Folder Title:	Comments - Aquaculture Meeting - Correspondence
Folder ID:	1856158
Series:	Subject Files of the Fisheries Program
Dates:	01/01/1989 - 12/31/1990
Fonds:	Records of the Agriculture and Rural Development Sector
ISAD Reference Code:	WB IBRD/IDA AGR-5891S
Digitized:	12/07/2023

Subject files of the fisheries program:
Comments aquaculture meeting

Trond Bjørndal

6.2 ECONOMICS

The economics of aquaculture is primarily an applied discipline, involving the application of various subdisciplines in economics and commerce to the field of aquaculture. It is also a fairly recent discipline, and so far very few scientific analyses have been undertaken.

Economics can be used to analyze both single projects and sector development. In addition, cost-benefit analysis of research projects relating to aquaculture may be undertaken.

As far as theoretical economics goes, one can envisage research in the following areas:

- Optimal feeding and harvesting in aquaculture
- Optimal rotation
- Polyculture
- The issue of property and use rights.

In the last years, a number of theoretical analyses of optimal feeding, harvesting and rotation have been undertaken. In most instances, it appears optimal to harvest all fish at the same time. This is in contrast to the practice of continual harvesting over some period of time. Problems relating to continual harvesting and feeding have not yet found their solution in the literature. The same relates to polyculture. This is, however, a matter of joint production (cf. multispecies fisheres), but the analysis needs to be extended to the context of aquaculture.

The issue of property or use rights varies widely from culture system to culture system. While private property rights exist for some systems, others resemble the open access situation of capture fisheries. This is particularly true for certain kinds of extensive aquaculture, e.g. ocean-ranching.

In the same way as for capture fisheries, the implications of property and use rights systems for aquaculture need to be researched. The problems relate to the allocation of rights, the tenure and the content of the rights. Moreover, issues related to private or communal rights need to be analyzed.

In the field of applied economics, research should be promoted in the following areas:

a. The development of aquaculture.

Essentially, this would be an economic analysis of the development of aquaculture (economic history). The primary purpose would be to analyze which factors are of critical importance to the successful development of aquaculture.

This development is likely to be similar to what has been experienced in agriculture. It is important to analyze factors which are critical for the successful development of aquaculture. These include designation of tenure systems and the availability of inputs, in particular credit, as aquaculture represents a delayed-output production process. Furthermore, in pre-capitalist societies markets for both inputs and outputs may need to be developed, which will necessitate institutional change.

In this context, the objectives of aquaculture development must also be considered. Some developing countries are focussing on aquaculture as a means for increasing export earnings; some for increasing domestic food supplies, and others for increasing employment opportunities. These policies are not always carefully thought out, and pursuit of one policy may be damaging to other national objectives. Furthermore, the true social costs of a policy may be overlooked. Economic analyses of alternative food policies may be important.

b. Production economics.

Aquaculture is traditionally defined to be extensive semi-intensive or intensive, usually on the basis of the usage of certain inputs such as feed and fertilizer. From an economic viewpoint, this may not be a very meaningful definition.

Economic criteria for the classification of aquaculture, e.g. investment costs per unit of production capacity or the labour/capital ratio, should be established and economic analyses undertaken on this basis. Inparticular, one would like to analyze the following factors:

- production efficiency (cost of production), including economies of scale
- productivity
- substitution between factors of production
- externalities.

In addition to comparisons according to the level of intensity, one should undertake comparative analyses for the culture of different species and for different countries.

As in capture fisheries, externalities are very important in aquaculture, although the nature of problems is different. Aquaculture produces externalities that affect both aquaculture entities and other activities. Similary, aquaculture is affected by externalities from outside sources.

Questions related to externalities are dealt with in the general economics literature. Only few applications have to date been made to aquaculture.

In general economic analyses in the field of aquaculture would consist of the following elements:

- Market analysis
- Market structure
- Institutions
- Production economics
- Investment analysis
- Financial analysis.

An economic analyses of aquaculture development will always start with a market analysis, as an actual or perceived demand is a precondition for successful development. While market supplies from capture fisheries are limited by nature, this is commonly not the case for aquaculture, where market demand may be the limiting factor for development.

In other words, where supply is limited by nature and demand is continuing to increase, this will result in an increasing real price of the product and create a potential for aquaculture. Whether aquaculture will affect market price is likely to vary from product to product.

Market structure and institutions influence how products are marketed. Moreover, the relationships between different agents determine both the efficiency of the distributions channels and profit margins for different kinds of economic agents.

For given constraints imposed by the market and institutions, production economics, investment and financial analyses deal with the economic viability of the micro units. In other words, these are economic planning tools to determine the profitability of aquaculture operations.

联合国粮食及农业组织
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION
منظمة الأغذية والزراعة للأمم المتحدة

Via delle Terme di Caracalla, 00100 Rome, Italy – Cables: FOODAGRI ROME – Telex: 610181 FAO I – Facsimile: 5782610/57973152 – Tel.: 57971

Our Ref.: Your Ref.:

16 FEB 1990

Dear Jean Paul,

I apologize for the delay in sending comments on the draft report of the SIFR Working Party on Research Needs for Aquaculture Development and hope that what follows will help in preparing the best possible report, which is in our mutual interest.

I would confine my comments to general ones as I am also attaching my copy of the draft with marginal detailed comments, which you may find useful when preparing the final document. My colleague, Mr. D J. Lens, has also seen the paper and contributed with very valuable points. I showed him the draft on purpose as, having participated in the meeting and the discussions, certain parts of the report could be clear to me but could also not be easy to understand for readers who did not attend.

I have to start by giving you credit for the courage demonstrated in accepting such a formidable task as the SIFR. Having said that, I do not fully understand what you intend to do with the document. You may wish to use it as a contribution to the final report, including the entire text, or use it to prepare a different document to cover aquaculture needs, attaching the present draft as an annex. Obviously, the final destiny of this draft jas a bearing on my comments related to the structure of the paper and you may find that some of them may be irrelevant.

In general, I found the paper interesting. It requires further elaboration as it contains an amount of interesting concepts, but has considerable problems of structure and contents which can, I think, be overcome, although this would require additional work. For ease of reference, I will number my comments:

Dr. Jean Paul Troadec
Team Leader
Study of International Fisheries
Research
AGRPS - Room N. 5021
World Bank

i) The paper is very long, difficult to read (very dense) and sometimes too cryptic or academic. As it is now, it would need a clear executive summary, highlighting the operational implications of the proposal, as it is unlikely that administrators in bilateral and multilateral agencies will find the time to read it entirely. If the expected audience for this paper are mainly administrators (perhaps with no background in fisheries), the reading has to be facilitated and jargon (biological, developmental, economic) should be minimized.

ii) A clearer paper would require a different outline if it has to stand by itself and we could suggest a different one, which is attached as Appendix 1. In particular, the conclusions, justifications and actions proposed should be more clearly presented, with an idea of the time frame, steps to be taken and at least a rough cost estimate. As very likely, the latter was not fully assessed at the Paris meeting (not certainly in the first session), this is something you may wish to add only for the main report of the study.

iii) Chapter 7 is a rather good analysis of a situation which is, however, not known to the reader, who is not fully conversant with the status of aquaculture development. It is not explained how these conclusions were obtained. It would need a previous presentation, even if short, of the status and evolution of aquaculture. The heading of this chapter is also rather misleading (Review of the Current Situation). It does neither provide an assessment of the adequacy of present research programmes vis-à-vis the production sector, nor does it specify what are the operators or the private sector contributing on aquaculture research.

iv) Chapter 8 "Conditions for Effectiveness and Efficiency" should set the scene for a section on specific proposals and related operational arrangements, but, up to this point, the paper does not provide a good justification (I´m playing the devil´s advocate) to change substantially the present situation. Questions of the type "is research the limiting factor for stimulating aquaculture development?" or "could an increased effort in aquaculture research produce a significant progress of aquaculture production?", which administrators of donor and financing agencies may ask, do not find ready answers in the document. It is sort of taken for granted that a substantial improvement in research would be a crucial element to foster development. I would agree that it is an important element, but I also gather that for agencies involved in development you may require a stronger argumentation, especially when taking into account that growth rates of the aquaculture subsector are far better than those of capture fisheries.

v) The identification of major problem areas or of new approaches (the innovation factor), which could be solved or should be investigated by the research community, is not clearly separated in the report. This identification should be an essential element for the definition of a strategy. I guess that the specialists convened for the second session of the working party should have given clearer indications in this respect, once the identification of the main systems had been completed by the first group.

vi) Clarifications on definition and on the tables included are necessary. Examples could be the types of research, farming systems and production systems. I found Tables 7-8 on economic processes/functions difficult to understand in relation to what the various headings meant, and you can be assured that I was not the only one. Similarly, the ranking given for the tables is not so crystalline. Nonparticipants may have a lot of difficulties in understanding the codes and meaning of the matrixes. A couple of examples per table would give them a clearer key to the understanding of these tables which were essential to separate major systems.

vii) I found the section on economics, and to some extent that on social sciences too, not very specific for aquaculture. To some extent, it is like reading a book on agricultural economics. Perhaps this part could be improved with the inclusion of some examples which could also be related to the tables. Since the material provided by Diaw and Aguero was not really discussed, as it was delivered at a late stage, it was not really possible to see to what extent it was understandable to nonspecialist. I find that it is nearly impossible to merge their tables with that of the biotechnical group to try giving a relative weight to the discipline, or other subcategories, in the context the systems analyzed and their evolution in time. Perhaps Aguero and Diaw could offer an alternative solution because, as it is now, the two groups of matrixes are totally disconnected.

These were the main comments I had on structure of the paper and presentation. Regarding the contents of the paper, these are my main comments:

a) The sequence of reasoning shows a clear disconnection between the two sessions. While in the first five chapters the main emphasis is put in the identification of a production system typology in relation to disciplines, a concept which would allow dealing with research needs for the various systems irregardless of the geographical location or the species to be dealt with, the second part reintroduces the concept of regions and the disciplines are dealt with in almost total isolation, at least with little or no relation to the systems identified in the first session, which seems to be a step backwards. It gives the impression that the second session went beyond the terms of reference indicated for it in the introduction (see pg 2), although one has to recognize too that the agenda for this section session was not sufficiently clear.

b) I feel that the report does not properly reflect the efforts and conclusions of the first session. Perhaps they were discussed by the second group and rejected or perhaps the second group failed to recognize the implications of the conclusions of the first group. This I do not know but, in reading the report, I got the impression that the work of the first group was of little use for the second. If I remember correctly, the main purpose of our trying to identify the main systems was for eliminating three major bottlenecks which plagued the efforts of groups trying to introduce aquaculture into the CGIAR system, which are the dependence upon species, regions and biological disciplines. With the identification of sufficiently distinct systems, it would be possible to study them in an integral way, irregardless of species, area or particular discipline, and establish a global framework for cooperation in research.

c) Towards the end of the first session, when we discussed the institutional arrangements on the last day, I recall that in elaborating on the item international level, I proposed an institutional arrangement based on the main systems identified (ocean ranching, extensive, semintensive - two of them eventually - and intensive), in which a specific network for each of them would be created with a recognized centre of excellence as its head and various national centres attached to it. A central secretariat, monitoring the work of the various networks and channelling resources according to perceived needs and progress, would be the head of the system. This has not at all been reflected in the report, although it was not rejected as a working mechanism by the participants of the first session.

d) Instead of elaborating on this line of thinking, the second group came up with a different solution, which brings in again the problems of the past and which had no thinking head. You can see that very clearly on pg. 63. para 5, in which it is said "great difficulty was experienced in identifying who would decide on programming ....". I do not believe in the capacity of scientist networks to come up with adequate and balanced programmes, really serving the needs of the production sector. In the first place, general networks tend to be dominated by scientists of a few disciplines as it has been proven in the past. Second, it presumes that organized and specialized associations of scientist exist for all disciplines and in all geographical regions, which is not the case. So, very likely, the use of collaborative networks of specialists would not take us very far from the present situation, in which every group tends to benefit its own interests (something also implicit in the initial remarks of Dr. Huisman ...), and thus disparities would be enhanced. Since we are after research programmes to favour development, you would need a group headed by generalists rather than specialist, which could come up with a balanced approach and should be advised, when necessary, by groups of specialists.

e) I feel that the research which is being carried out by the private sector is not properly considered in the paper. Think about aspects like diet formulation, vaccines or medicines and to some extent selection of specific strains of organisms, in which the private sector has played a very important role (I could think of specific examples such as microcapsulated feeds for larval rearing, bacterins for prevention of diseases, or the production of red tilapia fingerlings). The paper seems to concentrate on public-sector research or externally-assisted research, which is generally channelled to public sector institutions.

f) An idea of what the various disciplines have so far contributed for the development of aquaculture is missing in the paper and it would have been helpful to give a better idea of its evolution. The various specialists of the second session should have contributed some information in this respect. In this particular case, an analysis on a regional basis would have been adequate because of the existing disparities between regions.

g) The headings under 6.1.3, 6.2, 6.4 and 6.6 are discussed in total isolation from systems´ analysis. Scientific areas are also treated in almost total isolation from other disciplines (and this is something which could be expected from specialists), clashing totally with the spirit of the first session which tried to identify typologies defined by the mix of the various disciplines. I feel that <u>only</u> the item on ecology (not surprisingly) links properly with the first session. Moreover, the distinction for the research to be given priority on the medium run (10 years) and on the long-term (up to 25 years) is not at all evident in the various disciplines.

h) As a last point, I do not see the need to include a separate item under biotechnologies. Most of the points included under this heading could have been inserted in their respective disciplines (genetics, nutrition, etc.), making things much simpler and clearer.

And that is all for the main comments. Do not be discouraged by my comments as they do not at all intend to be negative. I feel that a paper which could be an important element in the future of aquaculture research deserves all the efforts we could make for it to result as good as possible. I hope I will be able to see you in Rome next March, when the paper is discussed with the Fisheries Department.

With my best regards, I remain.

Yours sincerely,

Mario Pedini

联合国
粮食及
农业组织

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE

ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION

منظمة الأغذية والزراعة للأمم المتحدة

Via delle Terme di Caracalla, 00100 Rome, Italy   Cables: FOODAGRI ROME   Telex: 610181 FAO I   Facsimile: 6799563   Telephone: 57971

Our Ref.: FI 7/17   Your Ref.:

Subject:

16 JAN 1990

Dear Jean-Paul,

... Here are some more comments on the aquaculture report from Colin Nash. I think that they make good sense and may be useful to you in your final write up.

With regards.

Yours sincerely,

David James
Senior Fishery Industry Officer
Fish Utilization and Marketing Service
Fishery Industries Division

Dr Jean-Paul Troadec
SIFR Secretariat
c/o AGRPS N 5021
World Bank
Washington, D.C. 20433
USA

IDRC-MR149e

International Development Research Centre

MANUSCRIPT REPORT

Research Priorities for African Aquaculture

Report of a workshop held in Dakar, Senegal October 13–16, 1986

April 1987

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE · CENTRE DE RECHERCHES POUR LE DÉVELOPPEMENT INTERNATIONAL
CANADA

RESEARCH IN AQUACULTURE, MEANING AND AIMS

by

S. Cataudella[1] and C.E. Nash[2]

INTRODUCTION

Discussing such a general but complex topic as research in aquaculture, it is difficult to say things which have not already been said, and not to speak in generalities which are far from practical reality.

We will try to focus on some aspects of research to be developed in the workshop and to identify issues and the difficulties in resolving them. The general strategies for finding solutions are the object of this workshop.

1. Meaning of Research in Aquaculture

1.1. Aquaculture as applied science?

To find the meaning of research in aquaculture, it is necessary first to determine if aquaculture can be considered as an autonomous science. Not because this autonomy is compulsory when a multidisciplinary approach is used, but to determine if "aquaculturology" has developed its own autonomous methodologies.

The practice of rearing fish, or at least managing fish stocks in limited environments, is very old, and evidence of this being discovered in many regions of the world all the time. It is possible that where favourable ecological and cultural circumstances occurred advanced management techniques developed.

It is possible to rebuild an evolutionary history of the productive activities in aquaculture, with its collection of trials and errors typical of an empirical approach.

However, aquaculture as a science ("when the trial and error process is organized or systematized", Shell, 1983) has a very recent history. Without citing milestones of research in aquaculture, we can assume that the first contributions using scientific methods came from biological research. Only those who knew aquatic organisms could interpret the principles. The anthropological sciences developed later.

In the last 40 years, a series of sectoral competences from fields of activities such as biology, engineering and economics, have laid the first foundations of that incomplete mosaic which is aquaculture as a discipline.

1/ Department of Human Biology, University of Rome, Rome, Italy
2/ Programme Leader, Aquaculture Development and Coordination Programme, FAO, Rome Italy.

Little has been done as yet to make it an autonomous discipline, as has happened for agriculture and, in some countries, for fisheries.

This lack of autonomy has reflected on research, as it has led to reduced communications and different levels of concern among researchers in the various fields.

Among aquaculture researchers, one can find biologists, fishery scientists, agronomists, engineers, socioeconomists, each dealing with the problems from his own point of view, but all having different ideas of what aquaculture really is, and of the meaning of research for its development.

1.2. Researchers in Aquaculture

Solutions to research problems are clearly linked to the development of study programmes at university level.

The present development of the aquaculture sector does not justify the creation of specific university faculties, with some exceptions.

The "World of Learning, 1986" gies an overview of scientific associations, research institutes and universities in the various countries. It it interesting to note how little the word "aquaculture" occurs, and how few research institutions, faculties, or lectures within agriculture centres deal with aquaculture.

It is useful to review programmes of Japenese university courses (Table 1) on fisheries with important components of aquaculture. This example refers to a particular national situation and it is not proposed as a model to imitate worldwide, but it is useful to understand the correlation of effort in school-research and results in terms of production obtaining in a short time. Japan, for example is now recognized as one of the leading nations in aquaculture production.

The efficiency of education programmes conditions the quality of research results. The acceleration of productive activities which research should catalyse depends on the adequacy of the preparation of people who work in research. Such people can only be trained through long and specialized study courses, and not in three-month training courses in some centre specializing in aquaculture.

1.3. The Three Levels of Investigation and Purpose

The purposes of research in aquaculture are generally to answer the many questions asked by fish farmers, namely: When to stock ? How to stock ? When to treat for disease ? When to harvest ? How to market ? and so on.

Research which produces "reliable and repeatable" information (Nash, 1986), useful to answer these practical questions, contributes to the progress of aquaculture.

The process of acquiring information is complex and is composed of results from research, but based on different motivations which may be linked to subsequent applications or not. It is necessary to recognize three levels of investigation and purpose (Ibid, 1986), namely:

A. fundamental or basic research
B. applied research, sometimes called research and development
C. empirical research.

The following considerations are important in planning research:

(i) the three levels do not constitute a hierarchy which creates competition in the development of research;

(ii) the functional relationship between each level depends on the flow of information between them;

(iii) researchers engaged at each level are all equal and not themselves in any hierarchy;

(iv) information and results obtained at each level must be considered equally for dissemination;

(v) the three levels must be recognized for all fields connected with aquaculture. For example, in addition to the biotechnical components, research is required in engineering and socioeconomical aspects to optimize specific methodologies for aquaculture, and to avoid generic proposals and evaluations. Equal weight must be given to all the sciences which contribute to research in aquaculture.

1.3.1. Fundamental or basic research

Fundamental research increases knowledge of the mechanisms underlying phenomena, and contributes to periodic preparation of general syntheses.

The value of fundamental research is that results may have broad ramifications and are very widely applicable.

The contributions of basic research results to aquaculture are many and important, even if much still remains to be done in genetics, pathology, breeding of marine species, etc.

Basic research, because of the vastness of the field open to it even in aquaculture, clearly requires priorities to be named before being undertaken.

1.3.2. Applied research

Applied research aims at obtaining applicable results. It requires experimental stations and pilot fish farms, generally with modular structures, which allow replicate trials in space and time to produce results which can be transferred with reliability. The tools of applied research are partly those of basic research and partly those of the world of the real production.

The right balance between these two components marks the success of applied research. The collection of data, as in basic research, and the pragmatism of the world of production to select priorities for intervention, are meaningful and successful if well balanced.

Research is always linked to the experimental equipment and facilities available. By using only the resources available, activities are applied immediately to local conditions.

A precise knowledge of the context of the project (the ecological and socioeconomical milieu in which an aquaculture activity is to be developed) is the basis for identifying applied research programmes.

It is important that applied research results are verified again by empirical research at production scale, as they may be different from those already obtained from simulated experiments.

1.3.3. Empirical research

At an empirical level many research activities in aquaculture are possible, and the evolutionary process of trial and error, not formalized but acquired by the experiences of fish farmers, is represented.

The limitations of these experiences and their origins make it difficult to express the results in scientific terms.

Because of the non-dimensional approach to the "experience", it is impossible to know whether results represent real knowledge of ecological, biological and technological phenomena, or simply the skill of the operator.

This does not mean that empirical research does not play a primary role. Its value depends on the organization of research, and the inter-relationships between researchers and producers. Where there is a good communication, a positive synergy is apparent.

The fish farmer, once confident, readily gives information, and is ready to undertake trials or experiment with new techniques in his farm. This collaboration is most efficient if the researchers are constantly present to monitor the work.

Empirical research on government fish stations is hampered if there is a necessity to produce. The staff, with multiple functions (administration, research, rearing, marketing, etc.) cannot do everything. Collection of research data is usually first to be penalized.

The same is true in multi-function projects with aims of research, training and production, etc.

2. AQUACULTURE RESEARCH, WHAT IT CAN DO

2.1. Background

The consideration which we have outlined for the three levels of research are of a general character. It is the purpose of our meeting to search together to find the most accurate criteria to classify correctly the work which must be done.

In this part, we shall try to analyze what research in aquaculture should do to perform its function of accelerating the process of development.

Particular emphasis must be given to problems of research in those countries which do not have a tradition of aquaculture, or which do not have at present their own research infrastructure. In most countries, particularly those with great food problems, aquaculture is listed among key interests which can contribute to development and food security.

Aquaculture in Africa appears to be very complex, and in most countries requires intervention and refocussing. Hence the need to define research priorities realistically in the light of present knowledge.

