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Fisheries and Aquaculture Research Capabilities and Needs in Latin America

Studies of Uruguay, Argentina, Chile, Ecuador, and Peru

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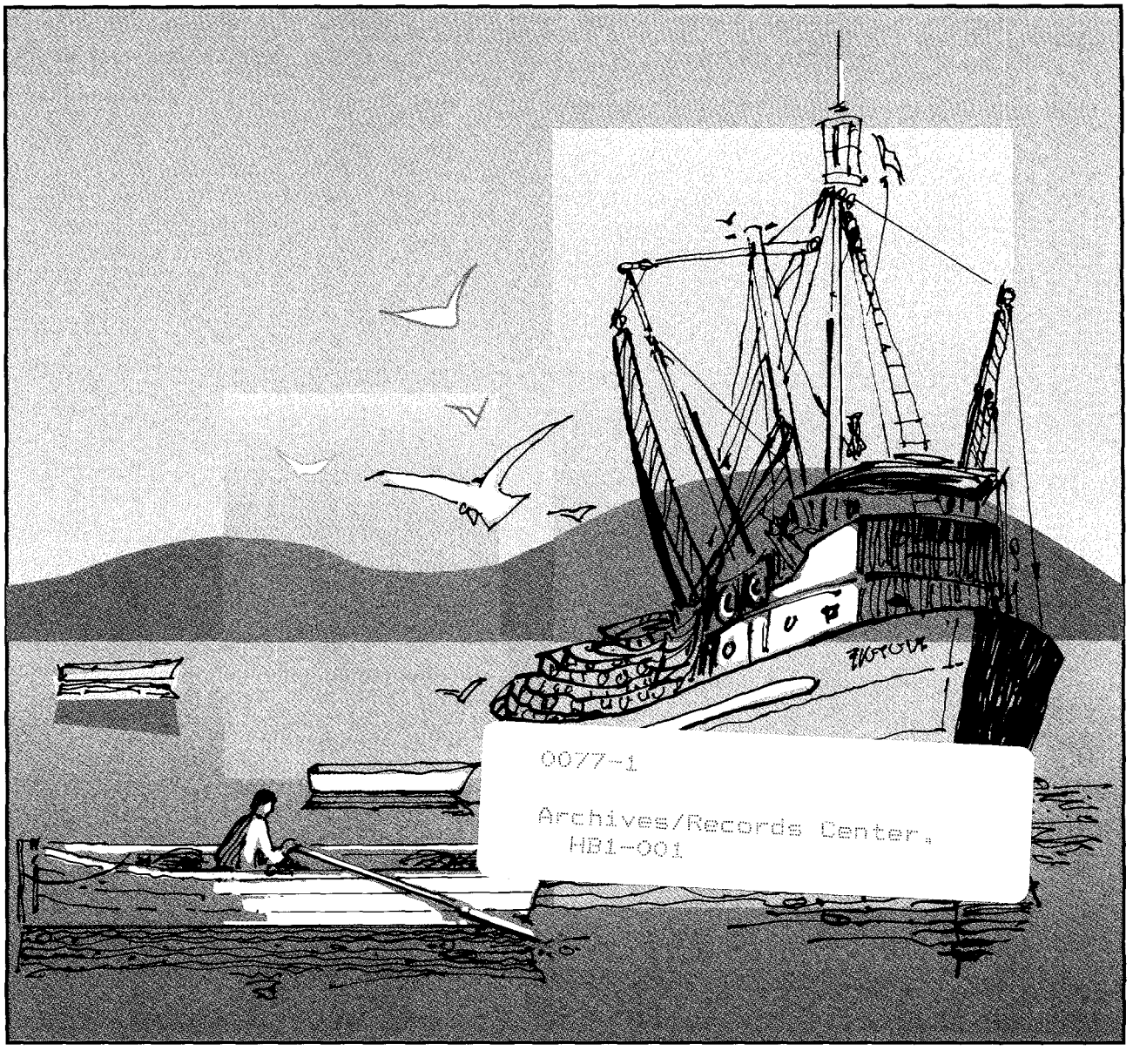

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ABSTRACT

This report contains the findings of two missions. One mission visited Uruguay and Argentina and the other covered Chile, Ecuador and Peru.

The report on Uruguay and Argentina starts with a brief overview of the fishing industry and the scope of fisheries and aquaculture research. Subsequent sections describe the organisation of research paying special attention to issues such as funding and prioritization. Further, the impact of research on the fishing and aquaculture industries of Uruguay and Argentina are assessed. General conclusions as well as recommendations are also presented. The studies of Chile, Ecuador and Peru start with a brief overview of the state of fisheries and aquaculture in the area. This is followed by an analysis of research capabilities in these three countries. Opportunities for enhancing the contributions of research to the economic and social progress of the sector are examined. Conclusions of the mission are also presented.

ACKNOWLEDGMENTS

The Members of the Mission are grateful to the following agencies for supporting this study:

Multilateral Agencies: (Steering Committee) The World Bank; United Nations Development Programme; Commission of the European Communities; and Food and Agriculture Organization.

Bilateral Agencies: DANIDA — Danish International Development Agency; AIDAB — Australian International Development Assistance Bureau; ICOD — International Centre for Ocean Development (Canada); NORWAY: ICEIDA — Icelandic International Development Agency; SIDA — Swedish International Development Authority; ODA — Overseas Development Administration (United Kingdom); ITALY; FRANCE; USAID — United States Agency for International Development; THE NETHERLANDS; GTZ — Deutsche Gesellshaft fur Technische Zusammenarbeit (Germany).

FOREWORD

This technical paper is one of seven mission and working group reports prepared during the Study of International Fishery Research (SIFR) in 1989-90. The juxtaposition of potentially high socio-economic benefits from fisheries and the relatively low level of success achieved in fisheries development projects has been a matter of serious concern and challenge to the donor community as well as to national fishery administrations. In view of this, the First Fishery Development Donor Consultation held in 1986 decided to undertake a Study of International Fishery Research to determine ways in which research could bring about improvements. This comprehensive effort has now been completed, thanks especially to the effective financial support of a group of multilateral and bilateral donors and the essential intellectual contributions made by virtually hundreds of professionals from academia, fishery administrations and donors who were associated with various stages of the Study.

The objectives of the Study were to identify the specific constraints to fisheries management and development (including aquaculture) posed by the lack of information or the inaccessibility of existing knowledge; to determine high priority research needs; to examine the capacity of developing countries to undertake research; and to propose a strategy and an action plan for improving donor support. It was carried out through a series of missions and by four working groups which addressed specific research topics under the direction of a Study Team Leader and a Deputy. SIFR identified a number of key strategic research areas which are vital for the future development of the sector. Institutes in developing countries may not immediately be able to carry out all of this research, but the Study clearly identifies them as the ultimate beneficiaries of its thrust. In the meantime, countries with important fishery resources and the willingness to further develop their research for improved management and sustainable use of their resources should be assisted in drawing up national research agendas and building up their capacities. In this context, the findings of regional missions are a useful starting point. This volume contains reports of missions to Uruguay, Argentina, Chile, Ecuador and Peru and is intended as background information to support the main Study which is being published as "Study of International Fishery Research".

I wish to express my sincere thanks to the fisheries researchers, fishery administrators in developing countries, as well as the leaders and members of the missions and Steering and Advisory committees for their vigorous effort and thoughtful contributions. It is my sincere hope that these Technical Papers will prove stimulating and provide practical guidance to donors, research institutions and fishery administrations in making progress toward sustainable resource utilization and the realization of new opportunities from fisheries and aquaculture in developing countries.

Michel J. Petit

Director, Agriculture and Rural Development Department

ACRONYMS

ALICMAR	Asociacion Latinoamericana de Investigadores en Ciencias del Mar
CEC	Commission of European Communities
CEPAL	Comision Economica para Latin America, Santiago (Chile)
CGIAR	Consultative Group on International Agricultural Research
CIC	Commission of Scientific Research of Buenos Aires
CIPU	Camera de Industrias Pesqueras del Uruguay
CITEP	Centro de Investigaciones de Technolgia Pesquera
CONACYT	Consejo Nacional de Ciencia y Tecnologia, Quito (Ecuador)
CONADE	Consejo Nacional del Desarollo, Quito (Ecuador)
CONCYTEC	Consejo Nacional de Ciencia y Tecnologia, Lima (Peru)
CONICET	National Council of Scientific Research
CONICYT	Comision Nacional de Investigacion Cientifica y Tecnologia, Santiago
CORFO	Corporacion Nacional de Fomento a la Produccion, Santiago (Chile)
CORPESCA	Corporacion de Productores de Harina de Pescado S.A., Santiago
CPPS	Comision Permanente del Pacifico Sur
DANIDA	Danish International Development Agency
ECM-UCV	Escuela de Ciencias del Mar, Universidad Catolica, Valparaiso (Chile)
ESPOL	Escuela Superior Politecnica del litoral, Guayaquil (Ecuador)
FAO	Food and Agriculture Organisation, Rome (Italy)
FUNCAP	Fundacion para la Capitacion del Pescador Artesanal, Santiago (Chile)
GTZ	German Agency for Technical Cooperation
ICCT	International Commission for the Conservation of Atlantic Tuna
ICES	International Council for the Exploration of the Sea
ICLARM	International Center for Living Aquatic Resources Management, Manilla
IDB	Inter-American Development Bank, Washington (USA)
IDRC	International Development Research Center, Ottawa (Canada)
IFOP	Instituto de Fomento Pesquero, Santiago (Chile)
IIAP	Instituto de Investigaciones de la Amazonia Peruana, Iquitos (Peru)
IMARPE	Instituto del Mar del Peru, Callao (Peru)
INAPE	Instituto Nacional de Pesca
INIDEP	Instituto Nacional de Investigaciones y Desarollo Pesquero
INIP	Instituto de Investigaciones Pesqueras
INP	Instituto Nacional de Pesca, Guayaquil (Ecuador)
INTI	National Institute of Industrial Technology
ITP	Instituto Tecnologico Pesquero del Peru, Callao (Peru)
JICA	Japanese International Cooperation Agency, Tokyo (Japan)
NORAD	Norwegian Agency for International Development
ODA	Overseas Development Administration, London (UK)
OLDEPESCA	Organizacion Latinoamericana de Desarollo Pesquero, Lima (Peru)
PNUMA	Programa de las Naciones Unidas para el Medio Ambiente
RAMCHI	Red de Algas Marinas, Chile
SARP	"Sardine and Anchovy Recruitment Program", conducted within the framework of IOC Programme on Ocean Sciences for Living Resources (OSLR) with input from FRG and USA
SIFR	Study of International Fishery Research
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organisation
URI	University of Rhode Island, Kingston (USA)
USAID	United States Agency for International Development, Washington (USA)
WB	International Bank for Reconstruction and Development (World Bank), Washington (USA)

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Fisheries and Aquaculture Research Capabilities and Needs in Latin America: Studies of Uruguay and Argentina

MISSION:

5-21 September 1989

MEMBERS:

David de G. Griffith (Leader)

Angel Gumy

Hector M. Lupin

MISSION LEADER'S SUMMARY AND RECOMMENDATIONS

INHERENT ADVANTAGES AND DISADVANTAGES

The strong points evidenced in the findings of the mission are conducive to a rational solution of the problems of the region, and to the expectation of a good return on investment of future development funding:

- Availability of extensive fisheries resources; therefore, the development effort is worthwhile.
- High standard of general education, and a bonus, the obvious commitment of key individuals and groups within the third level education sector.
- Reasonable level of scientific expertise, providing a foundation on which to build.
- Example of CITEP shows what can be achieved: a well-run organization with good communications with the industry.
- Industry keen for more information on scientific matters, and to cooperate.

The **weak points**, which require to be tackled are:

- No sector policies.
- Underfunding of research; low salaries; inadequate budgets for equipment, travels, libraries.
- Bad communication between research and industry (except in the case of CITEP) contributes to the continuation of inappropriate priorities.

ACTION

It is recommended that a two-phase action program be initiated building on the inherent strong points and setting up a solidly based research network which would utilize development funding in the most cost-effective way to realize the full potential of the region's living marine resources.

Phase I: Priming the Pump

Immediate re-organization should be carried out in order to make the better use of existing manpower and facilities, especially in Argentina where the pre-harvest research sector badly needs complete rebuilding.

Since all fisheries-related research in both countries is seriously under-funded, particularly in critical subjects such as the design of fishing boats and fishing gear, but also in the fields of fisheries economics and fisheries biology, funding should commence immediately to:

(i) train more people in the fields of fisheries-related science and technology, at scientist and technician level; new courses will need to be created where none exist at present;

(ii) upgrade existing laboratory and sea-going facilities, including research libraries.

Create travelling scholarships to enable researchers to keep up-to-date with fishery research developments in other world regions.

Write a Development Plan to take fisheries development and research in Argentina and Uruguay to the turn of the century. For Uruguay, this will be an update/expansion of the 1975 Plan. In the case of Argentina, it must be more extensive, starting from the bottom.

Phase II: Implementing the Development Plan

Start with Comodoro Rivadavia plan for Patagonia, and develop it as a model for the entire region. Unstinting funding is justified. Visible success of the early stages of the Development Plan is vital to its public acceptance and implementation, both in Patagonia and elsewhere. The Comodoro Rivadavia group has commitment and ability across a range of technical and administrative expertise, and must be given the means to achieve the significant progress of which they are capable.

Initially, funds are also needed for a planned program by which experts from other countries would come to work in Uruguay, and particularly in Argentina, to boost the local expertise in initiating the research elements of the Development Plan.

Research funding must be made conditional on the joint planning with the industry, and priority given to projects which incorporate more than one research institute.

A regional center for organizing and coordinating research will be essential. The Comision Tecnica Mixta del Frente Maritimo, which has already developed a role in South America, similar (but on a much smaller scale than) to that of the International Council for the Exploration of the Sea (ICES) in the North Atlantic, is ideally placed to identify gaps in available knowledge across a wide range of relevant topics. It is, thus, the obvious agency to be given this responsibility. Already, the active participation of scientists from other South American countries in the Commission's symposia is a testimony of the Commission success in meeting the existing for such an international regional forum, to the extent that the Commission's resources allow. Ways in which the donor agencies might facilitate the development of the Commission, whether directly or indirectly, should be examined.

The Comision Tecnica Mixta del Frente Maritimo would also be an appropriate regional channel for the distribution of donor agency funding of research in all branches of fisheries-related science, emulating the role of regional intergovernmental bodies elsewhere. The existence and track records of the Commission offers obvious advantages which should be seized.

1. INTRODUCTION

A Study of International Fishery Research needs in developing countries (SIFR) was undertaken under the auspices of the World Bank, FAO, the UNDP and the Commission of European Communities, with the support of a dozen bilateral agencies. The purposes of the Study were to determine high priority research needs, the capacities of developing countries to undertake the necessary research, and the ways in which donor support can be made more effective in supporting national efforts.

As part of the Study, field missions were conducted to selected groups of developing countries for the purpose of assessing research capabilities and identifying the factors that serve or impede the research process. Argentina and Uruguay were selected because of the importance of their fishery resources, and the new opportunities and responsibilities that the countries have acquired with the change in the Ocean regime.

The SIFR mission to Uruguay and Argentina was carried out during September 5-21, 1989:

Mr. David de G. Griffith	Director, Fisheries Research Center, Dublin (Ireland), Leader,
Mr. Angel Gumy	Fishery Planning Officer, Department of Fisheries. FAO, Rome (Italy),
Mr. Hector M. Lupin	Fishery Industry Officer,Department of Fisheries, FAO, Rome (Italy),

In order to fully elucidate the structure and objectives of fisheries research in the two countries, including such vital elements as the prioritization of research targets and the extent, nature and effectiveness of relationships with their respective fishing industries, the mission team held detailed discussions with a wide range of policy makers, advisors, research scientists and engineers, economists and industry representatives. Three days (September 6-8) were spent in Uruguay (Montevideo), and 12 days in Argentina (Buenos Aires, Mar del Plata, Puerto Madryn and Comodoro Rivadavia). A list of institutions visited and people with whom the mission held discussions is given in Annex I.

The sections of the report covering respectively Uruguay and Argentina both start with a brief overview of the fishing industry and the scope of related research. Subsequent sections in both chapters describe the organization of research paying particular attention to funding and proritization, and assess the impact of research on the national fishing industries of the two countries.

In the Argentina chapter, an additional section is devoted to the fishery potential and research in Patagonia, an area where there already exists a basic scientific research structure and an impressive commitment to the goal of obtaining the financial support necessary to set up a teaching and applied research facility in fishery science. In Comodoro Rivadavia, the mission was presented with an impressive plan (summarized in this report), well worthy of support, for the achievement of Patagonia's potential for economic and social growth through the development of its living marine resources.

Chapter IV describes the origin, objectives and activities of the Comision Tecnica Mixta del Frente Maritimo, the bilateral agency headquartered in Montevideo (Uruguay). The mission concluded that the Commission could well serve as a regional launching platform for an enlarged international effort in terms of scientific research and training in fishery matters.

Chapter V, in presentation of the mission's general conclusions, highlights critical difficulties - i.e., the shortage of trained workers in critical areas of fisheries-related science and technology, poor infrastructure and the stultifyingly bad communication between most research institutes and the fishing industry. Very limited opportunities for contact with scientific developments in other regions of the world further restrict the extent to which Argentinean and Uruguayan scientists can contribute to the development of the fishing industries of their countries.

2. URUGUAY

INTRODUCTION

The Fishing Industry

Fisheries development in Uruguay has been implemented through the development and implementation of a Fisheries Development Plan, initiated in 1974 within the framework of the Five Year Development Plan (1973-77). Four objectives were identified in the Fisheries Development Plan:

(i) increase export earnings;

(ii) increase employment;

(iii) improve fish supply to the domestic market;

(iv) fully exploit the Uruguayan EEZ.

The formulation of the Fisheries Development Plan was preceded by a number of studies related to the development potential of Uruguayan fisheries. The main purposes were to assess fishery resources, labor availability and capital requirements in order to formulate a rational development strategy before any large-scale exploitation could take place. An FAO Fisheries Development Project played a key role in assisting the Government of Uruguay in these tasks.

As a consequence of these assessments, the development strategy was founded mainly on the creation of a high quality land-based freezing sector for exports, accompanied by a fleet development plan which was strongly linked to the quantification of the resource base. The results achieved show that the Development Plan was successful, as indicated in Table 1.

Table 1. Statistics on the development of Uruguayan fisheries between 1975 and 1985

	1975	*1985*
Total catch (tonnes)	26,000	139,000
Small vessels	304	656
Industrial vessels	11	66
Freezing plants	5	19
Exports (US$ million)	3.5	55
Numbers employed (fishing & processing)	2,400	12,900

Hake (merluza comun, merluza argentina - Merluccius hubbsi) accounts for 70% of the landings, croaker (corvina - Micropogonias furnieri) for 14%, and striped weakfish (pescadilla - Cynoscion striatus) for 5%.

