

ABH-120



ICLARM REPORT 1989

International Center for Living Aquatic
Resources Management

ABH-120
~~PU-AB6598~~

ICLARM REPORT

1989

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 1989

Edited by

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

1990

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Published by the International Center for Living
Aquatic Resources Management, MC P.O. Box 1501,
Makati, Metro Manila, Philippines

Printed in Manila, Philippines

Maclean, J.L. and L.B. Dizon, editors. 1990. ICLARM
Report 1989. International Center for Living Aquatic
Resources Management, Manila, Philippines. 167 p.

ISSN 0115-4494
ISBN 971-1022-82-6

ICLARM Contribution No. 644.

14-

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ICLARM AND THE INDIVIDUAL RESEARCHER

Over the past 12 years since ICLARM's establishment in the Philippines, the Center has gradually become fairly well known in international fisheries circles as well as in the many national institutions with which it has worked.

One reason is the wide dissemination of ICLARM publications through their free distribution and sales. This has led to a high level of citation of these publications in the literature, presently well over 300 citations per year (or about one citation per day!). ICLARM's total annual budget continues to rise, meaning that donor organizations see the Center as an increasingly useful organization. But what does this mean to the individual researcher?



Messrs. Noli Navaluna (*left*), John McManus (*center*) and Jose Ingles having a professional chat, sometime in 1981. Mr. Navaluna, then a researcher from the College of Fisheries of the University of the Philippines later obtained an M.S. degree with the first Philippine thesis on fish population dynamics, based on work conducted during ICLARM's San Miguel Bay project. He is now at the University of Washington, USA, working on a Ph.D. Dr. John McManus is now Resident Scientist of the Philippine Module Fish Stock Assessment Collaborative Research Program, which links several US universities and ICLARM in a USAID-funded effort. Mr. Ingles was an ICLARM intern (see p. 2).

Postdocs, Predocs, PCVs and More

From the beginning, postdoctoral fellows have been encouraged, funding permitting, to spend a year or two at ICLARM working on specific projects. It has proven very successful for both the individual and the institution, especially where ICLARM was able to continue their employment subsequently. The late Dr. Ian Smith, who became Director General of the Center (see p. 32) was the first ICLARM postdoctoral fellow. Dr. Daniel Pauly was another.

There have been predoctoral fellows too, funded externally and spending 1-2 years with ICLARM. Generally, however, postgraduate supervision by ICLARM staff is external, being done through detailed correspondence and visits whenever possible.

At headquarters, many young researchers and trainees from colleges in the Philippines who have applied for positions or work experience have passed through our doors. Some obtain research assistant positions with



Dr. Jose Ingles, then a fresh MS graduate from the University of the Philippines, College of Fisheries, was the first ICLARM intern. He spent two years (1980-1981) working mainly with Dr. D. Pauly. He produced several papers and a widely appreciated atlas of the growth, mortality and recruitment of Philippine fishes, which ICLARM published.

our scientific staff; others are attached to the library for varying periods. Our staff make sure these persons receive broad training in their field.

Researchers from voluntary groups, such as the US Peace Corps Volunteers and their Australian, British and Japanese counterparts, receive special consideration. They are usually "resource-poor" and look to ICLARM and its library for guidance and assistance.

The library has developed into a special haven for some 2,000 visiting researchers from the Philippines and overseas each year. As well, it has become a model of its kind, such that the librarians are called upon to help others set up similar operations and to train individuals and small groups in modern library management. In 1989, for example, ICLARM librarian Norma Jhocson spent seven months setting up an aquaculture library and information center in Malaŵi, and 35 individuals spent periods ranging from days to months in the headquarters library, mostly on a one-on-one basis with staff librarians.

There are visiting researchers on sabbatical or who want to become familiar with ICLARM's methodologies and to analyze some data which they bring along. Staff usually manage to find desk space and a computer for such visitors and to interact with them regularly.



Mr. Joseph Ofori of the Institute of Aquatic Biology (IAB), Accra, Ghana, has worked closely with ICLARM Aquaculture Program staff for the last few years, has been trained in microcomputer use for data analysis and has been on study tours of fish hatcheries and farms in the Philippines and Thailand. IAB and ICLARM now have a Memorandum of Agreement under which two new projects have been proposed on aquaculture development projects for Ghana and management of fish genetic resources, respectively. Mr. Ofori will be a key person in both projects.



Mr. Thaddeus O. Acere, Senior Fisheries Officer of the Uganda Freshwater Fisheries Research Organization (UFFRO). His CEC-funded 3-month visit to ICLARM during which he analyzed artisanal fisheries data, led to continued interaction between UFFRO and ICLARM and has contributed to a more balanced view of the role of the introduced Nile perch in Lake Victoria.



Mr. Hussain Muhammed (*right*) from the Mariculture and Fisheries Department of the Kuwait Institute for Scientific Research, in conversation with ICLARM research assistant Mr. Victor Sanbilay, Jr. Mr. Muhammed, during his recent two-month visit at ICLARM wrote two papers, to be published in *Fishbyte*, on the population dynamics and fishery of *Metapenaeus affinis*, an important shrimp resource in Kuwait.

Finally, there are overseas colleagues for whom we prepare visits to our project sites and to other institutions around the Philippines or around the world. A staff member accompanies such visitors where possible and there is always a period of interaction at headquarters.



Dr. Stella Williams, a Nigerian resource economist with a background in aquatic biology, and a Professor at Obafemi Awolowo University, Oyo State, Nigeria, was enabled to visit aquaculture farms and research stations in Malawi, Thailand and the Philippines. She hopes to identify socioeconomic factors which are holding back aquaculture in her country and other parts of West Africa.

Theses Supervision

ICLARM senior staff are involved in supervision of postgraduate students in a variety of ways. For example, Dr. Pauly, the most active staff member in this role, has been the main advisor for 12 M.S. students at the University of the Philippines, and another at Central Luzon State University (Philippines); at present he has three Ph.D. students at the University of Kiel (Federal Republic of Germany), with four more beginning soon; as well he is on the thesis committee of students in Mexico and the USA and will soon have others from France and Sénégal.

Some Aquaculture Program staff are helping supervise six M.S. students and a Ph.D. candidate in Malawi. Others are advisors to grantees of fellowships from the International Foundation for Science and the Asian Fisheries Society. Many of the grantees are M.S. and Ph.D. students.

An "informal" supervisory role has been adopted by some staff, who send relevant new reprints that they receive to selected students in the field and provide them with technical information - even though the staff members concerned are not formally associated with such students.

ICLARM's Coastal Aquaculture Centre in the Solomon Islands also now provides postgraduate supervision and course work for students at the University of the South Pacific.



Mr. Mohammed Iqbal from Pakistan visited ICLARM for training in fish population dynamics and stock assessment. He hopes to apply his newly-acquired skills to formulating management options for Pakistan's marine fisheries.



Mr. U.S. Amarasinghe from the National Aquatic Resources Agency Regional Station, Kalpitiya, Sri Lanka, recently visited ICLARM for four weeks as a fellow of the Asian Fisheries Society. Mr. Amarasinghe has specialized in the investigation of the fisheries resources of Sri Lankan freshwater reservoirs.

Through the Mail

The volume of requests to ICLARM from individual researchers from all over the world is enormous. Amongst the many requests for information, senior staff each receive on average 3-4 letters per week which require a substantial investment of time and thought to answer. Usually the enquirers receive copies of relevant articles as well as a detailed response.

We try always to respond positively to requests and this leads to considerable expense in mailing - airmail is essential to Africa, for example - material such as books, magazines and reprints to enquirers.

Apart from requests to individual staff members, ICLARM's Selective Fisheries Information Service has answered some 25 enquiries per month over the past few years. Enquirers generally receive a printout of a search of the Aquatic Sciences and Fisheries Abstracts database and/or a list of relevant items in the ICLARM library or staff collections on their topic. There is a charge for additional services such as providing copies of the articles retrieved, otherwise the Service would eventually cripple the Center financially.

The bulk of mail enquiries and interaction between ICLARM staff and their colleagues around the world comes in two ways. The first is via the four networks maintained by the Center. Combined membership of these networks is presently about 1,550. The four networks are proving to be extremely valuable, not only in bringing scientists into contact with each other, but also in the help offered by the network coordinators with members' research activities and even in helping them into print, via network newsletters. Indeed, three of the four networks arose through

Many enquiries we receive from researchers concern opportunities for advancing their careers through course work. Much has been said - and written - about the dearth of training opportunities in fisheries and aquaculture. But what are the opportunities already available and where can they be found?

To find out, ICLARM conducted a questionnaire survey covering about 600 institutions worldwide. The material gathered has been developed into a database maintained on a microcomputer using dBase III. The results were presented in a Directory of Educational and Training Opportunities in Fisheries and Aquaculture, published in 1989 by the Food and Agriculture Organization of the United Nations (FAO) and ICLARM. The database is updated regularly. The project to prepare the Directory was sponsored by the Fisheries Department of FAO.

The Directory covers fisheries, aquaculture and combined courses offered by 427 institutions worldwide at various levels (high school, vocational, bachelor's, master's, doctorate). It includes information on language of instruction, areas of specialization, willingness to conduct individual training on request and to accept developing-country applicants, etc.

The Directory is available free from ICLARM (or \$5 airmail). Copies of the database are also available from ICLARM. Send your own (double-sided, double density 5-1/4") diskette and \$5 for return mail.

Directory of Educational and Training Opportunities in Fisheries and Aquaculture



the desire, on the part of staff members, to help overcome the "isolation" felt by individual, developing-country aquatic scientists. A special feature on the networks follows.

The other major mode of interaction is with the "invisible college" of researchers worldwide in ICLARM's areas of interest. Just as our scientific staff provide advice and material to some researchers, they also seek advice and material from perhaps these same and other researchers to keep abreast of their field and to monitor new trends.

Finally, to keep researchers within ICLARM up to date on each other's interactions with the outside world, a monthly compilation of outgoing letters, faxes and telexes is circulated around headquarters and also copied to field staff. Sometimes, this stimulates new rounds of correspondence by another of ICLARM's staff with the researcher concerned.

These various contacts between ICLARM staff and individual researchers around the world through networks, visits and correspondence add up to a significant part of the total activity of the Center. Like the many memberships and affiliations of staff in societies, editorial boards and with university faculties (listed in the ICLARM Report for 1987), staff contacts with individual researchers are a little-known aspect of the dynamic "machinery" that enables ICLARM to live up to its international status.

NETWORKING AT ICLARM

Networking — exchanging information or services amongst individuals and/or groups — has long been a feature of ICLARM. One salient reason is that "as funds tighten worldwide, administrators and donors are searching for ways to foster more efficient research", as Donald Plucknett and Nigel Smith wrote in an essay on the subject contained in ICLARM's Tenth Anniversary (1986) Report. They noted other advantages of networks too. One is the usefulness of networks in tackling problems that are regional or international, otherwise undertaken by isolated, individual researchers; collaborative efforts can produce new insights that would be difficult to achieve at the individual level; and the fact that networking leads to improved communications and dissemination of new or improved methodologies.

In 1981, the late Dr. Ian Smith of ICLARM began discussions with the International Development Research Centre (IDRC) of Canada that led to the establishment in 1983 of a network of institutions with programs related to social science research in fisheries, the Asian Fisheries Social Science Research Network (AFSSRN). It became the first network coordinated by ICLARM. The focus has been on training and application of methodologies.

While the AFSSRN concept was being developed, the Network of Tropical Fisheries Scientists (NTFS) was initiated within ICLARM by Dr. John Munro in 1982, based on his experiences as a relatively isolated researcher working in Jamaica and Papua New Guinea before joining ICLARM. In this case the focus was on a newsletter, Fishbyte, as a means of communication between individual scientists, quite a different approach to the institutional nature of AFSSRN and one which has also found favor with some donors.

Dr. Munro later went back to the field to direct ICLARM's South Pacific Office and Coastal Aquaculture Centre in the Solomon Islands. There he began to organize another network, the Coastal Aquaculture Network, with an informal newsletter, to help communications between researchers and institutions primarily in the South Pacific.

At headquarters, Dr. Roger Pullin witnessed the success of NTFS and, seeing parallel needs in the aquaculture field from his own extensive travels throughout the tropics, established a Network of Tropical Aquaculture Scientists (NTAS) in 1987. As with NTFS, a newsletter, Aquabyte, is the major instrument.

The networks have all prospered. The popularity of the two major networks of individuals is shown in their ability to continue attracting new members. In the older of the two, NTFS, healthy debate has sprung up in the Members Write pages of Fishbyte. More and more members are

sending in short technical articles to the point where the editor and the newsletter are becoming overloaded! NTAS shows signs of following suit.

Researchers in the member institutions of the AFSSRN have completed a large number of research projects since 1983 and some have appeared as Network publications. There is a strong desire amongst the members to continue and to consolidate this Network.

Unfortunately, these networks are only as stable as ICLARM's funding support, since some or all of the network expenses come from our core funds. FAO provides free books and modest funding assistance at present for NTFS; the International Development Research Centre (IDRC) of Canada has provided all the research funds to date for AFSSRN; the Ford Foundation supported AFSSRN coordination until 1989; and IDRC is assisting this activity now also. However, it is clear that most of the expenses related to such long-term activities will become ICLARM core expenses. It is hoped that donors will see fit to support them in future in this context.

Donor confidence in ICLARM's ability to organize and coordinate networks is becoming apparent. FAO recently agreed to assist NTFS for a further three years, while the United Nations Development Programme has requested ICLARM to investigate the prospects for a global network on fish genetics research.

Following are detailed accounts of these networks.

Asian Fisheries Social Science Research Network

Dr. Louise A. Fallon
(Network Coordinator)

The Asian Fisheries Social Science Research Network (AFSSRN) was established in 1983 to address the need to enhance domestic social science research capabilities relative to capture fisheries and aquaculture in Asia.

Formation of the Network followed discussions with the International Development Research Centre (IDRC) of Canada and the Ford Foundation, in which IDRC provided a generous fund to support research and educational activities of the Network members; the Ford Foundation agreed to fund the Coordinator; and ICLARM provided secretarial and administrative support.

Objectives

The objectives of the AFSSRN are as follows:

- To advance the professional capacities of its members and broaden the base of its membership.
- To support its members in the conduct of research in the social sciences that will generate results of value for the formulation of

development policies and management strategies in support of capture fisheries and aquaculture sectors.

- To develop educational programs in the social sciences related to capture fisheries and aquaculture at the graduate and undergraduate levels in AFSSRN member institutions.
- To augment national activities of the AFSSRN with international linkages among its members.
- To promote the use of the AFSSRN research results through effective dissemination.

Membership

The AFSSRN is currently composed of 13 research teams, totalling more than 80 researchers, at universities and national government and regional agencies in Indonesia, Malaysia, Thailand and the Philippines. These AFSSRN member institutions have a strong commitment to social science research relative to capture fisheries and aquaculture. Broader representation in the AFSSRN of social scientists from similar institutions in other countries within Asia is being pursued. The institutional affiliation of the current AFSSRN research teams are as follows:

Indonesia

- Faculty of Economics, Diponegoro University, Semarang
- The Research Group on Agro-Ecosystems (KEPAS), Agency for Agricultural Research and Development, Bogor
- Research Institute for Marine Fisheries, Jakarta
- Research Institute for Coastal Fisheries, Maros, Sulawesi Selatan

Malaysia

- Natural Resource Economics Department, Universiti Pertanian Malaysia, Serdang Selangor

Philippines

- College of Arts and Sciences, University of the Philippines in the Visayas, Iloilo City
- Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo
- College of Economics and Management, University of the Philippines at Los Baños, Los Baños, Laguna
- Bureau of Fisheries and Aquatic Resources, Department of Agriculture, Quezon City

Thailand

- Department of Agricultural and Resource Economics, Faculty of Economics and Business Administration, Kasetsart University, Bangkok
- Fisheries Economics Section, Department of Fisheries, Ministry of Agriculture and Cooperatives, Bangkok
- Coastal Resources Institute, Prince of Songkla University, Hat Yai, Songkla

Activities

Research

The AFSSRN assists researchers in its member institutions in developing and implementing programs of social science research related to fisheries and aquaculture. The Network administers small grants both for the formulation and implementation of selected research projects. Technical advice and assistance is provided when necessary by the AFSSRN Coordinator and other professional staff members of the International Center for Living Aquatic Resources Management (ICLARM).

Training and Education

The Network sponsors periodic short-term training courses, workshops and symposia designed to develop and strengthen the research skills and capacities of its members. The focus of such activities is the introduction and practice application of research methodologies appropriate for multidisciplinary social science research on fisheries and aquaculture, and presentation and discussion of development and management issues relative to fisheries and aquaculture in Asia.

Through a cooperative agreement with Simon Fraser University (SFU), British Columbia, Canada, financial support and advisory services are made available to selected AFSSRN members to pursue graduate degrees in Fisheries Economics at SFU. Also under this agreement, AFSSRN members, as visiting scholars to SFU, are funded for short visits to Canada to enable professional interaction with SFU faculty.

Similar arrangements with other donor agencies and educational institutions are being investigated in order to provide a broader scope of choice for AFSSRN members, in terms of social science discipline and institution.

Publications

The Network Publication Committee, made up of a group of team leaders from various Network research teams, provides a forum for internal review of manuscripts submitted by members for publication by the Network. Publication of research results outside of the Network is also supported.

A quarterly newsletter, *AFSSRN News*, is to be published as part of the newsletter, *Tropical Coastal Area Management*, by the Coastal Area Management Program of ICLARM. An independent AFSSRN newsletter is planned for the future as membership expands and more funds become available.

Professional Interaction

Professional interaction among the membership of the AFSSRN is encouraged. Workshops, training courses and seminars sponsored by the Network provide a good forum for sharing of experiences with research methodologies and issues. Peer review of proposals submitted for AFSSRN funding provides another useful mechanism for cross fertilization of research ideas.

In addition, AFSSRN members participate in joint projects of a regional scope. For instance, the Network is currently developing the concept of, organizing and will participate in a special socioeconomic session for the Third Asian Fisheries Forum to be held in Singapore in 1992.

Coordination

Coordination of the Network was supported by the Ford Foundation from its inception in 1983 to mid-1989. ICLARM has always provided a secretary and facilities for the Coordinator. The AFSSRN Coordinator provides technical assistance and advice to network members and assists them in developing research proposals in line with the objectives and functions of the Network.

The Coordinator also solicits advice and methodological support from the international research community for AFSSRN members in support of their research activities. Efforts are being made to establish an Advisory Committee of well-known experts in various fields of social science research relative to capture fisheries and aquaculture.

The first Coordinator was Dr. Brian Lockwood, who developed the various teams and assisted them in preparing proposals, workshops and publications. Brian left to make a new home in Australia in October 1986. His successor, Prof. Harlan Lampe, brought more training skills to the Network and a gradual shift in research emphasis by the Network members.

When funds for the Coordinator ran out in April 1989, we lost Harlan from our staff, but he continues to interact with the Network.

Dr. Max Agüero took on the position of Interim Coordinator for the next six months while we sought ways and funds for a Network newsletter and an international Advisory Committee to broaden the context of the Network. However, he was due to begin a two-year outposting in Latin America, representing ICLARM there and working with the UN Economic Commission for Latin America and the Caribbean.

Dr. Louise A. Fallon became the new Coordinator on joining ICLARM in October 1989. The position is a half-time one, since she is also the economist in ICLARM's Coastal Area Management Program. However, Dr.

Fallon is to be supported in this role by a full-time research assistant as well as a secretary and the Coordinator, as in the past, can call on other ICLARM scientists to help in Network activities where appropriate.

Funding

Funding for research, training, education and publication activities continue to be provided by IDRC. Network administration and coordination is currently funded by IDRC and ICLARM. Efforts are being made to increase and diversify the sources of funding for research, training and education, publication, coordination and advisory activities.

The Network of Tropical Fisheries Scientists: Bridging Communication Gaps

Abbie Cruz Trinidad
(Network Secretary)
Daniel Pauly
(Fishbyte Editor)

Rationale

Progress in stock assessment work on tropical fisheries has been slow and there are very few, if at all, fisheries which are rationally managed. The reasons are obvious: the biology of fishes, the nature of the fisheries and the institutions that manage them, as well as the limited educational opportunities available to scientists.

A great constraint is the fact that scientific personnel attached to fisheries institutions are often not well-versed in the quantitative aspects of stock assessment. This is partly an effect of the lack of relevant educational support systems. Only recently has fisheries stock assessment, and fisheries science for that matter, been given due consideration in universities in tropical developing countries. Furthermore, the avenues for information exchange are not many or are not fully utilized.

Objectives

As part of its commitment to disseminate and strengthen the use of stock assessment techniques, ICLARM announced the inception of the Network of Tropical Fisheries Scientists (NTFS) at a conference of the Indo-Pacific Fisheries Commission held in 1982. The NTFS has as its main objectives:

- The enhancement of communication between fisheries scientists working on aspects of management-oriented research
- The enhancement of output of these scientists by improving access to literature, providing free database searches, distributing

manuals and other literature and publishing a regular newsletter. 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.

Scope

Fisheries scientists invited or nominated for membership to the NTFS, who should have at least a B.S. degree or equivalent, are generally engaged in studies of the scientific aspects of assessment, conservation and management of tropical stocks. The orientation is two-pronged: one branch is oriented towards the development and/or improvement of existing methods for fisheries management (i.e., for stock assessment techniques) while the other emphasizes the application of these known techniques to specific fisheries. However, a recent survey of the perceptions of NTFS members regarding the future role of marine science revealed a list of nonconventional research themes such as coastal zone management and computer applications.

Membership

Network membership has grown from 60 in 1982 to the present 963. Meanwhile, the number of countries represented has grown from 52 in 1983 to 108 countries (see Table 1). The list of countries with the corresponding membership breakdown is shown in Table 2. A summary of the regional distribution of members is shown in Fig. 1. Members from Asia dominate the Network, accounting for 37% of total membership.

Table 1. Growth in NTFS membership and countries represented.

	1982	1983	1984	1985	1986	1987	1988	1989
Members	60	200	427	520	680	700	850	963
Countries		52	69	80	80	90	100	108

Membership growth can be largely traced to the participation of scientists in national/regional courses conducted by the Food and Agriculture Organization/Danish International Development Agency (FAO/DANIDA) Fish Stock Assessment Project in countries such as the Philippines, India, Tanzania, Mozambique or Venezuela. Likewise, the Norwegian Agency for Development Cooperation (NORAD), through its R/V Fridtjof Nansen Survey project, has bolstered the membership of Central and South American scientists. The remaining percentage of membership growth is accounted for by individuals who themselves expressed interest in the Network activities or were nominated by fellow members.

A survey of 103 NTFS members on their educational attainment and scientific productivity showed that 40% have Ph.D. or higher degrees;

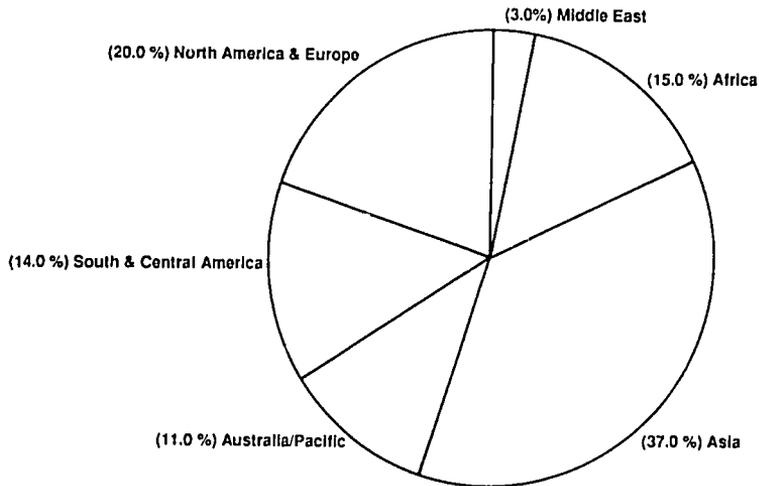


Fig. 1. Regional distribution of NTFS members, as of December 1989.

Table 2. Distribution of NTFS members as of December 1989, by country.

Country	Number	Country	Number	Country	Number
Algeria	9	Greece	2	Oman	3
American Samoa	1	Grenada	1	Pakistan	8
Angola	1	Guatemala	1	Palau	1
Argentina	2	Guyana	2	Papua New Guinea	15
Australia	51	Honduras	3	Peru	19
Bahamas	1	Hongkong	1	Philippines	113
Bangladesh	10	India	67	Puerto Rico	7
Barbados	7	Indonesia	42	Rwanda	1
Belgium	2	Israel	4	Saudi Arabia	2
Benin	1	Italy	20	Sénégal	10
Bermuda	2	Jamaica	3	Seychelles	5
Brasil	14	Japan	6	Sierra Leone	4
British Virgin Islands	1	Kenya	18	Singapore	3
Brunei Darussalam	5	Korea	1	Solomon Is.	9
Cameroon	6	Kuwait	6	Spain	4
Canada	12	Madagascar	2	Sri Lanka	23
Cayman Islands	1	Malawi	4	St. Lucia	2
Chile	11	Malaysia	38	Sudan	4
China	11	Maldives	3	Suriname	2
Colombia	8	Mali	1	Sweden	1
Cook Islands	1	Mariana Is.	1	Taiwan	1
Costa Rica	4	Mauritania	4	Tanzania	21
Cuba	2	Mauritius	6	Thailand	22
Côte d'Ivoire	4	Mexico	21	Trinidad & Tobago	6
Denmark	9	Micronesia	2	Turkey	2
E. Caroline Is.	1	Morocco	3	US Virgin Is.	3
Ecuador	5	Mozambique	2	USA	72
Egypt	12	Netherlands	7	Uganda	5
El Salvador	1	Netherlands Antilles	1	Union of Myanmar	7
Ethiopia	1	New Caledonia	5	United Kingdom	26
Fiji	10	New Zealand	3	Uruguay	1
Finland	1	Nicaragua	2	Venezuela	7
France	13	Niger	1	Yemen, Arab Rep.	1
Gambia	2	Nigeria	16	Yemen, Peo. Dem.	4
Germany, Fed. Rep. of	10	Niue	1	Zambia	4
Ghana	5	Norway	4	Zimbabwe	4

Total no. of members: 963
Total no. of countries: 108

45% are M.Sc. degree holders or equivalent; while 15% are B.S. or vocational degree holders or are informally trained.

Productivity of NTFS members (expressed in publication page "credits")¹ was culled mostly from the curriculum vitae of respondents. However, additional information was collected from literature searches made at the ICLARM library (ASFA, 1984-1988) and from the personal collection of ICLARM staff. The productivity profile of NTFS members is as follows:

No. of credits	No. of members
0	21
1 - 99	15
100 - 999	34
1,000 - 4,999	28
5,000 - 9,999	3
10,000 - 14,999	1
15,000 and above	1

Note that while 20% of the sampled members do not have any publications, only 5% have publication credits greater than 5,000. Furthermore, the geographical distribution of members did not have any significant influence on productivity, i.e., it did not appear that members from developed countries were more productive.

Fishbyte: The NTFS Newsletter

In their response to a questionnaire distributed in 1988, Network members unanimously ranked Fishbyte as the most useful service offered by the NTFS. The survey also showed that members were most interested in the main articles; this was followed by news items and bibliographic information.

The regular features of Fishbyte include: short scientific articles; letters to the editor; announcements pertaining to workshops/conferences, short- and long-term courses, job vacancies, and new literature and software; listing of publications available through the Network from various donors; listings of recent publications by Network members; and reports of current activities of Network members.

The main articles reflect the research themes of the Network and have either a methodological focus or a geographical focus, i.e., a direct application of existing methods to a specific fishery. The main articles are published in English although articles written in Spanish and French (with English abstracts) are also encouraged.

¹Publication credits were computed on the basis of quality (scientific content), quantity (number of pages), and relative contribution of individual author (position of author's name in cases where there is more than one author) to the publication. Quality or "scientific content" was based on categories devised by Rounsefell (1961) with minor modifications. For example, the category with the highest number of credits includes papers in journals, textbooks, and references of college level where each page is assigned 10 points.

Presently, selected publications from FAO and UNESCO² (titles are featured in Fishbyte) are available free of charge to all members. Additionally, reprints of papers by members, who otherwise do not have copies of their reprints or are not able to disseminate them due to mailing costs, are photocopied and distributed to interested members free of charge. Another important feature of Fishbyte is a report of the current activities of members. It is through this section that members are encouraged and enabled to communicate with each other. The 1988 survey revealed that 74% of the members communicated with each other to exchange reprints and other information. Furthermore, we found that communication flow among members did not follow the hypothesized "North-South" direction; "South-South" interaction was dominant. This suggests that the existence of the Network and the impact of Fishbyte help in partially resolving the problem of isolation among tropical fisheries scientists.

Fishbyte, which is published thrice a year is distributed free of charge to individual members and 130 libraries in 43 countries. Its publication and distribution costs are supported by a grant from the FAO/DANIDA Fish Stock Assessment Project and for the period 1987-1989, the NORAD.

Other Services

Aside from the publication of Fishbyte and the distribution of manuals and reprints from the NTFS collection and the ICLARM library, database searches are also offered although not many members avail of this service.

Since its inception, the NTFS has hosted 38 fisheries scientists from several of its member countries to train at ICLARM for periods from 2 weeks to 2 months and over to learn stock assessment techniques (see Table 3). Interns are usually provided a working space, a computer, free books and other publications, and the opportunity to interact with ICLARM's staff. This important service has elicited an enthusiastic response from and beyond the NTFS (an ICLARM training brochure is now available to respond to numerous inquiries). Thus, institutions would request training for some of their staff who may not yet be members of the NTFS. An expansion of this service is ideal but funding is the primary constraint. Interns who visit ICLARM usually secure their own funding from donor agencies (see Table 3) or use their personal funds, for which ICLARM provides discounts.

The NTFS also functions as an umbrella for the activities of other ICLARM projects which are related to tropical fish stock assessment, notably the Capture Fisheries Management Program's Tropical Fish Stock Assessment Project. Through this project, scientists from national fisheries agencies who have trained and are working on these techniques are integrated into the NTFS. Stock assessment modules are now at work in Indonesia, Peru, Zambia and Mozambique. Regular services and small incidental expenses are charged to the NTFS.

²Publications from the FAO/UNDP Regional Fishery Support Programme in the South Pacific are distributed free to all NTFS members who are Pacific Island nationals.

Table 3. Regional distribution of NTFS interns and funding institutions

Region	Number of trainees	Funding institutions
Southeast Asia	23	ICLARM, FAO, IDRC, JICA, BFAR, USAID, BOBP, FAO/SIDA, MMSU, GTZ/ICLARM Project, personal
South Asia & the Middle East	10	KISR, BOBP, UNESCO, IDRC, German Agency for Int'l Development (DSE), Univ. of Karachi, personal
Australia & the Pacific	1	personal
South America	1	GTZ
North America & Europe	2	FAO, French Ministry of Foreign Affairs
Africa	1	CEC

List of Abbreviations:

- BFAR - Bureau of Fisheries and Aquatic Resources, Philippines
- BOBP - Bay of Bengal Programme
- CEC - Commission of European Communities
- FAO - Food and Agriculture Organization of the United Nations
- GTZ - Deutsche Gesellschaft für Technische Zusammenarbeit
- IDRC - International Development Research Centre of Canada
- JICA - Japan International Cooperation Agency
- KISR - Kuwait Institute for Scientific Research
- MMSU - Mariano Marcos State University, Philippines
- SIDA - Swedish International Development Agency
- USAID - United States Agency for International Development

The Future Activities and Needs of the NTFS

The future activities of the Network can be gleaned from the survey responses of the Network members themselves. Network members foresee an expanded role of the NTFS to include the following: publication of a journal; extension work; submission of position papers; directory of personnel with a profile of research interests; assistance in securing funds, i.e., assisting members to secure funds for training/workshop; organizing regional meetings; and expanding the scope to aquaculture.

In the medium term, the most likely expansion of NTFS activities will focus on the increase in the frequency of publication of Fishbyte (4 issues/year); publication of a comprehensive directory of members with proper documentation of research interests and publications; and establishment of an internship program (in-house training at ICLARM) which will be granted to deserving members.

The Network of Tropical Aquaculture Scientists: Information Exchange among Tropical Aquaculture Scientists

Mary Ann P. Bimbao

(Network Secretary)

Roger S.V. Pullin

(Aquabyte Editor)

Rationale

Aquaculture scientists in tropical developing countries often lack critical information for their research activities. They tend to work in isolation using outdated research methods and approaches. They are not well informed on the status of aquaculture development, ongoing research by fellow scientists and recent publications and results. This lack of awareness reflects the high costs of communication and information, particularly books and technical reports. Tropical aquaculture scientists therefore need a mechanism to exchange information, results and ideas, a need that can be best served by a network.

Objectives

This critical need for information of aquaculture scientists in developing countries led ICLARM to establish the Network of Tropical Aquaculture Scientists (NTAS) in 1987. The NTAS aims to help put scientists in touch with each other and to provide them with information sources needed in their tropical aquaculture research. The specific objectives of the NTAS are: to enhance communication between tropical aquaculture scientists; to facilitate output by these scientists by assisting them in database searches, research methods, data analysis and interpretation; and to publish a newsletter at regular intervals.

Scope

As aquaculture is a large, diverse field of study, the research themes of the NTAS follow those of ICLARM's Aquaculture Program: the genetics of finfish cultured in the tropics, integrated agriculture-aquaculture farming systems, and coastal aquaculture of tropical molluscs. Thus, potential NTAS members are aquaculture scientists who are active in these research areas. However, this is interpreted broadly and members with broader or other interests in warmwater aquaculture, policymaking and development are also welcome.

Membership

The NTAS was launched through the July 1987 issue of *Naga*, the ICLARM Quarterly. The increase in the number of aquaculture scientists

joining the NTAS since its inception is shown in Table 1. The countries that have the highest number of members are the Philippines (51), India (25), Thailand (22), and USA and Nigeria (20). This signifies the importance of aquaculture and/or aquaculture research in these countries. The exceptionally large membership in the Philippines can also be attributed in part to the location in Manila of ICLARM's headquarters.

Table 1 also shows that the NTAS membership expanded from 57 countries at the end of 1988 to 71 countries in December 1989. As a whole, 72% of total NTAS members come from developing countries, confirming their need for its services.

Table 1. Year-end number of NTAS members by countries since its inception in July 1987.

Countries	December 1987	December 1988	December 1989	Total
Australia	1	5	7	13
Bangladesh	0	2	4	6
Belgium	1	2	0	3
Benin	0	1	0	1
Brazil	0	1	2	3
Burkina Faso	0	1	0	1
Cameroon	0	3	0	3
Canada	1	6	4	11
Chad	1	0	0	1
Chile	0	3	0	3
China	1	5	3	9
Colombia	0	0	1	1
Congo	0	1	1	2
Cook Islands	0	0	2	2
Costa Rica	0	2	0	2
Côte d'Ivoire	0	6	8	14
Cuba	0	0	1	1
Cyprus	0	0	1	1
Egypt	0	1	1	2
Ethiopia	0	0	1	1
Fiji	0	4	0	4
France	0	3	1	4
Gambia	0	1	0	1
Germany, Fed. Rep. of	0	4	3	7
Ghana	0	5	0	5
Guatemala	0	0	1	1
India	0	8	17	25
Indonesia	0	6	2	8
Israel	1	7	1	9
Italy	0	3	1	4
Japan	0	1	1	2
Jordan	0	0	1	1
Kenya	0	2	2	4
Kuwait	0	1	1	2
Malawi	1	7	0	8
Malaysia	1	3	4	8
Mauritius	0	1	1	2
Mexico	0	3	0	3
Micronesia, Fed. States of	0	1	1	2
Morocco	0	1	1	2
Mozambique, P. of	0	1	4	5
Myanmar, Union of	0	1	1	2
Netherlands, The	0	0	6	6
New Caledonia	0	1	0	1
New Zealand	0	1	0	1

continued

Table 1. (continued).

Countries	December 1987	December 1988	December 1989	Total
Nigeria	0	7	13	20
Norway	0	3	3	6
Palau, Rep. of	0	1	0	1
Panama	0	1	0	1
Papua New Guinea	0	0	1	1
Peru	0	0	3	3
Philippines	11	21	19	51
Saudi Arabia	0	0	2	2
Sénégal	0	1	0	1
Singapore	0	1	0	1
Solomon Islands	0	4	0	4
Sri Lanka	1	1	3	5
St. Lucia	0	1	0	1
Sudan	0	3	0	3
Sweden	0	1	0	1
Tanzania	0	3	3	6
Thailand	1	17	4	22
Tonga	0	1	0	1
Tunisia	0	1	0	1
Uganda	0	0	1	1
Uruguay	0	0	1	1
UK	0	11	1	12
USA	2	12	6	20
USSR	0	0	1	1
Zambia	0	4	1	5
Zimbabwe	0	1	4	5
Total				
Members	23	199	151	373
Countries	12	57	71	71
Members from developing countries(%)	74	70	72	72

The distribution of NTAS members by region is illustrated in Fig. 1. At the end of 1989, the regions with the highest proportion of members were East and Southeast Asia (29%) and Africa (26%).

Table 2 shows the fields of interest of some members of NTAS. Coastal aquaculture is the most popular broad field, followed by integrated farming, genetics and research on molluscs, especially giant clams. Tilapia was the most researched fish.

The NTAS Newsletter, Aquabyte

The main mechanism for putting NTAS members in touch with each other is the NTAS newsletter, Aquabyte, which is distributed free to members. Aquabyte readership also covers 92 fisheries and aquaculture institutions in 30 countries.

The first issue, Aquabyte 1(1), was published in March 1988. Aquabyte 1(2), the next issue, came out in October of the same year. In 1989, the NTAS published three issues of Aquabyte and hopes to maintain this number of issues per year.

The regular features of Aquabyte are short scientific papers; an African section in French and English; news items; a short humorous

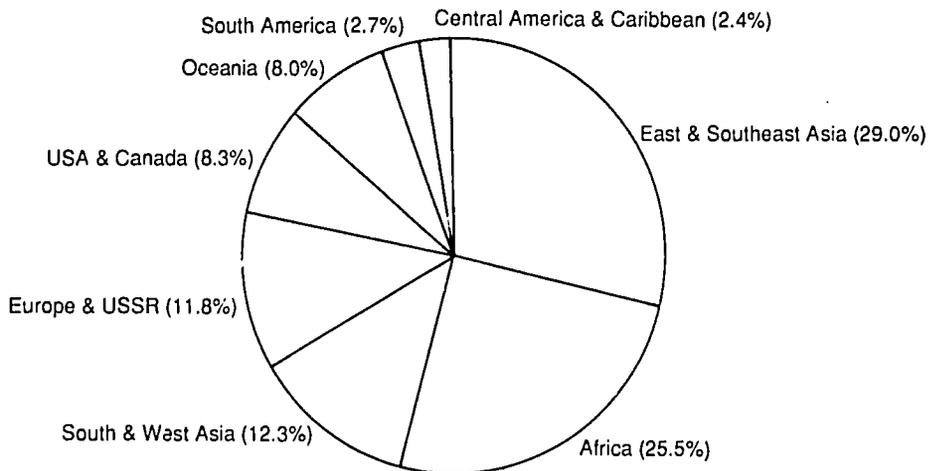


Fig. 1. Regional distribution (%) of NTAS members, December 1989.

Table 2. Field(s) of interest(s) of some NTAS members. Other members' interest(s) are not specified beyond "warmwater aquaculture".

