporated as "ELEFAN VI" in the Compleat ELEFAN package, and models behind its various routines will be documented in the primary literature.

The second line of study, followed mainly by Ms. M.L. Palomares, consists of identifying and standardizing, for as many species of fish species as possible, literature estimates of their food ration, and using the latter to derive an empirical model of food consumption in marine fish.

Extremely encouraging results were presented in December 1987 at a scientific meeting in Kuwait and it is expected that a suitable empirical model as needed for multispecies modelling, will be available by the end of 1988.

Regarding the third line of study on improving food web models, a first step was the reformulation of the "ECOPATH" approach of J. Polovina and coworkers (NMFS, South West Center, Hawaii) and its integration with the theory of R.E. Ulanowicz (1986, *Growth and Development: Ecosystems Phenomenology*, Springer Verlag). A computer program ("ECOPATH II") and documentation along these lines was presented at the Kuwait meeting mentioned above. This work, which is based on both ecological theory and on the theory of fishing, and which also relies on food consumption studies (see above) shows great promise for integration of studies on tropical aquatic systems, and will receive growing emphasis in 1988 and beyond.

As in previous years, opportunities were taken, whenever they offered themselves, to investigate various subject matter not necessarily covered by the main areas of emphasis. These various "excursions", and the main areas of emphasis described here led to a large number of publications and increased recognition for the project.

Also, two ICIARM staff successfully defended MS theses at the University of the Philippines in 1987:

- Ms. M.L. Palomares defended her thesis entitled "Comparative studies on the food consumption of marine fishes with emphasis on species occurring in the Philippines" (16 October 1987)
- Ms. M. Soriano defended her thesis entitled "A graphical method for separation of mixture distributions into its Gaussian components" (5 November 1987)

Project Title : Network of Tropical Fisheries Scientists

Cooperating Institutions : Fisheries Resources and Environment Division, Fisheries Department, FAO; FAO/DANIDA Training Course in Fish Stock Assessment in the Tropics; Norwegian Agency for International Development (NORAD)

Duration : Continuous from April 1982

Key Personnel ICLARM : Ms. A. Cruz (Network Secretary)
Dr. J.L. Munro (Fishbyte Editor)

Objectives

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

By the end of 1987, the Network of Tropical Fisheries Scientists (NTFS) membership totalled 760 from over 80 countries worldwide. Members from Asia accounted for 40% of the total (see Fig. 2). Potential growth areas are the Pacific, Caribbean and the South Central American region. Several new members from these regions were nominated by staff of the Norwegian/FAO RV FRIDTJOF NANSEN project, and it is expected that cooperation will increase between the NTFS and the latter project, which is also supported by NORAD.

Three issues of the newsletter Fishbyte were published in 1987. The second of these was mailed with an updated list of active NTFS members. Active members continue to contribute scientific publications to the growing Network library. These, and publications from the FAO, have been distributed to interested Network members.

The Marine Science Division of UNESCO has recently agreed to donate copies of its Reports in Marine Science Series to the Network for distribution to interested members. In late 1987, UNESCO questionnaires on the future of marine science teaching were distributed to the NTFS members.

These new interactions between NORAD and NTFS and between UNESCO and NTFS will strengthen the Network and make it even more relevant to the needs of fisheries research workers in the tropics.

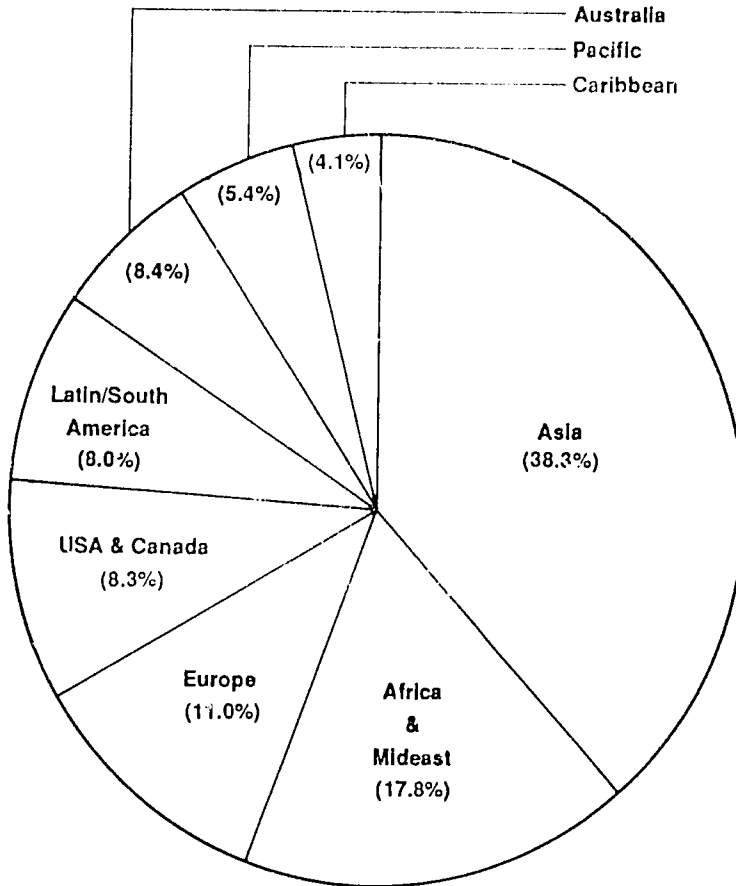


Fig. 2. Regional Distribution of NTFS members in 1987.

- Project Title** : Management-Oriented Fisheries Research Project
- Cooperating Institutions** : Marine Fisheries Research Institute (BPPL), Jakarta, Indonesia; Instituto del Mar del Peru (IMARPE) and Programa Cooperativo Peruano-Aleman de Investigatlon Pesquera (PROCOPA), Callao, Peru; Laboratory for Ichthyology and Coastal Systems (LICS), Limnology and Marine Science Institute, Universidad Nacional Aut6noma de M6xico (UNAM), Mexico City.
- Duration** : Continuous from April 1982
- Key Personnel**
- | | | |
|---------|---|------------------------|
| BPPL | : | Mr. A. Dwippongo |
| IMARPE | : | Ms. I. Tsukayama |
| PROCOPA | : | Dr. H. Salzwedel |
| UNAM | : | Dr. A. Yañez-Arancibia |
| ICLARM | : | Dr. D. Pauly |

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.
- 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

Several activities conducted under this project were successfully concluded in 1987. First, an update version of the ELEFAN programs for use on TRS-80 microcomputers was completed in mid-1987 and sent to Zambia, completing ICLARM's commitment of support to the Zambia module (1984-1986).

The work of the Indonesian module, whose staff were also supplied with the newly developed software, ended with the publication of an "Atlas of the growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters" (ICLARM Tech. Rep. 17), with generous support from the L.J. and Mary C. Skaggs Foundation, Oakland, California.

Informal links with the Department of Fisheries in Zambia and with BPPL Jakarta will be maintained to ensure, among other things, analyses of data sets gathered during the active phase of these modules.

The two other modules active in 1987 are the Peruvian module and the newly established Mexican module.

Peruvian module. The key results of the first phase of this module, completed in mid-1987, were published in a well-received volume entitled "The Peruvian Anchoveta and its Upwelling Ecosystem: Three Decades of Change" (D. Pauly and I. Tsukayama, eds., ICLARM Studies and Reviews 15) which was completed in time to be presented at a major congress of marine scientists in Lima, Peru, and which also formed the background of an international IMARPE/PROCOPA/ICLARM workshop on "Models for Yield Prediction in the Peruvian Upwelling Ecosystem" held at IMARPE, 24-28 August 1987.

This workshop accomplished several relevant tasks:

- provision of advice to IMARPE on its future sampling and research programs;
- definition of the elements of a simulation model of the Peruvian upwelling ecosystem, with emphasis on the food fishes and their management; and
- identification of areas of cooperation between IMARPE and ICLARM, and PROCOPA and ICLARM with regard to a second phase for this module.

The various workshop presentations, including monthly time series of primary production from 1955 to 1985 and stomach contents data from 10,000 anchoveta sampled since 1954 will be issued as a joint IMARPE/PROCOPA/ICLARM publication in ICLARM's Conference Proceedings Series, and will neatly complement the time series in the abovementioned book.

Mexican module. The basis of this module is a Memorandum of Understanding signed in September between LICS and ICLARM.

The module's main activity will consist of the (re) analysis, mainly using powerful length-based methods, of the large database on the fishes and shrimps of the southern Gulf of Mexico obtained by successive trawl surveys, in view of producing an "Atlas" documenting growth, mortality and related parameter estimates and providing the base for a fishery management model for the southern Gulf of Mexico.

Other aspects of the planned activities, initially scheduled for two years, include supervision of students' theses and various translations from and into Spanish.

Project Title : Growth Studies on Cultured Marine Bivalves of Thailand

Cooperating Institution : Chulalongkorn University, Department of Marine Science

Duration : December 1985-May 1987

Key Personnel Thailand : Dr. Suraphol Sudara
: Ms. Jintana Nugranad
ICLARM : Mr. J.M. Vakily

Objectives

- To develop and apply to as many important species as possible, methods for the age determination and growth parameter estimation of Thai bivalves, inclusive of methods based on daily shell rings.
- To analyze extant length-frequency data on Thai bivalves and to derive management options for the stocks investigated.
- To train Thai marine scientists in microcomputer-based stock assessment methods, particularly in analysis of size-frequency data.

Results

Field growth experiments on cockles (*Anadara granosa*) and mussels (*Perna viridis*) performed in 1986 were analyzed and periodic "growth rings" in the microstructure of the shells were identified. It is anticipated that Ms. Jintana will visit ICLARM in early 1988 to learn the operation of the Compleat ELEFAN package as applied to marine bivalves.

Detailed analysis of these data will be presented in (1) the MS thesis of Ms. Jintana on "Growth, mortality, recruitment and reproductive biology of the Asian moon scallop (*Amusium pleuronectes*) in the eastern part of the Gulf of Thailand" to be completed and defended at Chulalongkorn University in 1988 and (2) the doctoral thesis of Mr. J.M. Vakily (Kiel University; supervisor Dr. D. Pauly).

A manuscript containing intermediate results will be submitted to the primary literature in 1988.

- Project Title** : ASEAN/US Cooperative Program in Marine Sciences: Integrated Coastal Resources Management Project (CRMP)
- Cooperating Agencies** : BRUNEI DARUSSALAM-Ministry of Development: Department of Fisheries (coordinating agency), Forestry Department, Town and Country Planning Department, Department of Agriculture; Marine Department, Ministry of Communications; Brunei Museum; Public Works Department; Universiti Brunei Darussalam; INDONESIA-Indonesia Institute of Sciences (coordinating agency); Directorate General of Fisheries (lead implementing Agency); Center for Oceanological Research and Development; Center for Agro-Economic Research, Office of State Ministry of Demography and Life Environment; University of Indonesia; Bogor University of Agriculture; Research Institute for Marine Fisheries; MALAYSIA-Ministry of Science, Technology and Environment (coordinating agency); Fisheries Department (lead implementing agency); Universiti Kebangsaan Malaysia; University of Malaya; Forest Research Institute; Universiti Pertanian Malaysia; Department of Drainage and Irrigation; Department of Town and Country Planning; Universiti Sains Malaysia; Economic Planning Unit of Johore State Government; PHILIPPINES-National Science and Technology Authority; Philippine Council for Agriculture and Resources Research and Development (coordinating agency); University of the Philippines (Diliman); Marine Science Institute, Institute of Social Work and Community Development; University of the Philippines in the Visayas: College of Fisheries; Bureau of Fisheries and Aquatic Resources; SINGAPORE-Science Council of Singapore (coordinating agency); National University of Singapore; Primary Production Department; THAILAND-Office of the National Environment Board, Ministry of Science, Technology and Energy (coordinating

agency); Thailand Tourism Authority; Fisheries Department; Royal Forestry Department; Faculty of Science, Chulalongkorn University; Kasetsart University; Faculty of Social Sciences and Humanities, Mahidol University; Department of Land Development; Phuket Marine Biological Center

Duration : 4 years beginning January 1986

Key Personnel

Brunei Darusalam	:	Awang Matdanan bin Haji Jaafar, Pengiran Sharifuddin Pengiran Haji Yusof, Dr. M.W.R.N. de Silva
Indonesia	:	Dr. Purwito Martosubroto, Dr. Kasijan Romimohtarto, Dr. Subagjo Soemodihardjo, Mr. Mulia Purba, Mr. Zen Uemar Purba, Dr. Nurzali Naamin, Mr. Agus Brotosusilo, Mr. Subhat Nurhakim, Dr. Soerjono Soekanto, Mr. Budihardjo, Mr. Dikdik Sodikin
Malaysia	:	Dr. Abu Bakar Jaafar, Ms. Ch'ng Kim Looi, Dr. Arbain Kadri, Dr. Chan Hung Tuck, Dr. Lim Poh Eng, Dr. Kam Suam Pheng, Mr. Sieh Koh Chi, Dr. Koh Hock Lye, Mr. Mohd. Zaki bin Mohd. Saad, Dr. Ang Kok Jae, Dr. Jahara Yahaya, Dr. Wong Poh Kam, Dr. Wan Arafah
Philippines	:	Dr. Rafael Guerrero III, Dr. Edgardo Gomez, Dr. Liana McManus, Prof. Ricardo Federizon, Mrs. Leda Handog, Prof. Elmer Ferrer
Singapore	:	Mr. Leslie Cheong, Dr. Chou Loke Ming, Dr. Chia Lin Sien
Thailand	:	Mr. Arthorn Suphapodok, Dr. Teerayut Pcopetch, Mr. Yodchai Karnasuta, Mr. Somporn Losawadikul, Dr. Munawadi Hungspreugs, Mr. Prawin Limpasichol, Mrs. Nisakorn Kositrana, Dr. Sanit Aksornkoe, Dr. Choopol Ngampong-sai, Dr. Pisoot Vijarnsorn, Dr. Subarn Panvisavas, Mr. Robert J. Dobias, Mr. Chalernsak Wanichsombat, Dr. Sirikul Bunpapong
ICLARM	:	Dr. Chua Thia-Eng (Project Coordinator), Dr. Alan T. White (Technical Advisor), Mr. James N. Paw (Project Specialist), Mrs. Flordeltz Y. Guarin (Project Specialist)

Objectives

The goal of the CRMP is to increase existing capabilities within the Association of Southeast Asian Nations (ASEAN) region to develop and implement comprehensive, multidisciplinary and environmentally-sustainable coastal resources management strategies through:

- analysis, documentation and dissemination of information on trends in coastal resources development;
- increasing awareness of the importance of coastal resources management policies and identification, and where possible, strengthening of management capabilities;
- provision of technical solutions to coastal resources use conflicts; and
- promotion of institutional arrangements that bring multisectoral planning to coastal resources development.

Results

In 1987, the ASEAN-US Coastal Resources Management Project (CRMP) took initial steps towards the development of environmentally sustainable management plans for the ASEAN region's invaluable coastal resources. After two years of operation, the project has attained most of the goals originally set for the initial phase.

A major achievement of the project in 1987 is the full participation of Brunei Darussalam and Malaysia in all aspects of project activities, thus making the project one of the few with full ASEAN participation.

ICLARM project staff continuously provided technical advice, participated to the extent possible in in-country activities, provided logistical support and information services. They regularly visited the countries and met with the national staff and researchers to discuss problems, offer advice, make suggestions, join in the field surveys, help organize and conduct workshops, meetings and training courses, and bring in other organizations or individuals to the project as needed.

Brunei Darussalam. All planned activities of Brunei Darussalam for 1987 were carried out. A multidisciplinary team from ASEAN nations was deployed to work with the national scientific team in undertaking field surveys on the country's coastal ecosystems between April and June. The results were analyzed and published in "The Environmental Coastal Profile of Brunei Darussalam: Resource Assessment and Management Issues". This profile has provided the necessary database for the identification of management issues and information gaps which form the basis for the development of a coastal resources management (CRM) program in the country. The Government has shown great interest in the project and has incorporated a number of project tasks in its national program which is to be implemented using national funds.

Indonesia. The coastal profile of Cilacap was completed in early 1987. Field activities, however, were slow to commence because of technical refinements to the original 1987 work plan and cashflow difficulties. Other factors which contributed to the delay of project

activities were the Indonesian general elections on 22 March-25 April, the Ramadan feast in May, the lengthy process of procuring equipment and slow flow of documents.

By July, most field task activities were underway and by the end of 1987, significant progress has been made in field studies. The sub-project is planning a technical reporting and planning workshop in January 1988.

Malaysia. The Malaysian subproject commenced its coastal profile preparation activities in late 1986. The initial draft was completed by a team of scientists from the Universiti Kebangsaan Malaysia (UKM) and the results were presented at a national workshop in June. A second draft is currently being reviewed for publication. Two national workshops were conducted to develop CRM program plans which were finally completed in November. Both the Federal Government and the State Government of Johore are very keen in CRM planning as manifested by strong government commitment to project plan implementation.

Philippines. The Philippine subproject has been able to implement most of its planned field research for 1987. The coastal environmental profile has been completed and is ready for publication in early 1988. The biogeographical and anthropological study teams have gathered much information on the economic situation and perspective of rural fishermen at the project site. They have also put together a newsletter, "Mangalap", which comes out with current findings of the research teams. Some of the initial results have been included among the project's working paper series.

Singapore. Singapore has completed its country profile which is now in the final stages of editing. It has also administered a questionnaire survey in households to gauge their perception and use of coastal areas. Development of cage culture systems is an on-going task activity which also includes a study of fish caught near and outside cage farms. Site selection and assessment of artificial reefs has been completed and construction began in December. Rehabilitation of the Singapore River by stocking shrimps, seabass and red tilapia are on-going although initial results were not satisfactory.

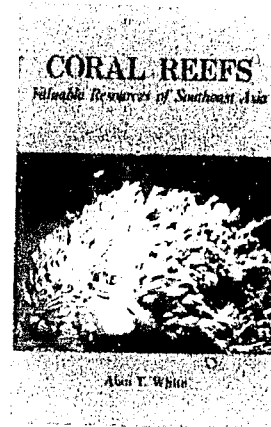
Thailand. Most research activities have been implemented according to schedule. The environmental profile of the Upper South is in the final stages of review and will be published in 1988. The emphasis, as research is completed, will turn to CRM planning. In late December, a planning team was appointed to oversee the development of CRM plans. In some project tasks base maps for CRM planning have been prepared from field data. Initial results will be presented as technical reports. The coordinating agency has conducted a public forum to seek local community participation.

Information

Newsletter. The project came out with three issues of the newsletter, "Tropical Coastal Area Management". It is now being distributed to approximately 1,500 institutions and individuals in 92 countries.

Technical Series. The Environmental Coastal Profile of Brunei Darussalam was published and the other five coastal profiles are being reviewed and edited for publication. Technical reports submitted on project tasks are also being reviewed for publication in the Technical Report series.