Scientific Research

Fisheries and aquaculture research is carried out by two agencies: (i) the Instituto Nacional de Pesca (INAPE) which is part of the Ministry of Livestock, Agriculture and Fisheries; and (ii) the Instituto de

Investigaciones Pesqueras (INIP), a research facility within the veterinary faculty of the University of the Republic of Uruguay.

INAPE is the principal body in the fisheries sector. It was set up in 1975, soon after the commencement of Uruguay's fisheries development program, and functions as a fisheries ministry within the Ministry. Approximately 60 professionals and technicians work not only on research and monitoring programs, but also on administration, fisheries statistics and sanitary control of products for human consumption. The mission was informed that no more than six people are engaged exclusively on full-time research.

Disciplines represented are biology, oceanography and veterinary medicine. Graduates with a veterinary background are among those who have received training in fisheries science by participating in courses organized by ICCAT (International Commission for the Conservation of the Atlantic Tuna), at other courses in Aberdeen and Lowestoft (UK), and also those run by UNESCO/FAO in Chile, Argentina and Brazil. Specialist training has also been provided through NORAD and DANIDA.

The staff at technician level are former undergraduates who did not complete their university careers and have left third level education.

The Fisheries Biology Division of INAPE is organized along three main lines: monitoring of exploited stocks, development of new fisheries, and aquaculture research. The major projects are demersal high seas resources (principally hake), demersal coastal resources (mainly croaker and sea-trout), pelagic resources (tuna, swordfish, squid, anchovy) and benthic populations (clams, mussels). The 'new fisheries' projects involve experimental fishing, the development of new gear (traps for red snapper, squid jigging machines, for example).

Aquaculture projects concern freshwater catfish, frogs and Macrobrachium, the Malaysian giant prawn. (At least part of this work is done in conjunction with INIP; see below.) Work is starting on clams and mussels.

The Fishery Economics Division of INAPE, although strong in the past, lacks personnel at present. Its main duties are to produce statistics, sectoral and investment studies, and advice on fisheries economic policy to the Director of INAPE.

INIP's scientific staff number 18, all part-time. Out of these, 10 are of M.Sc. equivalent and 8 are "medium level technicians". In addition, there are 6 support staff.

INIP has three functions: teaching, research, and applied research in fish technology (in conjunction with the industry) and aquaculture. The Director is also retained by the industry (CIPU[1]) as their scientific adviser.

INIP's teaching functions cover fisheries, quality control and inspection. In research, it works on fish products technology, quality control, surimi, minced fish and irradiation (with IAEA). In conjunction with FAO, research is carried out on artisanal fisheries and the development of under-utilized species, including freshwater fish. INIP also has an aquaculture research program (freshwater catfish, frogs) which has links with INAPE. With the Animal Nutrition Department of the University, they carry out research into the bio-conversion of fish wastes and by-products of the chicken industry. INIP participates in Antarctic research (particularly in ecology, microbiology and ichthyology) with the Antarctic Institute of Uruguay. Industry related research is represented by joint ventures with CIPU, INAPE and the local authorities of inland provinces.

1 Camara de Industrias Pesqueras del Uruguay.

Post-harvest technology will be a big part of their 1990 teaching program. As a bilateral project between the University of the Republic of Uruguay and the University of Mar del Plata (Argentina), a post-graduate course in marine science is currently at the planning stage, under a contract to a consultant, Dr.P.E.Penchaszadeh. The main objective of the programme will be to take the output from the different University faculties which offer particular individual aspects of marine science in isolation (engineering for example), and unify their undergraduate training at post-graduate level. This is planned as the first step towards an integrated undergraduate program between the two Universities.

RESEARCH ORGANIZATION

Funding

INAPE is funded from central exchequer. Budgets are prepared every 5 years and may be adjusted to take account of inflation and other justified factors during the interim period.

The Director of the Fisheries Economics Division of INAPE informed us that total INAPE expenditure, including the costs of administration, statistics collection and sanitary control, as well as research, amounts to about 2%-4% of the value of fish exports. The latter account for about 95% of all Uruguayan fish production. Main importers are USA (30%) and Europe (20%). He also pointed out that in other regions of the world the proportion corresponds to approximately 1%-1.5%.

INIP's funds come mainly from the University, but also from industry, IAEA and FAO for specific projects. The total budget amounts to US$ 60,000 over 2 years for the surimi project, and to US$ 10,000 from other sources.

Salaries are very low in both INAPE and INIP, around US$ 200 - 300 per month. Most people have to take two jobs in order to survive.

Prioritization

From earlier work, INAPE say they know the potential yields of the major stocks. Hake, for example, makes up over 60% of the landed catch weight. Assumptions are "cross-checked with market possibilities, infrastructure support, cpue, etc". Now, they are diversifying to new species. No consultations took place with the industry at the time these initial investigations were carried out (late 1960s - early 1970s), because the studies were made as a prerequisite of the fishing industry development program. Only very small artisanal fisheries existed at that time. While this was a soundly based approach to the development of an industry from scratch, it seems that no formal consultation process between research and industry has ever been put in place.

INIP's programs are designed to meet perceived national objectives. They also work on subjects of regional interest such as the production of fish silage for animal feeds (part of a cooperative regional programme sponsored by FAO and involving research institutes in several Latin American countries). Other projects such as surimi are carried out in conjunction with industry to increase added value from low-cost materials. The mission was shown a fish hamburger made from 'sabalo', a fatty unmarketable freshwater species caught by artisanal fishermen. This new product is aimed at institutional caterers (hospitals, etc) and the objective is to transfer the technology to the artisanal sector.

Contact with the Industry

INAPE sees relationships with the industry as being very close, in view of the fact that "we are a small country". Thus, they do not see any need for a formal structure to foster such relationships. Two processing plants have almost total control of this sector of the industry, for example.

INIP likewise sees its relationship with the industry, and with INAPE, as being very close. The dried squid project was cited as an example -started in INIP and now implemented by 2-3 factories. Scientists from INIP and INAPE work closely together, as the mission saw. The INIP Director feels that INIP's cooperative arrangements work very well. When drawing up research priorities, he places great emphasis on service to the community.

Internal Coordination

At the operational level, coordination between individual scientists of INAPE and those at INIP seems to be good. INIP has a clear sense of its institutional role (supporting the fishing industry through applied scientific research), enhanced by close contact with the industry through its Director who, subject to available resources, is in a position to implement projects which have been planned in consultation with CIPU.

INAPE, on the other hand, is severely hindered by the absence of an updated national fisheries policy designed to meet the changed requirements for continued development of the industry (see conclusions below). As an integral part of the Ministry, INAPE's contacts with the industry are official rather than intimate, and although its scientific program gathers essential data on trends in stock biomass of the most important commercial species, its work is not perceived by the industry as being directly relevant.

International Coordination and External Aid

Up to now, Uruguay's policy of coordination at international level has been very fruitful, good use being made of external aid (bilateral and multilateral). Foreign input has had a positive impact on fisheries in key areas, such as the optimization of vessel design, type and quality of fish products and the development of external markets. Both INAPE and INIP seem to be clear about their technical limitations (in terms of both manpower and the available range of expertise), and are able to identify specific areas in need of external technical input. Both institutes can also define concrete research possibilities, such as the design of nets appropriate to Uruguayan fisheries (at present, most designs are imported without modification).

IMPACT OF RESEARCH ON THE INDUSTRY

Industry Participation in Research Planning

As pointed out in earlier in the context of the recent history of Uruguayan fisheries development (virtually from nothing), no formal channels have ever been set up to enable industry to participate in the definition of fisheries research policies and programs, even though the industry has developed considerably and has its own representative body (CIPU). CIPU strongly voiced the need for a continuous and formal linkage between industry and INAPE on research. They want to be closely involved in research planning, and are prepared to provide financial support (how much support would be forthcoming was not discussed, but the principle of research funding by the industry was freely volunteered). It was suggested to us by the president of CIPU that the most effective way to implement both these proposals would be for CIPU to have a seat on the INAPE Board of Management in return for CIPU funding of INAPE scientists.

Application of Research

The applied research on which the 1974 Fisheries Development Plan was based, and which was carried out mainly through a FAO/UNDP project, was successful. To-day, however, the routine INAPE research and monitoring program on resources is being used in practice to define the national fisheries policy, rather than the other way round.

Fish product development research has been successful in some areas (e.g., dried squid), but unsuccessful in others (e.g., anchovy processing). Furthermore, up to now the links between this type of research and economic research (including market research and development) have been weak.

Use of Manpower Trained by the R & D System

Scientific manpower is directed towards an appropriate set of objectives, given the slender budget, but more research staff is necessary. There does not appear to be any cohesive Government policy on the fishing industry, and research funding thus has a low priority.

Industry's Priorities for Research

The industry is preoccupied with the state of the hake stock, industry finance, international prices and owner/fishermen relationships, and sees INAPE's research priorities as being largely irrelevant to the real needs of the industry. This view is mainly the result of a lack of effective communication between research and industry.

CONCLUSIONS

Throughout the development stage of the Uruguayan fishing industry, INAPE had a clear sense of what research programs were necessary, and implemented them. In general these objectives have now been achieved.

The view is now widely held, among industry people and scientists alike, that the main stocks (hake, croaker, striped weakfish) are fully exploited, or almost so, and that a new industrial strategy is essential. Uruguay is thus in the process of reformulating its approach to fisheries development. The following are some of the main elements (generally termed "diversification") which are under discussion:

(i) better management of the Common Fishery Zone;

(ii) increased catches and utilization of under-exploited species;

(iii) increased added value of fishery products;

(iv) development of small-scale fisheries;

(v) restructuring of the industrial fleet;

(vi) elective aquaculture development.

All these topics will require research support not only for scientific research on fish stocks and aquaculture, but also for market research.

Neither INAPE nor INIP is capable of meeting the demands of this new development phase as they are constituted at present. INIP, being free of an administrative load and political pressures, and because its

Director is scientific adviser to the industry, is probably in a better position to make a more immediate impact than INAPE, but INIP's resources are very small and it cannot cover a wide research spectrum.

The new research vessel for INAPE will undoubtedly boost the Uruguayan fisheries research effort, but the financial resources (more full-time research scientists and technicians, research vessel equipment and running costs) must be made available, not only to allow the ship to be fully utilized, but also to enable the data collected by it to be fully and efficiently transformed into reliable information for the benefit of administrators, politicians and the industry alike.

The seemingly enormous communication barriers between research (particularly biology) and industry need to be broken down. It was pointed out that where technology is concerned, a "fluent" relationship exists between science and industry, but that this was manifestly lacking in the biological area. Biologists are seen by fishermen and owners as being too academic, out of touch with reality and preoccupied with problems which to the industry appear irrelevant.

INAPE has had good working contacts with research and resource evaluation techniques in more developed regions of the world. These should be maintained or where possible extended. INIP personnel would benefit from an extension of foreign aid in this regard.

3. ARGENTINA

INTRODUCTION

The Fishing Industry

Total catches of the Argentinean fleet amounted in 1987 to 550 000 tonnes, compared with 364 000 tonnes in 1977. Foreign authorized vessels (USSR, Bulgaria) caught 339 000 tonnes in 1987.

Fishing activities are carried on exclusively by private enterprises. The State, the owner of the resource, grants fishing licences to vessels under special fishing agreements. The industry is an export activity, since internal demand absorbs only some 20% of total landings.

Commercial fisheries in Argentina can be traced back to the 19th century. Buenos Aires has had a fish supply since colonial times. By the turn of this century, colonies of fishermen were active in Buenos Aires and Mar del Plata. By 1930, steam fishing boats were providing a steady supply of iced fish - mainly hake, and fish cold storage facilities and ice plants were functioning in Buenos Aires and Mar del Plata.

Frozen fish was exported for the first time in 1932, but regular export flows were not developed until the late 60s following an FAO-UNDP project. Other early exports were shark liver oil (very active during World War II) and salted anchovy (following the fluctuations in anchovy capture in Spain). The canning industry started to function in the early 40s, utilizing fish caught by the coastal fleet of Mar del Plata and Necochea.

The internal market was always small and seasonal (with increased consumption during Easter and summer), and total catches remained relatively small until export markets started to develop in the 60s and 70s. Fishing in the Patagonia region (mainly Rawson) was active in the late 40s, and a coastal fleet used to move there during summer time to catch shrimp (catches decreased in the 50s due to different factors - including ecology, and this fishery was abandoned until it was rediscovered 30 years later, more to the south).

An attempt to develop the fisheries through a state company failed in the early 50s. The idea of state promotion of fisheries in support of the private sector returned about 15 years later (Law 19000) and has remained up to the present. This promotion has been erratic and without either medium or long term objectives. This has reduced the management to day-by-day responses to urgent problems, without a clear long-term perspective. The delay in implementing structural changes, such as the renewal of the very old industrial fleet or developing the fisheries of Patagonia, are clear indications of the lack of a continuous fishery policy.

Up to the mid 50s, a large part of the technological knowledge utilized in Argentinean fisheries came with immigrant fishermen, technicians, qualified workers and entrepreneurs from Spain and Italy. Some sectors, such as coastal fisheries, canning and salting, have remained unchanged since then. The canning sector is in crisis due to a mixture of economic problems and obsolescence, but some industries have initiated moves to modernize the sector. There is certainly sufficient technical knowledge and capability to do so. It is likely that other sectors will have to move in the same direction (e.g., the type of coastal fishing vessel utilized in Mar del Plata does not seem the best choice for the weather and sea conditions of Patagonia).

The fish industry has borrowed largely from the experience of the meat industry in the refrigeration field (cold and chill storage rooms, ice plants), light mechanics (stainless steel equipment and machines), and hygiene. However, improvements in specific subjects and areas are necessary (e.g., working lines and machine efficiency).

The boat-building industry is currently building fishing vessels (the fisheries research vessel for Uruguay is under construction in an Argentinean shipyard). However, the industry people complained that, in addition to the cost of locally constructed vessels, the design does not seem to them to be optimum for the different regional conditions. As this point of view was indicated in Mar del Plata and Patagonia for different type of fisheries, it seems that research on fishing vessel design is necessary.

All the fleet was of the "fresh" type until the middle 70s, when factory trawlers were introduced (under pressure from the state) in order to promote fish captures mainly on the Patagonian shelf. The declared objective was to achieve catches of one million tons per year, but this target was never reached. Total catches have fluctuated around half that level.

Fisheries development through the production of commodity type products for external markets, mainly based on industrial capture of hake and squid, has been and still is the key concept both at private and state levels. The shrimp ("langostino") fishery is still perceived as a "bonus" despite its economic importance. A true shrimp fishery with appropriate vessels and nets has not yet been developed, and factory vessels intended for hake and squid are utilized as shrimpers.

The increased fishing effort in the Argentina-Uruguay zone, the fishing inside the Falkland - Malvinas exclusive zone, the fishing in the adjacent zone by third party unregulated vessels, and the fishing by foreign vessels (authorized and unauthorized) within the Argentinean EEZ is perceived by Argentineans as a threat to the resources, in particular hake and squid. The subject is naturally very political, and discussions about resources and catches lack the transparency necessary to think in terms of rational development (investment, fishing boat and gear development, product and market development) and management.

The continuous discussion about the hake and squid problem obscures the possibility of a parallel development based on underexploited coastal resources (with the exception of the Buenos Aires province north of Quequen, and some specific places in the Patagonian gulfs). Certainly the lack of manpower and facilities (harbors) has hindered such development in Patagonia, but nevertheless the development of a non-commodity high value fishery seems feasible.

Scientific Research

- *Instituto Nacional de Investigacines y Desarollo Pesquero (INIDEP)*

INIDEP was preceded by a Marine Biology Research Institute, which was jointly funded and staffed by three major universities. The Institute was set up in 1977. Other research areas, such as gear technology, were added later to its mandate. INIDEP has sole responsibility for all fisheries research in Argentina.

Full-time research staff number 147, in nine grades of seniority. There are 42 administrative posts and 60 research fellowships, which together with 65 crew of the three research vessels gives a total of 314 on the INIDEP payroll (207 researchers and 107 support staff). The research staff are organized in 32 "laboratories" or sections.

The Institute has an uneven distribution regarding seniority; key development areas do not have the most senior and experienced scientists.

Radical changes in INIDEP's structure are being planned. This includes a program of regionalization, to which the Under-Secretary of Fisheries is committed. The latter policy, at least in part, is due to political pressure from the provinces, many of which already have research institutes or at least the means to provide a basic infrastructure for such a decentralization program. Participation of the private sector in INIDEP's research programme formulation is also in the government policy. Apart from these two aspects, no clear ideas seem to have yet emerged as to exactly how INIDEP should be restructured. There is general agreement, however, among everybody to whom the mission spoke, that extensive changes are essential in

order to overcome the serious organizational and personnel problems which beset INIDEP and which effectively prevent it from having any serious impact on fisheries development.

Along with the political and economic problems which have afflicted Argentinean state agencies in recent years, INIDEP appears to be undergoing a crisis of identity, in that it appears uncertain of its role in both potential sectors of its operation - academic research and applied (development-oriented) research. The mission was told that up to now there has been no political will to change this situation, but that such a climate now exists. Advantage must be taken of this development, but the size of the task is daunting.

The acting Director of INIDEP (appointed at the beginning of August 1989 and who has for the moment the title of "Interventor") has set up two advisory commissions to plan the restructuring of the institute - one management oriented to advise on internal reorganization, and the other for research planning. The latter will include fishing industry entrepreneurs, provincial authorities and eventually, it is hoped, the master fishermen's union. The first commission is already at work; the second one was scheduled to commence on September 1989.

The INIDEP "Interventor" and his Scientific Director see the setting up of these commissions as a positive and constructive development, and one which is in sympathy with the current political climate. As mentioned above, however, no ideas appear to have yet been developed concerning the type of structure which should replace the present INIDEP. They agree that there should be a change in the INIDEP law, and see the following as key features in the future development of fisheries research activities:

(i) the institute should receive concrete indications from the industry regarding research requirements;

(ii) the industry should make a contribution to research funding;

(iii) the institute should receive not only the required equipment and structure, but also the financial resources to utilize them fully; the institute staff feels that it might come partly from industry; they would also value political support from the industrial sector;

(iv) a body should be created to manage the research vessels in cooperation with the provincial governments and the private sector.

Biology has a very long tradition in Argentina. Studies on fish species - marine and freshwater, started towards the end of the 19th century. A small marine biology station was founded in Mar del Plata at the beginning of the 20th century. For many years and with few exceptions, the main aim of research in marine biology was linked to basic aspects such as taxonomy, feeding habits (trophic relationships), etc. The main universities have produced professionals in this area for more than 50 years. In the late 60s, and following the FAO-UNDP project, the interest in fisheries biology started to grow, and new areas such as resource evaluation, ecology, model development, etc., were added.

Until the late 60s, research was almost entirely academic in nature and had virtually no impact on fisheries development. The FAO-UNDP project attempted to modify this situation, but the communication between research and industry decayed immediately after the project finished.

Research in areas other than biology (quality control, fish composition, fishery economics, etc.) started following the FAO-UNDP project. Some innovative research (e.g., on fish spoilage or in biochemistry) had been done before, but not following a systematic way. A group which started to work on fish technology in 1971 at the University of Mar del Plata was transferred to CITEP[2] in 1975. The idea of the need for a multidisciplinary approach to tackle the fishery problems started to gain consensus during the late 70s.