Field(s) of Interest(s)	No.
Algae (marine)	3
Carp	3
Catfish	3
Coastal aquaculture	62
Culture systems	7
Disease	3
Ecology	2
(Socio)economics	8
Extension	1
Genetics	39
Hatcheries	3
Information	1
Integrated farming	50
Microbiology	1
Microcomputers	1
Milkfish	2
Molluscs	38
Mullet	2
Nutrition	25
Physiology	1
Remote sensing	1
Reproduction	13
Reservoirs	2
Seabass	2
Siganids	1
Tilapia	20

section, "Culture Club"; an information section which includes book reviews of relevant aquaculture materials, recent publications (indexed by genetics, integrated farming, coastal aquaculture, and general aquaculture), and listings of recent and upcoming meetings; a list of NTAS members; a "Members Write" section; and a photosection, made up of interesting photographs sent in by members.

The short scientific papers are contributions from members who write about their research work. Some contributions are "ideas papers", written to stimulate discussions on particular issues on aquaculture research and development.

The African Section began in Aquabyte 1(2). Its inclusion as a regular feature in Aquabyte is to encourage wider readership and membership in the Francophone and Anglophone countries of Africa. This section contains information pertinent to African aquaculture in the form of short scientific papers, news items and announcements.

The News Items Section provides recent and important information on aquaculture research and development and the Culture Club contains contributions from members that carry cautionary, humorous and cultural items of interest.

The Members of NTAS Section lists new members and their fields of interests to encourage members with common interests to correspond directly to each other. Changes in members' addresses are also published. The Members Write Section publishes letters from members, most of which ask for information, reprints and publications, and key contacts. Other letters contain views and comments on particular problems raised in previous issues or information on members' research work.

The Photosection features photographic materials that depict the species and culture systems of members' research work and aquaculture systems. Interesting photographs published in previous Aquabyte issues have included different species of tilapias and carps; integrated farming systems; and feeding, harvesting and other aquaculture practices.

Other Services

Other information services of the NTAS include free computerized literature searches and supply of published material unobtainable from reprint requests. The NTAS, through the ICLARM Library, has access to a number of aquaculture and fisheries databases. The most useful and relevant for the needs of NTAS members is Aquatic Sciences and Fisheries Abstracts (ASFA), available on compact disk (CD-ROM).

The NTAS has answered requests for literature searches from developing-country members covering a wide range of topics including tilapia (reproduction, spawning, fry rearing and feeding techniques; growth performance; hybrids); common carp (hybridization, breeding, osmotic and salinity effects on growth); *Lates calcarifer*; *Channa striata*; the *Schilbeidae*; eels (recruitment, reproduction, genetics, age and growth); bivalves (larval development and culture; socioeconomic studies); eutrophication and blue-green algae; and livestock-fish integrated farming systems. We encourage members to be very specific in their requested topics and to provide concise and detailed keywords.

The NTAS also receives requests for free publications, reprints and other materials, although we encourage members to request authors directly for reprints and other materials. In all our literature searches and in the listings of recent publications in the Information Section of Aquabyte, we always provide the author's address and affiliations.

Future Activities and Needs of the NTAS

Although the NTAS has been in operation for only two years, its success is already apparent. It has begun to fulfill an important need. Membership is expected to double in another two years, and thereafter stabilize at around 600. As part of its services to members, the NTAS will build over the next two years a database of all members' complete scientific backgrounds: institutions, publications and current research programs. This will further assist members in linkages and contacts with persons working in specific fields. After a third year, accumulated information will be published in a directory with annotations on the research programs of NTAS members.

The NTAS also plans to acquire software distribution rights for bibliographies so that members who request references for their research work can be sent such information on diskettes.

To answer the numerous requests from NTAS developing-country members for free publications, the NTAS proposes to give a one-time gift of free books that are related to members' research work.

All the above services will depend upon securing some financial support. ICLARM will seek appropriate donors for this effort.

The Coastal Aquaculture Network

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ICLARM's activities in coastal aquaculture focus on selected topics which are perceived to be of singular importance in ICLARM's research strategy. To promote collaborative research, we encourage the formation of Research Groups consisting of individuals and institutions working on selected topics under the umbrella of the Coastal Aquaculture Network (CAN).

The CAN differs in its objectives from those of the broader Network of Tropical Aquaculture Scientists and the Network of Tropical Fisheries Scientists, both of which exist for the specific purpose of fostering the development and professionalism of individual aquatic scientists in tropical developing countries. In contrast, the objectives of the Research Groups and of the entire CAN are purely functional in that they exist only for the purpose of promoting collaborative research and information exchange on a single topic. The Research Groups are planned to exist only as long as they serve a purpose and will be formed and dissolved as the need arises.

Currently a Giant Clam Research Group (GCRG) is operational and a Reef Fish Ranching Research Group is planned. Other possibilities currently include groups working on pearl oysters and the cage culture of marine fish.

Giant Clam Research Group

The GCRG currently comprises about 120 individuals and fourteen institutions, all of which are involved in some aspect of research in giant clams. The topics of interest range from pure biology to product development but the principal thrust is towards the development of farming systems for giant clams. Through the medium of a very informal newsletter "Clamlines", participants are kept abreast of developments in other groups and recent publications and reports. There is also space for plain gossip and idle speculation.

Clearly, the success of research groups such as these is entirely dependent upon the willingness of participants to genuinely collaborate and the ability of organizers to promote such collaboration. In a competitive world success is not always assured. Concerns that exchanges of ideas might be unidirectional and assistance unacknowledged have to be overcome and participants have to be convinced that they can benefit from such interchanges.

Exchange of Personnel

Real benefits are most easily perceived when funds are made available to promote visits between participating institutions. The CAN has modest funding for this purpose and, for example, was able to fund the visit of a scientist from James Cook University in Australia to the ICLARM Coastal Aquaculture Centre (CAC) in the Solomon Islands last year, where the near-continuous availability of giant clam eggs and larvae made it possible for him to test a series of formulations of microencapsulated diets. The reciprocal benefits to the CAC were significant in that different approaches to larval rearing were examined, the possibilities of using artificial feeds were more clearly understood and ultimately led to the CAC testing and adopting its current formulation of a 50:50 mix of microencapsulated feed and microalgae for giant clam larvae.

Collaborative work between the CAC and the UK-based Overseas Development Natural Resources Institute (ODNRI) is currently leading to progress in product development and a training visit of staff from the Fiji Fisheries Division led to the CAC's ocean nursery cage design being adopted for use in Fiji.

In the future, workshops and think tanks on specific topics will be organized. These could range from crash courses in the identification of giant clam predators to think tanks on optimizing water use. Useful collaboration at a basic level can include the compilation of lists of reliable sources of equipment, spare parts and supplies of aquaculture and scientific equipment. For each scientific group to reinvent these "wheels" is costly and the expense is avoidable, provided that the spirit of collaboration is present.

PROGRESS 1989

ICLARM's activities have now been following a Five-Year Plan (1988-1992) for two years. The plan is, in fact, a strategy for moving towards the goal of rational management of living aquatic resources. ICLARM's role, which is based on its areas of "comparative advantage" as an international research center, has three interconnected thrusts:

- (i) Strategic research on population dynamics methodology, which began with single-species stock assessment and has now entered the realms of multispecies modelling. Such modelling provides better understanding of the dynamics of multispecies fisheries as well as of fishponds and of integrated farming systems.
- (ii) Multisectoral management planning. Management of aquatic resources cannot be done in isolation from the other sectors that impinge upon them, particularly at the interface between land and sea. ICLARM's work in this area began as a coastal resources management project in 1986. In 1989, the subject matter became a long-term research program of ICLARM in view of its importance and the fact that there was both scope and need for international research. The work focuses on the solution of resource use conflicts in the coastal area through the development of appropriate policy guidelines and management options, socioeconomic and ecological analyses, as well as the development of working models at specific sites to demonstrate the value of rational resource management.
- (iii) Management of farming systems. This activity is aimed towards helping farmers get the most from their resources. On the one hand, it deals with the incorporation of fish into farming systems and on the other, breeding better fish to maximize their impact.

These three thrusts are supported by an active information dissemination program which itself includes research on improving the quality of information flow.

In 1989, the Center's "program" on Education and Training was removed, since the components of the "program" are embedded in the research programs and there has never been adequate funding to support separate education/training personnel.

Thus, ICLARM's work in 1989 was pursued in four Program areas: Coastal Area Management, Capture Fisheries Management, Aquaculture and Information.

Carrying out the Programs in 1989 were 22 senior scientists, 21 junior (mid-level) scientists and 38 support staff. Of these 81 persons, 63 were in the Philippines, 5 in our Africa project office in Malawi, 7 in the Coastal Aquaculture Centre in the Solomons, 4 in Bangladesh and one each in Brunei Darussalam and Peru. This year has seen staff actively researching or teaching in 12 countries, and they have organized workshops or meetings in some of them plus another eight countries.

Coastal Area Management

The Coastal Area Management Program began at the beginning of the year following the Board agreement in November 1988 to separate this research area from the then Resource Assessment and Management Program.

- The major activity is the ASEAN/US Coastal Resources Management Project, in which various in-country projects are being coordinated and assistance provided in drafting integrated management plans at pilot sites. Training has been organized at the regional and national levels, while some national personnel have completed M.S. degrees and others are working towards their degrees. The project has also successfully brought together various national government agencies related to resource use and management for closer coordination in developing resource planning and management strategies. Published output from the project has been prodigious, including workshop proceedings, research publications, educational material and a newsletter. The major results in 1989 were the completion of site-specific integrated coastal resources management plans for South Johore (Malaysia), Lingayen Gulf (Philippines), Segara Anakan (Indonesia) and Singapore. Being the first of their kind in Southeast Asia, these integrated plans are being tested and gradually integrated into national development plans. One significant training workshop organized in collaboration with the Government of Brunei Darussalam, Australian International Development Assistance Bureau, United Nations Environment Programme, Intergovernmental Oceanographic Commission/Western Pacific and the US National Academy of Sciences was the Management and Training Workshop on *Pyrodinium* red tides. It was a very successful workshop that culminated in the publication of a significant manual of field and laboratory research useful for researchers and managers.
- Program initiatives are in the pipeline on 1) a Philippine (Batangas) coastal area management activity; 2) curriculum development for coastal resources management; 3) an ecological-economic modelling project; 4) a mangrove workshop; and 5) a coastal area management information system.
- Members of the Program provide coordination of the Asian Fisheries Social Science Research Network.

Capture Fisheries Management Program

This Program has changed its name over the years but the thrust has always been on the fundamental research - concepts and methodologies - needed for rational management. Following separation of the coastal resources management work, the Program was renamed from Resources Assessment and Management at the beginning of 1989.

- The major output of the Program is the suite of computerized stock assessment programs that make up the ELEFAN software, used widely throughout the world. An agreement has now been signed with the FAO Department of Fisheries concerning the production of a new software for fish stock assessment in the tropics. This software will represent a fusion of the ELEFAN programs, produced and distributed by ICLARM, and of a similar software produced by FAO staff. The joint product, to be prepared by ICLARM under contract from FAO, will be used in all future stock assessment courses of FAO and will be fully supported by that organization.
- An interactive database project (FISHBASE) initiated last year at ICLARM which will eventually document the biology of 2,000 species of tropical fishes, important both for fisheries and aquaculture, is off to a very promising start. This will be a very large computer textbook to become available in compact disk (CD-ROM). Prospects for support by donors are good.
- In multispecies modelling, where we try to model all components of a fishery to better understand its dynamics, new models were recently presented to the International Council for the Exploration of the Sea at its meeting in the Netherlands. Further results are in press. One of the case studies is of the Peruvian upwelling system, supporting one of the largest fisheries in the world.
- Continued was the development and documentation of new approaches to infer vital statistics of fish from their shape and hence, to accelerate the estimation of parameters needed for stock assessment and multispecies modelling.
- Work was successfully completed on evaluating the recently implemented new management policy for the inland water fisheries of Bangladesh together with the publication of the proceedings of an associated workshop on "Experiments in New Approaches to the Improved Management of the Open Water Fisheries of Bangladesh" held in Dhaka, January 1989.

Aquaculture

In aquaculture, ICLARM's themes are development of low-cost farming systems and genetic improvement of cultured organisms.

- In low-cost farming systems, a great deal of progress has been made in a research and training project for the development of rural aquaculture in southern Africa. Most of the work is being done at the Domasi Experimental Fish Farm (DEFF) and with farmer cooperators in Malawi. The DEFF now has 65 new

experimental ponds and 96 new tanks. The excellent research being done by Malawian collaborators includes that of six new M.S. students whose results in the biological and social sciences are all important, e.g., on-farm vegetation feeds fish; fire ash raises the pH and phosphate levels in ponds; and maize bran is a fine fish food. A compilation of all aspects of African aquaculture development, using the Malawian situation as a case study, is nearly ready for press.

- Progress has been good in integrated rice-fish farming systems including new information on interactions between rice and fish, the role of fish in integrated pest management and the use of pond refuges to couple/decouple fish production from paddies. The International Rice Research Institute is interested to expand collaboration with ICLARM in this field.
- Work started in 1989 in Bangladesh to integrate fish culture into new farming systems tailored to the needs of rural people and to cope with adverse climatic changes. ICLARM's input into the USAID-funded Bangladesh Agricultural Project in 1989 will be linked to a new ICLARM-International Foundation for Agricultural Development (IFAD)-Danish International Development Agency (DANIDA) project in 1990 to study the socioeconomic impact of extension of such systems.
- Following the successful completion of ICLARM's project on reservoir fisheries and aquaculture in West Java, the World Bank has invited ICLARM to collaborate in a similar project in Orissa, India.
- ICLARM's Coastal Aquaculture Centre, a modest research and training facility near Honiara, Solomon Islands (total construction cost, about \$375,000) comprising a hatchery/laboratory building, tanks, housing and support facilities, was completed.
- Successful spawning and nursing to juvenile stage of the largest giant clam species (*Tridacna gigas*) took place this year; juveniles were transferred to ocean nurseries and growout sites in the Solomon Islands.
- New proposals formulated in 1989 include expansion of collaboration in rice-fish culture research to West Africa, Cambodia, East India and Vietnam and the establishment at the Asian Institute of Technology in Bangkok of an independent Integrated Farming Research Unit to study nutrient/energy flow and the economics of tropical crop-livestock-fish systems. Proposals to expand and diversify coastal aquaculture research into other species groups including reef fish ranching were also made.
- In genetics, significant progress has been made in projects funded by United Nations Development Programme (UNDP) and the Asian Development Bank (ADB) to develop improved breeds of cultured tilapias. New tilapia germplasm was collected this year from Egypt and Kenya and after thorough quarantine measures, is being evaluated in the Philippines in low technology culture systems. The 1989 results also included further work on genetic markers, characterizing fish strains by

biochemical and morphometric techniques; quarantine procedures; establishment of a tilapia germplasm reference center; evaluation of the culture performance of new and already farmed breeds; and training activities.

There has been increased collaboration with other groups researching fish genetics and a recent endorsement from UNDP of the concept of a global finfish genetics network. Proposals are being made to potential donors for an independent ICLARM Aquaculture Genetics Research Unit and for work on giant clam genetics in collaboration with Pacific and European institutions.

Information

The Information Program has maintained its publishing and information services. It also provides the secretariat for the Asian Fisheries Society and produces the Society's scientific journal "Asian Fisheries Science".

- The International Development Research Centre has been funding a user-pays type information service which ends in 1990. The idea of user-pays is being seen not to be viable as only 11% of users do pay, while another 22% offer exchange items. The project has allowed ICLARM to do research on the literature itself, resulting in a series of articles that give the latest papers and names and addresses of key contact persons.
- The library has become a major training resource. Most months see trainees from different countries there, and the chief librarian is in demand in Africa and China at present.

Outlook

The number of organizations with which ICLARM has had some form of activity over the past 12 years now totals close to 200, which indicates that ICLARM has no shortage of collaborators. However, the basic weakness remains that most of the activities, including such long-term involvements as networking (see p. 9) and genetics research which need to be sustained by realistic recurrent core funding, are still funded in short-term projects. This situation makes it difficult for ICLARM to maintain the momentum that has started and to capitalize on the Center's comparative advantage in its selected strategic research areas.

IAN R. SMITH, 1943-1989

A life dedicated to alleviating poverty in developing countries

Dr. Ian Roger Smith, ICLARM's Director General since 1985, passed away on 31 October 1989 after a prolonged illness due to brain tumors. He was only 46 years old.

Ian's contact with the developing world that he came to serve so well, began in 1964 when, as a fresh graduate of Trinity College, Connecticut (BA Economics), he joined the Peace Corps and was posted to Iran for two years. There he completed projects in school construction, surveying and poultry raising.



After brief work in The Maryland Department of Economic Development and Volunteers in Service to America, Ian rejoined the Peace Corps in 1967. Over the next five years he served in various capacities, culminating as Acting Director of the Peace Corps in Fiji. He supervised 135 volunteers in all aspects of their work and directed the Peace Corps School Partnership Program, assisting some 500 schools in 30 countries. He was awarded the Peace Corps Certificate of Merit for Extraordinary Contribution.

By 1974, Ian had decided to return to university, becoming a Degree Scholar at the Resource Systems Institute, East-West Center, Hawaii. It is during this period that Ian's love for the Philippines must have begun. He chose a research topic there. In fact, he spent one year as a visiting researcher at the then Philippine Council for Agriculture and Resources Research in Laguna, and was a visiting assistant professor in the School of Economics at the University of the Philippines (UP) in Manila. Also, back on campus in Hawaii, Ian first met his wife-to-be, Becky, who was a student from the Philippines.

Ian joined ICLARM in 1978 as postdoctoral fellow. ICLARM itself was new then - only one year had passed since its incorporation in the Philippines - and Ian was one of the pioneers who shaped the Center.

His first major contribution was "A Research Framework for Traditional Fisheries", published in 1979 in ICLARM's Studies and Reviews series. Economists worldwide have singled out this document as

perhaps the key paper in the development of ideas and subsequent research in this field.

Ian was promoted to Associate Scientist in 1979, to Senior Scientist and Director of the Traditional Fisheries Program in 1981, and to Deputy Director General in 1984. During this period, his research leadership bloomed and resulted in many well-cited publications. It was in this period that he led a multidisciplinary study with the UP College of Fisheries on small-scale fisheries of San Miguel Bay in the Philippines. This study has become a model for such research and influenced policymakers and donors in their attitudes to such fisheries. And it was in 1981 that Ian began discussions with the International Development Research Centre of Canada that led to the present Asian Fisheries Social Science Research Network of curriculum development, training and research. The Network remains active up to the present time.

The appended list of Ian's publications attests to his productivity and his area of interest; the identification and clarification of concepts and processes relevant to improving the income of small-scale fishermen and their families, and to their integration into the mainstream (rural) economies of their countries. Thus, Ian addressed in the early 1980s, before it became fashionable, one of the global issues on the world's agenda for the 1990s and the next millennium: the need to overcome rural poverty as a precondition to resolving the problems posed by such factors as global ecological destruction and by global climatic changes.

In 1985, ICLARM's Board of Trustees unanimously chose Ian to fill the vacant post of Director General of the Center. The challenges were enormous. It was the year when ICLARM almost closed - the "funding crisis" as we explained its onset in the July 1984 ICLARM Newsletter. Ian, with assistance from Board members, succeeded in obtaining the necessary funds that enabled ICLARM to survive the crisis. From that time up to October 1988 when his illness was diagnosed between fund-raising meetings in Washington, Ian's efforts were responsible for the relatively secure funding situation of ICLARM.

It was said of him by a colleague: "ICLARM survived its darkest hours and maintained its high reputation for excellence because of the singular commitment and tenacious search for resources that Ian led on behalf of the Institution he so deeply loved."

Shortly before he went on sick leave, Ian contributed his last major input to the Center's direction: a brief but significant editorial to an issue of *Naga*, the ICLARM Quarterly, devoted to "Women in Fisheries". There, Ian stated ICLARM's commitment to hire female scientists preferentially for some future job openings and to explicitly address issues relevant to the "strong role of women in fisheries in developing countries" in future projects of the Center. Here again, Ian identified with one of the crucial issues of our times.

Ian's leadership capability was clear within ICLARM. He was admired by all staff professionally for his uncompromising insistence on quality. Beyond that, there was no doubt that he had adopted ICLARM as an extension of his family and many were the parties for ICLARM staff and trustees at his house.

Indeed, it is this sense of family that makes his death most deeply felt by ICLARM staff.

Outside ICLARM, Ian's reputation was equally impressive. We can do no better than to summarize some of the tributes amongst the very many expressions of condolence that have been received from leading administrators, scientists, and from colleagues and friends around the world.

Some of these tributes related to Ian's leadership qualities: "an amiable, unpretentious, balanced leader"; "I admired him highly in the leadership style and accomplishments"; "most adequate and convincing leadership." Others referred to Ian's attitude towards ICLARM: "I was impressed by his dedication, enthusiasm and conscientiousness"; "his diligence and cooperation will always be remembered"; "he was one of the most capable and committed people I have known in my 22 years of development work." His accomplishments: "he greatly contributed to raising awareness for the need of a change in fishery development and management"; "his contribution to international fisheries, particularly in socioeconomic aspects ... will long be remembered"; and his attitude towards others: "his human qualities were exceptional."

But perhaps the greatest accolade came from a colleague who said "you know, people can have many friends, but Ian had **only** friends." Farewell Ian.

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COASTAL AREA MANAGEMENT PROGRAM

Background

The Coastal Area Management Program (CAMP) is a new program area for ICLARM. It was established in December 1988, following agreement by the Center's Board of Trustees in view of the growing importance of this topic. It builds on the groundwork and experiences gained under the ASEAN/US Coastal Resources Management Project (CRMP) which has been operating in pilot sites in the six ASEAN member countries since 1986. The project was previously reported to the Resource Assessment and Management Program (now the Capture Fisheries Management Program; see p. 58).

CAMP's main purpose is to promote integrated management of coastal resources to ensure long-term sustainability of the use of natural resources and economic activities which are directly or indirectly linked to the coastal environment. The program attempts to develop working models on coastal area management (CAM) through studies undertaken in different environmental and socioeconomic conditions in tropical developing nations worldwide. Training and education are an inseparable part of the program in strengthening national capabilities in CAM. Information dissemination also forms an integral part of its extensive activities in promoting public awareness and community mobilization towards the implementation of CAM plans.

While the main focus of the program in 1989 was to implement fully the planned CRMP activities, efforts have also been made to initiate new projects and establish or strengthen linkages with other related institutions and donor agencies.

Progress of Work

ASEAN/US Coastal Resources Management Project

In 1989, most activities of the ASEAN/US CRMP were carried out as scheduled; focus was on implementing fully the in-country activities. ICLARM provided coordination and technical advice to the national teams. In the previous years, there was no increase in the number of professional staff and in the budget, even with the participation of Brunei Darussalam and Malaysia. It was only in 1989 that supplementary funding was provided for the project to carry out the activities of the two countries. Some adjustments had to be made by using contingency funds

to cover the expenses of the technical executing agency up to the end of 1991 during which the project is extended.

In general, the project made significant progress in creating public awareness and interest in CAM, through regional and national workshops (Table 1), especially among the decisionmakers, resource managers and the coastal communities. A major achievement of the project has been the successful networking of 47 institutions and 200 scientists in the ASEAN region involved in research and/or management

Table 1. Regional and national workshops.

Brunei Darussalam

1. International Management and Training Workshop on *Pyrodinium* Red Tide, 23-30 May 1989 (42 participants)

Indonesia

1. Workshop on Guidelines and Policies for Coastal Resources Management in Segara Anakan, 27 February-1 March 1989 (in-country key personnel)
2. Planning Steering Committee, Cilacap, 4-5 October and 15-18 December 1989 (in-country key personnel)
3. Training Course on Extension for Coastal Resources Management in Segara Anakan, Cilacap, 19-23 December 1989 (in-country key personnel)

Malaysia

1. Third In-Country Meeting for the Development of a Coastal Resource Management Plan, 28 February-2 March 1989, Selangor (principal investigators and personnel of relevant government and semi-government agencies)
2. GIS Analysis, Penang (in-country key personnel)
 - a. Mangrove-Aquaculture Coastal Forest, 6-9 September 1989
 - b. Sand Mining-Coastal Erosion-Water, 28-30 September 1989
 - c. Fisheries, 17 October 1989
 - d. Tourism, 18 October 1989
3. Small Technical Working Group Meetings
 - a. Mangrove-Aquaculture, 12-13 September 1989, Kuala Lumpur
 - b. Coastal Forest, 14 September 1989, Kuala Lumpur
 - c. Sand Mining, 3 October 1989, Kuala Lumpur
 - d. Coastal Erosion, 4 October 1989, Kuala Lumpur
 - e. Water Quality, 5 October 1989, Kuala Lumpur
 - f. Tourism, 7 November 1989, Selangor
 - g. Fisheries, 8 November 1989, Selangor

Philippines

1. Action Planning Workshop, 10-12 August 1989, Baguio (CRMP staff and in-country key personnel)

Singapore

1. Second National Workshop on Urban Coastal Area Management in Singapore, 9-10 November 1989 (60 participants)

Thailand

1. Workshop on Bio-diversity, 27-30 March 1989 (in-country key personnel)
-

of the coastal areas. The "network" is aimed at closer coordination in developing resource planning and management strategies.

The major outputs of the project were the completion of site-specific integrated coastal resources management plans for South Johore (Malaysia), Lingayen Gulf (Philippines), Segara Anakan (Indonesia) and Singapore. The first of their kind in Southeast Asia, these integrated plans are being tested and gradually integrated into national development plans. The plans provide policy guidelines on land and water resource utilization in relation to socioeconomic, political and cultural characteristics of the country concerned. Policy guidelines cover fisheries resources exploitation and utilization, mangrove and coral resources conservation, aquaculture management and marine parks and protected areas.

The management plan of Brunei Darussalam aims at regulating and managing resources which are still relatively underexploited. Comprehensive field studies are being made which include a one-year fish stock assessment; sensitivity mapping of coastal resources susceptible to oil spill impacts; mangrove area analysis; and survey of artificial reefs and fish populations associated with underwater oil rigs and pipelines.

The management plan for Ban Don and Phangnga Bays of Thailand is being refined. The mangrove management plan for Ban Don Bay was adopted by the Thai Cabinet and is being implemented. Some recommendations on coral reef management in relation to tourism are also being implemented by the respective local governments through the efforts of the Office of the National Environment Board.

Training was organized by the project at the regional and national levels. National workshops were organized in Indonesia, Malaysia, Thailand, Singapore and the Philippines in developing integrated coastal resources management plans. Consultations were made with various resource users and interest groups which included fishermen's associations, government line agencies, law enforcers and nongovernmental organizations.

Asian Fisheries Social Science Research Network

The Asian Fisheries Social Science Research Network (AFSSRN) is an International Development Research Centre (IDRC)-Ford Foundation and ICLARM core-funded network which was started in 1983 to address the need to enhance domestic social science research capabilities relative to capture fisheries and aquaculture in Asia. IDRC provides the fund for the network's research and educational activities; the Ford Foundation until recently provided funding for the Coordinator; and ICLARM renders secretarial and administrative support. Efforts are being made to increase and diversify the sources of funding.

The AFSSRN is currently composed of 13 teams with a total of more than 80 researchers at universities and national government and regional agencies in Indonesia, Malaysia, Thailand and the Philippines. Broader representation of social scientists from other countries within Asia is being pursued.

Dr. Louise A. Fallon, who joined ICLARM in October 1989, is the new Network Coordinator. She holds the position on a half time basis, since

she is also CAMP's Resource Economist. Dr. Fallon will be supported in the network by a full-time research assistant and a secretary. As in the past, technical assistance is provided by other scientists of ICLARM.

Linkages

The Program has established linkages with the Bay of Bengal Programme (BOBP) through Dr. Chua's participation in the recent *Gracilaria* workshop held 22-27 October 1989 in Songkla, Thailand. Dr. Chua had been invited by BOBP to chair the workshop sessions. Possible future collaboration was discussed in the areas of joint publication and the Asian Fisheries Social Science Research Network (AFSSRN).

The program has also established a working relationship with the Division of Marine Sciences of UNESCO. Most of UNESCO's activities are closely related to CRMP activities. Preliminary discussion with UNESCO officials took place in Paris in September 1989 and collaborative activities are being worked out.

The Coastal Zone Management Program of the International Federation of Institutes of Advanced Studies (IFIAS) has initiated the establishment of an international coordinating center for coastal resource management. The Program has held discussions with members of the planning group and will cooperate with the coordinating center where possible.

The program has also cooperated closely with UNEP by participation of Mr. James N. Paw in UNEP's Task Team on Global Climatic Changes in the East Asian Seas Region. Similarly, Program staff are involved in the Asian Fisheries Society and World Fisheries Congress in addition to possible collaborative projects with ACIAR, IDRC, SAREC, UNESCO and USAID.

Advisory and Other Services

Dr. Chua Thia-Eng served as a member of the Working Party on Research Priorities for Aquaculture Development, under the Study on International Fisheries Research coordinated by the World Bank. He was again elected as President of the Asian Fisheries Society and served as Research Director of the IDRC/AFS Research Fellowship Award Scheme. He was elected as the Chairman of the Advisory Council to the World Fisheries Congress. Dr. Chua at the same time serves as a member of the Scientific Advisors to the International Foundation for Science. Dr. Alan White continued serving as a member of the Board of Directors of the Haribon Foundation.

Program Plans

The Program will continue to implement the planned activities of CRMP and AFSSRN as developed earlier. In addition, the Program has initiated the following new proposals for funding:

Batangas Coastal Management Project. This project, based on the experience of CRMP, will be addressing management issues confronting a

number of users of Batangas Bay, Philippines (Pilipinas Shell refineries, Caltex refineries, flour mills, shipyards, etc.); a particular issue is the rapid deterioration of the bay's environmental quality. Pilipinas Shell Foundation is interested to support the project which will develop an integrated management plan. A Geographic Information System (GIS) will be used as the main tool. The ultimate goal of the project is to encourage the principal users, i.e., private sector, to take up the major active role of bay management in collaboration with the local government.

Ecological Economic Modelling Project. The program has established a linkage with the Swedish Agency for Research Cooperation with Developing Countries (SAREC) and is in the stage of formulating a project to tackle the critical relationships among population, natural resources, environment and economic systems. The data will be gathered from field surveys to develop ecological and socioeconomic models. The project proposal will also include an on-the-job-training of African researchers in Asia and developing a CAMP in Africa. A preliminary agreement on the general approach of the project was made between SAREC officials and the academic staff of the University of Stockholm. A SAREC-funded planning workshop is expected to take place in late 1990 in Manila; some key persons from both institutions will attend.

Mangrove Management Workshop. A proposal will be developed for funding support from the ACIAR to conduct a workshop on how mangroves could be effectively managed for human benefits. Scientists working on mangrove ecology, fisheries, aquaculture and resources management will be invited to participate.

CAMP Information System. The program is preparing a proposal for the establishment of a simple but effective GIS-based tool for coastal area planning and management for use by planners of local governments or institutions. The proposal, submitted to the IDRC's Information Science Division, has for its main goal the establishment of GIS as an integral part of coastal resources planning and management. The software being intended for use is the Spatial Analysis System (SPANS). This proposal is expected to supplement the broader GIS and Remote Sensing project of CAMP being considered for funding by the Asian Development Bank (ADB).

Santiago Island Coastal Management Project. Three proposals are being made based on the projects identified in the action plans for the Lingayen Gulf (Philippines) area under the ASEAN/US CRMP. The pilot site will be Santiago Island, Bolinao, Pangasinan, where a single team will be based to implement all three projects using the integrated management approach. The mechanics on implementation will be discussed further among the agencies involved.

One proposal, which is on the establishment of a community-based marine park, will be sent to the Swedish International Development Agency (SIDA) for funding. This three-year project will be executed by ICLARM through a project team based in the island and in collaboration with the Marine Science Institute of the University of the Philippines (UP-MSI) and the municipal government of Bolinao. UP-MSI and the National Economic and Development Authority (NEDA) are working on the review and endorsement of the proposal.

The marine park project will be supplemented by an alternative livelihood project which is submitted for funding by the Netherlands Government.

The third proposal is a health and population project for possible funding by the Netherlands Government through the United Nations Population Fund (UNPF).

Meetings Attended, Papers Presented

Orientation Meeting of Philippine Municipal Mayors of 18 Coastal Municipalities of La Union and Pangasinan, Sar. Fernando, La Union, 17-19 January. (T.E. Chua).

ASEAN/US CRMP Fourth Annual Project Steering Committee (PSC) Meeting, Silahis International Hotel, Manila, 25-27 January. (ASEAN/US CRMP Staff).

Paper presented:

Chua, T.E. Progress Report of the Project Coordinator.

Second ASEAN Science and Technology Week, Manila, 29 January - 4 February. (ASEAN/US CRMP Staff).

Presented: CRMP Poster.

Development of a CRM Plan Meeting, Genting, Pahang, Malaysia, 28 February - 2 March. (T.E. Chua and A.T. White).

Management and Training Workshop on *Pyrodinium* Red Tides, Brunei Darussalam, 21-25 May. (T.E. Chua, J.L. Maclean).

Paper presented:

Chua, T.E. *Pyrodinium* red tide management issues: discussions and recommendations.

Seminar Workshop on Research and Development in Marine Sciences in the ASEAN Region: Investment Opportunities, Singapore, 25-27, 29 May-1 June. (T.E. Chua).

Paper presented:

Chua, T.E. Research and development in marine sciences and technology in the ASEAN region: opportunities and challenges.

First and Second Meetings of the Task Team on Implications of Climatic Changes in the East Asian Seas Region, Singapore, 25-26 May and 21-24 November, respectively. (T.E. Chua and J.N. Paw).

Paper presented:

Paw, J.N. and T.E. Chua. Implications of future sea level rise on coastal area utilization and management in Southeast Asia.

Meeting Organized by the State Economic Planning Unit to brief the Executive Committee Members of the State Assembly and Heads/Representatives of all Line Agencies from the Federal Government, Johore Bahru, Malaysia, 17-18 June. (T.E. Chua).

Think Tank for Global Assessment of Integrated CRM, Charleston, South Carolina, USA, CAMPNET International Coastal Seminar. 4-9 July. (T.E. Chua, S. Bunpapong, A.T. White).

Paper presented:

Preliminary summary workshop report by the Chairman: Chua, T.E. The status of integrated coastal zone management: a global assessment.

Coastal Zone '89, Charleston, South Carolina, USA, 11-14 July. (L. McManus, A.T. White and T.E. Chua).

Papers presented:

Bunpapong, S. Ban Don Bay, Thailand: issues, resources, status and management plan.

- Ch'ng, K.L. Integrated coastal resource management plan: a first for Malaysia.
- Chua, T.E. Developing coastal area management plans in the Association of Southeast Asian Nations.
- McManus, L.T. and L.A.B. Mines. Coralline resources of Lingayen Gulf, Philippines: a strategy for their management.
- White, A.T. Comparison of coastal resources planning and management in the ASEAN countries.
- Action Planning Workshop of the Philippine Project, Baguio, Philippines, 10-12 August. (T.E. Chua, A.T. White, F.Y. Guarin, J.N. Paw and R.J. Tobin).

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- Chua, T.E. 1989. Developing coastal area management plans in the Southeast Asian region, p. 2192-2201. *In* O.T. Magoon, H. Converse, D. Mines, T.L. Tobin and D. Clark (eds.) *Coastal Zone '89: Proceedings of the Sixth Symposium on Coastal and Ocean Management*. Vol. 5. American Society of Civil Engineers, New York.
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Coastal Area Management Program Project Summaries

Project Title : ASEAN/US Coastal Resources Management Project

Cooperating Institutions

Brunei Darussalam : Department of Fisheries (coordinating agency), Department of Forestry, Department of Town and Country Planning, Marine Department, Department of Public Works, Brunei Museum, Universiti Brunei Darussalam and Department of Agriculture

Indonesia : Indonesian Institute of Sciences (LIPI) (coordinating agency), Directorate General of Fisheries (lead implementing agency), Research Institute for Marine Fisheries, Centre for Oceanological Research and Development, Centre for Agro-Economic Research, University of Indonesia, Bogor Agricultural University, Office of State Ministry of Demography and Life Environment

Malaysia : Ministry of Science, Technology and the Environment (coordinating agency), Fisheries Department (lead implementing agency), Ministry of Defence-Hydrography Section, Department of Agriculture, Drainage and Irrigation Department, Department of Town and Country Planning, Coordinating and Implementing Unit of the Prime Minister Department, Department of Geology, Department of Survey and Mapping, Universiti Pertanian Malaysia, Universiti Kebangsaan Malaysia, Universiti Sains Malaysia, Economic Planning Unit of the State Government of Johore, Forest Research Institute, Pusat Penyelidikan Ternak Air Payau, Universiti Malaya, SERES Sdn. Bhd. and Universiti Teknologi Malaysia

Philippines : Department of Science and Technology Philippine Council for Aquatic and Marine Research and Development (coordinating agency), University of the Philippines-Marine Science Institute, UP College of Social Work and Community Development, UP Visayas College of Fisheries, Bureau of Fisheries and

Aquatic Resources and National Economic and Development Authority (NEDA) - Region 1

Singapore : Science Council of Singapore (coordinating agency), Primary Production Department, National University of Singapore - Department of Zoology and Department of Geography

Thailand : Office of the National Environment Board, Ministry of Science, Technology and Energy (coordinating agency), Department of Fisheries-Brackishwater Fisheries Division, Marine Fisheries Division and Phuket Marine Biological Center, Royal Forestry Department, Faculty of Forestry, Kasetsart University, Department of Marine Science, Chulalongkorn University and Faculty of Social Sciences and Humanities, Mahidol University

Duration : 6 years, beginning January 1986

Key Personnel

Brunel : Haji Matdanan bin Haji Jaafar; Pengiran Sharifuddin Pengiran Haji Yusof; Dr. M.W.R.N. de Silva

Darus-salam

Indonesia : Dr. Purwito Martosubroto; Dr. Kasijan Romimohtarto; Mr. Ben Abdui Malik; Dr. Subagjo Soemodihardjo; Dr. Mulia Purba; Dr. Nurzali Naamin; Mr. Agus Brotosusilo; Mr. Subhat Nurhakim; Dr. Soerjono Soekanto; Mr. Budirahardjo; Mr. Koesoebiono; Ir. Agustinus W. Taufik; Mr. Edi M. Amin and Mr. Zen Omar Purba

Malaysia : Dr. Abu Bakar Jaafar; Ms. Ch'ng Kim Loo; Dr. Chan Hung Tuck; Dr. Lim Poh Eng; Dr. Kam Suan Pheng; Ir. Sieh Koh Chi; Dr. Koh Hock Lye; Mr. Mohd. Zaki bin Mohd. Saad; Mr. Hambal Hanafi; Dr. Jahara Yahaya; Dr. Wong Poh Kam; Dr. Shaharuddin bin Mohd. Said; Ir. Zamali Midun; En. Ahmad Tajuddin Hj. Kechik and En. Redzuan Yusof

Philippines : Dr. Rafael D. Guerrero III; Dr. Edgardo D. Gomez; Dr. Liana T. McManus; Ms. Adelaida Palma; Mr. Nygiel Armada; Prof. Elmer M. Ferrer; Mr. Joseph Alabanza and Dr. Roberto A. de los Reyes

Singapore : Mr. Leslie Cheong; Dr. Chou Loke Ming and Dr. Chia Lin Sien

- Thailand : Mr. Arthorn Suphapodok; Mr. Chalerm Sak Wanichsombat; Dr. Sirikul Bunpapong; Dr. Teerayut Poopetch; Mr. Yodchai Karnasuta; Mr. Somporn Lohsawadikul; Dr. Manuwadi Hungspreugs; Mr. Prawin Limpasichol; Mrs. Nisakorn Kositratana; Dr. Sanit Aksornkoae; Dr. Vijarnsorn; Dr. Subarn Panvisavas; Mr. Robert Dobias; Ms. Chandhana Indhanya and Mr. Ilyas Baker
- ICLARM : Dr. Chua Thia-Eng (Project Coordinator); Dr. Alan T. White (Technical Advisor); Dr. Louise A. Fallon (Resource Economist); Mr. James N. Paw (Project Specialist) and Ms. Flordeliz Y. Guarin (Project Specialist)

Objectives

- To increase existing capabilities within the Southeast Asian 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-country projects. A highlight during the past year was the approval by USAID of the US\$800,000 supplementary budget and the extension of the project until 1991. This amount will be used to cover the budget allotment of Malaysia and Brunei Darussalam and to resume deferred project activities under Component 2. The extension of the project, however, has no provision for additional funding.