In a major "Thematic Evaluation of Aquaculture" funded by UNDP/FAO/ Government of Norway, which analysed the technical assistance provided to aquaculture by UNDP/FAO projects, particular attention was given to the research sector. A summary of some issues identified by the study are useful to our discussion. For example:

(i) the research output of aquaculture in developing countries is of poor quality;

(ii) a shortage of resources and facilities partly explains the quality of results achieved, and the lack of continuity of research thrusts;

(iii) a special difficulty of technical assistance to research is making "adaptive technology" suitable for the local needs;

(iv) aquaculture in developing countries will continue to benefit from basic research carried out in the industrialized countries;

(v) the priorities for technical assistance to aquaculture research must be to

- improve culture systems for species already cultured in the country/area,
- identify technically, economically and socially desirable species and culture systems combinations,
- identify new, locally occurring species for aquaculture.

Thirty projects involved in varying degrees in research were examined, and the fields of intervention were indicated.

Topic	Number of projects involved
Basic research	1
Applied research in the field	26
Benchmark surveys	17
Laboratory research	9

The results have been very diverse and have been used more readily where there are traditions in aquaculture, as in Asia, rather than in Africa or in Latin America.

This information is useful to enter a "second phase" of research in aquaculture, one based closely on local realities. This still requires a multidisciplinary approach, broadening out from the technical fields to other important areas relevant to aquaculture. Multiple function projects produce more usable research results and must be encouraged.

2.2. Which Strategy for Research Programmes ? How to Integrate the Different Levels

From the above, several points are evident, namely:

- the role of research as an accelerator of development;
- the recognition of levels of research;
- the irreplaceable role of applied research for its autonomous character and as the link between basic research and production;
- the need for the multidisciplinary approach for aquaculture research;
- the need to create simple systems for formalization of results for dissemination.

Choices must now be made in order to create a strategy for research. Both Governments and researchers are responsible for ensuring that:

- at least applied and empirical research are done, so that repeatable results are obtained;
- research programmes have both medium and long term aims;
- conflicts between applied research and production are resolved - optimistic extrapolation of research results, on topics which are known to be difficult to solve, must be evaluated with care;
- stability is maintained among research staff, particularly among Government employees, and also administrators who deal with aquaculture;
- failures are evaluated to avoid repeating the same mistakes.

2.2.1. Fundamental research

Fundamental research is not a high priority for aquaculture in developing countries because of the lack of research facilities and equipment, and high cost of research operations. It is not easy, however, or strategically advisable to condition the academic world in developing countries to work only on applied research. Indeed, the teaching and cultural roles of fundamental research in any University must not be neglected.

In the *Ad hoc* Consultation on Aquaculture Research (FAO, 1980), it was recommended that "particular emphasis can be given to research on tilapias, carps, mullets and milkfish". Governments can adopt recommendations of this type by supporting basic research on species and areas that concern their programmes of aquaculture development.

It is important to remember that many types of research do not require modern and costly equipment. Research topics such as:

- geographic distribution of species of interest to aquaculture;
- species ecology;
- reproductive biology;
- social and economic interaction between aquaculture and other prime sector activities (agriculture/animal husbandry/fishery);
- socio-cultural aspects of the farmer/fishermen population;
- culture and consumption trends for fish products;
- credit models for the sector, etc.

are all necessary to widen national knowledge, without having direct applied aims, and have so far been neglected.

The accumulation of descriptive fundamental knowledge is vital for the identification of good projects. Indeed, the lack of good data for project design has been a prime reason for the failure of many aquaculture projects in developing countries and developed countries alike.

International collaboration must play an important role in the development of aquaculture, and the donors and development agencies will create the necessary opportunties for contact among researchers.

Many scientists in developing countries, who can contribute to aquaculture development, lack information and up-to-date literature. This is another priority area for donors to assist.

2.2.2. Applied research

Research in aquaculture requires an increasing effort. The priorities must be identified at a local level, recognizing regional and environmental variability.

To define such priorities in Africa is the aim of this workshop; there are no ready-made formulas.

Applied research in aquaculture is conditioned by the structure in which it is framed. The experimental plan must be simple and easy to manage. Much depends on the collection of accurate information, and the simpler the experiment the easier the monitoring. Programmes of environmental control and sampling, which are complex, must be avoided.

It is better to reduce the number of research activities and to concentrate on a few priorities. Results will be fewer but of better quality, and transfer to production in the end will be quicker.

3. CONCLUSIONS

In the identification of priorities for research in aquaculture, we must consider:

(i) if there are existing aquaculture activities in the country;

(ii) if there are traditional activities which can be considered as simple forms of aquaculture, and

(iii) if there are no aquaculture activities at all.

In the first instance, we must extract from the existing activities the problems to be solved. In this case, a systematic procedure for making decisions on research needs, similar to that described in Fig. 1, is useful.

In the seond case, we must evaluate eventual impacts and conflicts created by new activities on the traditional ones (for example, on the use of land water bodies) before deciding which experimental systems or modules to be used.

In the third case, we must identify the whole strategy, taking into account the experiences of other countries with similar ecological and socioeconomic conditions.

The integration of the three different levels of research should be carried out by applied research. Where production activities are present, the use of these existing structures for experimental purposes will reduce investment costs and permit complete integration of the different levels.

Finally, I must repeat that while much of what we have said has a general value, identification of the real priorities depends on careful analysis of the local priorities and needs.

REFERENCES

The World of Learning, 1986, Europa Publishers Ltd., 1898 p.

Shell, E.W. Fish Farming Research (1983), Auburn University, 108 p.

Nash, C.E. (1986), Research Development in Aquaculture. Paper presented at the 51st Congress of the Italian Zoological Society, Rome, 6-10 October 1986 (in press)

Thematic Evaluation of Aquaculture, FAO (1986) (in press)

FAO, Report of the Ad hoc Consultation on aquaculture (1980), 5-9 May 1980 FAO Fish. Rep. 238: 26 p.

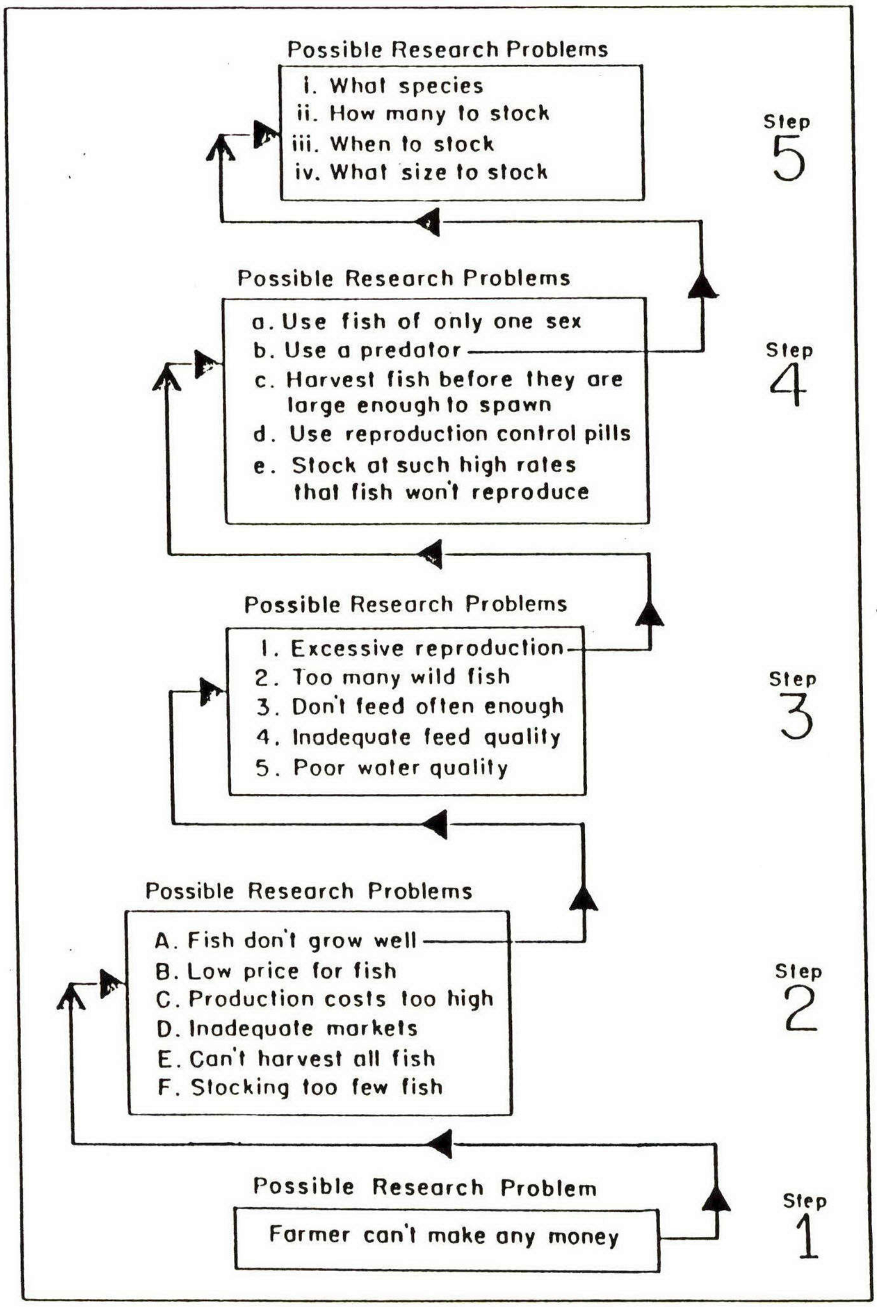


Fig.1

from .Shell (1983)

Table 1

TOKYO UNIVERSITY OF FISHERIES

Fishing Science and technology

- Fishing methodology
- Fishing gear technology
- Population dynamics
- Fishing technology and engineering
- Fishing instrumentation
- Navigation
- Seamanship
- Fishing boat instrumentation

Food science and technology

- Biochemistry
- Food chemistry
- Physical chemistry of foodstuff
- Food microbiology
- Food preservation and processing
- Food hygienic chemistry

Food technology and engineering

- Thermal process engineering
- Food refrigeration engineering
- Food packaging
- Marine industrial chemistry
- Food conversion engineering

Aquatic bioscience and mariculture

- Phycology
- Invertebrate zoology
- Fishery biology
- Animal ecology
- Algal cultivation

Aquaculture

- Ichthyology
- Fish physiology
- Fish pathology
- Fish nutrition
- Fish culture

Marine environmental science and technology

Environmental physics
Fisheries oceanography
Environmental protection engineering
Environmental hydraulic engineering

General education

Fisheries business management
Fisheries economics
Fisheries resources management

HOKKAIDO UNIVERSITY

Faculty of Fisheries

Marine zoology
Propagation of marine resources
Marine ecology
Oceanography
Animal histology
Fishing navigation
Mechnical engineering for fishing
Nautical dynamics
Fishing boat engineering
Mycology
Biology of fish population
Fishing grounds
Marine biochemical science
Marine botany
Training ship
Planktology
Fishing gear engineering
Biochemistry
Enzymology
Food microbiology
Fisheries business economics
Chemical engineering
Instrument engineering for fisheries
Chemistry of fats and oils
Freshwater fish culture
Analytical chemistry
Animal physiology
Ecology
Food chemistry

KYOTO UNIVERSITY

(in Faculty of agriculture)

Fisheries chemistry
Aquatic biology
Applied physics in fishing
Fishery resources

KYUSHU UNIVERSITY

(in Faculty of agriculture)

Fisheries chemistry
Marine biology
Fisheries technology
Fisheries environmental science
Fish nutriology

TOHOKU UNIVERSITY

(in Faculty of agriculture)
Fishery chemistry
Fishery biology
Aquaculture biology

Bollettino di

Zoologia

Vol. 53, 1986

INTERNATIONAL JOURNAL OF ZOOLOGY
PUBLISHED BY THE UNIONE ZOOLOGICA ITALIANA

51º CONVEGNO
DELL'UNIONE ZOOLOGICA ITALIANA

RIUNIONE DELLA
SOCIÉTÉ DE BIOSPÉOLOGIE

Roma 6 - 11 ottobre 1986

Riassunti / Abstracts

Mucchi editore

RESEARCH DEVELOPMENT IN AQUACULTURE ++

There have been a number of significant research results in the last fifty years which have enabled modern aquaculure (as I prefer to call the present discipline to distinguish it from the traditional practices of fish farming) to enable it to maintain its present important foothold among recognized food producing economies. In fact, I credit research with stabilising the present wave of enthusiasm for aquaculture, as interest has come and gone repeatedly throughout the last hundred years without fulfilling its promised potential.

Several early research results stand out, in my opinion, and have provided the present wave with reality and permanency. The first was the discovery of Rollefsen in 1936 that the nauplius of the brine shrimp, Artemia salina, was a suitable larval food organism for marine fish species. This was capitalized upon by Shelbourne in the late 1950s when he undertook his careful work on the propagation of marine flatfish. In 1949, Drew discovered the missing links in the life stages of the marine algae, Porphyra species, which proved to take place on the shells of molluscs. In 1960, Hickling achieved hybridization of two tilapia species, T. mossambicus and T. honorum, to produce an all-male strain for the first time; and in 1961 in Malaysia, Ling discovered the successful technique for raising the larvae of the freshwater prawns, Macrobrachium rosenbergii, by adding a little salt to the water.

++ By Colin E. Nash (FAO, Rome)
Presented to the 51° Convegno dell'Unione Zoologica Italiana, 6-11 Ottobre, 1986. Bollettino di Zoologia, 53,p10,1986 (Abstract).

Although these significant events have not been the only ones by any means, in a twenty-five year burst, research results laid the foundations for a number of practices for farming aquatic plants and animals which were subsequently carried through into economic production. It is not surprising that the seaweed industry in Japan (which is now over 500 000 tonnes annually) constructed a statue of Dr. Kathleen Drew on the shore adjacent to where her discovery has been put to so much use.

These notable events, clearly events of research, exemplify research at different levels of investigation and purpose. They are research because they all produced 'reliable and repeatable information' - the criterion I prefer to adopt to define research. There are three levels of investigation and purpose, namely:

(i) fundamental or basic research

(ii) applied research, sometimes called research and development, and

(iii) empirical research

Aquaculture research, both in developed and developing countries, does not have a good record, I regret to say. One reason for its lack of success, I believe, is the failure of research directors and managers to recognize these three individual levels of investigation and, importantly, what can be realistically expected and extrapolated from the results of each. Consequently, there has been too much optimism generated from too little information. Another reason for the lack of success is the lack of concentration on bottlenecks in priority production systems by a critical mass of effort. Effort has been dissipated among many researchers and institutes, and over a large variety of aquatic animals and plants many of which have no economic importance to the respective countries supporting the research.

During these formative years of the new discipline of aquaculture, governments have been the prime investors in research, either through their national fisheries organizations or through support to national universities. The private sector has also invested in research on problems within its immediate interests; for example, the feed manufacturers have supported work on fish nutrition and feed formulation, and the pharmaceutical companies on pathology studies. However, more emphasis has been given to applied research in the belief that a viable sector of aquaculture would develop quickly with minimal investment. Most effort has therefore been placed on the biotechnical problems associated with breeding, husbandry, and production. Almost no attention has been given to the building up of research capacity throughout the sector and obtaining information on other important sub-sectorial elements such as economics of production, engineering, labour utilization in the industry, social-anthropology, and marketing, for example. Furthermore, almost no attention has been given directly to fundamental research in the context of aquaculture alone - but usually in the context of general scientific pursuits. For example, many useful basic research results for aquaculture have been obtained indirectly and often fortuitously through continuous research work in the life sciences, particularly in the fields of zoology, botany, veterinary medicine, pathology, nutrition, etc.

Aquaculture development has been handicapped by the lack of investment in adequate facilities in the field to undertake realistic applied research at a practical level, and basic research has had to rely on the cooperation of existing laboratories at universities and in industry. Applied research has been carried out, for the most part, at places where production is being undertaken. This is an advantage in many ways, as applied research produces better results when practised or integrated with production and demonstration activities, and particularly when carried through to marketing and sale of products. However, in practice, problems for 'on farm' research can and do arise when production takes preference over the collection of reliable information which makes controlled production possible. As a result, much intended on-farm research has produced little more than empirical data - information of use only to the operations of that specific place and under those specific circumstances. Unfortunately, more significance has been placed on these empirical results nonetheless, and consequently subsequent failures to repeat any good results reliably have caused frustration and even stopped further interest and investment. This has been typical of work in many developing countries where resources are always limited and government staff have responsibility for management and production at government fisheries stations where both research and the supply of fingerlings for farmers are undertaken together. However, it is also true of developed countries.

One of the most serious detriments to the development of aquaculture in both developed and developing countries has been a failure to complete the logical progression from research through pilot-scale trials and demonstration to commercial production. This has been particularly evident when technology has been transferred between countries - and aquaculture has relied a great deal for development on the international exchange of information and experience. Invariably, research applications are always required to adapt the technology to local conditions before the progressive stages of development, but often this research and the intermediate phases before commercial production are omitted.

Most countries now have a nucleus of aquaculture expertise which can be usefully deployed at national centres ably supplied with facilities. National and regional linkages of such focal points become possible with cumulative benefits. However, it is important to recognize that research in a biotechnical field such as aquaculture, for many reasons, is a slow business, and building up national research capacity takes many years.

On the other hand, even though governments must recognize the importance of research to the development of aquaculture, the support must be in line with the size and potential of the sector, and its importance to the national economy. For example, many countries with aquaculture production of less than 10 000 tonnes, or about US$ 5 million - of which there are just over 50% of the 70 countries which provide data to FAO - cannot economically justify a large sector and research infrastructure. However, if a well-analysed potential for growth is technically feasible, and the sector receives the political support through government statements on policy and the preparation of national plans for development, then much greater investment in research infrastructure and manpower is merited. Countries with production of 40-60 000 tonnes - of which there are now about 25% and include such as Norway, Italy, Denmark, Malaysia - must have a well-established infrastructure and significant research capacity.

Unfortunately, the infrastructure of research cannot support every aspect of aquaculture which may have opportunity but which still has a bottleneck before final commercialization. There has to be national prioritization, and this must be dictated by a national need exemplified by a specific market of a quantifiable size. In the early days of modern aquaculture, almost every country was encouraged to invest in aquaculture research at all levels through the general interest in the subject matter itself and the biotechnical feasibility. Little or no attention was paid to the existence of a justifiable and quantifiable need. Arguments were always presented to justify research and investment based on the benefits for food security and nutritional requirements, increasing trade and foreign exchange, increase of maximizing producers' incomes, and increased employment opportunuties.

Although these reasons may still be behind government policies which enable aquaculture research to be supported, it is possible to provide more specific quantifiable and qualifiable goals. The immediate need is to identify the optimal and economic approach to attain them.

The solution must be research linkages of key institutes and personnel. Already, the linkage of so-called lead centres in four countries in Asia (and soon to be six) under the auspices of the Aquaculture Development and Coordination Programme, have enabled the foundations to be met for focusing attention on priority areas of research in the region. This approach is to be repeated elsewhere and will be the basis of new programmes in Africa, Latin America, and probably here in the Mediterranean. Another new programme in Asia among the ASEAN countries is planning to 'twin' research institutes in developing countries with the capable institutes in the EEC countries - and this is to be an EEC programme.

A Strategy for the Science Base

A discussion document prepared for the
Secretary of State for Education and Science
by the
Advisory Board for the Research Councils
May 1987

London: Her Majesty's Stationery Office

Contents

MEMORANDUM To David James (via Fran Henderson)

From Colin Nash

10 January, 1990

Ref: DRAFT OF THE WORKING PARTY ON RESEARCH NEEDS FOR AQUACULTURE DEVELOPMENT

I read the draft with interest and I think that the Working Party has done a very creditable job. Although analyses and development of research priorities have been carried out by many others before, I think that this approach by the group is new and the findings are well supported by the analyses. It is also more complete as it went beyond the usual biotechnical areas and provided a balanced analysis of the research needs of the sector as a whole.

I think there is little at fault with the draft and I do not draw attention to any specific paragraph or line. Although some small points might be raised they are arguable at best, and other reviewers have probably raised them already in their comments.

I do not know what the next stage of the process is, or what other sections of the report are being prepared and by whom. However, I believe that somewhere there must be considerable more attention to general research philosophy as a whole, and particularly with respect to aquaculture in a (metaphorical) geographic sense. For example, the draft does not expand very much on the fact that development, be it aquaculture or not, is market driven. Research is a follower, rather than a leader. It is better compared to an accelerator pedal rather than the starter motor, but acceleration, once underway, is more exponential than linear. Thus there is little in the draft which comments on:

(1) The key relationship between the roles and importance of the various levels of research and the existing national strength of the sector. National strength, which obviously differs from country to country, is difficult to quantify. It would be some indicative combination of number of producers, areas under production, diversity of practices and species, and production. Incidentally, from a development point of view, I believe that the strength of the sector should dictate not only the levels and subjects of research needed but also the levels and subjects of all other sectoral needs, such as government support services and private investments.

(2) Similarly the relationship between the roles and importance of the various levels of research and the potential growth of the sector. Analysing the current FAO Statistical Data for Aquaculture, and the history of growth in certain countries, one could hazard a guess that all countries with little or no farmers or aquaculture production at the present time (93 of the 142 countries reporting record less than 5,000 t, and most of them less than 1,000 t) are likely to have productions below 10,000 t twenty years from now. Those with a substantial nucleus of farmers and production of (say) 5,000-25,000 t (26 countries) are potentially able to attain 20,000-50,000 t in the same period, and will likely remain about there. Thus, what are the levels and subjects of research most suitable to this potential growth pattern?

There are also differences to be found within the levels of research. For example, I believe within fundamental research a difference should be recognized between traditional basic research and modern highly advanced research (biotechnology). Again, within the geographic contexts noted above, highly advanced biotechnology is only appropriate for those countries with a strong sector and which need it to advance beyond their approaching limitations and constraints.

I think that the final report would benefit if a Chapter or Section was devoted to this type of analysis, together with some brief references to the realism of aquaculture research efforts in the past. Examples (mini-case studies) might be made of such countries as Japan, China, Taiwan PC, Israel, USA, and Norway, with their research investment linked to their sectoral growth. Reference could also be made of the different transfer mechanisms used (planned or not) by each country; for example, the vast extension services of China with the convenience of target producers in communes and collective farms; the independent kibbutz of Israel (private sector research); the close interrelationship of farmers and researchers in Taiwan PC; the widespread and advanced levels of education and research in Japan down to prefectural locales; the national market drive in Norway; the plethora of printed and spoken information in the USA; etc. This would demonstrate clearly that there is no one common denominator or blueprint for aquaculture research and its application by producers, but they must be analysed and developed on a country by country basis. Many countries will no doubt have the same formula, but they might not necessarily be regional neighbours.