Education Series. The Project has published its first educational handbook "Coral Reefs: Valuable Resources of Southeast Asia". A second handbook, "Marine Parks and Reserves: Management for Coastal Environment in Southeast Asia", is scheduled for completion in February 1988. The third on seagrass habitats and management is currently being prepared.



Library and Services. The project continues to purchase relevant reference books and journals on CRM. The library has also solicited relevant articles from appropriate journals in response to requests of field staff.

Participating countries can avail of the library service and request reprints. The number of requests received to date is about 450.

Working Paper Series. The project has come up with a working paper series which consists of major project documents (progress reports, training documents, preliminary technical reports, country profiles, etc.) for in-house circulation. To date, there are 37 documents in the series. Notable outputs in 1987 included a draft directory of CRM institutions and scientists in ASEAN and the Project's research and training activities for 1986-1989.

Institutional Linkages

The Project continues to maintain dialogue and cooperation with various international and national agencies involved in coastal resources management and related activities. Linkages have been established with USAID missions and other relevant USAID CRM-related projects in Southeast Asia. The Project maintains close working relationship with 38 national institutions in the ASEAN countries. These form a sizeable network of ASEAN organizations engaged in coastal resources planning and management activities.

- Project Title** : Management Options for Tropical Small-Scale Fisheries
- Funding Institutions** : The Ford Foundation; Bay of Bengal Programme (BOBP); Food and Agricultural Organization (FAO) of the United Nations
- Cooperating Institutions** : Ministry of Fisheries and Livestock (MF&L), People's Republic of Bangladesh; BOBP; FAO; Bangladesh Centre for Advanced Studies (BCAS), plus informal linkages with other institutions
- Duration** : Four years, beginning March 1986
- Key Personnel** ICLARM : Dr. M. Agüero, Mr. E. Gonzalez

Objectives

- To develop further suitable interdisciplinary research methodologies for analysis of management options in small-scale fisheries.
- To develop further quantitative as well as qualitative tools for the analysis of important socioeconomic aspects of tropical small-scale fisheries and the identification of the basic underlying cause-effect relationships.
- To identify and document the various institutional types and conditions that have resulted in successful management of small-scale fisheries and related activities in tropical third-world countries.
- To develop and widely disseminate a research manual based on the above interdisciplinary methodologies and findings.
- To develop a curriculum and courses in the use of these methodologies and on applications of microcomputers in fisheries management.

Results

Several research and training activities were conducted during this year as part of the overall project:

Bangladesh Project. during 1987, the following activities were completed:

- A multidisciplinary research team was formed with members of BCAS and MF&L.
- A detailed bench mark study of the inland fisheries of Bangladesh was conducted and a final report drafted, which includes a description of the research methodology.

- Several meetings with the Secretary of the Ministry of Fisheries and Livestock, the Joint Secretary and the Director of Fisheries of Bangladesh were held on the research findings, policy recommendations and future activities of the project.
- Two powerful microcomputers were purchased and set up in the headquarters of the Directorate of Fisheries of Bangladesh.
- Two intensive training courses were conducted:

The first of these, on the "Methods, Problems and Solutions of Data Acquisition", was held in Dhaka, Bangladesh, 17-19 January 1987. The objectives of this training course were: 1) to enhance the skills and capabilities of MF&L District Officers and field officers in data collection, supervision and control; 2) to provide supervisors of data collection efforts with a better understanding of the methods, techniques and possible solutions to problems of data acquisition.

The second course was on "Fisheries Management in Bangladesh: Theory, Policy, Problems and Solutions", 19 October-13 November 1987. This course had two components: classes/lectures delivered at ICLARM headquarters with the participation of ICLARM staff and several guest lecturers with experience in fisheries management; and a field trip in the Philippines, Indonesia and Thailand. The purposes of this second course were: to enhance the skills and capabilities of Senior Officers of the MF&L Bangladesh directly involved in the project and of selected members of the monitoring team of the project and NGOs to analyze management problems of inland fisheries of Bangladesh; and to expose the participants to methods, techniques and possible management solutions that have been applied in other countries.

Parallel to these training activities, linear programming and econometric techniques are being used to model the inland fisheries of Bangladesh in a doctoral dissertation being conducted at ICLARM by University of Chittagong's resource economist, Mr. A.K.M. Mahfuzuddin Ahmed, who finished his Ph.D. course requirements at Universiti Pertanian Malaysia (UPM). Guidance and supervision is provided by Dr. Max Aguero.

In 1987, planning for an ICLARM/IFAD (International Fund for Agricultural Development) Project, "Socioeconomic Study of Impact of a Fish Culture Extension Program on the Farming System in Bangladesh", was initiated. It will strengthen ICLARM's involvement in the development of the fishery sector of Bangladesh, through the participation of both the Resource Assessment and Management and the Aquaculture Programs of ICLARM.

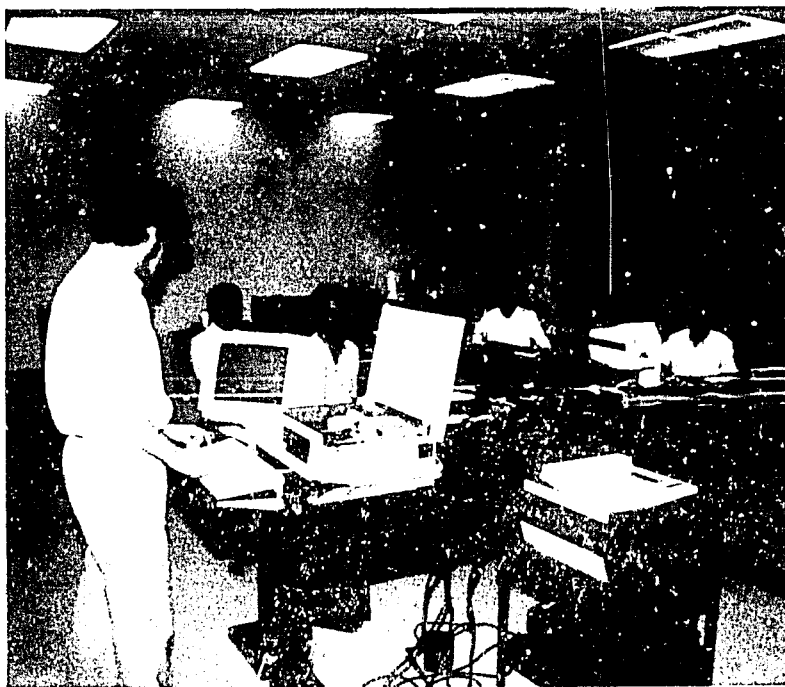
Self-regulatory mechanisms. A study on the identification, analysis and evaluation of self-regulatory mechanisms as management options for small-scale fisheries was conducted under the sponsorship of BOBP. A draft entitled "A Review on Self-Regulatory Mechanisms for Fisheries Management in Small-Scale Fisheries" was submitted to BOBP, containing the results, analysis and conclusions obtained during an extensive literature review and the development of case studies in

Indonesia, Malaysia, the Philippines and Thailand which were visited for discussions with representatives of the concerned communities. A joint FAO/BOBP/ICLARM publication is planned for 1988.

Manual on data and information needs for small-scale fisheries management. A manual intended to provide guidelines for the acquisition of information and implementation of a database system for small-scale fisheries management purposes is being elaborated by ICLARM in collaboration with an FAO staff member. A joint publication by ICLARM and FAO is expected to be released in late 1988.

Small pelagic fisheries economic profile. An economic profile of the various gears used in the small pelagic fisheries of the Philippines is under preparation in collaboration with the Small Pelagics Project (see next project summary). The profile is expected to provide indicators on the economic performance and operation of the most important gears used throughout the Philippines.

Master's thesis. RAMP Program Assistant, Ms. A.V. Cruz, worked on improved procedures for the economic and financial analysis of fishery investment projects, under the supervision of Dr. M. Aguero. The data are from the trawl fishery of western Peninsular Malaysia.



Executal Gonzalez uses a microcomputer with overhead projection during the training course for personnel from the Ministry of Fisheries and Livestock, Bangladesh.

- Project Title** : Assessment and Management of Small Pelagic Stocks of the Philippines
- Cooperating Institutions** : Bureau of Fisheries and Aquatic Resources (BFAR), Philippines, with funding from World Bank
- Duration** : August 1986 to August 1988
- Key Personnel** ICLARM : Mr. Paul Dalzell, Ms. Perlita Corpuz, Atty. Reuben Ganaden

Objectives

- To collate and review the available biological and economic data on the small pelagic fisheries of the Philippines.
- To establish a sampling program to obtain improved information on levels of catch, fishing effort and catch composition data on small pelagic fishes.
- To suggest means by which the economic performance of the fishery may be improved.

Results

During February 1987, sampling by field staff of small pelagic landings commenced at six sampling sites in the Philippines. Prior to this the sampling teams, consisting of two biologists and an economist, were trained in the identification of small pelagic fishes and the techniques of data gathering. Several follow-up visits were made to the sample sites by BFAR and ICLARM staff to monitor the progress of the sampling teams. Biological data collection has proceeded without any major problems, but all teams have reported some difficulties in obtaining economic data, particularly from commercial fishing operators. The teams are also required, with BFAR assistance, to collect data on the characteristics of major fishing vessels and gear types. Copies of the raw data are sent monthly to Manila where they are entered into computer files. Copies of these data sets, suitably edited, will be filed at the respective Department of Agriculture offices where the sample teams are based.

It is planned to compile, in a handy format, the length-frequency data for small pelagics from this project and from other sources in the Philippines. This will make the data readily available for fishery scientists to reanalyze in the future. Also, summaries of all the other data sets will be produced in a form readily accessible to other workers.

A large body of data on catch, effort and catch composition of small pelagic species in the Camotes Sea has been collected by BFAR between 1983 and 1987. Towards the end of 1987 these data were jointly analyzed by BFAR and SPM personnel. The results of the analyses will form one of the contributions of the Project. In connection with this work,

efforts were made to obtain growth parameters for one species (*Selar crumenophthalmus*) independent from length data by the use of daily growth rings in the otoliths.

A review of secondary data on Philippine small pelagic fishes was completed by mid-1987, while a general review of contemporary data on small pelagic catches was published in August 1987. Also, a history of the Philippine small pelagic fisheries was reconstructed, covering aggregate effort and catches from 1948 to 1985. These time series (Fig. 3), to be published in 1988, show that Philippine small pelagic stocks are severely overfished. Economic overfishing probably began by the mid-1960s whilst biological overfishing probably began during the mid-1970s.

The final Project document will propose an approach for further monitoring of these trends, and a management scheme for rehabilitation of the fishery.

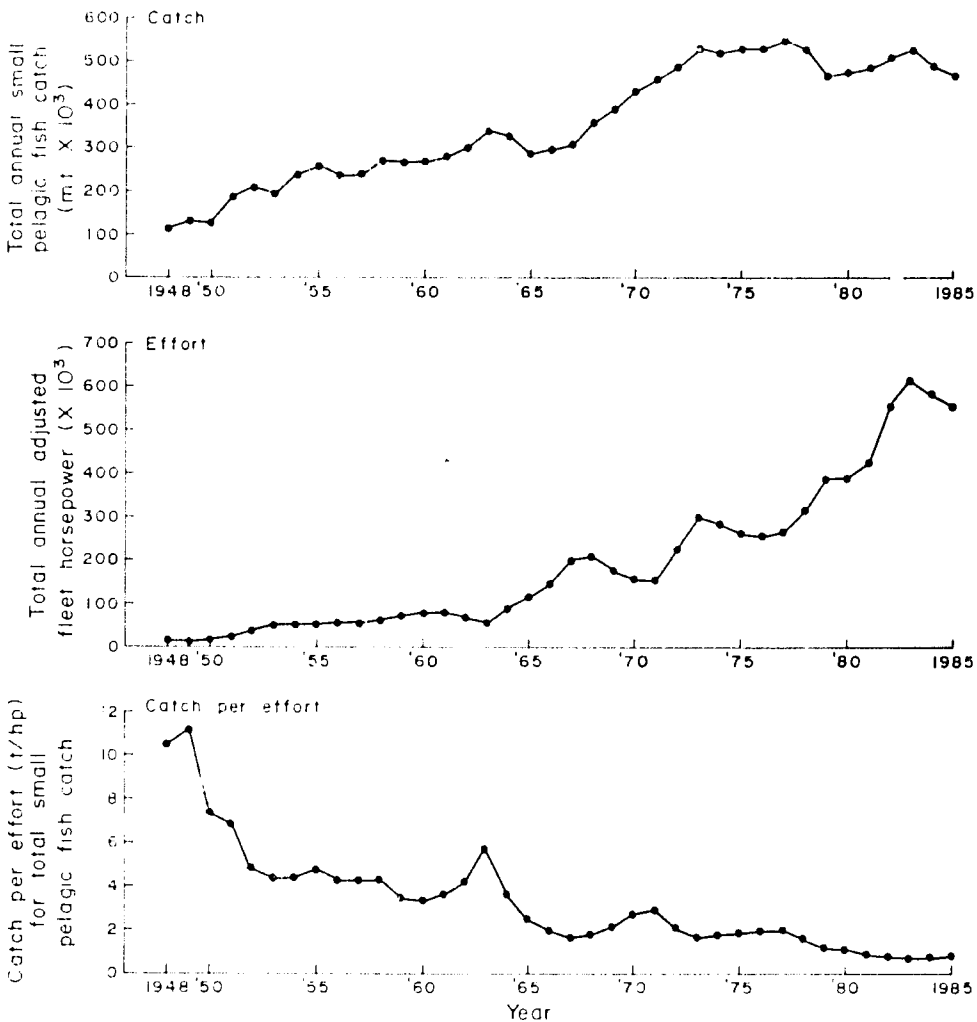


Fig. 3. Time series of total small pelagic catch, fishing effort and catch per effort in the Philippines, 1948-1985. Note steady increase of effort and decline of catch per effort, i.e., abundance and net returns.

- Project Title** : The ICLARM Software Project
- Cooperating Institution** : Predominantly in-house activity, with informal linkages with various individuals and research institution.
- Duration** : Continuous from 1986
- Key Personnel ICLARM** : Dr. D. Pauly, Ms. M. Soriano, Mr. F. Gayanilo, Jr.

Objectives

- Documentation and dissemination of software for calculators and personal computers in the areas of fish population dynamics, fisheries and aquaculture economics, fish genetics and other fields covering ICLARM's areas of interests.

Results

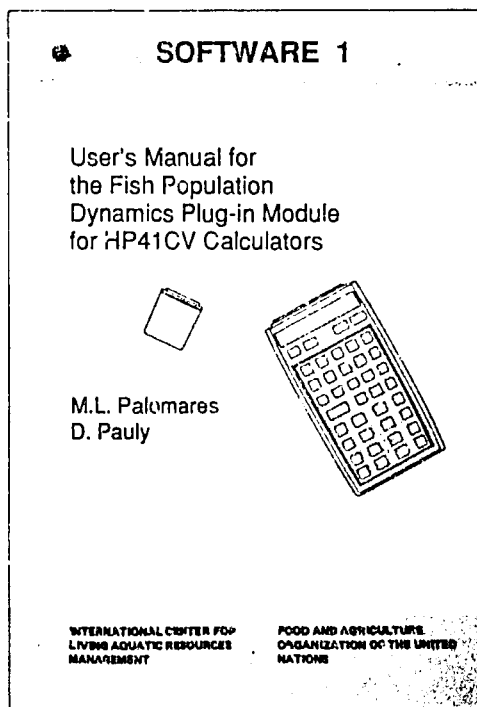
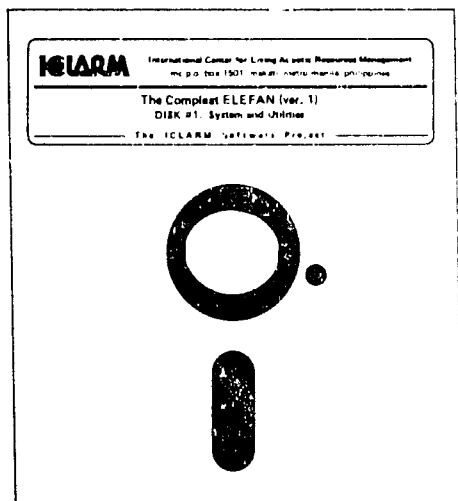
The ICLARM software project is a continuation and amplification of a more specific two-year project by GTZ, the University of the Philippines and ICLARM and devoted to the development of a specific, graphics-oriented software package, the Compleat ELEFAN, for the detailed analysis of length-frequency data. A test version was widely distributed in August-September 1987. The package was also successfully tested during three training courses held in 1987 in the Philippines, Peru and Mexico (further details in Table 1 of the Introduction to this Report). These experiences were used to finalize version 1.0 of the Compleat ELEFAN, which will be ready in early 1988. A detailed manual for this software will be written in 1988 which will replace the short "guide" now distributed with the 10 diskettes making up the Compleat ELEFAN.

Other software development included the updating of the one-diskette version of ELEFAN for Apple II (CP/M) and their compatibles, known as "Kiel Package", of which over 100 copies were distributed by ICLARM to users throughout the world. Additional copies were distributed by staff of the Institut für Meereskunde, Kiel, Federal Republic of Germany, our partner in this venture.

Also, a 16K RAM module for use with HP41CV calculators was designed, based on program listings in an earlier version and 10 modules were produced by a US-based manufacturer. Of these, five were purchased by FAO for distribution to field staff and the others were sold to other users. It is expected that further units will be ordered in 1988 and that this will gradually reduce the unit price.

The manual distributed along with these chips inaugurated the new "ICLARM Software" series, created especially to disseminate the output of this project.

In 1988 a number of programs will be made available for distribution, covering mainly fish stock assessment, but gradually expanding to include programs pertinent to aquaculture and fisheries-related socioeconomic research.



AQUACULTURE PROGRAM

Background

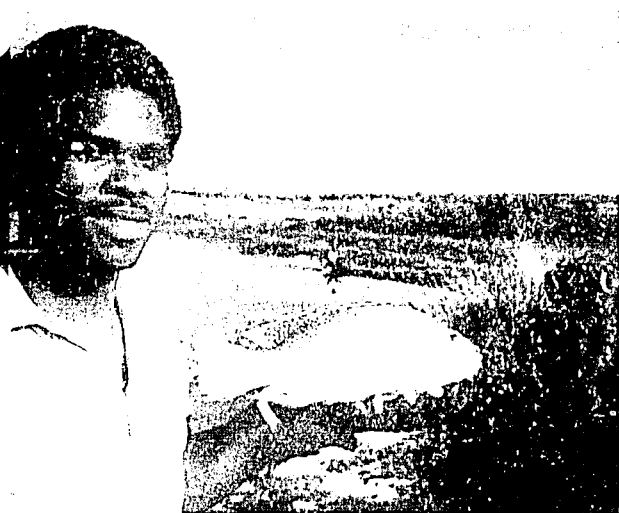
Aquaculture is a diverse set of technologies designed for rearing aquatic animals and plants and has been the topic of considerable discussion, speculation and promotion. With few exceptions, its technologies are poorly developed in comparison to the husbandry of poultry and mammals. In particular, warmwater aquaculture in tropical and subtropical regions is largely dependent on traditional methods involving more art than science, often with seed collected from wild stocks.