Most scheduled in-country project activities were implemented according to the 1989 workplans. However, some had to be deferred, such as the training course on economic valuation and academic training in ASEAN universities and/or research institutions.

The coordinating agencies of the six countries spent the year in developing coastal resources management plans for their respective pilot sites. This entailed research, writing, presenting the plans to concerned

government officials during workshops and soliciting support and commitment from national governments for the implementation of the plans. Studies were also conducted to assess the feasibility of plan implementation.

Other highlights of the countries' activities are as follows:

- In Brunei Darussalam, unimplemented proposed activities in 1988 were carried over to 1989 such as the task on fish and shrimp stock assessment. An ecological survey on coastal ecosystems and the possible impact of oil spill on them was undertaken jointly with scientists from Universiti Sains Malaysia and the Department of Fisheries, Brunei Darussalam. Legal and institutional studies were also completed. A full-time coastal planner, Dr. Rogelio O. Juliano, was posted in the country to draft the integrated CRM plans. A one-year intensive survey on coastal fisheries resources is also underway with part of the expertise drawn from the Philippines.
- In Indonesia, the field survey for the pilot site at Segara Anakan was completed. A general draft plan was prepared by planners from Bogor Agricultural University in collaboration with the Directorate General of Fisheries and the Provincial and District Planning Board (BAPPEDA) and with technical assistance from ICLARM. National workshops were also conducted to obtain inputs from concerned institutions as well as to train planning staff.
- Planning activities in Malaysia are coordinated through the implementing agency and the State Economic Planning Board of Johore. A coastal planner, Mr. David Tarnas, was posted in Johore Bahru. Most of the plans are in the final draft stage. The main feature of the Malaysian project is its use of the GIS software, SPANS, in its plan formulation. The outputs of the national teams were voluminous and of good quality. The planning procedure follows closely the requirements of the Town and Country Planning Act of the Malaysian government. The formulated CRM plans will be integrated into the state structural plans, thus, providing the legal framework upon their approval by the State Assembly.
- In the Philippines, the regional office of NEDA plays a major role in the formulation of CRM plans for Lingayen Gulf. The 18 coastal municipal mayors and their councilors took an active part in the plan formulation. The process applied a "bottom-up" approach. The general and specific draft action plans are either nearly completed or awaiting refinement and improvement. A striking feature of the Philippine project is the keen enthusiasm among local and regional officials to focus their attention on the coastal zone. A number of recommendations of the planning team was already adopted by the provincial governments of La Union and Pangasinan. The Regional Development Council also officially endorsed the project as a priority activity of the region and passed a resolution asking the country's Pres. Corazon C. Aquino to declare the Lingayen Gulf as a Special Coastal Management Area.
- The management plan for Singapore's coastal area, with special reference to the use of marine space for domestic recreation, was

prepared by project staff from the National University of Singapore. A national workshop was held 9-10 November 1989 to obtain feedbacks on the CRM plans from various interest groups and contributions from concerned government and private agencies. The artificial reefs project is ongoing. Concrete and tire reefs were recently installed near Pulau Busing. Another reef site (west of Pulau Semakau) was already approved by the government, and installation of the artificial reefs is scheduled in January 1990. The artificial seagrass project is also going on fairly well with reports of marine organisms (grouper and crustaceans) entering the rehabilitated Singapore River.

The Thailand Upper South Project completed all field studies. The general zonation and specific action plans for mangrove management, water quality, wildlife management, aquaculture and fisheries management, land use and others are still being finalized. The completed first drafts of the plans are being reviewed. The Thai Cabinet recently approved a mangrove management plan for Surat Thani prepared by the project with a national budget allocation of US\$6 million. Also, marine buoys have been installed at Ko Taen, an offshore island in the Gulf of Thailand, using USAID/University of Rhode Island (URI) funds to prevent coral damage due to dropping of anchors by boats ferrying tourists.

Training. Since 1986, a total of 102 participants have already benefited from the project's training component. Their distribution by country is given in Table 1.

Table 1. Number of training participants of CRMP.

Training program	Country						Total
	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand	
Short-term							
1. Information research and management		2	2	5	2	2	13
2. Principles of CRM							
a. Thailand		2	2	2	2	5	13
b. Malaysia	1	3	5	2	2	2	15
c. Indonesia	1	5	2	2	1	2	13
3. Socioeconomic analysis	1	2	2	2	4	7	18
4. GIS/remote sensing	2	2	4	3	6	2	10
Academic		1	1	1	1	1	5
On-the-job	1	2	2		1		6
Total	6	10	20	17	10	21	102

Four project staff from Indonesia, Malaysia, the Philippines and Thailand successfully completed their academic training (M.Sc. level) in the US. Another from Singapore is currently in Florida, USA, pursuing an M.Sc. degree in Microbiology.

Two project staff from Indonesia and one from Brunei Darussalam availed of on-the-job training in the US and the ASEAN, respectively.

An important workshop held in May 1989 in Brunei Darussalam was the international workshop on the training and management on

Table 2. Working Paper Series.

89/ 1	Brunei Darussalam: Annual Report 1988 (with annex)
89/ 2	Brunei Darussalam: Annual Workplan for 1989
89/ 3	Indonesia: Annual Report 1988
89/ 4	Indonesia: Annual Workplan for 1989
89/ 5	Malaysia: Annual Report 1988
89/ 6	Malaysia: Annual Workplan for 1989
89/ 7	Philippines: Annual Report 1988 and Annual
89/ 8	Workplan and Budget 1989
89/ 9	Singapore: Annual Report 1988
89/10	Singapore: Annual Workplan 1989
89/11	Thailand: Annual Report 1988
89/12	Thailand: Annual Workplan 1989
89/13	Summary Report, Workshop on Guidelines and Policies for Coastal Resources Management in Segara Anakan, 27 February-1 March 1989, Cilacap, Central Java, Indonesia
89/14	Task 210-I: Assessment of mangrove degradation and zoning for development (Terminal Report)
89/15	Final Report of Task 220-I: The Water Quality of Segara Anakan, 1987-1989
89/16	Task 230-I: Dynamics of water movement and sedimentation (Terminal Report)
89/17	Dynamics of water movement and sedimentation patterns of Cilacap/Segara Anakan Lagoon Final Report by Dr. Mulia Purba, PI, Task 230-I)
89/18	Subtask 242-I: Lagoon and Culture Fisheries (Terminal Report)
89/19	Socioeconomic study on three fishing villages of Segara Anakan Lagoon-Cilacap in relation to coastal resources management (Final Report of Division 300-I: Socioeconomic Studies of CRM Project)
89/20	Report of the Third In-Country Meeting for the Development of a Coastal Resources Management Plan for South Johore, Malaysia, 28 February-2 March 1989
89/21	Proceedings from the Presentation to Johore State Government Officials on the ASEAN/USAID Coastal Resources Management Project in Malaysia: The Development of the South Johore Coastal Resources Management Plan, 18 June 1989
89/22	Task 300-P: The people of the coastal communities of Lingayen Gulf: Profiles and conditions
89/23	Task 310-P: The economics of municipal fisheries--The case of Lingayen Gulf
89/24	Task 330-P: Marketing studies of selected commodities in Lingayen Gulf
89/25	Division 400-P: Political and socio-cultural context of coastal resource management in Lingayen Gulf, Parts I-IV
89/26	Final Report of Task 210-T: Coastal aquaculture, December 1988 with Annex
89/27	Final Technical Report on Coastal Environment of Phangnga Bay (Task 250-T), January 1987- August 1988
89/28	Guidelines for the environmental management of Phangnga Bay (Task 250-T), January 1987-August 1988
89/29	Task 267-T: Land-based pollution study/Pollution from coastal zone development (Final Report) Vols. 1 and 2
89/30	Evaluation of mangrove development potential of Phangnga and Ban Don Bays for coastal zone management, Thailand (270-T)
89/31	Final Draft Report of the Recreation and Tourism Subsector (420-T): Management of Coastal Tourism Resources at Ban Don Bay
89/32	Final Report of the Recreation and Tourism Subsector (420-T): Legal and Institutional Arrangements for Management of Coastal Resources in Thailand
89/33	Management of Coastal Tourism Resources at Phangnga Bay
89/34	Draft Final Report on Wildlife Resources of Ban Don Bay
89/35	Draft Final Report on Wildlife Resources of Phangnga Bay
89/36	Final Report of Task 290-T: Evaluation of land capability use development potentials
89/37	Final Sectoral Report: Assessment of the coastal environment of Ban Don Bay (Task 240-T: The Marine Environment of Ban Don Bay)
89/38	Sudara, Suraphol, Sirikul Bunpapong, Robert Dobias, Ilyas Baker and Alan White. Management Plan for Coral Reefs, Beaches and Island Environments of Ban Don Bay, Surat Thani

continued

Table 2 (continued)

89/39	Management Plan for Coastal Water Quality in Ban Don and Phangnga Bay (Draft)
89/40	The Legal and Institutional Environment for the Management of Coastal Resources in Brunei Darussalam by Richard J. Tobin
89/41	Assessing the Feasibility of Successfully Implementing a Coastal Resources Management Plan for the Lingayen Gulf by Richard J. Tobin
89/42	Assessing the Feasibility of Successfully Implementing Coastal Resource Management Plans in Ban Don Bay and Phangnga Bay, Thailand by Richard J. Tobin
89/43	Assessing the Feasibility of Successfully Implementing Coastal Resource Management Plans in Malaysia, Indonesia, Philippines and Thailand by Richard J. Tobin
89/44	Management Plan for Singapore's Urban Coastal Area--A Preliminary Plan by Chia Lin Sien
89/45	Progress Report of the Project Coordinator, 1989

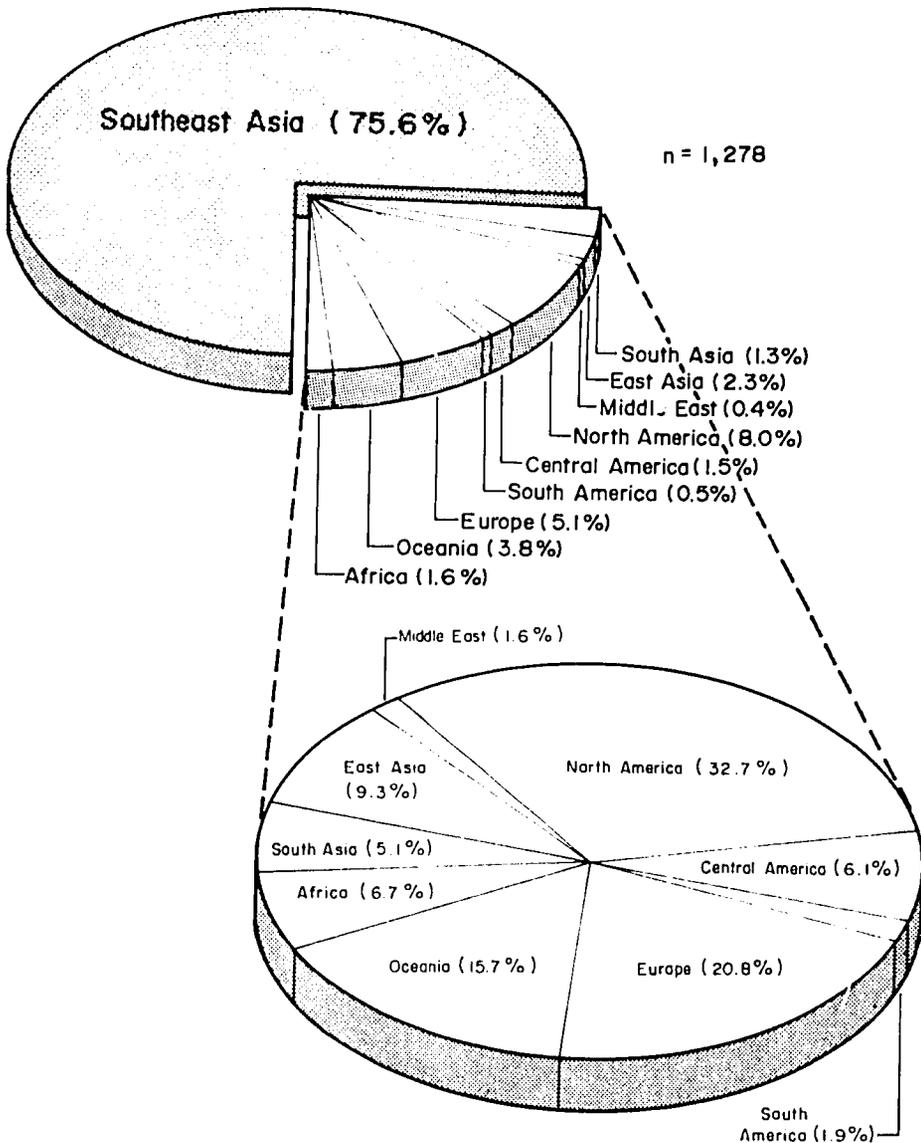


Fig. 1. Tropical coastal area management newsletter distribution by geographical category for 1989.

Pyrodinium red tides. This was participated in by 40 researchers from the six ASEAN countries, Australia, US, Canada, Japan, Papua New Guinea and Central America. The workshop was cosponsored by the Australian International Assistance Bureau (AIDAB)/Commonwealth Scientific and Industrial Research Organisation (CSIRO), ICLARM, United Nations Environment Program (UNEP) and the ASEAN/US CRMP. Other international agencies which also provided support were the Intergovernmental Oceanographic Commission/Western Pacific (IOC/WESTPAC), IDRC of Canada and the US National Academy of Sciences. The workshop was successful not only in terms of the level of participation, which included scientists, public health officers and government administrators but also in terms of contents and outputs, i.e., the publication of the book, *Biology, epidemiology and management of Pyrodinium red tides* which was edited by Gustaaf M. Hallegraeff and J.L. Maclean.

Policy conference. Preparations are currently being made for a major conference on "Managing ASEAN Coastal Resources for Sustainable Development" scheduled on 4-7 March 1990 in Manila and Baguio. The workshop attempts to bring together public officials at the highest level in government (cabinet secretaries/ministers, directors- or secretaries-general, etc.), senior representatives of donor agencies and international organizations, senior members of the international/national media and scientists. The workshop hopes to obtain a consensus on the importance and urgency to manage the coastal area for sustainable development and to show donor agencies what the CRMP has been doing for the past four years.

Information dissemination. In 1989, CRMP produced two technical reports (*The coastal environmental profile of Segara Anakan-Cilacap, Indonesia* and *The coastal environmental profile of Singapore*); two educational materials (on marine parks and seagrasses); three conference proceedings (*Coastal area management in Southeast Asia: policies, management strategies and case studies; Policy recommendations for coastal area management in the ASEAN region; and Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines*); and a directory (*Directory of institutions and scientists in the ASEAN region involved in research and/or management related to coastal areas*).

The project's newsletter, the *Tropical Coastal Area Management* (TCAM), 3 issues/year, is currently being distributed to almost 2,000 individuals and institutions in 95 countries (Fig. 1).

The project has also produced 45 working papers in 1989 written by various national and international project staff (Table 2).

- Project Title** : Asian Fisheries Social Science Research Network
- Cooperating Institutions** : INDONESIA - Faculty of Economics, Diponegoro University; Research Institute for Coastal Aquaculture, Maros, Sulawesi, Selatan; The Research Group on Agro-Ecosystems (KEPAS), Agency for Agriculture Research and Development, Bogor; Research Institute for Marine Fisheries, Jakarta; MALAYSIA - Natural Resource Economics Department, Universiti Pertanian Malaysia; PHILIPPINES - College of Arts and Sciences, University of the Philippines in the Visayas, Iloilo City; Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo; Faculty of Economics and Management, University of the Philippines at Los Baños, Los Baños, Laguna; Bureau of Fisheries and Aquatic Resources, Department of Agriculture, Quezon City; THAILAND - Department of Agricultural and Resource Economics, Faculty of Economics and Business Administration, Kasetsart University, Bangkok; Fisheries Economics Research Section, Department of Fisheries, Ministry of Agriculture and Cooperative, Bangkok; Coastal Resource Institute, Prince of Songkla University, Hat Yai, Songkla.
- Duration** : Phase I (1983-1985); Phase II (1985-1988); Phase III (1989-1991)
- Key Personnel** Indonesia : Faculty of Economics, Diponegoro University - Drs. Wiratno (Team Leader); Drs. Mudiantono; Drs. Dwisetia Poerwono; Drs. Syafrudin B. Suharto; Drs. Salrid; Drs. Basuki Suwardo; Drs. Edy Yusuf; Drs. Amier Kusnamawardain; Drs. Indah Susilowasi; Ir. Yollanes Husabarat and Ir. Argo; Research Institute for Coastal Aquaculture - Dr. Fuad Cholik (Team Leader); Ir. Alimusa Pasaribu; Drs. Hasseng Padda; and Dr. Adl Hanafi; The Research Group on Agro-Ecosystems, Agency for Agriculture Research and Development - Dr. Kedi Suradisastra (Team Leader); Dr. Ibrahim

- Manwan; Ir. Asep Saefuddin and Ir. Muchamad Yusron; Research Institute for Marine Fisheries - Mr. Victor P.H. Nikijuluw (Team Leader); Dr. Nurzali Naamin; Mr. Riyanto Basuki; Mr. Manadiyanto; Mr. Bambang Sadhatomo; Mr. Sarjana and Ms. Tuti Susilowati
- Malaysia : Natural Resource Economics Department, Universiti Pertanian Malaysia - Dr. Nik Mustapha Raja Abdullah (Team Leader); Dr. Mohd. Ariff Hussein; Dr. Syed Kadir Alsagoff; Dr. Ishak Hj. Omar and Mr. Kusatri Mohd. Noh
- Philippines : Department of Agricultural Economics, College of Economics and Management, University of the Philippines at Los Baños - Mr. Danilo L. Evangelista (Team Leader); Dr. Cynthia Bantilan and Dr. Agnes Rola; Faculty of Arts and Sciences, University of the Philippines in the Visayas Iloilo City - Ms. Chona A. Iturralde (Team Leader); Ms. Estela C. Alminza-Varua; Prof. Antonia Baldevia; Prof. Ma. Nuria B. Castells; Dr. Elviro Cinco; Ms. Ma. Elisa A. Diez; Prof. Ma. Luisa E. Mabunay; Prof. Benedict C. Posadas; Prof. Tomas A. Sajo; Ms. Peria del los Santos; Prof. Ebonia B. Seraspe; Prof. Ida M. Siason; Mr. Rodelio F. Subade; Prof. Gilma Tayo; Ms. Cynthia J. Ticao and Prof. Nida R. Ty; Bureau of Fisheries and Aquatic Resources - Mr. Nelson A. Lopez (Team Leader); Mr. Nemencio B. Arevalo; Mr. Severo D. B. Balane, Jr.; Mr. Abundio M. Galicia, Jr.; Ms. Emerita S. Lapasaran; Ms. Leonora O. Signey and Ms. Carmencita D. Tocino; Economics Section, Research Division, SEAFDEC AQD - Mr. Renato Agbayani (Team Leader); Mr. Romeo D. Caturao; Ms. Giselle P.B. Samonte; Ms. Susana V. Siar and Mr. Reuel E. Tumalluan
- Thailand : Fisheries Economics Research Section, Department of Fisheries - Mr. Pongpat Boonchuwong (Team Leader); Ms. Panipa Hanvivatanakit; Ms. Sonying Plumsombun; Ms. Pensri Julnimit; Mr. Pornsak Supavivat; Ms. Amporn Lawapong; Mr. Prayot Techapeowlert and Ms. Kulapa Mingmeag; Department of Agricultural and Resource Economics,

Faculty of Economics and Business Administration, Kasetsart University - Dr. Ruangrai Tokrisna (Team Leader); Dr. Thanwa Jitsanguan; Dr. Sarun Wattanutchariya; Mr. Somkit Tugsinavisutti; Mr. Somporn Isvilanondha; Ms. Penporn Janekarnkij; Mr. Pitti Kantangkul; Mr. Banlu Puttikorn and Mr. Sanit Koa-ian; Coastal Resource Institute, Prince of Songkla University - Dr. Somsak Baromthanarat (Team Leader)

ICLARM : Dr. Louise A. Fallon (Network Coordinator)

Objectives

- To advance the professional capacities of the network's members and broaden the base of its membership;
- To support its members in the conduct of research in the social sciences that will generate results of value for the formulation of development policies and management strategies in support of capture fisheries and aquaculture sectors;
- To develop educational programs in the social sciences related to capture fisheries and aquaculture at the graduate and undergraduate levels in the network's member institutions;
- To augment national activities of the network with international linkages among its members.
- To promote the use of the network's research results through effective dissemination.

Results

Training and education. The network sponsors periodic short-term training courses, workshops and symposia designed to develop and strengthen the research skills and capacities of its members. The focus of such activities is the introduction and application of research methodologies appropriate for multidisciplinary social science research on fisheries and aquaculture in Asia; development and management issues are also discussed.

Through a cooperative agreement with Simon Fraser University (SFU), British Columbia, Canada, financial support and advisory services are made available to selected network members to pursue graduate degrees in Fisheries Economics at SFU. Also under this agreement, members are funded for short visits to Canada to enable professional interaction with SFU faculty.

Similar arrangements with other donor agencies and educational institutions are being tapped in order to provide a broader scope of

choices for AFSSRN members in terms of social science discipline and institution.

Publications. The Network Publication Committee, made up of various network research team leaders, reviews manuscripts submitted by members for publication. Publication of research outside the network is also supported.

Initially, *AFSSRN News* will be published as part of TCAM. However, an independent network newsletter is eyed as membership expands and more funds become available.

Professional interaction. This is encouraged among the members through workshops, training courses and seminars. The network also plans to participate in regional joint projects, i.e., in a special socioeconomic session for the Third Asian Fisheries Forum to be held in Singapore in 1992.

Coordination. This was supported by the Ford Foundation from 1983 to mid-1989; and ICLARM has always provided a secretary and facilities for the Coordinator.

Dr. Fallon, like her predecessors, provides technical assistance and advice and assists members in developing research proposals in line with the objectives and functions of the network. She also solicits advice and methodological support from the international research community for the network members. Efforts are being made to form an Advisory Committee composed of experts in various fields of social sciences relative to capture fisheries and aquaculture.

CAPTURE FISHERIES MANAGEMENT PROGRAM

Background

The Capture Fisheries Management Program (CFMP) was created by ICLARM's Board of Trustees in December 1988 as heir to the Resource Assessment and Management Program (RAMP) *sans* its coastal area project, now part of the Coastal Area Management Program (CAMP). The RAMP had been the successor of earlier programs devoted to Marine Affairs, Traditional Fisheries and Resource Development and Management.

The CFMP activities imply both continuity and innovation. The continuity stems from the fact that the mandate of ICLARM has not changed over the years, despite changes in our organogram: we are still primarily devoted to raising incomes in developing-country communities dependent on fisheries, as can be achieved by, among other things, improved resource management. The bulk of the CFMP activities is therefore devoted to the continuous development, adaptation and dissemination of methodologies for the management of tropical multispecies resources, and of the fisheries they support.

ICLARM's five-year plan (1988-1992) for the program actually emphasizes the progressive refinement of these management methodologies and their incorporation into broader management systems, which take both the resource base and the human communities involved in the fishery into account, as well as other sectors of society involved in decisionmaking.

The year 1989 has also been one of transition and innovation inasmuch as the development of the stock assessment techniques incorporated in the Compleat ELEFAN software package has been completed and replaced, as the major research thrust of the program, by thrusts into multispecies modelling, to produce more realistic accounts of the dynamics of stocks, which lead to more appropriate management interventions.

However, multispecies modelling is data-intensive and has had therefore limited use in the tropics to this date. Thus, ways have to be found to obtain the information needed for construction of multispecies models rapidly, and in cost-effective fashion.

In 1989, we have concentrated on: (i) a method for estimation of food consumption of fishes, i.e., to quantify the major interaction (=predation) of the elements of any multispecies system; and (ii) the development of software for the straightforward construction and evaluation of multispecies box models of ecosystems based primarily on single-species

data obtained by fisheries biologists. These activities, concentrated on the resources side of fisheries research, must, in order for balanced management advice to emerge, be complemented with "shore-based research", covering the human element. Our progress in 1989 on these aspects is detailed below.

Progress of Work

The Tropical Stock Assessment and ICLARM Software Projects

The methodology developed at ICLARM that is best known is probably the different implementations of the ELEFAN program, especially the Compleat ELEFAN software package with over 200 packages in use worldwide, complementing another 200 sets of earlier versions distributed.

The popularity of ELEFAN received a strong confirmation in 1989 through the offer of the Marine Resources Service, Fishery Resource and Environment Division, Food and Agriculture Organization (FAO), of a contract to merge ELEFAN with a similar software developed by FAO staff and called LFSA (Fig. 1). This joint software, on which work began in 1989, will be distributed by FAO and ICLARM when it is completed, and will eventually also be translated into French and Spanish.

Other software for single-species analysis has been completed in 1989, notably "MAXIMS", a package for the analysis of stomach contents data. This software results from our recent emphasis on methods for the estimation of food consumption of fish populations to assist in the construction of multispecies models of ecosystems and give a management orientation to the activity of the many fishery biologists working throughout the world on often unfocused fish stomach content analyses.

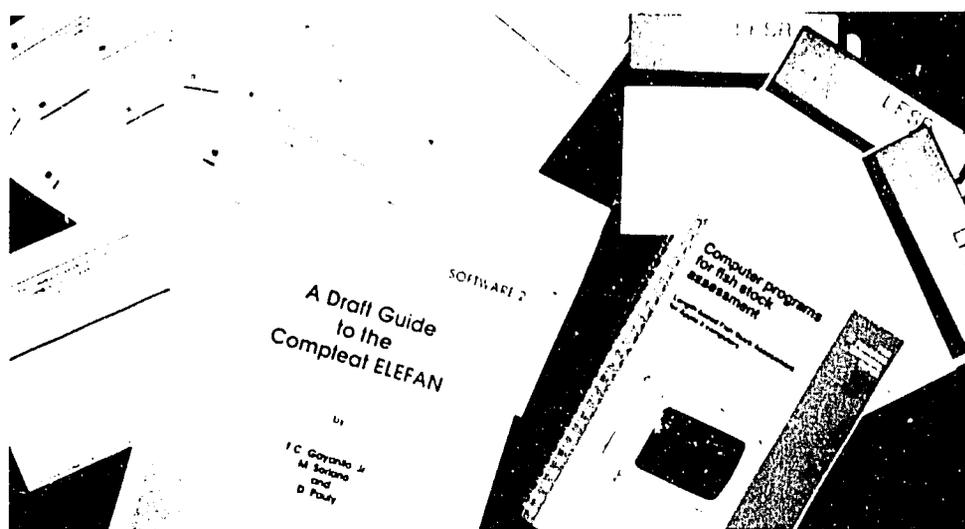


Fig. 1. The Compleat ELEFAN (Electronic Length Frequency ANalysis) and LFSA (Length-based Fish Stock Assessment) software packages of ICLARM and FAO, respectively, are extremely useful to fisheries scientists in developing countries. Rewriting these programs into a single, optimized software package will facilitate the training activities of both FAO and ICLARM.

Multispecies modelling

Two lines of research have been followed in 1989 with regard to multispecies modelling. The first of these has been the further development of ECOPATH II, a software package based on earlier work by J.J. Polovina and associates at the National Marine Fisheries Service (NMFS), Hawaii, and which can be used to construct rapidly a box model of any fisheries (or pond!) ecosystem (Fig. 2).

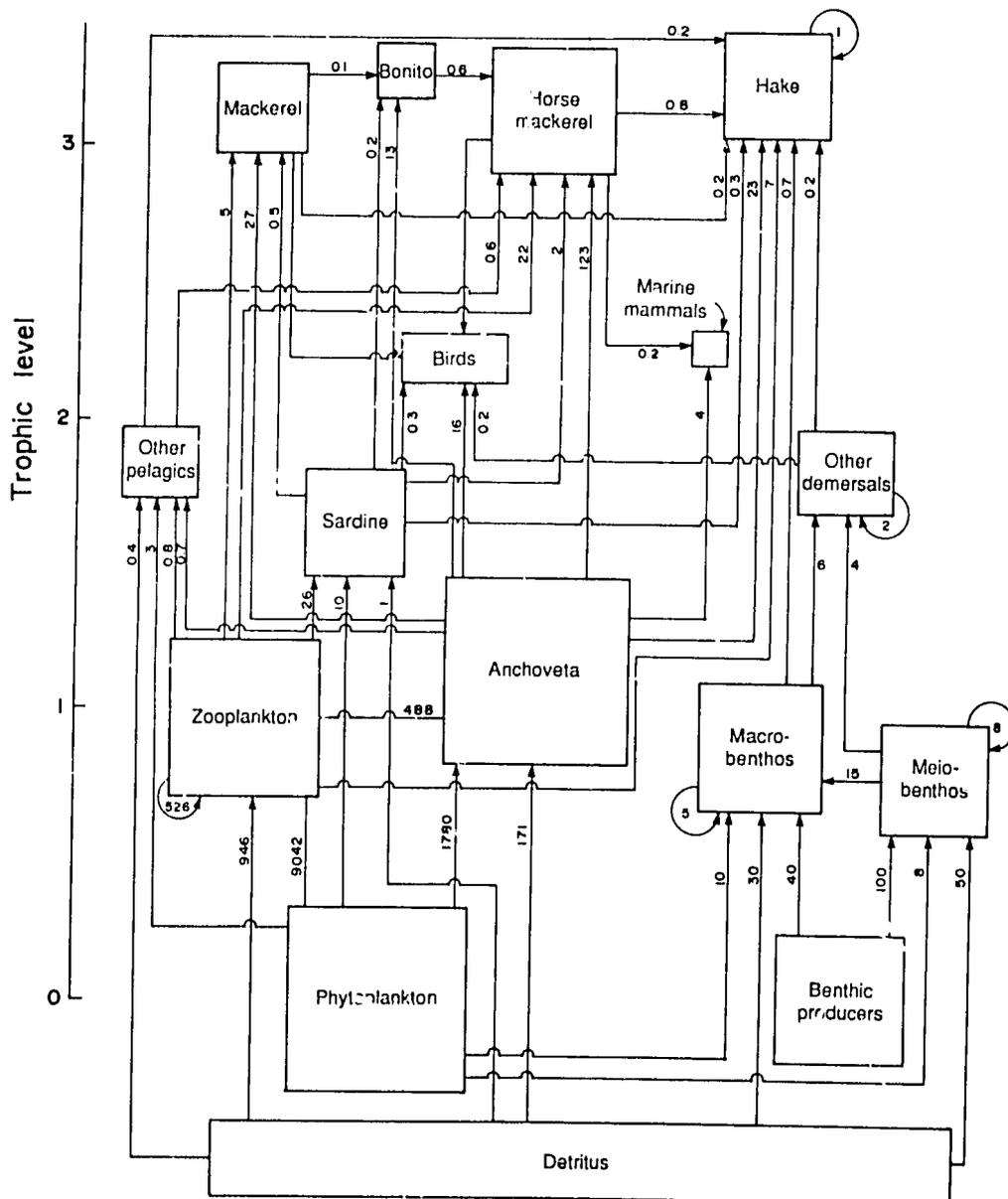


Fig. 2. A representation of the Peruvian upwelling ecosystem for the period 1960 to 1969 by means of a steady-state trophic "box model". Such models help identify the key elements of exploited ecosystems and verify the key rates (growth, mortality, food consumption) affecting their dynamics, and hence the fisheries based on them.

This program has been successfully applied to a wide variety of systems and appears to be an extremely useful tool for global comparisons of exploited ecosystems. In 1989, two developments occurred which will make such global comparisons possible:

- the International Council for the Exploration of the Sea (ICES) in October 1989 invited Dr. Pauly to organize a "Theme Session" to be held during the next Council Meeting of ICES in October 1990 on "Trophic Models of Marine Ecosystems: Construction and Comparisons", and
- a proposal was sent to and accepted by the Danish aid agency DANIDA to outpost a Danish scientist from early 1990 to work on the project on global comparisons of ecosystems modelled through the ECOPATH III software and its possible successors.

These positive responses to our new efforts in this area are encouraging.

Work on bioeconomic simulation of the Peru upwelling ecosystem also progressed well.

The model presently being developed by Dr. P. Muck of ICLARM, assigned to the Instituto del Mar del Perú in Callao, Peru, will be a useful tool for Peruvian managers to develop appropriate responses to e.g., strong anomalies of sea surface temperature as in El Niño events.

The Network of Tropical Fisheries Scientists (NTFS)

This successful network continues; it has now about 900 members, with new members from Latin America resulting from surveys of the Norwegian research vessel "Dr. Fridtjof Nansen" in Central America and from the first FAO/DANIDA course for Latin American fisheries scientists, held in Cumaná, Venezuela, in October/November 1989.

The Network's newsletter, *Fishbyte*, of which three issues were distributed in 1989, continues to contribute to information exchange on tropical fisheries and to the dissemination of stock assessment methodology for tropical multispecies situations. A detailed report appears on p. 14.

FISHBASE

FISHBASE, an interactive database to document the fisheries and aquaculture-related biology of some 2,500 species of tropical and other fishes, crustaceans and molluscs important to fisheries and/or aquaculture, is off to a good start. The new project obtained support from both FAO (Fisheries Department, Marine Resources Service) and the Commission of European Communities. FISHBASE is intended to reduce substantially the need for large and costly holdings of taxonomic and other material in the libraries of fisheries research institutions in the tropics.

Small-scale fisheries

1. Bangladesh

The monitoring of the New Management Policy for Inland Water Fisheries of Bangladesh with support of the Ford Foundation was successfully completed in September. The project demonstrated that the policy of licensing the fishermen can result in increase of fishermen's income, but that this, somehow paradoxically, happens through an increase of effort, rather than - as was intended by the framers of the New Management Policy - via the reduction of the number of intermediaries.

2. Latin America

A joint proposal for "Socioeconomic valuation of coastal resources in southwest Latin America" has been elaborated in 1989 between ICLARM and the Economic Commission for Latin America and the Caribbean (ECLAC) which will lead to an ICLARM staff member being outposted in Santiago de Chile in early 1990.

Women in fisheries

The issue of Naga, the ICLARM Quarterly, devoted to "Women in Fisheries" (April 1989) generated a rather strong feedback, which we interpret as indicating the need to pursue this issue actively and indeed, for ICLARM to provide leadership in this area. This should involve a rethinking of the way fisheries community development projects are formulated and conducted, particularly the way target groups are identified and involved in project activities. We believe that such activity could be best undertaken by an ICLARM staff member with a degree in Sociology/Anthropology and with experience in studies of communities of fisherfolk, especially women and children. A proposal to this effect was submitted to a donor agency in November 1989 which, if funded, will allow a substantial contribution to be made in this area.

Education and Training

Ms. A. Jarre taught a biostatistics course at the Marine Science Institute, University of the Philippines (UP), Dillman, Quezon City, throughout the second semester of the UP academic year (June-October).

Under special arrangements with the Universiti Pertanian Malaysia (UPM), Dr. M. Agüero was invited to participate as External Adviser and Thesis Committee Member of the Graduate School of UPM, for a doctoral dissertation on small-scale fisheries in Bangladesh, successfully defended in July 1989 by Mr. M. Ahmed and based on a bioeconomic linear programming model developed earlier by Dr. Agüero.

Mr. P. Dalzell submitted an M.Phil. thesis entitled "The biology of surgeon fishes (Family: Acanthuridae), with particular emphasis on *Acanthurus nigricauda* and *A. xanthopterus* from northern Papua New

Guinea" to the Department of Biology, University of Newcastle upon Tyne. This was accepted in October 1989.

Dr. J.L. Munro spent two weeks of July teaching part of a summer course on "Coral reef fish and fisheries" at the Discovery Bay Marine Laboratory of the University of the West Indies, Jamaica.

Dr. D. Pauly and Ms. M.L. Palomares participated on 5-22 February as lecturer and computer resource person, respectively, at the Regional FAO/DANIDA Training Course in Tropical Fish Stock Assessment held in Mwanza, Tanzania, for fisheries scientists from Kenya, Tanzania and Uganda working on Lake Victoria resources.

Dr. Pauly lectured from 15 October to 9 November at the first FAO/DANIDA Training Course in Fish Stock Assessment in Cumaná, Venezuela. As the participants originated from 14 different Latin American countries, this activity contributed markedly to the dissemination, throughout the region where they had been relatively unknown, of methods developed at the Center, notably the Compleat ELEFAN software, and various approaches for food consumption estimation and multispecies modelling.

Dr. Pauly also continued the guidance and supervision of graduates working on M.Sc. and Ph.D. theses at the University of the Philippines, Manila, and at the Institut für Meereskunde, Kiel, respectively. In June, the first of his Ph.D. students, Ms. Victoria Isaac from Brazil, graduated with a doctorate thesis entitled "The accuracy of length-based methods for fish population studies". He also supervised the Program's Network trainees (see NTFS project summary).

Advisory Services

Dr. M. Agüero performed a three-week consultancy in May for the World Bank and GTZ to advise on the social and economic feasibility of a waste-fed (tilapia) aquaculture project at the Miraflores Water Treatment Center in Lima, Peru, which is executed by the Panamerican Center for Sanitary Engineering and Environmental Science (CEPIS) and the Universidad Agraria La Molina.

Also, he participated in two activities of the Study on International Fisheries Research (SIFR) coordinated by the World Bank with FAO, UNDP, the CEC and twelve bilateral donors, as (i) a member of the SIFR mission to Ecuador, Peru and Chile (July/August 1989), and (ii) a member of the Working Party on Research Priorities for Aquaculture Development in Paris (September 1989).

Dr. J L. Munro's advisory activities are discussed on p. 153.

Mr. P. Dalzell's six-month secondment to the South Pacific Commission is detailed on p. 70.

Program Plans

Dissemination of various software completed in 1989, notably the Compleat ELEFAN (Version 1.1), ECOPATH II (Version 1.0) and MAXIMS (Test Version) will be initiated in early 1990.

The compilation of case studies on the food consumption of natural fish population will continue, eventually covering over 150 cases.

Comparisons between ecosystems using ECOPATH II and related approaches will be performed by Mr. Villy Christensen of the Danish Institute of Fisheries and Marine Research (DIFMAR), whose secondment to ICLARM, funded by DANIDA for a period of two years, will start in early 1990. He will interact with various groups of cooperators throughout the world, notably in the Philippines, Mexico, Kuwait, Venezuela, Indonesia and Brunei Darussalam. Intermediate results will be presented at the 1990 Statutory meeting of ICES. Dr. Pauly and Mr. Christensen will host a theme poster session devoted to this topic.

Further development of particle-size theory will occur as a result of the work with ECOPATH II and hopefully in interaction with scientists from outside ICLARM.

Work on a fishery management-oriented ecosystem simulation model of the Peru ecosystem will continue, and a preliminary version will be presented to the participants of the FAO/DANIDA Training Course in Fish Stock Assessment to be held in Lima, Peru, in September 1990.

A management-oriented bioeconomic simulation model of the demersal fisheries of Brunei Darussalam will be developed which will implement, in the form of computer-generated maps, the results of the survey presently conducted by Bruneian colleagues and ICLARM staff member G. Silvestre.

The transfer of Dr. Agüero to his new base at the headquarters of the Economic Commission for Latin America and the Caribbean (ECLAC) in Santiago, Chile, implies that our work on small-scale fisheries will, from 1990 on, acquire a strong Latin American "flavor", and generate ICLARM's first work in Spanish.