Finally, I copy the brief attempt I made with Professor Cataudella on this type of philosophical analysis of the background to aquaculture research for the first ADCP/IDRC Workshop on Research Priorities in Aquaculture in Africa, held at Dakkar in 1986. The Procedings are published (by IDRC). I also gave much of the same paper to a meeting of the Italian Zoological Society here in Rome the same year. They may be of some interest to you.

I also copy references of the UK Strategy for the Science Base (1987) and a New Scientist article on the UK NERC strategy for Marine Science. The original documents might be useful to the core team in the preparation of the final document, as I assume that much of the draft material will be annexed or abstracted.

Lifebelt for a drowning discipline

Marine scientists in Britain have been adrift in shark-infested waters for several years. Now five "flagships" are steaming to the rescue. But there isn't room for everybody aboard

Stephanie Pain

BRITISH marine science is about to undergo a metamorphosis. After several extremely lean years, the Natural Environment Research Council has designed a strategy for the next decade. It concentrates on five key projects, a strategy that the council hopes will convince the government that marine science is one area of big science that it should help.

Following the government's reluctance to support a British space programme, the NERC hopes to persuade ministers that Britain is a world leader in research in what it terms "inner space". It warns that if Britain does not stay ahead, it will lose the opportunity to exploit any new discoveries in marine sciences.

Launching the strategy last week, John Woods, head of the NERC's marine sciences directorate, emphasised the strategic value of the five "flagship" projects. Hugh Fish, chairman of the council, said that "by directing the programme towards real-life problems, marine science should attract better funding".

Sir Anthony Laughton, director of the Institute of Oceanographic Sciences, Deacon Laboratory, told *New Scientist* that the strategy "is absolutely essential. Marine science must declare where it wants to go, what its reasons for existing are and what are its benefits. It needs to formulate programmes that can be justified." The five big projects consist primarily of designing complex models of the processes in the oceans. These models should enable scientists to make early predictions of everything from storm surges and the state of fisheries to changing patterns of climate.

Defence comes first on Woods's list of the benefits brought by marine research. Better oceanographic data, the report suggests, will allow the navy to detect "hostile submarines" more easily. It stresses that the Soviet Union's navy has the largest oceanographic research fleet in the world. Some scientists feel that such research is not the NERC's responsibility.

The strategy lists other benefits as social, economic and cultural, including flood protection, waste disposal and reducing the cost of commercial operations at sea.

Two years ago, the House of Lords' select committee on science and technology criticised the state of marine science. Britain had "fallen by the wayside", the committee claimed, because it lacked a coherent framework for research and because it did not receive the funding it deserved.

The NERC, which funds most civil marine science, responded by setting up a marine sciences directorate to eliminate the flaws. The government promised to set up a coordinating committee for marine science and technology, reporting to the Department of Education and Science. The committee, which was finally unveiled last week with Sir John Mason in the chair, will develop a national strategy for government funded R&D in marine science and technology, to coordinate spending by the various government departments.

Since the Lords reported, the state of marine science has worsened. Funds have continued to shrink. Hugh Fish laid the blame last week on the loss of government commissions. In 1975, the NERC's science budget was reduced in line with the Rothschild Principle, in which money was taken from the research councils and given to Whitehall to pay for research on a contract basis.

Some institutes had more success in winning contracts than others. To even out the funding, the NERC cut the money it allocated to these institutes, and they came to rely primarily on commissions. In the 1980s, commissions have dwindled, and those laboratories that had spent the 1970s winning contract work began to run out of funds. "This loss demonstrates to me," says Fish, "that the Rothschild Principle is dead and buried. The NERC will draw attention to this issue in no uncertain terms in the next few months."

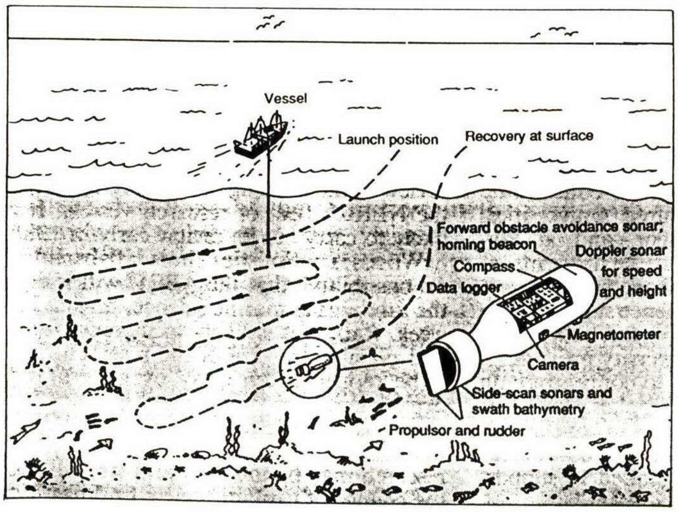
The NERC has reduced the size of its fleet of research ships and the amount of time the ships spend at sea. It has begun to "rationalise" its institutes, trimming staff and planning mergers of some laboratories.

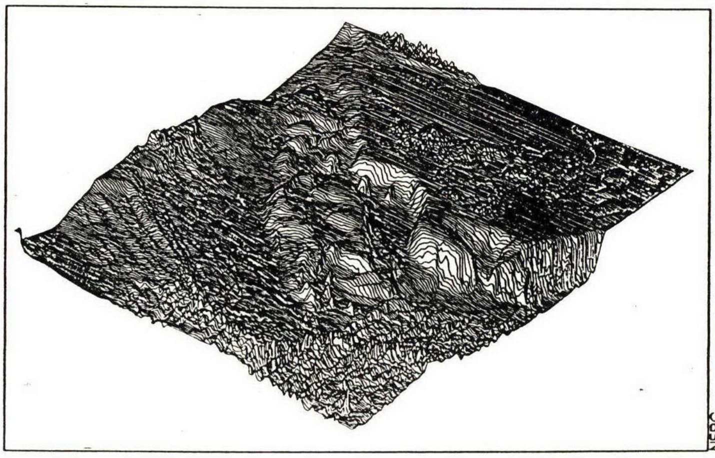
The problem came to a head last September, when the NERC told the directors of all its marine institutes to stop all "non-essential" research—that is, all research except contract research that they were legally obliged to continue. The ban is likely to stay in force at least until April.

Under its charter, the NERC must "ensure that there exists in Britain a strong community of marine scientists supplied with the resources and organisation needed to initiate and respond effectively to new developments in the rapidly advancing subject." This means that it must maintain research laboratories and scientific services, and a fully balanced programme of research.

In the current financial climate, the NERC might find it difficult to achieve this. The new strategy admits the need to focus on "a small number of themes at a given time." With this in mind, Woods has divided the NERC's programme into two—the core and the menu. Between them they cover academic research projects, laboratory projects (those carried out at the NERC's own laboratories, and at the British Antarctic Survey and the British Geological Survey) and individual projects.

The strategy lists 14 individual projects, all within the NERC's own institutes or grant-aided laboratories, and awarded to "scientists of exceptional calibre". One of these projects is Woods's own research, on modelling processes in the ocean, which he will carry out at the Robert Hooke Institute in Oxford. One of the conditions that Woods imposed before he accepted the post of director was that he should receive support for his research. ▶





AUTOSUB (left) could travel the oceans for five days, providing data for models like the one above of the floor of the northeast Atlantic

A model for the future of marine research

ERC's strategy concentrates on e central "community projects", ied because they will involve ntists from a number of disciplines d laboratories throughout the marine community. John Woods stresses that the way forward is through modelling. "Predictions," he claims, "will lead to practical exploitation".

The new design of marine science will depend more on the capabilities of a new generation of supercomputers than on research ships and seagoing scientists. In 20 years' time, Woods estimates, there will be computers 10 000 times more powerful than the research councils' Cray XMP. Woods maintains that the marine community needs 10 years to develop the new tools and do the experiments to feed the data into those computers.

"We must concentrate our resources so that when the machines come, we are ready to use them." The five community projects are:

- The North Sea Project, aims to develop three-dimensional models of the hydrodynamics and transport systems in the North Sea. The objective is to use these models as a tool for managing the quality of the water. The research ship Challenger will spend 15 months in the North Sea collecting data for the model.
- The Fine Resolution Antarctic Model (FRAM). The ocean is an important factor in controlling the world's climate. To understand how it does this, scientists working on FRAM will design a model for the global circulation of the ocean —beginning with the Antarctic circumpolar current.

A team at the Robert Hooke Institute is finishing a model for the Antarctic, which requires 500 hours on the Cray XMP. The team will move on to the North Atlantic and Arctic Oceans.

- The Biogeochemical Ocean Flux Study (BOFS) will develop models of the recycling processes in the oceans and how changes in climate affect the cycles. The eventual aim is to be able to predict changes in world climate: the ocean absorbs carbon dioxide from the atmosphere, helping to balance the greenhouse effect. BOFS will be coordinated at the new Plymouth Marine Laboratory. The project is Britain's contribution to the Joint Global Ocean Flux Study.
- The World Ocean Circulation Experiment (WOCE)—an international programme—should make possible long-term predictions of changes in climate. The project will begin in 1990, after the launch of Europe's latest remote-sensing satellite, the ERS-1. Britain's part in WOCE, organised by the Deacon Laboratory, involves the collection of hydrographic data from the research ship Discovery, coordinating measurements of sea level and analysing satellite data.
- AUTOSUB aims to design a system for observing the ocean routinely, to provide data to run the computer models. The free-ranging vehicle must navigate its way across oceans, collecting data and transmitting it to scientists ashore. □

The core programme is more or less guaranteed support. Projects on the menu will obtain funds only if extra resources become available. Within the core, the "big five" community projects take priority. Each one will cost between £5 million and £10 million over five years. The core also includes a small number of "long-term strategic research projects" selected from projects proposed by laboratories and individuals. The menu consists of relatively short-term projects that can be "turned on whenever funds are available".

Many scientists are concerned about the continual stress on value for money, and are disappointed that the NERC will support only goal-oriented research with well defined spin-offs. There is little opportunity for open-ended research.

On the other hand, given the problems of finding money to support basic research, some scientists think that the NERC has done the best it can in the circumstances.

Those scientists involved in the flagship projects will have a surer future than most. Fish promised that the NERC "will keep the core programme going at all costs. It will be treated as essential, regardless of the strain on the budget," he said. However, he admitted that there might be "a slippage in objectives" if money became still tighter.

At the moment, even the North Sea Project, so widely publicised as a token of the government's pledge at the North Sea Conference last month to do something about the state of the North Sea, is underfunded by £2 million. The NERC is paying £6·8 million over five years and the Ministry of Agriculture, Fisheries and Food is contributing £1·3 million.

The NERC hopes that the Department of the Environment will chip in with the remainder. According to the Rothschild Principle, the North Sea Project is the sort of research programme that the DoE should pay for almost in its entirety. However, a recent review of water research conducted by the department considered only coastal and estuarine waters—

Woods: the very model of a modern research director

ignoring waters further offshore.

Scientists outside the core programme have more to worry about. Those most at risk are in universities and the less-favoured of the NERC's laboratories. The Scottish Marine Biological Association, for example, which receives most of its money from the NERC, will have almost no part in the first five community projects.

Marine scientists in the universities have had a difficult time in recent years. In 1984, the University Grants Committee reviewed the state of the university oceanography departments and decided to concentrate resources at two favoured universities, Southampton and Bangor, and at Plymouth Polytechnic. The departments at Liverpool and Swansea have since closed. The new centres of excellence supported by the UGC will also receive the bulk of the NERC's support for university projects.

The NERC's decision to concentrate on a few areas of expertise applies also to its own laboratories, where it is to concentrate on a number of "well-found laboratories" that are "equipped and staffed to support research in clearly defined areas".

To this end, the council has restructured its institutes. Earlier this month, the council announced the merger of its Institute of Marine Environmental Research (IMER) in Plymouth with the grant-aided Marine Biological Association, also in Plymouth. Together they will form the Plymouth Marine Laboratory.

Two years ago, the NERC decided to close the Institute of Marine Biochemistry in Aberdeen, and announced that it would move its staff to the Scottish Marine Biological Association in Oban on the other side of Scotland. IMB staff are still in Aberdeen, four moving dates later, and are now expecting to transfer to Oban in August. The NERC still has no buyer for the Aberdeen laboratory.

Fish insists that, come what may, he will maintain well-founded laboratories—but perhaps fewer of them. "Unless someone, such as the DoE, comes up with more money," he said, "there will be compulsory redundancies within two years."

Only 2·5 per cent of the science budget is spent on marine science, compared with 12·7 per cent on nuclear physics and 6 per cent on ground-based astronomy, the two other areas of big science. Two years ago, the NERC spent 35 per cent (£23·3 million) of its budget on marine science.

In its *Strategy for the Science Base*, published last July, the Advisory Board for the Research Councils (ABRC), proposed a review of the funding of oceanography and the NERC's fleet of research vessels. It is likely to carry out its review early in 1988.

Woods is optimistic. There is "absolutely no possibility" that the ABRC will reduce the funding for marine science, he said last week. Rather, it is likely to increase funds and possibly the size of the research fleet. "The money taken away by government departments is not coming back in commissions. We must have it back," said Fish. If not, he warned, the "speed of research may be too slow and we will lose the chance of exploiting new findings." □

E/02/14/90

FAO/FAX 78

FACSIMILE

WORLD BANK
1818 H STREET, NW
WASHINGTON D.C.
20433 U.S.A.

FAX NO. (202)3340568

To: Mr. Eduardo A. Loayza
AGRPS

15 February 1990

From: for M. Pedini
Fisheries Officer (Aquaculture)
DDCB
FAO, Rome (Italy)

Subject: SIFR Working Party on Research Needs for Aquaculture Development

As discussed by phone, please find attached comments on draft report on the above subject.

MP/am
FR 41/1

cc: Godbole
Pedini (chrono)
RDG DDC (2)

Dear Jean Paul,

I apologize for the delay in sending comments on the draft report of the SIFR Working Party on Research Needs for Aquaculture Development and hope that what follows will help in preparing the best possible report, which is in our mutual interest.

I would confine my comments to general ones as I am also attaching my copy of the draft with marginal detailed comments, which you may find useful when preparing the final document. My colleague, Mr. D J. Lens, has also seen the paper and contributed with very valuable points. I showed him the draft on purpose as, having participated in the meeting and the discussions, certain parts of the report could be clear to me but could also not be easy to understand for readers who did not attend.

I have to start by giving you credit for the courage demonstrated in accepting such a formidable task as the SIFR. Having said that, I do not fully understand what you intend to do with the document. You may wish to use it as a contribution to the final report, including the entire text, or use it to prepare a different document to cover aquaculture needs, attaching the present draft as an annex. Obviously, the final destiny of this draft jas a bearing on my comments related to the structure of the paper and you may find that some of them may be irrelevant.

In general, I found the paper interesting. It requires further elaboration as it contains an amount of interesting concepts, but has considerable problems of structure and contents which can, I think, be overcome, although this would require additional work. For ease of reference, I will number my comments:

Dr. Jean Paul Troadec
Team Leader
Study of International Fisheries
Research
AGRPS - Room N. 5021
World Bank

i) The paper is very long, difficult to read (very dense) and sometimes too cryptic or academic. As it is now, it would need a clear executive summary, highlighting the operational implications of the proposal, as it is unlikely that administrators in bilateral and multilateral agencies will find the time to read it entirely. If the expected audience for this paper are mainly administrators (perhaps with no background in fisheries), the reading has to be facilitated and jargon (biological, developmental, economic) should be minimized.

ii) A clearer paper would require a different outline if it has to stand by itself and we could suggest a different one, which is attached as Appendix 1. In particular, the conclusions, justifications and actions proposed should be more clearly presented, with an idea of the time frame, steps to be taken and at least a rough cost estimate. As very likely, the latter was not fully assessed at the Paris meeting (not certainly in the first session), this is something you may wish to add only for the main report of the study.

iii) Chapter 7 is a rather good analysis of a situation which is, however, not known to the reader, who is not fully conversant with the status of aquaculture development. It is not explained how these conclusions were obtained. It would need a previous presentation, even if short, of the status and evolution of aquaculture. The heading of this chapter is also rather misleading (Review of the Current Situation). It does neither provide an assessment of the adequacy of present research programmes vis-à-vis the production sector, nor does it specify what are the operators or the private sector contributing on aquaculture research.

iv) Chapter 8 "Conditions for Effectiveness and Efficiency" should set the scene for a section on specific proposals and related operational arrangements, but, up to this point, the paper does not provide a good justification (I'm playing the devil's advocate) to change substantially the present situation. Questions of the type "is research the limiting factor for stimulating aquaculture development?" or "could an increased effort in aquaculture research produce a significant progress of aquaculture production?", which administrators of donor and financing agencies may ask, do not find ready answers in the document. It is sort of taken for granted that a substantial improvement in research would be a crucial element to foster development. I would agree that it is an important element, but I also gather that for agencies involved in development you may require a stronger argumentation, especially when taking into account that growth rates of the aquaculture subsector are far better than those of capture fisheries.

v) The identification of major problem areas or of new approaches (the innovation factor), which could be solved or should be investigated by the research community, is not clearly separated in the report. This identification should be an essential element for the definition of a strategy. I guess that the specialists convened for the second session of the working party should have given clearer indications in this respect, once the identification of the main systems had been completed by the first group.

vi) Clarifications on definition and on the tables included are necessary. Examples could be the types of research, farming systems and production systems. I found Tables 7-8 on economic processes/functions difficult to understand in relation to what the various headings meant, and you can be assured that I was not the only one. Similarly, the ranking given for the tables is not so crystalline. Nonparticipants may have a lot of difficulties in understanding the codes and meaning of the matrixes. A couple of examples per table would give them a clearer key to the understanding of these tables which were essential to separate major systems.

vii) I found the section on economics, and to some extent that on social sciences too, not very specific for aquaculture. To some extent, it is like reading a book on agricultural economics. Perhaps this part could be improved with the inclusion of some examples which could also be related to the tables. Since the material provided by Diaw and Aguero was not really discussed, as it was delivered at a late stage, it was not really possible to see to what extent it was understandable to nonspecialist. I find that it is nearly impossible to merge their tables with that of the biotechnical group to try giving a relative weight to the discipline, or other subcategories, in the context the systems analyzed and their evolution in time. Perhaps Aguero and Diaw could offer an alternative solution because, as it is now, the two groups of matrixes are totally disconnected.

These were the main comments I had on structure of the paper and presentation. Regarding the contents of the paper, these are my main comments:

a) The sequence of reasoning shows a clear disconnection between the two sessions. While in the first five chapters the main emphasis is put in the identification of a production system typology in relation to disciplines, a concept which would allow dealing with research needs for the various systems irregardless of the geographical location or the species to be dealt with, the second part reintroduces the concept of regions and the disciplines are dealt with in almost total isolation, at least with little or no relation to the systems identified in the first session, which seems to be a step backwards. It gives the impression that the second session went beyond the terms of reference indicated for it in the introduction (see pg 2), although one has to recognize too that the agenda for this section session was not sufficiently clear.

b) I feel that the report does not properly reflect the efforts and conclusions of the first session. Perhaps they were discussed by the second group and rejected or perhaps the second group failed to recognize the implications of the conclusions of the first group. This I do not know but, in reading the report, I got the impression that the work of the first group was of little use for the second. If I remember correctly, the main purpose of our trying to identify the main systems was for eliminating three major bottlenecks which plagued the efforts of groups trying to introduce aquaculture into the CGIAR system, which are the dependence upon species, regions and biological disciplines. With the identification of sufficiently distinct systems, it would be possible to study them in an integral way, irregardless of species, area or particular discipline, and establish a global framework for cooperation in research.

c) Towards the end of the first session, when we discussed the institutional arrangements on the last day, I recall that in elaborating on the item international level, I proposed an institutional arrangement based on the main systems identified (ocean ranching, extensive, semintensive - two of them eventually - and intensive), in which a specific network for each of them would be created with a recognized centre of excellence as its head and various national centres attached to it. A central secretariat, monitoring the work of the various networks and channelling resources according to perceived needs and progress, would be the head of the system. This has not at all been reflected in the report, although it was not rejected as a working mechanism by the participants of the first session.

d) Instead of elaborating on this line of thinking, the second group came up with a different solution, which brings in again the problems of the past and which had no thinking head. You can see that very clearly on pg. 63. para 5, in which it is said "great difficulty was experienced in identifying who would decide on programming ....". I do not believe in the capacity of scientist networks to come up with adequate and balanced programmes, really serving the needs of the production sector. In the first place, general networks tend to be dominated by scientists of a few disciplines as it has been proven in the past. Second, it presumes that organized and specialized associations of scientist exist for all disciplines and in all geographical regions, which is not the case. So, very likely, the use of collaborative networks of specialists would not take us very far from the present situation, in which every group tends to benefit its own interests (something also implicit in the initial remarks of Dr. Huisman ...), and thus disparities would be enhanced. Since we are after research programmes to favour development, you would need a group headed by generalists rather than specialist, which could come up with a balanced approach and should be advised, when necessary, by groups of specialists.

e) I feel that the research which is being carried out by the private sector is not properly considered in the paper. Think about aspects like diet formulation, vaccines or medicines and to some extent selection of specific strains of organisms, in which the private sector has played a very important role (I could think of specific examples such as microcapsulated feeds for larval rearing, bacterins for prevention of diseases, or the production of red tilapia fingerlings). The paper seems to concentrate on public-sector research or externally-assisted research, which is generally channelled to public sector institutions.

f) An idea of what the various disciplines have so far contributed for the development of aquaculture is missing in the paper and it would have been helpful to give a better idea of its evolution. The various specialists of the second session should have contributed some information in this respect. In this particular case, an analysis on a regional basis would have been adequate because of the existing disparities between regions.

g) The headings under 6.1.3, 6.2, 6.4 and 6.6 are discussed in total isolation from systems' analysis. Scientific areas are also treated in almost total isolation from other disciplines (and this is something which could be expected from specialists), clashing totally with the spirit of the first session which tried to identify typologies defined by the mix of the various disciplines. I feel that only the item on ecology (not surprisingly) links properly with the first session. Moreover, the distinction for the research to be given priority on the medium run (10 years) and on the long-term (up to 25 years) is not at all evident in the various disciplines.

h) As a last point, I do not see the need to include a separate item under biotechnologies. Most of the points included under this heading could have been inserted in their respective disciplines (genetics, nutrition, etc.), making things much simpler and clearer.