With the exception of work on common carp, oysters, salmon, and trout, aquaculture research is a relatively new activity when compared to agricultural research. Most terrestrial livestock were domesticated 7,000-9,000 years ago and have been subjected to selective breeding programs for centuries. For example, research during the past 50 years on poultry and mammals has involved thousands of scientists at numerous research institutions around the world, and there have been major advances in modern husbandry as a result. In contrast, aquaculture research efforts have been few and scattered and have originated largely within the past 15 years. A strong research effort along classical animal husbandry lines is lacking, especially for the most important tropical species.

Many national laboratories, international agencies and private producers are now placing emphasis on aquaculture as an important future source of food. However, they mostly pursue short-term adaptive research and technology transfer, neglecting longer-term, more basic research. Frequent shifts in priorities by governmental groups and by international assistance agencies, their emphasis on 'quick development results', their focus on extension of poorly developed technology, and the scattered and disjointed nature of support for research efforts have all hampered the organization and funding of vital longer-term research, particularly for tropical species. Moreover, there is a general lack of well-trained aquaculture researchers in third-world countries. Hence, research methodologies and rigorous experimentation are poorly developed in many tropical aquaculture research institutions.

A further problem has been the tendency of researchers, educators and their supporting donors worldwide to view aquaculture as a 'part of fisheries' and to isolate aquaculture research and training from agriculture. Aquaculture is a food producing system and must be seen in the broad context of food production by other systems - not only capture

fisheries but also agriculture. This viewpoint is essential for the success of aquaculture development and the avoidance of failures. In particular, it makes no sense to separate freshwater aquaculture from agriculture. Agricultural research and extension are well developed. Aquaculture research and extension are not and can benefit from a closer relationship with agriculture. This is a new perspective for aquaculture and aquaculturists that needs more active promotion and evaluation.



Finfish that feed low in the food chain are highly suitable for third-world aquaculture development. Examples shown here are (left) Nile tilapia (*Oreochromis niloticus*) at the Volta River, Ghana and (right) grass carp (*Ctenopharyngodon idella*) broodstock being sorted at the Udawalawe hatchery, Sri Lanka. Photos by R.S.V. Pullin.

It is the function of ICLARM's Aquaculture Program to help to bring such new perspectives to tropical aquaculture research and to provide leadership in research and training for the development of those sectors of tropical aquaculture most likely to provide income to small-scale farmers and fishermen and to provide fish (a high quality protein food) to domestic markets and consumers.

ICLARM's Aquaculture Program began ten years ago amidst considerable diversity of international opinion on aquaculture research priorities. ICLARM sought first to establish a successful track record in collaborative activities, sharing and wherever appropriate strengthening the facilities of existing national institutions, whilst developing a strategy for long-term work. Twenty-five projects were completed with 20 cooperating institutions together with various ancillary activities, such as training, workshops, conferences, reviews and advisory services. This project-by-project approach, rather than a longer-term program, was partly necessitated by financial constraints. Despite its limitations, it provided ICLARM with a clear perspective on the most appropriate focus for the future development of the program.

The spectrum of potential aquaculture research issues is extremely broad. Based on its work during the previous decade, ICLARM has come

to focus on two research themes as being of major importance for the expansion of tropical aquaculture. These are:

- The genetic improvement of cultured organisms, especially those feeding low in the food web that are cultured by small-scale farmers in less capital-intensive aquaculture systems to supply domestic markets, notably tilapias, carps (common carp, Chinese carps, Indian major carps and other local species) and molluscs (particularly the bivalves - clams, cockles, mussels and oysters).

- The development of technology for low-cost inland and coastal aquaculture systems in which the above species can be grown on organic residues and natural aquatic foods (bacteria, detritus, plankton and plant material).

The main program activities are interdisciplinary, cooperative research and training, combining the biological and social sciences. In addition to generating important research results and strengthening third-world institutions, the various activities undertaken provide leadership in the improvement of research methodology.

The Aquaculture Program is now in transition from a project-by-project approach to a core program of strategic research with associated networks. The structure envisaged for this (taken from ICLARM's 5-year Plan 1988-92) is shown in Fig. 4: three separate research units (with associated network activities) and a small core staff, ICLARM's headquarters to coordinate activities, to provide scientific leadership and to maintain a global Network of Tropical Aquaculture Scientists (NTAS). Interregional cooperation is a major feature of all activities; for example, Africa-Asia cooperation for the genetics and integrated farming themes and Asia-Pacific cooperation in coastal aquaculture. For all elements of the program, contributions to research and training activities include linkages with developed-country institutions and exploratory linkages to institutions in other regions.

The geographical scope for these activities is the entire tropical and subtropical belt. Aquaculture is most developed in Asia, where it has tremendous scope for future growth. However, established systems and recent advances in Asian aquaculture have tremendous relevance for aquaculture development in other regions, especially Africa. The developing countries of Africa lack a history and tradition of aquaculture comparable to those of Asia. Africa has common problems of malnutrition and poverty with many of the third-world countries of Asia, but has relied largely on traditional agriculture and capture fisheries for food production. Africa is the world's least developed region with respect to aquaculture. The reasons for this are complex and include lack of a strong research base and institutional support for aquaculture development and lack of trained personnel. Fundamental sociocultural and economic questions regarding land tenure, labor availability, acceptable farming practices and the scope for aquaculture development in the context of other food producing systems, are also critically important and need thorough appraisal.

Much of Africa is clearly unsuitable for aquaculture in the short term at least because of climatic, social and economic factors. Where aquaculture development makes sense in Africa, the primary need is for

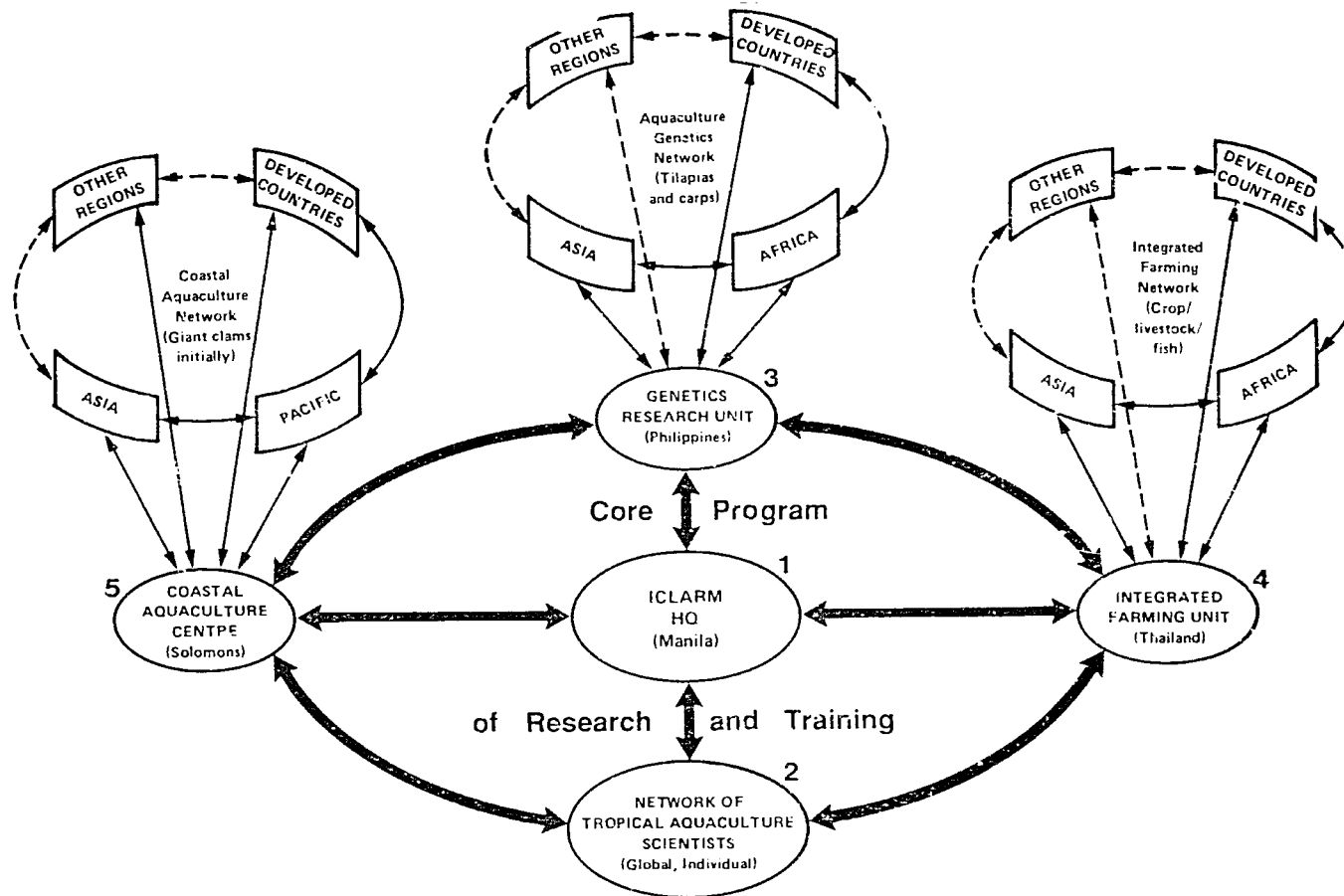


Fig. 4. Diagrammatic representation of the components of ICLARM's Aquaculture Program: 1, ICLARM Headquarters (HQ) (Manila); 2, the Network of Tropical Aquaculture Scientists (NTAS), coordinated by HQ; 3, the Aquaculture Genetics Unit (AGU) (Philippines) and its associated Aquaculture Genetics Network; 4, the Integrated Farming Unit (IFU) (Southeast Asia) and its associated Integrated Farming Network; and 5, the Coastal Aquaculture Centre (CAC) (Solomons) and its associated Coastal Aquaculture Network. The broad arrows (\longleftrightarrow) indicate the linkages between the HQ, NTAS, AGU, IFU and CAC that together constitute the Core Program of Research and Training. The narrow arrows (\longleftrightarrow) indicate interregional institutional networks coordinated from the AGU, IFU and CAC. The regions labelled with capital letters are those containing prominent institutions and research groups participating in network activities. Broken arrows (\longleftrightarrow) indicate possible linkages to other regions (see text).

low-cost technology suitable for broad implementation in rural areas. The criteria for suitability are success in fish production and income improvement over a wide range of conditions of input availability and prices, experience, social circumstances and markets. Systems are needed which are relatively insensitive to changes in inputs and management skills. Integrated farming systems and methods for improving fish production from farm dams and small reservoirs have excellent prospects. In this respect, the Asian experience is invaluable.

Coastal aquaculture of molluscs, especially bivalves, historically most developed in Asia, could be much more widely implemented in other tropical waters of suitable quality. There is interest in aquaculture development in Latin America, the Caribbean and some subtropical regions such as the southern part of the People's Republic of China. ICLARM is establishing aquaculture information and training linkages with individuals and institutions in these regions.

The potential for aquaculture in the South Pacific, in particular, is still largely untapped, although new ideas, technologies and changing economic potentials have suggested that a number of new approaches would be worth pursuing, especially in the context of the present lack of income-earning opportunities in this region. ICLARM has a South Pacific Office that plans and coordinates ICLARM's activities in the region. The South Pacific Office contributes to all ICLARM's scientific programs. However, its greatest emphasis is currently being given to the development of ICLARM's new Coastal Aquaculture Centre on Guadalcanal Island in the Solomon Islands.

The Coastal Aquaculture Centre (CAC) has been established at the invitation of the Government of Solomon Islands to develop economically viable aquaculture systems which will be of significance to the economies of the countries of the South Pacific region in particular and to tropical coastal areas in general. The first major activity is directed towards the development of economically viable hatchery and nursery systems for giant clams, principally the largest species, *Tridacna gigas*. This is a collaborative undertaking by ICLARM and the Division of Fisheries, Government of Solomon Islands. This activity follows a three-year collaborative research project with the James Cook University of North Queensland, Townsville, Australia, which aimed to develop a solid scientific basis for the intensive cultivation of *Tridacna gigas*.

The latter objective has largely been achieved. However, there are numerous other aspects of giant clam cultivation which need to be addressed and it is also apparent that, given the availability of giant clam hatchery facilities, a wide variety of other topics are opened to investigation, requiring few additional capital inputs. These activities are all consistent with the ICLARM objective of developing aquaculture technology suitable for widespread adoption by the island nations that the CAC is primarily designed to serve.

ICLARM's aquaculture program activities are expanding beyond their initial focus on Asian aquaculture systems to assist aquaculture development in other regions. This involves the establishment of mutually beneficial information, research and training linkages.

Progress of Work

Interregional linkages and activities

The year has seen significant progress towards interregional linkages in the Program's research and training activities. This has been possible largely through donor support for ICLARM field staff and facilities on a longer-term basis than hitherto.

ICLARM's African Project Office was established in 1987 in Malaŵi, the lead nation for fisheries and aquaculture development for the Southern Africa Development Coordination Conference (SADCC) countries (Angola, Botswana, Lesotho, Malaŵi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe) through the project Research for the Development of Tropical Aquaculture Technology for Implementation in Rural Africa, supported by the Deutsche Gesellschaft für Technische Zusammenarbeit, GmbH (GTZ). This has provided a modest beginning and a base in Africa for ICLARM's outreach in cooperative research and training.

Among the notable activities led from the Malaŵi project office in 1987 were: 1) the first training workshops conducted by ICLARM in Africa, in which lecturers from Asia, Europe and the United States gave courses on Asian aquaculture, research methods and microcomputer techniques to trainees from Malaŵi, Rwanda, Zambia and Zimbabwe; 2) commencement of construction of new experimental pond and tank facilities for integrated farming research in Malaŵi; 3) commencement of a detailed socioeconomic review of the prospects for development of integrated farming systems in Malaŵi; and 4) the first study tours of Southeast Asian aquaculture organized by ICLARM for African aquaculturists, including visits to Thailand and/or the Philippines by scientists from Cameroun, Côte d'Ivoire, Ghana, Malaŵi, Zambia and Zimbabwe. Two aquaculturists from Peru also joined the Philippine study tour.

The year 1987 was a year of transition for the South Pacific Office as preparations were made for relocating the Office to permanent headquarters at the ICLARM Coastal Aquaculture Centre near Honiara, Solomon Islands. This involved a transitional move to temporary quarters in Townsville, Australia, while the buildings were completed in the Solomon Islands. The office was scheduled to reopen in the Solomon Islands in January 1988. The Coastal Aquaculture Centre became operational in 1987, although the formal opening ceremony will be early in 1988.

The other major event of 1987 with respect to interregional linkages was the commencement of the NTAS - a worldwide network for individual tropical aquaculture scientists. Membership has already grown to more than 50, and is eventually expected to match that of the Network of Tropical Fisheries Scientists (which exceeds 700). The first issue of the NTAS newsletter 'Aquabyte' will appear in 1988.

Major events and achievements

The biggest event of the year for ICLARM's Aquaculture Program was the Second International Symposium on Tilapia in Aquaculture (ISTA II) held in Bangkok, 16-20 March 1987, co-organized with the Thai Department of Fisheries. ISTA II was a resounding success and drew 258 participants from 40 countries. ICLARM representatives will visit the Côte d'Ivoire in 1988 with a view to holding ISTA III there in 1991.

ICLARM also held a 'piggy-back' workshop on Tilapia Genetic Resources for Aquaculture, 23-24 March in Bangkok, following ISTA II. Thirty-seven participants from Africa, Asia and developed countries discussed the documentation, conservation and use in research for aquaculture development of tilapia genetic resources. The recommendations made will strengthen ICLARM's plans for a Genetics Research Unit and Network and the proceedings, to be published by ICLARM, will be a valuable source of reference for all concerned with tilapia culture. The workshop was sponsored by the Federal Republic of Germany, through the German-Israel Fund for Agricultural Research in Third-World Countries.

In genetics research, ICLARM continued its highly productive collaboration with the Philippine Bureau of Fisheries and Aquatic Resources and the Marine Science Institute of the University of the Philippines. The year was spent mainly in improving methods for testing the performance of tilapia strains on station and on farms, the latter being fraught with difficulties in tagging and retrieving fish but essential experience for development of methods for testing and demonstration of genetic gain.

In integrated agriculture-aquaculture research, ICLARM submitted in 1987 through the World Bank its report to the United Nations Development Programme (UNDP) entitled 'Research and Education for Development of Integrated Crop-Livestock-Fish Farming Systems in the Tropics', under a UNDP Preparatory Assistance Grant. This report will be published in 1988 and will provide the framework for ICLARM's future strategic research in this important field.

The year also saw the commencement of a new Asian Development Bank Regional Technical Assistance Grant to ICLARM for Rice-Fish Culture Research, in collaboration with the Asian Rice Farming Systems Network of the International Rice Research Institute and the Freshwater Aquaculture Center of Central Luzon State University in the Philippines. Moreover the International Fund for Agricultural Development commissioned ICLARM to prepare a project document on Rural Aquaculture Development in Bangladesh. This will lead to a project on integrated farming development to be implemented in 1988.

Progress in the construction and development of the Coastal Aquaculture Centre has been excellent. Technical innovations have included extensive use of low-cost ferro-cement tanks and drains and the use of coconut logs and a plastic fabric, usually used for lining dams, for the construction of very inexpensive raceways. While the prime focus of efforts has centered on the Centre's associated giant clam hatchery, the broader aspects of the International Giant Clam Mariculture Project have

not been neglected. Two issues of the informal newsletter "Clamlines" were produced for circulation within the Project group and to interested outsiders. The Fisheries Divisions of Western Samoa and of Kiribati and the Center for Oceanological Research and Development in Indonesia were new participants in the Project.

Collaboration with the Fisheries Research Branch of the Queensland Department of Primary Industry in the analysis of a large database resulted in the preparation of a report on the estimation of growth and size-specific mortality rates for *Tridacna gigas* and *T. derasa* on the Australian Great Barrier Reef.

Among the other important results of the various Program activities, the fish production achieved in the cage culture trials in the Saguling/Cirata reservoir project in Indonesia deserves special mention; 1.5 to 3.0 tonnes/140-m³ cage/year of carp were produced.