Meetings Attended, Papers Presented

- Workshop on "Experiments in New Approaches to the Improved Management of Open-Water Fisheries in Bangladesh", Dhaka, Bangladesh, 9-10 January. (M. Agüero)
 Paper presented:
 Agüero, M. Inland water fisheries in Bangladesh: management options and national interventions
- FAO/DANIDA Training Course in Fish Stock Assessment, Mwanza, Tanzania, 7-22 February. (M.L. Palomares, computer resource person, and D. Pauly, lecturer)
- First Philippine SAS User's Group Seminar/Meeting, Intercontinental Hotel, Ayala Ave., Makati, Metro Manila, Philippines, 15 March. (F.C. Gayani, Jr. and M. Soriano)
- Second Asian Fisheries Forum, Tokyo, Japan, 17-23 April. (M. Agüero, M. Ahmed, M.L. Palomares and D. Pauly).
 Papers presented:
 Agüero, M. and M. Ahmed. Economic rationalization of fisheries exploitation through management: experiences from the open-water inland fisheries management in Bangladesh.
 Bimbao, M.P., A.V. Cruz and I.R. Smith. An economic assessment of rice-fish culture in the Philippines (presented by M.P. Bimbao).
 Capili, J.B., S.M. Luna and M.L. Palomares. A multivariate analysis of the growth of three strains of tank-reared tilapia *Oreochromis niloticus* (presented by M.L. Palomares).

- del Norte, A.G.C. and D. Pauly. Virtual population estimates of monthly recruitment biomass of rabbitfish, *Siganus canaliculatus*, from Bolinao, Northern Philippines.
- Pauly, D., M. Small, R. Vore and M.L. Palomares. Morphoedaphic index and fisheries yield of Lake Mainit, Philippines.
- South Pacific Forum Fisheries Committee. Annual Meeting, Majuro, Marshall Islands, 25-28 April. (J.L. Munro).
- Stock Assessment-Cooperative Research Support Program (Philippine Module), Second Quarterly meeting, Miag-ao, Iloilo, Philippines, 2 June. (D. Pauly).
- International Scientific Symposium on "Research and Small-Scale Fisheries", Montpellier, France, 3-7 July. (M. Agüero, D. Pauly)
- Papers presented:
- Agüero, M. Small-scale fisheries research in Pacific South America: a regional synthesis
- Lampe, H. Small-scale fisheries and the development of related, particularly economic research in Southeast Asia (presented by D. Pauly)
- USAID/NMFS Workshop on Deepwater Handline Fishing, University of Hawaii, Honolulu, Hawaii, 5-26 July. (P. Dalzell)
- Paper presented:
- Dalzell P. Deep-water dropline fishery surveys in the South Pacific region from 1975 to 1988: a preliminary analysis of the data collected by the South Pacific Commission masterfishermen's programme.
- Symposium of Fish Population Biology, Aberdeen, Scotland, 17-21 July. (D. Pauly, Keynote speaker)
- Paper presented:
- D. Pauly. Food consumption by tropical and temperate fish populations: some generalizations
- First Symposium on Peruvian Ecology and Conservation, Lima, Peru, 24-29 July. (A. Jarre, D. Pauly and P. Muck)
- Paper presented:
- Muck, P., A. Jarre and D. Pauly. Estructura y dinamica del sistema de afloramiento peruano, con énfasis en el rol de la anchoveta (*Engraulis ringens*)
- Stock Assessment-Cooperative Research Support Program (Philippine Module), Third Quarterly Meeting, Bolinao, Pangasinan, Philippines, 31 August-2 September (D. Pauly, A. Jarre)
- South Pacific Forum Fisheries Agency, Tenth Anniversary Meeting, Honiara, Solomon Islands, 18-23 September. (J.L. Munro).
- Seminar on "Mutual Assistance in Ocean Sciences and Ocean Services for Sustainable Development", Alfred Wegener Institute for Polar and Marine Research (AWI), Bremerhaven, Federal Republic of Germany, 19-22 September. (D. Pauly)
- First Regional CDS/ISIS User's Group Workshop/Meeting, Asian Institute of Technology (AIT), Bangkok, 2-6 October. (F.C. Gayanilo, Jr., lecturer on CDS/ASSIST software)
- Multispecies Models Relevant to Management of Living Resources, The Hague, 2-4 October. (A. Jarre, D. Palomares and D. Pauly)
- Papers presented:
- Jarre, A., M.L. Palomares, M.L. Soriano, V.C. Sambilay, Jr. and D. Pauly. Some improved analytical and comparative methods for estimating the food consumption of fishes.
- Jarre, A., P. Muck and D. Pauly. Interactions between fish stocks in the Peruvian upwelling ecosystem.
- International Council for the Exploration of the Sea (ICES) Statutory Meeting, The Hague, The Netherlands, 5-10 October. (A. Jarre)
- Paper presented:
- Jarre, A., M. Clarke and D. Pauly. Reexamination of growth estimates in oceanic squids: the case of *Kondakovia longimana* (Onychoteuthidae)
- Regional Training Course on Fish Stock Assessment, Cumaná, Venezuela, 16 October-10 November. (D. Pauly, lecturer).

- Seminar/Workshop on Mini-Micro CDS/ISIS version 2.3 for Beginners, National Engineering Center, UP Diliman, Quezon City, Philippines, 19 October. (F.C. Gayanilo, Jr., lecturer on CDS/ASSIST software)
- The Compleat ELEFAN: A Population Dynamics/Stock Assessment Seminar, Bicol University, College of Fisheries (BUCF), Tabaco, Albay, 20 October. (F.C. Gayanilo, Jr., lecturer)
- The First Training Workshop on Quantitative Genetics of Farmed Tilapias, Central Luzon State University (CLSU), Muñoz, Nueva Ecija, 29 October-6 November. (F.C. Gayanilo, Jr., computer resource person)
- AFSSRN Mini-Symposium: Economic Perspective on Fisheries Management, Center for Research and Communication, Pasig, Metro Manila, Philippines, 27 November. (M. Agüero, A. Cruz and M. Ahmed)
- Paper presented:
Agüero, M. and J. Padilla. Fisheries social science research problems in the Philippines.

Publications and Consultancy Reports

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Capture Fisheries Management Program Project Summaries

Project Title	:	Tropical Fish Stock Assessment Project
Cooperating Institution	:	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 Mr. Victor Sambilay, Jr. Ms. Mina Soriano Ms. Astrid Jarre Mr. Geronimo Silvestre Mr. Paul Dalzell

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

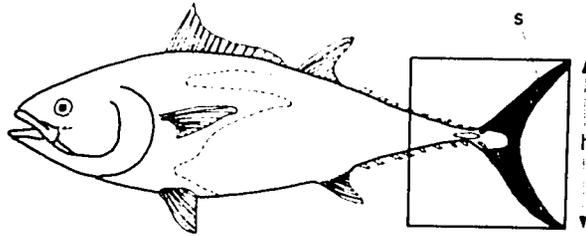
The major advances of this project in 1989 have been (i) the further development and presentation at several conferences and in the primary literature of various approaches to relate the food consumption of fishes and other vital rates to their morphology, particularly to the aspect ratio of their caudal fins (see Fig. 3); (ii) the completion of a generalized model for estimating the food consumption of fishes (see "The ICLARM Software Project" summary); and (iii) the establishment of an informal network, throughout the tropics and also in temperate areas of colleagues interested in modelling various aquatic ecosystems using the ECOPATH II software and other approaches developed at the Center.

These three items jointly form a coherent whole, which is gradually replacing length-based stock assessment methods as the main area of emphasis of this project.

This new line of work appears to elicit great interest among colleagues, as evidenced by the encouraging response to the poster session we are organizing for the next ICES Statutory meeting.

Supporting activities relevant to this project are: (i) the demersal and shrimp surveys conducted by Brunelian colleagues and Mr. Geronimo

Thunnus thynnus
Aspect ratio: 9.8



Epinephelus aeneus
Aspect ratio: 1.3

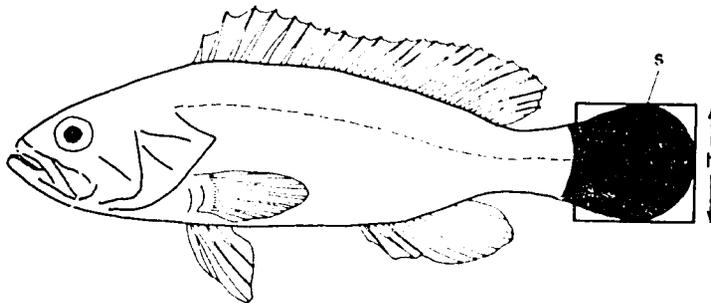


Fig. 3. Schematic definition of the aspect ratio ($A = h^2/s$; h = height, s = surface area of fin) of the caudal fin of fishes, which is strongly correlated with their level of activity, and hence with their food consumption.

Silvestre off the coast of Brunei Darussalam and (ii) a secondment of Mr. P. Dalzell to the South Pacific Commission (SPC) in Noumea, New Caledonia, January to September 1989.

The objectives of the consultancy were to summarize and analyze a large body of catch data collected between 1975 and 1988 by the SPC masterfishermen during a fishing survey beyond the shallow reef areas. Catch rates and catch composition were investigated with respect to island size, depth and time of the day. Other activities during the consultancy were the training of a Vanuatu fisheries scientist in analysis of length-frequency and catch and fishing-effort data from deepwater handline fishery, and the formulation of a sampling protocol for detection of ciguatoxic fishes in the Federated States of Micronesia.

Dr. J.L. Munro, jointly with Dr. Paul Holthus of SPC, has initiated work on the feasibility of coral reef ranching in the latter half of the year. Current work is concentrated on making an inventory of species of potential interest and on a tagging study which will give information on the relative range of movement of species of potential interest.

Antillean fish traps were constructed for sampling the reef fish stocks in the CAC's reef leaseholding and have been used with some success. Fish tags were delivered in late December and the tagging program will commence in February.

Additional funding is being sought to broaden the scope of these investigations.

Project Title : Network of Tropical Fisheries Scientists

Funding Institutions : FAO/DANIDA Training Course in Tropical Fish Stock Assessment Project; Norwegian Agency for Development Cooperation (NORAD)

Duration : Continuous from April 1982

Key Personnel ICLARM : Ms. Abbie Cruz, Network Secretary Dr. Daniel Pauly, Fishbyte Editor

Objectives

- To enhance communication between fisheries scientists working on the assessment, conservation and management of tropical stocks.
- To enhance the output of these scientists by improving access to literature, providing free database searches, distributing manuals and other literature and publishing a regular newsletter. 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

Network membership totalled 960 by the end of 1989. Three issues of Fishbyte were published. Over 40 new members from Africa and Latin America were welcomed to the network as a result of FAO/DANIDA regional training courses held in Mwanza, Tanzania on February 1989 and Cumaná, Venezuela on 16 October-10 November, respectively, and as follow-up of surveys by the Norwegian R/V Fridtjof Nansen off Central America.

Three NTFS members came to ICLARM to be introduced to methods for tropical fish stock assessment. These are:

Name	Training Period	Institution	Funding Agency	Publication
Md. Serajul Islam	9-27 January	Fisheries Research Institute, Baburhat Chandpur, Bangladesh	IDRC - India	The life history and fishery of <i>Misla</i> in Bangladesh and their implication for management Fishbyte 7(1): 3-4.
Victor Soliman	5-30 June	Bicol University Coll. of Fisheries Tabaco, Albay Philippines	Guest of ICLARM	Population dynamics of "sinarapan" (<i>Mistichthys luzonensis</i> Smith) in Lake Bato. MS thesis, Central Luzon State University
Muhammad Iqbal	13-25 November	Univ. of Karachi Karachi, Pakistan	Univ. of Karachi	Population dynamics of <i>Pomadourys kakaan</i> . Fishbyte 7(3): 4-5.

Ms. A. Cruz analyzed the perceptions of NTFS members regarding the services offered by the Network and its impact on strengthening communication, based on questionnaires earlier sent and retrieved by former Fishbyte editor, Dr. J.L. Munro. This paper (see Fishbyte 7(1): 8-10) showed that the facile hypothesis of a predominant "North-South communication flow" is in fact invalid, and that instead, most network members from developing countries now utilize information obtained in other developing countries - a "South-South flow" to which Fishbyte can contribute markedly. In a follow-up paper by A. Cruz and D. Pauly published by UNESCO (see p. 66), new research areas which NTFS members perceived to be increasingly important were identified. These were: marine aquaculture, resource assessment and management (including coastal zone management), computer applications (GIS, remote sensing), automated monitoring, acoustics, environmental impact and monitoring, and ecology/ecosystem approaches. These findings will be useful for ICLARM's planning, and for other institutions as well.

- Project Title** : Management-Oriented Fisheries Research Project
- Cooperating Institutions** : Instituto del Mar del Perú (IMARPE), Callao, Peru; Laboratory for Ichthyology and Coastal Systems (LICS), Limnology and Marine Science Institute, Universidad Nacional Autónoma de México (UNAM), Mexico City; Uganda Freshwater Fisheries Research Organization (UFFRO), Jinja, Uganda
- Duration** : Continuous from April 1982
- Key Personnel**
- | | | |
|--------|---|-------------------------------|
| IMARPE | : | Ms. Isabel Tsukayama |
| UNAM | : | Dr. Alejandro Yañez-Arancibia |
| UFFRO | : | Mr. Thaddeus O. Acere |
| ICLARM | : | Dr. Daniel Pauly |
| | | Ms. Astrid Jarre |
| | | Dr. Peter Muck (c/o IMARPE) |

Objectives

- To train fisheries 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.
- Overall, to strengthen the capabilities of the participating countries to manage their fisheries.

Results

Uganda module

Three comprehensive bibliographies on (i) Lake Victoria, (ii) Nile perch *Lates niloticus*, and (iii) Lake Idi Amin (ex Edward) were produced in 1989 by the Uganda module of the Management-Oriented Fisheries Research Project which is funded through the Commission of European Communities (European Development Fund - EDF). Items (i) and (ii) will become part of a book on the "Ecology of Fisheries of Lake Victoria" for which funding is presently being sought, and which will also include the edited version of the papers produced by the Ugandan, Kenyan and Tanzanian participants of the FAO/DANIDA Regional Training Course in

Tropical Fish Stock Assessment, held in Mwanza, Tanzania, in February 1989. Item (iii) similarly will become part of a bilingual French/English volume on Lake Idi Amin (ex Edward) to be copublished with the Zairean Department of Fisheries, UFFRO and ICLARM.

Mexico module

The activities in this module involved, on the part of our Mexican colleagues, the compilation of their massive trawl survey data set into a format amenable for analyses similar to those presented in earlier "Atlases" of the growth, mortality, recruitment and related features of Southeast Asian fishes. This work is progressing but is not expected to lead to the planned UNAM/ICLARM copublication before 1991.

Dr. Pauly visited the group in early August to discuss matters of common interest, and to supervise a Mexican Ph.D. student he "shares" with Prof. A. Yañez-Arancibia, while Ms. A. Jarre spent three days there in October to introduce our colleagues to the ECOPATH II and MAXIMS programs.

Dr. Pauly and Prof. A. Yañez-Arancibia cooperated on two book chapters, now submitted, on (i) "Coastal lagoons as fish habitats", and (ii) "Fisheries and fisheries management in coastal lagoons", based, to a large extent, on their previous work in West Africa and Mexico, respectively.

In 1990, the interactions between our two groups will be more intense and will concentrate on the elaboration of a steady-state trophic model of Terminos Lagoon, Southern Gulf of Mexico.

Peru module

This year saw the end, in early 1989, of the Programa Peruano-Alemán de Investigación Pesquera (PROCOPA), which had provided the funding and organizational support for ICLARM's activities in Peru since 1981.

The last major output of PROCOPA was the joint publication of the Proceedings of the IMARPE-PROCOPA/ICLARM Workshop on "Models for Yield Prediction in the Peruvian Upwelling Ecosystem", held in August 1987 at IMARPE. We hope that this book will be appreciated as was its predecessor of 1987 "The Peruvian Anchoveta and its Upwelling Ecosystem: Three Decades of Change".

These two books represent a concentration of all published knowledge on the Peruvian upwelling ecosystem and its pelagic fisheries, and thus provide the background to achieve the ultimate goal for which PROCOPA was originally designed, the construction of a simulation model of the Peruvian upwelling ecosystem and its pelagic resources, implemented such that it can be used as a fishery management tool.

A generous grant was provided to ICLARM by GTZ to achieve this goal, and hence to cap a decade of GTZ-supported fishery research in Peru. This grant enabled us to hire Dr. P. Muck, formerly with PROCOPA, for one year, from May 1989 to April 1990, with the task of writing, while outposted at IMARPE, the program in question. The funds

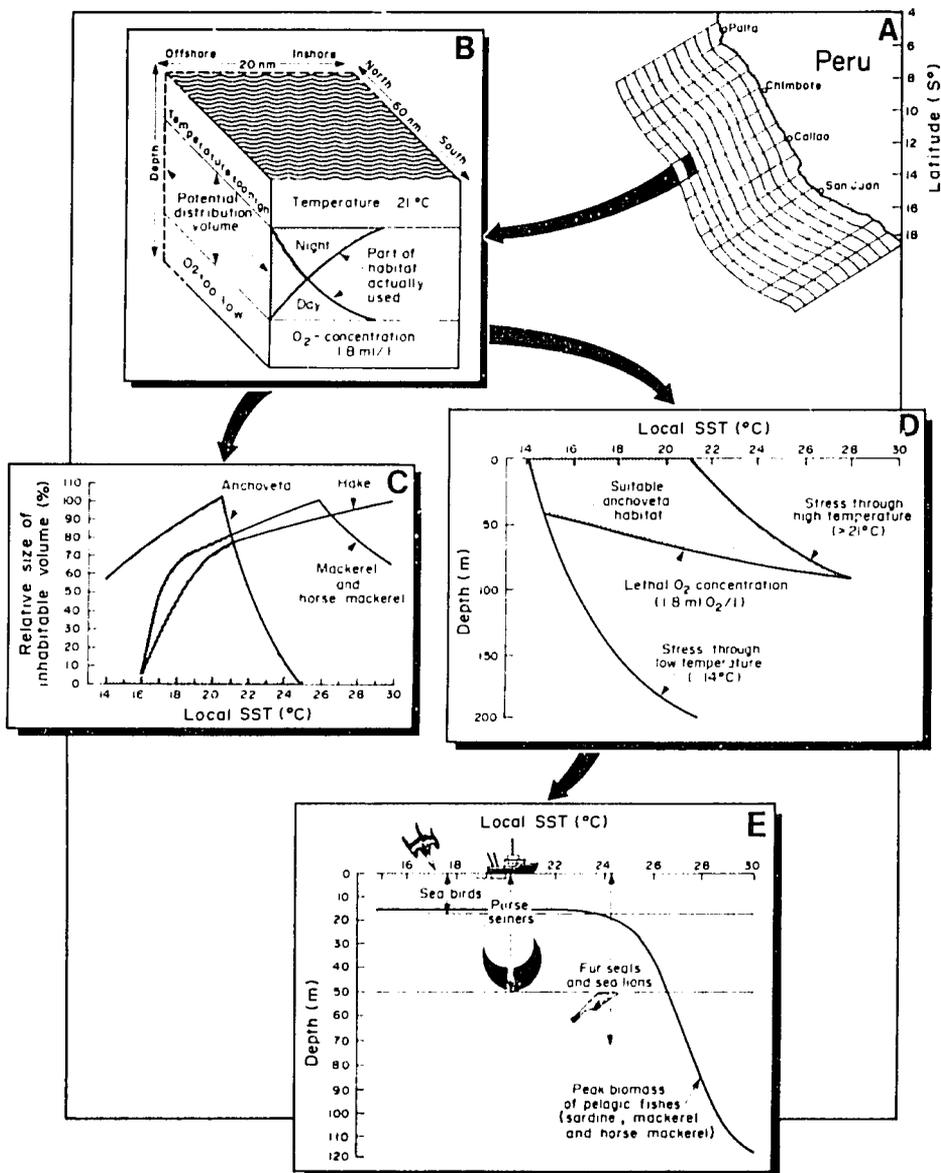


Fig. 4. Schematic representation of submodels incorporated in large simulation model of the Peruvian upwelling ecosystem.

- A. Definition of the subareas used for spatial modelling.
- B. The volume potentially inhabited by a given species within each subarea is a function of sea surface temperature (SST), oxygen (O_2) concentration and time of the day.
- C. Each species has different physiological requirements which, given changing SST, result in different fractions of a subarea's water column being occupied by that species.
- D. The effects in (C) cause vertical changes in distribution, all of which occur within a narrow range of temperature and above a critical O_2 concentration.
- E. Combined, these effects determine whether the fish will be high enough in the water column to be caught by guano birds, purse seiners or marine mammals.

also allowed some supporting activities such as the gathering of fish prices and related data by research assistants in Peru (for the economic component of the model), a visit to Peru by Ms. A. Jarre to coordinate her modelling approach - involving a successive steady-state model such as shown on Fig. 2 - with that of Dr. Muck, and an early 1990 visit of Dr. Muck to ICLARM headquarters in Manila.

As of December 1989, the bulk of the planned simulation model has been written. This involves three major routines:

- An "oceanographic" component, which defines the suitability in terms of sea surface temperature, and related factors to key pelagic species of 150 small subareas along the Peruvian coast (see Fig. 4A-D).
- A component which describes the predation between stocks, and reproduction and growth of each single species stock, as well as the impact of fishery (=catches) in each subarea (see Fig. 4D-E).
- An "economic" component which allows deployment of a fleet of arbitrary size and structure in any combination of subareas, and which computes the gross and net returns from the fishery, allowing comparisons of short- and long-term management interventions.

The structure of this model, and some preliminary results, were presented at two international conferences, on Peruvian ecology (Lima, 24-29 July), and on multispecies fisheries modelling (The Hague, 2-4 October), and the papers in question are in press. Additionally, a draft program documentation titled "The Upwelling Ecosystem off Peru: Modelling and Management" has been written.

Despite these advances, it is anticipated that the finalization of the simulation program will require more time than originally planned. Particularly, the interfacing of the program outputs with a robust, user-friendly graphics interface (in both English and Spanish) and with a routine for construction of "box models", will require many months of programming. It is anticipated that a preliminary version of the model will be available for presentation at the FAO/DANIDA Training Courses in Tropical Fish Stock Assessment to be held in Lima in the second half of 1990. The graphic routines will then be elaborated by programmers at ICLARM headquarters and the interfacing of program outputs with successive box models (for analysis as network of flows) will be performed by Ms. Jarre as part of her doctorate thesis on this topic, to be initiated in 1990.

- Project Title** : Management Options for Tropical Small-Scale Fisheries
- Funding Institution** : The Ford Foundation with additional support from other donors (Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Food and Agriculture Organization (FAO) and World Bank).
- Cooperating Institutions** : Ministry of Fisheries and Livestock (MF & L), People's Republic of Bangladesh; FAO; Bangladesh Centre for Advanced Studies (BCAS), plus informal linkages with other institutions, e.g., Bureau of Fisheries and Aquatic Resources (BFAR) in the Philippines; Corporacion Regional para el Desarrollo de Nariño (CORPONARIÑO) in Colombia; Instituto del Mar del Perú (IMARPE) in Peru; Kasetsart University in Thailand; University of Rhode Island in the USA; Escuela Politecnica Nacional del Ecuador (ESPOL) in Ecuador.
- Duration** : Four years, beginning March 1986
- Key Personnel ICLARM** : Dr. Max Agüero

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 developing countries.
- To write and disseminate written documents 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

A comprehensive narrative report on the achievements of this project was sent in mid-December to the Ford Foundation. Its key point is the completion in September 1989 of project entitled "Experiments in new approaches to the improved management of open-water fisheries of Bangladesh", whose various outputs include a set of quantified management options for the Government of Bangladesh; a group of Bangladesh researchers well trained in this area of inquiry; and on the publication side, a doctoral dissertation, an edited book (Fig. 5) and several other contributions to be published.

Dr. Agüero also actively contributed in the Study of International Fishery Research, funded by a variety of donors and coordinated by the World Bank (see Advisory Services, p. 63) and to the preparation of the International Symposium on "Research and Small-Scale Fisheries" held in Montpellier, France, 3-7 July, in which he presented an account of small-scale fisheries research in South America, now in press.

Dr. Agüero devoted much of his time to the preparation of his outposting to Latin America. This involved preparation and submission of a major proposal to the Economic Commission for Latin America and Caribbean (ECLAC), extensive correspondence with and visits to various research institutions in Latin America and donor organizations in North America and Europe.

We have every reason to hope that 1990 and 1991 will see ICLARM recover the heavy time investment that was extended to organize this first outposting of an ICLARM headquarter staff to Latin America.

Inland Fisheries Management in Bangladesh

Edited by
M. Agüero
S. Huq
A.K.A. Rahman
and M. Ahmed

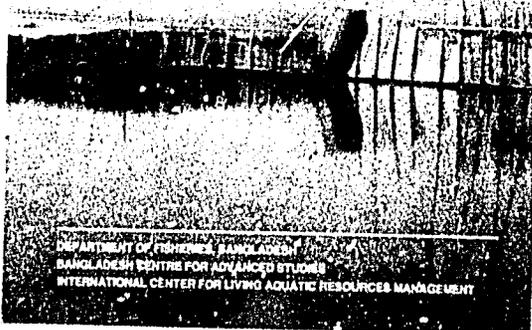


Fig. 5. This book on the inland fisheries of Bangladesh is devoted mainly to the implementation of the Government's new management policy, aimed at increasing benefits to small-scale fishermen.

Project Title : The ICLARM Software Project

Cooperating Institution : Predominantly in-house activity, with informal linkages with various individuals and research institutions.

Duration : Continuous from 1986

Key Personnel ICLARM : Dr. Daniel Pauly
Mr. Felimon Gayanilo, Jr.
Ms. Mina Soriano
Ms. Astrid Jarre

Objectives

- To document and disseminate 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 interest.

Results

Throughout 1989, sales of software released by this project in 1988 or earlier have continued and this applies to plug-in chip and preprogrammed cards for HP 41CV programmable calculators, and the ELEFAN programs for length-based fish stock assessment, of which two versions exist:

- the one-diskette "Kiel version", developed jointly with a staff member of the Institut für Meereskunde, Kiel, Federal Republic of Germany, for IBM PC or Apple II (CP/M) and their compatibles; and
- the 12-diskette graphic-oriented Compleat ELEFAN software package.

About 150 sets of the former package were shipped as of December 1989. As for the Compleat ELEFAN, 300 copies of Version 1.0 were shipped. The release of Version 1.1, based on work conducted in the second half of the year, was announced in the December issue of Fishbyte, and it is expected that even more sets of the improved version will be shipped, both to new users and to replace copies of Version 1.0.

The success of the ELEFAN software was further documented in 1989 by a contract awarded by FAO to the project to combine this software with a similar software developed by FAO staff, the LFSA package (see Fig. 1 on p. 59). The aim is to produce a new package, to be supported and disseminated by both organizations notably via training courses throughout the developing world - and which should in the process become a standard tool, available also in French and Spanish, and for which other scientists would be encouraged to write "add-on" routines.

Development of new software during 1989 included the following:

- (i) a program for users of the widely-used CDS/ISIS bibliographic software called "CDS ASSISTANT", which was developed to (a) import into CDS/ISIS files documents from other bibliographic packages and (b) to facilitate the use of CDS/ISIS, a UNESCO-sponsored "freeware" package used by librarians throughout the developing world;
- (ii) several sophisticated routines for investigating various aspects of the growth of fishes, and which will be incorporated into the new FAO/ICLARM software mentioned above;
- (iii) MAXIMS, a program for the study of fish food consumption, notably for estimation of daily ration from diel variation of stomach contents (Fig. 6); and

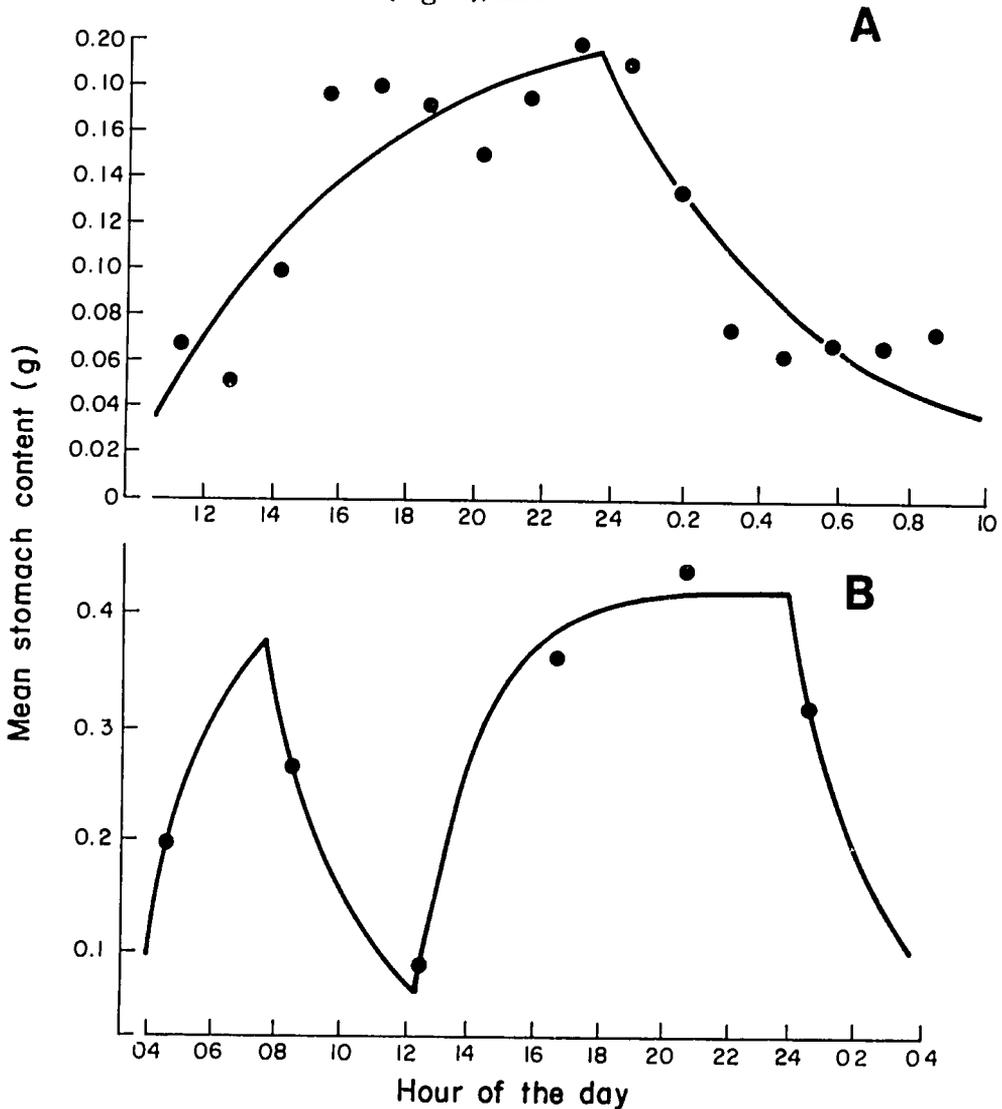


Fig. 6. Data on mean stomach contents of fish during a 24-hour cycle (dots) as used by the MAXIMS program to fit a theoretical model accounting for different periods of ingestion, and simultaneously occurring stomach evacuation

- A. Single cycle of feeding in Peruvian anchoveta (*Engraulis ringens*) as estimated from data for over 5,000 individual fish.
- B. "Dusk and dawn" feeding of lizardfish *Saurida undosquamis*, as suggested by data collected off Aden and fitted with the "two cycle" version of the MAXIMS program.

- (iv) a set of 14 diskettes containing all of the time series data on the Peruvian upwelling ecosystem used to derive the contributions in the two above-mentioned books on that system, as well as picture files of anchoveta egg maps, an anchoveta bibliography and other information.

Distribution of items (i) and (iii) will begin early in 1990. Items (ii) and (iii), written by Ms. M. Soriano and Ms. A. Jarre, respectively, as products of the Tropical Fish Stock Assessment Project, are supportive of that project's thrust towards development of computer-based, easy-to-implement methodologies with which we assist the work of fisheries scientists throughout the tropics. Item (iv) which was compiled as part of the Peru module of the Management-Oriented Fisheries Research Project, was made available for distribution in late 1989, along with our second book on the Peruvian upwelling system, in which the contents of these 14 diskettes are described in detail. Various contributions documenting these developments are listed in the CFMP's list of papers published, or presented at meetings (see p. 64).

- Project Title** : Interactive Database on Tropical Fisheries Resources Management
- Funding Institutions** : Food and Agriculture Organization of the United Nations (FAO); Commission of European Communities (CEC)
- Cooperating Institutions** : Institut für Meereskunde (IfM), Kiel University; Food and Agriculture Organization (FAO) of the United Nations; and the Commission of European Communities (CEC)
- Duration** : October 1988 to end 1992
- Key Personnel**
- | | | |
|--------|---|-----------------------|
| IfM | : | Mr. Rainer Froese |
| FAO | : | Dr. Walter Fischer |
| ICLARM | : | Dr. Daniel Pauly |
| | | Dr. Roger S.V. Pullin |
| | | Ms. Belen Acosta |
| | | Ms. Susar Luna |

Objectives

Recognizing the need for accurate information for researchers, planners and managers to manage fisheries resources, ICLARM, FAO and CEC have agreed to collaborate on the establishment of a large computerized database on aquatic organisms of current and future potential in developing-country fisheries development. This is envisaged as a "mini-library" of key information to assist the work of international, regional, and national developing-country agencies and institutions. Within the framework of this large database will be special modules emerging from collaborative programs with developing-country scientists and institutions. The database will cover all major groups of aquatic animals important to developing countries: finfish, crustaceans and molluscs.

Results

The design of the database pertaining to finfish was completed in 1989 and agreed upon between ICLARM and FAO. Data entry for finfish began in April 1989 at ICLARM Headquarters. A module for edible crustaceans is ready for data entry, and one for cephalopods will be developed in 1990.

FISHBASE contains information on the ecology, population dynamics, reproduction, identification, taxonomy, aquaculture and diseases of each of the species included.

Data are from relevant literature, using mainly the ICLARM library collections. Every entry is referenced. The database can access on-screen pictures of species or distribution maps (Fig. 7).

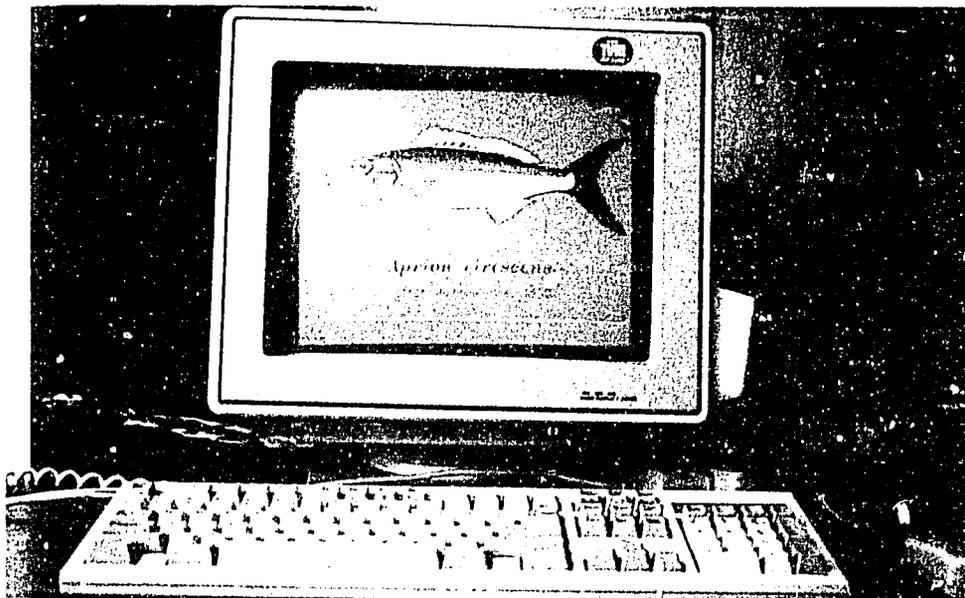


Fig. 7. An important component of FISHBASE is full color computer graphics, particularly useful when the database is used for species identification - a role in which FISHBASE effectively replaces costly taxonomic books.

The database to date contains over 1,250 fields distributed in 36 relational tables where information is stored for 1,400 species. About 10% of the total number of species records are filled with data for all the existing tables. This figure includes 116 species for capture fisheries and 26 species for aquaculture.

During development of FISHBASE fields, we have also had meetings and communication with experts, notably Dr. Rosemary Lowe-McConnell (British Museum/Natural History, ret.), Prof. Wolfgang Villwock (University of Hamburg Museum, Federal Republic of Germany) and Dr. Thys van den Audenaerde (Musée Royal de l'Afrique Centrale, Belgium).

A major proposal will be submitted in early 1990 which, if funded, will allow this activity to be run by an internationally recruited project leader, supported by several keyboard entry personnel. Distribution of a version on diskettes may begin in about two years and on CD-ROM in about four years.

AQUACULTURE PROGRAM

The Aquaculture Program is focused on research for the development of small-scale aquaculture, i.e., at the family or village community level rather than larger-scale corporate activities. This focus is based on the equity and environmental issues implicit in ICLARM's mandate to work for the benefit of disadvantaged peoples and comparative advantage to lead and coordinate strategic research for such development, complementary to the efforts of national programs. Small, multi-enterprise farms are usually more sustainable and environment-friendly than large export-oriented operations and they provide employment for rural producers and food for rural and urban consumers.

The overall objective of the Program is to increase dramatically the number of families operating small-scale aquaculture systems not only for their own benefit but also to feed the rural and urban poor. This is approached by interactive research to develop new, sustainable, integrated aquaculture-agriculture and coastal aquaculture systems and new improved breeds of aquatic organisms that perform well in these systems.

Conceptual Framework

The conceptual framework, on which all the Program's activities rest, consists of five interacting activities: a) genetics; bioeconomic modelling; c) farmer participatory research; d) problem-solving aquaculture component research; and e) use of Geographic Information Systems (GIS), conducted in a wide array of environments (Fig. 1).

The genetic activities comprise documentation of genetic resources and their conservation; collection and maintenance of fish strains; evaluation of strain performance in different farming systems; and development of improved synthetic strains. The approach is to work mainly with species of wide importance that have short generation times, such as tilapias, so as to demonstrate methods that can then be applied to a wider range of species in national breeding programs. These activities interact with the modelling activities in receiving farm environment parameters for evaluation work and giving potential production coefficients to the models. New strains will be provided for evaluation in farmer participatory research and feedback on their performance will be gathered.

Farmer participatory research is directed towards the evolutionary integration of aquaculture with agriculture or coastal activities and

consists of environmental analysis, system synthesis, adaptive trials with farmer cooperators and subsequent assessments. These activities also interact with component research activities. Farmers' problems are fed to component researchers and the technical options generated are provided for implementation in farming systems.

The bioeconomic modelling also interacts with farmer participatory research and GIS. Farmer participatory research provides information on existing models and receives information for the design of new integrated farming systems. Interactions between modelling and GIS entail provision of data for mapping environments and receiving impact estimates.

The component research comprises problem-solving, more basic, disciplinary research (nutrition, reproduction, pathology, engineering, etc.) that is largely the province of national specialists in developing- and developed-country institutions. Many of these, particularly the former, merit sustained and increased support to undertake such research. ICLARM's collaborative mode of operation facilitates the identification of key problems and the catalysis and coordination of efforts to solve them. ICLARM's main role in component research is defining problems and approaches and seeking advances in research methodology.

Matrix of Activities

The Program activities fit into a matrix of ecosystems and locations (Fig. 2). The important ecosystems for the low input, semi-intensive or extensive systems being developed are: wetland rice-based; rainfed terraces; deepwater floodplains; freshwater rivers and lakes, including reservoirs; estuarine and other coastal brackishwaters; and coastal reefs. Ongoing and proposed project activities are placed in the matrix to indicate not only what is being covered now but also the gaps in the Program.