And that is all for the main comments. Do not be discouraged by my comments as they do not at all intend to be negative. I feel that a paper which could be an important element in the future of aquaculture research deserves all the efforts we could make for it to result as good as possible. I hope I will be able to see you in Rome next March, when the paper is discussed with the Fisheries Department.

With my best regards, I remain.

Yours sincerely,

Mario Pedini

ICLARM
INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
MC P.O. BOX 1501, MAKATI, METRO MANILA 1299, PHILIPPINES

January 25, 1990

Dr. Jean-Paul Troadec
SIFR AGRPS
World Bank
Room No. N5-015
1818 H. Street, N.W.,
Washington, D.C. 20433

Dear Dr. Troadec,

Comments on Draft Report of the SIFR Working Party on Research Needs for Aquaculture Development

Enclosed are the individual comments of Dr. Roger Pullin, Dr. Max Aguero and Dr. Chua Thia-Eng on the Draft Report of SIFR Working Party on Research Needs for Aquaculture Development. As three of us did not attend the Part II of the working party, our comments pertaining to those matters discussed are strictly our own views based on what has been written in the report. You may find it useful for your consideration in the final report.

Thank you again for giving us the opportunity to share our views with our fellow colleagues in this valuable World Bank endeavor.

Best regards.

Yours sincerely,

Dr. Chua Thia-Eng
Officer In-Charge

2ND FLR., BLOOMINGDALE BLDG.
205 SALCEDO ST., LEGASPI VILLAGE
MAKATI, METRO MANILA 1200
PHILIPPINES

CABLE: ICLARM MANILA
TELEX: (ETPI) 64794 ICLARM PN, 4900010376 ICL UI (USA)
FAX: (63-2) 816-3183
TEL.: 818-0466, 818-9283, 817-5255, 817-5163
E-MAIL: (CGNET) ICLARM, (SCIENCENET) ICLARM.MANILA

ICLARM INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
MC P.O. BOX 1501, MAKATI, METRO MANILA 1299, PHILIPPINES

January 23, 1990
Total Pages : 4

FAX MESSAGE TO:

DR. JEAN PAUL TROADEC
WORLD BANK,
SIFR, AGRPS
ROOM 5-025

Dear Jean-Paul:

As promised in my fax message last friday, attached you will find my comments to the draft report on the SIFR Working Party on Research Needs for Aquaculture Development.

Before writing my comments, I had the opportunity to read Roger's and therefore, I will not repeat here what he has already said in reference to international research centers and small coordinating secretariats. In general, I do agree with Roger's comments on this.

As before, my comments and suggestions are made according to page and paragraph number; you may use them as appropriate.

I am also sending you a copy of this fax in case the transmission is not clear.

Please let me know if I can be of any further assistance on this.

best regards,

Max Aguero
ICLARM

2ND FLR., BLOOMINGDALE BLDG.
205 SALCEDO ST., LEGASPI VILLAGE
MAKATI, METRO MANILA 1200
PHILIPPINES

CABLE: ICLARM MANILA
TELEX: (ETPI) 64794 ICLARM PN, 4900010376 ICL UI (USA)
FAX: (63-2) 816-3183
TEL.: 818-0466, 818-9283, 817-5255, 817-5163
E-MAIL: (CGNET) ICLARM, (SCIENCENET) ICLARM.MANILA

COMMENTS ON THE DRAFT REPORT OF THE SIFR WORKING PARTY
Research Needs For Aquaculture Development
(Max aguero - ICLARM)

Page 5.
-Chapter IV, starts with a reference to the introduction made by Prof. Edwards during the first meeting of the Working Party; I'd like to suggest that the text makes it clear where Prof. Edwards' remarks start and where they end.

Page 6 and 7; Table 1.-
-Table 1 should keep consistency throughout its entire list; part b) points out factors rather than specific constraints as done in part a.

Page 7; "Product market"
-(insert): "(high **social** barriers to entry)
-This section should make reference to:
* biased consumer's preferences against some culture species (tilapia, carps, etc)
* scarcity of appropriate marketing channels,
* lack of consumer's information on alternatives available to consume aquaculture products (cooking, drying, salting, etc)

"Labor market".
(replace) "...migratory patterns" for "part-time nature of farmers in aquaculture activities

I think this entire Table needs some further elaboration.

Page 8; para 2.
-The concept of optimization when the extensive system is fully developed needs further clarification; what is to be optimized?.. total biomass?.. total revenues?,.. total number of fish?.. total agriculture-aquaculture production? etc.

Page 11; parag 4.
-It would be better to distinguish between "value of variables" and "stages of the systems" (instead of the variables)

Parag 5.
-the concept of "externalities" has a precise meaning in economic jargon;--since it may assume positive or negative values, it would be convenient to specify what kind of externality is the paragraph referring to (technological, pecuniary; positive, negative, etc)

Page 14; parag 10.

-I think the concepts of production function and production process are mixed-up in this parag.

Parag 11 and 18

-Production does not take place only in "response to market demand" (or demand supported by money) as the parag. seems to suggest; production in small-scale fisheries respond to other mechanisms and incentives as well; See also page 18, parag. 3 where a similar statement is made (Keynes)

Page 14-15;Section 4.4

-I think this section does not read smoothly; as is, it seems like a short list of statements on basic Production Economics. Maybe a short paragraph indicating the purpose of this section and some linking phrases, may help.

Page 15;parag 2 and 3.

-Again, the concepts of production systems, production process and production function (not to mention production units) should be further specified to avoid confusion. See also page 17 parag 2, where production system is defined in terms of a "unit" but with aggregate (macro) components and implications. Wouldn't it be simpler to use the traditional concept of "production function" viewed at different levels of aggregation, rather than re-defining terms?.

Parag 3.

-Seems to imply that the production system is somehow "selected", while in the first parag. of page 15, it is the production function which determines it. These statements may be a source of confusion.

Parag 4

-The hierarchy and difference between "farming" and "production systems" should be also further specified. Is the production system part of the farming system or is a given farming system a production system?; I think the same applies to the difference between "farm" and "production unit" and "industry" mentioned here and in earlier paragraphs or sections.

Parag 7

-I'd like to suggest change of the word "optimize" for "choose among", since the farmer does not optimize his <u>options</u> but his <u>decision</u>.

-The last sentence is not fully clear; what probability is the sentence referring to? of not making the right decision (choosing the right option)? or of the option to be feasible?. etc

Page 17; parag 2

-The relationship between the "social goals of a given unit" and the concept of "production system" is not clear in the text. Does it mean that the economic requirements and social goals of a given production unit determines the production system?; from the second part of the parag. I get the impression that the distribution system is part of (is implied in) the production system.

Parag. 4

-Needs to specify what kind of "demand" is it referring to; for fishery products? for inputs? or should it be the"**supply** and the existence of suitable potential farmer groups"?

Page 26; parag. 1

(insert) "...may also **be used as** alternative **inputs** to fish meal"

Parag. 2

(replace): economic mechanisms for **economic settings**
(replace): efficiency for **performance of the system under**

Parag 3

(replace): linear programming by **mathematical programming**; (as linear programming is just a small subset of mathematical programming tools/techniques)

Parag 6

(replace): "...farming systems which will be feasible and effective" for **feasible, profitable and effective farming systems from a social and economic point of view.**

Page 28; Table 8

(spelling): socio-economics (in title)
(replace) : "input demand" for **Market Demand**
(add) : Industry Behavior **& Performance**
(delete) : "Industry Performance"

Page 29; Table 9

***first item.**-(replace) "...value of species **produced** under **alternative** levels..."
***second item.**-(replace) "...economic and social **benefits;**
"conditions; **with special emphasis on their impact on employment, income, food supply and environmental damage"**
***fourth item.**- (add) **Determination and analysis of** "economic performance **(identification of comparative advantages)** of **selected** technologies and **species..."**
***fifth item.**- (delete entire item)
***sixth item.**- (add): "...performance and **identification** of potential...according to **regions of origin, specie cultured, socio-cultural characteristics of the population, etc.**
*(delete) items: **seventh, eight and twelv e items**

Comments on Draft Report of the SIFR Working Party on Research Needs for Aquaculture Development

1. The Einstein quotation should be removed. It was his comment on Heisenberg's Uncertainty Principle and he (Einstein) was mistaken as to the utility of the Principle.

2. There is still some confusion over definitions and terms for different fish production systems. Page 4, first para. includes the terms "extensive systems" and "culture-based fisheries" whereas the list of definitions on p. 11-12 excludes these. The solution is probably to state that the open water systems on p. 11 ("open seas, open coastal waters and open inland waters") contain the so-called culture-based fisheries systems whereas extensive aquaculture (ie. farming on farms) is another category of water and land-based farming in which no feeds or fertilizers are given to enhance national productivity.

3. Page 5, First para. I do not understand the last sentence.

4. The categorization of different kinds of research is confusing. The terms used include `basic´, `applied´, `innovative´, `strategic´, `targetted´, `adaptive´, `comprehensive´. These are reduced to three main categories - basic, strategic and adaptive on p. 58. I delete the word `innovative´ as used in conjunction with `strategic´ because all research is innovative by definition and the word is superfluous. Strategic research and basic research are difficult to separate. I cannot offer a better scheme or definitions, but suggest that at least the report use only consistent and defined terms for categories of research and deletes others.

5. Table 2a, b. Captions are reversed.

6. Page 6. Para. 5. The term is usually `agroecological zones´.

7. Page 11, para 3, Table 3. The Table 3 does not really indicate very clearly the needs for control as systems `mature´. The text overstates this.

8. The definitions of "Stock Variables" p. 13-14 need slight attention. The report should not use the work `Stock´ as a `subvariable´ of itself! The solution is to substitute "Species" for "Stock" and to put in a classical definition for Species. Then the words "the

cultivated organisms" disappear. They would otherwise be confused with the subsequent variable `Population´. Similarly in the definition of "Breed", the word "stock" should be substituted by the words "cultivated organisms". Then the three levels of genetic variables - Species/Breed/Population are OK. The main problem is that `stock´ itself is such a loose term. It means about the same as `population´ in many cases!

9. Page 19, 5. ii. "The quantification is only qualitative"! Please change this to "The assessments are only qualitative".

10. Page 25. Para 2. Effluents can also be reused in agriculture.

11. Page 30, last para. The list of social science descriptions must include economics.

12. Page 39, bottom line. Should read "founding" not "funding".

13. Page 40. - Spellings - heritability and chromosomal are correct. Also note that first para (b) is not a good statement of breeding goals. The key words to use are `domestication´ and `commercial traits´. Traits can include growth, maturation, fecundity etc. but may also include body shape, color, dressing percentage etc. In aquatic organisms, resistance to disease is probably a highly complex polygenic trait and is unlikely to be easily obtained from selection programs.

14. In para (c) `sex control´, I cannot follow the logic of how producing sterile progeny can preserve wild gene pools - unless you mean that escapees will be unable to compete or interbreed with wild fish. If so, please state it clearly.

15. Page 43, last para, first line. Should read "development of disease resistant strains of key species".

16. Page 44. Section 6.4. Surely there is a key word and concept missing here - domestication! This is what geneticists are bringing to aquaculture. Domesticated animals behave very differently to wild animals. Perhaps you could work this in as at present the wording is rather clumsy and reflects a fishing rather than a farming viewpoint.

17. Institutional aspects. The terms `international´, `global´ and `regional´ are not defined. This is important because they are often interchanged rather loosely. For example, p. 55, line 2 uses the term

'global' (avoiding 'international'?) and in para 2, line 6 on the same page, it is not clear why the recommendation given is restricted to "developed countries": why not developing countries also - especially given the examples quoted for agriculture (foot of page 51)?

Regarding networks, at the top of page 55, the report says that only regional networks exist in aquaculture, yet ICLARM has a truly global (developed and developing countries) Network of Tropical Aquaculture Scientists. It has 376 members from 74 countries.

The scenario for the "small secretariat" (p. 60, para 3) is unlikely to be workable and the assumption (p. 60, para 5) that the only alternative is a "single large institute of the CGIAR model" is false: not all CGIAR institutions and similar international NGO's are large. A core that is not scientifically active will not be able to lead and coordinate research effectively. Isn't the report actually self-contradictory on this issue as page 55, line 2 says that "Global institutions should not be only clearing house (sic) for information, nor act simply as coordinators of groups, but be directly involved in research to maintain their supportive capacity in research areas that cannot yet be properly dealt with at national level"?

Page 63, para 2 record unanimous agreement that an international centre is inappropriate. May be a large centre is not needed, but some capacity definitely is. Can we learn nothing from successes in agriculture? Surely what is needed is a marriage of the best aspects of international and national groups working in partnerships.

I do not think that the final scenario proposed of networks of national research laboratories and "tropical aquaculture centres in developed countries" (my underlining) will work. How can such a system avoid the shifts of short-term political changes and carry out sustained work? It is well agreed that the historical pattern of international agricultural research should not be copied directly for aquaculture, but this does not mean that it does not have some useful lessons. There is a clear need for an international, independent research component in tropical aquaculture located in developing regions to help with research leadership and coordination.

If the final report on the two sessions is a combined volume like this, then it may appear that the ICLARM staff listed as participants endorse the proposed institutional scenario - which they would not without an unequivocal statement of the need for international research capacity in the tropics to undertake sustained, strategic research: not a single large center but certainly active research teams with facilities collaborating with national groups and networks.

COMMENTS ON THE DRAFT REPORT OF THE SIFR WORKING PARTY ON RESEARCH NEEDS FOR AQUACULTURE DEVLOPMENT

by

CHUA THIA-ENG

Pg.5. suggest delete paragraph 5; it doesn't add to the information already stated earlier

Pg. 6. Section 4.1. requires considerable rephrasing so as to highlight the constraints affecting aquaculture development.

(a) Point No. 1 of Peter Edwards' remark contradicts with point no.4 which suggests that research on disciplinary lines are still necessary.

(b) Lack of relevant and comprehensive research is only one constraint, other constraints, such as inadequacies in aquaculture planning, development and management; lack of technical and managerial capability; lack of marketing and post-harvest support should also be stressed. The ad hoc manner in which aquaculture development took place in many developing nations need to be emphasized.

(c) Whilst it is useful to think of aquaculture devlopment in relation to eco-agricultural zones, especially with special reference to small-scale aquaculture, one must not lose sight of the fact that aquaculture development in the world in general is towards a modern fish producing industry through continuous technological improvements and improvements in economic viability.

(d) the purpose of research in aquaculture is to provide scientific information that will lead to (i) sound formulation of development startegies, policies and management for sustainable aquaculture development at national or regional levels; (ii) improvement of aquaculture techniques/technologies, the application of which will lead to economic production and hence increase the efficency of the production systems; (iii) provide information on the appropriateness and potential of species or strains that could improve yields through genetic selection and germplasm development; (iv) provide information on the social acceptability and economic viability of various forms of aquaculture.

The ultimate objective of aquaculture research is to transform from traditional, experience-dependent practices into technologically packaged system based on scientific principles. This will ensure a reliable mechanism for production in the future.

Scientific research in aquaculture like any other scientific research is a continuous process, the focus of which varies according to the current status and magnitude of the problem as well as depending on the urgency of the information needs. Thus, short-term research on specific localized problems may be a continuous process whilst strategic research may resolve major issues which may require collaborative efforts of numerous research teams over an extended period of time.

(e) The use of the terminology is confusing: adaptive , basic, strategic, innovative, etc. and should be adequately defined. For the prupose of this document, they should be simplified and reduced.

Pg.9. Table 2(a) caption mixed up with Table 2(c)

Pg.11. Open coastal waters: the word mangrove should be replaced by estuaries.

Pg.18. Paragraph 5, last sentence- It is not necessary that the proposed work be carried out only by resource economists. The experienced broad-based natural resource planner or a "generalist", with inputs from various relevant disciplines can do the job. I suggest you delete this sentence.

Last paragraph on research strategies is misleading especially pertaining to research priorities, vis a vis ecomnomics and social sciences versus biological/technical research. Before determining aquaculture research priorities, the needs and justification for aquaculture development in a specific country/region should first be decided by national policy makers and included in the coastal and land use planning. Such macro planning usually allows government to rationalize utilization and allocation of its natural resources, establish regulatory mechanisms and provide the basic infrastructure needed for their development. Appropriate land or water areas could be zoned either for protection, conservation or for certain development. Such zonation scheme takes into consideration appropriateness of the designated zone in terms of technical suitability, economic viability, sociocultural acceptability and environmental compatibility. Thus an aquaculture zone indicates the size and suitability of the designated area for a particular or a variety of aquaculture activities taking into consideration their relationship with existing and future developmental activities and the actions or measures necessary to ensure sustainability. Social and economic research should be carried out within such a broader context.

Pg.25. Last sentence- I doubt if sewage is treated for re-used in aquaculture systems in Indonesia. The cage culture in sewage-fed running water uses raw sewage.

Pg.60. The proposal for a "small secretariat" attached to the international set-up requires further reconsideration with respect to its effectiveness and leadership that an international institution is supposed to play. FAO in many ways has operated along the same line but this has not (eg. ADCP) proven to be effective. Existing international or regional research institutions can be strengthened to play the various roles that have been outlined in the text. One of the existing international research organizations can be strengthened to play the coordinating role of research in developing and developed nations, regional networks and regional and national research institutions.

Pg. 61. The statement of Prof, Huisman is somewhat misleading and should be modified to higlight the importance and usefulness of scientists in national institutions in the developing nations to work alongside scientists in centres of excellence be it in regional/national or international institutions or in tropical aquaculture centers in the developed nations. I am very disturbed with this division of scientists from developed and developing nations indicated throughout the text in Section IX. While in general it may be acceptable that research scientists in developed nations generally do good research work (although a fair number are migrants from developing nations), many outstanding research achievements in aquaculture were made by scientists in the developing nations working on conditions where façilities are much inferior. The breakthrough in hormonal manipulation in fish breeding and successful seed propagation technology of Chinese carps, Indian carps, as well as the culture technology for shrimp. seabass and groupers were all developed in the developing nations. The closer linkage is good but one cannot say that aquaculture will never develop if cooperative research with developed nations scientists are not realized.

Pg.61. Paragraph 5- The high overhead cost of developed nation universities/institutions undertaking tropical aquaculture research and the differences in development needs of the developed nations speak in favour of the necessity to strengthen regional/international institutions located in the Third World region so that scientists from developed nations can work in the region, to have better understanding of the development needs of developing nations and to work with scientists in the developing nations to solve problems in the region. While we should support the proposal to strengthen a closer working relationship among scientists from developed and developing nations, we certainly do not wish that international aids or development assistance be used to advance the concept of academic colonialism.

Pg.62. Second paragraph, second sentence- The suggestion that research centers in developed countries would concentrate on basic or strategic research while the regional programs be primarily strategic and training oriented, has repeatedly undersocred the total incapability of national or regional institutions to do basic research work. They will never be if such suggestion is accepted without challeneges. The document has earlier recognized the existence of research institutions of excellence located in the region (Pg.58). Why can't such institutions conduct basic research? The Rubber Research Institute and Palm Oil Reseach Institute are good examples where excellent genetical research have contributed to substantial growth of these two industries. The important thing is to equip the regional institutions with good scientists, good facilities and capable leadership with minimal political intervention and we can be assured of good research results. The main problem is that scientists have no inputs to the types and research they would want done in developing countries.

Pg.63

(a) It may be logical to assume that a single international institution may not be able to achieve the various activities indicated and may result in the establishment of an enormous infrastructure which will be costly to maintain. However, establishment of regional aquaculture institutions such as those under ADCP/FAO in Africa and Latin America have also not achieved the objectives. Certainly upgrading of exisiting centers of excellence at national and regional levels will definitely lead to the network of centers of excellence in the region and therefore provide the needed regional leadership. An international coordinating body is again essential.

(b) Last paragraph- The immediate need to improve aquaculture development strategies is not just limited to socioeconomic research only but should also cover aquaculture developemnt planning and policy formulation taking into consideration competitive users of resources. Socio-economic research should form part of resource allocation and utilization study.

Pg.64. Requirements.

The practical functions of three task forces proposed for Asia, Africa and Latin America are rather vague. The structural organization should be indicated. Are the task forces given the responsibility to undertake the tasks described for the next 10-15 years or are they just developed research protocol for the national scientists?

Prof.dr. E.A. Huisman

Koningsweg 6
6655 AC PUIFLIJK

tel. 08870 - 15679

Puiflijk,

16-1-1990

World Bank
c/o Dr. Jean-Paul Troadec, SIFR
Room nr. N 5015
1818 H Street, N. W.
Washington DC. 20433
U.S.A.

Dear Jean-Paul,

Sorry to be so late with my remarks, but after the Indonesian-trip I suffered some climatological stress and got a stroke of that - what we call - English flu.
But, anyhow, I started the year with reading your final draft and my remarks are annexed.
Wishing you all the best and looking forward to meeting you in Rome.

Sincerely yours,

Prof.dr. E.A. Huisman

ANNEX: Remarks on draft report SIFR WP on Research Needs for Aquaculture Development.

General

* I must say that in general the report on the first week seems less specific than that on the second week (although in view of the "horizon" one would expect the reverse). Formulation is sometimes superfluous and thereby looses conciseness. It becomes too abstract in my opinion.
A few examples:

a) paragraph 4.4. This paragraph is almost so general, that it could be part of any document concerning biological (or other) production.

b) Lines 6 1/2 till 8 on page 17 say "that a concept expresses the articulation ..... etc." I loose firm ground here (as well as in other - more or less similar - cases, where a more clear formulation may improve not only readability but also understanding.

** The matrix tables in my opinion were good for the discussion as such but in the report they seem to illustrate more the human drive for esthetics rather than for reality. And in this drive for completeness and esthetics (my opinion) they loose accuracy.
A few examples:

- Table 4. Why is population ecology in sea farming (extensive) so much more limiting than in coastal farming, whereas the ecosystem of coastal areas is much more complex than in the open sea.
Why has population ecology effect on feed lot systems?
- Table 5. Why is engineering in intensive seaweed farming limiting and not relevant in intensive mollusc farming?? Why is ethology in crustacean farming (intensive) more important than in finfish farming?
- In fact I do not always believe these tables. They indicate trends and in my opinion it is better to formulate the trends in this case.

Specific (without bothering typing errors, etc.)

* I do not see how "Social" fits in under "Institutions" on page 7.

* Legenda table 2a en 2b should be reversed.