2 Centro de Investigaciones de Tecnologia Pesquera (see later).

First-line researchers are very scarce and proper training of human resources has been severely affected by the dramatic economic situation.

The Department of Fishery Economics of INIDEP has a staff of five persons including the head of the Unit who is a member of the Institute staff. The rest of the staff consists of two technicians (INIDEP), and two graduates in economics who hold fellowships from INIDEP and the University of Mar del Plata respectively.

The Unit has coordinated several surveys on the fleet and industry. These took place in 1972, 1978, 1982 and 1987. In regard to the evolution of the fleet, there is information available from 1960. Based on the data base constructed on the results of the surveys, two main types of studies were conducted. One group of them was related to the assessment of the evolution of the fisheries' economic structure and the other to short term sectoral studies. At present, the Department is working on three main topics. It is participating in a joint research activity with the hake stock assessment group trying to develop a bio-economic model for that species.

Another line of work is the development of indicators to measure coastal and industrial fleet efficiency and productivity.

A study is also being conducted to assess the level of technology acquired by the fisheries sector during the last twenty years.

The impact of the studies prepared by this Unit on the decision-making process is very limited. They are mostly descriptive.

Furthermore, the bio-economic modelling has not yet been useful in providing any practical results. The Department is not involved in any long-term fisheries strategic planning.

At INIDEP, investigations on fish product technology are divided among four laboratories, with 8 professionals, 2 technicians and 9 fellowship holders. They cover a wide range of specific fields (18). Actual research is limited due to budgetary constraints, and the laboratories/pilot plant are not adequate. It seems that they have a relatively good degree of communication with industry. However, in practice, activities are hindered by legal considerations. Project titles suggest that some of the research activities may overlap with those of CITEP, but a more detailed analysis reveals that specific subjects and research levels differ significantly.

- *Centro de Investigaciones de Tecnologia Pesquera (CITEP)*

CITEP is located in Mar del Plata and is mainly devoted to post harvest aspects of fish utilization, both at technological and basic level. CITEP comes under the National Institute of Industrial Technology (INTI) system of research centers. It was created in 1975, with the support of the National Council of Scientific Research (CONICET) and the Commission of Scientific Research of Buenos Aires Province (CIC).

The executive board of CITEP is constituted by INTI, CIC, three industry associations - (i) the Argentine Association of Fish Processing Industries (fresh and frozen fish), (ii) the Association of the Fish Industry of Mar del Plata (fish canning, salting and drying) and (iii) the Argentine Ship Owners Association (trawlers) - and one technical foundation (also sponsored by the industry). CITEP has a staff complement of around 36 people, of which 30 are researchers in the field of chemistry, biochemistry, microbiology, engineering and economics. Half the staff is paid by INTI, 40 % by CONICET and 10 % by CIC. The current contribution of the industry is around 5 % of the total budget, and INTI believes that this could be increased. The industry participates in deciding CITEP research projects.

The current projects of CITEP are:

(i) fresh and frozen fish products (4 researchers);

(ii) myofibrillar protein behavior during fish storage in ice (5 researchers);

(iii) fish proteases and lipids (7 researchers);

(iv) cured fish products (4 researchers);

(v) economic engineering for the fish industry (3 researchers);

(vi) canned fish products (3 researchers);

(vii) design of machinery for the fish processing industry (2 researchers);

(viii) packaging of food products (2 researchers).

Each project has a researcher in charge.

After a period of about 10 years during which the Centre gathered specific knowledge and expertise, CITEP is now in a position to transfer knowledge to the industry on a firm basis.

Since its creation CITEP has pursued a strong and continuous policy of training people for the production sector. In association with the Engineering School of the University of Mar del Plata, it has organized several general training courses on fish technology for professionals from the industry. CITEP also regularly conducts short training courses on specific subjects.

RESEARCH ORGANIZATION

Funding

The 1988 budget of CITEP totalled US$ 900 000, of which 77 % come from INTI, 18.6 % from CONICET/CIC and 4.5 % from industry. The INTI contribution is divided between salaries and overhead in the ratio 30:70 respectively. Regarding industry funding, CITEP's goal is to raise it to 10 % of the total budget.

The INIDEP budget for the period 1984-1988 is shown on Table 2. The 1988 total was only 37% of the 1987 figure.

Prioritization

For CITEP, the current processes and species utilized by the industry have priority.

In INIDEP, the mission was unable to obtain any clear indication of what criteria are used to evaluate what programmes should be initiated, maintained or discontinued. It was not clear that any system of prioritization exists or existed, at least in the recent past.

Contact with the Industry

CITEP's contracts with the industry are close, continuous and productive (as discussed earlier).

Industry's priorities for research are discussed within the management board of CITEP, of which the industry is a member. With the exception of some very basic research activities of dubious applicability (e.g., studies on enzymatic hydrolysis of fish), the industry agrees on the current subjects, provided their

practical importance can be proved and explained. The industry, however, is not only interested in research which can be applied directly, but also in basic research which can provide a better understanding of the changes occurring in fish and fish products.

In INIDEP, on the other hand, communication between the institute and the industry seem to be negligible. According to information obtained, it is limited to personal contacts such as those developed in obtaining catch samples. From the industry side, however, the opinion was unanimously expressed to the mission that there is no communication in either direction. The industry says it is impossible to obtain any information from INIDEP concerning catch possibilities, nor are they able to make any input to INIDEP's research planning. "Too little information, and not of the right kind" was how one entrepreneur put it.

Table 2. INIDEP budget of expenditures (in million of Australes of December 1988, P.M.N.G. index)

CONCEPTS	*1984*	*1985*	*1986*	*1987*	*1988*	*VARIAT. (% 88/87)*	*STRUCT. (% 1988)*
CURRENT EXPENDITURES	22.75	35.51	79.74	103.39	37.72	36.48	41.23
PERSONNEL	17.22	28.01	39.55	62.73	22.25	35.47	24.32
GOODS AND SERVICES	5.33	7.50	25.78	27.06	12.82	47.38	14.01
TRANSFERENCES (fellowships, UNMP, etc.)	0.00	0.00	0.16	0.64	1.92	300.99	2.10
INT.EXTERNAL DEBT	0.00	0.00	14.25	12.97	0.73	5.63	0.80
CAPITAL EXPENDITURES	0.58	0.16	2.07	3.24	3.48	107.32	3.80
EXT.DEBT PAYMENT	0.00	0.00	27.32	35.72	12.56	35.16	13.73
TOTAL EXPENDITURES	46.09	71.10	188.87	245.75	91.48	37.22	100.00

The ship owners told the mission that they are willing to provide facilities for INIDEP scientists to go on board their fishing vessels to gather data, but INIDEP seemed unaware of this. They said that obtaining catch related data from the industry was very difficult, and depended on building up and carefully nurturing a friendly relationship with individual skippers. The industry representatives to whom we spoke were very clear in their own minds that INIDEP has "special internal problems" which must be resolved before fruitful links with the industry can be set up. "For the moment, INIDEP for us is a ghost", the mission was told.

Internal Coordination

There appear to be no major problems of internal coordination in CITEP, which has a relatively small and highly motivated research staff.

Internal coordination is implemented between the "laboratories" (sections) of INIDEP, in the sense that researchers from one section will join with those of another section on certain projects, in order to provide specialist expertise where required. It is uncertain what level of planning goes into this procedure, however. It seems inevitable that such internal links must be a regular feature of INIDEP programs, given the degree of overlap apparent in the "laboratory" titles given in the annex. Alternatively, it is possible that

there is widespread duplication of research effort. We were unable to obtain clear evidence to suggest which of these scenarios is in operation, but it appears likely that overt duplication is avoided by collaboration between INIDEP sections, even though this may be achieved in a haphazard way.

International Coordination and External Aid

International coordination in CITEP is carried out through INTI, and CITEP has good contacts with similar institutions overseas. CITEP has received a pilot plant for development of fresh and frozen fish products from UNDP (through INTI), and is currently participating in the FAO Cooperative Research Programme in Latin America (development of breaded fish products).

Some fisheries scientists in INIDEP have participated in training courses organized by international development agencies. Various assistance programs available from foreign government agencies have also enabled some researchers to travel and work abroad. The present level of expertise seems adequate to enable standard assessment techniques to be applied to the stocks fished by Argentina, but facilities should be provided and maintained in assessment techniques as these become available.

IMPACT OF RESEARCH ON THE INDUSTRY

Industry Participation in Research Planning

Contact between INIDEP and the industry is virtually non-existent. The entrepreneurs are anxious to collaborate with INIDEP at senior research management levels in order to identify priority areas in which research could be carried out to meet the industry's needs. They see the best way to implement this as obtaining membership of the INIDEP management board.

Industry representatives volunteered to us that they would be willing to fund research projects which matched this criterion. They also told the mission that they would be prepared to help INIDEP construct a long-term research and development plan.

The industry expressed satisfaction with the results of INIDEP's shrimp research program, but reiterated that the information they had been given concerning the stock abundance of other species was totally inadequate in terms of both quantity and quality. They found it impossible to find out the basis of INIDEP assessments and the reasons behind such fisheries management proposals as were passed to the industry.

Industry Priorities for Research

Topics identified by the industry representatives as being among their top priorities were:

(i) to assess the distribution and biomass of fish resources available within Argentina's EEZ;

(ii) to determine the size and design of fishing vessel best suited to exploit the target resources identified in the EEZ, and to develop new markets;

(iii) to develop a long-term research and development plan which would allow rational exploitation of the resources without overfishing;

(iv) to improve the present exploitation pattern (particularly for hake) and to achieve more added value through product development.

FISHERIES POTENTIAL AND RESEARCH IN PATAGONIA

Puerto Madryn

In Puerto Madryn, the Centro Nacional Patagonico (CENPAT) carries out research in various subject areas: marine science, meteorology, arid zone ecology and other terrestrial topics. A total of 134 scientist work there, about 20 in marine biology and approximately another 20 in other branches of marine research.

Funds come mainly from CONICET[3], but also from SECYT, the universities and the provincial government. All four fund individual projects, but no programs, and this hinders the development of any multidisciplinary approach. On the other hand, Madryn, as a coastal town adjacent to sheltered waters with at least one significant industry (aluminum ore processing), seems to be a suitable location for aquaculture and environmental studies. Such programs could be the best vehicles for developing a less individual approach and for reducing the sense of isolation which was expressed. This isolation applies not only to the separation of individual projects within CENPAT, but to the lack of contact with other institutes. The mission was told, for example, that CENPAT scientists have no access to any research vessel, but in Mar del Plata it was informed that INIDEP has surplus ship time.

The aquaculture project at CENPAT (on scallop) is still at the laboratory stage, and industry is not prepared to give it any financial support until it gets to the pilot stage. The industry, apparently, is not in a position to take an investment risk approach.

The opinion was expressed that at least some CENPAT researchers would welcome closer contacts with industry so that industry's priorities could be implemented in the research projects.

As elsewhere, the CENPAT library particularly suffers from lack of funds, and several scientists are paying their own subscriptions to technical journals.

Another difficulty is the lack of continuity in scientific research. Priorities alter with every change of government.

Comodoro Rivadavia

The mission met a group made up of members of the science faculty of the University of Patagonia of St. John Bosco, the Regional Health Council, and representatives of the municipal authority's Committee on Development and Marine Affairs. This group has prepared a document expressing the unanimous views on the urgent need to develop Patagonia's fishery resources, on the necessity for scientific researchers to work closely with the University to train future fisheries scientists in the specialized research techniques, and on the great potential contribution which a developed Patagonian fishing industry could make to the region in both economic and social terms.

The proposal has four main points:

(i) bring fisheries scientists to Patagonia;

(ii) initiate a resource evaluation program;

(iii) set up specialized postgraduate university course in fisheries science (not in the too broad field of marine biology);

3 Consejo Nacional de Investigaciones Cientificas y Tecnicas.

(iv) initiate development programs in fisheries, aquaculture, product technology and socio-economics (in that order).

They see a three-year (minimum) foreign aid program as being necessary to teach and organize, with a goal of at least 25-30 people and up to 30-40, to form a core of institution and research evaluation. In order to guarantee continuity of trained output, the Comodoro Rivadavia group recommends that this teaching and research facility should be located in the University.

The mission feels that the document produced by the Comodoro Rivadavia group is a soundly based proposal, and is one of the most clearly argued and positive set of ideas which it encountered during its trip.

CONCLUSIONS

The relationship between research and development and the fishery industry should be analyzed in a more general framework. The country still lacks a proper fisheries development plan and, consequently, Government agencies and the industry have been unable to put forward a clear and continuous set of demands for scientific and technical knowledge.

As already described, the relationship between INIDEP (the main fisheries research body in Argentina) and the fishing industry is poor. The impact of research on fisheries development shares the same characteristics.

To better understand the reasons lying behind this situation, it is necessary to refer to national as well as sectoral constraints.

A general factor that has significantly affected all sectors of the economy, including fisheries, has been the long-lasting economic and political instability of the country. While fisheries research was undergoing growing budgetary problems, the industry had to cope with the fluctuations of either the national economy or the international markets and their requirements.

Paradoxically, the law which gives INIDEP a virtual monopoly in fisheries research and related fields hinders rather than facilitates the planning and implementation of productive research activities in the field of fisheries and aquaculture development. There are two main reasons for this. Firstly, the legislation of exclusive responsibility for fisheries research to INIDEP was not accompanied by sufficient resources to carry out this large, complex and vital task. Secondly, because the responsibility under the law was given specifically to INIDEP, it has been legally impossible for other agencies to take a share of the workload and for INIDEP to establish flexible and fruitful working relationships with provincial governments, universities and other research institutions. Argentina's economic situation has compounded these problems, while the absence of a national policy framework for fisheries, covering research as well as development, has prevented the establishment of clear objectives and research priorities.

4. COMISION TECNICA MIXTA DEL FRENTE MARITIMO

INTRODUCTION

The Comisión Técnica Mixta del Frente Marítimo is a binational body based in Montevideo (Uruguay). Is is formed by representatives of Argentina and Uruguay, and has been created by the "Tratado del Río de la Plata y su Frente Marítimo" signed by both countries in November 1974. The Commission legally initiated its activities in February 1975, and the first Ordinary Session took place in 1976. Since then the Commission has held 98 Ordinary Sessions.

Article 80 of the Treaty indicates that both parties will set up a Commission with equal membership from each country. The Commission objectives are to undertake studies, to adopt and coordinate plans and measures related to the conservation, preservation and rational exploitation of the living resources, and to protect the marine environment, in the common zone.

The common zone (Art. 73) is situated in front of the mouth of the Rio de la Plata river from its external border which is determined by a straight line running from Punta del Este (Uruguay) to Punta Rasa de Cabo San Antonio (Argentina). The zone is delimited by two arcs of radius 200 sea miles, whose centers are at the above mentioned geographical points of Uruguay and Argentina respectively. The territorial seas of the two countries (12 miles from base lines) are excluded from the common zone.

In summary, the main functions of the Commission are the following:

(i) to determine catch quotas by species and to allocate them between both parties, as well as to adjust such quotas periodically;

(ii) to promote joint studies and scientific research - particularly inside the common zone and with special reference to the evaluation and conservation of the living resources and their rational exploitation, and to the prevention and elimination of pollution and other harmful effects that could derive from the use, exploitation and exploration of the marine environment;

(iii) to formulate recommendations and to present projects designed to ensure the preservation of the value and equilibrium of bio-ecologic systems;

(iv) to establish regulations and measures related to the rational exploitation of the species in the common zone and to prevent and eliminate pollution;

(v) to formulate preservation, conservation and development plans for living resources in the common zone which will be submitted for the consideration of the respective governments;

(vi) to promote studies and present projects on the harmonization of related legislation of both parties.

The Commission is organized at three levels. The executive level comprises the plenary, ordinary and extraordinary sessions of the Commission.

A second level is formed by subcommissions, such as Living Resources, Pollution Prevention, Administration and Finance, and Legal Matters.

The technical level consists of several working groups: Programming and Evaluation, Hake, Coastal Resources, Economic Criteria, Legal Experts and Cartography.

Working groups are created by the Commission in relation to the approved programs of work.

The activities of the Commission, and its technical and administrative staff, are funded by contributions of both countries. Due to the present economic difficulties faced by Uruguay and Argentina, the Commission has authorized the Technical Secretary to initiate a search for funding sources in the private sector and in national and international donor agencies.

RESEARCH RELATED ACTIVITIES

Once the Commission assigns subject matter priorities and the related working groups are set up, the research activities are implemented according to their specific requirements. Some of them are conducted jointly while others are undertaken by either of the two research institutes, INAPE (Uruguay) or INIDEP (Argentina). In any case, the results of research activities are discussed within the framework of the bi-national working groups.

The most important research activities of the Commission cover four main areas:

(i) Living resources

This includes the Fishery Resources Research Campaigns. They are conducted by both national institutes utilizing at present three research vessels, two from INIDEP and one from INAPE. For 1989, the Research Plan includes the implementation of three joint research campaigns to evaluate hake (Merluccius hubbsi) and its by-catch, and two joint seasonal campaigns to evaluate coastal resources - in particular croaker and sea trout (striped weakfish). A campaign on mesh selectivity related to coastal resources is also planned.

The annual organization of scientific symposia is another activity included in this research area. These meetings have taken place since 1984 with the purpose of disseminating the results of the scientific studies.

At present, annual meetings on technology and fishery economics are also organized. They serve the same purpose as the symposia and replace the former meetings for fishery entrepreneurs which were cancelled due to lack of success with the recipients.

Related to the symposia and meetings mentioned above, and the other regular activities, the Commission periodically issues two publication series: "Publicaciones de la Comisión Técnica Mixta del Frente Marítimo" and "Series Circulares".

(ii) Pollution prevention

In this area, the Commission coordinates its work with the bi-national bodies in charge of the management of the Uruguay and Rio de la Plata rivers. It also has a close relationship with the respective Ministries of Defence, Navy, Coast Guard and Hydrological Resources Offices.

(iii) Legal Matters

Experts of both countries are preparing harmonized fishery regulations based on existing legislation.

(iv) Cartography

Experts of both parties are preparing a revised edition of the common zone chart.

RELATIONSHIPS WITH THE INDUSTRY

In spite of past efforts, the Commission, being an inter-governmental body, has not succeeded in attracting the full interest of the private sector in its activities. However, the industry is aware of them since they involve discussions related to the adoption of quotas in the common zone and some applied research considered necessary (e.g., mesh size for hake, net and vessel design).

On the other hand, it appears that entrepreneurs of both countries often meet to discuss common matters although they have different interests and opinions regarding the fishing effort to be applied in the common zone.

In regard to the two main levels of discussions, representatives of the Argentinean private sector showed little interest in the technical meetings. They expressed the desire to participate formally in the political level of the Commission, at which the private sector of neither country has any representation. They explained their absence, shared also by Uruguayans, from the former meetings for Fishery Entrepreneurs, by pointing out that the subjects under discussion were often too technical and were not of sufficient interest to the industry.