Clearly the Program has yet to implement fully the framework indicated in Figs. 1 and 2. For example, there are as yet no Latin American/Caribbean activities apart from membership of scientists from those regions in the Program's Network of Tropical Aquaculture Scientists. However, this framework will allow expansion of activities to fill the gaps. Moreover, it will accommodate future new activities on fish production through ecologically-based management of aquatic environments, including the concept of 'culture-based fisheries', extensive aquaculture, fisheries enhancement and fish ranching in such diverse environments as floodplains, reservoirs and coral reefs.

In order to operate effectively in strategic research and training, the Program is seeking to develop two modest core research and training units, for aquaculture genetics and integrated farming systems, to be established on the campuses of host institutions in developing countries. These would complement the small ICLARM Coastal Aquaculture Centre (CAC), already established in the Solomon Islands.

All other Program activities are in collaboration with national or regional institutions. This arrangement has worked well and will be continued. However, the long-term strategic research elements, methodology advancement, coordination of networks and some aspects of

Environment

Region	Activity	Wetland rice-based	Rainfed terraces	Deep-water floodplains	Rivers and lakes, including reservoirs	Estuarine and other coastal brackish-waters	Coastal reefs
Southeast Asia	GEN	●	●		●	○	
	FPR	○	○	○		○	
	BEM	○	○	○		○	
	ACR	○	○	○	●		○
	GIS						
South Asia	GEN						
	FPR	●	●	●	○	●	
	BEM	○	○	○		○	
	ACR	●	●	●	○		
	GIS	○	○	○		○	
South Pacific	GEN						○
	FPR						●
	BEM						●
	ACR						●
	GIS						
Africa	GEN	○	○		○		
	FPR	●	○		○		
	BEM	●			○		
	ACR	●	○		○		
	GIS	○					

● Ongoing Activities GEN Genetics ACR Aquaculture Component Research
 ○ Proposed Activities BEM Bioeconomic Modelling GIS Geographic Information Systems
 FPR Farmer Participatory Research

Fig. 2. Matrix of Aquaculture Program activities by environment and region.

training that constitute ICLARM's comparative advantage in the global picture of aquaculture research *do* require the development of these modest additional genetics and farming systems facilities that will be internationally orientated and independent of national policy shifts.

The development of all these facilities will be dependent upon available funding. ICLARM's hope is that they will play a role in the new global scenario for international aquaculture research that will emerge from ongoing deliberations by the Technical Advisory Committee Consultative Group on International Agricultural Research (TAC/CGIAR) and the World Bank. In this regard, ICLARM's Aquaculture Program framework has many advantages for combining the strengths and talents of developed- and developing-country institutions with those of international centers in long-term strategic, collaborative research.

Staffing

In mid-1989, the Program became fully staffed at HQ for the first time. It is now staffed down to mid-level professional status as follows:

Headquarters - Program Director; Farming Systems Specialist; Geneticist; Program Assistant (Aquaculture Biologist); Program Assistant (Economist) and Project Officer (Technical Cooperation with Francophone Countries).

Field (Genetics) - Two Research Assistants.

Field (Integrated Farming Systems) - Two Senior Aquaculturists (Malawi); One Senior Aquaculturist and One Associate Expert (Philippines); One Senior Aquaculturist (Bangladesh).

Field (Coastal Aquaculture Centre, Solomon Is.) - One Senior Scientist/Director; Three Research Associates and Three Research Assistants.

Progress of Work

Program wide activities

The recent ICLARM publications - Research and Education for the Development of Integrated Crop-Livestock-Fish Farming Systems and "Detritus and Microbial Ecology in Aquaculture" have become tertiary teaching texts in some developed and developing countries. The former is being translated into French. A new review on 'Aquaculture Systems Modelling: An Introduction With Emphasis on Warmwater Aquaculture' was published. It includes a description of the application of modelling techniques to rice-fish integrated farming.

The ICLARM Network of Tropical Aquaculture Scientists grew to 350 members from 70 countries and three issues of its newsletter 'Aquabyte' were published.

The Program expanded its collaboration with Francophone countries, especially those in Africa, through translation of technical material, a bilingual Africa section in Aquabyte and advisory services, including missions to Côte d'Ivoire.

Program staff commenced work on the aquaculture components of ICLARM's large database FISHBASE (see p. 61), incorporating genetic stock registries, museum data and data on farming systems and yields.

Genetics

Significant progress was made in projects funded by UNDP and the Asian Development Bank to develop improved breeds of farmed tilapias (see p. 109). New Nile tilapia (*Oreochromis niloticus*) germplasm was collected this year from Egypt, Ghana, Kenya and Sénégal and, after very thorough quarantine measures, is being evaluated in the Philippines in low technology culture systems. This was the first direct transfer of Nile tilapia germplasm from Africa to tropical Asia. *O. niloticus* has been chosen as a test species in finfish genetic improvement: a good candidate for low cost farming systems. The new germplasm and existing cultured strains in the Philippines have been characterized by a range of morphometric and biochemical methods.

There are highly significant differences between the growth performance of strains. Some wild African strains performed at least as well or better than established 'domesticated' 'Philippine' strains. Also, there was little or no genotype X environment interaction - a big boost to the aim of breeding an 'all-purpose' improved Nile tilapia for tropical developing countries wishing to culture this fish, and a hopeful sign for work with other species.

The ICLARM book 'Tilapia Genetic Resources for Aquaculture' was translated into French mainly for use in Francophone African countries.

There has been increased collaboration between ICLARM and other groups researching fish genetics. ICLARM staff continued their technical advisory role in the collaborative tilapia genetic research project between the University College of Swansea, UK and the Freshwater Aquaculture Center of the Central Luzon State University (FAC/CLSU), Philippines, funded by the Overseas Development Administration (ODA). The most notable new contacts were those with African groups in Côte d'Ivoire and Ghana and with the Freshwater Fish Specialist Group of the International Union for the Conservation of Nature (IUCN). New proposals are under discussion for collaborative work on the genetic diversity of African fishes and Asiatic carps and on management of fish genetic resources in Africa and Asia. A workshop on genetic resources of Asiatic carps is being planned in collaboration with IUCN and the Asian Wetlands Bureau, Kuala Lumpur.

Future directions will include the development of microcomputer software for fish geneticists and increased interaction between the genetic and farming systems activities within the Program.

Proposals have been made to potential donors for an independent ICLARM Aquaculture Genetics Research Unit and a request has been received from the United Nations Development Programme (UNDP) for ICLARM to develop the concept of a global finfish genetic improvement network. Meanwhile, the ongoing genetic projects, supported by UNDP and Asian Development Bank (ADB), have established some facilities for keeping tilapia germplasm at national institutions in the Philippines.

This work is at an exciting but vulnerable stage: vulnerable mainly because of the present short-term nature of available funding and lack of an independent facility for strategic, international work complementary to national breeding programs.

Integrated farming systems

The rationale for this Program theme is that integrating fish production as a routine subsystem in crop-livestock-tree-fish systems can revolutionize their sustainability and profitability (Figs. 3 and 4).

The Program has ongoing and upcoming activities in integrated farming systems research in Africa and Asia. ICLARM believes that there are many valuable lessons to be learned by increased interregional Africa-Asia collaboration in this field, and by the involvement of other developing regions when their scope for growth of such farming systems becomes clearer.

The major advance during 1989 was ICLARM's entry into the agricultural world proper through the hiring of Dr. Clive Lightfoot, a Farming Systems Specialist with expertise in research and training in Africa and Asia. Dr. Lightfoot has put great emphasis on the development of appropriate training materials and farmer participatory research. These involve a growing 'in-house' activity on the development of training books and software in addition to research activities. For the latter, the Program has 'cornerstone' projects in Asia and Africa: a common project with the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) in

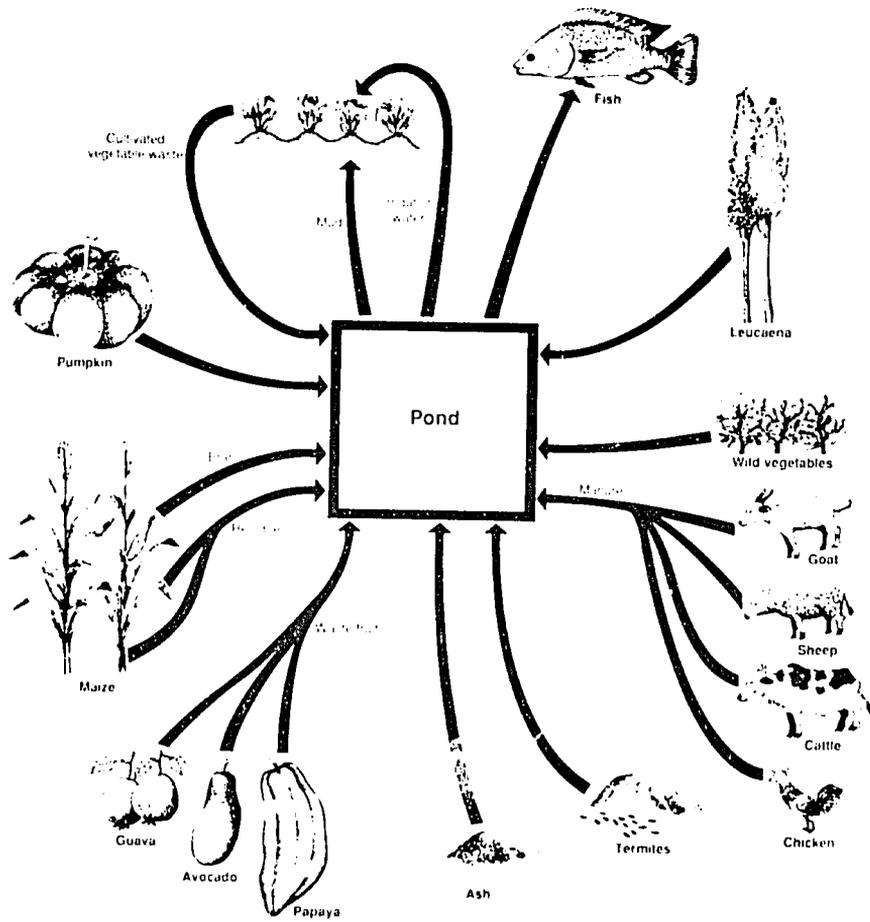


Fig. 3. Material flows between agriculture and aquaculture on Mr. Malekebu's farm, Zomba, Malawi.

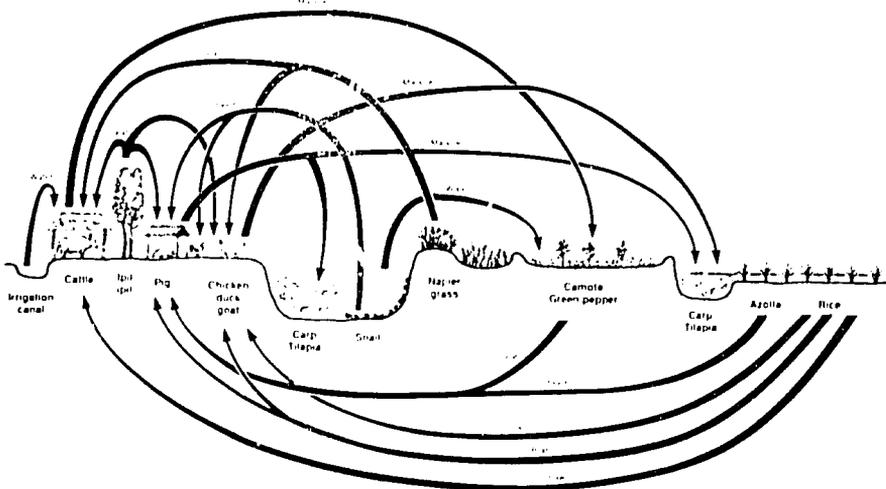


Fig. 4. Material flows between enterprises on Mr. L. Ignacio's integrated aquaculture farm, Cavite, Philippines.



Vietnamese farmer proudly holds his picture of the material flows in his integrated farming system.

Malawian farmers use local materials to construct a model of their integrated farming system.



Malawi and a regional project with the International Rice Research Institute (IRRI) on Asian Rice-Fish Farming Systems, funded by ADB.

Much progress has been made in the ICLARM-GTZ Malawi project in collaboration with the Fisheries Department and the University of Malawi. The project has enabled expansion of the Domasi Experimental Fish Farm, Malawi, with 65 new experimental ponds and 96 new tanks. Excellent research is being done by Malawian collaborators including six new Masters students whose results in the biological and social sciences are all significant; e.g., on-farm vegetation feeds fish; fire ash raises the pH and phosphate levels in ponds; maize bran is a fine fish food, etc. A large report on all aspects of African aquaculture development, using the Malawian situation as a case study, will go to press in 1990.

The ICLARM-IRRI-ADB rice-fish project has also made good progress both in on-station research at FAC/CLSU, and throughout its various work sites in the Asian Rice Farming Systems Network. Important results include new information on interactions between rice and fish, the role of fish in integrated pest management and the use of pond 'refuges' to couple/decouple fish production from paddies. IRRI is interested to expand collaboration with ICLARM in this field from 1990 onwards. The project held its second Asian Regional Rice-Fish Workshop in October, with cosponsorship from the International Development Research Centre (IDRC).

In Bangladesh, ICLARM provides aquaculture expertise to the US Agency for International Development (USAID)-funded Agricultural Research Project. Work started in 1989 to integrate fish culture into new farming systems tailored to the needs of rural Bangladeshis and the constraints of adverse climatic changes. Short-cycle systems using tilapia and silver barb (*Puntius gonionotus*) have proven very promising. As their adoption increases, however, their socioeconomic impact must be thoroughly researched. In 1990, ICLARM will start a second activity in Bangladesh on 'Socioeconomic Impact of Fish Culture Extension in the Farming Systems of Bangladesh', funded by the International Foundation for Agricultural Development (IFAD) and the Danish International Development Agency (DANIDA). Unlike the USAID-funded project, through which aquaculture advice is provided countrywide, this second activity will focus on two village target areas for in-depth impact studies.

The year 1989 also saw the successful completion of ICLARM's involvement in a World Bank project to develop aquaculture and fisheries for persons displaced by the construction of new reservoirs, Saguling and Cirata, near Bandung, West Java, Indonesia. Developments from the project now yield 20% of the freshwater fish supply in the Bandung region (3 million people). The World Bank has invited ICLARM to collaborate in a similar project in Orissa, India. In 1989, ICLARM and its Indonesian collaborators published a series of extension booklets on reservoir fish production systems developed through this project. ICLARM is keen to develop this field of work beyond studies of resettlement aquaculture and fisheries into a broader look at culture-based fisheries in natural and artificial waterbodies and their true potential for improving the nutrition and livelihood of disadvantaged peoples.

In the Philippines, ICLARM and FAC/CLSU convened in November a Workshop on Environmental Impact of Golden Snail (*Pomacea* sp.) on Rice Farming Systems. This snail, an exotic species introduced to the Philippines, is having serious effects on over 400,000 ha of rice lands.

As with the genetic activities, ICLARM plans to develop a modest independent research unit to undertake and coordinate strategic research and training in integrated farming systems. A proposal is being developed to build this unit at the Asian Institute of Technology (AIT), Bangkok. Its main on-station research activities will be to study and model nutrient/energy/cash flow in integrated crop-livestock-tree-fish systems and the socioeconomic and environmental impacts of their implementation. Policy studies will also be linked to this work and to the work of collaborators in a network mode.

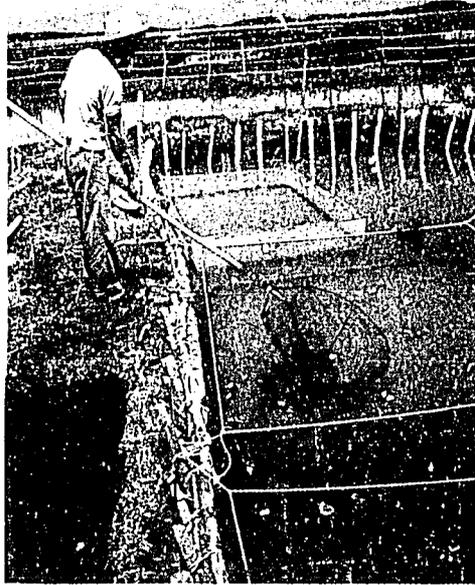
ICLARM and the International Food Policy Research Institute (IFPRI) plan to commence collaborative studies in aquaculture policy in 1990.

Coastal Aquaculture Centre

ICLARM's Coastal Aquaculture Centre (CAC) is situated near Honiara, Solomon Islands. Construction began in 1986 and most of the work is focused primarily on the development of farming systems for giant clams.



Nile tilapia (*Oreochromis niloticus*), a species of worldwide importance in tropical aquaculture - here shown at an experimental sewage-fish project in Peru.



Small-scale tilapia hatchery at Pililla, Rizal Province, Philippines. The swim-up fry are scooped from the breeding ponds and held in simple hapas for buyers.



Chinese and Indian major carps are very important species in polyculture systems. Dr. Roger Pullin displays a bighead carp (*Aristichthys nobilis*) at Laguna de Bay, Philippines.



The produce of simple aquaculture systems and culture-based fisheries are frequently sold by women in local markets; here in the tropical Terai region of Nepal.

At the year's end, completed buildings included the hatchery/laboratory, houses for the Hatchery Manager and the Director, cottages for the Foreman and Deputy Foreman, a set of four small chalets and a processing facility. Additionally, extensions to the power house have provided further storage space and a carpentry workshop. An enclosed store area for diving equipment was added under the main hatchery/laboratory building. A 12.5-kva diesel generator provides general power supplies and two small freshwater pumps supply potable water from a spring which emerges on site.

The primary pumping facility at the CAC is a newly installed stainless steel 100 mm pump powered by a diesel motor. Backup pumps consist of one 50 mm and one 100 mm diesel powered pumps. Sea water is drawn from the edge of the adjacent reef and is then passed through 80 mm PVC pressure pipes mounted 2-3 m above ground to a variety of circular fiberglass (4), vinyl (4) and ferrocement (10) tanks, used variously for broodstock holding and spawning, larval culture and settlement of spat. Four of the ferrocement tanks were added during the year. Additionally, a total of sixteen raceways have been constructed for use as giant clam nurseries. The raceways are simple troughs constructed (in thirteen cases) of 5.6 m of "Canvacon" fabric fitted between four sections of coconut logs on a sandy base to give a tank of 5.0 x 1.0 x 0.3 m. The tanks are very inexpensive to construct. Three raceways constructed of cheaper fabrics rapidly deteriorated and are being replaced.

Some improvements and additions were made to the hatchery/laboratory building during the year. The 12-m² patio/conference area was enclosed to provide additional office space giving a total area of 65 m² of general office space, plus the small (7.3 m²) air-conditioned computer room and scientific laboratory (14.6 m²). Wooden work benches were added to the wet laboratory on the ground floor of the laboratory/office building which has sea water reticulation, two 1.6 m³ fiberglass larval culture tanks and a small array of aquaria.

An Information Centre was completed in time for the CAC's "Open Day" on 7 October. The Information Centre features posters about giant clams, aquaculture and ICLARM and has an 820-liter seawater aquarium with displays of various species of giant clams, colorful coral reef fish and invertebrates. An outdoor "touch tank" contains turtles, large *Tridacna gigas*, other tridacnids, trochus, green snails and various reef curiosities. The Information Centre was funded by a grant from the New Zealand External Aid Division.

A small processing building, funded by ODA/BDDP, has recently been completed at the CAC, and will serve to meet the CAC's commitment to giant clam product development. The building has a comprehensive array of processing equipment including refrigerators, freezers, cooker, microwave, mincers, slicers and kitchen ware. A smoking and drying kiln will be installed in January.

Significant additions made to the inventory of scientific and technical equipment during the year included the new stainless steel pump and two UV-sterilizers, all of which were funded by a grant from the British High Commission in Honiara. A Suzuki 4-wheel drive station wagon was purchased to supplement the CAC's single Land-Rover pick-up truck.

CAC research progress

The CAC's *Tridacna gigas* broodstock spawned 14 times during the course of the year. Additionally, one cohort of *Hippopus hippopus* was reared. Spawning was often spontaneous, but inducers such as intragonadal injections of 2 mM serotonin, the addition of suspensions of frozen freshly spawned eggs (egg water) and/or macerated gonad to the spawning tanks, heat stress and changes in water level were also routinely used.

Following the completion of the planned first phase of development of the CAC, emphasis was placed on larval rearing methods. Parts of the February and March cohorts were fed with Frippak "booster" micro-encapsulated diet, to attempt to eliminate the need for the setting up of axenic algae cultures or unreliable phytoplankton blooms. These gave encouraging results in terms of growth but initial feed concentrations used caused considerable fouling problems and high mortalities especially when used without antibiotics.

Subsequently, a 50:50 mix of freeze-dried *Tetraselmis suecica* and Frippak microcapsules was used. Successive experiments proved conclusively that this particular artificial diet can be used for mass rearing *T. gigas* larvae. The cost of the larval feeding regime is around US\$50.00 per cohort, which is negligible in relation to other operating costs and the costs of axenic cultures of live algae. A paper has been prepared for publication detailing the results of these experiments.

Departures from previously-accepted larval rearing methods have included keeping pediveligers in vinyl-lined outdoor larval-rearing tanks through metamorphosis until 2-3 weeks old and maintaining the feeding regime until large numbers of symbiotic zooxanthellae were visible in the juvenile clams. In the past, pediveligers have been stocked into settlement tanks prior to metamorphosis but this has prevented accurate monitoring of the survival through metamorphosis or any accurate estimate of settlement success. By holding the larvae in the larval rearing tanks until 1 week after metamorphosis, much better estimates of survival can be obtained. It appears that 10-30% of 2.5-week-old juveniles will survive to 1-2 mm size at about 2 months. If the survival is thus known it is possible to stock 2-3-week-old juveniles at densities that will not lead to serious stunting of juveniles at a later date.

Attempts to further refine food mixes and rearing techniques will be continued. However, with the larval and early juvenile rearing techniques now used at the CAC, even a bimonthly spawning regime will provide more 1-2 mm juvenile clams than can be stocked in the tanks currently available at the CAC.

The land-based nursery stage was the most problematical area of the operations of the CAC during 1989. Owing to very high losses in this stage only three cohorts totaling about 38,000 *Tridacna gigas* juveniles in the 2-20 mm size range were present in the settlement tanks and raceways at the end of the year. The major limiting factors at the nursery stage appear to be the density of clam settlement and competitive algal growth within the tanks. Very high settlement densities (>5,000/m²) have been attained but this resulted in stunting of the clams at approximately 3 months postspawning. If left at these densities, the clams remained stunted and eventually died off in mass mortalities. An

optimum density of 1,000-2,000/m² appears to be supported by our observations. This conforms with estimates made by other research groups.

Severe overgrowths of juvenile clams by a fine, dark turf of blue-green algae, predominantly composed of a species tentatively identified as *Microcoleus lyngbya*, caused severe losses in the 10-20 mm stages. Investigations therefore concentrated on developing the most effective methods for the removal of these algae from the culture tanks, including the use of a variety of grazers, manual cleaning and the use of algicides. A combination of various species of rabbitfish, surgeon fish and salt-water acclimated tilapia (*Oreochromis mossambicus*) proved to be effective in controlling algal overgrowths in the nursery stages and the problem appeared to have been resolved by the end of the year.

Various experiments were also executed during 1989 to try to maximize the use and effectiveness of the nursery tanks. These have included attempts to optimize water depth, flow characteristics and flow rates within tanks and raceways, assessments of optimum density of clams per unit area. Experiments on the addition of various fertilizers to improve growth and allow higher densities of clams to be cultured are continuing.

There are currently eight cohorts of juvenile *T. gigas* and one of *Hippopus hippopus* in ocean nurseries situated at the CAC and at 12 other locations around the Solomon Islands as part of the village-based trials. The oldest cohorts will be moved to grow-out sites in the early part of next year. A variety of ocean nursery types and cage designs are being tested, including floating nurseries and a large (75 m²) intertidal pond. The most cost-effective cage design so far has been a simple cement and chicken wire cage which is easily constructed with locally available materials. Growth and survival rates for juvenile clams varied greatly between ocean nursery sites. To date, the best growth has been achieved in shallow sites (1 m) which are thoroughly flushed with oceanic seawater by tides and currents but are not exposed to significant wave action. Losses have been severe in many of the tested habitats and by the end of the year only about 6,000 juveniles were alive, about half of these in the village-based ocean nurseries.

Invertebrate predators of juvenile clams, particularly gastropods, have been studied in both the field and aquaria and it is expected that the results obtained will represent a significant advance in the knowledge of this aspect of giant clam farming. Experiments are in progress to attempt to assess the effects of density, handling, substrate and ocean nursery regime on growth and survival in juvenile clams.

A relational database for tracking the history and disposition of cohorts of giant clams through the hatchery, nursery, ocean nursery, growout and harvest stages is nearing completion. The database is designed to permit the rapid evaluation of the precise history of any batch of clams, irrespective of the number of times they have been subdivided or recombined. Environmental factors, identities of predators and other pertinent information are monitored. Stocking densities, survival rates, mean sizes and growth rates are automatically computed on a continuing basis. The database design is adaptable to almost any cultivated organism and we expect to be able to release it for the use of other groups by the middle of 1990. The software used is "Dataease", a

very versatile program which is also being used for development of ICLARM's "Interactive Database on Tropical Fisheries Resources Management" (see p. 82).

Work on the feasibility of coral reef fish ranching started in the latter half of the year. Current work is concentrated on making an inventory of species of potential interest and on a tagging study which will give information on the relative range of movement of species of potential interest.

CAC institutional linkages

The Coastal Aquaculture Network (CAN) was formally created in 1988. Membership is now comprised of the thirteen institutions participating in the "Giant Clam Research Group" plus over 100 individuals. Two issues of the newsletter "Clamlines" were published during the year. Interested parties have been contacted in the Caribbean and the Pacific in connection with the creation of a "Reef Ranching Research Group" and the group will be formally launched early next year.

Links with the South Pacific Commission's (SPC) Inshore Fisheries Research Project were strengthened by the secondment of ICLARM scientist Paul Dalzell to the SPC at the beginning of the year. Close liaison is maintained with the Forum Fisheries Agency, particularly in matters connected with coral reef fisheries.

Training

Training continued to be a major part of the Program's activities. In genetics, Dr. Ambekar Eknath and Norwegian colleagues from AKVAFORSK led the training efforts. The First Training Workshop on Quantitative Genetics of Farmed Tilapias was held from 29 October to 6 November at FAC/CLSU. This included lectures on quantitative genetics, instruction in microcomputer methods for Philippine collaborators and analysis of a large dataset from first generation tilapia performance trials.

In Malaŵi, Dr. Costa-Pierce was appointed Associate Professor in the Department of Biology, University of Malaŵi. He designed and implemented with Dr. Reg Noble (a University staff member seconded to the ICLARM-GTZ project) a revised Freshwater Biology course and assisted with the Department's growing undergraduate curriculum in Fisheries Biology. He also worked on proposals to offer Tropical Aquaculture Science and Fish Biology courses in 1990. Nine upper-level undergraduates took the Freshwater Biology course. With help from the staff, equipment and transport of the ICLARM/GTZ project, limnological/fisheries expeditions were made to the high altitude Mulunguzi Dam, the lowland eutrophic lakes Chilwa and Chiuta, and the oligotrophic Lake Malaŵi. Students gained practical experience in water quality, biological, and fisheries techniques and data analysis and a

reader was assembled by Drs. Costa-Pierce and Noble which will be refined into a report in 1990.

Dr. Costa-Pierce also trained 4 M.Sc. students in microcomputer techniques, applied statistics, data analysis water quality, and modern biochemical methodologies. By the end of the year, all M.Sc. student thesis data, statistical analyses, and manuscripts were computerized. A Malawian student was supported in M.Sc. aquaculture studies at the Asian Institute of Technology, Bangkok and one Malawian counterpart, assigned to ICLARM-GTZ from the Malawi Fisheries Department, was trained to coordinate the project's growing collaborative water quality and pond dynamics research program.

In Farming Systems Research and Extension (FSR/E) Training, Dr. Clive Lightfoot and other ICLARM staff contributed to the 4-month FSR/E training course held at IRRI. The trainees came from all over Asia. The other principal lecturers came from the International Institute of Rural Reconstruction (IIRR). This course is an annual event. ICLARM, IRRI, IIRR and possibly other centers such as the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) and the Centro Internacional de la Papa (CIP) will be involved in the future. The course may transfer from the Philippines to Thailand in 1991.

In response to the shortage of aquaculture and fisheries scientists in the South Pacific Region the CAC now provides supervision and course work for graduate students of the University of the South Pacific. Mr. Toata Molea is the first of the CAC's Scientific Assistants to be enrolled. He is jointly supervised by Drs. J.L. and P.E. Munro and by Dr. Alison Haynes of the University of the South Pacific.

Mr. Felipe Viala from the Fisheries Division, Fiji and Mr. Hestoni Aloua from the Tonga Fisheries Division spent two weeks at the CAC in July studying the CAC's hatchery, nursery and ocean nursery methods. Their travel and accommodation costs were funded by the FAO South Pacific Regional Aquaculture Development Project.

Dr. J.L. Munro spent two weeks of July teaching part of a summer course on "Coral reef fish and fisheries" at the Discovery Bay Marine Laboratory of the University of the West Indies, Jamaica.

The UK Overseas Development Administration's environmental promotional film "Planting a Future" has been released. The film was produced by David Bellamy Associates and features the work of the Coastal Aquaculture Centre and two other ODA environmental projects in the Cameroons and Kenya. A highlight of the film was the CAC's village-based ocean nursery at Ghulavu, Guadalcanal. Fifty copies of the film have been ordered by the South Pacific Regional Environmental Program for distribution to schools and colleges throughout the region.

Advisory Services

Program staff provided a wide range of services: advising national, regional and international bodies; editing for scientific journals; and reviewing of grant proposals for donor agencies.

Dr. Roger Pullin assisted the Philippine Department of Agriculture and National Economic and Development Authority on the prioritization of aquaculture research and development needs and options and served on the panel advising an FAO/UNDP project on possible fish introductions to Papua New Guinea. Dr. Pullin also joined in discussions of the Working Party on Research Priorities for Aquaculture Development, under the World Bank's Study on International Fisheries Research and remains a member of the Aquaculture Working Party of Experts in Aquaculture of the Indo-Pacific Fisheries Commission of FAO. Dr. Pullin took over from Dr. Daniel Pauly as the ICLARM contact person for IUCN.

Program Plans

Plans were continued for more international conferences including the Third International Symposium on Tilapia in Aquaculture (ISTA III) to be held in Côte d'Ivoire in 1991 and a Bellagio conference on Third World Aquaculture Development and the Environment, to be held in 1990. ICLARM is also on the International Organizing Committee for the first Asian Farming Systems Research and Extension Symposium - "Sustainable Farming Systems in 21st Century Asia", to be held in Bangkok in 1990.

Research for the development of integrated farming systems is being planned for West Africa, East India and Vietnam. For West Africa, new proposals include an expansion of collaborative activities with the Institute of Aquatic Biology, Ghana, to gather information and model the real scope for growth of small-scale aquaculture; in Côte d'Ivoire, preliminary discussions were held with the West African Rice Development Agency (WARDA) and the Institut des Savannes (IDESSA), Bouaké, for future collaboration on the integration of agriculture and aquaculture.

ICLARM is beginning collaboration with IRRI and the Indian Council of Agricultural Research (ICAR) in farming systems work in East India funded by the Ford Foundation and IFAD to develop, evaluate and refine methodology for ecosystems analysis and farming systems research for rainfed environments. A training resource book for agroecosystem mapping prepared by IRRI is to be followed by IRRI-ICLARM resource books on farming system diagnosis and farmer participatory experiments for integrated farming. Participatory experiments will focus on the integration of fish into rice-based systems. Mapping techniques will be developed to look at extrapolation of these integrated farming systems.

In Vietnam, IRRI and ICLARM are developing proposals for a farming systems research and training program with the National Institute of Agricultural Science (INSA) and Cantho University. The purpose is to develop research and training instruments for the integration of rice, fish

and other enterprises into new, more profitable farming systems. ICLARM will be providing expertise in aquaculture and farming systems.

In the South Pacific, major broodstock collecting expeditions will be mounted during the 1989-1990 monsoon season with the objective of doubling the CAC's stock of broodstock clams.

Dr. Russell Parry of the London-based Overseas Development Natural Resources Institute (ODNRI) will be attached to the CAC for three months, starting in January and will work on the storage qualities of giant clam mantle and adductor muscle, production of dried adductor muscle and the effects of various cooking and storage techniques on flesh quality. An ICLARM consultant will investigate aspects of the market for fresh and dried "kaibashira" (bivalve adductor muscle) in Japan and Southeast Asia in April and May.

The new UV-sterilizers and the expected excess supply of juvenile clams will permit the CAC to start supplying fully-quarantined 21-28-day-old juvenile clams to hatcheries in areas where *T. gigas* has become extinct or nearly so. Preliminary experiments have shown adequate survival of juveniles in sealed oxygen-filled bags over 3-4 days.

Investigations will be made of the role of different strains of zooxanthellae in the growth and survival of juvenile *T. gigas* and further experimentation will take place on the use of various artificial diets for larval rearing. An array of small Canvacon-lined raceways will be constructed to facilitate experimentation.

There will be a strong emphasis on solving problems of maximizing spat production during the 2-20 mm nursery stage. This area was the main constraint on the maximization of production from the Coastal Aquaculture Centre during 1989. Subject to the outcome of a grant proposal, the numbers of hatchery tanks, settlement tanks and raceways at the CAC will be trebled during 1990.

The ocean nursery system will be greatly expanded in size during 1990 to accommodate the increased numbers of spat which are currently moving through the nursery system. This will include the creation of a CAC-controlled ocean nursery system, probably in the Western Province of the Solomon Islands and the testing of floating "catamaran" ocean nurseries. Funding for this work has been confirmed by the Skaggs Foundation.

Subject to the success of a funding proposal to the EEC's Science and Technology for Development Programme, a major genetics project will be launched in mid-year in collaboration with the University College, Galway, of the National University of Ireland, aimed at selective breeding from broodstock with favorable characteristics (particularly growth), the development of homozygous strains of giant clams by self-fertilization and the creation of triploid stocks.

Accumulated data on the costs of operation and construction of the CAC's giant clam hatchery, in relation to production rates, will be subjected to economic analyses and a "Manual of Methods for the Cultivation of Giant Clams" will be prepared and published during the year.

Funding will be sought to expand the work on the potentialities for coral reef fish ranching. Current work is concentrated on making an inventory of species of potential interest and studies of their relative range of movement.

The Coastal Aquaculture Network (CAN) will be expanded and consideration will be given to the formation of additional research groups and the formation of linkages with other institutions concerned with tropical marine aquaculture.

Meetings Attended, Papers Presented

Third Provisional Governing Council Meeting, Network of Aquaculture Centers in Asia, Bangkok, Thailand, 10-13 January. (A.E. Eknath)

The Second Asian Fisheries Forum, Tokyo, Japan, 17-22 April. (M. Ahmed, M.P. Bimbao, B.A. Costa-Pierce, C.R. dela Cruz, A.E. Eknath)
Papers presented:

Agüero, M. and M. Ahmed. Economic rationalization of fisheries exploitation through management: Experiences from the open-water inland fisheries management in Bangladesh.

Bimbao, M.P., A.V. Cruz and I.R. Smith. An economic assessment of rice-fish culture in the Philippines.

Costa-Pierce, B.A., C. dela Cruz, O. Soemarwoto and B. Sudiharto. Improved traditional hatchery technology for common carp (*Cyprinus carpio* L.) in West Java, Indonesia.

dela Cruz, C.R. Fish culture trials in rice fields in North Sumatra, Indonesia.

Eknath, A.E. and R.W. Doyle. Repeatability of relative size of individuals under communal stocking: Implications for size-grading in aquaculture.

Eknath, A.E. A review of carp genetics research and possible approaches to genetic improvement of major Asian carps.

Zainal, S., P. Effendi, B.A. Costa-Pierce, H. Hadikusumah, Iskandar and Rusydi. The aquaculture resettlement option in the Saguling reservoir, Indonesia - its contribution to an environmentally oriented hydropower project.

South Pacific Forum Fisheries Committee. Annual Meeting. Majuro, Marshall Islands, 25-28 April. (J.L. Munro)

Fifth International Integrated Aquaculture Systems Course, Woods Hole, MA, U.S.A., 26-31 May. (B.A. Costa-Pierce)

Papers presented:

Costa-Pierce, B.A. Integrated reservoir management through the development of aquaculture and fisheries.

Costa-Pierce, B.A. ICLARM's activities and networks related to integrated farming.

Ruddle, K. and B.A. Costa-Pierce. Aquaculture development in and challenges of technology transfer to Malawi, Africa.

Final Seminar on the Resettlement of the Population of Saguling and Cirata through the Development of Fisheries and Aquaculture, Bandung, Indonesia, 19-20 June. (B.A. Costa-Pierce)

Paper presented:

Soemarwoto, O. and the Saguling-Cirata consulting team, including ICLARM staff members B.A. Costa-Pierce, C.R. dela Cruz, H. Lampe and J.L. Munro. 1989. Rencana pengelolaan situ Saguling dan situ Cirata untuk Pemukiman Kembali Penduduk Melalui Pengembangan perikanan. (Management plan for the Saguling and Cirata Reservoirs for resettlement through the development of fisheries. Institute Lembaga Ekologia, Padjadjaran University, Bandung, West Java, Indonesia, 46 p. In Bahasa Indonesia.

Technical Consultation on Aquaculture and Human Nutrition. ALCOM, NORAD/FAO Workshop, Maseru, Lesotho, 5-8 June. (J.D. Balarin)

SAARC Workshop on Fish Seed Production, Mymensingh, Bangladesh, 11-12 June. (M.V. Gupta)

Consultative Meeting Among Regional Organizations and Agencies Executing Aquaculture and Related Development Programmes, Bangkok, Thailand, 21-22 June. (M.P. Bimbao)

Workshop Methods to Promote Aquaculture in Rural Development

- (ALCOM/FAO-SIDA), Chipata, Zambia, 10-14 July. (J.D. Balarin and B.A. Costa-Pierce, observers)
- Experiential Learning Workshop in Farming Systems Diagnosis, Ranchi, Bihar, India, 10-15 July. (C. Lightfoot)
- Paper presented:
Lightfoot, C. Systems diagnosis of farmers' problems.
- Farming Systems Research and Extension Skills Course, IRRI and IIRR, Los Baños, Philippines, 24 July-13 October. (A.A. van Dam, C.R. dela Cruz, C. Lightfoot, R.C. Sevilleja and R.S.V. Pullin)
- Papers/handouts presented:
dela Cruz, C.R. and R.C. Sevilleja. Case study on rice-fish farming.
van Dam, A.A. Analyzing large sets of biological rice-fish production data with the multiple linear regression techniques.
Edwards, P., R.S.V. Pullin and J.A. Gartner. 1988. Research and education for the development of integrated crop-livestock-fish farming systems in the tropics. ICLARM Studies and Reviews 16, 53 p. International Center for Living Aquatic Resources Management, Manila, Philippines.
Lightfoot, C. Participatory on-farm experiments.
Lightfoot, C. Agroecosystems analysis methods.
Lightfoot, C. The FSR/E concept of complementarity
Lightfoot, C. The FSR/E concept of systems
Lightfoot, C. Skills in systems thinking
- Science Literary Forum of the National Academy of Science and Technology, Metro Manila, Philippines, 27 July. (R.S.V. Pullin)
- Paper presented:
Pullin, R.S.V. A response to Dr. Rafael Guerrero's address on leading edges in the Philippine aquaculture sector.
- South Pacific Commission. Regional Technical Meeting on Fisheries. Noumea, New Caledonia, 6-13 August. (M.H. Gervis)
- Sustainable Agriculture for the Uplands Workshop, IIRR, 25 August-7 September. (C. Lightfoot)
- Paper presented:
Lightfoot, C. Agroecosystems mapping: a tool for workers on sustainable agriculture.
- Third Advisory Committee Meeting on Aquaculture for Local Community Development Programme (ALCOM/FAO-SIDA), Maseru, Lesotho, 5-8 September. (B.A. Costa-Pierce, observer)
- Working Party on Research Priorities for Aquaculture Development; World Bank Study on International Fisheries Research. Paris, 5-8 September. (M.N. Agüero, T.-E. Chua, R.S.V. Pullin)
- South Pacific Forum Fisheries Agency. Tenth Anniversary Meeting. Honiara, Solomon Islands, 18-23 September. (J.L. Munro)
- UNESCO CDS/ISIS Introductory Course: Lilongwe UNESCO Office, Lilongwe, Malawi, 22 September. (C.B. Jenya)
- Workshop on Experiments in New Approaches to Improved Management of Open-Water Fisheries in Bangladesh, Dhaka, Bangladesh, 24-26 September. (M.V. Gupta)
- Twentieth Asian Rice Farming Systems Working Group Meeting, Puncak, Bogor, Indonesia, 2-6 October. (C.R. dela Cruz)
- Paper presented:
dela Cruz, C.R. Progress Report on collaborative rice-fish research.
- 9th Annual Farming Systems Research and Extension Symposium, University of Arkansas, USA, 8-11 October. (C. Lightfoot)
- Papers presented:
Harrington, L., P. Hobbs, T. Pokhrel, B. Sharma, S. Fujisaka and C. Lightfoot. The rice-wheat pattern in the Nepal Terai: Issues in the identification and definition of sustainability problems.