* The tables 2a and 2b do not represent systems. In fact these tables boil down to the fact that past, present and future commodity targetted biological (and other) research (reproduction, nutrition, health control, engineering, etc.) enables to cultivate more species in an increasingly controlled way.

May I elaborate a bit here on the course aquaculture has been taken and is taken: As any form of animal production aquaculture tries to reach the optimum configuration of an environment and an organism. So we try to manipulate both.

* Any ecosystem has 3 basic functions e.g. production, consumption, decomposition.
  In aquaculture we try to manipulate these functions.
  The production function by supplying nutrients (fertilization/manuring.
  The consumption function is enhanced by using feeds (produced outside the culture unit - for instance Peruvian fish meal).
  The decomposition function is enhanced by aeration sothat waste becomes not a limiting factor (for instance in recirculation feed lot systems).
  And concomitantly with this we exert more control on the commodity (like density, species (composition), sex, genetic make-up, etc.).
  The combined effect of intensifying control over environment and organism leads to what is given in table 2a and b.

So there is a difference: resources oriented research (disciplines) benefits extensive culture whereas commodity oriented research (disciplines) favours intensive culture (to say it black/white).
Well, so far, so good (I hope)?

* On p. 15, 2nd paragraph: "family bounded care benefits raising of the young". This may be so, but both chicken and salmon farming do quite well whereas industries are divided into multiplication (reproduction) centres and grow out (feed lots) centers.

* Page 26, first paragraph of 5.3.
  This paragraph is another example of what I mentioned under "General" * b).

* Matrix tables 7 and 8: see under "General" ** and the same applies to table 10 (table 9 hardly being a table).

N.B. Sorry to be so critical on the first part, but again, in this part there is a strange contradiction: the text is often lacking conciseness whereby the tables do pretend to offer a conciseness which in fact is not there.

联合国
粮食及
农业组织

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE

ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION

منظمة الأغذية والزراعة للأمم المتحدة

Via delle Terme di Caracalla, 00100 Rome, Italy Cables: FOODAGRI ROME Telex: 610181 FAO I Facsimile: 6799563 Telephone: 57971

Our Ref.: FI 7/17 Your Ref.:

Subject:

-9 JAN 1990

Dear Jean-Paul,

... I attach for your information some comments that Fran Henderson made on the aquaculture report.

I have now sent the full collection round the Department (with the exception of E. Africa) in the hope of getting some comment and feedback in advance of our meeting in March. As I will be away on home leave until 12 March, I would suggest that you contact John Kambona (Ext. 6422) or Janet Webb (Ext. 5889) if you have any enquiries about the meeting. I understand it is to be held in F-107 from 26 to 28 March. I will ask Dr Lindquist on behelf of the Steering Committee if he would be prepared to open the meeting. Perhaps you could inform Eduardo.

With regards.

Yours sincerely,

David James
Senior Fishery Industry Officer
Fish Utilization and Marketing Service
Fishery Industries Division

Dr Jean-Paul Troadec
SIFR Secretariat
c/o AGRPS N 5021
World Bank
Washington, D.C. 20433
USA

David James
SIFR coordinator, FII

4 January 1990

F. Henderson
Director, FIR

Report of Working Party on Research Needs for Aquaculture Development

Thanks for letting me have a look at this preliminary draft. There are a lot of good ideas in it, but it is rather verbose and needs a lot of editing to clarify the propositions and conclusions it contains. The following comments may be of some use in your discussions of the document at the next meeting of the steering group:

p.4 While appreciating the view of Francis Christy and others that the use of property rights to fish stocks "is not a discriminant" between fishing and aquaculture in any strict sense, I still would maintain that it is a useful indicator. The result of adopting a continuum view of the fishing-aquaculture spectrum is the kind of lack of clarity which results in this document, for example, about the potentials and the research needs for so-called culture-based fisheries. In my view (based largely on freshwater fisheries in Africa), the major management problems of "culture based fisheries", whether in small ponds or large reservoirs or the great lakes, are those concerned with conferring and enforcing "use rights". It is only when that problem is solved for the body of water in question that the possibility of intervening in the the management of the stocks by culture-type activities becomes economically feasible without public subsidy, and a transition to "aquaculture" can be made. I am quite willing to call even a large pelagic fishery using factory ships "aquaculture" provided that there is an effective use rights allocation which would make it profitable for the fishery to regulate its own fishing levels, and/or replace the stocks with seed stocks produced in appropriate hatchery facilities. But I am not willing to call a reservoir fishery in which there is regular stocking of fry but no effective control of harvesting by the name "aquaculture"! I do compromise, however, with the use of "culture-based" as a useful adjective to describe the latter kind of fishery. Logically this also means that culture-based fisheries generally entail some fairly direct public subsidy from fuinding sources not directly derived from the proceeds of the fishery.

.../.

FI 7/19

cc: Welcomme Nash Pedini (DDC) Coche Muir/Martinez
Garcia Insull Willmann FIRD(2) FI Reg (2)

Thus, in my view, there is not too much point in dwelling on "culture-based" fisheries in this report. And in fact very little of substance has been said in the report about them except to suggest that Latin America and Africa should concentrate on this kind of "aquaculture". It would be better to deal with these as a specific issue for socio-economic research in discussions of <u>fishery</u> research needs.

p 23. Paragraph 3. I am not convinced. I would rather say that the tables were constructed on the assumption that the research needs intensify and diversify as the aquaculture systems intensify, an assumption which is almost, but not quite tautological. Not quite because, in my view, the more intensive systems can be less demanding on "site factors" than extensive ones, hence require rather less fine-tuning to local conditions.

p 23. The title of section 5.2.1. is misleading. Presumably it should be "Chinese-type integrated farming systems" as the section refers to research needs everywhere, not just in China. Further the last paragraph on page 25 doesn't fit even with the title changed, and needs to be made as a separate point.

p.26 This section on economics, and the following one on sociology, are treated at a more general level than the previous ones, and describe the status of the diosciplines rather than research needs as such. Perhaps they should both be combined with their corresponding sections in Chapter 6. I do agree in principle with the statement at the end of the page, and that the problem is that known economic methodologies are little applied. I also would strongly support the views expressed in the paragraph on page 29 about applications. I would like to emphasize, however, that economic analyses of small-scale, extensive and semi-intensive aquaculture systems, like ecological analyses, have to be carried out contextually or in their environmental setting, ie. at several levels at once. If the section is to be kept, it should address the rationale behind the seemingly arbitrary evaluation in table 7.

p.30-32 This is perhaps the place, if the section is kept separate from 6.1, to discuss the importance of sociological studies to settling "use rights issues" and how best to organize or coordinate group effort or investment in extensive aquaculture and culture based fisheries, in various types of social systems.

p. 36-37. Continuing from the point I made above on section 5.3, studies on production economics need to address not only th task of defining typical values of economic criteria for well defined aquaculture systems, but also their variability across various agroecological settings, types of social organization, along the rural-urban axis, etc. It seems to me that much of the lack of enthusiasm for studies of economics of aquaculture is because there is too little study of how the typical variables of an economic analysis can be related in a general way to location variables. Unless this is possible there is little value in such analyses for planning. Another way to state the point is that there is at present too little linkage between macro- and micro- economic studies.

p. 39-40 Under genetics one should also mention preservation/conservation of strains and germplasm, and, in connection with cage culture and culture-based fisheries, genetic conservation of wild stocks in the presence of cultured strains.

p. 42 An important area of study in pathology that needs more research is that of the production and certification of disease-free seed stocks for both internal use and international transfer. The problem of detecting and controlling the distribution of asymptomatic carriers is particularly problematic.

p. 44 Again making reference primarily to culture-based fisheries, sea ranching, and even some forms of extensive aquaculture, behavioural research is needed on ways to restrict or predict the movements of fish, and/or to attract fish to feeding devices or to harvesting equipment.

p. 49 Section 7.1 While it is understood that the working group was primarily concerned with public-funded research, some reference should be made to innovative (strategic) research carried out by private companies. This has been a major source of funding for salmon and shrimp culture, and for much of the current research being carried out on such species as cod, halibut, plaice, etc. It has also been rather long-term research, which, partly because rather new areas are being explored, is of a much more discipline-oriented nature than much of conventional R & D work. The important issues are not whether research should be publically or privately funded, but rather how to coordinate the research being carried out by producers and that which needs to be supported publically.

p. 50 Last paragraph, 1st sentence I assume that the word "not" has been ommitted inadvertently!

p. 64 I have considerable reservations about section B. In the case of programme (i) my problem is the one mentioned above, that the combinations of possible operations are not only numerous, but impractically large, to approach in conventional ways. A real effort has to be made to quantitatively formalize comparative studies of aquaculture systems, and to link these studies to local site and social factors within as well as across agro-ecological zones and farming systems (themselves equally variable within the broad classes by which they are usually described).

Under (ii), I do not accept that the full potentials of lakes, reservoirs and other open systems have not been developed for lack of scientific investigation or knowledge. We know very well how to improve the productivity of these systems very substantially. We do not know how to obtain effective collaboration of fishermen and the public in general in putting the methods in place (e.g. control of effort or of use rights by a variety of means), or even public agreement that it has high enough priority to warrant financing the traditional modes of enforcement. I do agree that this is an important area of international collaboration in scientific social and economic research.

I also question whether open systems are the "only sustainable aquaculture for rural populations in Africa and Latin America in the short run". I'm quite sure that several forms of aquaculture will prove sustainable on these continents during the next few years, but only in relatively restricted areas and circumstances. I would thus accept that open-systems may provide the only significant increases in fish production in inland waters on these continents in the near future.

IDA
INSTITUTE FOR DEVELOPMENT ANTHROPOLOGY
99 COLLIER STREET, P.O. BOX 2207, BINGHAMTON, NEW YORK 13902 USA
Telephone (607) 772-6244 FAX (607) 773-8993 Telex 932433 Cable DEVANTHRO BINGHAMTON, NY

27 December 1989

Mr. Jean-Paul Troadec
Team Leader
Study of International Fisheries Research
The World Bank
1818 H. Street, N. W.
Washington D. C. 20433

Dear Mr. Troadec:

Thank you for sending me a copy of the draft report of the Working Party on Research Needs for Aquaculture Development. Thank you also for the very nice note. I enjoyed the workshop tremendously and learned a lot, and I also enjoyed meeting you and the other participants.

You ask for suggested modifications of the report. In my review of the document I have focused on Part VI, specifically section 6.1 Social Sciences. Instead of trying to comment on each sub-section separately, I thought it would be more efficient to re-write the entire section along the same guidelines. Would you consider replacing VI.6.1 with what I have enclosed? For your convenience, in addition to a hard copy, I am sending you a diskette (WordPerfect 5.0).

Please accept my warmest wishes for a very happy new year.

Sincerely,

Muneera Salem-Murdock
Senior Research Associate

6.1 Social Sciences

6.1.1 Present State of Knowledge

Three areas of socioeconomic and cultural investigation can shed important light on the development and conduct of socio-economic inquiry in the field of aquaculture: cultural change, innovation, and diffusion; farming systems research and extension; and, household dynamics and the organization of production.

Many anthropological and sociological studies have been conducted on innovation and cultural diffusion and models to predict the acceptability or rejection of these innovations have been developed. Some of the conclusions reached by these studies are: (i) innovations should be compatible with the aspirations, needs, desires, and socioeconomic, political, and environmental conditions of the target populations; (ii) the new ideas, methods, or technical innovations should be communicated clearly to the concerned populations; (iii) the target population will accept or reject a given innovation depending on whether it serves a perceived need or desire.

Similarly, numerous studies have been conducted on farming systems, household dynamics, and the organization of production. In all the production systems examined (e.g., dryland farming, recession cultivation, irrigation, herding, fishing), scientists have identified and studied the factors that are also likely to be of importance in aquaculture research. Areas of investigation relevant to the socioeconomics of aquaculture are:

(1) Social Organization

Although rural communities are often presented in the development literature as if they were internally homogeneous, again and again social science has demonstrated their internal diversity, reflecting in a local area the larger social division of labor and relations of production. The indices of segmentation are many and may include class, ethnicity, kinship, caste, gender, occupation, and political, and religious affiliation. These are made relevant in differential access to and control over the means of production (land, labor, and capital). In each target community, researchers will need to identify and analyze the conditions under which various attributes are made relevant in the struggle for access to strategic resources.

(2) Organization of Production

Rural communities in the developing world are increasingly incorporated into the global economy. The degree of incorporation and its effects on the community are functions of specific histories. Hence, the situation is everywhere dynamic, and these communities are in constant process of transition. Commodity relations of production tend to compete with other, more domestic or communal relations. Thus, although the overall direction is clearly to greater commoditization, it is critical to specify the situation for each target community. In order realistically to assess the needs of a target population and more effectively to plan project intervention that will generate equitable and sustainable development of a whole region, a detailed and dynamic study of the organization of production of the concerned populations is vital. Aquaculture development, according to scale, will carry with it complex innovations that will require technical and organizational skills, labor inputs, and socioeconomic roles that might not be present in traditional systems of production. The organization of production can be investigated from many avenues:

(a) Units of Production/Distribution/Consumption

What is the unit of production? Is it the individual, the household (what is meant by "household"?), a group of households, the clan, the village? Do production units differ from group to group? Do they differ within a group? Why? How? What are the units of consumption? Do they coincide with production units? Who has authority over distribution and what are the mechanisms utilized?

(b) Economic Activities

-- What economic activities exist in the area? Attention should be paid to all activities, including farming, herding, fishing, forestry, crafts, wage labor, and other non-agricultural activities. Potential competition for resources attendant on the introduction of aquacultural interventions must be specified.

-- What are the farming systems in the area? Close attention should be paid to the range of crops grown, the division of labor and the economic roles of women and children, methods of cultivation,the availability of credit, both formal and informal, and whether livestock production is integrated with farm activities or animal traction utilized. What is the likelihood that aquaculture might compete with present landuse?

-- What farm practices, including farming cycles, are followed?

-- What is the nature of the marketing system?

-- What are the incentives and constraints on productivity?

-- Will aquaculture production conflict with other economic activities, especially agricultural practices? Can it be integrated with animal and plant production?

-- If fishing is a prominent economic activity in the area, who are the fishermen ethnically and in class terms? Is fishing a year-round or a seasonal occupation? Are the fishermen also farmers? How does planting and harvesting affect time of fishing?

-- Will aquaculture compete with capture fishing? To whose benefit?

(3) Inter- and Intra-household Differential Access to Resources of Land, Labor and Capital

Researchers will quantify households resources in land, livestock, and other forms of capital and will anticipate the impact on differential access to resources of introducing new technologies and the reverse. As resources are researched it is important to remember that households are highly differentiated internally. It is therefore critical to ascertain which household member(s) have which kind of control over which resources, and which members perform which kinds and amounts of labor. Also, what is the likelihood that the introduction of the new technology will increase gender inequalities, elitism, and social stratification?

(4) Land/Water Tenure and Use

Land/water tenure and landuse rights have been shown to be the framework within which traditional farming and herding patterns operate. As such, they often play key roles in determining the propensity among farmers for technology adoption. Thus, a study of land/water tenure and use should be undertaken in any development effort, whether it is irrigation, livestock, or aquaculture. Some of the questions t raise are:

(a) Who owns and controls the land?

(b) Who has access to land of different kinds?

(c) What are the conditions under which this access is maintained?

(d) What impact do present land tenure systems have on agricultural productivity?

(e) Does field location make a difference in land use decisions and why?

(f) Is there a correlation between access to land and crop selection?

(g) Will new tenure systems come into direct conflict with traditional tenure? If so, how will that affect project sustainability? Is there anything that can be done at the planning stage to avoid or minimize conflict?

(5) Division of Labor by Gender/Age/Status

A comprehensive understanding of the local economy necessitates a thorough examination of existing division of labor. Often, planners fail to take the traditional division of labor and the role of women and children into consideration. For example, although it is will documented that women are the primary food producers in much of Africa, food production projects are too often designed and implemented almost exclusively in terms of male heads of households. Men receive the land, technical and agricultural inputs, and credit. Women may receive little but increased burdens and dependency on men. This increased dependency might have negative nutritional and health implications since women's reduced ability to dispose of household resources is likely to affect the quality and quantity of foods available for them and their children.

(6) Labor Availability, Strategies, and Migration.

(7) Household Decision Making

Since households are the ultimate implementors of development projects the processes by which household decisions are made should be an important component of the research portfolio. Household decisions are informed by issues such as household composition, labor availability, access to resources (including political and social resources), income, and education.

(8) Marketing and Rural/Urban Exchange.

6.1.2 Shortcomings

Little systematic investigation of the issues discussed above has been conducted specifically in the context of aquacultural development. Although several of the factors demonstrated relevant in the context of other production and farming systems are likely to be of relevance in aquacultural research and development, it is naive to assume they will carry the same weight. The critical issues are likely to differ between countries where aquaculture is a new and unfamiliar activity, those where it is of minor importance, and others where it is already important but of a different scale. The introduction of aquaculture or its intensification is likely to involve profound technical, and institutional changes and implies the evolvement of new adaptive strategies on part of the new users. For example, conflicts over the ownership rights and use of the newly introduced resources, in the absence of adequate institutional arrangements to regulate and resolve them, are likely to take entirely different forms and expressions.

These and other issues have to be re-examined and re-analyzed in the context of the broader revision of rights over the fishery resources and the uses of aquatic environments, raised by the full exploitation of the former, the diversification of uses of the latter (including pollution), and the effects of open-access on their efficient utilization and the resolution of conflicts over both. Accordingly, all likely relevant issues have to be re-identified and reformulated in the light of new opportunities for aquaculture development and new needs for fishery ecosystem management.

6.1.3 Future Plans

To correct the wide gap in our knowledge of aquacultural socioeconomic, the following reviews and investigations are suggested.

(1) Immediate Actions

* Review the state-of-the-art in the socioeconomics of aquaculture. This will include a compilation of existing literature, including the relevant knowledge derived from other production systems and their historical developments, a partially annotated bibliography (annotations of works that are specifically relevant to aquaculture research and development), and an identification of the present gap in knowledge.

* A draft copy of the paper will be used as a background document for a seminar to be attended by relevant experts; the purpose of the meeting will be to discuss preliminary findings and conclusions, to prepare a preliminary field research strategy, and to formulate a field research agenda.

(2) Long-term Research

The meeting referred to above will produce a framework for:

* initiating field research on identified topics in selected regions;

* data analysis and interpretation of research results;

* formulation of principles, guidelines, and scenarios for socioeconomically sound development of small-scale aquaculture.

INRA

RÉPUBLIQUE FRANCAISE
INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE
CENTRE DE RECHERCHES DE BORDEAUX

STATION D'HYDROBIOLOGIE
de Saint-Pée-sur-Nivelle

NUTRITION DES POISSONS

Mr Jean-Paul TROADEC
Team Leader, SIFR
The World Bank
1818 H Streer, N.W.,
Washington DC, 20433, USA

V / Réf. :

N / Réf. : SK/89/758

Objet :

Saint-Pée-sur-Nivelle, le 20 décembre 1989

Dear Mr Troadec,

I am in receipt of your letter and the draft report of the SIFR working party meeting held last september in Paris. As I was a participant of the second session, I can only limit my comments on that part.

With regard to the nutrition research inputs, with which I was particularly concerned, I feel that all that was said during the meeting is rightly drawn into the minutes. There is nothing much to add or change.

Of the rest of the meeting, two other points appear to me personally as important. I believe that there is an over emphasis on socio-economic research. While I agree that this aspect should not have been neglected in the past, the African experience may not be considered as the unique model for setting forth future actions over the world. In some other parts of the world, there have been significant efforts towards research by the local established socio-economic scientists themselves, and it is my sincere belief that much knowledge can be gained by the already existing analytical data. On ne doit pas essayer de réinventer l'eau chaude.

A second point which appears to me as having too much emphasis in the draft report is on the potentially high role of the tropical aquaculture research institutes of the northern/western hemisphere. As it appears from the reports of the first session, part at least of the current stagnation in the aquaculture front in some parts of the world derives from bad planning of research and development by the existing developed country institutes where vested interests have probably played a major role. It might then be questionable whether the current developed country institutes having had some significant role in the planning of the past tropical aquaculture development are the right partners or should other partners be looked for. Their own roles require finer tuning, based on past achievemnts and in the context of the present exercise. These are just my personal comments.

A point of importance : page 69. I originate from India, but am a French National, working for INRA!

May I also take this opportunity to wish you a very happy new year.

Yours Sincerely,

Dr S.J. Kaushik

ICLARM

mc p.o. box 1501, makati, metro manila 1299, philippines

Cable : ICLARM MANILA
Telex : (ITT) 45658 ICLARM PM
(ETPI) 64794 ICLARM PN
Fax : (63-2) 818-3183
(63-2) 819-3329 MAKATI
ATTN: ICS 406
Tel. : 818-0466, 818-9283
817-5255, 817-5163

FAX No. 202-477-6391
Washington, D.C.

To : Dr. Jean Paul Troadec
Team Leader
Study of International Fisheries Research
The World Bank

From : Dr. Chua Thia-Eng
Officer-in-Charge

Date : January 24, 1990

This is to inform you that the written comments to the draft report on the SIFR Working Party on Research Needs for Aquaculture Development by Drs. Roger Pullin, Max Aguero and myself will be sent to you tomorrow by courier service. Due to very heavy travel schedule of our colleagues we were not able to send you our comments early as expected. We apologize for this delay.

international center for living aquatic resources management

3rd floor, bloomingdale bldg., 205 salcedo street, legaspi village, makati, metro manila 1200, philippines

UNIVERSITETET I TRONDHEIM
NORGES TEKNISKE HØGSKOLE
INSTITUTT FOR BIOTEKNOLOGI

Vår dato 29.12.89 – referanse AJ/ja

Vår saksbehandler, innvalgstelefon

Deres dato – referanse

Mr. Jean-Paul Troadec,
Study of International Fisheries Research,
The World Bank,
1818 H Street N.W.,
WASHINGTON D.C. 20433,
U.S.A.

Dear Mr. Troadec.

Thank you for your letter of December 11 1989 and for the draft report, which arrived here in the middle of my exam period. I have just corrected and graded 144 exams in Biochemistry and 15 in Marine production, and there has therefore been little time to go through the draft report.

I have, however, skimmed through it, and I must confess that I am impressed with what you have managed to abstract from the various rather variable contributions. The chapter on biotechnology is very correct and to the point. This section I have read carefully. I am planning to go through the whole draft in the beginning of January, and I can send you comments, provided I feel they might be helpful. They will then arrive after the dead-line, so you may not be able to use them.