POSSIBILITIES AND LIMITATIONS

The Commission can be considered a very important body related to fisheries policies and research in the sub-region. Although its jurisdiction is limited to a small area of the South-West Atlantic, some contextual features exist which sustain this perception.

There is no other active international, regional or sub-regional body in the area, and in practice the Commission constitutes the only formal forum to discuss fishery matters, especially technical aspects, in spite of the geographic limitation mentioned above.

Additionally, the creation of the Commission is due to the joint initiative of the two neighboring countries alone. It has been solely funded by their national contributions and has, from a technical point of view, received only very limited support from international organizations.

On the policy side, the Commission has failed to meet its main mandate. Up to now, it has been unable to establish catch quotas for each country in the common zone and the fixation of the total catch for the area concerned (200 000 t) has been reached, according to information obtained, only through a rather cumbersome procedure. The main reasons of this failure could be the diverse structure of the fishing industries as well as diverse national fisheries policies. The joint technical work conducted at the research level, in particular in biology, can be considered satisfactory, although disagreements also appear at this stage of discussion. An important conflictive topic arises from the divergent interpretation of some provisions of the Treaty, in particular those referring to the economic criteria to be used for establishing the quotas for each country.

The Commission has been very successful in developing a number of symposia and technical meetings, enlarging the original subject range from biology to fishery economics and technology. These meetings have, as their primary purposes, the promotion of contacts and exchange of ideas among experts of both countries, and to make their work known.

However, they are increasingly attracting scientists from other countries of the region such as Brazil, Chile and Perú, and providing the Commission with the character of a subregional forum for fishery scientists.

The Commission is also organizing training courses in different disciplines,and has received some technical assistance from FAO in this activity. Travel costs and per diem expenses for a limited number of participants on these courses are paid by the Commission.

There is good potential for increasing the development of these technical activities. The long term work of the Commission in the regional context creates the appropriate framework for its strengthening.

CONCLUSIONS

As mentioned before, the Commission failed in meeting its main objective - i.e., the fixation of catch quotas for each participant country. Nevertheless the technical work developed and the discussions held at different levels in seeking an agreement has not insignificant value since they have created in both parties full awareness of the need for resource management and conservation. This consciousness has increased lately by the growing fishing effort and some hake population fluctuations in the area. This will place pressure on the Commission to reach decisions on quotas.

The joint research effort has also been fruitful. It has provided a better knowledge of the resources and has established a very fluid relationship among scientists of both countries.

The training activities and technical meetings organized by the Commission are very successful in regional terms. It should be stressed that they are prepared without any international funding and little technical cooperation from international agencies.

The Commission is facing similar financial shortcomings as the member countries do at present.

An interesting feature is that it is authorized by its statutes to seek funding autonomously. This provision, fully implemented to-day, together with its long established status and the technical prestige acquired in the region creates the potential for a further technical strengthening. It could well serve as a regional launching platform for enlarged international effort in terms of fishery scientific research and training.

5. GENERAL CONCLUSIONS

The mission visited a wide range of research institutions and met leading representatives of the main industries, both in Argentina and Uruguay.

There is in both countries a reasonable level of expertise in the different scientific and technological disciplines necessary for fisheries development.

In some areas, notably fishery biology, fishing gear development, fishing boat design and fishery economics, there is an insufficient number of trained people. This is linked to the lack of specific training programs aimed at producing new experts in such fields.

Above all there is very poor communication between the research institutions and the industry (with the exception of the institutions specifically devoted to post-harvest technology). In Argentina, there is also poor communication between research institutions themselves.

There is a general difficulty, due to economic constraints, in maintaining international contacts with institutions working in related fields. Participation in scientific and technical meetings at international level and visits by foreign experts are practically nil. In many cases, there are severe difficulties in purchasing technical journals and books.

Salaries of scientists are very low in absolute and relative terms. This forces them to seek alternative or parallel activities or to emigrate.

In summary, the main shortcomings which limit the impact of scientific research on the development of the fishing and aquaculture industries in Uruguay and Argentina are:

(i) lack of funds for adequate numbers of research staff, research vessel operation and infrastructure;

(ii) deficiencies in research structures;

(iii) poor communication between research and industry.

An international research centre, conducting innovative targeted research, would not facilitate scientific cooperation with research institutes in developed countries. Instead, the scientific work of the Comision Tecnica Mixta del Frente Maritimo should be used as the foundation for any such international input to the institutional structures of the region.

Annex I
List of Institutions Visited and Persons Met

URUGUAY

Instituto Nacional de Pesca (INAPE)

Pedro C. Marquez Strada	Director General
Dr. Hebert Nion,	Director, Division Biologica Pesquera
Cr. Diego Artagaveytia	Director, Div.Economia Pesquera
Dr. Amador Ripoll	Sub-director, Division Industrias Pesqueras and Co-ordinator, Pesquerias Artesanales
Dr. Eduardo Morales	Director, Division Industrias Pesqueras

Instituto de Investigaciones Pesqueras (INIP)

Dr. Enrique Bertullo	Director

Comision Tecnica Mixta del Frente Maritimo

Lic. Hector Otero	Technical Secretary

Camara de Industrias Pesqueras del Uruguay (CIPU)

C/F (R) Edinson Errecart	President
Dr. Ernesto Gravier	Executive Secretary
Sr. Mateo Frugoni	Asociacion de Armadores Pesqueros
Dr. E.Bertullo	INIP Director; CIPU scientific adviser

United Nations Development Programme

Mónica Massey de Hoyos	*Deputy Resident Representative*

ARGENTINA

Ministry of Economy

Secretariat of Agriculture, Livestock and Fisheries

Undersecretaiat of Fisheries

Dr. Luis Otero	Under-Secretary
Dr. Anibal Enrique López	Adviser to the Under-Secretary

Ministry of Foreign Affairs

Dr Aldo A. Dadone	Advisor to the Minister on International Fishery Matters

Consejo Nacional de Investigaciones Cientificas y Tecnicas (CONICET)

Dr. G.E.Joandet	Vice-President

Intsituto Nacional de Tecnología Industrial (INTI)

Ing. Carlos Ernesto Giudicci	President in charge of
Dr. Enrique Grundhut	International Affairs

Centro de Investigaciones de Tecnologia Pesquera (CITEP)

Ing. Aurora Zugarramundi	Director
Ing. Ricardo L.Boeri et al.	

Cámara Marplatense de Industriales del Pescado (canning, salting, drying)

Dr. Miguel A.Dobarro	President

Camara Argentina de Procesadores de Pescado (fresh, frozen fish)

Homero R.Canepa

President

Camara de Armadores de Buques Pesqueros de Altura

Lic. Roberto Baltar	Executive Secretary

Instituto Nacional de Investigacion y Desarollo Pesquero (INIDEP)

Dr. O.J.Lascano	Interventor
Dr. Luis S.Monticelli	Scientific Director
Dr. Boschi	Researchers
Dr. Fenucci	
Dr. Bastida	
Dr. Cuello	
Dr. Cousseau	
Dr. Verazay	
Dr. Bertolotti.	

Patagonian National Center (CENPAT), Puerto Madryn

Dr. Marcelo Salzo	in charge of marine biology research

Federation of Patagonian Industries, Puerto Madryn

Dr. J. Soriano	Vice-president

University of Mar del Plata (Argentina) / University of the Republic (Uruguay)

Dr. P. Penchaszadeh	in charge of organizing jointpostgraduate program on Marine Science

National University of Patagonia, Comoro Rivadavia

Ing. Irene Ormachea	Dean
Dr. Susana Leon de Uriarte	Vice-Dean Faculty of Natural Sciences
Dr. Hector E. Zaixso	Professor

Dr. Alicia Boraso de Zaixso	Professor and Secretary of Science and Technology

Municipal Commission for Marine Affairs, Comoro Rivadavia

Dr. Miguel Webb	Pediatrician Zonal Health Council
Ing. Maria Flor Pola	Direction of Planning, Promotion and Development, Municipality of of Comodoro Rivadavia
Architect L.M. Madueño	Government Technical Subsecretary
Jorge Holomenski	Manager, Frigorífico Siracusa S.A.

United Nations Development Programme

Ignacio Pérez Salgado	Resident Representative
Eduardo Niño-Moreno	Deputy Resident Representative
Eduardo Rodríguez Vergez	Programme Officer

Instituto Interamericano de Cooperación para la Agricultura

Ing. Marcelo Ferrada Cortés	Coordinador Proyecto Pesquero

Fisheries and Aquaculture Research Capabilities and Needs in Latin America: Studies of Chile, Ecuador and Peru

MISSION:

24 July - 13 August 1989

MEMBERS:

Jean-Paul Troadec (Leader)

Max Aguero

Gilles Boeuf

Hans Henrik Huss

I. INTRODUCTION

ORIGIN AND PURPOSE OF THE MISSION

A Study of International Fishery Research needs in developing countries (SIFR) has been undertaken at the initiative of a group of multilateral and bilateral donor agencies[1] The Study sought to determine:

(i) the priority needs for fisheries and aquaculture research;

(ii) the present capacities of developing countries to undertake the research that is needed; and

(iii) the ways in which donors could contribute effectively in supporting desirable investigations.

The decision to initiate the Study was based on three considerations:

(i) the recognition that, during the past decades[2], fisheries development projects have had, in general, a low rate of success, and the desire of aid agencies to have a diagnosis of the sector to see whether development approaches could be improved by a better appreciation of the sector particularly its features and dynamics;

(ii) the suggestion, made on several occasions, to extend CGIAR activities to aquaculture, to stimulate the development of small-scale operations in developing countries; and

(iii) the desire of donor agencies to improve the aid they provide to fishery and aquaculture research through better coordination,

The Study was requested to assess the research needs over the next 25 years, and to propose a strategy for action for the next 10 years. The review, therefore, focuses on strategic aspects.

The Study assessed the research capabilities of developing countries through a series of missions in selected geographic areas. The general terms of reference and composition of such missions are given in Annex I.

Chile, Ecuador and Peru were chosen because of the economic importance of their marine fisheries, the scientific problems associated with the instability of small pelagic stocks instability, the existence of significant freshwater fisheries (Amazon), the dynamic emergence of large-scale aquaculture industries (shrimp and salmon), the existence of appreciable fishery and aquaculture research capabilities, and the substantial aid programs which fishery research benefitted during the past 25 years.

The mission was composed of:

Jean-Paul Troadec,	Mission leader,
Max Aguerro,	Resource economist,
Gilles Boeuf,	Aquaculture biologist,
Hans Henrik Huss,	Bacteriologist and fish technologist.

1 SIFR, 1989." Assessing Fisheries Research Needs in Developing Countries. An Approach and a Framework". First Meeting of the Advisory Committee, Washington, DC, USA, May 15-17 1989.

2 World Bank, 1984. "Harvesting the Waters. A Review of Bank Experience with Fisheries Development". The World Bank, Operations Evaluation Department, Report No. 4984.
" " , 1986. "World Bank Paper on Harvesting the Waters. A Review of Bank Experience with Fisheries Development". Fishery Development Donor Consultation, Paris, France. Oct. 13-15, 1986.

Three mission members had direct experience of fishery and aquaculture research in the area.

THE APPROACH

Within the time available, a quantitative assessment of national research capacities could not be undertaken. Therefore, hard data (e.g., on investments in research as percentages of GNP, man-years and expenditures by major programs, scientific publications, number of citations in international journals, ...) were not systematically collected. The method which was adopted consisted of interviews of management and staff in national research institutions, and of major research users (public and private sectors, large-scale and small-scale sectors). Development agencies (national, bilateral and international), and national planning and research administrations, were also consulted. Though less quantitative, this approach drew on the experience accumulated in the countries. The list of institutions and organizations visited is given in Annex II, together with the mission's itinerary. A list of topics and criteria for evaluation (Annex III) was prepared prior to the mission.

The assessment is affected by the personal views of the mission members. Criteria for assessing research capacities were derived from the mission's understanding of the future development opportunities and management needs of the sector, and their implications of research priorities. Annexes IV and V give a brief account of the changes that are affecting research and of certain definitions of research. Research capacities in the three countries were analyzed by reference to this understanding of the present and future research needs.

Despite the limitations of the approach, the mission got evidence that its conclusions were reasonably accurate, if not exhaustive, or balanced. This is based on the consistency of answers obtained from different sources, the analysis of information reviewed (e.g., relative importance of research programs as indicated by staff and discipline distribution, their past evolution, balance between scientific and technical publications, and "grey" literature,...), and the convergence of opinions developed by mission members.

The mission could not have accomplished its task without the cooperation of national administrations and research institutions. The Minister of Fisheries in Peru, Vicealmirante A.P. Willy Harn Esparza, generously shared his limited time to give his views on the state of Peruvian fisheries and the expected inputs from research. The mission benefitted greatly from the experience of directors and senior staff of fisheries administrations and research institutes, who provided information and explanations in a highly constructive manner. The Camara de Camaroneros in Guayaquil (Ecuador) organized a visit to a shrimp farm. In Ecuador, the mission was directly assisted by Ms. P. Gomez, from CONACYT, and the Economist E. Castro, from CONADE, who both collaborated in the mission work. In each country, UNDP offices diligently and effectively made contacts, organized meetings and provided ground support. In Chile, Principal Program Assistant T. Reich, of UNDP, and in Peru, Engineer E. Pastor, organized the mission's trips and visits.

It is, thus, a pleasure and a duty for the mission to acknowledge these inputs, and to express the genuine appreciation and thanks of its members for the help they received.

The report is structured as follows. Chapter II presents a brief overview of the state of fisheries and aquaculture in the area. Chapter III analyzes the research capacities in the three countries. From this review, opportunities for enhancing the contribution of research to the economic and social progress of the sector are examined in Chapter IV. Chapter V summarizes the mission's conclusions.

Since the purpose of the mission was to identify opportunities for improving the usefulness and effectiveness of research, emphasis is necessarily put on gaps and weaknesses. This is where opportunities for improvement lie. However, the focus put on shortcomings does not imply an overall negative judgement on the state of research in the countries visited. Indeed, many of the weaknesses that were identified can be

observed in many developing and developed countries, an indication that the development of research is a long process, and that, everywhere, its management is complex.

The report does not review the state of research on a country by country basis, nor does it propose country-specific solutions. This was not the purpose of the mission. The six SIFR missions were intended to evaluate, from a geographically balanced sample, the overall capabilities of developing countries in the field of fisheries, aquaculture and aquatic environment research, and major opportunities for improvement over the next 25 years. Therefore, the missions conclusions are not intended to be used directly by the countries which were visited or by aid agencies, but as inputs for the preparation of the Final Report. Still, Chapter V presents suggestions that could be of value to individual countries. However, the Final Report of the Study gives a more comprehensive and articulated analysis of the matter.

2. PRESENT STATE OF FISHERIES AND AQUACULTURE IN CHILE, ECUADOR AND PERU

GENERAL STATE OF THE SECTOR

Chile, Peru and Ecuador are the most important fishing countries of the South American sub-continent. Their aggregate production contributes to 87% of the total landings of the region. Most harvests come from wild marine resources.

Aquaculture production and catches from inland fisheries are comparatively modest in physical terms. Still, significant breakthroughs have been made recently. In Ecuador, shrimp culture, stimulated by a high demand on world markets, has become the second - after oil - source of export earnings. In Chile, salmon culture took off more recently, but is growing rapidly. Benefiting from an increasing demand for freshwater species in local markets, inland fishing and aquaculture are also developing in countries such as Columbia.

Although fisheries and aquaculture have not the same relative importance, nor the same potential for expansion in either physical or economic terms, and their prospects differ among Southwest American countries, they offer considerable opportunities for an increased contribution to national economies.

OPPORTUNITIES AND CONSTRAINTS OF CAPTURE FISHERIES

Coastal waters off the West coast of South America, particularly off Peru and Northern Chile, are among the most productive of the world's oceans. This productivity is generated by southeasterly trade winds which, along the coast, upwell cold, nutrient-rich waters to the surface, euphotic layer. The dynamics of the upwelling system is characterized by high seasonal and interannual variability. Some years, warm, clear, nutrient-poor, oceanic waters extend superficially from the West and the North. This phenomenon, known as "El Nino", generates dramatic changes in the species composition of fishery ecosystems, the productivity of commercial fish stocks, and the performances of the fishery sector.

Off the West coast of South America, fisheries are predominantly based on small pelagic species associated to the upwelling system, with anchoveta, sardine, jack and horse mackerels dominating the group. These species make up three quarters (9,5 million tonnes) of the total landings in the area. Total catches of Chile and Peru amounted to 94% of the overall yield (1987). Most catches of small pelagic species are reduced into fish meal for industrial purposes.

Though, today, Chile and Peru harvest comparable quantities of small pelagic species, their industrial fisheries expanded along different paths. Peruvian catches came back to the current level after recovering from an unexpected collapse of the anchoveta stock in the early 70's. This resulted in a slump of the domestic fishing industry, with dramatic economic, social and political consequences for the whole country. The Chilean fishing industry took off only in the early 70's, and has enjoyed continuous expansion. Since small pelagic stocks are characterized by a natural high instability, this development does not imply that the Chilean pelagic fishery is less susceptible to collapses and economic crises.

In fisheries which are based on unstable stocks, harvesting and processing capacities tend to correspond to or even exceed (see later) production during years of high abundance. This induces excessive investments and fishing rates during the periods of low abundance.

Besides pelagic species, hake and other demersal species, as well as tunas, support important trawl and offshore pelagic fisheries, even if, in physical terms, their catches are much lower. Several mollusc (e.g., clams, cockles, mussels, abalone) are important target species for small-scale fisheries.

Aside from the risk of stock collapse associated with climatic and hydrological changes, fisheries are also vulnerable and economically inefficient because of excessive fishing capabilities built up over years. When fisheries operate under a regime of open and free access to the resources, investments in harvesting and processing capacities tend to exceed levels corresponding to maximum average production of fish stocks. Consequently, substantial economic rents are dissipated. Stock variability is enhanced. The probability of collapse may be increased[3].

The economic and social importance of the fishing industry relates basically to export earnings, employment and food supply. Recreational fisheries play a minimal role in the region. Compared to the high labor intensity which characterizes the small-scale branch, the large-scale industry is capital intensive. Its greatest contribution to domestic economies is in terms of foreign exchange and employment. Its contribution to direct food supply is small. In Chile, Ecuador and Peru, fishery exports are the second most important source of foreign exchange. On the other hand, the small-scale fisheries contribute to approximately 90% of the domestic food supply, and provides substantial employment opportunities in coastal areas.

Though, in physical terms, Chile and Peru rank among the top five world's fishing nations, the fishery sector contributes to less than 3-4% of their GNPs. Made up essentially of small pelagic species, landings command low prices, both locally as input raw material (on the bulk), and as a final commodity (fish meal) on international markets. However, as in most fisheries throughout the world,current shortcomings in management - resulting from the inability to adjust investments to maximize net economic and social benefits - prevent the sector from contributing efficiently to national economies (see Annex IV).