- Second Asian Regional Workshop on Rice-Fish Farming Systems Research and Development, CLSU, Nueva Ecija, Philippines, 23-27 October. (M. Ahmed, M.P. Bimbao, C.R. dela Cruz, A.A. van Dam, M.V. Gupta, C. Lightfoot, R.S.V. Pullin)
 Papers presented:
 Ahmed, M., M.P. Bimbao and R.C. Sevilleja. The economics of rice-fish in Asian mixed farming systems - a case study.
 van Dam, A.A. and C.R. dela Cruz. Problems in rice-fish on-station research.
 Lightfoot, C., B.A. Costa-Pierce, and A.A. van Dam. What's happening to the rice yields in rice-fish systems.
 Sevilleja, R.C., A.G. Cagauan, E.A. Lopez, C.R. dela Cruz and A.A. van Dam. Component technology research in rice-fish systems in the Philippines.
- First Training Workshop on Quantitative Genetics of Farmed Tilapias, CLSU, Nueva Ecija, Philippines, 29 October-6 November. (B. Acosta, A.E. Eknath, M. Palada, R.S.V. Pullin, R. Recometa)
- National Experts Workshop on Farming Systems Research, SEARCA, Los Baños, Philippines, 6-8 November. (C. Lightfoot)
- Workshop on "Environmental Impact of Golden Snail (*Pomacea* sp.) on Rice Farming Systems in the Philippines", CLSU, Nueva Ecija, Philippines, 9-10 November. (B.O. Acosta, M. Ahmed, M.P. Bimbao, C.R. dela Cruz, A.A. van Dam, R.S.V. Pullin)
- Fourth Workshop of the IDRC Aquaculture Genetics Network in Asia, Singapore, 17-18 November. (A.E. Eknath)
- Twenty-Second Meeting of the Council of Southeast Asian Fisheries Development Center, Singapore, 21-24 November. (A.E. Eknath)
- Symposium on "Economic Perspective on Fisheries Management", Manila, Philippines, 27 November. (M. Ahmed, M.P. Bimbao)
- UNESCO CDS/ISIS Software: Training Course for Users: Chancellor College, Zomba, Malawi, 4-8 December. (C. Jenya)
- Australian Centre for International Agricultural Research. Workshop on the Biology and Exploitation of Baitfish. Honiara, Solomon Islands, 11-13 December. (J.L. Munro)
- First Meeting of the Governing Council of the Network of Aquaculture Centres in Asia and Pacific, Dhaka, Bangladesh, 11-14 December 1989. (M.V. Gupta)

Publications and Consultancy Reports

- Costa-Pierce, B.A. and R.S.V. Pullin. 1989. Stirring ponds as a possible means of increasing aquaculture production. *Aquabyte* 2(3):5-7.
- Costa-Pierce, B.A., M.P. Bimbao, S. Zainal and P. Effendi. 1989. ICLARM and south-south technology transfer: Philippine aquaculture technology and Indonesia. Part 2. *Naga, ICLARM Q.* 12(1):14-16.
- Costa-Pierce, B.A., Rusydi, A. Safari and G.W. Atmadja. 1989. Culture of common carp in floating net cages. *ICLARM Educ. Ser.* 7, 42 p.
- Costa-Pierce, B.A., Rusydi, A. Safari and G.W. Atmadja. 1989. A small-scale hatchery for common carp. *ICLARM Educ. Ser.* 8, 42 p.
- Costa-Pierce, B.A., Rusydi, A. Safari and G.W. Atmadja. 1989. Growing fish in pen systems. *ICLARM Educ. Ser.* 9, 40 p.

- Costa-Pierce, B.A., G.W. Atmadja, Rusydi and A. Safari. 1989. Growing fish in cages. ICLARM Educ. Ser. 10, 43 p.
- Costa-Pierce, B.A., H.Y. Hadikusumah and Y. Dhahtyat. 1989. Tilapia (*Oreochromis* sp.) and carp (*Cyprinus carpio*) production in cage systems in West Java, Indonesia, p. 84-96. In E.A. Huisman, N. Zonneveld and A.H.M. Bouwmans (eds.) Aquacultural research in Asia: management techniques and nutrition. Centre for Agricultural Publishing and Documentation, Pudoc, Wageningen, The Netherlands.
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- Cuenco, M.L. 1989. Aquaculture systems modeling: An introduction with emphasis on warmwater aquaculture. ICLARM Stud. Rev. 19, 46 p.
- IOE/ICLARM. 1989. Development of aquaculture and fisheries for resettlement of families from the Saguling and Cirata Reservoirs. Volume 1. Executive Summary and Management Plan, 50 p. Volume 2. Main Report, 400 p. Volume 3. Main Report, Appendices 1-18, 150 p. Consultancy Reports submitted to the State Electric Public Corporation, Ministry of Mines and Energy, Government of the Republic of Indonesia, Jakarta. Institute of Ecology, Padjadjaran University and the International Center for Living Aquatic Resources Management.
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- Munro, J.L. 1989. Development of a giant clam management strategy for the Milne Bay Province: A report to the Department of Fisheries and Marine Resources of the Government of Papua New Guinea. ICLARM South Pacific Office Report. 29 p. plus 6 annexes.
- Munro, J.L. 1989. Fisheries for giant clams (Tridacnidae: Bivalvia) and prospects for stock enhancement. p. 541-558. In J. Caddy (ed.) Marine invertebrate fisheries: their assessment and management. John Wiley and Sons, New York.
- Munro, J.L. 1989. An evaluation of progress of the Inshore Reef Fishery Assessment and Monitoring Project. Report to the Government of Tonga. Joint ICLARM/South Pacific Commission Report. 25 p.
- Munro, J.L. and C.M.T. Gervis. 1989. Giant clam bibliography: 1985-1989. *Clamlines* 7:3-10.
- Pullin, R.S.V., Editeur. 1988. Ressources genetiques en tilapias pour l'aquaculture. ICLARM Conference Proceedings 16, 129 p. Edition française 1989, traduite par Catherine Lhomme-Binudin. Centre international de gestion des ressources aquatiques vivantes, Manille, Philippines.
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van Dam, A.A. 1989. An example of the potential application of modeling in aquaculture: Production of *Oreochromis niloticus* in rice fields (Appendix), p. 36-46. In M.L. Cuenco. Aquaculture systems modeling: an introduction with emphasis on warmwater aquaculture. ICLARM Stud. Rev. 19, 46 p.

Aquaculture Program Project Summaries

- Project Title** : Network of Tropical Aquaculture Scientists (NTAS)
- Duration** : Continuous from July 1987
- Key Personnel** ICLARM : Ms. Mary Ann P. Bimbao (Network Secretary)
: Dr. Roger S.V. Pullin (Aquabyte Editor)

Objectives

- To enhance communication between aquaculture scientists working in the tropics, especially in genetics, integrated agriculture-aquaculture farming systems and coastal aquaculture of tropical molluscs.
- To facilitate increased output by these scientists by assisting in information and database searches, research methods, data analysis and interpretation, and publishing a newsletter at regular intervals.

Results

The continuing applications to join the NTAS indicate the great need for this network, especially for developing-country members, who comprise approximately 79% of the total membership.

The NTAS continues to serve as a mechanism for information exchange among members on recent progress in aquaculture and current research activities. The NTAS newsletter, Aquabyte, provides a vehicle for members to write about their work, including short scientific papers. The network also helps members by answering requests for literature searches and sends out free reprints selected from the Aquabyte Information Section when these cannot be obtained from the authors.

A detailed report on NTAS appears on p. 20.

Project Title	:	Transfer of Asian Aquaculture Technologies to Africa
Duration	:	Continuous from 1988
Cooperating Institutions	:	Centre Technique Forestier Tropical (CTFT), Ecole Nationale Supérieure Agronomique de Toulouse (ENSAT)
Key Personnel	France	: M. Jean-Marie Travers, Multilateral Division, Ministry of Foreign Affairs, Jerome Lazard, CTFT; Dr. Jacques Moreau (ENSAT)
	ICLARM	: Dr. Roger S.V. Pullin; Ms. Catherine Lhomme-Binudin; Mr. John D. Balarin; Ms. Mary Ann P. Bimbao

Objectives

- To examine the scope for application of Asian aquaculture principles and practices in Africa.
- To prepare and distribute information relevant to African aquaculture development, especially for Francophone African countries.
- To foster interregional cooperation between Africa and Asia for the benefit of aquaculture research and development.

Results

ICLARM is taking a cautious approach to the application of Asian aquaculture principles and practices in Africa. The first prerequisite is information. Asian aquaculture, unlike that in Africa, has developed in an environment of settled, productive agriculture; well-established traditions of water management; acceptance of fish husbandry as means of food production; and buoyant markets for cultured fish with the rise in human populations and the stasis or decline of capture fisheries. Through this project, supported by the French Government, a thorough study of African farming systems and their socioeconomic context is being made, leading to ways in which Asian aquaculture technologies can be modified and applied in appropriate African contexts.

The first activity of this project is to acquire and disseminate relevant information on these topics and in particular to consider the needs of Francophone African countries.

The translation of *Tilapia Genetic Resources for Aquaculture*, edited by R.S.V. Pullin, ICLARM Conference Proceedings 16, 1988 was completed in 1989. It is a key work for African aquaculturists to appreciate the need to conserve wild genetic resources and to use them wisely. It is being distributed widely in Francophone countries. Other translations are in progress.

In addition to these large translation tasks, the African page in 'Aquabyte', the newsletter of ICLARM's Network of Tropical Aquaculture Scientists (NTAS), appears in French as well as in English through this project.

Parallel to ongoing translation and information distribution work, the ICLARM staff involved in this project are now establishing closer ties with aquaculture research and development groups in Francophone African countries. Following the signature in November 1988 of an agreement between ICLARM and the Ivoirian Ministry of Scientific Research to hold the Third International Symposium on Tilapia in Aquaculture (ISTA III) in Côte d'Ivoire in 1991, Aquaculture Program Director, Dr. Roger S.V. Pullin and Ms. Catherine Lhomme-Binudin travelled to Abidjan in October 1989 to start the organization of the Symposium with the Centre de Recherches Océanographiques, an Ivoirian research center associated with ORSTOM.

In 1989, the French government through its Fond d'Aide et de Coopération (FAC) offered a contribution of about US\$30,000 to ICLARM for the organization of ISTA III. This Symposium will afford a major opportunity for African aquaculturists to discuss their work with Asian counterparts; the proceedings will be conducted and published in French and English.

- Project Title** : Genetic Improvement of Farmed Tilapias (GIFT)
- Cooperating Institutions** : The National Freshwater Fisheries Technology Research Center of the Philippine Bureau of Fisheries and Aquatic Resources (NFFTRC/BFAR); the Freshwater Aquaculture Center of the Central Luzon State University (FAC/CLSU); the Marine Science Institute of the University of Philippines (UPMSI); the Institute of Aquaculture Research of Norway (AKVAFORSK) through the Norwegian Centre for International Agricultural Development (NORAGRIC/NORAD); the Asian Development Bank (ADB); and the United Nations Development Programme-Division for Global and Interregional Projects (UNDP/DGIP).
- Duration** : April 1988 to June 1991
- Key Personnel**
- | | |
|-------------------------------|--|
| NFFTRC/
BFAR | : Mr. Melchor Tayamen; Mr. Ruben A. Reyes; Mr. Hermogenes Tambalque; Mr. Marlon A. Reyes; Ms. Jodecel Casayuran; Ms. Edna Dionisio |
| BFAR
Satellite
Stations | : a. Freshwater Demonstration Farm, Sto. Domingo, Bay, Laguna — Mr. Orlando F. Comia |
| | b. Freshwater Fish Farm, San Mateo, Isabella — Mr. Mario Aquino |
| | c. La Trinidad Fish Farm, Benguet — Mr. Jesus Astrero |
| | d. Freshwater Fish Farm, Bambang, Laguna, — Ms. Angelina Tolentino, Ms. Eunice Villanueva |
| FAC/
CLSU | : Mr. Tereso A. Abella; Mr. Antonio V. Circa; Mr. Hernando Bolivar; Ms. Remedios Bolivar |
| UPMSI | : Dr. Julie M. Macaranas; Ms. Maria-Josefa R. Pante ¹ ; Ms. Carmen Ablan; Ms. Liza Agustin |

¹Currently studying for a Master's degree at the University of Houston at Clear Lake, USA.

AKVAFORSK : Dr. Trygve Gjedrem; Dr. Hans B. Bentsen; Dr. Bjarne Gjerde; Dr. Terje Refsle

ICLARM : Dr. Ambekar E. Eknath; Dr. Roger S.V. Pullin; Ms. Josephine B. Capili²; Ms. Ravelina Recometa; Ms. Marietta Palada; Ms. Belen O. Acosta

Objectives

The project focuses on Nile tilapia *Oreochromis niloticus*, the tilapia species with the greatest immediate potential for aquaculture in Asia and elsewhere.

The primary objectives are to produce better breeds of tilapia by selection for high growth rate and other economically important traits as and when appropriate and to provide such fish to national and regional testing programs and from thence to fish farmers. This will be accomplished with the following specific and sequential objectives:

- Documentation of tilapia genetic resources in Asia and Africa and establishment of a collection of promising strains from new importations from Africa and from existing Asian cultured stocks.
- Evaluation of new African germplasm along with existing cultured stocks in the Philippines in different culture systems and under various agroclimatic conditions.
- Selective breeding using promising strains and strain crosses (base population).
- Distribution of genetically-improved fish through national broodstock distribution channels and testing programs and finally to fish farmers.
- Dissemination of information and training of personnel from various national and regional institutions, through a series of training workshops and regional workshops.
- Formulation of plans and policy guidelines for effective genetic management of cultured stocks and establishment of national breeding programs.
- Defining methods and approaches to fish genetic improvement from this work with tilapia for application to other species.

Results

The year began with excellent responses from both the ADB and UNDP/DGIP to the first extended progress report submitted in March 1989. To strengthen the efforts of ICLARM and its collaborators, the UNDP/DGIP approved its support to the project through 1991. The project research plan was circulated for critical comments to twenty-five internationally recognized aquaculture geneticists actively involved in

²Currently studying for a Master's degree at the University College of Swansea, Wales, UK.

tilapia genetics research in Belgium, Canada, Federal Republic of Germany, Ghana, India, Israel, Thailand, UK and USA. It was well received and widely endorsed. As a result, the project established linkages with eighteen research institutions. Areas of cooperation include collection and shipment of African tilapia germplasm, documentation of wild and cultured stocks of tilapias, collaborative research and information exchange.

Collection of Germplasm

The second shipment of tilapia germplasm (collected during the first series of expeditions to Egypt, Sénégal and Ghana, May-October 1988, and temporarily held at the University of Hamburg, Federal Republic of Germany), arrived in the Philippines on 9 March 1989. To augment heavy mortality in the earlier shipment of Egypt founder stocks, a second expedition to Egypt was successfully accomplished in August 1989. It was carried out in collaboration with Mr. Toby Adamson (EEC project on Marine Biology, Suez Canal University), Dr. Samir Ghoneim (Fish Research Center, Suez Canal University) and Prof. Wolfgang Villwock (Zoologisches Institut und Zoologisches Museum, University of Hamburg). This new Egypt founder stock arrived in the Philippines without mortality and will be available for testing during the project's second generation experiments.

Lake Turkana (Kenya) germplasm also arrived in the Philippines in August 1989. This Kenya founder stock comprises first generation progeny of parental stocks collected from the wild by Mr. Rene Haller, Baobab Farms, Mombasa, Kenya. Progeny will be used in comparative evaluations as soon as possible.

All new importations, as in the previous year, were held in a completely isolated quarantine facility at the NFFTRC/BFAR complex for a minimum period of three months. The project has been collaborating with the BFAR-International Development Research Centre of Canada (IDRC) Fish Health Unit in developing effective quarantine procedures. The rigorous quarantine procedures followed in the project for periods ranging from three to seven months could serve as a model in the region and elsewhere.

Completion of Facilities

Construction of a Tilapia Germplasm Reference Collection Center at the NFFTRC/BFAR complex was completed on schedule in April 1989. This self-contained facility comprises seven units of twin holding tanks (14 tanks) measuring 1.5 x 10 m for holding founder stocks; seven units of twin tanks (14 tanks, 1.5 x 5.0 m) for replacement stocks; three units of twin quarantine tanks (6 tanks, 1.5 x 1 m); a sump pond for treatment of tank effluents, a deep well and a water pump. The eight African and Philippine strains are already housed in this complex.

The renovation of a similar indoor unit at the FAC/CLSU campus was also completed and the tanks here were also used to house founder stocks.

At the NFFTRC/BFAR Complex, renovation of a laboratory unit was completed for project activities and equipment.

At UPMSI, equipment for isozyme analyses and morphometric studies was installed. Computers were installed in the three Philippine collaborating institutions. However, further upgrading of computer capacity will be needed to handle the large datasets being generated.

Genetic Characterization of Strains

Following reassessment and standardization of buffer and staining systems currently in use at UPMSI, genetic characterization of the seven African and Philippine strains commenced during the second quarter of 1989. Three sets of markers were used to detect genetic differences between the seven strains: isozyme markers, which are indices of single-gene differences at electrophoretically detectable loci; morphometric and meristic characters, which provide discriminating indices based on size and shape analyses of fish; and mitochondrial-DNA markers which directly indicate differences in nucleotide sequences, thus providing a finer detailed picture of the genetic structure of the strains.

Preliminary investigation of fifteen enzyme systems and two protein markers, hemoglobin and muscle proteins, resulted in successful resolution of 31 loci. Observed heterozygosity values over the 31 loci for each strain ranged from 0.002 to 0.022 with mean value of 0.01. A dendrogram (see Fig. 1) constructed from Nei's Genetic Distance (D) values revealed three separable groups at the subpopulation level: a cluster of Philippine strains; the Egypt strain; and a grouping of the

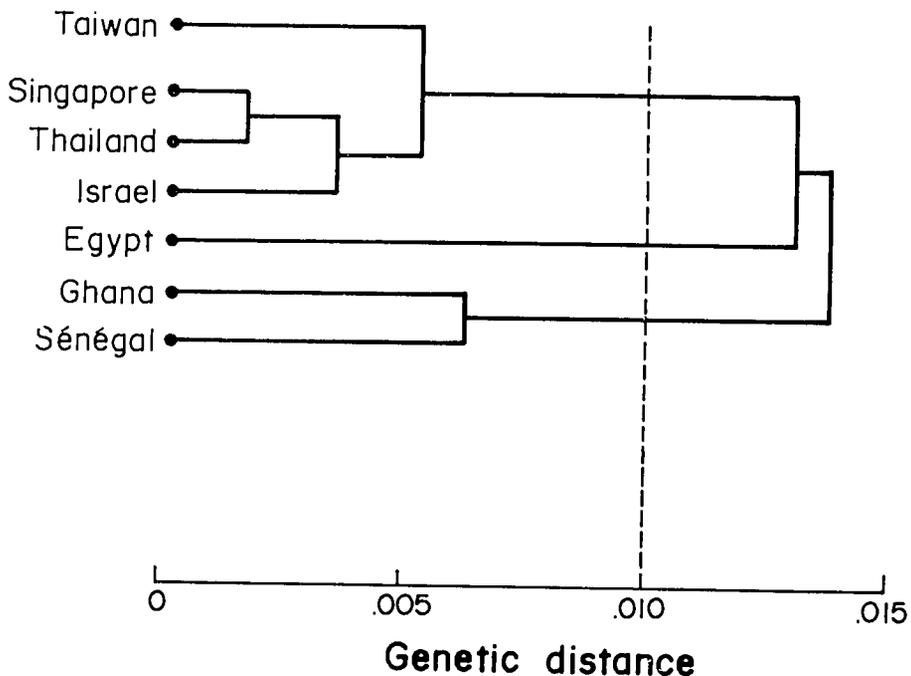


Fig. 1. Genetic characterization of African and Philippine strains: dendrogram constructed from Nei's Genetic Distance shows three separable groups at subpopulation level - a cluster of Philippine strains; the Egypt strain; and a grouping of Ghana and Sénégal strains.

Ghana and Sénégal strains. The results show a surprising genetic stability across strains and may lead to interesting insights on the evolutionary genetics of these strains.

Isolation of mtDNA from liver, gonad and muscle was encouraging. Further standardization of techniques is in progress. Characterization of strains after cleavage of mtDNA with restriction enzymes is being carried out.

A computerized approach to document shape differences between the seven strains was carried out. An array of 25 morphometric and 5 meristic characters of 350 individuals were measured and counted, respectively, to detect discriminating markers between the strains. Analysis of these data is in progress.

First Generation Growth Comparison Trials

After an initial delay caused by the late arrival of first founder stocks from Sénégal and Ghana and heavy mortality of the first Egypt founder stock, the first generation experiments commenced in March 1989, according to the revised workplan agreed upon in January 1989. Procedures were standardized for controlled mating, large-scale individual tagging and large-scale recording of ancestry, hatching data, growth rate and survival. Four BFAR satellite stations, representing different agroclimatic zones and tilapia farming systems, were identified as field testing units.

In addition to the six strains available for testing, progeny from the few surviving breeders of the first Egypt founder stocks were produced and included during this first generation strain evaluation. The results for the Egypt strain should therefore be regarded as preliminary because of inbreeding.

Genotype X Environment Interaction

The primary objective of the first-generation pure strain evaluation experiment, successfully carried out from March to November 1989, was to determine the magnitude of genotype X environment interaction - a most important step in making decisions pertaining to national breeding programs. This study was carried out in 11 different test environments representing various tilapia farming systems and different agroclimatic conditions. The general approach was to rank the seven strains based on their growth, survival and reproduction performance in each of the eleven environments.

During the second week of March 1989, single-pair mating (25 breeding pairs from each strain) was done in 175 1-m³ hapas installed in seven separate breeding ponds. Collection of fry was done in batches to control size and age effects. During July and August, 11,400 individuals were tagged with modified Floy fingerling tags and distributed to the 11 test environments for testing using communal stocking. Regular sampling was carried out every 21 days. During each sampling, a total of 18 traits on each individual was recorded.

Preliminary data analysis was carried out during the first Training Workshop detailed below.

The results of the first generation pure strain evaluation studies indicate that:

- there are highly significant differences between the growth performances of the seven strains tested;
- with the apparent exception of the Ghana strain, the *wild* African strains performed far better than the established 'domesticated' Philippine strains presently used by fish farmers;
- the most widely cultured strain in the Philippines, locally known as the 'Israel' strain, is *not* the best locally available strain;
- there was little or no change in the ranking of the seven strains among environments, except in one environment where growth of all strains was severely depressed due to low temperatures (see Table 1). This is perhaps the most encouraging and significant result obtained. It means there is very little or no genotype X environment interaction - a tremendous boost to plans for developing an 'all-purpose' genetically improved Nile tilapia breed for tropical developing countries that wish to farm this species. It also indicates that the total gene action realizable through *additive genetic variation* in the strain that will be eventually released for culture will be there to be expressed to whatever degree the new farm environments allow, except where very adverse conditions are found.

Table 1. Relative ranking of 7 African and Philippine strains based only on final harvest size in 10 different test environments representing various tilapia farming systems and agroclimate conditions.

Strains	BFAR	FAC	Cages (without feeding)	Cages (with feeding)	Agricultural residues	Rice-fish	SMD*	LTRIN*	LosB*	BAY*
African "wild"										
Egypt	1	1	3	1	1	1	1	1	2	1
Ghana	7	7	4	6	7	6	7	3	2	7
Sénégal	5	3	1	4	4	1	6	2	1	4
Philippine 'domesticated'										
Israel	4	5	4	5	5	5	5	6	6	5
Singapore	6	6	7	-	6	7	4	4	7	6
Taiwan	2	2	2	2	2	3	2	6	2	3
Thailand	3	3	2	3	3	4	3	4	2	2

* BFAR Satellite Stations: SMD - San Mate Fish Farm; LTRIN - La Trinidad Fish Farm; LosB - Freshwater Fish Farm, Bambang, Laguna; BAY - Freshwater Demonstration Farm, Sto. Domingo, Bay, Laguna.

In the words of Prof. E.W. Shell of Auburn University, the UNDP/DGIP Consultant appointed to observe the first training workshop, "... this [the project objectives and performance so far] is the most exciting and potentially the most worthwhile tropical aquaculture genetics research effort anywhere in the world... the exacting experimental designs and the statistical techniques developed in this project will probably be described in standard genetics and statistics textbooks".

Training

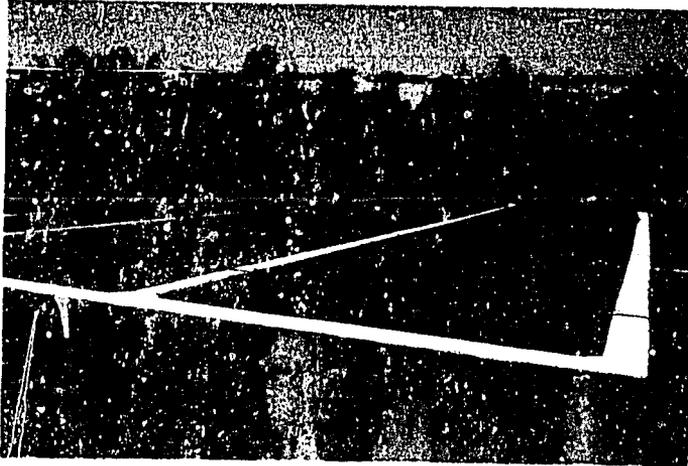
Training of project personnel from the Philippine collaborating institutions has been a major component of this project. Training during

1989 involved hands-on experience in management of large databases using microcomputers; introduction to several software packages such as Lotus, dBaselll, SPSS and SAS; designing experimental procedures to estimate genetic parameters; and scientific report writing. At UPMSI, training was focused mainly on multivariate statistical techniques, and population genetics techniques to characterize the diverse strains of tilapia. Three graduate students, working towards their M.Sc. (aquaculture) degree at the College of Inland Fisheries, CLSU, are presently involved in the project. Research topics directly related to the project have been identified and their theses are expected to be submitted by June 1990.

The First Training Workshop on Quantitative Genetics was held at FAC/CLSU from 30 October to 4 November 1989. Thirty participants from the collaborating institutions and other regional organizations and university groups joined the workshop. This workshop was a combined introduction to quantitative genetics and selective breeding and a thorough review of the project activities by the staff involved. Plenary discussions on special topics and group work were also included. The active participation of the invited observers was very encouraging and may initiate further cooperative research activities.

Other Project Related Work

In addition to the main project experiments, several project-related complementary experiments, principally on methodology, were carried out by the staff of collaborating institutions. The titles of these studies are as follows: (a) effects of sampling frequency on the growth and maturation of Nile tilapia; (b) evaluation of different types of external tags for individual identification of Nile tilapia; (c) phenotypic correlations between growth and reproduction traits of seven African and Philippine Nile tilapia strains; (d) evaluation of spawning efficiency and the quality of progeny of fed and unfed Nile tilapia breeders; (e) growth performance of seven tilapia strains under separate and communal rearing; (f) number of caudal fin bars as an indicator of growth and reproduction potential of Nile tilapia; (g) comparative analysis of genotype X environment interaction of seven African and Philippine Nile tilapia strains under relatively 'stressful' and 'unstressful' environments; (h) repeatability of relative growth rate of individuals under communal stocking; (i) growth performance of five strains of Nile tilapia fry fed mixed phytoplankton supplemented with high protein formulated diets; and (j) growth and reproduction performance of Lake Turkana (Kenya) Nile tilapia in raceways and pond environments.



Concrete tanks at the Tilapia Germplasm Reference Center, built for this project at the Bureau of Fisheries and Aquatic Resources, National Freshwater Fisheries Training Research Center, Muñoz, Nueva Ecija, Philippines. African and local tilapia strains are kept here as a 'live gene bank' for research to develop improved breeds.

An Egyptian fisherman Mr. Said with tilapia in a trap net during the project's Second Germplasm Collection expedition to Egypt in August 1989. The location is Sweet Water Canal, Ismailia.



A battery of over 500 tilapia breeding hapas used during the genetic improvement project.

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); Institut für Meereskunde at Kiel University (IfM)
Duration	:	1986 - 1990
Key Personnel		
	ARO	: Dr. Gerald L. Schroeder; Dr. Giora W. Wohlfarth; Dr. Ana Milstein; Dr. Gideon Hulata
	T/IIT	: Prof. Yoram Avnimelech; Dr. Shoshana Mokady
	IfM	: 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 developing countries for monitoring and increasing yields in fishponds, especially in those fed with organic residues and agricultural by-products.
- 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 developing countries.
- To develop diagnostic techniques, kits and instrumentation.
- To train scientists from developing countries in these techniques.

Results

ICLARM's main role in this subproject is collaboration with project researchers in the analysis and interpretation of aquaculture datasets by multivariate techniques.

In 1989, the bulk of the work in this subproject was performed by Mr. Mark Prein, who spent much time on the painstaking task of standardizing and preparing for analysis the large dataset assembled

from 1986 to 1988 in Israel and the Philippines. It was expected that this work and the ensuing analysis, which will identify and quantify key physical and biological variables relevant to production in agriculture ponds, would be completed in 1989, but the amount of work needed to get to the analysis stage was underestimated.

The present plan is that by mid-1990, a first report (in the form of Mr. Prein's doctoral thesis, which is being supervised by Dr. Daniel Pauly) will be completed, with the subsequent preparation of a book for publication and wide distribution in developing countries.

The book in question will be jointly coedited by Mr. Mark Prein (senior editor), Drs. Gideon Hulata and Daniel Pauly, each of whom represents one of the three key institutions that cooperated in this project. The book will be copublished in the ICLARM Studies and Reviews series by ARO, BMZ and ICLARM.

The key contributions to be included will present and discuss multivariate analyses of tilapia growth and production data from production farms in Israel, and tilapia growth experiments from Israel, Peru, Philippines, and Zambia, thus covering a wide range of conditions and environments in three developing regions.

The book will contain about 300 pages and include an Appendix describing data diskettes to be made available separately and which will enable readers to perform their own analyses of the data collected by project staff. The book will cover:

- comparisons of classical and multivariate analyses of aquaculture production data;
- data requirements and data preparation for multivariate analyses;
- country- and location-specific case studies.

The following major results and generalizations will be extracted from the cases studied:

- Identification of environmental factors and management interventions that are crucial and/or beneficial in tropical and subtropical tilapia culture
- Identification of major problems in multivariate analyses applied to aquaculture;
- Hardware and software requirements for multivariate analyses;
- Step-by-step approach for implementation of multivariate analyses.

Detailed indices, glossaries, etc. will complete the volume.

It is expected that this document will become a key reference for culture researchers in developing and developed countries alike. Textbooks and/or manuals for application of multivariate analyses to aquaculture have been missing to date in spite of: (i) the fact that aquaculture experiments generate an immense amount of suitable data, and (ii) the wide availability of suitable hard- and software.

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

Cooperating Institutions : Agricultural Research Organization (ARO), Israel; Zoologisches Institut und

Zoologisches Museum, University of Hamburg (HU); Institute of Aquatic Biology (IAB), Achimota, Ghana.

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; Dr. Eddie Kofi Abban
	ICLARM	: Dr. Roger S.V. Pullin; Dr. Ambekar E. Eknath; Ms. Josephine B. Capili

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.

During 1989, the close collaboration of ICLARM with the ARO (Dor Station) of Israel, the University of Hamburg, and the Institute of Aquatic Biology (IAB) of Ghana was continued. A result of this was that IAB and ICLARM signed on 19 December 1989 a Memorandum of Agreement. This will facilitate further collaboration, provide help to IAB staff through ICLARM's information services and assist IAB with approaches to donor agencies likely to support its further development.

ICLARM's role during 1989 was largely supportive, in information exchange and provision of technical advice. Dr. Pullin visited Ghana in October and discussed plans for future development of IAB's Akosombo Research and Development Center (ARDEC) and possible funding sources. IAB still lacks the substantial funding needed to turn ARDEC into the fully operational research and training facility that it could and should become. In discussions at IAB, Dr. Pullin was given summaries of the needs of IAB for full development of its HQ and of ARDEC. Dr. Pullin also visited the Institute of Renewable Natural Resources, University of

Science and Technology (UST), Kumasi, and its new aquaculture 'complex' - a small area of ponds on the campus and a small laboratory building under construction with some EEC support. The facilities will be mainly used for training and fry production. There is a problem with high levels of iron in the water. Iron-floc precipitates may clog the gills of tilapia and stunt their growth.

A French translation of the Proceedings of the Workshop on Tilapia Genetic Resources for Aquaculture, 23-24 March 1987, Bangkok, Thailand (the holding of which was sponsored by the subproject) was produced in October 1989 and distributed by means of a grant to ICLARM from the Multilateral Division of the French Ministry of Foreign Affairs (see p. 107). The full reference is:

Pullin, R.S.V., Editeur. 1988. Ressources genetiques en tilapias pour l'aquaculture. ICLARM Conference Proceedings 16, 129 p, Edition Française 1989, traduite par Catherine Lhomme-Binudin, Centre international de gestion des ressources aquatiques vivantes, Manille, Philippines.

Plans for 1990 include a visit by Dr. R.S.V. Pullin to IAB in February-March for a proposed 'minisymposium' and invitations to geneticists Dr. Eddie Kofi Abban (IAB), Dr. Gideon Hulata (ARO) and Prof. W. Villwock (Hamburg) to participate in ICLARM's Asian Regional Workshop on Tilapia Genetic Improvement, to be held in August in the Philippines.

- 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**
- | | | |
|----------|---|---|
| FAC/CLSU | : | Prof. Ruben C. Sevilleja; Dr. Rodolfo G. Arce |
| IRRI | : | Dr. Virgilio R. Carangal; Dr. Nimal Ranaweera |
| ICLARM | : | Dr. Catalino de la Cruz; Mr. Anne A. van Dam; Dr. Clive W. Lightfoot; Dr. Roger S.V. Pullin |

Objectives

- To establish collaborative research on rice-fish farming among 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 IRRI 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.

Results

Significant results both positive and negative have been achieved. A brief summary of these is presented in order of the project objectives.



On-farm testing of a pond refuge in concurrent rice-fish culture in Central Luzon, Philippines.

Collaborative Research

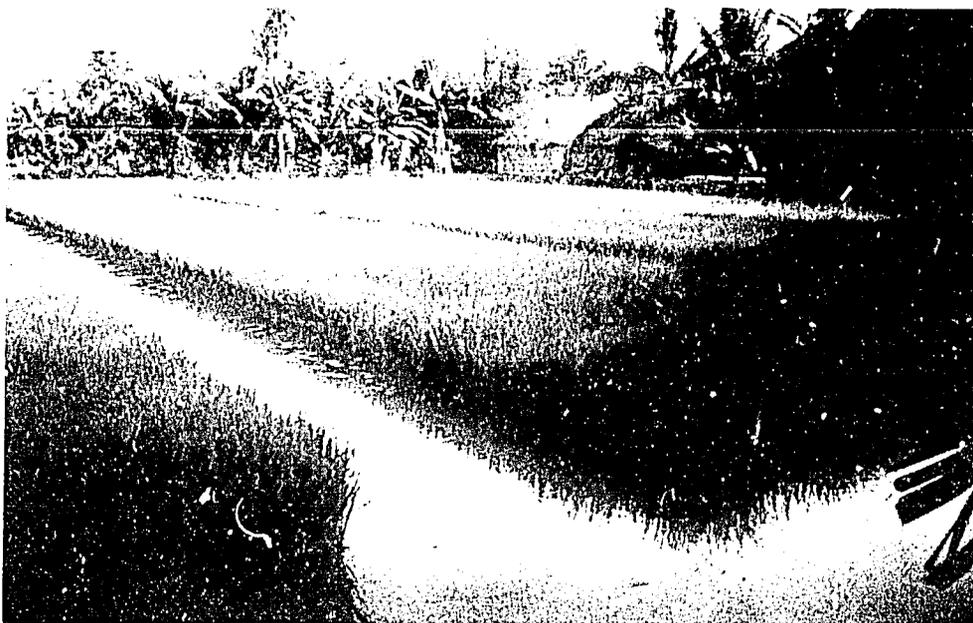
Cooperation between ICLARM, FAC/CLSU, IRRI and national rice-fish research programs within the IRRI-based Asian Rice Farming Systems Network (ARFSN) generated several collaborative projects in India, Indonesia and Thailand. The ADB-funded IRRI/Indian Council of Agricultural Research (ICAR) deepwater rice-fish Technical Assistance Project in India exchanged information and technical advice with the project team. Similarly, projects funded by the International Foundation for Science (IFS) in Malaysia and China allowed the team to monitor their rice-fish research results. As a result of the project's work, the Republic of Korea has initiated a rice-fish research program.

Methods for Rice-Fish Research

Standard pond techniques in sampling fish for growth studies were found unsuitable for on-station rice-fish experiments. Alternative methods are being developed.

Farmer participation techniques for assessing resource endowments and allocations prior to design of on-farm tests have been developed to sharpen the design of on-farm tests, to ensure a focus on most important field problems, and to make technology appropriate to farmers' circumstances.

Apart from the usual analysis of variance (ANOVA) used for data from replicated, randomized experiments, more techniques for experimental data analyses have been demonstrated. Multiple-regression techniques have been applied to cross-site and season analysis of rice-fish experimental data for the detection of fish growth-limiting and



Large trenches of the rice-fish systems on farms in the Mekong Delta, Vietnam.

promoting factors. Researchers are being encouraged to use other applicable techniques such as multivariate statistics in observational studies, modelling and simulation.

Options for Integrated Rice-Fish Production

Integrated rice-fish farming is more profitable than rice monoculture. Preliminary annual cost and return analyses of rice-fish culture in the Philippines, Indonesia and Thailand show that higher net income can be obtained from rice-fish culture than from rice monoculture. Increases in net returns over rice monocropping occurred in all situations. The range of increases was, however, very wide. Intensive systems in Indonesia and Thailand gave returns of as high as 252% and 821%, respectively, while trench systems in the Philippines only returned 10%. Except in the Philippines, net returns over rice alone exceeded 100%.