Three meetings were particularly important for the Program in 1987. The presence of ICLARM representatives at the mid-year meeting of the CGIAR at Montpellier in May and the meeting of the Technical Advisory Committee and the CGIAR in Washington in October undoubtedly helped to emphasize ICLARM's viewpoints on those sectors of tropical aquaculture most in need of research support through a CGIAR initiative. Finally, the visit to China by Director General Dr. Ian Smith and Aquaculture Program Director Dr. Roger Pullin was the first opportunity to explore possible linkages in aquaculture research between ICLARM and Chinese scientists.

In summary, 1987 was a year of planning, and consolidation of the Program's research focus and interregional linkages.

Training

In addition to the African training workshops and study tours mentioned above, Program staff were active in lecturing on overseas trips. Dr. C.R. dela Cruz lectured on aquaculture technologies and systems on a visit to Bangladesh and, with Drs. Munro and Lampe, provided considerable training input to the Saguling-Cirata Reservoirs project in Indonesia. Two Indonesian scientists from this project visited the Philippines for training and orientation on aquaculture and reservoir fisheries. Details of such training are noted in Table 1 of the Introduction to this Report.

Program staff and consultants also assisted graduate students with thesis programs in Asian and African countries. As ICLARM develops its facilities and completes its staffing under the 5-year Plan, training activities, both organized courses and assistance to individuals, will increase.

Advisory Services

Program staff were very active in 1987 in supplying advisory services to numerous individuals and institutions, particularly on research

methods and choice of tilapias for different culture environments and sources of good broodstock. The advent of the NTAS will augment such services in the future. In addition, 1987 saw the first involvement of ICLARM with project development for the International Fund for Agricultural Development, when Dr. Catalino R. de la Cruz and ICLARM consultant C. Lightfoot completed a mission to Bangladesh and a project document for the People's Republic of Bangladesh Aquaculture Research Project.

In Africa, project leader John Balarin travelled extensively in the SADCC subregion for interaction with government agencies, universities and development projects.

Program Plans

The Aquaculture Program structure, depicted in Fig. 4, p. 45, will take at least five years to complete and will depend upon available funding. Table 2 gives an approximate timeframe. The network activities in Aquaculture Genetics, Integrated Farming and Coastal Aquaculture will be established without waiting for the completion of construction of the respective research units.

The construction and staffing of the research units will depend upon the progress of negotiations with cooperating institutions and donors.

The Aquaculture Genetics and Integrated Farming Units will be established in tropical Southeast Asia, probably in the Philippines and Thailand, respectively. The Coastal Aquaculture Centre is already functional in the Solomon Islands. Associated network activities will link research and training efforts with national and regional institutions. This networking will be vital in ensuring complementarity of the program's activities with national and regional programs. It will also provide opportunities for visiting researchers to participate in program activities. Networking activities will be highly interactive between the three program areas shown in Fig. 4, particularly the development of improved tilapia and carp breeds for integrated farming systems. Genetics and integrated farming system research will be combined in some institutions. The NTAS will link individual scientists in all the Program's chosen fields.

Genetics

Using criteria for selecting sites for an international center, ICLARM is seeking an appropriate site in the Philippines for an Aquaculture Genetics Unit in association with one or more existing institutions, to be constructed when funds permit. It will occupy a 3-4 ha site, having a modest laboratory and hatchery, ponds and tanks and a small scientific and support staff. It will concentrate primarily on tilapia genetic improvement and secondly on training in this field. The unit will receive tilapia founder populations (principally *O. niloticus* collected from its wide geographical range in Africa) and will develop improved breeds. The unit will incorporate a tilapia germplasm collection, duplicated at one or

Table 2. Approximate timeframe for the future development of ICLARM's Aquaculture Program.

Program Component/Activity	1988	1989	1990	1991	1992	1993
A. Manila Headquarters (HQ)						
1. Acquisition of additional facilities and staff	-----					
2. In-house research, training and information activities	----->					
3. Organization of conferences and workshops	----->					
4. Coordination and organization of reporting, reviews and other publications	----->					
5. Organization of activities of the Network of Tropical Aquaculture Scientists; publication of 'Aquabyte'	----->					
6. Advisory services	----->					
B. Aquaculture Genetics Unit (AGU) and Network Activities						
1. Planning/siting/agreements/securing funding for AGU	-----					
2. AGU construction and staffing/initial germplasm collection		-----				
3. AGU tilapia breeding programs start			-----			
4. Establishment of network activities; initial coordination from HQ		-----				
5. Network cooperative research and training: tilapias and carps		-----				
6. AGU fully operational				----->		
C. Integrated Farming Unit (IFU) and Network Activities						
1. Planning/siting/agreements/securing funding for IFU	-----					
2. IFU construction and staffing		-----				
3. IFU research program starts			-----			
4. Establishment of network activities; initial coordination from HQ		-----				
5. Network cooperative research and training: crop-livestock-fish farming		-----				
6. IFU fully operational				----->		
D. Coastal Aquaculture Centre (CAC) and Network Activities						
1. Establishment of network activities; coordination from CAC	-----					
2. CAC cooperative research and training: coastal aquaculture, focus on giant clams	----->					
3. CAC fully operational		----->				

more network institutions, and will be responsible for an international registry of tilapia strains.

Selective breeding research will be done at the unit and in cooperation with the national institutions participating in the associated network activities. Any genetic gain will be transferred rapidly to the culture industry through supplying information and improved breeds to national research and extension organizations and thence to farmer cooperators. Germplasm and improved breeds will be distributed through the network to member institutions for cooperative research and adaptive field trials, especially in integrated farming systems.

For the tilapias, ICLARM attaches particular importance to developing interregional (Asia-Africa) linkages so that Asian researchers and culturists can access tilapia germplasm to produce improved breeds.

while African researchers and culturists can benefit from Asian experience in developing aquaculture systems.

ICLARM's plans include the development of network linkages with African national institutions in an international effort to promote the documentation, conservation and wise use of tilapia genetic resources, many of which are threatened by environmental degradation and mixing through poorly controlled fish and water transfers.

A similar effort is possible for the carps (common carp, Chinese carps, Indian major carps and some other local carps such as *Puntius* and *Labeo* spp.) but is of second priority for ICLARM because of the lower potential of carps in many locations. Carp genetic resources are found mainly in China, central and eastern Europe and the Indian subcontinent. The indigenous carps of Africa have yet to be screened for culture potential. Carp genetic improvement research will be included in the program's networking activities.

Integrated farming systems

This second program theme is highly interactive with the genetic improvement theme, because the cultured organism and its culture environment must be studied together. A truly interdisciplinary research approach is required, combining biology, economics and sociology. Related social science work will be conducted in part by the Asian Fisheries Social Science Research Network, which is coordinated by ICLARM (see p. 89). Here also, the focus is on systems appropriate for small farms where the research rationale is guided by issues of income and employment generation and by concerns for equitable distribution of benefits from aquaculture technology.

The development of integrated farming technologies requires a long-term research effort. This is possible only in a dedicated facility which is currently lacking. ICLARM is planning such a facility, an Integrated Farming Unit, in tropical Southeast Asia, in cooperation with institutions experienced in this field, principally the Asian Institute of Technology (AIT), Bangkok, Thailand, a well-established, independent, nongovernmental, regional institution with its aquaculture research and education (M.Sc.) program focused on crop-livestock-fish farming systems.

An Integrated Farming Unit facility is envisaged similar in size to the Aquaculture Genetics Unit previously described. It will require experimental ponds and plots, tanks, animal houses, laboratory facilities and a scientific and support staff to complement existing facilities. It will lead associated network activities with selected institutions, principally in Africa and Asia, with linkages to a select number of universities in developed countries and other regions. The research program will focus on how to integrate a fish subsystem into existing Asian and African farming systems for the benefit of small-scale producers. Rice-based and maize-based systems will be investigated through the network, the former in Asia and the latter in Africa.

The first priority is technology development for viable crop-livestock-fish integrated farming systems in Asia and Africa. The challenge in this area of research is to examine existing farming systems and to develop, through research, technology for the integration of a fish culture subsystem into these farming systems to improve productivity, profitability and human nutrition. We must study how to manipulate and optimize systems in Asia and, after very careful appraisal of African farming systems and their economic and social context, how to adapt promising technology for use in Africa.

The second priority is development of systems models, based on analysis of existing data sets and new experiments which are interactive with the modelling work. Systems modelling, including biotechnical and economic factors, is an important tool for understanding the potential and constraints of integrated farming systems. The priority for ICLARM work in this area is to apply this technique to existing data sets (from African and Asian farms and experimental stations) and then to test/improve models by further experimentation and application.

The Integrated Farming Unit and network institutions will pursue in-depth research on subsystem interactions in crop-livestock-fish systems, including biological, technical, economic and sociological constraints to their implementation by small-scale farmers. Investigation of cost-effective inputs (agricultural byproducts) to fishponds and methods for maximizing productivity and profitability by manipulation of terrestrial and aquatic food chains will be carried out. Adaptive field trials will be undertaken by participating network institutions and by farmer cooperators.

Coastal aquaculture

The prime focus of the Coastal Aquaculture Centre for the foreseeable future will be on the culture of giant clams. While a satisfactory initial scientific basis has now been laid for giant clam culture, there are still many topics which need to be investigated before there is an adequate understanding of most aspects of the subject. Of high priority are further studies of the basic ecology and biology of giant clams, management of fisheries for giant clams (including studies of the feasibility of supplementing natural stocks with hatchery-reared seed clams) and the development of cost-effective hatchery and nursery systems. Much more work is needed on reproductive condition and seasonality and spawning induction in broodstock. Knowledge of the genetic characteristics of giant clams is minimal. Improvements in hatchery and nursery methodology are possible and will have a strong bearing on the economics of giant clam culture. Aspects of the growout systems include practical considerations in addition to investigations of social and legal aspects of clam nurseries and farms.

The Coastal Aquaculture Centre is expected to become a regional source of information, training and research supervision for higher degrees in aquaculture. The degrees themselves would be offered by a regional university, such as the University of the South Pacific which has its main campus in Fiji and outreach activities throughout the region.

Meetings Attended, Papers Presented

The Second International Symposium on Tilapia in Aquaculture (ISTA II), Bangkok, Thailand, 16-20 March. (J.D. Balarin, J.B. Capili, J.L. Maclean, M.C. Pagulo, D. Pauly, R.S.V. Pullin, I.R. Smith, J.M. Vakily).

Papers presented:

Armstrong, A.T.C., J.D. Balarin and R.D. Haller. The design of a tilapia grader for intensive tank systems.

Balarin, J.D. The logistics of development planning for tilapia farming in Africa.

Hopkins, K.D., M.L. Hopkins and D. Pauly. A multivariate model of tilapia growth, applied to seawater culture in Kuwait.

Langholz, H.J. A. Kronert, W. Oldorf, G. Hoerstgen-Schwark, R.D. Haller and J.D. Balarin. Prospects for late maturity in tilapia under laboratory and field conditions.

Pagulo, M.C. and I.R. Smith. Philippine tilapia economics: industry growth and potential.

Pante, M.-J.R., L.J. Lester and R.S.V. Pullin. A preliminary study on the use of canonical discriminant analysis of morphometric and meristic characters to identify cultured tilapias.

Pauly, D., J. Moreau and M. Prain. A comparison of overall growth performance of tilapia in open water and aquaculture.

Pullin, R.S.V. and J.B. Capili. Genetic improvement of tilapias: problems and prospects.

Workshop on Tilapia Genetic Resources for Aquaculture, Bangkok, Thailand, 23-24 March. (J.D. Balarin, J.B. Capili, M.C. Pagulo and R.S.V. Pullin).

Paper presented:

Pullin, R.S.V. Electrophoresis.

Australian Marine Science Association Meeting. Aquaculture in the tropics, Townsville, Australia, 12-15 May. (J.L. Munro)

Consultative Group on International Agricultural Research, Mid-Year Meeting, Montpellier, 18-22 May. (R. Jackson, H.R. King, R.S.V. Pullin, I.R. Smith, J. Storer).

Eighteenth Asian Rice Farming Systems Network Working Group Meeting, 30 August - 4 September 1987, Islamabad, Pakistan. (C.R. de la Cruz)

Papers presented:

C.R. de la Cruz. Technical Assistance for a reappraisal of and the development and testing of new rice-fish systems.

C.R. de la Cruz. Issues on rice-fish farming systems research.

Consultative Group on International Agricultural Research International Centers Week and Associated Technical Advisory Committee Meeting, Washington, DC, 21-30 October. (R. Jackson, R.S.V. Pullin, I.R. Smith, J. Storer).

Technical Consultation on Aquaculture in Rural Development, Lusaka, Zambia, 27-30 October. (J.D. Balarin).

Paper presented:

J.D. Balarin. ICLARM's Africa Aquaculture Project.

Workshop on Reservoir Fishery Management and Development in the Asian Region, Kathmandu, Nepal, 22-29 November. (B.A. Costa-Pierce).

Paper presented:

Costa-Pierce, B.A., G. Wira Atmadja, P. Effendi and Z. Sutandar. Integrated aquaculture systems in the Saguling reservoir, Indonesia.

Seminar-Workshop on Reservoir Fisheries Development and Management, Freshwater Aquaculture Center, Central Luzon State University, Muñoz, Nueva Ecija, Philippines, 3 December. (B.A. Costa-Pierce).

Paper presented:

Costa-Pierce, B.A. Development of reservoir aquaculture in the Saguling reservoir, West Java, Indonesia.

Seminar-Workshop on Culture and Utilization of Carps, Philippine Council for Agriculture and Resources Research and Development, Los Baños, Philippines, 11 December. (B.A. Costa-Pierce).

Paper presented:

Costa-Pierce, B.A. Traditional methods of common carp breeding and culture in West Java, Indonesia.

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Aquaculture Program Project Summaries

Project Title	:	Evaluation of Farmed Tilapia Stocks
Cooperating	:	Marine Science Institute, University of the Philippines (UPMSI); National Freshwater Fisheries Technology Research Center, Bureau of Fisheries and Aquatic Resources (NFFTRC/BFAR)
Duration	:	Continuous from April 1984
Key personnel	:	UPMSI : Ms. Julie M. Macaranas; Ms. Ma. Josefa R. Pante and Miss Ma. Carmen A. Ablan NFFTRC/BFAR : Mr. Melchor M. Tayamen ICLARM : Dr. Roger S.V. Pullin; Ms. Josephine B. Capili and Ms. Mary Ann P. Bimbao

Objectives

- To investigate the genetic characteristics of cultured tilapia 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.
- To improve and develop standardized research methods for tilapia genetics research.

Results

Five 'strains' of Nile tilapia (*Oreochromis niloticus*) were used in on-station and on-farm comparative culture performance trials. These were: 1) 'Israel' strain (1979 introduction to the Philippines from Israel, origin Ghana); 2) 'Taiwanese' strain (1984 introduction to the Philippines from Taiwan, origin Egypt or Israel); 3) 'Freshwater Aquaculture Center of Central Luzon State University (FAC-CLSU)' strain (derived from selected research lines held at FAC-CLSU); 4) 'Singapore' *O. niloticus* (1977-78 introduction to the Philippines, origin Ghana via Israel and Singapore) and 5) 'Philippine' strains, as held by farmer cooperators (derived from fish distributed by NFFTRC/BFAR and between farms).

During the year comparative growth trials using fish of these strains marked with fingerling tags (Floy tag, USA) were performed in concrete tanks at NFFTRC/BFAR (with both communal and separate stocking of the different strains) and on different farms chosen to represent a range of farming systems - rice-fish and gabi-fish integrated farming and tilapia pond culture.

These trials were undertaken primarily to develop reliable methodologies for testing new strains and hopefully improved breeds of *O. niloticus* that ICLARM and its cooperating institutions plan to develop through new introductions from Africa in 1988. The strains used in this preliminary work have been examined for introgressive hybridization with *O. mossambicus* using electrophoretic markers that can discriminate between the species at seven loci and canonical discriminant analysis of morphometric and meristic data. These techniques were reported in previous publications from the project and to the Second International Symposium on Tilapia in Aquaculture (ISTA II), 16-20 March 1987, Bangkok, Thailand.

The electrophoretic data are shown in Table 3. This shows clear evidence of introgression in the strains - an unstable and unsatisfactory situation that only serves to emphasize the need for new strains and the fact that the work described here is of value only for developing methods rather than for choosing among existing strains. NFFTRC/BFAR has in any case taken the decision to distribute only 'Israeli' strain until such time that better material is available. This choice has been based on general observations of performance.

Table 3. Frequencies of *Oreochromis mossambicus* genes at 7 diagnostic loci in cultured 'strains' of *O. niloticus* in the Philippines.

Locus	Strain			Philippine farmers stock
	'Israeli'	'Taiwanese'	'CLSU-FAC' Philippine	
Pgi	0.039	0.025	0.288	0.025
Ck	0.158	0.088	0.162	0.025
Sdh	0.042	0.026	0.290	0.014
Sod	0.079	0	0.188	0.013
Mp-2	0.039	0.038	0.200	0.100
Mp-3	0.197	0.075	0.175	0
Mdh-1	0	0.132	0.050	0.025

The first series of trials in concrete tanks and in a rice-fish farm were seriously affected by mortalities and loss of tags from the fish. Tagging techniques and survival were subsequently improved by using larger fingerlings (ca. 12 g initial weight), attaching the tag by a thread through the dorsal musculature, knotted at each end like a rivet - rather than having a loop of external thread. Survival in tank trials is now from 63% to 100%. The circular tanks constructed at NFFTRC/BFAR in mid-year are shown on p. 59.

On-farm testing suffered many setbacks including the total loss of data from gabi (laro) fish farm plots due to water shortages, fish kills in rice-fish farm plots due to water shortages, fish kills in a rice-fish farm (probably due to application of molluscicide) and poor returns of tagged fish. The data are still being analyzed for presentation at the



Circular concrete tanks at the Bureau of Fisheries and Aquatic Resources National Freshwater Fisheries Technology Research Center, Muñoz, Nueva Ecija, Philippines, built for the project's on-station growth trials with different strains of *Oreochromis niloticus*.

International Symposium on Genetics in Aquaculture to be held in Trondheim, Norway, June 1983.

In summary it has been a rather disappointing year for the project which has served mainly to point out the difficulties of performing culture performance trials with tilapia fingerlings, particularly on farms. Nevertheless the project team is resolved to solve these problems in 1988 by working with new farmer cooperators and improving further tagging and retrieval techniques. The need to demonstrate genetic gain on farms remains.