Finally I should like to express my gratitude for being invited to part-take in the work. The meeting in Paris was very interesting and useful to me. I did learn a lot about aquaculture and people.

I am sending my best wishes for the New Year,

Sincerely yours,

Arne Jensen.

8

POSTADRESSE:
UNIT/NTH
INSTITUTT FOR
BIOTEKNOLOGI
Sem Sælands vei 6/8
N 7034 Trondheim

TELEFONER:
Sentralbord: (07) 59 40 00
Instituttet: (07) 59 33 20

TELEX:
55637 NTHAD.N
(Att.: IB)
TELEFAX:
(07) 59 51 03
(Att.: IB)

THE UNIVERSITY OF TRONDHEIM
THE NORWEGIAN INSTITUTE OF TECHNOLOGY
LABORATORY OF BIOTECHNOLOGY

NATIONAL RESEARCH INSTITUTE OF FISHERIES SCIENCE
5-5-1 Kachidoki Chuo-ku Tokyo 104

Telephone (03) 531-1221
TeleFax (03) 533_5693

Dec. 21, 1989

Dr. Jean-Paul Troadec
The World Bank
1818H Street, N.W.
Washington, D.C. 20433
U.S.A.

Dear Dr. Troadec:

Thank you very much sending me a copy of draft report on the SIFR Working Party on Research Needs for Aquaculture Development. I appreciate very much inviting me to join the working party. It was some experience for me working with you.

I would like make one comment on this report. It is stated in the report that even research aiming at quick results through technological introduction had made some positive contributions to the development of aquaculture in the developing countries. So I still believe that applied, locally targeted, adaptive research or technology transfer of immediate application to development and management are more important than pure basic research for the developing countries to achieve quatum jump in aquaculture without making redundancy. From longer term point of view, however, I agree with your opinion that basic research providing universally relevant new knowledge via testing of hypothesis and experiments should be initiated in a certain institutes of the developing country because all good teaching, research training and planning for the longer term had to be based on at least some element of basic science taking place in a country.

Wishing you a Merry Christmas and a Happy New Year.

Sincerely yours,

Takeshi Murai

Takeshi Murai
Research Coordinator

6.2 - Economics

The economics of aquaculture is primarily an applied discipline, involving the application of various sub-disciplines in economics and commerce to the field of aquaculture. It is also a fairly recent discipline, and so far very few scientific analyses have been undertaken.

Economics can be used to analyze both single projects and sector development. In addition, cost-benefit analysis of research projects relating to aquaculture may be undertaken.

As far as theoretical economics goes, one can envisage research in the following areas:

- optimal feeding and harvesting in aquaculture,
- optimal rotation,
- polyculture,
- the issue of property and use rights.

In the last years, a number of theoretical analyses of optimal feeding, harvesting and rotation have been undertaken. In most instances, it appears optimal to harvest all fish at the same time. This is in contrast to the practice of continual harvesting over some period of time. Problems relating to continual harvesting and feeding have not yet found their solution in the literature. The same relates to polyculture. This is, however, a matter of joint production (cf. multi-species fisheries), but the analysis needs to be extended to the context of aquaculture.

The issue of property or use rights varies widely from culture system to culture system. While private property rights exist for some systems, others resemble the open access situation of capture fisheries. This is particularly true for certain kinds of extensive aquaculture, e.g. ocean-ranching.

In the same way as for capture fisheries, the implications of property and use rights systems for aquaculture need to be researched. The problems relate to the allocation of rights, the tenure and the content of the rights. Moreover, issues related to private or communal rights need to be analyzed.

In the field of applied economics, analyses should be expanded in the following areas:

(a) the development of aquaculture:

Essentially, this would be an economic analysis of the development of aquaculture (economic history). The primary purpose would be to analyze which factors are of critical importance to the successful development of aquaculture.

(b) production economics:

Aquaculture is traditionally defined to be extensive, semi-intensive or intensive, usually on the basis of the usage of certain inputs such as feed and fertilizer. From an economic view point, this may not be a very meaningful definition. Economic criteria for the classification of aquaculture (e.g. investment costs per unit of production capacity or the labour/capital ratio should be established and economic analyses undertaken on this basis.

In particular, one would like to analyze the following factors:

* production efficiency (cost of production), including economies of scale,
* productivity,
* substitution between factors of production,
* externalities.

In addition to comparisons according to the level of intensity, one should undertake comparative analyses for the culture of different species in different countries. As in capture fisheries, externalities are very important in aquaculture, although the nature of problems is different. Aquaculture produces externalities that affect both aquaculture entities and other activities. Similarly, aquaculture is affected by externalities from outside sources. Questions related to externalities are dealt with in the general economics literature. Only few applications have to date been made to aquaculture.

In general, economic analyses in one field of aquaculture would consist of the following elements:

- market analysis,
- market structure,
- institutions,
- production economics,
- investment analysis,
- financial analysis.

An economic analyses of aquaculture development will always start with a market analysis, as an actual or perceived demand is a precondition for successful development. While market supplies from capture fisheries are limited by nature, this is commonly not the case for aquaculture, where market demand may be the limiting factor for development.

In other words, where supply is limited by nature and demand is continuing to increase, this will result in an increasing real price of the product and create a potential for aquaculture. Whether to product.

Market structure and institutions influence how products are marketed. Moreover, the relationships between different agents determine both the efficiency of the distributions channels and profit margins for different kinds of economic agents.

For given constraints imposed by the market and institutions, production economics, investment and finalcial analyses deal with the economic viability of the micro units. In other words, these are economic planning tools to determine the profitability of aquaculture operations.

6.3 - Physiology

Within the following investigations, a useful distinction could be made between programs aiming at improving husbandry techniques and those, conducted on a few species models, aiming at acquiring the basic knowledge needed for the long-term developement of the branch. This includes also the development of research tools (e.g., tissue culture techniques for investigations in pathology). These considerations should be kept in mind when consulting the following lists. They simply provide a general framework. Within the justification for short- and long-term research priority of each item must be modulated, depending on the farming systems, their development stages and the species under consideration.

6.3.1 - Reproductive biology

The control of reproduction responds to different objectives in aquaculture. These goals are listed below. As already emphasized, their relevance will vary according to the farming systems under consideration.

(a) Conservation and enhancement of natural reproduction (habitat management):

* protection of natural spawning grounds;
* preparation of artificical spawning grounds;

(b) Control of spawning (by inhibition or by stimulation):

* age at puberty (first sexual maturity): this control can have different purposes: early reproduction for fry production, or delayed reproduction to spare growth potential;
* reproduction cycles: production of eggs at any season, synchronization (to maximize the synchronous production of

NORGES HANDELSHØYSKOLE

Norwegian School of Economics and Business Administration

FISKERIØKONOMISK INSTITUTT
INSTITUTE OF FISHERIES ECONOMICS

TELEFAX

To: Dr. Jean Paul Troadec

Fax: 095-1-202-477 6391

Telephone:

From Trond Bjørndal, Institute of Fisheries Economics
Telefax No. +47 5 95 95 43
Telephone No. +47 5 95 94 03 (direct line)
or +47 5 95 92 50 (secretary)

Beskjed/Message:

No. of pages (incl. this page):

Please report any errors to us!

Adresse/*Address*
Helleveien 30
N-5035 BERGEN-SANDVIKEN, NORWAY

Telefon/*Telephone*
Nasjonalt (05) 25 65 00
Internat. +47 5 25 65 00

Telefax
(05) 25 83 83

Teleks/*Telex*
40642
nhh n

Bankkonto/
Bank account
0616 05 70367

Postgiro/
Postal giro account
3 72 00 00

NORGES HANDELSHØYSKOLE
Norwegian School of Economics and Business Administration

FISKERIØKONOMISK INSTITUTT
INSTITUTE OF FISHERIES ECONOMICS

Bergen, December 22, 1989

Dr. Jean Paul Troadec
Team leader, SIFR, AGRPS
Room N5025
The World Bank
Washington, D.C.
USA

Dear Dr. Troadec,

Enclosed please find a revised version of section 6.2. Some of Dr. Christy's comments have been included (points 1, 3 and 4).

I would like to do some more work on this document and will submit the final version on December 28.

Have a Merry Christmas!

Yours sincerely,

Trond Bjørndal
Associate Professor

Enclosures

Adresse/*Address*
Helleveien 30
N-5035 BERGEN-SANDVIKEN, NORWAY

Telefon/*Telephone*
Nasjonalt (05) 25 65 00
Internat. +47 5 25 65 00

Telefax
(05) 25 83 83

Teleks/*Telex*
40642
nhh n

Bankkonto/
Bank account
0616 05 70367

Postgiro/
Postal giro account
3 72 00 00

Trond Bjørndal

6.2 ECONOMICS

The economics of aquaculture is primarily an applied discipline, involving the application of various subdisciplines in economics and commerce/to the field of aquaculture. It is also a fairly recent discipline, and so far very few scientific analyses have been undertaken.

Economics can be used to analyze both single projects and sector development. In addition, cost-benefit analysis of research projects relating to aquaculture may be undertaken.

As far as theoretical economics goes, one can envisage research in the following areas:

- Optimal feeding and harvesting in aquaculture
- Optimal rotation
- Polyculture
- The issue of property and use rights.

In the last years, a number of theoretical analyses of optimal feeding, harvesting and rotation have been undertaken. In most instances, it appears optimal to harvest all fish at the same time. This is in contrast to the practice of continual harvesting over some period of time. Problems relating to continual harvesting and feeding have not yet found their solution in the literature. The same relates to polyculture. This is, however, a matter of joint production (cf. multispecies fisheres), but the analysis needs to be extended to the context of aquaculture.

The issue of property or use rights varies widely from culture system to culture system. While private property rights exist for some systems, others resemble the open access situation of capture fisheries. This is particularly true for certain kinds of extensive aquaculture, e.g. ocean-ranching.

In the same way as for capture fisheries, the implications of property and use rights systems for aquaculture need to be researched. The problems relate to the allocation of rights, the tenure and the content of the rights. Moreover, issues related to private or communal rights need to be analyzed.

In the field of applied economics, research should be promoted in the following areas:

a. The development of aquaculture.
Essentially, this would be an economic analysis of the development of aquaculture (economic history). The primary purpose would be to analyze which factors are of critical importance to the successful development of aquaculture.

b. Production economics.
Aquaculture is traditionally defined to be extensive semi-intensive or intensive, usually on the basis of the usage of certain inputs such as feed and fertilizer. From an economic viewpoint, this may not be a very meaningful definition.

Economic criteria for the classification of aquaculture (e.g. investment costs per unit of production capacity or the labour/capital ratio should be established and economic analyses undertaken on this basis. In particular, one would like to analyze the following factors:

- production efficiency (cost of production), including economies of scale
- productivity
- substitution between factors of production
- externalities.

In addition to comparisons according to the level of intensity, one should undertake comparative analyses for the culture of different species and for different countries.

As in capture fisheries, externalities are very important in aquaculture, although the nature of problems is different. Aquaculture produces externalities that affect both aquaculture entities and other activities. Similary, aquaculture is affected by externalities from outside sources.

Questions related to externalities are dealt with in the general economics literature. Only few applications have to date been made to aquaculture.

In general economic analyses in the field of aquaculture would consist of the following elements:

- Market analysis
- Market structure
- Institutions
- Production economics
- Investment analysis
- Financial analysis.

An economic analyses of aquaculture development will always start with a market analysis, as an actual or perceived demand is a precondition for successful development. While market supplies from capture fisheries are limited by nature, this is commonly not the case for aquaculture, where market demand may be the limiting factor for development.

In other words, where supply is limited by nature and demand is continuing to increase, this will result in an increasing real price of the product and create a potential for aquaculture. Whether aquaculture will affect market price is likely to vary from product to product.

Market structure and institutions influence how products are marketed. Moreover, the relationships between different agents determine both the efficiency of the distributions channels and profit margins for different kinds of economic agents.

For given constraints imposed by the market and institutions, production economics, investment and financial analyses deal with the economic viability of the micro units. In other words, these are economic planning tools to determine the profitability of aquaculture operations.

END

WORLDBANK TMSS

to

DISCONNECTED

WORLDBANK TMSS

ZCZC ADRP1065 RCA1100
AGRPS
.TCP VR
****
* AGRPS *
****

RCA1100
248423 WORLDBANK

EAN PAUL TROADEC, SIFR, AGRPS N5021
GREETINGS. AGUERO, CHUA N PULLIN RECD THEIR DRAFT AQUACULTURE REPORT
S
TODAY. GIVEN THE PROXIMITY TO XMAS I HOPE YOU WILL NOT MIND IF THEIR

COMBINED COMMENTS ARE SENT TO ARRIVE BEFORE 15 JAN. BEST OF THE
SEASON TO U, FRANCIS N ED LOAYZA. J.MACLEAN
248423 WORLDBANK
64794 ICLARM PN

PLS. RESPOND TO (64794 ICLARM PN)

=12200230

=12192217

AIT

Asian Institute of Technology

G.P.O. Box 2754 • Bangkok 10501 • Thailand • Tel. 5290100, 5290041, 5290091 • Cable : AIT-BANGKOK • Telex : 84276TH • FAX. (66-2)5290374

Division of Agricultural & Food Engineering

20th December 1989

Dr. Jean-Paul Troadec
Team Leader
Study of International Fisheries
Research
The World Bank
1818 H Street, N.W.
Washington, D.C. 20433
Fax No.(202)477-1234, (202)477-6391

Dear Jean-Paul,

I was pleased to receive the Draft Report on the SIFR Working Party on Research Needs for Aquaculture Development. I felt even more pleased after reading it because it does represent a remarkable consensus for such a diverse group of people. The scenario presented in pages 64 & 65 is indeed feasible and should carry considerable weight as it is supported by weighty arguments in the text of the draft.

My comments as follows :

1. p2. Should the first objective not also include mention of the short-term (< 10 years) potential contribution of research? After all this was the emphasis of the first Workshop.

2. p4, paragraph 1. Extensive systems most certainly do not "dominate in physical terms the world aquaculture production". Finfish are the largest commodity in terms of tonnage and most are raise in semi-intensive systems. Bivalves may be a close second but they comprise mainly inedible shell and most are raised in developed countries - we are talking about research needs and potential for developing countries where the potential for shellfish is constrained by several factors. I suggest you delete the whole sentence. It is not appropriate also to single out large water bodies which are of limited area in many countries, are difficult to manage technically and socially are of little relevance to small-scale farmers, the single most populous (& needy) group in the world.

3. p4, last paragraph should be rewritten. I accept your point that aquaculture development until recently has been impeded by the availability of wild fish. However, your reference to the "fluidity" of aquatic ecosystems manily applies to extensive open water systems and hardly to the important semi-intensive land based systems. I suggest you add "particularly in extensive open water systems" at the end of the third sentence. However, I would rather see you delete the last two sentences in the paragraph.

4. p5, paragraph 2. While mentioning that applied research can have "immediate positive returns" the impression is given that such research is straight forward and hardly worthy of support. It is in fact, exceedingly difficult to establish effective multi-disciplinary teams and hence the relatively low current aquaculture production compared to agronomy and animal husbandry. To strengthen the paragraph and to better indicate the tremendous potential of applied research (the only research I wish to become involved in because I want to live to see the fruits of my endeavours), I suggest you continue paragraph 2 as follows: "Although the establishment of effective multi-disciplinary teams is difficult, they should identify and overcome various constraints to aquaculture development with significant increases in production in many countries".

5. p6, point 2. I did not say "population dynamics" but "resource management" which is broader and includes feed / fertilizer inputs as well as the stock being cultured.

6. p6, point 5. The usual term is agro-ecological zones rather than "eco-agricultural zones" as written (written twice). The term agro-ecological zones is also used elsewhere in the report.

7. p8, paragraph 3. Does the development of extensive modes of culture depend on "to effectively enhance natural recruitment of wild populations? Surely extensive culture can be based on repeated stocking of either hatchery produced or wild seed caught for the purpose? You are correct using the later definition of the meeting but not for the one I originally presented (see point 9 below).

8. p8, paragraph 4. Perhaps you should also add another significant negative effect of density - dependent process : reduced growth rate of the stock.

9. I regret to say that you should delete Tables 2a & 2b as they are based on a different definition of extensive / semi-intensive from succeeding Tables and Text. In Tables 2a & 2b the six major sets of systems have been defined on the basis of :

   (i) Coastal and inland systems, and
   (ii) Extensive (no nutritional inputs), semi-intensive (addition of fertilizer and/or supplementary feed, natural foods still important), and intensive systems (fish are fed complete diets and natural food has little or no nutritional importance).

   However, the definition of aquaculture was later widened to include ranching or fisheries enhancement of the ocean and open coastal and inland waters, a term to which "extensive" was then applied. The later definition of semi-intensive includes both extensive and semi-intensive categories of the initial classification.

3/...

FISHERIES/AQUACULTURE BRIEFING

Due to the increased importance of living aquatic resources to human nutrition, LDC economics, and the environment, the S&T Office of Agriculture has conducted a sector analysis, including trends within the Agency.

Dr. Clarence Idyll
distinguished aquatic resource scientist
will report on the sector analysis

Room 5951-NS
(Administrator's Conference Room)
Tuesday, November 14
1000 to 1200

OBJECTIVES OF FISHERIES BRIEFING

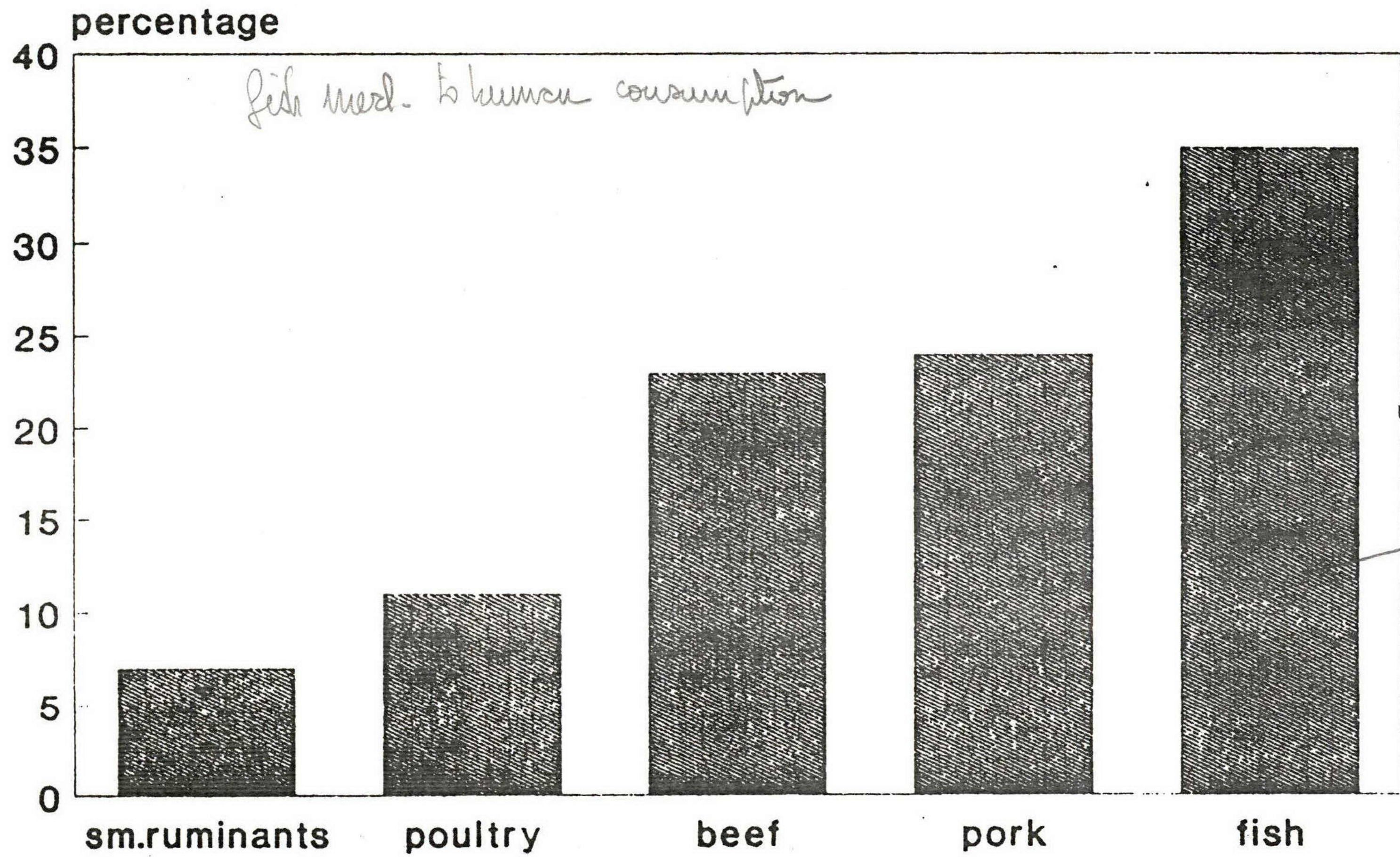
- o Demonstrate the Importance of Fishery Production to Food Security and Economic Growth to Developing Countries

- o Summarize Worldwide and U.S. Support and Assistance to Fisheries Development

- o Demonstrate the Experience and Comparative Advantage of U.S. Expertise in Fisheries