Reappraisal of the concurrent trench refuge system for rice-tilapia culture in the Philippines showed that the system is too risky. Trenches 50 cm wide and 40 cm deep are too small. Water does not last through the (often delayed) irrigation schedules. Fingerlings of 5-10 g cannot be grown out to marketable size concurrently with short-duration rice crops.

The limitations of the trench refuge to produce market-size fish have led to a modified refuge system, consisting of a small pond (about 10% of the rice-fish plot and 1 m deep) connected to the ricefield. Initial comparison between the trench refuge and pond refuge systems in rice-fish culture favors the latter in terms of fish and rice production and water quality. With a pond refuge, net return in the Philippines improved to about 40% and could be improved further.

Small fishponds on irrigated and rainfed rice farms, whether isolated from the paddy fields or connected to them, can be a highly productive asset for the farmer. The small pond can be: a "pond refuge" for fish that forage for part of their growth period in the paddy field; a pond for breeding or nursing fish; a location for holding fish after rice harvesting, thus resulting in higher production and larger-size fish; and a means of accumulating and stocking small fingerlings (5-10 g). Such pond refuges allow great flexibility in integrated rice-fish farming; coupling rice and fish production cycles as and when appropriate and decoupling them to suit different culture cycles when such flexibility is required.

Rotational multiple rice and fish cropping systems in irrigated paddies were found risky in areas of the Philippines with limited supply of water (i.e., during the second or dry season rice crop). Alternating rice-fish during the dry season discourages farmers. A modified cropping pattern that fits such conditions will consist of one wet season of concurrent rice-tilapia farming, using a pond refuge for extended culture of tilapia for up to two months immediately following the rice harvest. In parts of Indonesia, where water is available year-round, many systems are successful. An example is the annual cropping sequence: rice+fish - fish - rice+fish - fish.

On-station component technology research to improve rice and fish culture compatibility was also conducted. The border method of rice planting, the use of livestock manure with inorganic fertilizers, and the potential of fish as biological control agents for rice pests were tested.

The border method of planting and the use of fish in the biological control of rice pests indicated some positive but still variable results. These need further investigation.

Use of farm livestock manure (5.0 to 7.0 t/ha/crop) in combination with inorganic fertilizer in concurrent rice-fish culture showed that the manure is more favorable for the fish than for the rice crop. A useful fertilization technique that takes care of both rice and fish in the system can be developed from this information, although the long-term effect of manure on rice yields still warrants further investigation.

The growth performance of Indonesian Majalaya carp (*Cyprinus carpio*) under Philippine conditions showed positive results in concurrent and rotational rice-fish systems. In concurrent rice-fish culture, carp stocked at 5-8 g had recovery as high as 100% with only three out of 18 plots showing fish recovery below 50%. With inorganic fertilizers appropriate to rice culture, the highest average gross and net yields (104 and 84 kg/ha) and weight gain of 0.74 g/day were obtained at 3,000 carp/ha. With chicken manure, 4,000 carp/ha gave the highest gross and net yields (149 and 120 kg/ha) with weight gain of 0.61 g/day. In rotational rice-fish culture, carp weighing 42-61 g were restocked after the rice harvest. After 30 days, the average gross and net fish yields were 326 and 189 kg/ha, respectively, with weight gains of 2.16 g/day in the treatment fed with rice bran and corresponding values of 278 and 116 kg/ha with weight gain of 1.21 g/day in the cattle manure treatment. These values are comparable with production values from Indonesia.

Compared to the tilapia experiments with animal manure and all other rice-fish experiments with tilapias (*Oreochromis niloticus*), common carp (both "local Philippine" and Indonesian Majalaya strains) showed better growth and survival. In Indonesia, recent results showed that the

efficiency of nutrient uptake by rice has improved in the fields stocked with common carp. Although common carp is less preferred than tilapia in the Philippines, this information may improve its production and acceptance. Filipino farmer cooperators indicated that they are willing to raise common carp if they are fast growing and beneficial to rice.

Filipino farmer rice-culture adoptors, cooperators, and rice-fish culture nonadopter groups have indicated satisfaction with the demonstrable benefits of rice-tilapia technology. Nonadoptors have reasons such as unsuitable soil texture and locations too far from their houses to prevent poaching.

Experiments in India, Thailand, Indonesia and the Philippines confirmed tilapia, common carp and silver barb as the most appropriate species for rice-fish systems.

Information Exchange and Training

Information on rice-fish farming has been shared not only among project collaborators, but also with other agencies and institutions in China, the Republic of Korea and FAO. Workshops have provided major fora for information exchange. The First Asian Regional Workshop on Rice-Fish Farming Research and Development held in Ubon, Thailand, March 1988, reviewed the state of the art of rice-fish farming and planned future research and methodologies for on-station and on-farm research. Participants came from Bangladesh, Bhutan, China, India, Indonesia, Lao People's Democratic Republic, Malaysia, the Philippines and Thailand. Representatives from the Asian Institute of Technology (AIT), IDRC, ADB, the Canadian International Development Agency (CIDA), the United Kingdom Overseas Development Administration (UK/ODA), and Care International also attended. A second Asian Regional Workshop at CLSU in October 1989, brought together again many of the same institutions and individuals and additional participants from Madagascar, Nepal, the Republic of Korea and Vietnam. It addressed issues in research and extension methods including credit schemes for rice-fish farmers and was opened by the Philippine Secretary for Agriculture, the Honorable Carlos Dominguez.

The project has trained farmers and scientists in rice-fish culture in the Philippines and Indonesia. Fifty-three Filipino farmers visited the CLSU station and farm sites and a scientist from the Republic of Korea received a 3-month training in rice-fish culture. In Indonesia, farmers were briefed on rice-fish technology at the Sukamandi Research Institute for Food Crops in March 1989. Project staff contributed the rice-fish component to IRRI's Farming Systems Research and Extension Training held from July to October 1989.

Factors Promoting Rice-Fish Farming in Asia

There are many areas in Asia where current conditions for rice-fish culture development are favorable. There is increasing adoption of the technology in Indonesia and Thailand with involvement of governments and NGOs. The government of Indonesia has announced a plan to

expand rice-fish farming in West Java by 20,000 ha and in North Sumatra by 2,500 ha. In Thailand, the Canadian Agency for International Development (CIDA) has provided support for rice-fish development in six northeast provinces. The Thai Department of Fisheries has a target to train 480 farmers per province this year and to contact a total of 2,000 farmers per province. In addition, the Department of Agriculture has a policy to extend rice-fish farming in all 17 provinces of northeastern Thailand.

This Asia-wide project also coincides with a growing consciousness of the need for more cost effective and judicious pest control in rice farming to limit detrimental ecological effects. Intensified cropping and chemical inputs have degraded many irrigated rice ecosystems. Growing rice and fish may facilitate the adoption of low chemical input Integrated Pest Management (IPM) practices.

Conclusion

The two-and-a-half year duration of the project has been insufficient to assess adequately different rice-fish systems and to see clearly the impact generated by early research results. More on-station investigations and more on-farm testing of promising systems are needed to enhance the prospects for large-scale implementation.

- Project Title** : Research for the Development of Tropical Aquaculture Technology Appropriate for Implementation in Rural Africa
- Cooperating Institutions** : Malaŵi Fisheries Department (FD); Bunda College of Agriculture and Chancellor College of the University of Malaŵi (UM); Ministry of Agriculture (MOA); National Research Council of Malaŵi (NRCM); Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ)/Malaŵi German Fisheries and Aquaculture Development Project (MAGFAD); Asian Institute of Technology (AIT)
- Duration** : Planning phase, November 1985-April 1986; Startup phase, May 1986-October 1986; Main project, November 1986-October 1989 (Extended to October 1991)
- Key Personnel**
- | | | |
|----------------|---|---|
| FD | : | Mr. Michael Kapaleta; Mr. Orton V. Msiska; Mr. Justin Mutambo; Mr. Brian B.A. Rashidi |
| UM-students | : | Mr. Godfrey Banda; Mr. Fredson J.K.T. Chikafumbwa; Mr. Amos Chikhadze; Mr. Daniel M. Jamu; Mr. Winston Kadongola; Mr. Emanuel Kaunda; Ms. Muyesoyo Kapalamula; Mr. Zakaria Magombo; Mr. Alfred O. Maluwa; Mr. Sloanes Chimattiro- Phiri |
| UM-staff | : | Mr. Sostan Chlota; Dr. Emmanuel Fabiano; Dr. Owen J.M. Kalinga; Dr. Benson F. Kandoole; Dr. Paul Kishindo; Dr. Elenemo Khonga; Mr. Jeremy S. Lkongwe; Dr. Graham Mills; Dr. Davis H. Ng'ong'ola; Dr. John Seyani; Dr. Martin Williams |
| MOA | : | Ms. Ruth Ayoade |
| GTZ/
MAGFAD | : | Mr. A. Janke |
| ICLARM | : | Mr. John D. Balarin; Dr. Barry A. Costa-Pierce; Ms. Chipo Jenya; Dr. Clive Lightfoot; Dr. Reg Noble; Dr. Roger S.V. Pullin |
| AIT | : | Dr. Peter Edwards; Mr. Aggrey J. Ambali |

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.
- To conduct basic research on-station in aquaculture pond dynamics, and associated fish yield characteristics using agricultural crop and natural plant residues available on small-scale farms in Malaŵi.
- To extend successful on-station results in integrated aquaculture-agriculture to small-scale farmers in Malaŵi and monitor the development of introduced innovations through involvement of farmers in participatory research using a farming systems research (FSR) approach.

Results

With the extension of the project through continued financial assistance from GTZ, office and research facilities were further upgraded at the Domasi Experimental Fish Farm (DEFF), 15 km north of Zomba, Malaŵi. Construction of three additional staff offices, a computer room, new library building, data bank, pond office, work shed, two storerooms, a new garage and Technical Assistant's house was completed and the Aquaculture Research Laboratory was upgraded. Additional research facilities constructed included 25 x 200 m² experimental ponds securely fenced, 4 x 500 m² nursery ponds, 50 breeding hapas plus 5 x 50 m² traditional demonstration ponds. The total research area for the station now comprises 6 ha with 105 pond units and 114 experimental tanks.

These additions to the DEFF facilities have substantially increased the project's capacity to carry out research and training. Moreover, Dr. Barry A. Costa-Pierce transferred from Indonesia in February 1989 to join the project as a Research Scientist, and became involved in research and in teaching at Chancellor College, UM, where he was appointed as an Associate Professor in the Department of Biology. Dr. Reg Noble, Lecturer in Biology at UM, was seconded to the project by ICLARM. The project now employs two Malaŵian Research Associates (both of whom are ex-ICLARM/GTZ-sponsored M.Sc. students), a Research Assistant (Information) and 30 support staff, and initiated an additional five M.Sc. research studentships beginning September 1989.

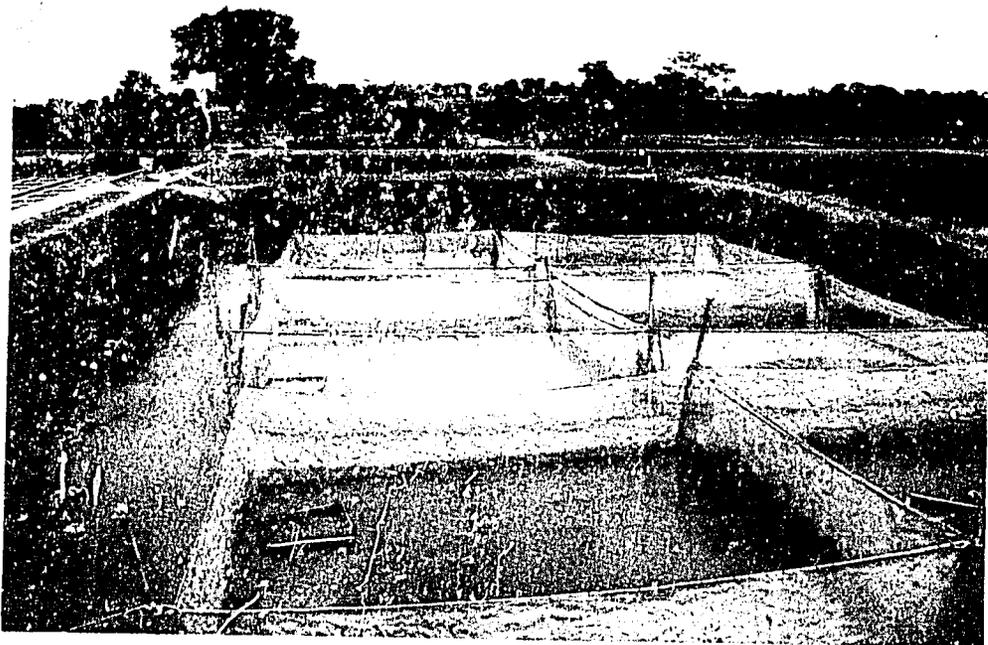
Collaboration with the UM was strengthened by further links with the newly-appointed University Research Coordinator, and by the

development of a Freshwater Biology Course at Chancellor College, with 14 students registered. The M.Sc. Research Assistantship scheme initiated in 1988 is rapidly becoming recognized as a valuable asset to the development of aquaculture in the whole Southern African Development Coordination Conference (SADCC) subregion. Over 60 applicants applied for the assistantships when these were advertised. Four students in Biology and one in Sociology have completed their work and will submit their theses to graduate in 1990. Four more candidates have now registered with the Biology Department of Chancellor College and one with Rural Development Department, Bunda College of Agriculture. All students will interact with ICLARM Visiting Scientists, Project Scientists, and ICLARM's new Farming Systems Research (FSR) Specialist, Dr. Clive Lightfoot. In February 1990, Mr. Anne A. van Dam, an Associate Expert seconded to ICLARM by the Ministry of Development Cooperation of the Government of the Netherlands will transfer to Malawi from the Philippines. He will undertake part of a newly initiated FSR program, initiate bioeconomic modelling research in collaboration with the UM and the FD, assist in the supervision of M.Sc. studies, and contribute to aquaculture teaching at the Bunda College of Agriculture, UM.

Of 21 collaborative research projects with the FD and UM staff and students, thirteen were completed, with eight more nearing completion (Table 1). ICLARM Affiliate Scientist Dr. Kenneth Ruddle visited in

Table 1. Reports of studies completed in 1989 in collaboration with the University of Malawi and the Malawi Fisheries Department, now in preparation for publication.

-
- Banda, G.A. 1989. An investigation of factors affecting the adoption of fish farming in a matrilineal social system: The case of the Zomba District. ICLARM/GTZ-UM Study Report. 22 p.
- Chikafumbwa, F.J.K.T. 1989. Studies on napier grass (*Pennisetum purpureum*) as a pond input for the culture of *Tilapia rendalli* (Boulenger) and *Oreochromis shiranus* ssp. (Boulenger). Dept. of Biology. 179 p. M.Sc. Thesis.
- Chiota, S. and Jenya, C. 1989. The potential of fishponds in bilharzia transmission. ICLARM/GTZ-UM Study Report.
- Jamu, D.M. 1989. Studies on ash as a liming agent in fishponds. Dept. of Biology. 188 p. M.Sc. Thesis.
- Kachala, F.F.C. 1989. Aquaculture bibliography of Malawi. ICLARM/GTZ-National Archives Study Report.
- Kadongola, W.K. 1989. Maize (*Zea mays*, Linnaeus) bran (madeya) as a supplemental food in the culture of juvenile *Tilapia rendalli* (Boulenger) and *Oreochromis shiranus* ssp. Dept. of Biology. M.Sc. Thesis.
- Kalinga, O.J.M. 1989. Fish farming in Malawi from the 1940's to the 1960's: A socio-economic study. ICLARM/GTZ-UM Study report. 53 p.
- Likongwe, J.S. 1989. Mechanisms of informal extension and the rate of innovation diffusion among small-scale fish farmers and non-fish farmers in Lilongwe, Dedza and Ntcheu Districts in Central Malawi. ICLARM/GTZ-UM Study Report. 82 p.
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Asian aquaculture technology used in African aquaculture research: hapas (net cages) at the Domasi Experimental Fish Farm, near Zomba, Malawi.



Malawian smallholder fishfarmers have a great need to improve the productivity and profitability of their farm enterprises. Integrated farming and good extension services will be crucial.

February and September 1989 to follow-up on research progress with the FD and UM collaborators and to finish work on a socioeconomic study of aquaculture in Malawi. Results of these studies will be presented at a conference now rescheduled for April 1990. A number of scientific articles are now in preparation (Table 1). During 1989, seminars were presented (Table 2) and a number of training programs were carried out (Table 3).

Results from scientific studies in 1989 show that most small-scale farmers with fishponds have a limited resource base from which to select pond inputs; consequently, pond foodwebs are nutrient-starved, and the more successful farmers rely on inputs from off-farm sources. Maize bran (madeya), a traditional fishpond input, was shown to be required at 2.5 to 5.0% of body weight per day for good growth performance of local tilapia species, (*Oreochromis shiranus* spp. and *Tilapia rendalli*). This rate of application is often limiting during the hot, wet months. However, during this period green grass is in abundance, and tests with napier grass (*Pennisetum purpureum*), presented whole, chopped or ground at 46 to 92 kg dry matter/ha/day, produced no significantly different fish yields to those achieved with madeya. The addition of green grass, however, affected water quality; in particular, lowering dissolved oxygen and pH. Aquatic composting of dry plant material at 100 kg dry matter/ha/day gave similar problems, but maize stover gave promising results. Low pH can be rectified by the single application of 0.75 to 1.50 t/ha of cooking fire as a liming agent, and the ash was found to have added value as a pond phosphate fertilizer. Stirring twice a week of pond sediments and grass residues with no additional inputs gave fish yields comparable to those achieved when fish received supplemental feeds. Stirring is being investigated further as a potential means of increasing the efficiency of nutrient conversion through pond foodwebs to cultured fish.

Surprisingly, the incidence of bilharzia-infected host snails in ponds was a low 20%, perhaps due to the strong social taboo of contaminating



Mr. Aggrey Ambali (left) is completing his studies for a Master's degree at the Asian Institute of Technology. He is soon to return to Malawi to assist aquaculture research and development using his research findings and experience of Asian aquaculture systems.

Table 2. Seminars and other talks presented in 1989 through the ICLARM/GTZ Africa Aquaculture Project in collaboration with the University of Malawi and the Malawi Fisheries Department.

	Topic	Venue
Mr. John D. Balarin	Crocodile Farming in Africa	National Fauna Preservation Society
Mr. Godfrey A. Banda	Methods of Data Collection in Socioeconomic Research: A Case Study of Fish Farming	University of Malawi, Sociology Department
Mr. Godfrey A. Banda	Family Organization in Matrilineal Societies: The Case Study of Aquaculture in Zomba District	University of Malawi, Sociology Department
Mr. Godfrey A. Banda	The Position of Fish Farming in Agriculture: A Historical View	University of Malawi, Sociology Department
Mr. Fredson J.K.T. Chikafumbwa	Effect of Different Presentation Methods of Napier Grass (<i>Pennisetum purpureum</i>) on Water Quality and Growth of Juvenile <i>Tilapia rendalli</i> and <i>Oreochromis shiranus</i> spp.	University of Malawi, Biology Department
Mr. Daniel Jamu	Effects on Water Quality and Juvenile fish (<i>Oreochromis shiranus</i> spp.) of Applying Various Common Dry Plant Materials as Aquatic Composts	University of Malawi, Biology Department
Mr. Winston K. Kadongola	Effect of Different Feeding Rates of Matze Bran (<i>Zea mays</i>) (madeya) on the Growth of <i>Oreochromis shiranus</i> spp. and <i>Tilapia rendalli</i> Reared in Polyculture in Ponds in Malawi	University of Malawi, Biology Department
Mr. Alfred O. Maluwa	Size at First Maturity, Fecundity, Gonadosomatic Index, Brooding Efficiency, and Length-Weight Relationship of <i>Oreochromis shiranus</i> spp. in Ponds	University of Malawi, Biology Department
Dr. Roger S.V. Pullin	New Centre for Research into Fish Farming in Africa	BBC World Service, London

Table 3. Training programs organized by the ICLARM-GTZ Africa Aquaculture Project in collaboration with the University of Malawi and the Malawi Fisheries Department.

Date	Topic	Participants	Instructor(s)
Jul 1988- Nov 1989	Integrated-Aquaculture Agriculture Systems including Fish Biology, Research Methodology, Water Quality and Computerized Data Analysis	5 M.Sc. students, Chancellor College UM	Mr. John D. Balarin Dr. Barry A. Costa-Pierce Dr. Reg Noble
Dec 1988- Oct 1990	M.Sc. in Aquaculture	1 M.Sc. student, Asian Institute of Technology, Bangkok	Dr. Peter Edwards
24-27 Jul 1989	Data Handling and Analysis, Thesis Write-up and General Introduction to Nutrition in Tilapia	1 M.Sc. student, Bunda College of Agriculture	Mr. John D. Balarin
27-29 Sep	Introduction to Fish Biology, Water Quality Pond Construction and ICLARM's Research Results	2 Fisheries Department Technical Assistants 2 Peace Corps Volunteers (GTZ/MAGFAD)	Mr. John D. Balarin Dr. Barry A. Costa-Pierce
27 Oct 1987	Introduction to Concepts of Integrated Fish Farming and ICLARM's Research Results	89 School Headmasters + Inspectors (Malawi Institute of Education)	Mr. John D. Balarin
4 Sep- 13 Dec 1989	Freshwater Biology Course, Biology Dept. Chancellor College, UM with Field Trips to L. Chiuta, L. Chilwa, L. Malawi, Mulunguzi Dam	5 M.Sc. students 1 Fisheries Department Technical Assistant 8 UM undergraduate students	Dr. Barry A. Costa-Pierce Dr. Reg Noble
Apr-Aug 1989	Training of a Librarian in Cataloguing, CDS/ISIS, Computerized Data Retrieval and ICLARM's SFIS	1 Research Assistant (Information)	Ms. Norma Jhocson
2-23rd May 1989	Orientation of Fisheries Department Librarians to Computerized Information Systems and ICLARM's SFIS	1 Professional Officer and 2 Technical Assistants	Ms. Norma Jhocson
15 Sep 1989	Rapid Resource Appraisal Techniques in Farming Systems Research	1 Professional Officer 2 Fisheries Department Technical Assistants 4 M.Sc. students 3 ICLARM staff	Dr. Clive Lightfoot

water with human excreta, a feature which also negates sewage-fish culture options. Ponds, however, are infested with snails, and trials are underway with traditional plants that contain molluscicides which are nontoxic to fish. Interestingly, this study revealed that some plants could also be used as fish stupefiers for fish harvesting.

Most farmers rely on extension staff to provide nets for harvesting and, therefore, ponds are cropped only once a year. Because of difficulties in storage of fresh fish, farmers usually sell a large portion of the catch. This is not a very flexible system and they could benefit from more variable harvesting options. Tests with traditional gears showed that hook and line or plunge baskets are very effective, and can provide a farmer with a means of intermittently harvesting fish as desired for sale or home consumption.

For the first time, *Oreochromis shiranus* were bred in hapas (net cages), and gave comparable fry yields to published *O. niloticus* yields of 5 to 10 fry/m²/day. Breeding, however, was limited by low temperature, with 20°C the lower limit for successful reproduction.

The project base at DEFF received many visitors including staff and representatives from the Iceland International Development Agency (ICEIDA), Norwegian Agency for Development (NORAD), United Nations Educational, Scientific and Cultural Organization (UNESCO), Food and Agriculture Organization (Aquaculture for Local Community Development Programme) (FAO ALCOM), European Economic Commission (EEC), the International Bank for Reconstruction and Development (World Bank), Japan International Cooperation Agency (JICA), US Agency for International Development (USAID), Peace Corps Volunteers (PCV), and Kuopio University, Finland.

ICLARM Librarian, Ms. Norma Jhocson, spent seven months setting up the library at the DEFF and training a librarian. The library operates a UNESCO micro CDS/ISIS system for storage and retrieval of bibliographic data and has ASFA in CD-ROM. Two acquisitions lists were published and 65 requests handled for information, 29 from other African countries, during the eight months that this service has been fully operational. Visitors to this information service at the DEFF included personnel from the Natural Resources College, Bunda College of Agriculture, Chancellor College, National Research Council of Malawi, Malawi Institute of Education, United States Peace Corps Volunteers, UNESCO's Programme et Services d'Information and the Southern African Regional Commission for the Conservation and Utilization of Soil (SARCCUS).

- 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 (UPTD) for Saguling and Cirata; with funding from the World Bank.
- Duration** : July 1986 to January 1989; extended to June 1989
- Key Personnel**
- | | | |
|--------|---|--|
| IOE | : | Prof. Dr. Otto Soemarwoto; Ir. Gelar Wiraatmadja; Drs. Rusydi Kotanegara |
| UPTD | : | Mr. Pepen Effendi |
| PLN | : | Mr. Sutandar Zainal |
| ICLARM | : | Dr. Barry A. Costa-Pierce, Dr. John L. Munro, Dr. Catalino R. dela Cruz and Prof. Harlan Lampe |

Objectives

- To identify the appropriate aquaculture and fisheries methods for the resettlement of 3,000 families; 1,500 each from the Saguling and Cirata Reservoirs.
- To establish and conduct research on various aquaculture systems with potential for large-scale job creation among displaced persons.
- To provide technology transfer, extension and training advice, and scientific training of selected staff at Asian Centers of Excellence.
- To complete a comprehensive aquaculture and fisheries development plan for these reservoirs.

Results

The reservoir cage aquaculture industry of common carp (*Cyprinus carpio*) in Saguling and Cirata continued to grow, to provide an important source of new jobs in the region and to contribute significantly to the supply of freshwater fish in Bandung and Jakarta markets. A complete survey of the aquaculture industry in Saguling showed that 964 family heads were employed either full- or part-time in cage culture; with 482 families owning cages; 368 cage workers; 30 fish or fish-feed traders; 58 carp hatchery operators; and 26 new tilapia hatchery operators. Using the current average Indonesian family size of five persons, it was



The final closing ceremony of the collaborative project was held at Bongas Village, Saguling, and was attended by over 300 villagers, fishermen, cage operators, and Indonesian governmental officials from all levels. The Indonesian Minister of Population and the Environment, Hon. Dr. Emil Salim, presided over the final ceremonies.

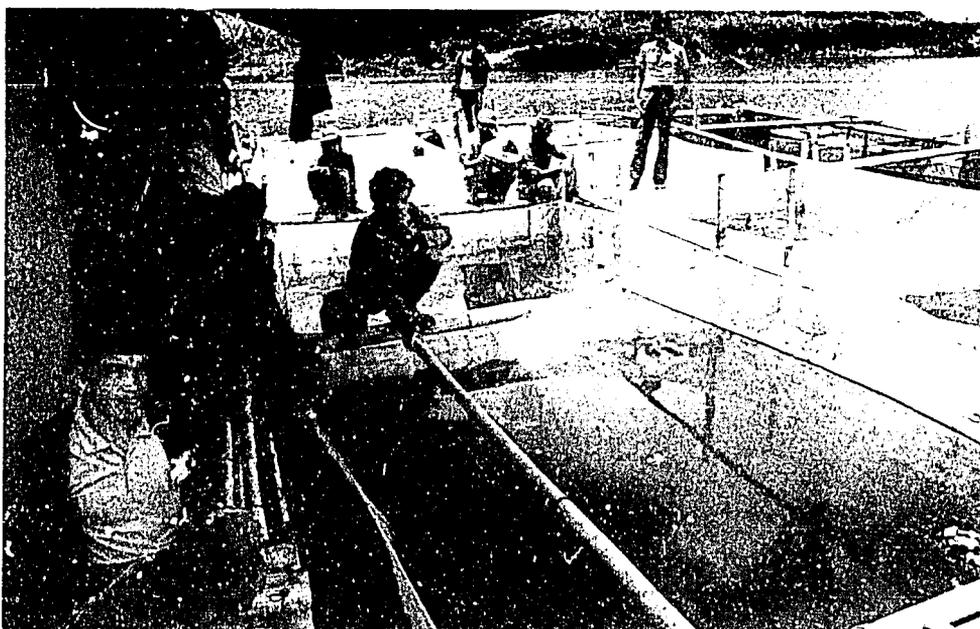
estimated that approximately 4,820 persons had benefitted from the aquaculture developments since the beginning of the project in 1986.

Rapid expansion of cage grow-out systems in the reservoirs simultaneously increased dramatically the demands for fish seed for stocking. Applied research in 1989 thereby addressed testable hypotheses, implemented experiments, and developed methods to increase production of traditional pond hatchery and nursery systems, and introduced modern methods in the form of double-net tilapia hapa (cage) hatcheries in the reservoirs.

Experiments with floating hapa hatcheries for red hybrid tilapia (*Oreochromis* spp.) were very successful; fry production in double-net systems averaged 22 fry/m²/day, or 15 fry/female/day. With a single exception, this fry production was higher than all previously reported studies in the scientific literature.

Use of a water hyacinth/earthworm compost in conjunction with occasional spraying of a biodegradable pesticide (Sumithion EC₅₀) markedly increased the production of 30-day old common carp fingerlings (3-5 cm) from traditional pond nursery systems. Increased availability of a direct feed, enrichment of pond foodwebs, and disruption of predatory insect life cycles were implicated. Mean fry production using the new inputs was 350 fry/m² (range = 279-410). In contrast, fry production in traditional hatcheries in Java ranges from 16 to 69/m², with few exceptions.

Experiments with concurrent rice-fish nursery systems demonstrated that, by using a closer planting distance, the total number of rice plants otherwise lost to fish trenches and total rice yields could be conserved, even if fish trench sizes were increased from 5 to 15% of the



Tilapia hapa hatcheries in the Saguling Reservoir. In 1989, 26 new hapa hatcheries began operations using a modified version of technology and methods obtained during two ICLARM study tours for Indonesian scientists to the Philippines in 1987 and 1989, respectively.

total paddy area. Fingerling (3-5 cm) yields were not significantly increased by increasing trench area from 5 to 15% of paddy area because of increased predation. However, feeding rice bran to fish in paddies with 5% of the area devoted to fish trenches significantly increased fingerling yields after 90 days.

The project developed in 1989 two new, low-cost designs for cages which cut the capital cost of construction of a 7 x 7 m cage unit by 35%, from Rp 274,500 to Rp 177,500; in June 1989, US\$1.00 = Rp1,720. The new models used bamboo and banana trunks for cage flotation, and optimized the binding and netting structures, thereby minimizing the quantity of imported materials needed. The new cage designs were introduced into both reservoirs, and had been adopted by over 20 farmers by the end of the project.

The project had a final closing ceremony in June attended by hundreds of villagers and officials and closed its doors in July. Dr. Emil Salim, Indonesian Minister of Population and Environment, presided over the closing ceremonies, and praised the work of the project. He challenged the government officials present to incorporate the aquaculture resettlement option in all current and future reservoir projects in the country, and to support financially IOE and NGOs in the country for continued work.

A major technical report, an aquaculture reservoir management plan, four extension workbooks and numerous journal and conference contributions from the collaborative project published in 1989 and in press for 1990 are available from ICLARM.

The pioneering work of the project may be applicable to many tropical reservoirs in developing countries.

Project Title	: Agricultural Research Project-II (Supplement)
Cooperating Institutions	: Bangladesh Agricultural Research Council (BARC); Bangladesh Fisheries Research Institute (FRI) and United States Agency for International Development (USAID)
Duration	: May 1989 to April 1992
Key Personnel	: Dr. M.V. Gupta, Dr. C.W. Lightfoot, Dr. R.S.V. Pullin

Objectives

The Government of Bangladesh (GOB) is implementing the Agricultural Research Project-II (Supplement) with funding from USAID, for strengthening its National Agricultural Research System, aimed at increasing domestic food production, small farm income and rural employment. One of the components of the National Agricultural Research System to be developed through the project is aquaculture, a core discipline given priority by the GOB. ICLARM is providing technical assistance in planning and implementation of aquaculture research, training and extension.

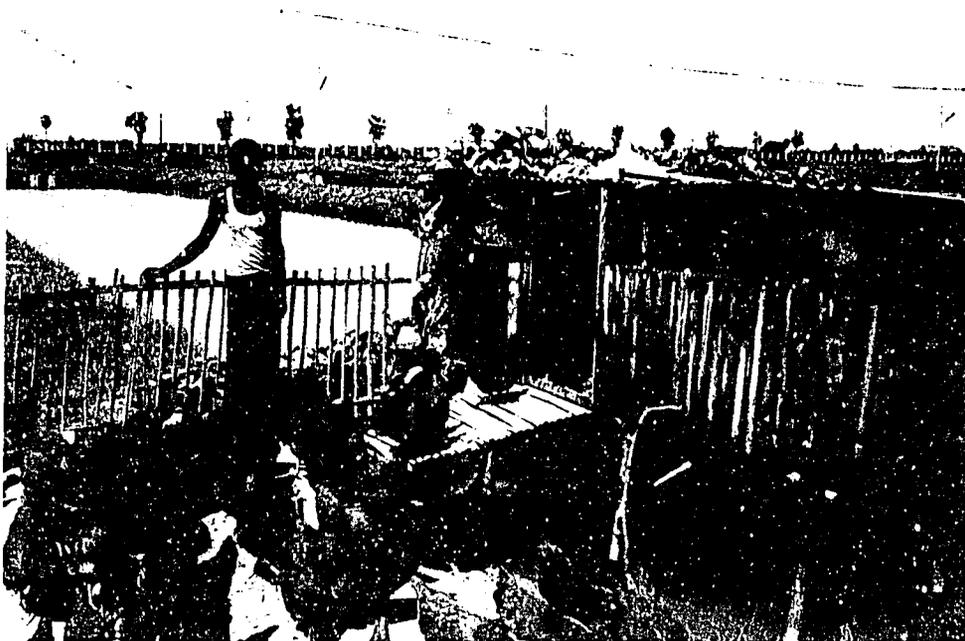
The objectives of the project with regard to the aquaculture component are:

- to assist the FRI in planning and implementation of research programs;
- to recommend specific research ideas/technologies that could be incorporated in farming systems research programs;
- to provide technical guidance to farming systems research incorporating aquaculture; and
- to assist the extension agencies in disseminating research results to farmers and fishermen.

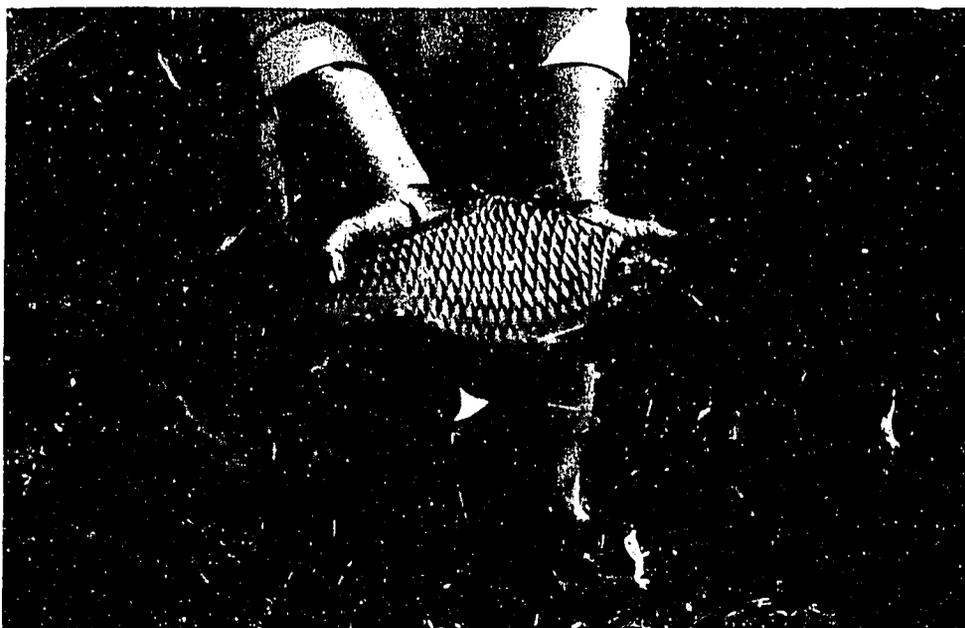
Results

ICLARM signed a contract with the BARC on 10 February 1989 to provide technical assistance for the aquaculture component of the Agricultural Research Project-II (Supplement). Subsequently, Dr. Pullin visited Bangladesh and held discussions with officials of BARC and USAID. Project activities were initiated with the recruitment of Dr. M.V. Gupta as ICLARM's Aquaculture Specialist based in Bangladesh.

As a first step, the core research program for the FRI was formulated. In freshwater aquaculture, 14 problems were identified for on-station research in the fields of carp hatchery management, culture systems, nutrition, disease genetics and socioeconomics. These projects are presently under various stages of implementation.



Integrated poultry-fish farming trial at the Fisheries Research Institute, Mymensingh, Bangladesh.



The silver barb (*Puntius gonionotus*) - a very promising herbivorous/omnivorous species for small-scale aquaculture in Bangladesh.

In project operations, emphasis was given to developing low-input technologies that would be suitable for resource-poor rural farmers and could fit into their farming systems. For this purpose, studies were initiated in farmers' ponds, for culture of tilapia (*Oreochromis niloticus*) and silver barb (*Puntius gonionotus*), integrated poultry-fish farming and integrated rice-fish farming. Bangladesh has a large number of seasonal ditches/ponds which retain water for 4-7 months in a year. These ditches are very shallow, with water depths ranging from 0.6 to 1.0 m, and are not presently used for fish culture. These seasonal waters can be used for short cycle culture of species such as tilapia and *Puntius*.

With this in view, studies were initiated for culture of *O. niloticus* and *Puntius gonionotus* in these seasonal ditches/ponds. When these ponds were stocked with *O. niloticus* fry at a density of 16,000/ha and fed with rice bran, productions of 1.2 to 1.3 t/ha were obtained after 5-6 months. For *Puntius* culture, the ponds were stocked with 2.5 g fingerlings at 15,000/ha. Productions of 1.1 to 1.6 t/ha were obtained after 6 months rearing, feeding only rice bran. In both cases, there was no fertilization of the ponds.

These studies have revealed the high economic viability of such culture operations and their suitability for involvement of rural women. Many nongovernmental organizations (NGOs) are showing interest in wider dissemination of these technologies and they are being given technical advice. Already 270 farmers around the FRI are practising tilapia culture and they are being helped and monitored.

Integrated poultry-fish farming studies are also in progress. Broiler chickens are being raised over ponds at a density of 500 birds per ha of water area. Ponds were stocked with catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*), silver carp (*Hypophthalmichthys molitrix*) and mirror common carp (*Cyprinus carpio*) at a density of 6,000 fingerlings/ha. Chickens, when fed with formulated feed, reached marketable size of 1.5 to 1.8 kg each after 7-8 weeks. The operation is profitable, with the cost of production amounting to Tk 25/kg live weight of chicken against a market price of Tk 45/kg; (US\$1.00 = about Tk 32). The fish are also showing good growth, but analysis of their income generating potential is still awaited.

Integrated rice-fish farming studies were conducted in rainfed ricefields, with plots ranging from 0.13 to 3.10 ha. Farmers have dug ditches in the fields, with areas ranging from 2.5 to 5.0% of the ricefield area to act as fish refuges. The ricefields were stocked with *Puntius gonionotus* fingerlings at 3,000/ha. After 2-3 months rearing, productions of 53 to 174 kg/ha were obtained with the fish reaching average sizes of 50 to 70 kg. Low productions were obtained from plots which had water in ricefields for only about a month.

Five farmer's days were organized to show the results of various culture systems to farmers. Assistance was provided to the Bangladesh Agricultural University for developing curricula for incorporation of 'aquaculture engineering' as a subject for graduate studies.

Plans have been prepared for incorporating aquaculture as a component of farming systems at seven Farming System Research sites in the country, in collaboration with the Bangladesh Agricultural Research Institute, the Bangladesh Jute Research Institute and the Sugarcane Research and Training Institute.