- Project Title** : The Federal Republic of Germany-Israel Fund for Agricultural Research in Third-World Countries: Aquaculture Project
- Subproject 1** : Optimal Management of Aquaculture Pond Systems in Developing Countries
- Cooperating Institutions** : Agricultural Research Organization (ARO), Israel; Technion, Israel Institute of Technology (T/IIT); University of Kiel (KU); African and Asian institutions (to be identified)
- Duration** : 1986-ongoing
- Key Personnel**
- | | | |
|--------|---|--|
| ARO | : | Dr. Gerald L. Schroeder; Dr. Giora W. Wohlfarth; Dr. Ana Milstein; Dr. Gideon Hulata |
| T/IIT | : | Prof. Yorani Avnimelech; Dr. Shoshana Mokady |
| KU | : | Mr. Mark Prein |
| ICLARM | : | Dr. Daniel Pauly; Dr. Roger S.V. Pullin |

Objectives

- To identify and quantify the effects of major variables affecting production in aquaculture ponds.
- To develop methods applicable to third-world countries for monitoring and increasing yields in fishponds, especially in those fed with organic residues and agricultural byproducts.
- To understand the flow of nutrients through the autotrophic and heterotrophic food webs to target organisms.
- To optimize the effect of the available inputs (organic and mineral nutrients, fishes stocked) on fish growth and yields.
- To increase yields above the currently attained plateau in ponds without supplemental feed.
- To develop management techniques for aquaculture in third-world countries.
- To develop diagnostic techniques, kits and instrumentation.
- To train scientists from third-world countries in these techniques.

Results

ICLARM's main role in this subproject is collaboration with project researchers in the analysis and interpretation of aquaculture data sets by multivariate techniques. During 1987, the collection of raw data from Israeli fish farms and their input into computer files were completed. Mr. Mark Prein (KU) went to Israel in November 1987 and visited, with Israeli

counterparts, several farms to record their different management practices; mainly with respect to weighing and harvesting techniques, feeding, manuring and aeration systems. This kind of information is not part of their normal reporting practice. Also discussed were various methodological procedures. Other data were obtained from the Meteorological Services of Israel.

Mr. Prein also spent time at ICLARM headquarters, Manila, where he completed the standardization and computerization of the large data set on tilapia growth and environmental parameters collected during the research collaboration between ICLARM and the Freshwater Aquaculture Center of Central Luzon State University (FAC-CLSU) from 1978 to 1982. Both the Israeli and the ICLARM/FAC-CLSU data sets will be analyzed in 1988 using multivariate techniques developed or adapted at Dor Station and ICLARM for use in aquaculture.

Subproject 2 : Utilization of Tilapia Genetic Resources for Expansion of Aquaculture

Cooperating Institution : Agricultural Research Organization (ARO), Israel; University of Hamburg (HU); Institute of Aquatic Biology (IAB), Achimota, Ghana; other African and Asian research institutions (to be identified)

Duration : 1986 - ongoing

Key Personnel

ARO	:	Dr. Gideon Hulata
HU	:	Prof. Wolfgang Villwock
IAB	:	Dr. Martin A. Odei; Mr. Joseph K. Ofori; Mr. J.N. Padi
ICLARM	:	Dr. Roger S.V. Pullin; Ms. Josephine B. Capill

Objectives

- To conduct a literature survey on commercially important species, particularly *Oreochromis niloticus*.
- To contact key persons with experience on native populations of tilapia in Africa.
- To establish working relations with African institutes that can participate in the collection and evaluation of resources.
- To select sites for collection of genetic material on the basis of gathered information.
- To assess the needs of selected African countries, with reference to improving their capability for culture of tilapia in general and upgrading their stocks in particular.

- To investigate stock diversity by comparison of morphometric and meristic characters with reference collections and published descriptions.
- To investigate genetic variability using electrophoretic and other analytical techniques.
- To design methods for evaluation of production traits.
- To train African personnel in tilapia genetics research, culture and management.

Results

ICLARM's main activity in 1987 in this project was the Workshop on Tilapia Genetic Resources for Aquaculture, 23-24 March, held in Bangkok, Thailand. Among the 37 participants from a total of 17 countries were scientists from Cameroun, Côte d'Ivoire, Ghana, Malaŵi, Rwanda and Zimbabwe. This was the first time that African scientists interested in the genetic improvement tilapias were able to discuss this topic with researchers from Asian countries having large and successful tilapia industries such as the Philippines and Thailand. The workshop was also attended by geneticists and aquaculturists from Canada, France, the Federal Republic of Germany, Israel, the United Kingdom and the United States of America. Drs. R.H. Lowe-McConnell and D.F.E. Thys van den Audenaerde were invited as resource persons to contribute their long field experience of tilapia biology and distribution. Representatives from FAO and the Network of Aquaculture Centres in Asia also took part.

The result was a large report on Tilapia Genetic Resources for Aquaculture, to be published by ICLARM in 1988, and a clear set of recommendations for an international program of research cooperation for the future documentation, conservation, evaluation and utilization of tilapia genetic resources. The detailed recommendations included the establishment by ICLARM of an international registry of tilapia strains and the development by the University of Hamburg of a reference collection of preserved specimens. A new field guide to the cultured tilapias is being prepared and will be incorporated in the published workshop report. Documentation and collection of genetic material will commence in 1988 together with assistance to the Institute of Aquatic Biology, Ghana, for development of aquaculture research facilities and the identification of additional cooperating institutions in Africa and Asia. For this, extensive travel will be undertaken by the project's key personnel.

- Project Title** : Research for the Development of Tropical Aquaculture Technology Appropriate for Implementation in Rural Africa
- Cooperating Institutions** : Department of Fisheries, Malaŵi (DOF); Chancellor College, University of Malaŵi; other African institutions to be identified; Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ)
- Duration** : Planning Phase, November 1985-April 1986; Startup Phase, May 1986-October 1986; Main Project, November 1986-October 1989 (with provision for extension)
- Key Personnel**
- | | | |
|--------|---|--|
| DOF | : | Mr. Orton V. Msiska; Mr. Max K. Nyirenda |
| ICLARM | : | Mr. John D. Balarin; Dr. Roger S.V. Pullin |

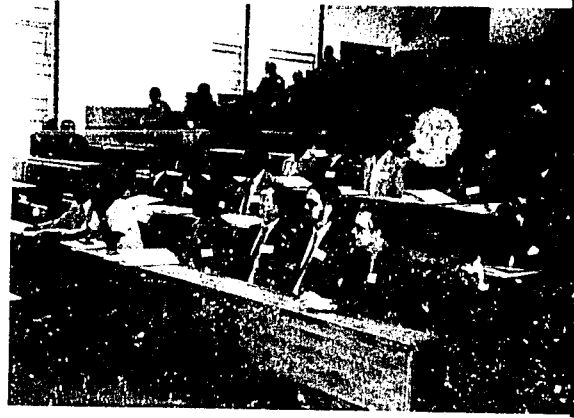
Objectives

- To develop aquaculture technology appropriate for implementation in rural Africa through a program of cooperative research with African and Asian institutions.
- To train research and teaching personnel from African institutions to strengthen their capabilities for supporting aquaculture research and development.
- To strengthen aquaculture research, training and information exchange activities between African and Asian institutions.
- To provide African cooperating institutions with relevant information for the furtherance of rural aquaculture research and development.
- To publish and disseminate widely the results of all cooperative research and training activities.

The startup phase of the project was completed by further planning missions to Botswana, Lesotho, Malaŵi, Swaziland, Zambia and Zimbabwe to discuss cooperative research links. By mid-year, formalities within Malaŵi were completed and the project office was opened with the project leader in residence.

The first major project activity was in March, when five African scientists from Cameroun, Ghana, Malaŵi (2) and Zimbabwe were sponsored to attend the Second International Symposium on Tilapia in Aquaculture (ISTA II) in Bangkok, Thailand, followed by a two-day Workshop on Tilapia Genetic Resources for Aquaculture. Thereafter, the visitors were taken on a three-day awareness tour of various examples of

Participants at the opening ceremony of the Aquaculture Awareness Workshop held at Chancellor College, University College, University of Malawi, Zomba, Malawi, September 1987.



Aquaculture scientists visiting Malawi discuss pond research at the Bunda College of Agriculture (BCA), University of Malawi. *(left to right)* ICLARM consultants Drs. Rafael Guerrero and Kevin Hopkins; Mr. J.G. Likongwe (BCA); ICLARM Consultant Dr. Peter Edwards and Aquaculture Program Director Dr. Roger Pullin. Photos by John Balarin.

Examining madeya (a coarse maize bran) one of the possible resources that could be used to feed fish in Malawi.



That aquaculture. The Malawi delegation went on to visit ICLARM, Manila, and to tour aquaculture establishments in the Philippines.

In May, ICLARM consultant Dr. Kenneth Ruddle visited Malawi for a review of the socioeconomic aspects of aquaculture development and to plan further collaborative work, including higher degree studies, with the Center for Social Research, Chancellor College, University of Malawi.

In September, an Aquaculture Awareness Workshop and Consultation was held in Malawi. Attended by 33 participants from Malawi, Rwanda, Zambia and Zimbabwe, the week-long workshop consisted of a series of lectures by five experts from Germany, the Philippines, Thailand and USA and followup discussions. They also

toured nearly 10% of the farm ponds in the country and made recommendations for future research. Emphasis was placed on utilizing on-farm resources such as grass, compost, ash and maize bran. The theme throughout was to create a better understanding amongst African scientists of aquaculture technology advances in Southeast Asia. The development of tilapia culture systems in the Philippines proved most interesting to the participants, who saw scope for similar developments in their countries. The course material distributed is listed in Table 4. Eight senior staff from the Malaŵi Fisheries Department plus a visitor from Lesotho went on to attend a six-day workshop on use of microcomputers in aquaculture research run by Mr. J.M. Vakil of Kiel University, who prepared comprehensive course notes.

Work started in October on the construction of thirty-six 200-m² experimental ponds and thirty-six 5-m³ bioassay tanks at Domasi Experimental Fish Farm. Due for completion by January 1988, these facilities will accommodate the main research thrust of the project. To increase the research capacity of the project, candidates at Chancellor College, University of Malaŵi have been shortlisted for four Master's level scholarships and some of their thesis work will be done at the Domasi station.

The project has established a modest aquaculture library in Malaŵi and in 1988 will begin offering an aquaculture information service. ICLARM publications have also been distributed to libraries in the SADCC subregion.

Table 4. Course notes and other materials (reprints, books, etc.) given to all participants in the Aquaculture Awareness Workshop held under the GTZ-ICLARM project Research for the Development of Tropical Aquaculture Technology Appropriate for Implementation in Rural Africa, 21-25 September, Chancellor College, Zomba, Malaŵi.

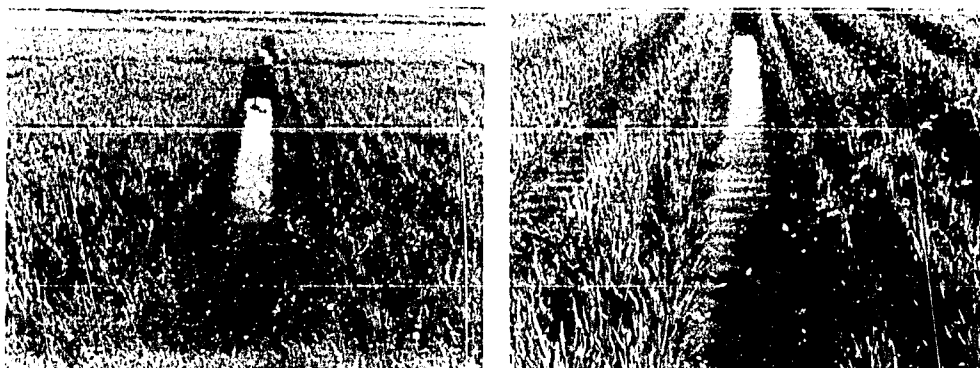
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- Shell, E.W. 1983. Fish farming research. Auburn University, Auburn, Alabama, USA. 108 p.
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- Project Title** : Rice-Fish Farming Systems Research
- Cooperating Institutions** : The International Rice Research Institute (IRRI) and its Asian Rice Farming Systems Network (ARFSN); the Freshwater Aquaculture Center of Central Luzon State University (FAC-CLSU); funding is from the Asian Development Bank, supplemented by additional funds for workshop organization from the International Development Research Centre of Canada and provision of an Associate Expert by the Ministry of Development Cooperation of the Government of the Netherlands.
- Duration** : August 1987-February 1990
- Key personnel**
- | | | |
|--------|---|---|
| ICLARM | : | Dr. Catalino R. de la Cruz; Dr. Roger S.V. Pullin; Mr. Anne Van Dam |
| IRRI | : | Dr. Virgilio R. Carangal |
| CLSU | : | Prof. Ruben C. Sevilleja;
Dr. Rodolfo G. Arce |

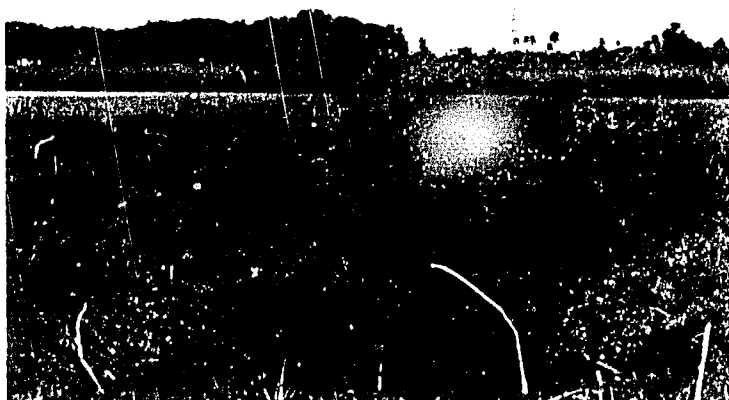
Objectives

- To establish collaborative research on rice-fish farming between national, regional and international programs as a means of overcoming the narrowness of previous research on this subject.
- To formulate and refine rice-fish research methodologies to be applied in the development of technology within the Asian Rice Farming Systems Network (ARFSN)
- To evaluate options for integrating rice and fish production, including concurrent and rotational rice-fish farming, deepwater rice-fish systems and smallholder rice/backyard fish farms.
- To facilitate training and the exchange of research information and ideas on rice-fish farming among rice and aquaculture scientists in Asia by holding meetings and workshops and distributing publications.
- To develop improved rice-fish farming systems which will increase the productivity and income of Asian rice farmers.

The project is an Asian Development Bank Regional Technical Assistance Project for reappraising rice-fish farming and developing and testing new rice-fish farming systems. This is being accomplished through a farming systems research approach developed in the Asian Rice Farming Systems Network (ARFSN) of IRRI. It includes on-station and on-farm research in Bangladesh, India, Indonesia, the Philippines and Thailand, as well as meetings, workshops and exchanges of publications to disseminate research results and technology.



Improving concurrent rice-fish farming systems. An example: the prevailing method of planting rice in rice-fish system (*left*) vs. the border planting method (*right*).



A deepwater rice area in West Bengal. Photos by Catalino R. de la Cruz.

Results

The project began in August 1987 when the newly-hired Project Leader reported for duty. Linkages and work plans were then established with the national programs in the five participating countries. The main site for on-station research is the Freshwater Aquaculture Center of Central Luzon State University (CLSU-FAC), Muñoz, Nueva Ecija, Philippines. A new 4-ha research area has been constructed there for the project. However, some research will also be done at the International Rice Research Institute (IRRI), Los Baños, Philippines.

Protocols for the on-station research at FAC-CLSU were finalized. The research will focus on rice-fish farming component technology modification/verification, development and evaluation.

On-farm research in the Philippines and Indonesia, in collaboration with national programs has already commenced. Plans for research in the other participating countries will be finalized during the project's first rice-fish workshop, to be held in Ubon, Thailand, 21-25 March 1988. Planning for this major workshop has begun; the objectives are: 1) to review the state of the art of rice-fish farming; 2) to determine strategies for rice-fish farming systems development; 3) to discuss plans for on-farm and experiment station research programs and determine common methodologies. There will be about 35 participants in the workshop representing seven Asian countries (Bangladesh, China, India, Indonesia, Malaysia, the Philippines and Thailand) and a number of national, regional and international institutions within the region.

- Project Title** : Development of Aquaculture and Fisheries Activities for Resettlement of Families from the Saguling and Cirata Reservoirs, West Java, Indonesia
- Cooperating Institutions** : Institute of Ecology (IOE), Padjadjaran University; Indonesian State Electric Company (PLN); West Java Provincial Fisheries Agency and its Technical Management Unit (UPT)-Saguling and Cirata; with funding from the World Bank
- Duration** : July 1986-January 1989
- Key Personnel**
- | | | |
|--------|---|---|
| IOE | : | Professor Otto Soemarwoto; Ir. Gelar Wira Atmadja |
| UPT | : | Mr. Pepen Effendi |
| PLN | : | Ir. Sutandar Zainal |
| ICLARM | : | Drs. Barry A. Costa-Pierce, John L. Munro, Catalino R. de la Cruz and Prof. Harlan C. Lampe |

Objectives

- To identify the most appropriate aquaculture and fisheries methods for resettlement of 3,000 families from the Saguling and Cirata reservoirs.
- To establish, run and conduct research with various aquaculture systems with potential for large-scale job creation among displaced persons.
- To provide technology transfer to UPT, extension and training advice, and scientific training of selected staff at Asian centers of excellence, including ICLARM.
- To complete a comprehensive aquaculture and fisheries development plan for reservoirs.

Results

The project established and conducted research with land-based and water-based aquaculture systems in 1987. Experiments with commercial-sized (7.3 x 7.3 x 2.6 m) floating net cages (hereinafter called 7 x 7) stocked with common carp of average initial weight 1.3 g produced 1.07 ± 0.15 t/cage (mean \pm SD) of fish of average weight 260.8 g in 90 days with a feed conversion ratio (FCR) of 2.3 (n = 4). Net profit for this unit was Rp 270,000 (about US\$170) in 90 days. Experiments with subsistence units constructed of low-cost materials (bamboo, wire and netting) of 17.0 to 17.5 m³ stocked with fish of average initial weight 70.8 g produced 147.3 ± 20.5 kg of fish of average weight 278.1 g in 90



Floating net cage aquaculture operations in the Saguling Reservoir, West Java, Indonesia. The aquaculture businesses of five families are located here. Photo by B.A. Costa-Pierce.

days at an FCR of 2.0 ($n = 7$). The yield of fish from one cage is sufficient to supply the entire annual animal protein needs of a family of five persons. In addition, pen systems of 1.5 ha and 5,000 m² sizes were established in some bays of the Saguling reservoir and developed into community fisheries centers. These are now being further developed into model integrated farming units.

By October, 928 families had been trained in aquaculture and fisheries methods by the project and the West Java Fisheries Agency. Some 430 families have now been resettled and are engaged in aquaculture occupations in the Saguling reservoir. Over 800 floating 7 x 7 net cage units are operating in the Saguling reservoir, and total aquaculture production from floating net cage aquaculture reached over 2,400 t in 1987, worth an estimated \$2.2 million.