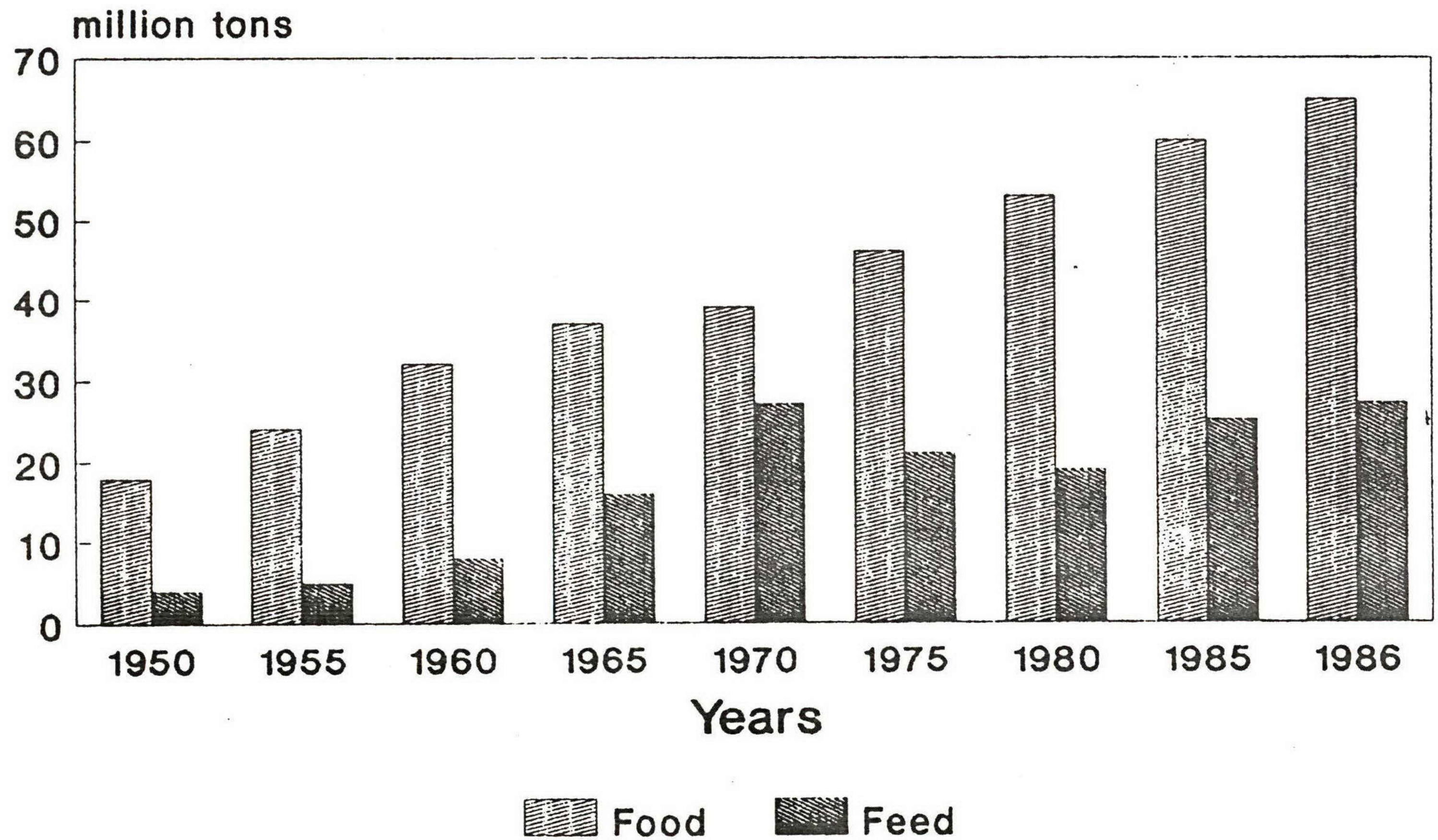
- o Recommend Focus for USAID Fisheries Program

Relative Importance of Fish
as Source of Animal Protein



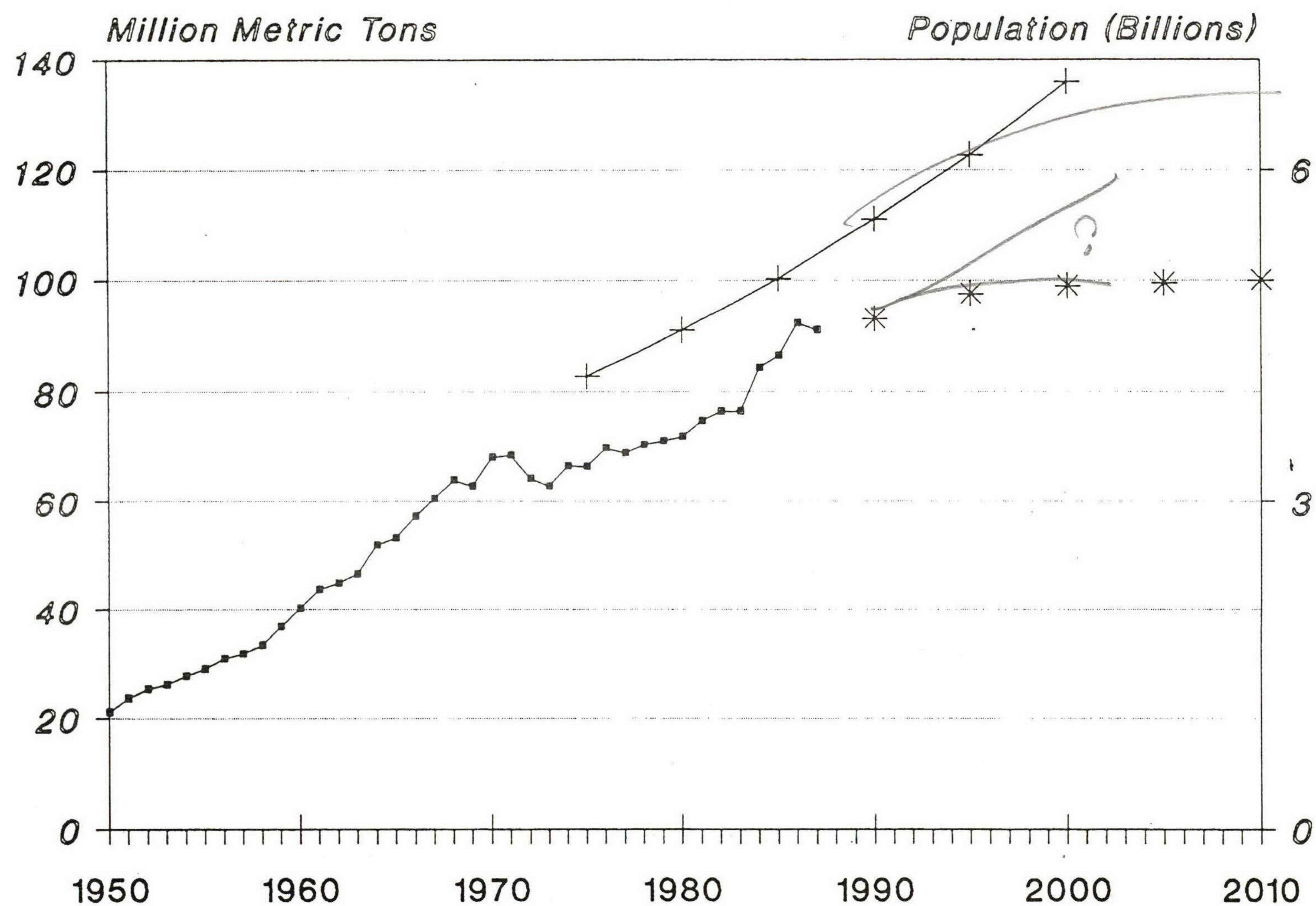
(FAO 1980, 1981b)

World Fish Catch
By Type of Utilization



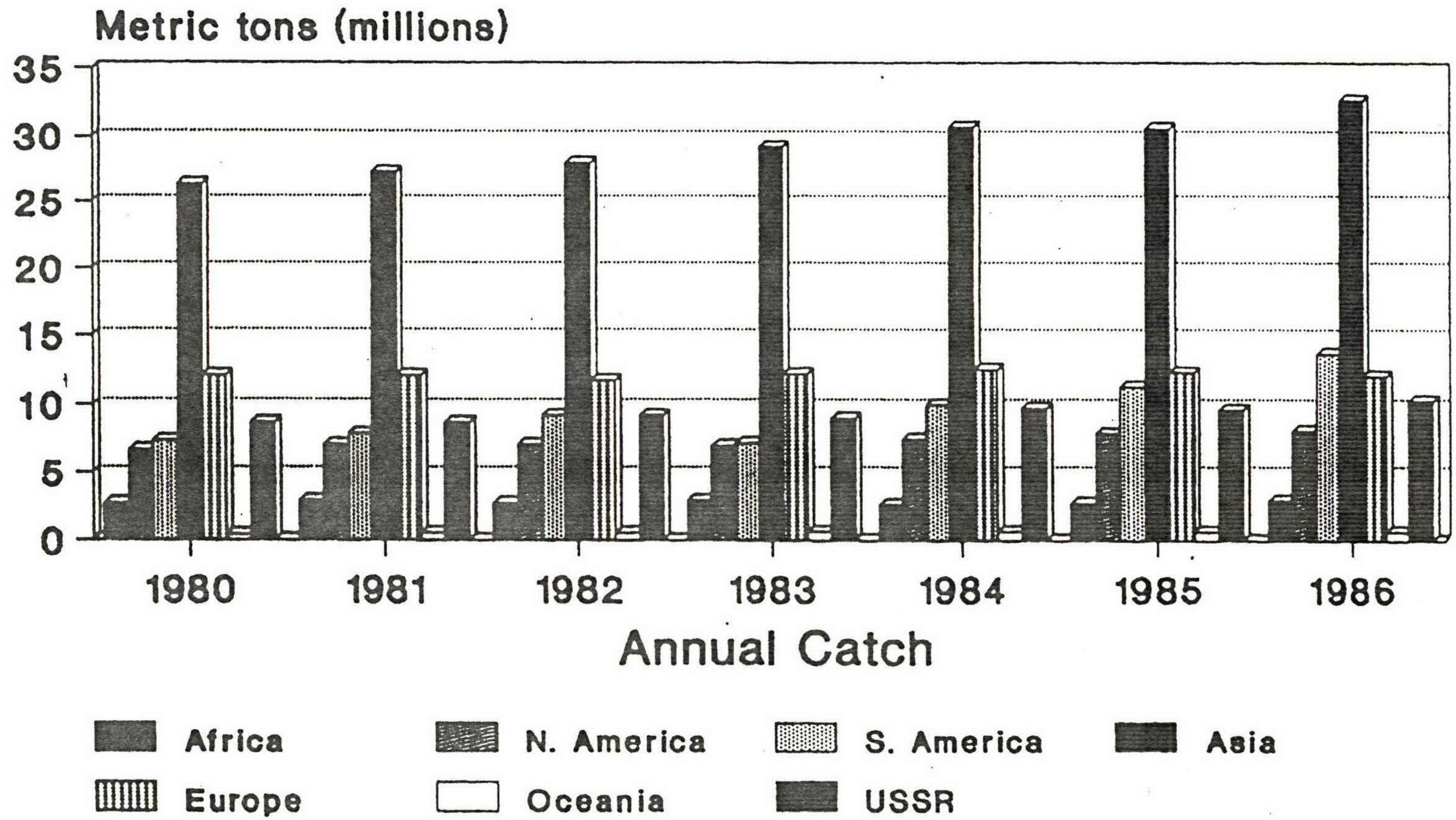
(Nierentz and Josupeit 1987)

2 of 3

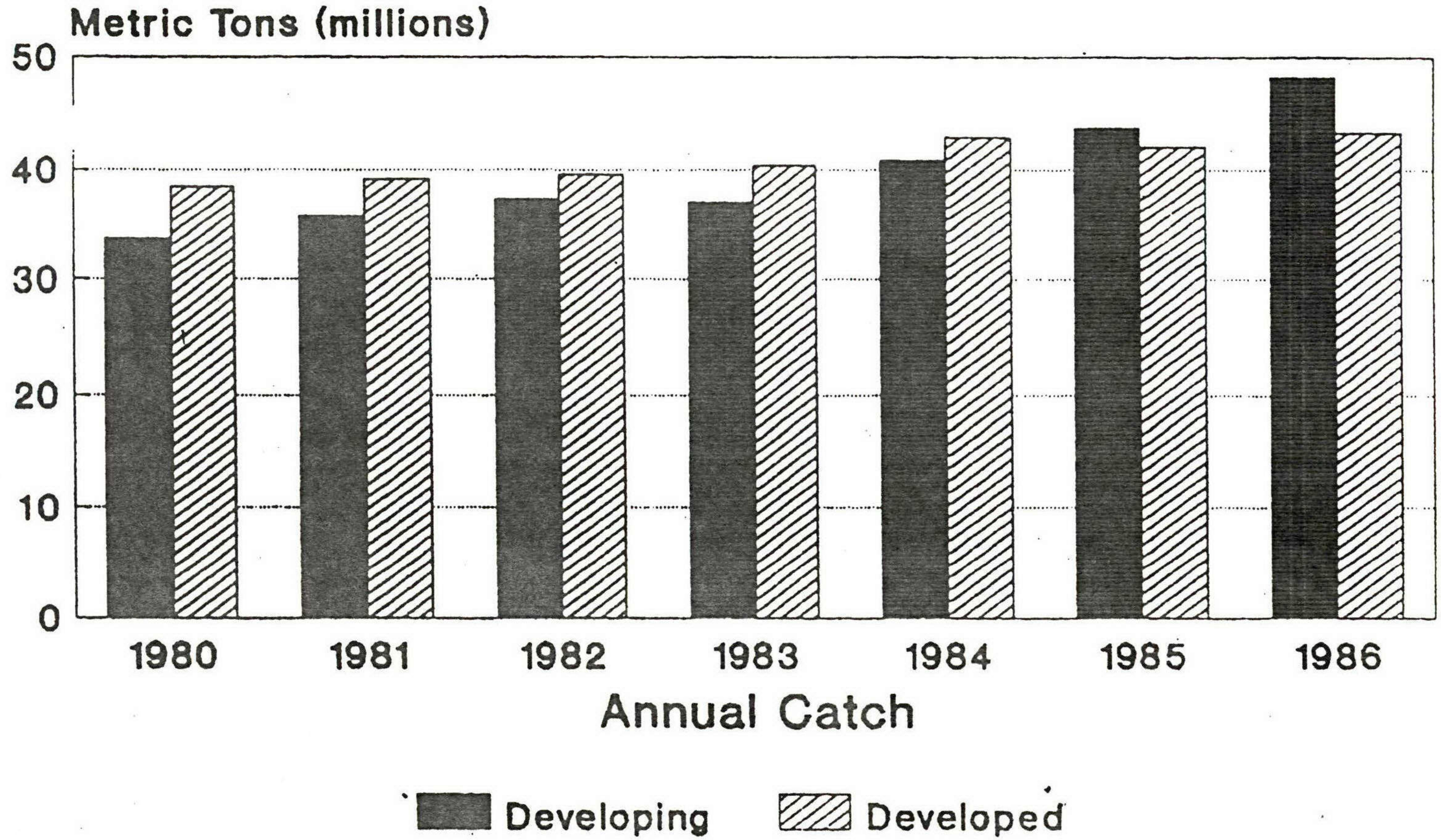

Million Metric Tons
Population (Billions)
140
120
100
80
60
40
20
0
6
3
0
1950
1960
1970
1980
1990
2000
2010

WORLD FISHERIES HARVEST

By Continent

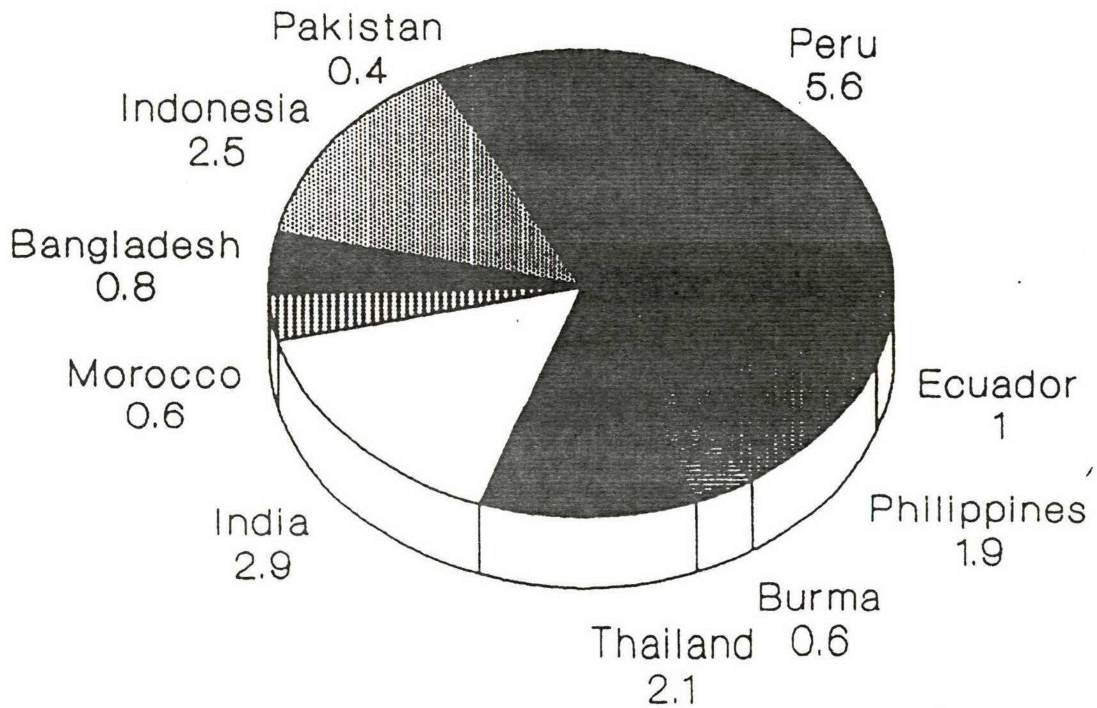


WORLD FISHERIES HARVEST
Developing vs. Developed Countries



Centrally planned economies?

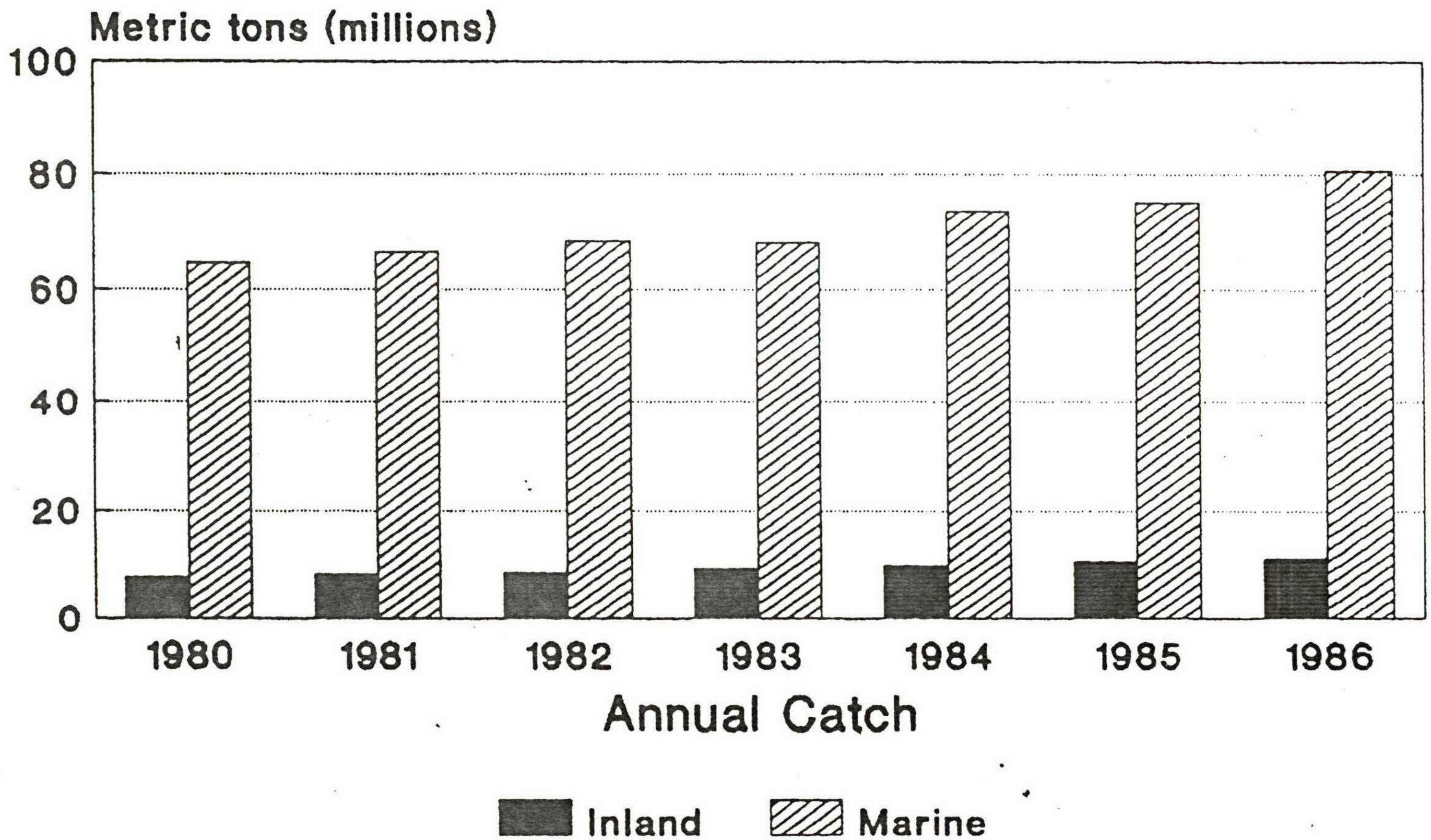
1986 DEVELOPING NATION FISHERIES HARVEST
Top Ten A.I.D.-Recognized Countries