- Project Title** : Coastal Aquaculture Network
- Cooperating Institutions** : James Cook University of North Queensland, Australia; Fisheries Research Branch, Department of Primary Industry, Queensland, Australia; Fisheries Division, Ministry of Agriculture and Fisheries, Suva, Fiji; Center for Oceanological Research and Development, Jakarta, Indonesia; Fisheries Division, Tarawa, Kiribati; Micronesian Mariculture Demonstration Center, Koror, Palau; University of Papua New Guinea, Port Moresby, PNG; Siliman University, Dumaguete, Philippines; Marine Sciences Institute, University of the Philippines, Quezon City, Philippines; Fisheries Division, Honiara, Solomon Islands; Overseas Development Natural Resources Institute, London, UK; University of Newcastle-upon-Tyne, UK and the Fisheries Division, Apia, Western Samoa.
- Duration** : Indefinite
- Key Personnel** ICLARM : Dr. John L. Munro, Ms. Cathreena M.T. Gervis

Objectives

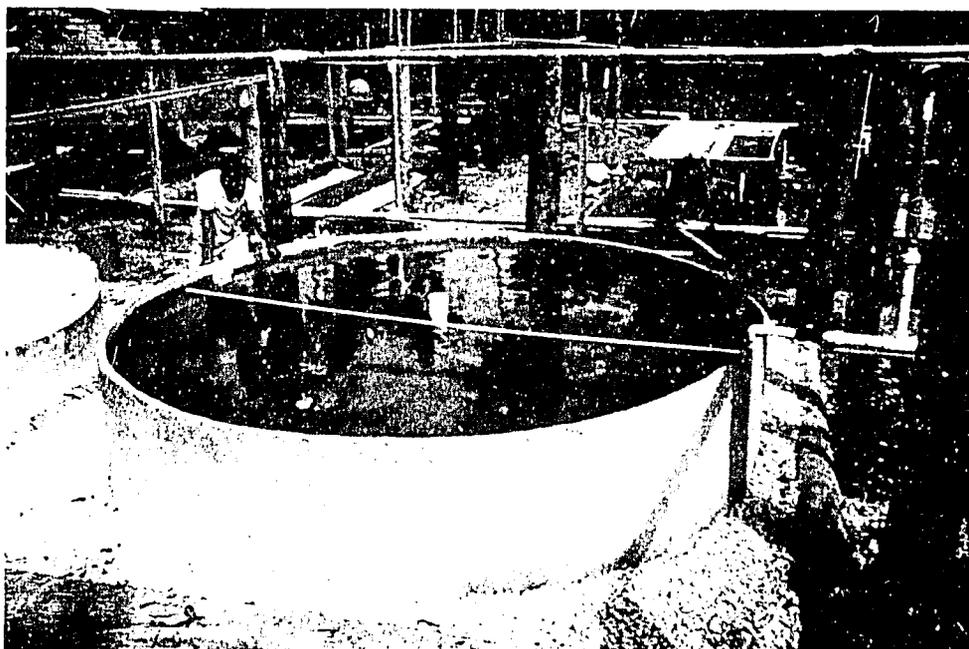
- To enhance and promote international collaboration in coastal aquaculture by creating networks of interested institutions and individuals.
- To develop participating research groups concerned with specific organisms or aquaculture by creating networks of interested institutions and individuals.
- To promote exchange visits between participating institutions.

Results

The Coastal Aquaculture Network (CAN) was formally created in 1988. Membership is now comprised of the thirteen institutions participating in the "Giant Clam Research Group" plus over 100 individuals. Two issues of the newsletter "Clamlines" were published during the year. Interested parties have been contacted in connection with the creation of a "Reef Ranching Research Group" and the group will be formally launched early next year, including participants in the Caribbean and the Pacific.



The giant clam (*Tridacna gigas*).



Giant clam hatchery/nursery tanks and raceways at ICLARM's Coastal Aquaculture Centre, near Honiara, Solomon Islands.

Project Title : Reef Fish Ranching Research Project

Cooperating Institution : South Pacific Regional Environmental Programme, South Pacific Commission (SPC)

Duration : Indefinite

Key Personnel ICLARM : Dr. John L. Munro
SPC : Dr. Paul Holthus

Objectives

- To investigate the feasibility of ranching systems for coral reef fish and invertebrates, based upon the release or transplantation of juveniles of selected species to reef systems.
- To enhance the fisheries productivity of coral reef systems clams by artificial means.
- To investigate economic, social and legal factors which affect reef ranching or replenishment systems in the South Pacific Region.

Results

Work on the feasibility of coral reef fish ranching started in the latter half of the year. Current work is concentrated on making an inventory of species of potential interest and on a tagging study which will give information on the relative range of movement of species of potential interest.

Antillean fish traps were constructed for sampling the reef fish stocks in the CAC's exclusive reef leaseholding and have been used with some success. Fish tags were delivered in late December and the tagging program will commence in February 1990.

Additional funding is being sought to broaden the scope of the investigations.

INFORMATION PROGRAM

The Information Program is responsible for production of most of ICLARM's publications, for providing information and library services and for undertaking research relevant to improving the quality and availability of aquatic resource information.

The year 1989 was a strenuous one for Information Program staff. As well as the routine preparation of ICLARM publications, a considerable amount of time was spent copyediting the 1,000-page proceedings of the Second Asian Fisheries Forum. In the library, the bibliographic database that forms the bulk of Naga's Information Department increased so rapidly that a 44-page supplement to the October 1989 Naga issue was necessary. The Program Director was also Acting Director General throughout the year.

Progress of Work

Publications

From sales, library exchange and free issue, the total number of books in ICLARM's seven technical series distributed since the first publication in 1980 is over 87,000.

Significant publications in the technical series produced in 1989 include: *The Peruvian Upwelling Ecosystem: Dynamics and Interactions; Biology, Epidemiology and Management of Pyrodinium Red Tides; The Biology and Culture of Mussels of the Genus Perna; and Aquaculture Systems Modeling: An Introduction with Emphasis on Warmwater Culture.*

During the year, English translations of four Indonesian extension manuals were published, as well as a French translation of the book *Tilapia Genetic Resources for Aquaculture.*

Distribution of *Naga, the ICLARM Quarterly* (formerly the *ICLARM Newsletter*) from the first issue in July 1978 is more than 144,000 copies. Circulation at the end of 1989 was 2,750 of each issue.

ICLARM hosts the Asian Fisheries Society's Secretariat and handles its editorial and publishing functions. In 1989, as well as copyediting the Society's Forum proceedings, the Center edited and produced for the Society the following: two issues of the journal *Asian Fisheries Science* and two proceedings volumes, *Exotic Aquatic Organisms in Asia* and *Fish Nutrition Research in Asia.*

Book exhibits. In 1989, ICLARM's publications were exhibited during the celebration of the National Science and Technology Week focusing on

"The Country's Leading Edges in Fisheries", 10-14 July, Makati, Philippines; at the 21st Festival of Books and Book Fair, World Trade Center, Singapore; and the Frankfurt Book Fair, Federal Republic of Germany, in October.

Contributions. The number of items published or in press by ICLARM staff and in the Center's technical series during 1989 was 108. The total number of contributed items since ICLARM's first output in 1975 is now 610.

Research

Our information research activities were limited to preparation of minireviews of various subjects for publication in *Naga* as part of the IDRC-sponsored Selective Fisheries Information Service. These reviews summarize the development of the literature in a field and provide readers with names of experts to contact as well as titles of key articles.

Two studies on the use of fisheries literature are being continued. The study by Joey Vega compares the citation behavior of scientists in two Philippine biological journals and an overseas journal. The other research by Managing Editor Letty Dizon is an analysis of citations to the same biological journals.

Library

By December 1989, the library's holdings consisted of 9,510 volumes of books, monographs, theses and dissertations including conference papers and proceedings; 713 serial titles; 4,334 reprints; over 2,000 pamphlets and clippings; and 264 titles of nonbook materials such as microforms, videotapes, maps, and filmstrips.

The library has computerized its collection and databases contain a total of 12,373 references. Materials acquired from 1978 to 1986 however, are still maintained on a catalog card. A 1987-1988 Book Catalog was produced in-house and made available to other interested local and foreign fisheries libraries.

In 1989, there were 2,555 external users representing a 27% increase over last year.

Use of the ASFA CD-ROM by external users has grown continuously since its introduction in late 1986. There were 555 users who made access to this database during 1989.

Quick access to the marine science libraries and information centers worldwide has been made possible through the use of the SCIENCEnet electronic mail. It is particularly helpful in providing interlibrary loan service to the researchers. The library staff monitors the electronic bulletin board for the use of other ICLARM staff as well.

During the year, the library staff trained 35 individuals both from local and foreign countries in fisheries librarianship, online searching, database management and nontechnical library activities.

The library staff attended and participated in several conferences, meetings and workshops, both local and foreign, on librarianship and other information matters. Librarian Erlinda Gonzalez started to pursue

a Masters Degree in Library Science at the University of the Philippines. Librarian Norma I. Jhocson was seconded to the ICLARM Africa Project Office in Malawi for seven months to set up an aquaculture library and train the Malawian fisheries librarians. Chief Librarian Rosalinda M. Temprosa served as a resource person to several meetings, seminars and conferences, both local and foreign, in library management and computerization.

Training

The library staff have carried out the following training activities during the year:

- Lecture-Demonstration on the Use of Compact Disc-Read Only Memory (CD-ROM) and Computerized Database for De La Salle University (DLSU) Library Staff, Manila, 17 and 24 February.
- Technical Assistance to the Philippine Aquatic Sciences and Fisheries Information System (PASFIS) Staff in the Initial Development of their Database Using Micro CDS/ISIS System Software Package, Manila, 6 and 7 March.
- Lecture-Demonstration on the Application of Computer in Library Operation for the South East Asia Iron and Steel Institute (SEAISI) Information Staff, Manila, 29 March.
- On-the-Job Training Apprenticeship in Library Methodologies for a B.S. Psychology Graduate from Far Eastern University (FEU), Manila, 29 March to 12 May.
- Lecture-Demonstration of Computerized Library Operation and Database Management System for a Nepalese Information Officer, Small Business Promotion Project (SBPP), Kathmandu, Nepal, 18 April.
- Training in Library Methodologies for Three Indonesian Fishery Information Officers, Makati, Metro Manila, 3-30 June.
- Training in Database Management Using Micro CDS/ISIS System Software Package and ASFIS Documentation Methodologies for Three Indonesian Fishery Information Officers, Makati, Metro Manila, 8-29 July.

Program Plans

The library is envisioned to increase the use of computer technologies and more cooperation and resource sharing with other fisheries libraries worldwide. Specific projects for the years ahead are to:

- automate other library functions such as acquisitions and internal circulation procedures and report mechanisms;
- computerize all book and monograph holdings;
- create an online catalog for the ICLARM staff through a Local Area Network (LAN);
- continue electronic access to online databases and to other library collections from around the world;
- participate in a more active role in networking and resource sharing with other fisheries libraries worldwide;

- review, update and publish the library's manual of operating guidelines;
- publish a 10-year indexed compilation of all the articles appearing in the Information Department of the ICLARM Newsletter and its successor Naga;
- produce bibliographies and minireviews on subjects of importance;
- produce a supplement to the Serial Holdings List;
- produce an Annual Book Catalog;
- produce a supplement to the Red Tide Bibliography;
- continue ICLARM's Selective Fisheries Information Service to provide computer-based literature searches and document delivery;
- continue citation analyses of ICLARM documents to find out the extent to which the Center's publications have been used by other researchers in various countries;
- accept more trainees from developing countries; and
- expand library facilities and staff.

Meetings Attended, Papers Presented

SEAFIS Seminar on Fishery and Aquaculture Information in Southeast Asia, Bangkok, Thailand, 7-10 February. (J.L. Maclean and R.M. Temprosa, resource speakers)

Paper presented:

Temprosa, R.M. ICLARM's Selective Fisheries Information Service. Project ADD (Analysis and Document Delivery).

Symposium on the Minimum Standards for the Special Libraries, Manila, Philippines, 23 February. (E.B. Gonzalez and N.R. Balagapo)

Twelfth Annual Convention, Philippine Fisheries Research Society, Quezon City, 24 February. (M.J.M. Vega)

Post-Bangkok Meeting of the Philippine Fisheries Information Group, Los Baños, Laguna, 3 March. (R.M. Temprosa, adviser)

PASFIS (Philippine Aquatic Sciences and Fisheries Information System) Meeting, University of the Philippines in the Visayas (UPV), Iloilo City, 6-7 April. (R.M. Temprosa, Technical consultant)

Asian Fisheries Society Council Meeting, Tokyo, Japan, 16 April. (J.L. Maclean)

Second Asian Fisheries Forum, Tokyo, Japan, 17-21 April. (J.L. Maclean)

Eighth Summer Institute on Library and Information Sciences (Information Consolidation). National Engineering Center, University of the Philippines, Diliman, Quezon City, 15-19 May. (M.J.M. Vega)

Third Summer Institute on Library and Information Services (Abstracting and Indexing). National Engineering Center, University of the Philippines, Diliman, Quezon City, 22-26 May. (A.P. Mendoza)

Management and Training Workshop on *Pyrodinium* Red Tides, Brunei Darussalam, 23-30 May 1989. (J.L. Maclean)

Papers presented:

Maclean, J.L. An overview of *Pyrodinium* red tides in the Western Pacific.

Maclean, J.L. Red tides in Papua New Guinea waters.

Maclean, J.L. Economic aspects of *Pyrodinium* red tides in the Western Pacific.

- Second Pacific Conference on New Information Technology, The Glass Hotel, Singapore, 29-31 May. (R.M. Temprosa)
- General Assembly of the Philippine CDS/ISIS Users' Group (ISISPHIL), University of the Philippines, Diliman, Quezon City, 21-23 June. (E.B. Gonzalez)
- Information Officers' Training Course (INFOTRAC), Institute for Small-Scale Industries, University of the Philippines (UPISSI), Diliman, Quezon City, 12 July to 16 August. (R.M. Temprosa, resource speaker)
- SEAFDEC Program Committee meeting, Singapore, 22-25 August. (J.L. Maclean, observer)
- Fifteenth Annual Conference of the International Association of Marine Science Libraries and Information Centers (IAMSLIC), Bermuda, 2-6 October. (J.L. Maclean, resource speaker)
- Paper presented:
Maclean, J.L. and N.I. Jhocson. ICLARM's information activities in Africa.
- CGIAR Public Awareness Association meeting, Bonn, Federal Republic of Germany, 9-10 October. (J.L. Maclean)
- Frankfurt Book Fair, Frankfurt, Federal Republic of Germany, 11-16 October. (J.L. Maclean)
- Preliminary Discussion on the Preparation of "Introductory Manual for Marine Information Centre Development", by A. Varley, Plymouth, UK, 10-20 October. (R.M. Temprosa, technical adviser)
- Consultative Meeting on "Training Strategy for Aquatic Sciences and Fisheries Information System (ASFIS)" Intergovernmental Oceanographic Commission, (IOC/ UNESCO) Paris, France, 21-25 October. (R.M. Temprosa, technical adviser)
- CGIAR Centers Week, Washington, DC, USA, 30 October to 1 November. (J.L. Maclean)

Publications and Consultancy Reports

- Carigma, M.A.A. and R.C. Morales. 1989. Directory of educational and training opportunities in fisheries and aquaculture. FAO and ICLARM.
- Dizon, L.B. 1989. The new College of Fisheries of the University of the Philippines in the Visayas. Naga, ICLARM Q. 12(4): 10.
- Hallegraeff, G.M. and J.L. Maclean, editors. 1989. Biology, epidemiology and management of *Pyrodinium* red tides. ICLARM Conf. Proc. 21, 286 p.
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- Maclean, J.L. 1989. Red tides in Papua New Guinea waters, p. 27-38. In G.M. Hallegraeff and J.L. Maclean (eds.) Biology, epidemiology and management of *Pyrodinium* red tides. ICLARM Conf. Proc. 21, 286 p.
- Maclean, J.L. 1989. Economic aspects of *Pyrodinium* red tides in the Western Pacific, p. 179-185. In G.M. Hallegraeff and J.L. Maclean (eds.) Biology, epidemiology and management of *Pyrodinium* red tides. ICLARM Conf. Proc. 21, 286 p.

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- Maclean, J.L. 1989. Info 89: fisheries information services. *Naga, ICLARM Q.* 12(2): 17-19.
- Maclean, J.L. 1989. On publishing, perishing and promotion in fisheries science. *Naga, ICLARM Q.* 12(4): 8-9.
- Maclean, J.L. 1989. Red tides of the dinoflagellate *Pyrodinium* cause paralytic shellfish poisoning on both sides of the tropical Pacific. *Naga, ICLARM Q.* 12(3): 9. Also in *Trop. Coastal Area Manage.* 4(2): 14-15.
- Maclean, J.L. and L.B. Dizon, editors. 1989. ICLARM Report 1988. 126p.
- Maclean, J.L. and R.M. Temprosa. 1989. Bibliography on Indo-Pacific red tides. *ICLARM Bibliogr.* 8, 23 p.
- Temprosa, R.M., compiler. 1989. Tropical fisheries and aquaculture literature 1989. Supplement to *Naga, ICLARM Q.* 12(4). 44 p.
- Temprosa, R.M., N.I. Jhocson, N.R. Balagapo and E.B. Gonzalez, compilers. 1989. ICLARM Library serial holdings list. *ICLARM Educ. Ser.* 6, 99 p.
- Vega, M.J.M. 1989. Who's working on echinoderm fisheries? *Naga, ICLARM Q.* 12(1): 18.
- Vega, M.J.M. 1989. Who's working on *Epti:ephelus* culture? *Naga, ICLARM Q.* 12(1): 19.
- Vega, M.J.M. 1989. Who's working on women in fisheries? *Naga, ICLARM Q.* 12(2): 16.
- Vega, M.J.M. 1989. Who's working on *Caulerpa* culture? *Naga, ICLARM Q.* 12(3): 10.
- Vega, M.J.M. 1989. Who's working on tropical red tides? *Naga, ICLARM Q.* 12(3): 11.

Information Program Project Summary

- Project Title** : Selective Fisheries Information Service (SFIS) Phase II: Project ADD (Analysis and Document Delivery)
- Cooperating Institutions** : International Development Research Centre (IDRC), Canada
- Duration** : 2 years beginning March 1988
- Key Personnel** ICLARM : Mrs. Rosalinda M. Temprosa
Mr. Marcos Jose M. Vega
Ms. Adelina P. Mendoza
Ms. Matintiman E. Cruz

Major Objective

To extend the capabilities of the existing ICLARM Information Program to users in tropical developing countries.

Specific Objectives

- To assist in an advisory capacity in strengthening the information capability of fisheries institutions in developing 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 analyze 50 selected specific topics of the literature built up over the first three years of the SFIS.
- To provide key literature to enquirers.
- To produce bibliographies and minireviews on important topics as identified by trends in enquiries.

Results

Under the question-and-answer service component of the project, a total of 298 enquiries from 68 countries/territories were received during the period January to December 1989. Queries from Nigeria were the most numerous followed by India, then the Philippines. An average of 25 enquiries is received each month. Fig. 1 shows the geographical pattern of enquiries received.

From the 298 enquiries, 12% were "user pays"; 41% were still answered free and 36% availed of the exchange procedure from which we received 88 reprints, 15 monographic/technical reports and 3 journals. Requests outside ICLARM's areas of expertise were referred to other appropriate information centers. The remaining 11% were referred to other services. SFIS provided a total of 5,565 abstracts from the Aquatic

Sciences and Fisheries Abstracts (ASFA) plus photocopies of 1,066 articles totalling 9,877 pages.

User responses are carefully monitored to evaluate the usefulness of the user-pays policy.

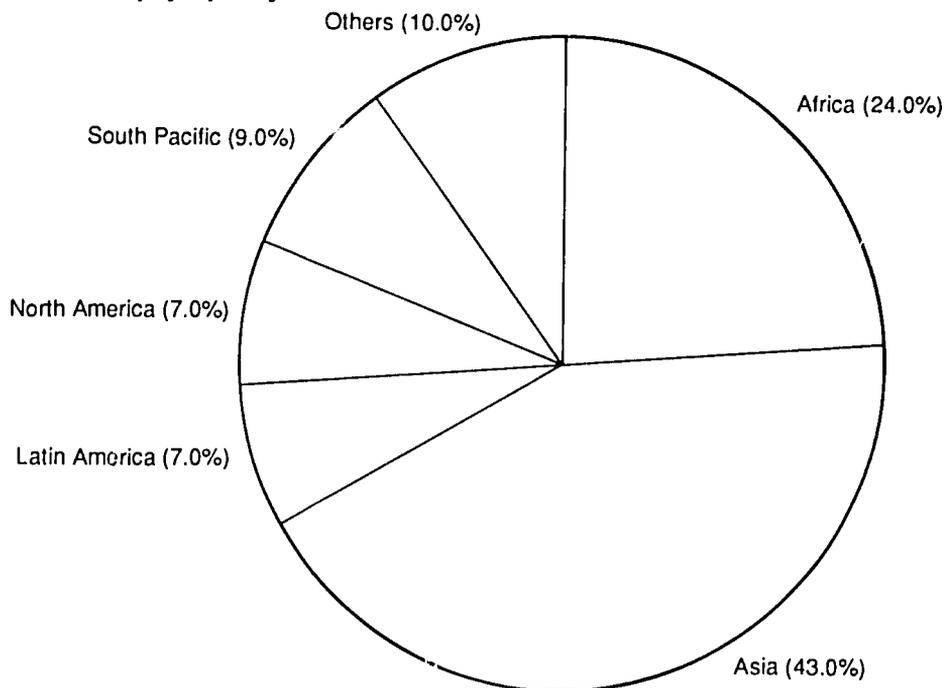


Fig. 1. Geographical spread of SFIS enquiries (January to December 1989, N=298).

Table 1 shows that culture systems was the most requested topic. The next largest groups were fish biology, followed by crustaceans, then general fisheries. This pattern differs from the initial 3-year phase of the project when tilapia, integrated farming and socioeconomic aspects, respectively, were the most requested subjects.

Table 1. SFIS enquiries by major subject (January to December 1989).

Topic	No.
Culture systems	70
Fish biology	38
Crustaceans	31
General fisheries	29
Tilapia	18
Molluscs	15
Resource management	15
Integrated farming	13
Ecology	8
Processing	8
Nonfish culture	6
Carp	6
Socioeconomics	4
Fish/shellfish nutrition	4
Seaweeds	4
Others	29

An analysis of occupation or position held by the enquirer was also made. Of the 202 known user-types, in decreasing order of frequency of request is researchers (33%), administrators (29%), academic/library personnel (18%), students (13%), growers (6%) and volunteers (US Peace Corps and British VSO) (1%) (Fig. 2).

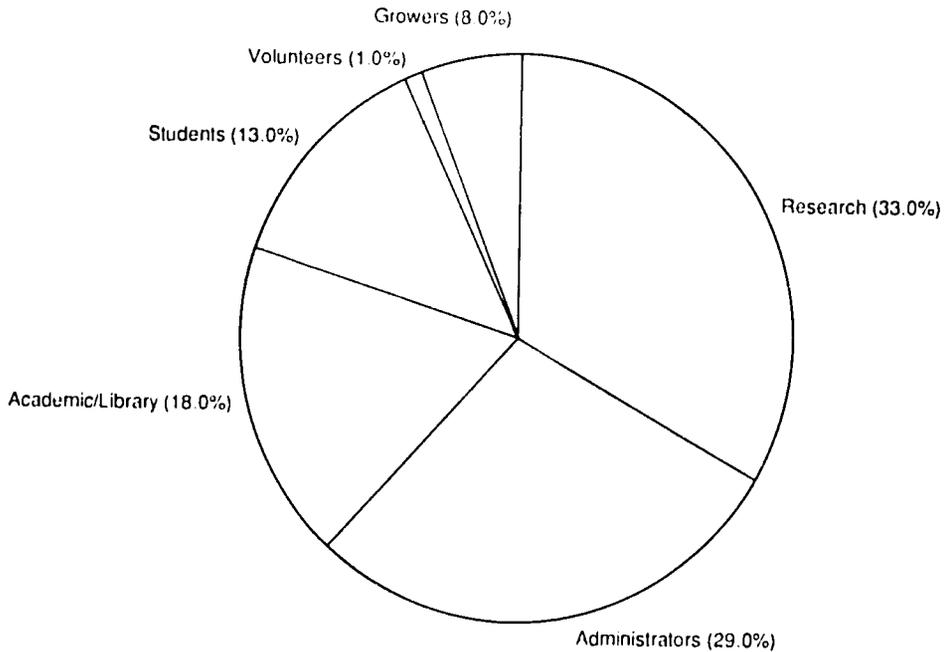


Fig. 2. Distribution of known user-types (January to December 1989, N=202).

Assistance in information use and handling has been provided through participation in local and international conferences, workshops and meetings. Short-term training in fisheries librarianship, online searching and nontechnical library activities was also conducted for various groups and individuals, both local and foreign.

Cooperative information activities have also been strengthened with other specialized information centers like the Brackishwater Aquaculture Information System of the SEAFDEC Aquaculture Department, Seaweed Information Center of the Marine Science Institute of the University of the Philippines and the Indonesian Fisheries Information System.

In September 1989, Mrs. Matimtiman E. Cruz was hired to assist in the preparation of a 10-year indexed bibliography on tropical fisheries and aquaculture literature.

During the year, three bibliographies have been published through the project and sixteen minireviews on various topics have been prepared, five of which have been published in the *Naga*. Prior to publication, each article is sent to two experts identified during the literature surveys.

SOUTH PACIFIC OFFICE

The South Pacific Office (SPO) came into existence in 1984 with prime responsibility for development of an international giant clam mariculture project. One of the prime objectives was to create a purpose built giant clam hatchery in a representative Pacific equatorial environment at which giant clam farming systems could be tested for their practicality, productivity and economic viability.

The SPO administers the Coastal Aquaculture Centre (CAC) and is responsible for the development and coordination of all other ICLARM activities in the South Pacific Region.

The site for the giant clam hatchery was identified in 1985, a formal collaborative agreement was entered into with the Government of Solomon Islands and construction of the CAC started on 14 October 1986, following registration of ICLARM's 50-year lease on the 5-ha site.

Progress of the CAC during 1989 is described on p. 92.

Work on the feasibility of coral reef fish ranching started in the latter half of the year. Current work is concentrated on making an inventory of species of potential interest and on a tagging study which will give information on the relative range of movement of species of potential interest.

Links with the South Pacific Commission's (SPC) Inshore Fisheries Research Project were strengthened by the secondment of ICLARM scientist Paul Dalzell to the SPC at the beginning of the year. Close liaison is maintained with the Forum Fisheries Agency, particularly in matters connected with coral reef fisheries.

Advisory Services

At the request of the Government of Papua New Guinea, SPO Director Dr. John L. Munro visited PNG over the period 6-14 May to assess the status of the Milne Bay giant clam fishery and advise the Government on future management options, including cultivation. He also made an evaluation of the Tonga "Nearshore Fisheries Assessment Project" on behalf of the Government of Tonga over 18-24 November. The work was executed in collaboration with the SPC's Inshore Fisheries Research Project.

Additionally, he served on a review panel for the Australian Centre for International Agricultural Research (ACIAR) research project on "Baitfish Biology in the Solomon Islands, Maldives and Papua New Guinea" during December and was also a reviewer for a proposed ACIAR coral reef fish stock assessment project.

ADMINISTRATION AND FINANCE

Board of Trustees

The Center is administered by a Board of Trustees composed of fifteen members. Two of these members serve on an ex-officio basis, while the others, though affiliated or formerly affiliated with various international and national institutions, serve in their personal capacities. The ex-officio members of the ICLARM Board are the Center's Director General and the highest ranking Philippine government official with direct responsibility for fisheries (presently the Secretary of the Department of Agriculture).

The Board's primary responsibilities are:

- a) to act as the policymaking body of the Center;
- b) to lay down or approve the Center's programs;
- c) to review the finances of the Center and approve an annual budget; and
- d) to review the progress and management of the Center.

The ICLARM Board of Trustees also has several standing committees to assist the Board in carrying out its responsibilities. The Board members elect, from among themselves, members to these standing committees. In 1989, the Board had four standing committees - the Executive Committee, Finance Committee, the Program Committee and the Nominating Committee.

A list of members of the 1989 ICLARM Board of Trustees and the activities and terms of reference of and membership on the 1989 Board Committees follow.

Board Membership

At the end of the 1988 meeting, the terms of Mr. Roy Jackson, Dr. James Storer, Dr. Klaus Tiews, Dr. Ziad Shehadeh, Mr. Alban Gurnett-Smith, Senator Edgardo Angara and Ratu Sir Kamisese T. Mara expired.

For the sake of continuity, Mr. Roy Jackson, Dr. James Storer and Mr. Alban Gurnett-Smith were elected by the Board of Trustees to a final three-year term to expire at the end of the 1991 Annual Meeting of the Board.

New trustees elected to serve a three-year term beginning in 1989 were:

1. Dr. Agustín Ayala-Castañares - Institute of Marine Sciences and Limnology, National Autonomous University of Mexico (UNAM) - Senior Researcher (1973 to present).
2. Dr. Edgardo Gomez - Marine Science Institute, University of the Philippines - Director (1975 to present).
3. Dr. Peter Larkin - Institute of Resource Ecology and Department of Zoology, University of British Columbia (Canada) - Professor (1969 to present); Vice-President, Research (1986 to present).
4. Mr. Philipp Muller - South Pacific Forum Fisheries Agency, - Director (1981 to present).

Throughout 1989, Mr. John L. Maclean, designated as ICLARM's Acting Director General in November 1988, occupied the ex-officio Board seat of the ICLARM Director General.

1989 Meetings

In 1989, the Center's trustees held the following meetings.

- Executive Committee Meeting - 25-26 June 1989
- Program Committee Meeting - 27-28 November 1989
- 14th Annual Meeting of the ICLARM Board of Trustees - 29 November to 1 December 1989
- Nominating Committee Meeting - 29 November 1989
- Finance and Management Committee Meeting - 28 November 1989

The various actions taken by the Board of Trustees during the above meetings are summarized below:

Programs

- Reviewed the progress and activities of the Center's research programs.
- Approved the recommendation that ICLARM initiate action to address the issue of global climatic change in relation to living aquatic resources.
- Reviewed proposals for the future establishment of ICLARM regional offices in Africa and Latin America and agreed to continue consideration of the proposals within the framework of a Strategic Plan for ICLARM.
- Reviewed the specific details of the direction of the Center's research on tilapia genetics.

- Confirmed the management decision to place the Asian Fisheries Social Science Research Network (AFSSRN) within the Coastal Area Management Program.
- Reviewed the potential implications of CGIAR affiliation on ICLARM's programs.
- Approved the recommendation for the Center to prepare a Strategic Plan.
- Approved the recommendation that ICLARM staff conduct regular "retreats".
- Reviewed the progress of the International Fisheries Research Study.

Finances

- Reviewed the 1989 financial performance and declared as satisfactory the Center's financial and budget management.
- Reviewed and accepted the 1988 external auditor's reports.
- Approved a 1990 core expense budget.
- Reviewed the 1991 projected core expenses budget.
- Reviewed the progress of the Center's fundraising activities and prepared strategies for future fundraising efforts.

Administration

- Reviewed and took action on the recommendations of the Acting Director General on personnel management issues.
- Reviewed the progress of the Director General Search Committee.
- Conducted Memorial Services for Dr. Ian R. Smith.
- Approved the recommendation to rename the library as the Dr. Ian R. Smith Memorial Library.
- Appointed Dr. James Storer to look into other activities that would continue the memorial of Dr. Smith.
- Reviewed the status of ICLARM's request for land allocation from the Department of Agriculture to serve as the site of the proposed ICLARM Headquarters Building.
- Reviewed the progress of ICLARM's efforts to obtain international organization status within the Philippines.

Board Matters

- Accepted the retirement from the Board, effective end-1989 of Dr. Gunnar Saetersdal and Dr. Gunawan Satari.
- Evaluated the list of potential trustees and approved the invitation of two new trustees to join the ICLARM Board in 1990.
- Approved the amended By-Laws.
- Elected the officers of the Board for 1990 as well as the 1990 membership to the Board's various committees.

1989 BOARD OFFICERS AND COMMITTEES

BOARD OFFICERS

Mr. Roy I. Jackson	-	Chairperson
Mr. Carlos G. Dominguez	-	First Vice-Chairperson
Mr. Alban F. Gurnett-Smith	-	Second Vice-Chairperson
Dr. Roger S.V. Pullin	-	Treasurer
Mr. Basilio M. Rodriguez, Jr.	-	Secretary

BOARD COMMITTEES

1. *Executive Committee*

- Functions:**
- To implement and execute the policies and decisions laid down by the Board.
 - To exercise the powers and perform the duties delegated by the Board.
 - To act for the Board between Board of Trustees meetings on matters requiring immediate attention.

Members: Mr. Roy I. Jackson - Chairperson
 Mr. Carlos G. Dominguez
 Mr. Alban F. Gurnett-Smith
 Dr. Martin Bilio
 Dr. James A. Storer
 Dr. M.S. Swaminathan
 Mr. John L. Maclean

2. *Finance and Management Committee*

- Functions:**
- To review the external auditor's report and the Center's financial statements and recommend their acceptance by the Board of Trustees.
 - To review budget recommendations made by the Director General.
 - To make budget and financial policy recommendations for adoption by the Board of Trustees.
 - To evaluate the management performance of the Center in relation to policies and budgets established by the Board of Trustees.
 - To evaluate the performance of the external auditors.
 - To review management issues, including personnel matters, appropriate to the Board of Trustees' responsibilities and make recommendations thereon to the Board of Trustees.
 - Other duties and functions delegated to it by the Board of Trustees.

Members: Dr. James A. Storer - Chairperson
 Mr. Roy I. Jackson
 Mr. Carlos G. Dominguez
 Mr. Alban F. Gurnett-Smith
 Dr. Martin Bilio
 Dr. M.S. Swaminathan
 Mr. John L. Maclean

Continued

3. **Program Committee**

- Functions:**
- To receive and review, on behalf of the Board of Trustees, the Director General's annual report on the Center's research, training and information programs.
 - To review and evaluate proposed changes in and/or additions to the Center's program structure.
 - To review and evaluate the Center's annual and long-term program plans.
 - To conduct all of above functions and duties with due consideration to the Center's mandate and previously established program plans, directions and priorities.
 - To review the results of any external reviews conducted of the Center's programs, as well as the Center's responses as proposed by the Director General, to recommendations made by the external reviewers.

Members: Dr. Martin Bilio - Chairperson
 Dr. Keishi Amano
 Ms. Hannah R. King
 Dr. Peter Larkin
 Dr. Gunawan Satari
 Mr. John L. Maclean

4. **Nominating Committee**

- Functions:**
- To assist the Board in establishing criteria and procedures for the election of members to fill vacancies on the Board.
 - To review and identify potential candidates who meet established criteria.
 - To recommend and present to the Board of Trustees a short list of possible members for election to the Board and its subsidiary committees.
 - To nominate persons who would be required to serve in the positions of Chairperson, Vice-Chairpersons and Secretary and any other officers as may be deemed necessary by the Board of Trustees.

Members: Mr. Alban F. Gurnett-Smith - Chairperson
 Ms. Hannah King
 Dr. Gunawan Satari
 Dr. James A. Storer
 Mr. John L. Maclean

1989 SOURCES OF SUPPORT

1. Unrestricted Support

World Bank - (CGIAR)
 United States Agency for International Development (USAID)
 Australian International Development Assistance Bureau (AIDAB)
 Danish International Development Agency (DANIDA)
 Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ)

2. Restricted Support

Activity	Sources of 1989 Support
a. Giant Clam Project/Coastal Aquaculture Centre	Commission of European Communities (CEC) New Zealand Government Overseas Development Administration (ODA) South Pacific Commission Skaggs Foundation Australia and Pacific Science Foundation United States Agency for International Development (USAID)
b. Asian Fisheries Social Science Research Network	International Development Research Centre (IDRC) of Canada Ford Foundation, New York
c. Management Options for Small-Scale Fisheries	International Development Research Centre (IDRC) of Canada
d. Selective Fisheries Information Service	Food and Agriculture Organization (FAO)/Danish International Development Agency (DANIDA) Norwegian Ministry of Development Cooperation (NORAD)
e. Network of Tropical Fisheries Scientists	

- | | |
|--|--|
| f. Integrated Farming Systems | United Nations Development Programme (UNDP) |
| g. ASEAN/US Coastal Resources Management | United States Agency for International Development (USAID) |
| | Brunei Darussalam Government |
| 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 | Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ) |
| l. Rice-Fish Farming Systems | Asian Development Bank (ADB) |
| m. Publication - The Peruvian Anchoveta and Its Upwelling Ecosystem: Three Decades of Change | Programa Cooperativo Peruano |
| | 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 |
| p. Tilapia Genetic Improvement | Asian Development Bank (ADB) |
| | United Nations Development Programme (UNDP) |
| q. Collaborative Research Support Program | University of Rhode Island (URI-USAID) |
| r. Artisanal Fisheries Resource Study, Uganda | Commission of European Communities (CEC) |
| s. Fishbase Project | Food and Agriculture Organization (FAO) |
| | Commission of European Communities (CEC) |
| t. Software on Fish Stock Assessment | Food and Agriculture Organization (FAO) |
| u. Bangladesh Aquaculture Research | International Foundation for Agricultural Development (IFAD)/Danish International Development |

- v. Global Multispecies Trophic Modelling
- w. Directory of Education and Training Opportunities
- x. The Third International Symposium on Tilapia in Aquaculture

Agency (DANIDA)
United States Agency for
International Develop-
ment (USAID)
Danish International Deve-
lopment Agency (DANIDA)
Food and Agriculture Organi-
zation (FAO)
French Government

STATEMENT OF REVENUES AND EXPENSES¹ (US\$)

	1989	1988
REVENUES		
Grants	\$ 3,375,903	3,375,027
Consultancy and service fees	122,405	106,458
Publications	26,367	22,492
Miscellaneous	281,911	110,241
	<u>\$ 3,806,586</u>	<u>3,614,218</u>
EXPENSES		
Aquaculture	\$ 1,406,345	1,250,503
Coastal Area Management ²	895,062	1,013,655
Capture Fisheries Management ²	555,561	461,944
Social Sciences	95,586	244,048
Library and Information Services	214,839	199,485
Board of Trustees	117,032	95,128
Administration and Finance	232,797	257,466
General Operating Expenses	117,188	95,976
Capital Expenditures	93,278	110,674
	<u>\$ 3,727,688</u>	<u>3,728,879</u>
EXCESS (DEFICIENCY) OF REVENUE OVER EXPENSES	<u>\$ 78,898</u>	<u>(\$ 114,661)</u>
FUND BALANCE AT BEGINNING OF YEAR	45,260	159,921
FUND BALANCE AT END OF YEAR	<u>\$ 124,158</u>	<u>45,260</u>

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

²In January 1989, the ASEAN/US Coastal Resources Management Project became a major ICLARM Program, the Coastal Area Management Program, and the Resource Assessment and Management Program was renamed the Capture Fisheries Management Program.

ICLARM STAFF

Acting Director General

Jay L. Maclean, M.Sc.

Coastal Area Management Program

Chua Thia-Eng, Ph.D.

Director

ASEAN/US COASTAL RESOURCES MANAGEMENT PROJECT

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INTERACTIVE DATABASE ON TROPICAL FISHERIES RESOURCES MANAGEMENT

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Amos Chinkhadze, B.S.	Research Assistant Trainee/M.S. student -
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Ali Duncan	Watchman (Ponds)
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Medson Alei	Watchman (Birds)
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Fred Khanganga	General worker (Ponds)
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BANGLADESH AGRICULTURAL RESEARCH PROJECT

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