The project conducted research on the carrying capacity of the floating nets in 1987 after data analyses from farmers' surveys indicated possible overstocking. A 9 x 9 m unit stocked at 0.5 kg/m³ was compared to a 7 x 7 unit stocked with the density of fish normally used by the farmers (2.4 kg/m³). Mean production for the lower stocking density was 975.6 kg in 90 days, compared with 1,070 kg for the 2.4 kg/m³ density. However, the lower stocking density exhibited a 67% savings in the required amount of seed fish needed, and a 50% savings in the amount of feed used. Total capital cost for the 9 x 9 m unit was only 1.5 times that of the conventional 7 x 7 unit, but its net profit over a 90-day growout period was Rp 655,200 vs. 331,000 (\$423 vs. \$214).

The project initiated an intensive monitoring of fish population dynamics in the Saguling reservoir in September 1987. A series of 36 experimental gill nets at sizes of every one-half inch from 1" (2.5 cm) to 5" (12.5 cm) are being set weekly for a 50-week period. Length frequencies of the multispecies stocks are being tabulated along with gut

contents analyses. By the end of 1987, project scientists determined that the Saguling reservoir has a virtually empty pelagic zone, and its fish population is dominated by a small, carnivorous cyprinid, *Hampala macrolepidota*. Surveys of the capture fishermen in the reservoir showed that small mesh gill nets of 1-2" (2.5-5 cm) mesh sizes were the dominant fishing gear, and that capture fisheries yields were very low, approximately 1-3 kg/fishermen/week. Management recommendations are being formulated to enhance the stocks in Saguling by the project scientists, including the possibility of introducing species to occupy the pelagic niche.

The project also constructed a modern hatchery with running water and flow-through drum systems to produce fingerlings for farmers in the Cirata region, and to conduct research on feed formulations and practices.

Project Title	:	Development of a Research Framework for Integrated Agriculture-Aquaculture Farming Systems
Cooperating Institutions	:	The United Nations Development Programme (UNDP) Global and Interregional Programme and the World Bank (WB)
Duration	:	One year, beginning July 1986
Key Personnel		
UNDP	:	Mr. Timothy Rothermel
WB	:	Mr. Eduardo Loayza
ICLARM	:	Dr. Roger S.V. Pullin

Objectives

- To evaluate the applicability to integrated agriculture-aquaculture farming systems research of the analytical methodologies being used in farming or cropping systems research.
- To develop interdisciplinary research and data analysis methodologies appropriate for the examination of integrated agriculture-aquaculture farming systems (i.e., crop-fish, animal-fish) and for the development of systems modelling, involving biological and economic factors.
- To prepare an extensive literature review on integrated agriculture-aquaculture farming systems
- To publish the results of these investigations in the form of a research framework.
- To develop a fundable plan for the application and further refinement of this research framework through cooperative research, workshops and on-farm testing.

Results

The project completed its report to the United Nations Development Programme entitled 'Research and Education for Development of Integrated Crop-Livestock-Fish Farming Systems in the Tropics'. The report was submitted through the World Bank and was accepted with the comment that the project had more than fulfilled its objectives. The report was compiled from materials presented and discussed at the Workshop 'Towards a Research Framework for Tropical Integrated Agriculture-Aquaculture Farming Systems', held at ICLARM, Manila, in October 1986 and from review material written by Drs. Peter Edwards and Joseph A. Gartner of the Asian Institute of Technology (AIT), Bangkok, and Dr. Roger S.V. Pullin of ICLARM. A condensed and edited version of the report will be published in 1988 in the ICLARM Studies and Reviews Series. Work is still in progress on two other products of this project: an annotated bibliography for integrated farming research

and a review of the application of systems modelling techniques to integrated farming.

During 1988, the report and formulation of proposals for future research cooperation in integrated farming research will be discussed with interested institutions, agencies and donors including the Aquaculture Development and Coordination Programme (ADCP) of FAO, AIT, the Consultative Group on International Agricultural Research (CGIAR) and UNDP. The report has been circulated to ADCP and appropriate CGIAR research centers for comment.

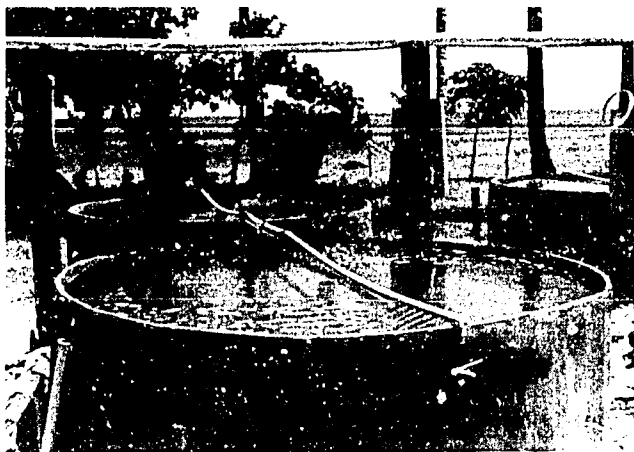
Project Title	:	Coastal Aquaculture Centre
Cooperating Institutions	:	The Government of Solomon Islands (GSI) and the Guadalcanal Provincial Government (GPC)
Duration	:	1986-1988
Key Personnel	ICLARM	: Dr. John L. Munro; Mr. Graham F. Usher - Technical Cooperating Officer seconded to ICLARM by the Ministry of Overseas Development of the United Kingdom (ODA); Mr. Hugh Govan - Voluntary Service Overseas (VSO) of the United Kingdom, also seconded to ICLARM.
	GSI	: Mr. Baraka Kaitera (GSI Fisheries Division)

Objectives

- To test, develop and demonstrate methods for the cultivation of economically valuable aquatic organisms, including the production of eggs, larvae, spat, seed and mature animals or plants.
- To investigate methods for environmental enhancement or manipulation which relate to artificial improvement of natural fisheries.
- To investigate and develop methods for processing and marketing aquaculture products.
- To appraise the social and economic impacts of such developments in the region (as encompassed by the South Pacific Forum).
- To provide public dissemination of the results of the above activities.
- To serve as a regional source of fisheries and aquaculture information and as an administrative base for ICLARM's activities within the South Pacific region.

Results

The Coastal Aquaculture Centre is located about 25 km from Honiara on the narrow northwest Guadalcanal coastal plain. The 4.8-ha site, together with the adjacent seabed to a distance of 100 m from shore, has been leased by ICLARM from the GSI for 50 years (from 13 October 1986) for a nominal fee. At the termination of the lease or its expiry the facilities on the property will become the property of the GSI. The property is bounded by coral reefs bathed in clean, clear, high-salinity seawater. Approximately 4.5 ha of reef and shallows lies within the leased area and offers scope for testing a variety of nursery and growout



Broodstock tanks at ICLARM's Coastal Aquaculture Centre near Honiara, Solomon Islands.

techniques. Additionally, two isolated offshore reefs are within 0.6 km of the Centre.

The first phase of development of the Centre has involved pump/power house and fencing the property. By the end of 1987 completed buildings included a small hatchery/laboratory building, a house for the Hatchery Manager and cottages for two security guards/caretakers. A residential block consisting of four small chalets was nearing completion. A diesel generator provides general power supplies and a diesel pump draws water from the ocean to supply the giant clam hatchery, broodstock tanks, settlement and nursery tanks.

The first major clam spawnings were initiated at the CAC in November 1987, just over one year from the acquisition of the site and the start of construction. Very high settlement rates were obtained and by the end of the year over one hundred thousand settled juveniles were established in five ferro-cement settlement tanks. This was a very encouraging initial result which suggested that the attention paid to site selection was paying dividends.



Giant clams (*Tridacna gigas*) in broodstock tanks.

A modest array of scientific and technical equipment has been assembled from various sources, including a significant component loaned to the giant clam hatchery project by our collaborators, the Solomon Islands Fisheries Division, and derived from Japanese bilateral grants.

As part of the collaborative arrangements the GSI seconded a qualified Technical Assistant to the Project for a period of five years. Unfortunately, the incumbent resigned from the GSI Fisheries Division in mid-year. A replacement is expected early in 1988 when a GSI fisheries officer returns from overseas training.

Funding for the first phase of the development of the Coastal Aquaculture Centre and the Giant Clam Hatchery has been derived from a number of sources. Over the period 1985-86 part of the Australian Development Assistance Bureau's core contribution to ICLARM was earmarked, at their request, for support of activities in the South Pacific region. The New Zealand External Aid Division provided NZ\$25,000 which enabled ICLARM to investigate possible sites for the Centre and subsequently to enter into negotiations with the Government of Solomon Islands. Funds for construction of the hatchery/laboratory building and the set of four chalets, totalling approximately A\$55,000 have been provided by the Australia and Pacific Science Foundation and a sum of US\$10,000 provided by the L.J. and Mary C. Skaggs Foundation has been utilized for the purchase and installation of the pumps, pipes and tanks which constitute the seawater system. The United Kingdom Ministry of Overseas Development is providing the services of the Hatchery Manager, together with travel funds and a contribution towards project coordination costs and has provided the project with a vehicle - all totalling 39,000 Pounds Sterling over three years (1986-89). The Voluntary Service Overseas (VSO) organization has provided a Research Assistant for two years to assist the Hatchery Manager in the development of the facilities plus a grant of 5,300 Pounds Sterling for construction of village-operated giant clam nurseries.

The total capital cost for the first phase of development, to the end of the 1987, has amounted to approximately US\$111,000. The second phase will commence early in 1988, after the official opening of the Centre. Thereafter reporting on the activities of the Centre will be on a project-by-project basis.

Project Title : International Giant Clam Mariculture Project

Cooperating Institutions : James Cook University of North Queensland, Townsville, Australia (JCUNQ); Fisheries Research Branch, Department of Primary Industry, Brisbane, Queensland (DPIQ); University of Papua New Guinea, Port Moresby (UPNG); Silliman University, Dumaguete City, Philippines (SU); Marine Sciences Institute, University of the Philippines, Quezon City (UP); Fisheries Division, Ministry of Agriculture and Fisheries, Suva, Fiji (FDF); Fisheries Division, Ministry of Natural Resources, Honiara, Solomon Islands (FDSI); Overseas Development Natural Resources Institutes, Overseas Development Administration, London, England (ODNRI); University of Newcastle-upon-Tyne (UNT); Center for Oceanological Research and Development, Jakarta, Indonesia (CORD); Fisheries Division, Tarawa, Kiribati (FDR); Fisheries Division, Apia, Western Samoa (FDWS) and the Micronesian Mariculture Demonstration Centre, Koror, Republic of Palau (MMDC).

Duration : 1983-1988 (first phase)

Key personnel ICLARM : Dr. John L. Munro
Mr. Graham F. Usher
Mr. Hugh Govan

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 create mariculture systems for the only phototrophic, and thus self-feeding potential farm animal known to humankind.

Results

The International Giant Clam Mariculture Project is a loose network of collaborating institutions linked by the common objectives listed above. For the three years up to mid-1987 the ICLARM and JCU activities were particularly closely linked, with Dr. J.L. Munro based in Townsville, Australia, and serving as joint coordinator of a major project proposed by ICLARM and funded by the Australian Centre for International Agricultural Research (ACIAR). Funding for scientific work on giant clams was channeled through JCU to four of the cooperating agencies (UPNG, UP, SU, FDF). However, ICLARM had no financial involvement with JCUNQ or ACIAR.

While the prime focus of ICLARM's efforts has been on the development of the Coastal Aquaculture Centre, with its associated giant clam hatchery, the broader aspects of the International Giant Clam Mariculture Project have not been neglected. Two issues of the informal newsletter "Clamlines" were produced for circulation within the group and to interested outsiders. The Fisheries Division of Western Samoa and of Kiribati and the Center for Oceanological Research and Development in Indonesia have become new participants in the Project. ICLARM functions as a source of reference materials and information for participants.

Collaboration with the Fisheries Research Branch of the Queensland Department of Primary Industry in the analysis of a very large database resulted in the preparation of a report on the estimation of growth and size-specific mortality rates for *Tridacna gigas* and *T. derasa* on the Australian Great Barrier Reef.

INFORMATION PROGRAM

Background

The value of information in aquatic sciences was well recognized by the founders of ICLARM, who prescribed a library of international standards for the Center as well as its own publishing unit.

Information retrieval and dissemination have become cornerstones of ICLARM's activities and since 1984 these functions have been combined in a Selective Fisheries Information Service, which has been funded by IDRC of Canada. It is widely used by researchers all over the world. ICLARM's information resources are unique in Asia, with computerized, easily searchable databases, not only of library holdings but also of compact-disk and online overseas aquatic databases, together with the substantial contributions of ICLARM's own seven technical series and four regular newsletters/magazines.

The evolution of ICLARM's information resources into an information service is continuing, with critical analyses of the literature and databases; investigations into the shortcomings of scientific communication in aquatic sciences; and research that may lead to improving both the information resource and access to it. Thus, the present Information Program has the dual roles of service and research.

For aquatic science, as for many other fields of science, information is difficult to get in tropical and third-world countries. Researchers in particular suffer from lack of access to current ideas, current literature and even standard textbooks whether in fisheries, aquaculture or related coastal zone or rural research. Compounding this, too often, research activities fail to produce usable research results and publications. In general, the flows of information are south-north in direction rather than around the tropics.

There are also financial aspects to the acquisition dimension of this problem. Researchers in the tropics often cannot attend meetings with their peers in other countries, particularly those in other regions; library budgets (where there is a library) are meager, while the costs of western journals and books and use of computerized database services are exorbitant by third-world standards. The high cost of journals leads further to the ironic situation that third-world researchers who publish in western journals cannot afford to buy back their own research results.

The progress of fisheries science in the third world has been fragmentary partly as a result of the above mentioned problems. However, apart from such general statements, there is very little that can be said authoritatively about the status of fisheries science because there

are no quantitative data. Without such data it is impossible to set realistic goals to improve the situation. For example, we know little about the scientists themselves as a group, their numbers, their educational background or their productivity. How well do they access and use fisheries literature? We know even less about the use and usefulness of their work. Measuring citations to published papers is one technique to establish impact but as yet there is no database in this field from which to make the calculations. Thus, there are presently no data to indicate how well scientific results are being used by other scientists either within a country or regionally/internationally.

Assuming that published papers achieving some impact in the fisheries scientific community add to our knowledge of the resources or their use in fisheries or aquaculture, then these papers can be considered to be impacting, possibly in the same relative proportions, on the development of fisheries management mechanisms and institutions or on aquaculture development.

In order to make proper judgements about the effects of future programs aimed at improving scientific education or productivity in fisheries science, such baseline information about the present scientific community is indispensable.

Fisheries information research is needed to make the necessary quantitative data available. Not only fisheries administrators and the researchers themselves would benefit; there are uses of the data for educators, librarians and publishers also.

Armed with quantitative measures of these characteristics, numerous parameters can be extracted. For example, a donor given a proposal for an information retrieval project can use the publishing productivity of the average scientist to estimate how much literature is likely to emanate from a given country or subregion per year, and relate this to the estimates in the proposal. Of course, the proposal writer can benefit from the same data. Publishers can determine whether the market is large enough for a projected fisheries publication or new journal in a specific field. Authors can see which are the dominant publication channels. Educators (and donors) can assess the need for new courses/degrees within the region. Administrators can use the data on numbers of research/training institutions and the relationship between institution size and productivity.

Research of this nature is basic and long-term; it is research that national institutions would be unlikely to carry out, yet has clear usefulness to them and others. In short, it represents the kind of research that ICLARM was specifically designed to carry out.

Progress of Work

Publishing activities

Two items were added to ICLARM's technical series in 1987: *Software and Education*. From sales, library exchange and free issue, the

total number of books in the technical series (now numbering seven) distributed since the first publication in 1980 is over 71,000.

The major publications of 1987 include *The Peruvian Anchoveta and Its Upwelling Ecosystem: Three Decades of Change*, a 351-page book which analyzes over 30 years of monthly time-series data on the oceanography, biology and fisheries of one of the most productive ecosystems in the world; *Length-Based Methods in Fisheries Research*, 468 pages, proceedings of the International Conference on the Theory and Application of Length-Based Methods for Stock Assessment containing 25 papers; and *Detritus and Microbial Ecology in Aquaculture*, 420 pages, proceedings of the Bellagio Conference on Detrital Systems for Aquaculture, which contains 16 papers as well as related discussions and question and answer sessions.

On behalf of the Asian Fisheries Society we edited and printed *The First Asian Fisheries Forum*, 727 pages, consisting of 165 papers. We are also beginning to process the proceedings of the Second International Symposium on Tilapia in Aquaculture comprising around 100 papers.

Distribution of *Naga, The ICLARM Quarterly* (new name for the *ICLARM Newsletter*) from the first issue in July 1978 is more than 122,500. Circulation at the end of 1987 was 2,000 of each issue, after "pruning" the number of recipients based on a questionnaire sent out to readers in July 1986.

Book Exhibits. ICLARM publications were exhibited through the Philippine Information Agency at the Book Fair Manila, 20 February to 11 March, Philippine Center for International Trade and Exhibitions; Agri-Aqua, Livestock and Poultry Caravan Fair '87 on 22-29 March in Manila, 25 April to 2 May in Cebu and 17-24 May in Cagayan de Oro, Philippines; the International Council for Research in Agroforestry Book Exhibit in Kenya on 7-11 September 1987 and the Frankfurt Book Fair in the Federal Republic of Germany in October 1987.

Contributions. The number of items published or in press by ICLARM staff and in the Center's technical series during 1987 was 56, bringing the total number of items to 408 since ICLARM's first output ten years ago.

Library

The library's continued growth has enabled the staff to play an important and active role in providing information services to the Center's staff as well as to non-ICLARM staff. In fact, there was a 44% increase in library use by external users from 1,338 in 1986 to 1,929 in 1987.

As expected, the library holdings have increased with the arrival of new reference materials for the ASEAN-US Coastal Resources Management Project. By the end of 1987, the library contained: 8,206 volumes of books and monographs, including theses, dissertations and conference papers and proceedings; 657 serial titles; 3,389 reprints; 117 microfiche titles and 1 microfilm. Other information materials such as maps, newspaper clippings, filmstrips and video films are also available.

Through the Selective Fisheries Information Service (SFIS) project funds from IDRC, additional microcomputers and the compact disc version of the Aquatic Sciences and Fisheries Abstracts (ASFA CD-ROM), including a player, were acquired during the year. A total of 125 persons (March-December 1987) used the compact disc to perform their own literature searches.

A computer database (Micro-ISIS application) for the serials holdings and monograph or analytic type of materials was developed during the year. As of end of 1987, the library database contained 6,352 references on broad areas of fisheries and aquaculture materials including coastal zone management.

An updated Serials Holdings list was also prepared during the year. Work is also progressing on computerizing all the references which have appeared in the Information Department of Naga, the ICLARM Quarterly, over the past 10 years.

The library staff were also engaged in conducting information training activities for several institutions and individuals during the year (see Table 1 in the Introduction to this Report for details).

Program Plans

In publications, the growing number of manuscripts requiring typesetting and editing, from the seven ICLARM technical series, the various newsletters and Asian Fisheries Society publications, will require some expansion in staffing and equipment in the near future.