PROSPECTS AND CONSTRAINTS OF AQUACULTURE SYSTEMS

In physical terms, aquaculture production is still modest in South America. With a reported production of 106,000 tonnes in 1986, it represents slightly more than 1% of the world total (estimated at 12 millions tonnes in 1987). However, the take-off of shrimp culture in tropical and sub-tropical latitudes and, more recently, of salmon culture in temperate waters, have been major development events. Because the unit value of products is higher by several orders of magnitude, their importance in monetary terms (of the order of US $ 500 millions for shrimp, and $ 50 millions for salmon) already compares well to that of wild catches.

Ecuador, for example, has become a leading world producer of shrimp (Penaeus vanamei, P. stylirostris). Shrimp production is also increasing in Columbia and Peru (with a production over 6 000 tonnes for an export value of almost US $ 50 millions in the latter country).

Following experiments demonstrating its technical feasibility and economic profitability, salmon culture is growing rapidly in Southern Chile. Production, which was close to 7 000 tonnes for salmon and to 3 000 tonnes (in sea and fresh waters) for trout in 1988, is expected to double in 1990. Already, 2 500 jobs have been created in this industry.

Bivalve mollusc (mussel, oyster and scallop) and seaweeds (22 000 tonnes of Gracilaria in Chile in 1988) are other aquaculture species which are expected to grow significantly in the area.

Although several technical, economic and institutional problems remain to be solved (stabilizing the supply of shrimp larvae and fish fingerlings of good quality, determining optimum stock densities and total biomass to minimize damaging effects on the environment, future development of world markets,

3 See Annex IV for a brief presentation on the implications on research opportunities resulting from the need to design management systems which would improve the effective utilization of fishery resources now that most of the latter are fully exploited.

introduction of adequate use-right systems), aquaculture is expected to contribute further to national economies.

On the other hand, despite interesting technical developments, small-scale aquaculture in inland waters is not making significant progress (aside from the capital intensive production of trout, amounting to 2 650 tonnes in the three countries in 1988). Abundant supplies from capture fisheries in the Amazonian area, income availability, the absence of traditional farming systems, distribution costs, food habits, ... are important constraints which need to be analyzed and quantified to understand the opportunities and conditions for small-scale aquaculture development in inland areas.

Table 1. Annual production of aquaculture (1988) in Chile, Ecuador, and Peru (in tonnes; based on data collected by the mission)

	Countries		
Species	*Chile*	*Ecuador*	*Peru*
Seaweeds			
- Gracilaria	22 000	0	1 000
Mollusc			
- mussels	1 000	0	a few t.
- oysters	1 000	a few t.	0
- scalops	1 000	0	20
Shrimps			
- P. vannamei	a few t.	65 000[a] (1989)	6 000
- P. stylirostris	0	2 500	300
- freshwater species	20	0	20
Finfishes			
- Rainbow trout			
[a] freshwater	1 800	200	650
[a] seawater	1 115	0	0
- coho salmon	5 300	0	0
- Atlantic salmon	1 500	0	50
- tropical inland sp.	0	70	90

a. The "Libro Blanco del Camaron" gives a production of 70 000 tonnes, for a total export value of US$ 387 in 1988.

3. THE STATE OF FISHERIES RESEARCH IN CHILE, ECUADOR AND PERU

INSTITUTIONAL SET-UP

Despite marked national differences, the overall organization of fisheries and aquaculture research presents a certain number of similarities in the three countries visited.

In addition to basic research which the mission did not examine, teaching institutions at university level conduct innovative and adaptive investigations of potential or immediate interest for fisheries management, aquaculture development and the conservation of aquatic environments. In the three countries, the universities, and the different faculties within them, are generally organized by disciplines. There are, however, schools of engineering which are organized by fields of application - e.g., in fish processing (ECM/UCV), aquaculture (ESPOL).

Chile has the highest number of faculties and teams involved in various fields of marine science and technology. Geographic dispersion of faculties reflects in part the desire of maritime regions to have research capacities locally. This dispersion necessarily spreads the limited means available which may impede the achievement of critical mass and discipline coverage.

Some facilities have been built with foreign aid. For example, Japan has provided infrastructures and equipment for aquaculture research at Coquimbo (Chile). These are used by the local university (Universidad del Norte). Negotiations are also well advanced for the creation of facilities for shrimp aquaculture research within the framework of ESPOL, in Ecuador.

The three countries have, at least, one sectoral fisheries research institute: IFOP in Chile, INP in Ecuador, and IMARPE in Peru. Two of these were established during the period of fisheries expansion, under multilateral assistance programs. The chief objective was to conduct exploration and investigations for fishery resource evaluation. At a later stage, fish technology and fish quality control units were added in some institutes. Japan financed the building of a fish technology institute (ITP) in Peru. This country disposes also of an institute (IIAP) to conduct investigations for the conservation of Amazonian resources (forestry, fisheries and aquaculture, wildlife, aquatic environment) and the management of their uses.

Marine fisheries research institutes were established outside existing research capacities - i.e., essentially universities. This was considered appropriate since the methodology required for stock evaluation, then the priority task, was well developed in industrialized countries. What was then needed was to transfer existing methods for their application to local resources. However, the establishment of fisheries research institutes outside the national research fabrics was mentioned as an initial cause of the current lack of cooperation between sectoral institutes and universities.

Globally, fishery and aquaculture research is dominated by biologists. Biologists and technologists may represent some 80% of professional staff; environment scientists, marine ecologists and oceanographers some 15-20%; economists and sociologists less than 5%.

Although sectoral institutes have extended their research programs to other fields of application (aquaculture, environment, fish quality control, ..), major initiatives in aquaculture research and development have been taken, either by parastatal agencies such as Fundacion Chile, or by universities (notably in Chile and in Ecuador). Similarly, universities in Chile (and to a lesser extent an independent organism - FIRBA in Ecuador) are actively engaged in environment studies. Compared to fisheries investigations, aquaculture and environment studies are dispersed across institutions.

In Chile and Peru, parastatal institutions and, in a few cases, private interests started to conduct R & D projects with their own means (aquaculture in Fundacion Chile; fishing and fish technology, extension and information services for the small-scale sector with FUNCAP; fish processing technology for the production of new fish products in Peru by a private company, Concentrados Marinos S.A.).

Fundacion Chile has no equivalent in the other two countries. It is a non-profit, financially self-sustained development agency, standing between research and production. Its field of activity is not restricted to aquatic living resources, but covers other renewable resources. It has been instrumental in the development of salmon culture.

FUNCAP is also supposed to be economically self-sufficient, through the operation of a processing plant and the sale of its services. Its mandate is to transfer, through demonstration and extension work, technological innovations in harvesting and processing to the small-scale sector.

In the three countries, research is administrated at national level by an horizontal administration: CONICYT in Chile, CONCYTEC in Peru, and CONACYT in Ecuador. Although their objectives are similar, their policies regarding the contribution of research to the promotion of basic knowledge, education, and economic development differ. CONICYT has analyzed ways and means, and implemented procedures, through which national scientific capabilities could be promoted and mobilized on priority research programs. However, the mechanism does not cover the specific requirements of targeted research and the cooperation between sectoral institutes and universities.

Chile and Ecuador have agencies or administrations in charge of development planning, CORFO in the former, CONADE in the latter. They operate differently. CORFO finances short-term projects on specific applications of direct interest to the large-scale industry and the small-scale sector. CONADE operates primarily through CONACYT, at the broader level of country planning.

The three countries have fisheries administrations located within a ministry (Peru), or a sub-secretariat (Chile and Ecuador), of fisheries.

CURRENT PROGRAMS

Resource Evaluation

In IFOP, IMARPE and INP, research programs and activities still largely reflect largely the goals which they were assigned at the time of their creation. Resource monitoring and the provision to national fishery administrations of technical advice on stock abundance and production for managing fisheries remain their dominating activity. Technical competence for that purpose have been acquired initially through international projects and training in foreign institutions. Most of the region's fishery resources have been assessed.

For monitoring the state of the resources, research institutes rely primarily on acoustic and trawl surveys, rather than on the analysis of commercial fishery statistics. This preference was justified by the pervasive deficiencies of commercial statistics and collection systems, as well as by the interest shown by the fishing industry for information simultaneously gathered on the geographical distribution of major fish stocks.

Whatever the origin of funds, public or private, research programs conducted by the sectoral institutes focus heavily on immediate applications. For example, during the past decade, IFOP combined evaluations of latent fish resources with economic analyses aiming at assessing the potential profitability of commercial exploitation. This work contributed probably to development by reducing the uncertainty for potential entrepreneurs. However, now that commercial fishing operations are well developed, this kind of information is readily available to the fishing industry. In the same institute, there has been a change in research policy. When the institute started to rely directly on private funding, research priorities shifted, away from

programs on fishery management towards direct support to industry for immediate development purposes.

In the three countries, sectoral institutes conduct little research on topics of more strategic nature, such as on mechanisms for regulating access to domestic fisheries. Investigations on the "El Nino" phenomenon, or on the instability of small pelagic stocks and the variability of their recruitment (SARP), are generally parts on international initiatives. Many biologists are aware of the need to develop research investigations on new research topics. However, since adequate means for innovative research are not available, this preoccupation is not reflected in the research agendas of institutes.

Aquaculture

For many years, research programs have been conducted on salmon culture and ranching in Southern Chile. Although this work did not result in commercial production, it contributed to the building of research capacities. More recently, Fundacion Chile successfully adapted to Chilean conditions techniques developed in the Northern hemisphere. Without minimizing the role of Fundacion Chile in this development, the role of the expertise available in public institutions should not be under-rated. For example, Fundacion Chile recruited several of its experts from public institutions.

In Ecuador, a dynamic shrimp culture industry has emerged, largely at the instigation of private initiatives. In Peru also, a shrimp culture industry is developing successfully in the Northern part (Tumbes), using similar, though less intensive, techniques than those adopted in Ecuador.

Many university programs are conducted in support to aquaculture development. This is particularly the case in Chile, where a dozen universities, faculties and technological schools have programs in this field. They focus on biology (pathology, nutrition, and marine ecology). There are plans to expand investigations to physiology and genetics. At ESPOL, in Ecuador, research programs are being initiated on shrimp reproduction - for the production of post-larvae with a viability comparable to that of wild post-larvae whose supply is short -, as well as on nutrition and pathology for the grow-out phase of penaeid shrimps. In Chile, research programs on bivalve mollusc (oysters, mussels, ostion) and seaweeds (Gracillaria) are conducted. In Ecuador, scientists are aware of the particular advantages of bivalve mollusc for aquaculture, and envisage programs on such species. In the three countries, investigations are carried out on the technology, nutrition and reproduction aspects of freshwater finfish species (trout and tropical freshwater species). IIAP has mastered simple reproduction techniques for local species and feed formulae using locally available raw materials and offals.

Still, most aquaculture research programs are fragmented by disciplines and methodologies, departments, and institutes or faculties. Consequently, there are considerable gaps and overlaps in research agendas. This reduces the potential contribution of research to the development of commercial systems. In one country, two universities, closely located, are developing similar programs independently. The mission noted only two exceptions to the present fragmentation of means and efforts. In Chile, researchers belonging to different institutions are planning a cooperative program on seaweed culture research (RAMCHI). In Ecuador, ESPOL has formulated a comprehensive program on shrimp culture research, covering reproduction, nutrition, pond ecology and pathology, but this program remains to be implemented.

Fish Technology

Research programs in fish technology are conducted, and some quality control services provided, in sectoral institutions (IFOP, ITP, INP). At present, however, research in fish technology has been reduced, or even completely removed from the agendas of certain sectoral institutes (IFOP, IMARPE), or continued in others (INP, ITP) largely through inputs from foreign aid (e.g., ODA for ITP). On the other hand, a few large companies have created their own fish technology departments (e.g., Concentrados Marinos S.A. in Peru). ITP (Peru) has developed cheap products for local consumption using local fish species. However,

private enterprises have not shown any interest to initiate commercial production of those products, despite the fact that, simultaneously, a private company has invested in fish technological research with the same objective.

Fisheries and Aquaculture Economics and Management

Fishery and aquaculture economics, as well as social aspects of fisheries, are receiving marginal attention in national research institutions, despite their critical significance for the design of sound development and management strategies. In the Amazon region (Peru), for example, it is doubtful that small-scale farming can take-off, even if technically feasible innovations are available. Local demand seems to be filled by supplies from small-scale fisheries. Access to outside markets is heavily taxed by high transportation costs. Almost none of the research institutions have regular programs with social sciences as major disciplines. Hardly any has on its full time payroll economists, sociologists or anthropologists. Publications in this area reflect the under-development of applications of economic and sociological theories and analytical methods to fisheries and aquaculture.

Although several attempts have been made in Chile (IFOP and ECM-UCV), and lately in Peru, to develop training programs in fisheries economics and social sciences, programs are still in an infant stage, needing much support before becoming useful. Investigations are mostly descriptive, consisting of straightforward applications of existing methods. Selection of programs is made on an ad hoc basis depending on funding opportunities. For example, a program on small-scale fisheries is conducted in a Chilean university under funds provided by a bilateral donor (IDRC). No funds are available for the routine collection of data on important factors and indices through which the state of the sector state and its performances could be monitored and projections made.

In the large-scale sector, most of the work is limited to cost and return analyses at the enterprise level. Programs focus on market analyses, and costs and returns studies, from a micro-economic perspective. This results in disjoined collections of data (surveys through questionnaires) with little attention being devoted to the development of principles and tools of predictive or prospective capacity.

Few attempts are made to integrate fisheries components into an overall framework. Dynamic or inter-temporal considerations have not been addressed yet. Neither are distributional (between sectors, uses, or operators) effects analyzed. The consequences of fishery resources scarcity and of open-access conditions are not subjects of research. Although the situation is changing as professionals with academic training in economic theories, social sciences and analytical methods are becoming interested in fisheries issues, the process is slow and does not involve more than a couple of institutions.

As research, policy-making has traditionally been dominated by resources and technology oriented professionals who put emphasis on fishery resources and alternative harvesting techniques, rather than on development and management strategies to maximize economic and social benefits, and of mechanisms for the efficient allocation of fishery resources among competing alternative uses.

The Chilean fishery administration has prepared a new law on fisheries management. Foreign consultants were hired on that occasion. However, no initiative has been taken to initiate locally research programs on these topics. Since the formulation and gradual improvement of institutions for fishery management require a direct appreciation of local contexts, and continuous interaction between administration, industry and research, national expertise is needed in this field. Several representatives of the industry and fishery administrations met by the mission appeared not to be fully aware of the opportunities offered by, and of the technical aspects of, the different mechanisms for resource allocation.

Some fisheries and research administrators expressed the opinion that fishery and aquaculture economics are concerns for fishery administrations and not a topic for research. The value of quantifying and integrating, through modeling, biological constraints, economic forces and social aspects of fishery and aquacul-

ture systems is not fully appreciated by the different parties. Research in resource economics is not distinguished from applications of analytical techniques.

Program Selection and Evaluation

In sectoral institutes, research programs are usually formulated and implemented by departments. Decisions on program priorities and allocation of means are generally taken through hierarchical procedures, or in response to short-term funding opportunities. Changes in research priorities resulting from structural changes affecting production systems are not thoroughly analyzed. Little attention is given to needs for new programs involving different units in an institute or in different institutions with complementary expertise.

This situation has various causes: priority to short-term applications, severe competition for scarce resources, lack of demand for prospective and comprehensive programs, lack of scientific interaction, and institutional isolation, ... As mentioned to the mission, initiatives to implement new multidisciplinary programs involving several units are not necessarily welcomed by hierarchies since this would imply new arrangements cutting across existing structures.

RESEARCH MEANS

Total expenditures in research amount to almost 0.5% of GNP in Chile, and 0.2% in Ecuador and Peru. This is about one order of magnitude lower than research expenditures in highly industrialized countries. A comparatively higher proportion of national research expenditures may go to research on natural and renewable resources, but the mission did not get separate figures to ascertain this point.

In recent years, funding of fishery research has deteriorated seriously in countries affected by economic crises. This was the case in Chile, and Peru is now in a very difficult economic situation. In the three countries, wages and operating funds are dramatically insufficient. As a consequence, foreign aid has become a regular source of funds. Donor agencies (CEC, GTZ, IAF, IDRC, JICA, ODA, USAID, ...), international organizations (FAO, PNUMA, UNDP, ...) and development banks (IDB, World Bank) are providing, not only facilities and equipments, but also direct support to research programs through grants, consultancies, ...

Staff

The importance of research for fisheries developemnt was recognized early in the late fourties and early fifties, when training programs in oceanography, biological sciences and fishery technology were initiated. Students were trained locally, and research teams acquired methods and experience in classic fields of fisheries (resources assessment, fishing and fish technology), aquaculture (biology and physiology), and environment (oceanography and ecology) research. Good opportunities for enhancing training in specialized fields are available through foreign fellowships. Working exchanges are maintained with foreign institutions, often through personal contacts. At least half of the professional research staffs have post graduate training (Master or Ph. D.). Foreign assignments of national scientists are evidence that the training and initial quality of research personnel is generally very good.

With marked national differences, countries have, or had before being harmed by economic crises, basically the human resources to undertake research programs of adaptive nature. In universities, notably but not only in Chile, programs of an innovative nature are conducted and capacities exist to expand research on topics of a more strategic nature.

Compared to the number of programs and projects that are conducted, or to the outputs of other research institutions with similar mandates, the average staff of research institutes is fairly large. The proportion of

staff that is not directly productive can be high. In one major public institute, the proportion of researchers and technicians actually involved in the conduct of research programs represents only a third of the total staff.

However, the use of the human potential is affected by important weaknesses.

First, there are marked imbalances among disciplines. The under-development of economics and social sciences has been noted. No undergraduate training program in this field has been initiated, although Peru started recently a graduate program in fisheries economics and management.

Second, economic conditions offered to researchers are unattractive. The average gross monthly salary of a researcher with a graduate degree and several years of professional experience does not exceed US $ 300 in Peru, $ 500 in Ecuador and $ 600 in Chile, while technical professionals with comparable formal education and experience are earning considerably more in the private sector. The difference is even greater for managerial positions.

This situation has increased the staff turn over (professional drainage), with a net flux toward the private sector and foreign countries. Those who have the highest mobility are on average the better qualified, the best experienced and the most dynamic. A progressive deterioration of the quality of research programs is to be expected, even though it may not be visible from outside.

Researchers have to look for supplementary incomes (consultancies for the private sector and international organizations, second jobs such as the operation of aquaculture farms). Outside activities are sought primarily within fields of specialization. They are considered within the professional's rights. Consultancies are not viewed simply as an additional source of income. They are also regarded as outside recognition of professional skill, and as a means for making foreign contacts and for acceding to other sources of information.

In general, researchers working in universities enjoy fairly flexible working schedules, longer vacations and larger freedom to select their own programs. They are highly regarded in the public. All these elements should be considered when evaluating options, mobility and income differentials, as well as the efficiency of research. Still, there is a contradiction between this social recognition and the means provided to research, both at individual and institute levels.