The library will make use of the computerization of its collections to produce a 10-year indexed list of book and monograph holdings and a 10-year indexed compilation of all the articles appearing in the Information Department of the ICLARM Newsletter and its successor Naga. These will be unique, useful bibliographies of tropical fisheries literature.

SFIS is expected to begin again in 1988, while an African module of the Service is planned to begin during 1988, with its office within ICLARM's African project office in Malawi.

In the research area, the Asian Fisheries Society's information project will continue in 1988 under ICLARM supervision. Inhouse information research will include a citation analysis of ICLARM documents to find out the extent to which the Center's publications have been used by other researchers in various countries.

Meetings Attended, Papers Presented

- In-Depth Training Course on Mini-Micro CDS/ISIS for Information Management, Bangkok, Thailand, 19-30 January 1987. (J.L. Maclean and R.M. Temprosa)
- Seventh Congress of Southeast Asian Librarians, Manila, 15-21 February 1987. (N.I. Jhocson, J.L. Maclean and R.M. Temprosa)

- Fifth Council Meeting, Asian Fisheries Society, Tokyo, Japan, 14-15 May 1987. (J.L. Maclean and L.L. Estudillo)
- Asian Fisheries Society Workshop on Fisheries Education and Training in Asia, Kitasato University, Iwate, Japan, 16-17 May 1987. (J.L. Maclean and L.L. Estudillo)
- Paper presented:
Maclean, J.L. An overview of fisheries education and training in Asia.
- Book Development Association of the Philippines General Meeting, Quezon City, Philippines, 14 October 1987. (L.B. Dizon)
- Book Development Association of the Philippines and United States Information Service Seminar/Workshop on The Business of Book Publishing: Managing for Profit and Economic Choices, Thomas Jefferson Library, Manila, Philippines, 24-27 November 1987. (L.B. Dizon)
- University of the Philippines Institute of Mass Communication/UNESCO Training Course on Book Publishing for Middle Level Professionals (Asia and Pacific), Quezon City, Philippines, 1 November to 15 December 1987. (L.B. Dizon, resource person)

Publications

- Carigma, M.A. 1987. The Asian Fisheries Social Science Research Network. *Naga* 10(3):10-11
- Carigma, M.A. 1987. A list of societies and networks related to fisheries and aquaculture. *Naga* 10(3):12-14.
- Carigma, M.A. and E. Tech. 1987. The Asian Fisheries Society. *Naga* 10(3):15.
- Maclean, J.L. 1986. An Asian Fisheries Forum, p. 268-271. In H.H. Chan, K.J. Ang, A.T. Law, M.I.B.M. Mohamied and I.B.H. Omar (eds.) Development and management of tropical living aquatic resources. Universiti Pertanian Malaysia, Serdang, Malaysia.
- Maclean, J.L. 1987. Small-scale integrated farming in the Philippines. *Naga* 10(1):11-12.
- Maclean, J.L. 1987. Who's working on *Lates calcarifer* (seabass)? *Naga* 10(1):16.
- Maclean, J.L. 1987. Microcomputers in information services in developing countries. *Naga* 10(2):15-16.
- Maclean, J.L. 1987. Who's working on fisheries computer applications? *Naga* 10(2):18.
- Maclean, J.L. and L.B. Dizon, editors. 1987. ICLARM Report 1986. ICLARM, Manila, Philippines.

Information Program Project Summary

Project Title	:	Selective Fisheries Information Service
Cooperating Institution	:	International Development Research Centre (IDRC), Canada
Duration	:	3 years beginning March 1984
Key personnel	ICLARM :	Mr. Jay L. Maclean Mrs. Rosalinda M. Temprosa Mrs. Norma I. Jhocson

Major Objective

To extend the capabilities of the existing ICLARM Information Program to users in tropical third-world countries.

Specific Objectives

- To assist in an advisory capacity in strengthening the information capability of fisheries institutions in third-world countries.
- To provide answers to specific questions to researchers working in subject areas in which ICLARM has special expertise--finfish and mollusc aquaculture, integrated farming, small-scale fisheries and resource management.
- To produce bibliographies and reviews on important topics as identified by trends in enquiries.

Results

The Selective Fisheries Information Service (SFIS) was first announced in the April 1984 ICLARM Newsletter. Since then, the service has been promoted through a regional press release, publications in newspapers and international newsletters, personal contacts and brief "talks" in local and foreign conferences/meetings. In addition, a brochure was produced to facilitate publicity.

The project ended in April 1987, having answered 678 enquiries. Sixty-two per cent were from Asia, 15% from Africa, 8% from Latin America, 7% from Oceania and the remaining 9% from North America and Europe.

The 10 major areas of enquiry are shown in Table 5.

Table 5. SFIS enquiries by major subjects.

Topic	No. enquiries
Tilapia	88
Integrated farming	50
Resource management	49
Shrimps	47
Culture systems	41
Socioeconomics	35
Fish biology	31
Nutrition	23
Molluscs	22
Fisheries, general	21

Each requester was sent an evaluation questionnaire postcard along with the information package to obtain feedback about the service and its products. Users were asked to indicate the quality of the information received. There were 176 returns. An overwhelming majority of the respondents marked that the information sent was "very useful" for their needs. Question 2 enquired of the quantity of information, to which most of the users answered "most of what was needed". However, while 13% of the users found the information "inadequate", it was nevertheless "very useful". One reason for the inadequacy was that we did not provide many of the documents themselves; another was that not much had been published in the field. Respondents using the information for a specific project indicated that the information "improved the project quality" and when looking for general knowledge, the information "improved the subject knowledge" but did not lead to new research ideas". Most of the requesters indicated that the information helped them locate or communicate with other researchers in their field. In general, the responses were very encouraging. Nevertheless, there were complaints about delayed postal deliveries; one respondent suggested the use of telefax in transmitting data.

Assistance and advice on information use and handling has been provided through attendance and papers presented at various workshops in Southeast Asia, USA and lately Africa. Short-term training in fisheries librarianship, online searching, database management and non-technical library activities have been conducted for individuals and various groups both local and foreign.

ICLARM's information capabilities have been strengthened to carry out project activities through the acquisition of library materials, installation of a microfiche reader/printer, an IBM-PC XT computer and recently the ASFA CD-ROM and player. The last mentioned item is proving exceptionally popular for personal users of SFIS and the library.

EDUCATION AND TRAINING PROGRAM

As in past years, ICLARM's activities in this field have been carried out primarily in the context of the Center's networks and cooperative research programs as well as in response to requests by FAO and other international agencies. The diverse activities carried out during 1987 are shown in Table 1 of the Introduction to this Report.

Recently, the Center clarified further its role in fisheries education and training. Details follow:

Educational Opportunities

ICLARM is not an educational institution and does not offer degrees or diplomas. However, ICLARM seeks to assist researchers to further their careers within the limits of staff time and expertise. The Center undertakes the following:

- *Thesis Supervision.* ICLARM staff can provide supervision of M.S. and Ph.D. theses/dissertations in fisheries and aquaculture topics related to the Center's research.
- *Scholarships.* Scholarships for degree courses are sometimes available to researchers in particular projects implemented by the Center.
- *Teaching.* Undergraduate and graduate teaching and individual lectures are often undertaken by staff on request.
- *Curriculum Development.* ICLARM has experience in assisting educational institutions to develop teaching programs and offers such assistance in most branches of the aquatic sciences.

Availability of staff for these educational activities is limited. Interested persons/institutions should plan well ahead and contact ICLARM as early as possible in the development of their proposals.

Visiting Scientists, Training Visits

Study or training visits normally last from two weeks to two months. Longer visits can also be arranged. The site is usually ICLARM headquarters in Manila, Philippines. There are no laboratory facilities, but visitors are given desk space and access to ICLARM's excellent library and computing facilities. Opportunities for field studies on selected aquaculture topics will also become available.

Study and training opportunities at ICLARM headquarters are available in all the Center's areas of research and expertise:

- stock assessment, population dynamics;
- coastal zone management;
- tropical aquaculture (carps, tilapias and bivalve molluscs);
- social sciences; and
- information and library science.

A study or training visit to ICLARM headquarters typically consists of some or all of the following:

- introduction to new research methods;
- introduction to numeric or bibliographic data processing using microcomputers;
- processing, with assistance from ICLARM staff, a data set brought along by the visitor and, if time permits, completion of a publishable report;
- free searches in the visitor's field of interest of computerized literature databases, such as ASFA and those of the ICLARM library and staff. Available articles can also be supplied;
- guided readings in the visitor's subject area;
- up to five free ICLARM books or reports relevant to the visitor's subject area;
- visits to appropriate cooperating institutions and fisheries/aquaculture operations in the Philippines; and
- a seminar consisting of a lecture by the visitor about his or her research topic, followed by discussions with ICLARM and other invited researchers.

A certificate is normally issued by ICLARM attesting to the successful completion of the visit.

ICLARM believes that followup activities are an important part of the training function. This is done through the Center's networks in aquaculture, social sciences and stock assessment and through involvement of successful trainees in project activities where possible.

A fee of US\$350 per week is charged. In addition, visitors must cover their own daily lodging and food costs ranging from US\$40 to US\$60 for modest accommodations, as well as their roundtrip airfare to Manila. ICLARM can assist in booking suitable lodging. Interested persons must identify their source of funding before contacting ICLARM. The fee is negotiable in the case of visitors who pay their own transportation costs and for members of ICLARM's networks.

Program Plans

Beginning in 1989 stock assessment courses are being offered, consisting of a structured series of lectures by ICLARM and external researchers and practical sessions using microcomputer and other techniques. Emphasis will generally be on methods developed at the Center, notably length-based methods, multispecies modelling and other topics related to fisheries management.

When fully operational, ICLARM's Coastal Aquaculture Centre in the Solomon Islands, South Pacific, will offer on-the-job training to selected applicants in research methods as well as in cultivation and postharvest

techniques, particularly to extension workers in the South Pacific. Initially training activities will focus on giant clam culture.

ICLARM aquaculture facilities in other regions are planned for the future. Training will be offered in freshwater fish culture research, especially in genetics and culture systems.

SOCIAL SCIENCES

Background

Since its inception ten years ago, ICLARM has been engaging with cooperating groups in social science research on fisheries and aquaculture issues. ICLARM has long recognized the importance of the social sciences and their potential contributions to issues of fisheries and coastal zone management and to aquaculture development. As fisheries resources have become increasingly overfished and as coastal resources especially have become scenes of intense competition amongst various user groups, issues of resource management, including the required institutional development and allocation of the available catch and other benefits, have become increasingly important.

The importance of these issues and those related to the nontechnical aspects of aquaculture development have become generally recognized, yet the number of social scientists available to address these and related issues has remained small. While the usefulness of the early social science work of ICLARM has been widely acknowledged, it became quite clear in the early 1980s that the Center's task needed to shift from the research *per se* to include that of helping develop a group of practicing social scientists at the national level who could begin addressing these critical issues. The Asian Fisheries Social Science Research Network was an outgrowth of this concern, which was shared by IDRC of Canada and the Ford Foundation, both of which have become major financial supporters of the Network since it formally began in 1983.

While other social science work outside Network member institutions and countries continues to be pursued under the Aquaculture and the Resource Assessment and Management Programs, this work will increasingly involve coordination and collaboration with this Network.

The Asian Fisheries Social Science Research Network (AFSSRN) is an attempt to remove two serious constraints on social science research related to fisheries and aquaculture in Asia: 1) the serious shortage of experienced social science professionals and 2) the weak institutional support for long-term fisheries social science research. The results of these constraints have been a dependence upon countries outside the region for education, consultation and research in social sciences. The overriding objective of the AFSSRN, therefore, is to build national research capacity to address important economic and social issues in the management and development of the living aquatic resources in Asian countries. It is a program of institutional and professional development which seeks to provide continuity to and improve the quality of fisheries social science research and to assure that future professional social science needs can be largely met within the region.

Current Network membership consists of eight institutions in Southeast Asia (see Fig. 5) and includes both university and government research groups.

The importance of the Network program rests in the great economic and social importance of fisheries and aquaculture to the countries and the people in Asia. Fish supplies most of the animal protein to the people of the region and provides an income to more than twenty million people in Southeast Asia alone. The regional fisheries resources are large, but the nearshore fisheries of the region are threatened by overexploitation. This has increased the expectations for aquaculture, which are very high indeed. To achieve these development expectations and to achieve a rational management of the fisheries resources it is essential that policymakers, planners, managers and other decisionmakers have available to them adequate information on the economic and social consequences of their decisions. This can only be provided by research done by competent social scientists committed to the solution of problems of the region. However, the number of professionals currently involved in the effort is not nearly adequate to the task and their distribution within the region is uneven. Moreover, the current scope of the Network is not broad enough to be able to address the variety of issues that arise in all Asian countries.

The Network has two broad program areas:

(1) The development of medium- to long-term programs of social science research on management and development issues of national and regional importance related to fisheries and aquaculture resources.

The AFSSRN assists researchers from the social sciences in affiliated universities and government research institutions to 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. The Network organizes special workshops to develop and evaluate appropriate methodologies for economic, social and multidisciplinary research on fisheries and aquaculture in the Asian region.

(2) The development of national programs of professional training in fisheries and aquaculture economics.

The Network has, heretofore, linked eight institutions in four countries of Southeast Asia and the number of institutions will be increased during the next phase of development. The interest in and awareness of the importance of this kind of research is growing throughout the world and the Network will grow both within and out of Southeast Asia in order to support the development of effective fisheries social science research programs. Expansion to South Asia in Bangladesh, Sri Lanka and South India will take place when adequate financial resources are available. Consideration will also be given to Network expansion to the People's Republic of China at one or two major research centers. Within the countries already in the Network, it is planned

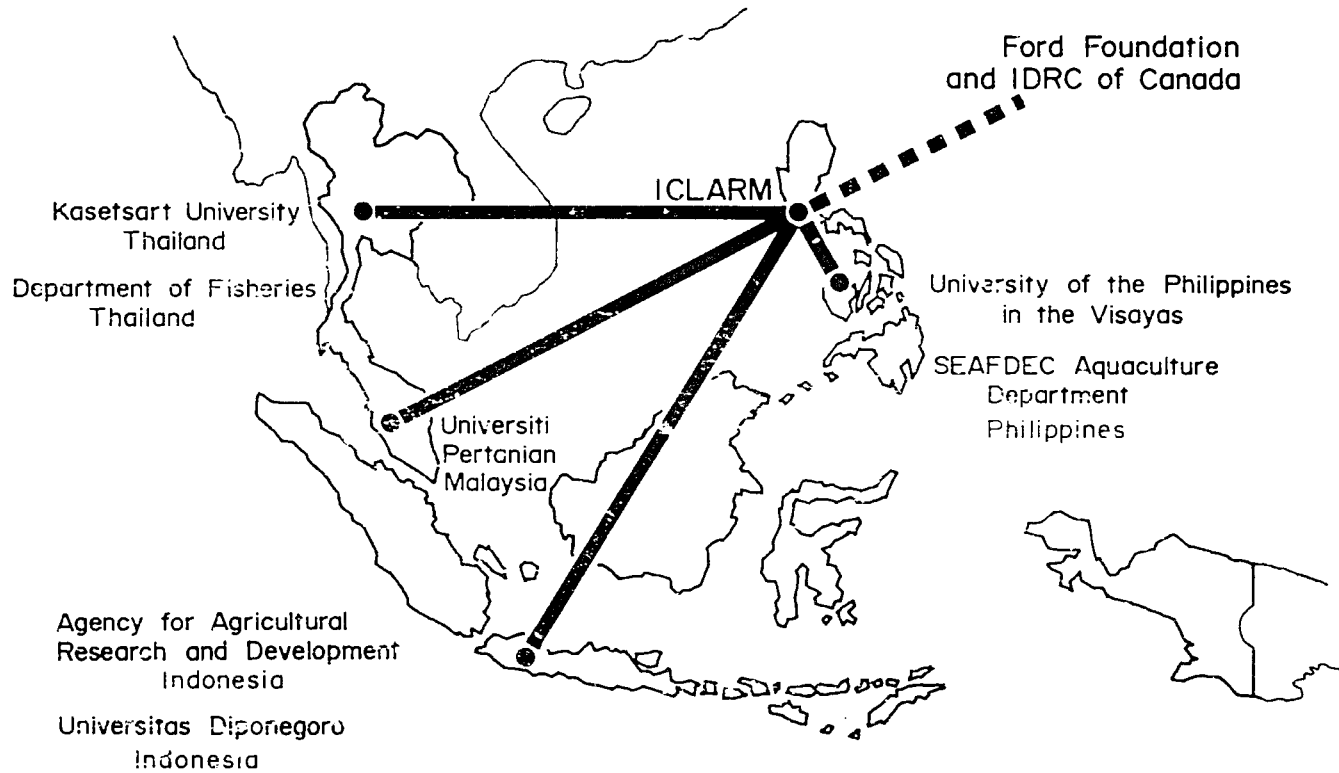


Fig. 5. Member institutions of the Asian Fisheries Social Science Research Network as of late 1987. Further linkages are being promoted at the national level, in order to broaden the participation of social scientists in research on issues of resource management and aquaculture development.

that the geographic and issue orientation will be broadened through the admission of additional collaborating institutions. National networks will be built around the member institutions. Later, the Network, or others like it will include Latin America and Africa.

The Network aims to assist a university in each major fishing nation in Asia to become a national leader in this specialized field of applied social science and to assist other universities and institutions to develop special competence to deal with issues of national importance. Particular attention is given to the development of training material related to the unique conditions under which aquaculture and marine fisheries operate in the region. The Network provides affiliated universities with professional and technical assistance in designing fisheries and aquaculture economics courses and programs of study, assistance with teaching and research materials and literature, and identifying opportunities for staff training and professional exchange in association with IDRC of Canada, one of the key supporters of the AFSSRN.

As these two program areas develop, the Network will encourage: (1) the establishment of strong professional working relationships (linkages) between the fisheries social scientists and agencies responsible for fishery resource use management, planning and development; (2) the increasing collaboration of social scientists with fisheries and aquaculture scientists in research; and (3) the formation of a regional professional association to carry on the work of the Network.

Progress of Work

A list of all projects undertaken by the network institutions is shown in Table 6. Twenty-three were active during 1987. Results of some of these projects are being prepared as Network working papers from which a selection will be made for publication.

The Coordinator of the Network was active in assisting the various projects in ongoing planning of future projects at the various institutions and in training activities (see Table 1 of the Introduction of this Report).

Program Plans

The Network research activities will fall within three program areas of which the first two will be emphasized. These are: 1) Capture fisheries systems and their management, 2) Aquaculture systems and enterprise management and 3) Market systems analyses. Participating institutions will each have research programs that are similar to some or all of these three program areas but each institution has defined its programs somewhat differently to suit national needs and the special skills and interests of the team.

The discipline mix in some cases may include biology, economics, geography, anthropology and sociology. The past Network experience provides a foundation for the effective integration of input from a number

Table 6. Completed and ongoing research projects of the Asian Fisheries Social Science Research Network, as of December 1987.

Title	Researcher and Institution	Duration
Market Potential for Freshwater Fish	Kusairi Mohd. Noh: Faculty of Resource Economics and Agribusiness, Universiti Pertanian Malaysia (UPM), Serdang, Selangor, Malaysia	March-October 1986
Marketing Analysis of the Fish Fry and Fingerling Industry in Malaysia	Mohd. Ariff Hussein: Faculty of Resource Economics and Agribusiness, Universiti Pertanian Malaysia (UPM), Serdang, Selangor, Malaysia	October 1986-1987
A Firm Management Analysis of Integrated Farms with Freshwater Fish, Prawn and Other Agricultural Activities	K. Kuperan: Faculty of Resource Economics and Agribusiness, Universiti Pertanian Malaysia (UPM), Serdang, Selangor, Malaysia	August 1987-March 1988
Review of Malaysian Fisheries Management Policies	Kusairi Mohd. Noh: Faculty of Resource Economics and Agribusiness, Universiti Pertanian Malaysia (UPM), Serdang, Selangor, Malaysia	August 1987-March 1988
Economic Analysis of Cockle Culture in Thailand	Ruangrai Tokrisna: Faculty of Economics and Business Administration, Kasetsart University, Bangkok, Thailand	August 1985-September 1986
Economic Evaluation of Sea Bass Culture in Selected Coastal Areas in Thailand	Marut Muangkoe: Faculty of Economics and Business Administration, Kasetsart University, Bangkok, Thailand	August 1985-September 1987
Economic Analysis of Green Mussel Culture Systems in Thailand	Sanit Kao-ian: Faculty of Economics and Business Administration, Kasetsart University, Bangkok, Thailand	August 1985-September 1987
Economic Analysis of Various Oyster Culture Practices in Thailand	Somkit Tugsinavisutti: Faculty of Economics and Business Administration, Kasetsart University, Bangkok, Thailand	August 1985-September 1987
Price Analysis of Selected Marine Fish	Ruangrai Tokrisna: Faculty of Economics and Business Administration, Kasetsart University, Bangkok, Thailand	August 1987-March 1988
Economic Viability of Freshwater Prawn (<i>M. rosenbergii</i>) Culture in Thailand	Ruangrai Tokrisna: Faculty of Economics and Business Administration, Kasetsart University, Bangkok, Thailand	August 1987-March 1988
Freshwater Aquaculture in Northeastern Thailand: The Development and Constraints	Piti Kantangkul: Faculty of Economics and Business Administration, Kasetsart University, Bangkok, Thailand	October 1987-March 1988
Evaluation of the Socio-economics and Diffusion Process of "Hulbot-Hulbot" Fishing in Iloilo, Philippines	Benedict Posadas: College of Arts and Sciences, University of the Philippines in the Visayas, Iloilo, Philippines	April 1986-February 1987
Patterns and Processes of Decision-Making Among Small-Scale Fishermen in Selected Areas of Iloilo, Philippines	Ida Sison: College of Arts and Sciences, University of the Philippines in the Visayas, Iloilo City, Philippines	December 1985-January 1987
A Socio-Economic Analysis of the Seaweeds Industry in Selected Areas of the Philippines	Benedict Posadas: College of Arts and Sciences, University of the Philippines in the Visayas, Iloilo City, Philippines	August 1987-March 1988
Economics of Aquaculture: Case of Shrimp Cultivation in Central Java, Indonesia	Mudiantono: Faculty of Economics, Diponegoro University, Kotak Pos 270, Semarang, Indonesia	November 1985-August 1986

Continued

Table 6. Continued

Title	Researcher and Institution	Duration
Analysis of Catfish Production and Marketing in Central Java Province, Indonesia	Basuki Suwardo: Faculty of Economics, Diponegoro University, Kotak Pos 270, Semarang, Indonesia	August 1986-July 1987
The Economic Assessment of Household Fishponds in Central Java, Indonesia	Mudiantono: Faculty of Economics, Diponegoro University, Kotak Pos 270, Semarang, Indonesia	August 1987-March 1988
An Evaluation of the Methods and Level of Management of Aquaculture Systems and Enterprises in Java	Mudiantono: Faculty of Economics, Diponegoro University, Kotak Pos 270, Semarang, Indonesia	September 1987-March 1988
Analysis of Fish Consumption Patterns in Selected Urban and Rural Areas of Central Java	Syafrudin B. Suharto: Faculty of Economics, Diponegoro University, Kotak Pos 270, Semarang, Indonesia	August 1987-March 1988
A Review of Fisheries Management Measures and Estimates of Fisheries Potential in Use for the North Coast of Java	Wiratno: Faculty of Economics, Diponegoro University, Kotak Pos 270, Semarang, Indonesia	September 1987-March 1988
Assessment of the Credit and Financial Programs for the Fishery Sector, Philippines	Generoso Octavio: Center for Policy and Development Studies, University of the Philippines at Los Banos (UPLB) College, Laguna, Philippines	August 1985-August 1986
Market Structure Analysis of Fish Distribution Channels Supplying Metro Manila	Enriqueta Torres: Center for Policy and Development Studies, University of the Philippines at Los Banos (UPLB) College, Laguna, Philippines	February 1986-November 1987
Impact of Fishing Boat Motorization on Income Distribution in Indonesia	Faisal Kasryno: Center for Agro Economic Research, Jl. Ir. H. Juanda 20, Bogor, Indonesia	April 1986-December 1987
Comparative Economic Analysis of Different Prawn Nursery Production Systems in the Philippines	Danilo Israel: Aquaculture Department, Southeast Asian Fisheries Development Center (AQD-SEAFDEC), Tigbauan Iloilo, Iloilo City, Philippines	July 1985-August 1987
Economics of Prawn Hatchery and Integrated Hatchery-Floating Nursery Operations in the Philippines	Danilo Israel: Aquaculture Department, Southeast Asian Fisheries Development Center (AQD-SEAFDEC), Tigbauan Iloilo, Iloilo City, Philippines	July 1985-August 1987
Costs and Returns Analysis of Newly Developed Aquaculture Production Systems in the Philippines	Danilo Israel: Aquaculture Department, Southeast Asian Fisheries Development Center (AQD-SEAFDEC), Tigbauan Iloilo, Iloilo City, Philippines	July 1985-August 1987
Socio-economic Analysis of the National Bangus Breeding Program (NBBP)	Noel Lopez: Aquaculture Department, Southeast Asian Fisheries Development Center (AQD-SEAFDEC) and Bureau of Fisheries and Aquatic Resources (BFAR), Quezon Avenue, Quezon City, Philippines	August 1987-March 1988

of disciplines in a single research effort. This research is somewhat more difficult, given the nature of the production process and fisheries property rights, or lack thereof, than research with similar objectives in agriculture or other land-based systems. The concepts and practice of modelling and simulation will be introduced into the Network research programs to assure that an adequate analytic framework is prepared to address questions concerning the dynamics of fisheries systems. Simulation can play a particularly important role in analyzing systems and provides a framework in which optimization need not be the driving force or the central objective. Optimization models, in contrast, tend to place an unnecessary constraint on both researchers and policy decisionmakers.

Capture fisheries. The Network research program on capture fisheries systems and their management will direct its effort to an assessment of the costs and benefits of managing the nearshore resources. The research will be conducted at a number of levels of complexity. At the most basic level the research will focus upon estimating the level of effort reduction necessary to improve or maintain production of selected coastal systems and the benefits that will result from these changes. Estimates of the costs and the community social impact will also be made in these cases. Attention will be given to both pelagic and demersal resources, the focus to be determined by the significance of the resource in the community or district under consideration. At a greater level of complexity, the research will attempt to formulate models of management systems that can support decisionmaking by policymakers and resource managers. A subset of the research activity will be directed to exploring the potential of simulation methods in dealing with the nearshore and other fisheries management problems of the region.

The interdisciplinary research mentioned above is only a part of a broader mix of disciplines that are necessary to address questions concerning the impact of management on the community, broadly construed. A significant part of the Network research effort will attempt to address the social and political impacts of management at the community level. This work will provide a broader basis for policy and management decisionmaking.

Aquaculture. The focus of Network research in aquaculture will shift substantially beginning in 1988. The enterprise management of farming systems, integrated and otherwise, will constitute a major thrust of the research. This represents a substantial change in approach from earlier work which concentrated on costs and earnings.

The Network will focus on the dynamics of the farming process. To provide a framework for dynamic analysis a subset of the research effort will be devoted to exploring the simulation of aquaculture systems as a basis for more effective management and planning.

An important new approach to Network research in aquaculture will be the effort to link the research activity to other ongoing development as well as research programs. The objectives of the link are two: 1) to obtain data, over time, on the operations of the development program and of the enterprises that are part of it and 2) to provide timely analysis for the

support of the development project and for extension systems in support of the enterprises in it. Another important benefit of this approach to research is that it will force attention to the analysis of the dynamics of management and development in a systems context.

Network aquaculture research will shift some of its resources to the development of dynamic analytic and management models of aquaculture enterprises and of farming systems. Using these models as a guide, teams will experiment with the creation of fish farm simulators, for integrated and other farms as well. The program of the Network seeks to provide a research foundation for the more effective management of fish farms.

As in the case of marine fisheries management research of the Network, aquaculture research will also address the larger questions of community impact. This, in fact, is an integral part of what has been termed aquaculture systems analysis. There is a clearer framework, which derives from agriculture, for this kind of analysis than exists for marine fisheries and coastal communities. This stems to some extent from the fact that the production processes in land-based systems are generally less erratic than those based upon the sea.

Marketing. Marketing and pricing issues are sometimes central to fisheries aquaculture development and management. The Network will address these issues as they arise. The research will be on the markets as a system.

With regard to training and education, plans are being made for doctoral courses and increased M.S. programs in network institutions. The methodological skills of team members will be advanced through short courses of two-weeks duration. Eight such courses will be offered over the next three years.

ADMINISTRATION AND FINANCE

Although ICLARM experienced, in 1987, a growth in total revenue of over 40%, the Center's revenue profile continued to shift away from unrestricted grants to restricted and special project grants which, when combined, accounted for 76.2% of total 1987 revenue as compared to 63.5% in 1986 (see Figs. 6 and 7).

While the jump in total revenue was primarily caused by increased activities in various projects which commenced in 1986, close to 6% of total 1987 revenue was received from five new donors - the Danish International Development Agency, the Asian Development Bank, the Skaggs Foundation, the Australia and Pacific Science Foundation and the French Government. The involvement of these five new donors in ICLARM increased the total number of ICLARM donors to nineteen - evidence that the Center continues to draw more donor interest and support.

In fact, it was also in 1987 that the Center received the good news that the World Bank and the Federal Republic of Germany's Der Bundesminister für Wirtschaftliche Zusammenarbeit (BMZ) were to provide unrestricted support for the Center's 1988 programs. These announcements were most welcome since unrestricted grants continue

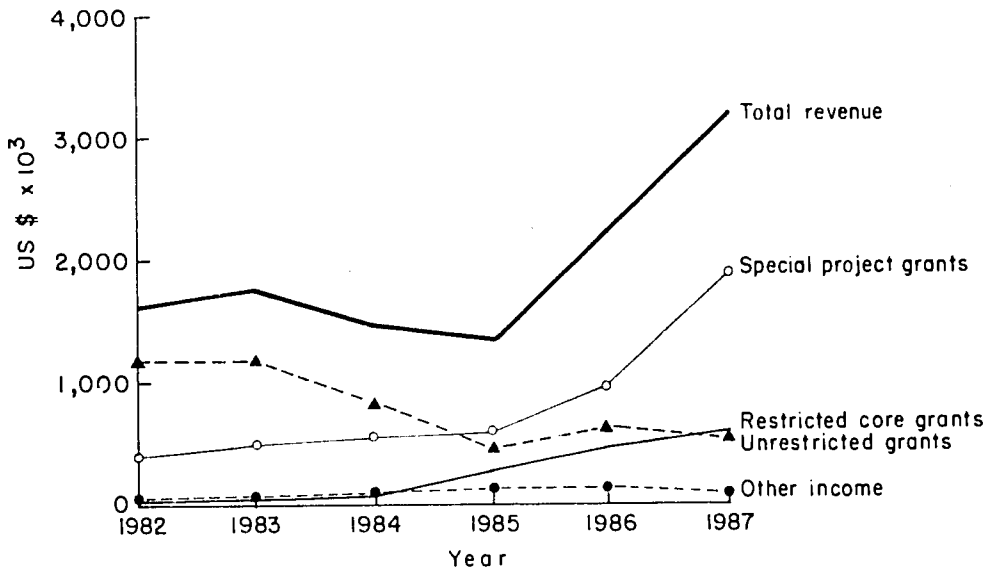


Fig. 6. Revenue profile in actual amounts, in million US\$.

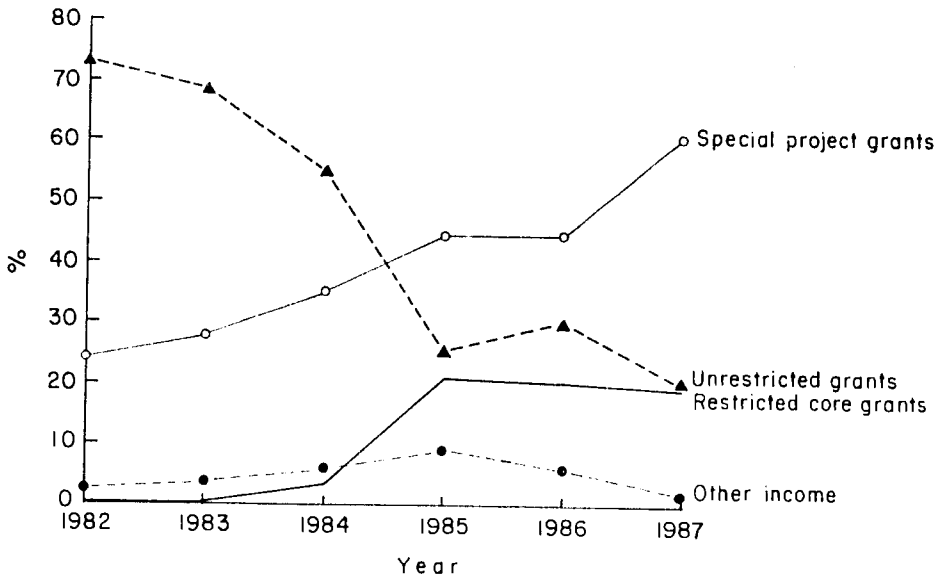


Fig. 7. Revenue profile as a percentage of total revenue.

to play a key role in keeping ICLARM's programs together especially in an environment of numerous restricted grants.

While unrestricted grants continue to be sought for the above purpose, ICLARM also welcomes restricted grants which will provide funding for the various programs and projects set forth in its Five-Year Plan (1988-1992). The Center's Five-Year Plan, which was approved by its Board of Trustees in 1987, describes the various research programs and activities which ICLARM feels are of utmost importance for fisheries and aquaculture research. If successful in encouraging donors to provide restricted funding for these high priority programs and activities, ICLARM will remain faithful to its mandate to provide leadership in fisheries and aquaculture research in spite of the donor shift towards restricted grants.

It is therefore expected that over the next few years, the level of restricted core grants will continue to increase while special project grants decline as the Center focuses management resources on its core programs.

1987 SOURCES OF SUPPORT

1. Unrestricted Support

United States Agency for International Development (USAID)
 Australian Development Assistance Bureau (ADAB)
 Danish International Development Agency (DANIDA)

2. Restricted Support

Activity	Sources of 1987 Support
a. Giant Clam Project/Coastal Aquaculture Centre	Overseas Development Administration (ODA) Skaggs Foundation Australia and Pacific Science Foundation
b. Asian Fisheries Social Science Research Network	Ford Foundation International Development Research Centre (IDRC) of Canada
c. Management Options for Small-Scale Fisheries	Ford Foundation
d. Selective Fisheries Information Service	International Development Research Centre (IDRC) of Canada
e. Network of Tropical Fisheries Scientists	Food and Agriculture Organization (FAO)/Danish International Development Agency (DANIDA) Norwegian Ministry of Development Cooperation (NORAD)
f. Integrated Farming Systems	United Nations Development Programme (UNDP)
g. ASEAN Coastal Resources Management	United States Agency for International Development (USAID)
h. Reservoir Management (Cirata and Saguling Dams, Indonesia)	International Bank for Reconstruction and Development (IBRD)

- | | | |
|----|---|--|
| i. | Philippine Small Pelagics Management | International Bank for Reconstruction and Development (IBRD) |
| j. | Appropriate Technology for Aquaculture in Africa | Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) |
| k. | Germany-Israel Third-World Aquaculture Research Cooperation | Der Bundesminister für Wirtschaftliche Zusammenarbeit (BMZ) |
| l. | Rice-Fish Farming Systems | Asian Development Bank (ADB) |
| | | Programa Cooperativo Peruano |
| m. | Publication - The Peruvian Anchoveta and Its Upwelling Ecosystem: Three Decades of Change | Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) through Programa Cooperativo Peruano |
| n. | Management of Tropical Small-Scale and Open Water Fisheries in Bangladesh | Ford Foundation, Bangladesh |
| o. | Interregional (Asia-Africa) Cooperation in Aquaculture | French Government |

STATEMENT OF REVENUES AND EXPENSES¹ (US\$)

	1987	1986
REVENUE		
Grants	\$ 2,878,675	\$ 1,791,092
Consultancy and service fees	198,291	396,910
Publications	19,440	18,720
Miscellaneous	36,949	18,168
	3,133,355	2,224,890
EXPENSES		
Resource Assessment & Management	\$ 1,651,372	\$ 713,509
South Pacific Office	-	27,773
Aquaculture	820,274	565,697
Education & Training	183,651	284,306
Library & Information Services	161,614	264,750
Information Research	18,308	-
Board of Trustees	67,925	82,001
Program Development	4,084	15,007
Program Advisory Committee	-	43
Administration & Finance	228,490	152,235
General Operating Expenses	109,611	50,927
	\$ 3,245,329	\$ 2,156,248
EXCESS (DEFICIENCY) OF REVENUE OVER EXPENSES	(111,974)	68,642
FUND BALANCE AT BEGINNING OF YEAR		
As previously stated	405,317	368,381
Adjustment ²	(133,422)	(165,128)
As restated	271,895	203,253
FUND BALANCE AT END OF YEAR	\$ 159,921	\$ 271,895

¹As audited by Sycip, Gorres, Velayo & Co.

²Adjustment was caused by changes in 1987, in the policies for accounting for property and equipment. The new accounting policies are now closer to those used by members of the CGIAR.

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