Under these conditions, difficulties to attract and retain researchers and technical staff can be expected to be greater in disciplines, such as economics, or for jobs, such as in computer or aquaculture technology, which enjoy a high demand in the private sector. A low priority to innovative research probably adds to the difficulty of attracting scientists of good caliber, since the proportion of Ph. D's is lower in sectoral institutes than in universities. Attraction, for researchers and institutions, of additional incomes attached to "research on request" will primarily affect programs falling under the direct responsibility of the public sector. Those will be lagging behind needs. Users of research will not receive proper messages on the need for changes. The long delays associated with the building or rebuilding of research teams should also be kept in mind when assessing present capabilities in relation to future needs.

Criteria for selection for governmental and academic posts are not systematically stated in an explicit manner. Although in most universities and sectoral institutes, job vacancies should be filled through public announcements, factors external to the professional qualifications sometimes interfere. Complicated procedures have been devised to assess staff performances, but promotions are not always decided only on professional criteria.

In certain research institutes, the proportion of professionals, with direct experience in the conduct of research, which are directly involved in the management of research, is low. This suggests a relative lack of confidence in the managerial capabilities of researchers, or a lack of appreciation of the kind of professional experience that is required for managing fishery research efficiently.

Operating Funds

The lack of operating funds is an equally critical constraint. Those are markedly insufficient for the number of staff employed and the volume of programs. There are few exceptions, Fundacion Chile being a case in point (but Fundacion Chile sells its services and products, and is not a research institution). Several institutions had to develop commercial production (shrimp larvae, salmon eggs, fish products) to complement their budgets, but these are expedient arrangements, diverting human and financial resources away from investigations and generating distortions with the private sector.

In Chile and Peru, the contribution of public funds to universities and fisheries research laboratories has decreased substantially. This reflects the impact of the economic crisis and, in Chile, an important change in research policy. In this country, a greater proportion of sectoral institutes budgets comes from the private sector and the development planning agency (CORFO). These funds are used primarily for the execution of fixed-term and narrowly-focused development projects. In addition to new research facilities (Iquique) the production sector has also directly financed some important research programs (Talcahuano). Private contracts represent now more than two thirds of the total running expenses of certain faculties. Innovative research has been seriously affected by this policy (see Annex V for a discussion on the roles of public and private research).

The funding of research by the private sector reflects a rise in the latter's awareness of the potential economic return of research. Recourse to economic mechanisms for the selection of research applications has enhanced the concern of research managers for performance and accountability. Misuse of funds does not seem to be a major problem. Most institutions have established procedures for the disbursement of funds and the reporting of their consumption. However, effectiveness and performances in research do not receive the same attention when few professionals with direct experience in research are involved in its management.

Equipment

The availability of scientific equipment varies between institutions, as well as between countries. ITP (Peru) has no micro-computer and has to rely entirely on foreign aid (ODA) for acquiring laboratory apparatus. Generally speaking, the situation is less critical for short-term projects financed by the industry, and worst for research topics under the direct responsibility of the public sector, i.e., fishery and environment management, support to the small-scale sector, innovative research.

With a few exceptions, there is a wide use of micro-computers. Most software is fairly up-to-date and programming capacities well developed.

COMMUNICATIONS AND USE OF RESEARCH

According to the views expressed on both sides, communications between sectoral institutes and fisheries administrations work satisfactorily. Both parties share the same paradigm under which large-scale fisheries are currently managed (i.e, the setting of catch limitations on the basis of resource assessments). This requires considerable and repetitive inputs from biological research and close interactions between sectoral institutes and fishery administrations.

As in the case of research, policy making has traditionally been led by professionals with training in biology and engineering. Predictably, fishery policies put emphasis on resources conservation and harvesting techniques, rather than on the efficient use of resources among competitive groups of users, and the achievement of economic development objectives. Because investigations on economic and social aspects of fishery management are not undertaken in sectoral institutions, fishery administrations and the fishing industry are not receiving adequate advice on how to use fishery resources efficiently, or on how capital

and manpower can be best balanced to the resource productivity. Similarly, development and research strategies for small-scale aquaculture are affected by the lack of investigations on economic and social aspects of its development.

The funding of research projects by the industry is indicative of a new interest for research. The move in that direction is clear in Chile, and to a lesser extent, in Ecuador. However, in Peru, the industry is not using the work of ITP while a private company has been independenttly investing in the development of a line of production of beef substitutes. On both sides, there are misunderstandings on the respective roles and conditions for an effective contribution of research to economic growth. Cooperative mechanisms are insufficiently developed.

Formal participation of representatives of the small-scale and large-scale harvesting and processing segments, as well as of representatives of related scientific institutions, in the advisory boards of fishery research institutions is not the rule. One exception is the board of IIAP, whose membership is comprehensive.

Similar difficulties were expressed regarding the inputs from research to the small-scale sector. The latter is not better represented in the advisory boards of fisheries research institutes. In addition, the small-scale sector has no means to finance the kinds of research that it needs. It has to rely on the good will of research institutes, which is likely to be insufficient considering the tight budgetary constraints under which the latter operate. Even if research projects of potential interest for the small-scale sector are funded by CORFO, this does not eliminate the need for direct and institutionalized communications between this sector and research institutions.

COOPERATION IN RESEARCH

At National Level

As already noted, there is little cooperation among different national research institutions. No formal mechanisms, nor means (e.g., seed money to stimulate cooperation), are available to facilitate the formulation, implementation and evaluation of comprehensive programs in which research teams from different institutions, but with complementary fields of expertise, would cooperate. This seems particularly important in countries which, owing to their limited means, face problems of critical mass and comprehensiveness in research. Environment, aquaculture and fisheries issues are not discipline-specific. Research needs change both between production systems and, within them, with their development stages. Consequently, disciplinary inputs need to be selected and integrated according to the opportunities and needs that characterize production systems at given stages of their development.

Several factors explain this lack of cooperation: exclusive relationships between fisheries laboratories and administrations resulting in a research monopoly which carries the risk of scientific isolation and bureaucratization; lack of systematic evaluation of research programs and personnel; lower scientific credibility of some institutions which hinders cooperation between good and less good teams; lack of appreciation by certain research administrators of the particular requirements of scientific research; demand concentrated on narrow applications; severe competition for funds, ...

Few scientific papers are signed jointly by researchers belonging to different institutions. Many institutes and faculties edit their own magazines. Publication in international journals with peer review is not the rule, especially in sectoral institutes. Publications do not always distinguish clearly presentation of methods developed elsewhere and original works. Writing for refereed journals is not a major requirement in institutions whose policies de-emphasize innovative research. As a consequence, scientific competition for achieving excellence in research for the long term progress of scientific capabilities, is low.

A quick examination of lists of publications show a growing predominance of "grey" literature, and a decline of scientific publications in sectoral institutes. The development of "research on request" and consultancies reinforces this trend for contracts frequently stipulate confidentiality on the release of project findings.

At Regional Level

Joint activities are organized by regional fisheries and economic bodies, such as CPPS, CEPAL, la Junta del Acuerdo de Cartagena, OLDEPESCA. CPPS has organized several regional meetings to exchange information and methods. FAO is periodically arranging and supporting regional meetings on fish technology. IDRC has established networks for investigations on small-scale fisheries, aquaculture and seaweed exploitation, which did promote cooperation. FAO and the Government of Italy have attempted to develop a similar network in aquaculture and are now evaluating the performances of past activities. CORPESCA tried to stimulate cooperation between Latin American countries in the field of fisheries, although the emphasis was put on mechanisms rather than on programs and their implementation. PNUMA indirectly helped fisheries scientists concerned with ocean and environment matters to harmonize their work. Agreements on access by local scientists to facilities (laboratories, experimental stations, research vessels) available in other countries have been signed (IMARPE-ICLARM-GTZ, UCV/ECM-Scripps Institute of Oceanography- International Sea Grant Program, ESPOL-URI-USAID, ...).

Despite these various activities and initiatives, regional cooperation remains fragmented and less active than in other regions. It lacks dynamism. There are no cooperative activities, nor mechanisms for that purpose, in the field of fishing technology and fish processing, or fishery and aquaculture economics. There are no active regional structures or mechanisms to facilitate cooperation in fisheries research, as distinct from immediate applications to development and management. Some organizations and professional associations (ALICMAR) are getting concerned by the relative isolation of national institutions engaged in fisheries and aquaculture research.

Lack of proper structures, understanding by national administrations of political implications of research findings on the sharing of common resources, low autonomy of sectoral institutions, lack of credibility of research and recognized scientific leadership, ... are among the reasons which explain the relatively low development of regional cooperation in the region.

At Global Level

Research institutes and universities in all three countries have developed active cooperation with similar institutions in the Northern Hemisphere. Researchers, who had training in Northern universities and fisheries research institutes, maintain good personal contacts afterwards. Important cooperative programs have been organized in the field of oceanography and climatology with various universities in North America and Europe. The CEC and Italian universities are mounting a program on environmental studies with universities in the region.

However, exchanges with other developing regions are comparatively very limited, despite the similarity of research issues of a strategic nature (tropical fishery resources, cultivated species and ecosystems; small-scale fisheries; development of aquaculture and fisheries systems in developing countries; international trade issues; ...). Most research works are published locally, only in Spanish. Consequently, their diffusion and impact remain limited to the sub-continent, thus reducing the exchange of information with other regions.

INTERNATIONAL AID TO RESEARCH

After an initial period (the "pre-investment" phase) during which international aid contributed to the establishment of research institutes and of new research capabilities in applied fields, such as stock assessment, and fish technology, priority shifted to more directly development-oriented activities. Aid to research concentrated on the provision of infrastructures (buildings), heavy equipment (research vessels), laboratory apparatus and computers, and training (on-the-spot training in projects and provision of fellowships). In addition, certain aid agencies provide grants to local teams for undertaking investigations directly related to development issues. Negotiations are taking place for the provision of additional facilities (e.g., the shrimp aquaculture research center in Ecuador).

The priority given to hardware and infrastructure reflects in part the higher mobility of capital. However, the facility to supply certain means does not imply that they are the most needed ones.

Aid programs do not always pay attention to the integration of inputs within national infrastructures, nor to whether governments are ready, or able, to commit the necessary counterparts and other means that will ensure that the activities promoted by external aid will be continued when projects are terminated. The problem has been well analyzed with respect to research vessels, or research laboratories, for example. In this respect countries in the region made the same unfortunate experiences as others did in other parts of the word. For refitting two research vessels and conducting resource surveys during two years, IMARPE, for example, is receiving assistance for an amount substantially exceeding its annual budget. However, without changes in institutions for fishery management, resource evaluation cannot improve the economic efficiency of fisheries, and an increase in government expenditures on research is unlikely. Consequently, it is difficult to see how the industry or the government will be able to take over the expenses of routine resource surveys and, therefore, how the project can have a lasting impact on the country's fishery research and management capacities.

Shortcomings are also observed in the transfer of scientific knowledge and methods. The international community devoted considerable efforts for the training of applied biologists in developing countries. This has taken the form of intensive training courses in specialized fields, preparation of manuals, running of workshops, and provision of fellowships. As a result, the methodology for stock assessment, for example, has been spread throughout the world in less than a decade. Most fishery resources have been assessed. It is largely through this research topic that fishery science was introduced in developing countries.

However, the coin has two faces. Analysis of issues, formulation of research strategies matched to local conditions by national researchers, assessment of future research needs, and institution building did not receive equal attention. Excellence and sophistication in the application of imported tools tended to dominate the identification and formulation of questions of local significance. This was considered appropriate for extending to developing countries approaches that were previously mastered in Northern latitudes. But, now that everywhere the future of fisheries depends on the initiation of new kinds of investigations, the lack of perspective associated with this approach has left fishery science somewhat disoriented.

The risk for aid to be overwhelming, financially and conceptually, is thus real. IIAP, in Iquitos, is isolated geographically and economically. Compared to other institutes on the coast, it seems to have received less aid. If it is the case, this has apparently not affected its capacity for independent thinking.

4. STRENGTHENING NATIONAL RESEARCH CAPABILITIES

INTRODUCTION

With appreciable differences, Chile, Ecuador and Peru have acquired several components of effective research systems. They have acquired physical facilities, developed an institutional framework, and trained a core of research personnel in various disciplines of environment ecology, fishery and aquaculture biology, and fishing and fish technology. In Chile notably, universities represent a potential that, if it can be properly mobilized, could contribute to the development of more advanced investigations. Still, national capabilities are affected by serious shortcomings that prevent research from contributing as it could to economic development.

Research effectiveness could be enhanced through various ways: the formulation of clearer fishery and research policies, the upgrading of salary structures and operating funds, the development of disciplines such as economics and social sciences that are under-represented, the development of innovative research in response to new needs, the implementation of comprehensive research programs in response to major development and management issues, the cooperation of national institutions in such programs, better communication between public research and the production sector, the improved management of research, and the strengthening of regional and inter-regional cooperation.

The following chapter examines the components of national research systems that need to be strengthened. Many of the gaps examined in this section are not particular to the three countries that the mission visited. They are encountered in many countries, including developed ones.

RESEARCH POLICIES

Analyses for Development and Research Strategies

Optimally, fisheries policies should provide guidelines for research planning. For that purpose, they need to be more specific than they generally are. They must clearly identify development opportunities and management needs by economic activities - i.e., environment, fisheries, aquaculture, processing, distribution and trade, as well as trade-offs between resources exploitation and conservation, small and large-scale sectors, domestic food supply and exports, immediate and long term objectives. In addition, if extended to economic and social aspects of development and management, research can provide analytical tools and information of strategic significance for the design of sound sector policies.

First, such policies should reflect adequately the specific features of the sector, i.e., the limited production of fishery resources and absorbing capacity of aquatic environments, the open access regime which still prevails in domestic fisheries, the resource jointness which complicates the allocation of exclusive quantitative use rights, and the importance of social organizations and rapports in the economies of small-scale communities. Because of these particularities, development models that are restricted to the provision of capital and technology are doomed to fail.

Second, conditions for economic development and efficiency change markedly with the successive development stages of production systems. This has direct implications on research needs and priorities. Systems which have recently taken off - e.g., salmon or shrimp culture - can expand without major structural changes. In fully developed systems, such as fisheries, economic efficiency now depends on the prior adoption of institutions for regulating access. The possibility to developing new aquaculture systems, or of introducing foreign systems among small-scale groups in rural areas, is conditioned by local social and economic factors which considerably restrict the choice of technological solutions.

In the first case (salmon and shrimp culture), projections of future research needs are not excessively conjectural. With a proper understanding of the particularities of fisheries, the identification of research topics that are left unattended in conventional fishery management approaches do not raise major difficulties. The development of small-scale aquaculture in areas where it has not taken off is considerably more hypothetical. An understanding of economic and social contexts - social organizations in particular, have to be acquired before priorities in zoological and technical research can be determined. This kind of research requires background work for the collection of appropriate data, and the validation of theories that apply to particular socioeconomic organization of production systems.

Distinction between Research and Applications

In the development of salmon culture in Chile, the work of Fundacion Chile has been immediately more determinant than that of research. Fundacion Chile has been effective in transferring and adapting technologies available abroad, in integrating them in a technologically and economically viable system of production, and in transferring it to the private sector. In so doing, Fundacion Chile has not actually conducted original research. Its role was that of an "assemblier" operating between research and commercial production. Comfortable funds, rigorous project selection, strict planning and evaluation procedures, solid technical competence, and good contacts with industry and research were mentioned as important success factors.

This example does not imply that research was not necessary. Investigations conducted earlier in Chile contributed to the acquisition of technical capacities that have been useful. Salmon culture would never have developed without the investigations conducted since the end of last century on the control of reproduction or nutrition. The point made here is that, because fisheries and aquaculture development depends critically on complex ecological, biological and sociological factors, research cannot contribute to qualitatively significant breakthroughs if prior investments are not made in the acquisition of basic knowledge and the development of investigation methods. The integration of scientific developments and other components into production systems that are economically viable and socially acceptable, is a separate endeavor. Although quantitative analysis always helps to identify systems that are potentially viable, research and development, or management, work on different time scale, and require different technical qualifications and operating conditions. Their efficiency depends on the answers that are given to these specific requirements (see Annex V).

Fundacion Chile indicated to the mission that, because it experiences difficulties in getting the research inputs it needs, it plans to develop its own research programs, in salmon genetics in particular. For reasons given above, it is not evident that this is the right approach. The fact that Fundacion Chile succeeded in development does not imply that it will succeed in research. Dispersion of research capacities may further complicate its organization at national level and the communication between research and its users.

On the other hand, with a better distinction between research and development, or management, there is a risk that targeted research looses sight of its goals and justifications. It is to minimize this risk and to enhance comprehensiveness in research programs that medium and long-term research plans are needed, and that appropriate mechanisms are critical to ensure two-way communication between research and the potential users of research.

Distinction between Public and Private Research

In recent years in Chile the policy has been to encourage the contribution of the private sector to the funding of public research through tax exemptions. For that purpose, economic mechanisms have been used to select and finance directly applied research projects which were conducted in public institutions. Such procedures can improve greatly the performances of R & D activities, through better selection and evaluation of research applications, and fund allocation. However, this policy did not take properly into account the different requirements of the various kinds of research and the respective responsibilities of the

private and public sectors (see Annex V). It resulted in a reduction of investigations in support to fishery management and environment conservation, to the small-scale sector, as well as of innovative research.

There is, thus, a need for clear-cut policies with respect to the funding and conduct of the different kinds of research, and development and management applications. Such policies should reflect the respective advantages of the public and private sectors (see Annex V), clarify their respective roles, and define arrangements for their cooperation. There would be advantages in promoting the direct involvement of the large-scale sector in the conduct of R & D activities. The example of Fundacion Chile indicates that this is feasible. A better distinction of gains and costs between the private and the public sectors should improve the effectiveness of public research, since the latter could then concentrate the limited public means on fields falling directly under the government responsibility. This would also lead to a shift in communications between public research institutions and the production sector from a top-down and passive to a bottom-up and participative approach.

Need for Innovative Research

In the three countries, sectoral research institutions are primarily involved in short term applications. These activities leave them very little time and means for developing the knowledge, the methods and the expertise which condition contributions of more strategic significance for the future progress of the sector.

The concentration of sectoral institutes on immediate requests from the industry and the fishery administrations would be appropriate, if research needs were restricted to quantitative improvements of existing production systems - which is not the case (see Annex IV), or if the need for new knowledge and methods could be fulfilled through tranfers from local or foreign universities. But, cooperation with basic research cannot be developed effectively if sectoral institutes are not themselves directly engaged in innovative research. Their capacity to identify emerging research issues and to initiate interactive cooperation with more advanced scientific teams depends on the availability in sectoral institutes of minimum scientific capabilities. In several institutes, such capacities are presently insufficiently developed.

Lack of innovative research in sectoral institutes results in lags in the recognition of the emergence of new opportunities and needs, in the acquisition of new methods and techniques, and in the raising, in the industry and administration, awareness of the existence of new opportunities. In this respect, the detrimental consequences of a lack of research in economics and sociology of fisheries and aquaculture has been noted. Countries with important aquaculture potentials have to develop a full range of scientific competence in reproduction, nutrition, epidemiology and pathology, genetics and physiology, since investigations on these disciplines will become more important as aquaculture systems that have already taken off develop.

The emphasis put on innovative research does not imply that adaptive research is not important. It is through adaptive research that innovative findings are transferred to the economic sector. But, there cannot be productive research in the long run without innovative investigations. The essence of science is to identify questions, to formulate hypotheses, and to design investigation protocols. Without intellectual investments, the capacity to apply will progressively become exhausted.

Given the difficult economic situation in certain countries, it is certainly difficult for them to consider aspects of research which will pay only in the medium run. But costs should be assessed against effectiveness with time. Poor research is costly. Good research is cheap. Certain countries already have, in their universities, advanced capabilities at their disposal or the potential to develop them. Communication between universities and sectoral institutes could contribute to the upgrading of national capacities.

RESEARCH PROGRAMS

To be effective, targeted research needs to encompass the different research areas that condition the development and management of given production systems through their successive development stages. For that purpose, the different disciplines that are needed have to be mobilized and integrated into comprehensive research programs. Two priorities result from this observation: (i) comprehensive programs need to be developed; and (ii) priority in recruitment should go initially to disciplines that are under-represented, especially economics and social sciences.

INSTITUTIONAL STRUCTURES

Sectoral Research Institutes

Sectoral institutes are, in principle, in a good position to plan and implement comprehensive research programs, when necessary in collaboration with universities. They can ensure continuity of programs which are required for monitoring the state of natural resources and major production systems (routine collection of data). This is important, since universities do not have the mandate to conduct such programs and cannot ensure continuity in data collection. Being public and scientific, sectoral institutes should be able to provide technical advice for the management of natural resources, independently of particular user interests.

However, when they depend excessively on a single administration, especially for their budget, they can experience difficulties in providing advice that reflects the interests of other groups (consumers and tax payers), the need for environment conservation, as well as to develop research programs in anticipation to future needs.

When they enjoy a quasi monopoly in certain fields of research (e.g., in fishery resources assessment), they are in danger of scientific fossilization and bureaucratization. Confronted with the deficiencies of current fishery management practices, fisheries administrations may be inclined to maintain the status quo in fisheries. In this case, their requests for research will concentrate on trite inputs. They may view inputs on new institutional arrangements or alternative management strategies as unacceptable encroachments on their prerogatives. At the same time, sectoral institutes may be tempted to rely on their institutional competence to offset insufficient scientific capabilities.

Such risks can be minimized through: (i) the separate funding of sectoral institutes by the different governmental departments that need research (fisheries and aquaculture, environment, health), and by the national administration in charge of research to ensure that longer term needs are given proper attention; (ii) the participation of governmental departments, as well as of representatives of the fishing industry, and of related research institutions, in the boards of institutes; and (iii) the adoption of rigorous evaluation procedures. Separating the sources of funding between users will improve the adjustment of research programs to different demands and priorities, while giving research institutions more autonomy and means for the conduct of innovative research.

Development Organisms and Extension Services

National research and development policies should define the mandate of development organizations, such as Fundacion Chile, FUNCAP, or other institutions in similar fields (e.g., fish processing, quality control), and their relationships with research institutions and the industry.

The organization of extension work is an area where an assessment of needs and conditions for effectiveness seems to be needed. The capacity of the small-scale sector to support extension work depends on: (i) a

change in fishery management systems to improve return rates of its activities, and (ii) its organization to compensate for the negative effects of enterprise dispersion. Until these conditions are met, the public sector have to provide support. However, there will be advantages in promoting the direct association of the small-scale sector in extension work. A change from a top-down to a bottom-up approach would improve the selection of technological innovations that the small-scale sector can assimilate.

The creation of an institution, such as FUNCAP, in charge of technology transfer to the small-scale sector, has apparently not reduced the communication gap between this sector and research, since it has not provided the small-scale sector with appropriate means to mobilize public research. Formal mechanisms (participation in the boards of research institutes, special committees) should enable representatives of the small-scale sector to participate in the assessment of research priorities and in the evaluation of research programs of direct interest.

The mission did not visit FIRBA. From second hand information, this "semi-public" institute carries out environment studies for management purposes under contracts of various sources. This may create duplication of effort and confusion in the provision of scientific advice to management administrations. However, private companies can discharge research institutions of routine assessments related to application of existing legislation on environment conservation. Research institutions could then concentrate on investigation of a more prospective nature.

Since it is the private sector which ultimately integrates technological inputs into economically viable systems, there would be advantages in the long run for locating development structures, not within the public sector and the research set-up, but in, or with the direct participation of, the production sector.

Communication and Use of Research

Conditions for cooperation between research and enterprises differ significantly, whether or not production has already started. In the first case, economic and social constraints have already been identified and partly overcome. Entrepreneurs are operating and likely to be motivated by technological innovations which can enhance their competitiveness. Even when such conditions prevail, exchange of information with the industry before new investigations are initiated is important, since enterprises are likely to be more receptive to research findings if they have been associated since the initiation of new research programs.

When there is no production, expecting automatic transfer of innovations disregards the existence of critical economic and social constraints. It assumes that entrepreneurs with adequate technological background and information on potential markets are present, that there is an adequate demand, etc... For the development of small-scale systems, the probability that existing rural groups will be able to integrate new systems to their current activities, or leave their activities to embark on new ones where the risk is high, is extremely low.

The importance of a formal participation of the various users of research, notably representatives of the large-scale and the small-scale sectors, in the boards of sectoral research institutes has been emphasized. However useful, this is not enough for ensuring effective communication between technological research and its users. Technical committees in which industry and research could exchange ideas on potential innovations, jointly assess, select and undertake technological projects, and evaluate their outputs and past selection criteria, are also needed. If such committees have funds, from contributions by the industry and the public sector, to support investigations, they can play a very effective role. Such mechanisms should preferably be established by a major branch of economic activity (e.g., fish processing), and involve all national research institutions and economic operators concerned.

CONDITIONS FOR RESEARCH

The different users of research, whether public or private, met by the mission said that they consider research as important. However, this statement is ill-reflected in the means made available to research, or in the conditions offered to research personnel. This indicates a lack of appreciation of the potential contributions of research, and of the intellectual qualifications and operating conditions it requires to be effective. With current salary scales and career development prospects, it is difficult to see how research institutions will be able to attract, motivate and retain the intellectual resources that are needed to carry out programs of quality.

Under the present conditions, improvements in the organization, conditions and use of research are immediately more important than quantitative increases of existing means (increased number of staff in existing disciplines, or increasing private contributions to public research, creation of new research facilities).

MANAGEMENT OF RESEARCH

Mechanisms for Directing Research Activities

Basically, three mechanisms are used for selecting and directing research activities; (i) administrative directives issued by government departments, or advisory boards of research institutions; (ii) funds allocated by research users for investigations of immediate applicability; and (iii) scientific methods in advanced fields of research.

These mechanisms correspond to different needs and should, thus, be appropriately mobilized. In institutions dealing primarily with R & D activities, the recourse to scientific methods often results in program fragmentation and dispersion, low accountability and poor performance. When administrative directives concentrate on requests for immediate application, instead of on policy guidelines, all demands tend to be given equal weight. If innovative research is to be successful, researchers should have opportunities to present and defend new ideas and programs. Scientists with recognized credibility should be involved in the evaluation of research programs and their outcomes.

Different mechanisms can fulfill these specific needs: (i) boards should provide research institutions with policy guidelines and ensure that means are matched to programs; (ii) technical committees are needed, by major economic activities, to further cooperation with the industry; and (iii) scientific committees and working groups are required, by major research areas, to provide scientific guidance and stimulate cooperation between national research institutes.

In general, scientific competition needs to be stimulated. This is primarily achieved through publications in scientific journals with international distribution and peer review. This may require the creation of national, or even regional, journals. Researchers involved in innovative fields of research should be encouraged to publish in such journals and publications used as criteria for individual evaluation.

Indices reflecting the different kinds of research (innovative, adaptive, transfer, supervision of research, management of research) should be used for assessing the performance of research personnel. This should provide the basis for deciding promotions and allocating research means.

Management of Sectoral Research Institutes

Progress in scientific methodologies requires that researchers work by disciplines. Contribution to development and management imply an integrated input of different disciplines. These two contradictory require-

ments can be met by organizing the research capabilities by disciplines within institutions and integrating their inputs through the joint conduct of problem-oriented programs. Direct cooperation should take place at two steps: the program design and the data interpretation. It is not required during the data collection, conduct of experiments, and primary data analysis within disciplines. This implies that institutions have the capacity to implement horizontal programs of limited duration (3-5 years), with different assemblages of expertise.

This would not solve all the difficulties encountered in multi-disciplinary work. Often, it is in the joint interpretation of their respective findings that disciplinary theories start to conflict. However, multi-disciplinarity will enlarge the fishery science paradigm, which is still fragmented and primitive. System analysis and modeling offer tools for that purpose. Sectoral institutes need to invest in the development of such methods and approaches if their programs are to be problem-oriented and to provide effective inputs for development and management.

These different working modes are not easy to accommodate in the organization and running of institutions. This is why, in the management of research institutions, professional experience in the conduct of targeted research is as important as administrative experience and political skills.

Cooperation between Research Institutions

To promote cooperation between sectoral institutes and universities, adequate mechanisms are needed. They can take the form of permanent scientific committees and working groups, in which well recognized scientists participate. The mandate of such groups would be to prepare assessments of research needs, to set up medium-term research priorities, to formulate comprehensive programs defining research approaches, to assess research proposals made in response to national programs, and to evaluate inputs to such programs. If they can have a formal status and limited funds to provide seed money for investigations which need to be promoted, such mechanisms could reduce isolation, stimulate scientific competition, and enhance the overall quality and effectiveness of national research. At the same time, they can provide information on research priorities that will be directly useful to central administrations for allocating funds.

In implementing such mechanisms, the specific needs of scientific research should be taken into account. Scientific cooperation relies on partnership - as opposed to leadership or contractual arrangements -, open confrontation of views in program formulation, systematic evaluation of research findings, and peer recognition.

REGIONAL COOPERATION

Regional cooperation can be a very effective tool for accelerating exchanges of views and ideas on emerging priorities, as well as new concepts and methods, for achieving economies of scale in tasks that cannot be undertaken with national means only, for organizing high level training in specialized fields, or for providing common services (publication of scientific journals, compilation and dissemination of data and other information). It can also stimulate scientific competition. Regional cooperation allows participating countries with limited means to keep abreast with developments in larger ones. Periodic confrontations of views reduce the risk for national research programs to go astray. New issues are recognized and investigated earlier.

Scientific exchanges with research institutes in other developing regions could improve the formulation of research approaches and the development or adaptation of methods well matched to local conditions. Because of the wider range of development stages that are encountered in the developing world, several important fisheries development and management issues have been identified in economically less-advanced regions before being recognized by the Western community. Similar observations have been made in other economic fields. Without under-rating the value of N/S cooperation for the acquisition of new

methodologies, S/S collaboration can contribute greatly to the identification and formulation of problems related to the overall development process.

Regional cooperation implies certain investments - e.g., to set up appropriate structures and mechanisms, to participate in regional activities, to share information and knowledge on an equal footing. But, benefits can be extremely high. In certain regions, including developing ones, networking, research bodies and other cooperative arrangements have demonstrated their considerable value for strengthening national capacities. Actually, international cooperation is a critical factor in the progress of research.

Mechanisms for regional cooperation in fisheries research should preferably not be part of economic or political organizations, because research would then be subordinated or trade off against more immediate concerns. Such bodies should focus on broader and longer term aspects of fisheries, aquaculture and environment research, which national institutions have difficulties to address with their own means, rather than on immediate applications which fall primarily under national prerogatives.

PRIORITIES FOR AID

The ultimate objective in strengthening national research capacities is to make national institutions capable, individually and jointly, to formulate and implement research programs that contribute effectively to the economic growth of the fishery sector. To reach that objective, institution building and the promotion of human resources have become more important than the provision of physical facilities and equipment.

This kind of assistance is much more difficult to provide. Progress towards self-reliance implies the development of absorption capacities of recipient institutions, and the matching of foreign inputs with national efforts. Consistency and continuity in the provision of aid, and adjustment of inputs to local constraints and conditions, depend on the direct involvement of national institutions and administrations in the selection, implementation and evaluation of aid-to-research projects, even if this may imply immediate losses in efficiency.

Regional institutions, such as regional research bodies, networks, ... can facilitate the harmonization of aid. If applications for development and management are national or local, research issues are common to large groups of countries. If it can be strengthened, regional cooperation in research would produce assessments of research priorities that are widely recognized. Participation of national researchers in this task would generate government support. Clearer guidelines would be available for donor agencies. Those should, therefore, consider the extension of aid in institution building to the promotion of regional mechanisms and structures. However, the strengthening of regional cooperation depends on the responses that the countries concerned will give to this opportunity.

5. CONCLUSIONS

In terms of export earnings, food supply and employment, the fishery and aquaculture sector is one of the most important in national economies of Chile, Ecuador and Peru. The conservation of the quality of aquatic environments is an essential condition for the sustained exploitation of aquatic living resources.

With appreciable differences between countries, Chile, Ecuador and Peru have acquired considerable research means. In terms of institutions, infrastructures and research personnel, the area is one of the most advanced among developing regions. These capacities have already contributed to the development of the sector. Fishery resources in national EEZs have been assessed and are regularly monitored. Scientific information and advice contributed to the emergence of a dynamic shrimp and salmon culture industry in the region. However, despite these capacities, research is not contributing as it could to the economic growth and efficiency of fisheries and aquaculture in the region.

Economic development can occur without inputs from research, although, in most cases, the process is extremely slow. The powerful analytical instruments that research has developed can always contribute to speed up the development process by quantifying opportunities and constraints. On the other hand, excellent research findings can remain unused if they are not matched to the particular needs of production systems. By generating common appreciation of development opportunities and management needs, sector and research policies can improve greatly the relevance and use of research.

To day, research has a particular role to play in the progress of the fishery sector in the Southwest American area. Opportunities and conditions for economic progress have changed dramatically with the full exploitation of conventional fishery resources (see Annex IV). Considerable gains in economic efficiency could be reaped if the institutional innovations that condition the adjustment of investments in fishing capacities to the productivity of the resources, and the efficient use of technological innovations in harvesting, were adopted. Inputs from research are needed for the design of adequate institutions. The variability of small pelagic stocks has to be better understood to appreciate whether the amplitude of such fluctuations and the probability of collapse cannot be reduced through the manipulation of the fishing regimes. Research in the biology and physiology of cultivated species will play a much greater role for the further development of shrimp and salmon cultures than it did for their take off, and technological innovations derived from research is likely be critical for enhancing the competitiveness of national aquaculture industries. Research in food technology can also be a condition for adding value to the huge harvests of small pelagic stocks that are presently reduced into meal for industrial purposes.

The causes of the relative ineffectiveness of research in the area are many. One is the shortage of operating funds and the low wages of research personnel. Substantial gains in productivity can be expected if wages and operating costs were increased relatively to investments in infrastructures and absolute number of staff. To day, science is viewed as a source of technological innovations which, by the opportunities they offer for capital investments, sustain economic growth. However, science cannot be expected to effectively play this role, if it operates under conditions that do not compare with those prevailing in other fields of economic activity.

The second reason is that the nature of research needs has changed considerably. Now that most conventional resources are fully exploited, fisheries cannot contribute effectively to economic growth, if they are managed according to principles that were developed during the period of extensification. The smooth development of aquaculture implies the acquisition of a range of disciplines and the building of an experience which did not exist two decades ago. The new research approaches and agendas that are required will not be developed if research relies on past receipes. Innovative research is a critical factor for the relevance, comprehensiveness and quality of research programs that are needed, as well as of the capacity of research for self-progress.

Still, fishery research is used primarily for operational purposes, i.e., on short term applications for the industry and fishery administrations. If this input is necessary, it is not sufficient. In sectoral institutes, programs are essentially reactive, not anticipatory. Reactive research cannot be expected to contribute to the future growth or efficiency of economic activities when those are being affected by major structural changes.

There is, therefore, a need for clear-cut policies determining priorities in the different kinds of research, the respective advantages of public and private sectors in conducting the different types of investigations, and the responsibilities of universities, sectoral institutes, and development agencies in their implementation.

The mobilization of private funds should be used primarily in investigations and technical work of direct interest to the industry. This should create an opportunity for public institutions to enhance their overall efficiency by concentrating the limited public funds on topics which depend directly on inputs from governments.

A clearer distinction between scientific and technological research, and development and management activities, implies that adequate structures and mechanisms are in place to facilitate communications and cooperation between the different partners. Present arrangements need to be developed and strengthened. By mobilizing existing research capacities in comprehensive, multi-disciplinary national programs, the effectiveness of existing means could be significantly upgraded. This would be a cost/effective way to strengthen innovative research.

With the exception of disciplines such as economics and social sciences that are under-represented and the increase of operating funds and wages, gains in research effectiveness should come first from qualitative improvements in research policies, in the organization and management of research, and in the use of existing research capacities, rather than from a quantitative increase of existing means (infrastructures and staff). This means that costs of improvements are primarily institutional, rather than financial.

This conclusion has implications for priorities for aid. There must be a shift, from the provision of facilities and hardware, to support for institution building and the promotion of human resources. Provision of this kind of aid is more complex. Since appreciation of local constraints, continuity and balance in the provision of aid, and progress in institution building, depend on the direct involvement of national institutions and administrations, close collaboration between donor agencies and national institutions is critical.

Regional cooperation in fishery research can be an effective way to strengthen national research capabilities. Research strategies and approaches could be improved, scientific competition stimulated, and national talents and efforts shared for the achievement of joint self-reliance. But, here too, mechanisms for cooperation need to be strengthened. This requires support. The building of regional institutions is an area where international aid could be usefully employed.

Annex I
Missions to Assess Research Capacities

a.Terms of reference

The assessment will cover the following aspects:

- relevance of research programs;
- means available: staff, equipment, budget;
- status of scientific personnel: salaries, role;
- cooperation (and mechanisms for) with the:
  - scientific community: national level (basic, agricultural, food research.....); regional level (fisheries research); international level (advanced institutes, universities);
  - national administrations (fisheries, environment, agriculture, planning);
  - national fishing industry (harvesting, farming, processing, distribution and trade);
  - small-scale sector;
  - development and aid agencies.

The assessment will cover national institutes, regional centers, and regional cooperative mechanisms.

b. Mission composition

Each mission will comprise in principle:

1 biologist (fisheries or aquaculture),
1 technologist (fishing or fish technology),
1 economist,

of which one will be from the countries to be visited.

c. Places of visit

Ministries in charge of fisheries and research,
Directorates of fisheries,
Planning administration,
Fisheries and agriculture research institutes,
Food technology research institutes,
Regional research institutions,
Regional fisheries bodies.

Annex II
Itinerary and List of Institutions Visited[4]

22-23 July

- Travel to Santiago (Chile)

A - Chile

24 July

- UNDP Office
- Fundacion para la Capitacion del Pescador Artesanal (FUNCAP)
- Instituto de Fomento Pesquero (IFOP)

25 July

- Fundacion Chile
- Corporacion de Productores de Harina de Pescado S.A. (CORPESCA)

26 July

- Universidad Catolica de Valparaiso (Escuela de Ciencas del Mar (ECM/UCV); Escuela de Alimentos)
- Sub-Secretaria de Pesca

27 July

- Comision Nacional de Investigacion Cientifica y Tecnologia (CONICYT)
- Corporacion de Fomento a la Produccion (CORFO)
- Comision Economica para America Latina (CEPAL)

28-29 July

- Universidad Catolica de Chile, Sede Talcahuano
- Universidad de Concepcion
- Instituto Profesional, Osorno
- Universidad Austral de Chile, Valdivia
- Universidad Arturo Prat, Iquique

30 July

- Travel to Lima

B - Peru

31 July

- UNDP Office

4 Owing to the number of institutions visited, it is not possible to give the list of the persons that the missions met in each of them.

- Junta del Acuerdo de Cartagena
- Ministry of Fisheries
- Organizacion Latinoamericana de Desarollo Pesquero (OLDEPESCA)
- International Potato Research Centre, Lima
- Universidad Nacional Agraria, La Molina
- Consejo Nacional de Ciencia y Tecnologia (CONCYTECH)
- Sociedad Nacional de Pesqueria

1 August

- Commission of European Communities (CEC), Lima
- Instituto del Mar del Peru (IMARPE), Callao

2 August

- Instituto Tecnologico Pesquero del Peru (ITP), Callao
- Japanese International Cooperation Agency (JICA), Lima

3-4 August

- Instituto de Investigaciones de la Amazonia Peruana (IIAP), Iquitos
- Shrimp farming industry: "Cultivadores Industriales de Langostinos S.A. (SILANSA), Tumbes
- Japanese training shool for fishermen: "Centro de Entrenamiento Pesquero de Paita". Paita
- Canning industry: "Empresa del Mar", Paita
- Fish processing private project: "Planta de Concentrados Marinos S.A.", Sechura.

5-6 August

- Analysis of the survey findings

6-7 August

- Travel to Guayaquil

C - Ecuador

7 August

- Sub-Secretario de Recursos Pesqueros, Guyaquil
- Instituto Nacional de Pesca (INP), Guayaquil

8 August

- Direccion General de Pesca, Guayaquil
- Instituto Nacional de Pesca (INP), Guayaquil
- Shrimp farming industry, Guayaquil

9 August

- Escuela Superior Politecnica del Litoral (ESPOL), Guayaquil

10 August

- Travel to Quito

- Consejo Nacional de Ciencia y Tecnologia (CONACYT), Quito
- Commission Nacional de Desarollo (CONADE), Quito

10-11 August

- Discussion of the conclusions of the mission and the report contents

12 August

- Back to office travel

Annex III

A. CHECKLIST FOR EVALUATING RESEARCH PROGRAMS

1. Description of current and future research programs

1.1 - Current programs

- description of current research activities; costs, manpower, duration;
- recent changes and reasons for changes.

1.2 - Future research activities, planned and anticipated

- short run;
- long run.

1.3 - Evaluation

- adequation between research programs and research needs;
- relative importance of applied and innovative research;
- research strategies;
- allocation of research and development topics between public institutions and private sector.

2. The formulation of national research programs

2.1 - Sources of ideas

- internal thinking,
- exchange of ideas with potential research users (administrations, industry, small-scale sector, international aid agencies),
- with the foreign fishery research community through regional and international mechanisms,
- with the national scientific community (universities, agricultural research, food technology institutes.

2.2 - Processes for formulating and adopting national research programs and their funding:

- internal mechanisms, including programs and staff pre- and post-evaluation procedures;
- with the funding administrations.

2.3 - National fishery and research policies.

3. The implementation of research programs

3.1 - Means

- Staff
  - number, distribution by disciplines;
  - training of scientists and technicians;
  - recruitment capacities;
  - status.
- Budget
  - investments vs. operating expenditures;
  - outside sources;

    - long term funding commitments.
  - Equipment
    - computers;
    - laboratory apparatus;
    - research vessels.

3.2 - Data base

3.3 - Effectiveness

4. The transfer and use of research findings

4.1 - Formal structures and mechanisms for communicating with users

- national administrations;
- industry;
- small-scale sector;
- investors;
- aid agencies.

4.2 - Actual use of research findings

4.3 - Causes of ineffectiveness

- lack of relevance;
- lack of comprehensiveness;
- inadequacies of mechanisms and media.

5. Regional and international cooperation

5.1 - Regional cooperation

- areas: scientific cooperation, management of shared stocks;
- existing mechanisms: effectiveness and weaknesses.

5.2 - International cooperation

- areas: institution building, development of new research disciplines, scientific backstopping;
- forms of cooperation: training abroad, local projects, cooperative programs, consultancies, funding (including equipment);
- effectiveness and limitations.

6. Ways and means to improve research contribution

6.1 - Internal capabilities

- means and status of research;
- administration of research (programming and evaluation procedures);
- cooperation with national scientific community (e.g., as a way to strengthen innovative targeted research in countries where fishery research institutes have limited means for medium term research).

6.2 - Use of research

- completing the expertise of research users to increase their capacity to use research findings;
- developing cooperative mechanisms between each kind of user and research institutions.

6.3 - Strengthening regional and international cooperation in research

- issues which could be better investigated at regional or international levels;
- need for regional research activities:
  - documentation centers and fishery research magazines;
  - dissemination of information to potential users;
  - joint research programmes, networking;
  - regional research institutions;
  - international research institutes, by fields;
- mechanisms to improve N/S cooperation:
  - twinning arrangements, exchanges of scientists;
- how to improve the use of international aid.

B. FISHERIES DEVELOPMENT AND MANAGEMENT ISSUES TO ASSESS THE ADEQUACY OF RESEARCH PROGRAMS

- Fishery management:
  - Bio-economic assessment;
  - Institutions (use rights systems, structures for their implementation).
- Variability of pelagic fish stocks.
- Aquaculture:
  - Shrimp,
  - Salmon,
  - Mollusc and seaweeds,
  - Freshwater aquaculture.
- Fish processing:
  - Technological innovations,
  - Fish processing as a factor of fishery development.
- Distribution, marketing and trade.
- Cooperation:
  - Regional (fisheries management, research);
  - International research.

Annex IV
Implications on Research Priorities of Structural Changes Affecting the Sector

NEW CONDITIONS AND NEED FOR ADJUSTMENT IN THE SECTOR

Up to the early 1970s[5], world fisheries developed at a rate of 6-7% annually, i.e., more rapidly than the human population and the production of major agricultural commodities. This resulted essentially from the expansion of large-scale operations over previously untapped resources, first by industrialized nations whose fleets spread over the productive areas of the world ocean, then by fleets of medium-range trawlers and seiners in developing countries. Since the rise in demand was expected to be filled through extensification of large-scale fishing operations, aquaculture and small-scale fisheries received little attention, even in countries where traditional production was important.

In 1972, the growth rate of world production dropped suddenly to 1% per year. Confronted by falling catch rates and the collapse of important fish stocks - the Peruvian anchoveta in particular, large-scale fleets had hardly any latent conventional resources to sustain further their expansion. Unconventional species (krill, mesopelagics) failed to provide the opportunities that were once expected.

The pervasiveness of resource scarcity had profound effects on fisheries both in developing and developed countries. The first one was that it prompted coastal countries with abundant resources off their shores to extend their jurisdiction. This was seen as a way to extend expansion opportunities by substituting domestic for foreign fishing. In other countries, gains were minimal. Although the change in the Ocean regime allowed coastal nations to exert controls over foreign fishing operations, very few countries have yet introduced access controls in their domestic fisheries. Most domestic fisheries still operate under the regime of open access which prevailed during the extensification period.

The second one is that, the growing gap between world supply and demand induced a general increase in fish prices, particularly marked for high valued species. As a consequence, fish became more expensive for high income consumers, and scarcer for low income ones. This rise in fish price triggered important developments.

First, there was a growing interest for aquaculture. Research and development efforts concentrated primarily on new, more intensive, modes of production. Traditional systems (e.g., shellfish culture, traditional pond culture of finfishes) initially received less attention. New farming systems emerged (shrimp, salmon), largely as a result of initiatives taken by the large-scale sector. Attempts at introducing aquaculture in new rural areas failed in most regions (Africa, Latin America), an indication that, in the take-off of new small-scale systems, economic and social constraints are stronger than technological ones. The prospects and development conditions of extensive systems (shellfish, ranching) were generally overlooked.

Second, the supply shortage for high valued species stimulated a major technological innovation in the large-scale processing industry. Through the restructuring of proteins, lower valued species could be upgraded into higher valued products for high income markets, thus reducing species characteristics and relaxing constraints in adjusting supply to the demand for high valued products. So far, however, no similar breakthrough has been made to meet the needs of low-income consumers.

Third, the economic and social significance of small-scale fisheries received greater recognition. It was realized that small-scale fisheries have particular assets for the exploitation of inshore resources, but that

5 With differences of timing between regions, but without major deviation in the process as shown by the sequence of events.

they were frequently being harmed by the open access conditions and the industrialization model which has been dominating conventional fishery development approaches.

Fourth, recognizing the need for regulating access into domestic fisheries, certain countries (Australia, Chile, Iceland, New Zealand) started to adopt new mechanisms for the allocation of exclusive, quantitative and transferable use rights. Although the process has been started too recently to draw definite conclusions, considerable improvements in the economic profitability of fisheries, and in the effectiveness and ease of fishery management are being achieved.

During the past two decades, the degradation of aquatic ecosystems has also raised growing concerns. Problems are particularly acute in freshwater and coastal waters where many important commercial fish stocks spend the early stages of their life, and where aquaculture activities are concentrated. The similarity of the technical, economic and institutional issues encountered in environment conservation and in fisheries management show that the problem is considerably broader. It concerns all uses of natural ecosystems.

IMPLICATIONS ON DEVELOPMENT AND MANAGEMENT STRATEGIES

These changes in the fishery sector have profound repercussions on the prospects and conditions for economic growth. Because of the important structural differences that exist between economic activities, different development and management strategies must be applied. Actually, three major avenues can be distinguished depending on the kinds of activity.

Fisheries Management and Natural Ecosystem Conservation

In the exploitation of natural ecosystems, and notably in fisheries, opportunities for improvement are not immediately associated with technological innovations. Institutional innovations (adoption of use right systems and structures for their implementation) are required for the effective allocation of scarce resources, before economic gains can be expected from technological innovations. To day, administrative mechanisms are largely inoperative because they do not take into account the increase in resource rents induced by resource scarcity, which triggers overinvestment and overfishing. Economic mechanisms cannot function either, unless adequate use right systems are introduced. Recently, considerable improvements in the effectiveness of fishery management have been achieved when economic mechanisms were introduced for allocating resource access in large-scale fisheries.

The resource rents that are presently wasted because of the open access regime can be extraordinarily large, amounting to billions dollars in resource rich regions. Their waste is particularly detrimental for developing countries, since these countries have to rely primarily on the exploitation of their natural resources to generate the investments necessary for the development of their industrial sectors, as well as to enhance domestic demand.

With adequate institutions for regulating access in domestic fisheries, considerable benefits could be derived from the information that research can generate on fish stock distribution and production. Stock productivity and unit value of harvests could be enhanced considerably by optimizing the distribution of fishing operations over the sizes and species of fish stocks. With adequate institutional changes (but only on that condition), fishing technologies that reduce fishing costs could increase economic efficiency, instead of furthering resource depletion which is their major effect under open access conditions.

Aquaculture

In aquaculture, economic growth through technological innovations and investments is possible when certain conditions are met.

The systems that have already taken off (e.g., shrimp and salmon culture, fish pond systems in Asia) will benefit greatly from investigations in the biology and physiology (reproduction, nutrition, genetics, epidemiology and pathology) of the commercial species.

However, in rural areas where small-scale aquaculture is still latent, introduction of aquaculture depends on prior identification of farming systems that match the social and economic contexts in which potential farming groups would operate. Investigations in sociology and economics are more critical initially than experimentation in zoology and technology.

Strong evidence suggests that extensive forms of aquaculture (bivalve mollusc, seaweeds, culture fisheries) offer large opportunities for increasing fish production in open water bodies (marine and fresh waters). Already, roughly half of the world aquaculture production come from such systems. In the short run, they may offer the only practical solution for increasing the resource base of many groups of small-scale fishers in remote areas where aquaculture is still latent. Also, since intensive systems cannot produce large quantities at low prices, they may be more appropriate for reducing the world gap in fish supply. Their development depends on research on reproductive strategies of fish populations, and on use rights systems, in addition to the production of fingerlings or spat of good quality.

Harvest Utilization

In a general situation of supply shortage, adding value to raw materials that presently command low prices is strategically relevant. In this respect, small pelagic species deserve a particular attention. Contrary to most other species, small pelagic do not enjoy a high demand on world markets and in the countries where there are most abundant. They make half of the marine fishery production, but half of that production is reduced into meal for industrial purposes, or used directly as feed for aquaculture. Although there are technological difficulties (rapid deterioration of harvests, stock variability), upgrading the utilization of small pelagics through the application of new processing techniques is, among the opportunities that exist, one that deserves particular attention.

CONSEQUENCES ON RESEARCH PRIORITIES

Aside from those that are classically conducted, new research investigations have to be undertaken if the sector is to respond to changes in development opportunities and management needs. These new needs can be grouped into seven major categories:

(1) conservation of aquatic ecosystems: e.g., hydrodynamics modeling of coastal environments to minimize the effects of pollution, modeling of abnormal plankton blooms, ...

(2) population dynamics of early stages of selected fish populations for (i) the development of extensive aquaculture systems, (ii) the management of unstable stocks, and (iii) the conservation of the fish productivity of aquatic ecosystems (separating man-made from natural effects in changes in fish stock abundance, development of quantitative criteria for environment quality preservation);

(3) conditions for small-scale aquaculture take-off in new rural areas (typology of aquaculture systems, relationships between farming systems and the economies and social organization of potential farmer groups, ...), with three specific purposes: (i) determining farming systems suitable to specific regions, (ii) identifying potential farmer groups, and (iii) improving development strategies;

(4) intensification of established aquaculture systems (fish pond aquaculture in Asia, large-scale intensive systems), through investigations in the physiology and biology of commercially-dominant species;

(5) utilization of small pelagics, with investigations concentrating on: (i) basic composition of raw material and the functional properties of proteins and lipids, (ii) analysis of spoilage processes (oxidation, bacterial degradation, formation of biogenic amines), and (iii) analysis of traditional and modern preservation techniques;

(6) management of common use resources: typology and analysis of customary right systems, exclusive - collective or individual - use right systems, physical supports of use rights (licences or quotas in fisheries), institutions for aquatic environment conservation, and

(7) policy analysis: inter-sectoral spillovers, food policies, market and trade analysis, long-term trends in fisheries and aquaculture.

Annex V
On Research Definitions and Policies

DIFFERENT KINDS OF RESEARCH

Depending on the objectives, different kinds of research can be distinguished.

Adaptive research consists of direct application of available methods and techniques for the improvement of existing production systems. It is demand-driven and, because its significance for development or management is direct and immediate, it generally enjoys a higher demand. Problems are easy to identify and to formulate. Feasibility of investigations and probability of success are high. Investigations are essentially deductive. It can be understood as the implementation step between scientific investigations and the introduction of innovations into economic activities. It, thus, covers the transfer of technologies.

When production systems are bound by constraints which cannot be properly apprehended with available theories and methods, or when the purpose is to develop new systems, or to introduce existing ones into new regions, investigations of a more strategic nature are required. Prior to applications, new concepts, theories and methods have to be developed. This is the field of innovative research. Here, the formulation of questions depends in part on speculative thinking. Hypotheses have to be conceptualized and research protocols formulated. This step of innovative research is intuitive, but the validation of new theories is deductive. Its conduct requires a knowledge of relevant scientific disciplines and of their likely future developments.

For the selection, formulation and evaluation of research programs of an innovative nature, as well as for appraising scientists and their work, recourse to scientific methods and procedures - such as the open confrontation of scientific views, is critical. These procedures differ from those used in adaptive research which, because it is less speculative, can be directed through economic mechanisms (e.g., the funding of fixed term, precisely defined applications).

The complexity of the methods and techniques used is not a relevant criterion for distinguishing between the two types of research. For example, sophisticated mathematical models or electronic equipment are used for the routine monitoring of fish stocks, without improving the contribution of fisheries to national economies. Similarly, the evaluation of economic and social losses resulting from the absence of use rights in fisheries may be based on sophisticated models, but this is not sufficient for reducing economic wastes.

Innovative research requires academic qualifications, a proper scientific environment, an appropriate degree of autonomy, and funding that matches the span of investigations. It is, however, distinct from basic research. Whereas basic research aims at enlarging the knowledge in general, without concern for particular applications, innovative research aims at developing the understanding and the tools that condition future applications in different fields of economic activity.

Inputs from basic science are necessary for the development of innovative research. For example, because aquaculture is still in its infancy, knowledge in biological disciplines is considerably less advanced for finfishes, and even less for invertebrates (bivalves, shrimps) and seaweeds, than it is for mammals and birds raised in animal husbandry.

THE ROLE OF THE PRIVATE AND PUBLIC SECTORS IN RESEARCH

Among the factors which justify the involvement of the public sector in fisheries research, the following are important;

1) environment and resource conservation, and fishery management, aim at long term benefits for the nation as a whole which, owing to the resource jointness and its conflicting uses, private enterprises cannot maximize, especially under present institutional arrangements;

2) when the level of technology and industrialization in an economic sector is low, knowledge and techniques are easily copied by others; this can be a cause of under-supply by the market;

3) in developing countries in particular, infant industries have not developed their own research capacities; in addition, technology transfer is not innate to the private sector; consequently, certain development opportunities may remain latent, unless they are promoted by the public sector;

4) prospective investigations - e.g., for aquaculture development - are risky and costly endeavors; costs are amortized only on long time scales; for that reason, they cannot be supported by small companies, unless they can share the cost and the risk through professional associations;

5) economies of scale can be made when a single research institution can be more effective than several small laboratories; in this respect, the small-scale sector is handicapped by the small size of enterprises;

6) consumers are often disorganized and need protection, in particular against health hazards.

For these reasons, the public sector will generally concentrate the support it provides to research on the following areas:

1) conservation of environment and fisheries management;

2) improvement of the economic and institutional "environment" of productive activities (e.g., the institutional set-up for fishery management);

3) basic and innovative research, ahead of R & D activities conducted by the private sector;

4) technical support of the small-scale sector; and

5) protection of consumers health.

Conversely, research areas where the private sector is likely to invest include:

1) technical information on equipment and markets;

2) common services, such as in product quality control;

3) technological experimentation and adaptation in boat design, fishing equipment, aquaculture, fish technology;

4) market and trade analyses.

However, the boundary between two areas is not fixed. With more appropriate institutions for fishery management, for example, a substantial part of the present management function could be taken over by fishermen bodies. Generally, the large-scale sector is immediately in a better position than the small-scale one to engage itself in R & D activities. However, in developing countries, the private sector has conducted so far very little research with its own means, and most of it consists of simple adaptations. Most of the knowledge that the private sector needs to develop new technologies come from research institutions in developed countries.

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