Catch in Millions of Metric Tons

WORLD FISHERIES HARVEST

By Origin of Catch



Inland includes aquaculture

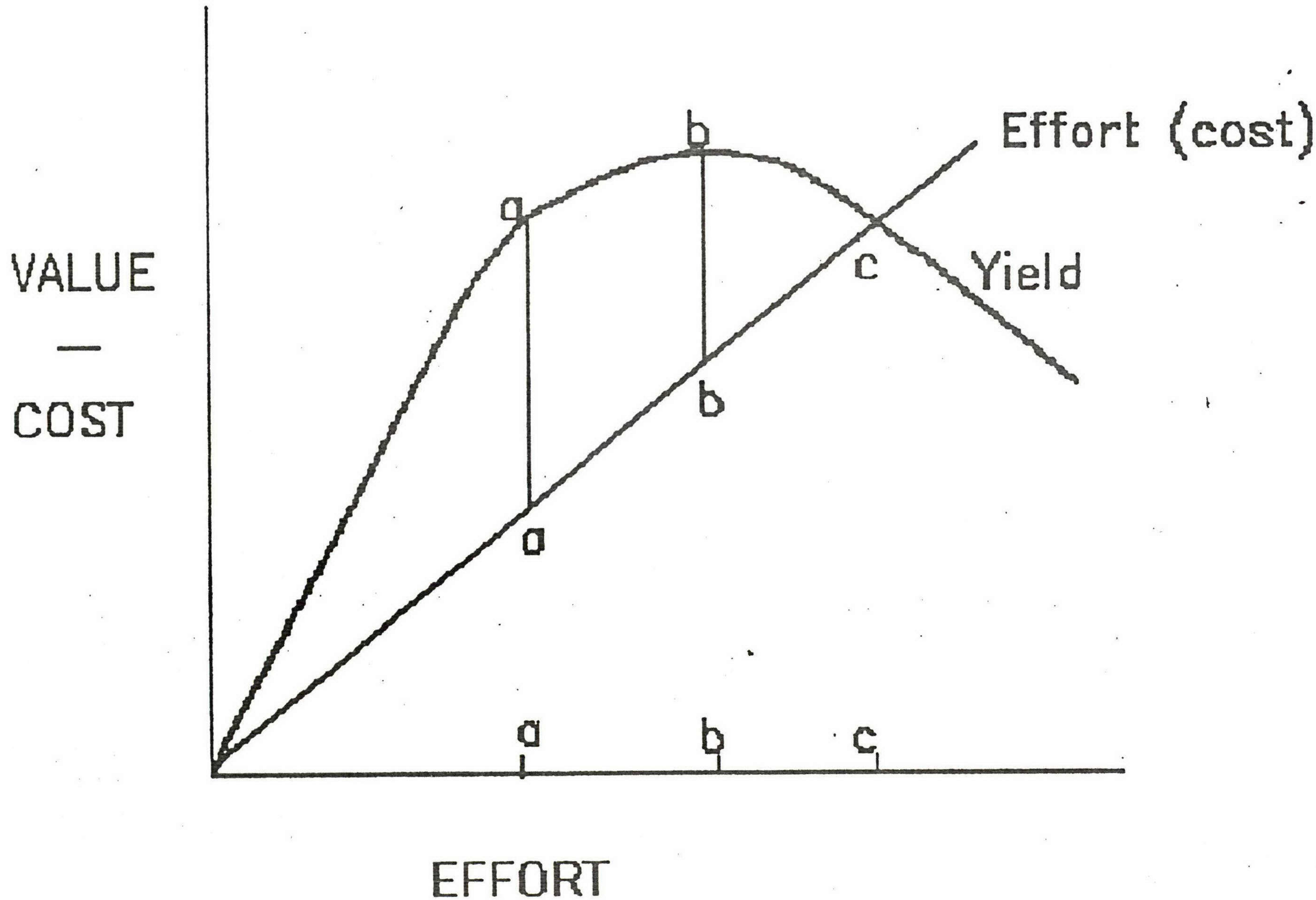
ESTIMATED NUMBER OF SMALL-SCALE FISHERMEN IN THE SOUTHEAST ASIAN AND SOUTHWEST PACIFIC REGIONS

Country	Fishermen
Southeast Asia	
Brunei	325
China	1,678,000
Hong Kong	7,900
Indonesia	860,800
Kampuchea	1,600
Malaysia	65,000
Philippines	500,665
Singapore	650
Taiwan	181,000
Thailand	60,000
Vietnam	187,000
Subtotal	3,543,440
Southwest Pacific	230,000

Adapted from Smith 1979

CONSTRAINTS TO FISHERIES DEVELOPMENT

- Size and Sustainability of Fisheries Resources
- Common Property Nature of the Resource
- Vulnerability of Fisheries Resources to Environmental Degradation
- Inadequacy of Knowledge Base
- 200-Mile Limit - Access and Responsibility for Resource
- Lack of Institutional Support for Fishery Management, Aquaculture, Environmental Protection
- Infrastructure and Institutions for Processing, Marketing, and Distribution


Effort (cost)
Yield
VALUE
—
COST
EFFORT
a
b
c
a
b
c
a
b
c

WAYS TO INCREASE FISH CONSUMPTION

- o Greater Production from Improved Management
  - Restore Overfished Stocks
  - Reduce Pollution and Habitat Destruction
  - Develop Improved Tools for Stock Assessment Through Research

U Sea

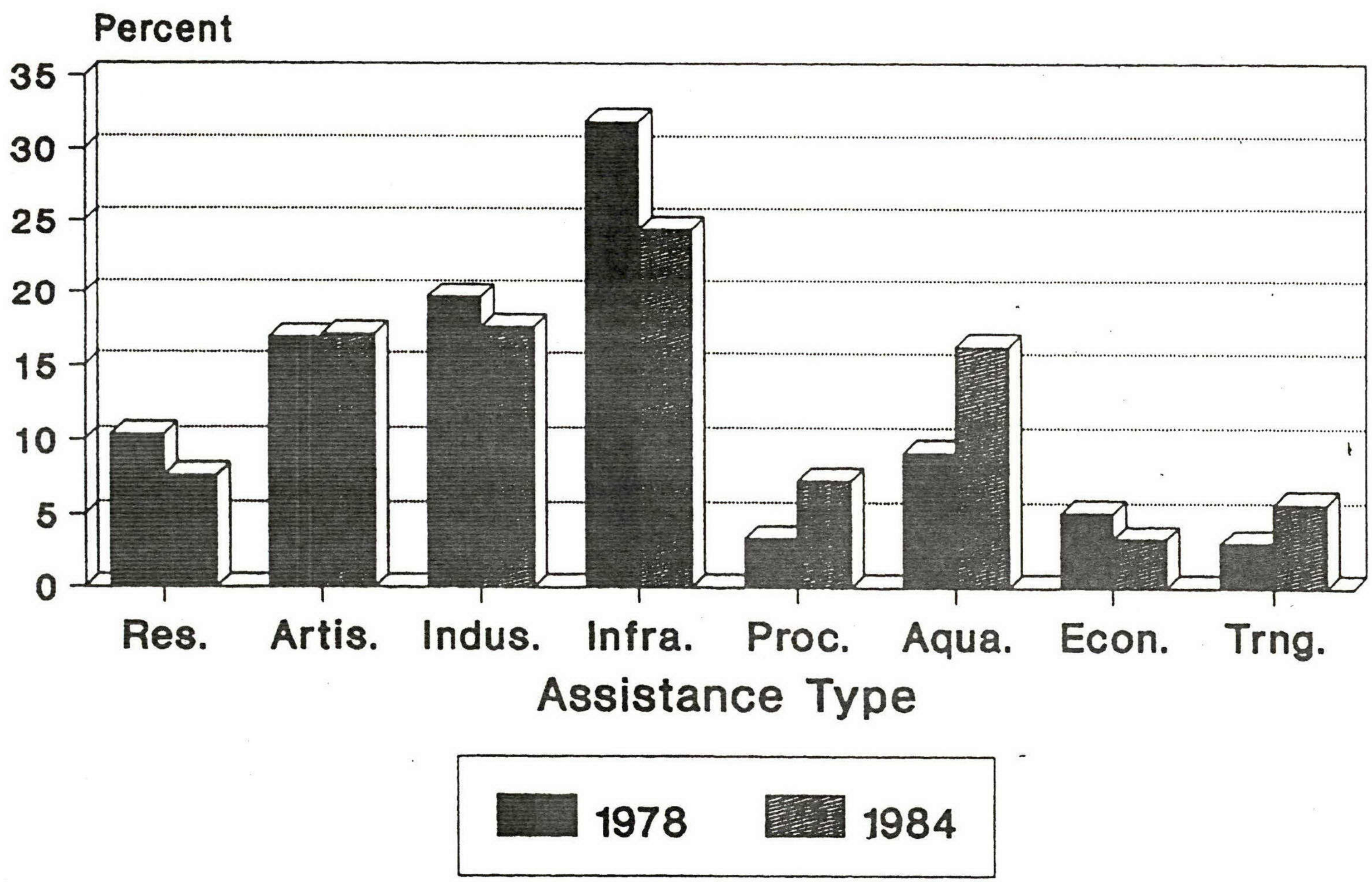
- o Convert Fishmeal Production to Direct Consumption

- o Reduce Post-harvest Loss
  - Utilization of By-catch
  - Improved Processing and Storage Technology

- o Expand Aquaculture Production
  - Research (Pond dynamics, Nutrition, Genetics, Disease)
  - Technology Transfer (New technology, Improved Pond Management)

Escuela superior politecnica

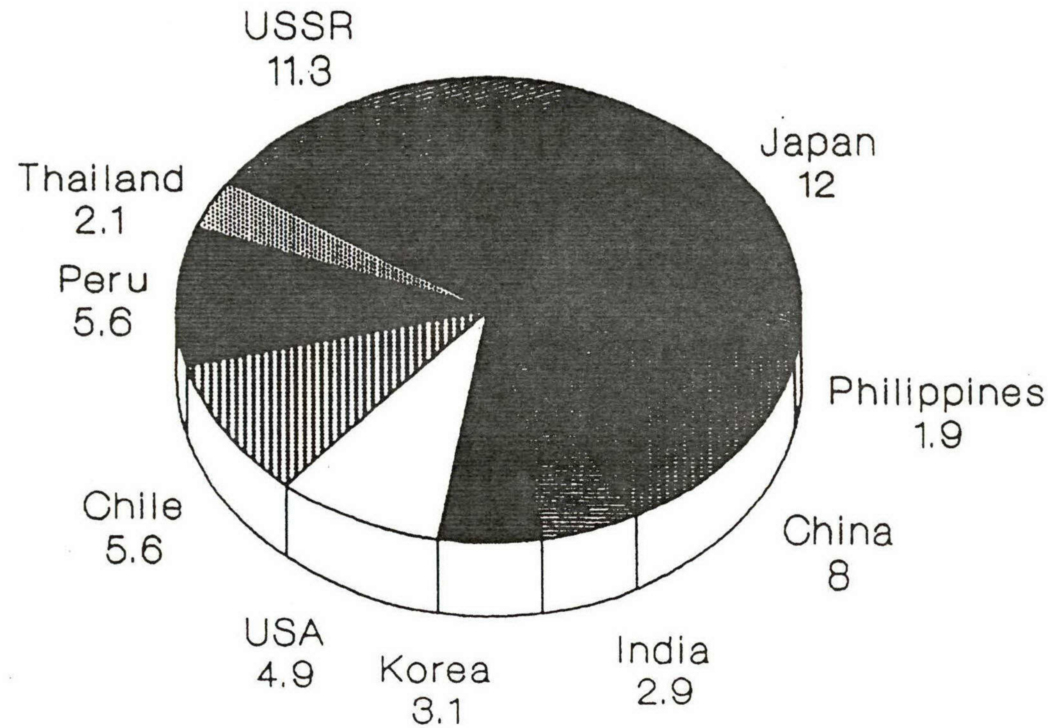
FISHERIES DEVELOPMENT ASSISTANCE 1978 AND 1984



COMPARATIVE ADVANTAGE OF U.S. FISHERIES INSTITUTIONS

- U.S. Competence in Fisheries and Aquaculture is Unmatched
- U.S. is a Major Fishing Nation -- Sixth in World
- Well-developed Public/Private Mechanism for Development of Policy -- "Conservation Ethic"
- Pioneer in Science of Biometrics/Population Dynamics -- U.S. remains Preeminent
- Strong Federal, State, and University Fisheries Research Centers
- World Leaders in Aquaculture Sciences - Water Quality, Genetics, Nutrition, Induced Breeding, Disease
- World Renowned Fisheries and Aquaculture Training Facilities
- World Leader in Science, Technology and Policy for Protection of Aquatic Environment

Major Fishing Nations
1986 Harvest



Catch in Millions of Metric Tons

SUCCESS STORIES -- FISHERIES AND AQUACULTURE

- Jamaica --Development of Commercial Farming of Tilapia
- Djibouti -- Fish Production and Resource Management
- Rwanda -- National Fish Culture Project

RECOMMENDATIONS

- Review Size and Scope of A.I.D.'s Fisheries and Aquaculture Program
  - Importance of Fish for Food
  - Importance of Fish for Employment and Income
  - Importance Scientifically-sound Management for Sustained Production
  - Relationship to Protection of Aquatic Environment

- Focus Fisheries Development Program. Priorities:
  - Small-scale (Artisanal) Fisheries
  - Integration into Programs for Small Farmers
  - Stock Assessment to Permit Rational Resource Management for Sustainable Fisheries Production
  - Protection of Aquatic Ecosystems

- Improve Internal Administrative and Technical Capabilities
  - Sustained Program of Fisheries and Aquaculture Information to Missions and LDC Officials
  - Improve Agency-wide Coordination of Fisheries Programs and Projects
  - Enhance Technical Capability for Internal Review and Evaluations
  - Develop Capability in Economics of Aquaculture and Fisheries

WORLDBANK TMSS

ZCZC ADRP1071 RCA1336
AGRPS
.TCP1 MET
****
* AGRPS *
****

RCA1336
248423 WORLDBANK

TO: DRS. JEAN PAUL TROADEC/FRANCIS CHRISTY
WORLD BANK, SIFR, AGRPS
ROOM N-5-025

1) DR. AGUERO IS PRESENTLY ON VACATION LEAVE. WE HAVE RECEIVED BOTH

DRAFT REPORTS AND DR. CHRISTY'S LETTER OF NOV. 11/89.
2) DR. AGUERO HAS INFORMED ME HE WILL RESPOND TO YOU WITH PRIORITY A
S
SOON AS HE RESUMES ACTIVITIES.
RGRDS. MS. SANDRA ABETO
(DR. AGUERO'S SECRETARY)

248423 WORLDBANK
64794 ICLARM PN

PLS. RESPOND TO (64794 ICLARM PN)

=12210151

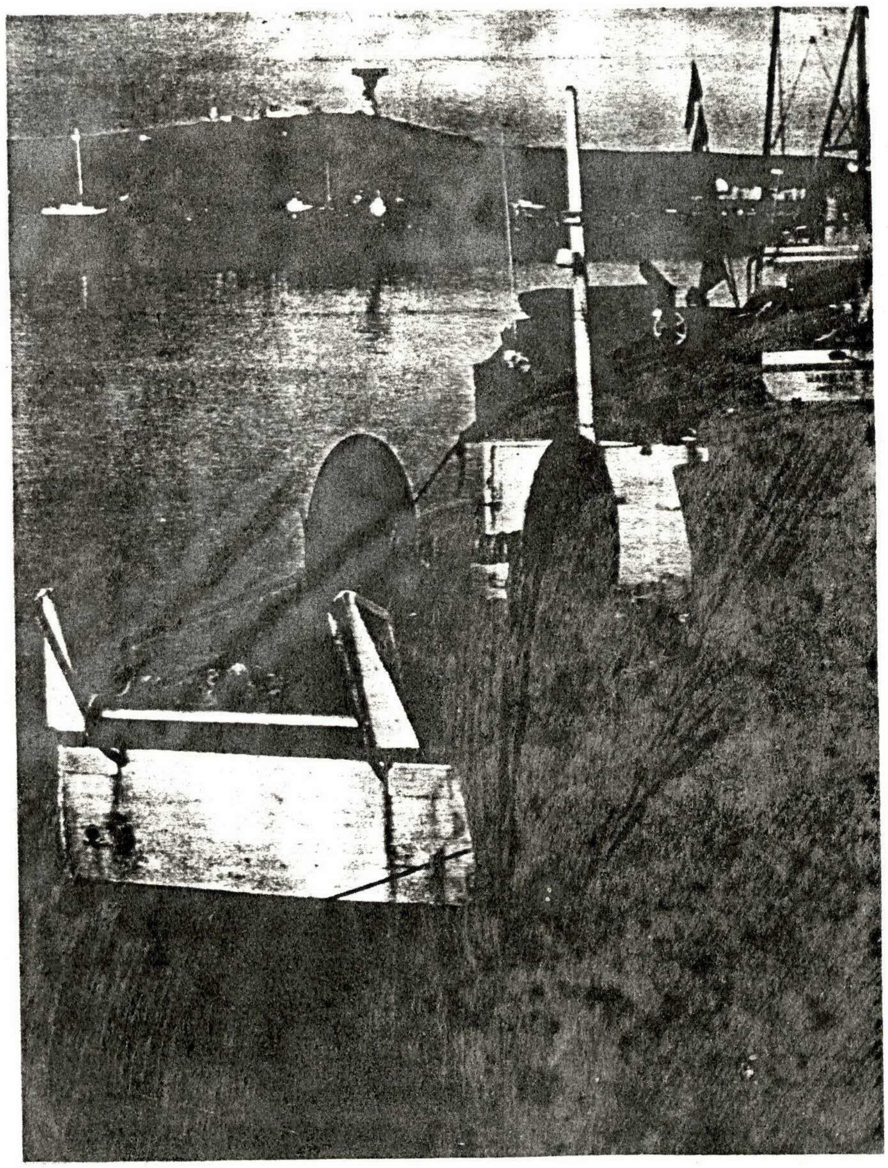
=12210648

NNNN

Marine Fisheries REVIEW

Vol. 50, No. 2
1988

National Oceanic and Atmospheric Administration • National Marine Fisheries Service



Setnet Fisheries

World catch trends

Recent Trends in World Fish Harvests

The world catch of fish, shellfish, and other aquatic organisms reached an all-time record of nearly 90 million metric tons (t) in 1986, according to a preliminary estimate prepared by the Food and Agriculture Organization (FAO) of the United Nations (UN). The estimated 1986 catch was a 5 percent increase over the previous record catch of 85.5 million t set in 1986.[1,2] Despite warnings from environmentalists concerned with rising levels of pollution, fishermen, are continuing to report increasing fishery catches. Since 1980, the world fisheries catch has increased an impressive 25 percent. Developing countries are responsible for most of the increased catch.

Preliminary data suggest that efforts by developing countries in the southern hemisphere to expand their fishing industries will result in continued increases through the year 2000, although this could be affected by a wide variety of economic and climatic factors. The 1986 increase was primarily due to the expanded Asian and, to a lesser extent, Latin American catches. Nearly 40 percent of the total world catch is taken by Asian countries, including Japan, which dominate the world fishing industry. The most rapidly growing catch, however, is in Latin America, where fishery catches have increased by 60 percent since 1980.

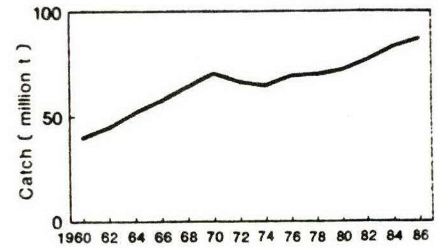


Figure 1.—World fisheries catch, 1960-86.

Table 1.—Annual world fish catch increases, 1980-86.

Year	Catch (million metric tons)	Percent increase
1980	72.1	1.4
1981	74.9	3.9
1982	76.8	2.5
1983	77.3	0.6
1984	83.4	7.9
1985	85.5	2.5
1986	89.6	4.8
Average		3.4

Source: FAO "Yearbook of Fishery statistics."

Catch Increases

The world fisheries catch has grown steadily since 1980. Annual increases have ranged from a high of 7.9 percent in 1984 to a low of 0.6 percent in 1983 (Table 1). The small 1983 increase was primarily caused by the effects of both the 1982-83 El Niño event in the Eastern Pacific and sharp price increases for fuel. Some observers suggested that the world fisheries catch was leveling off at about 70 million tons in the early 1970's (Fig. 1). The collapse of the Peruvian anchovy fishery in 1971-72 did cause overall world catches to decline during the early 1970's. The predictions, however, that the world catch had reached its maximum potential of conventional species proved erroneous. The expected leveling off did not materialize, and the world catch has expanded continuously since 1977.

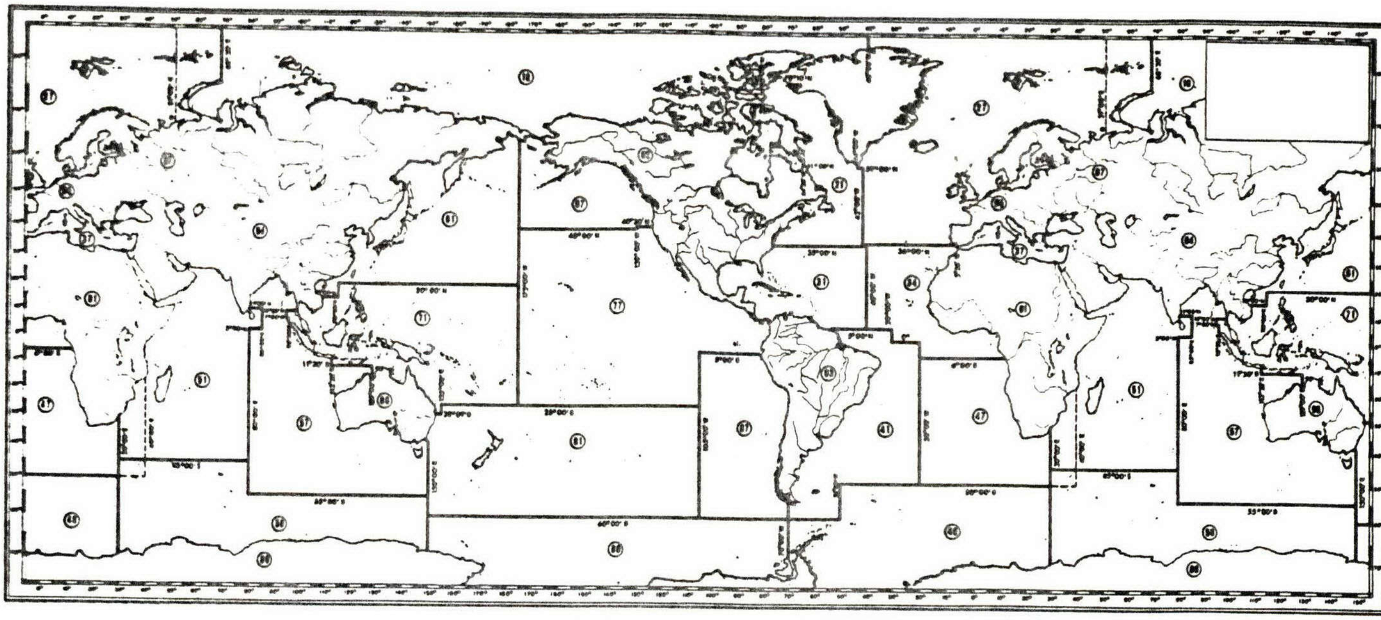
The average annual increase during the 1980's was 3.3 percent. The catch since the 1982-83 El Niño has been well above that average level, suggesting that the expansion of the world catch has not yet begun to level off. The increases since 1982 have come mostly from developing countries, and have been achieved even though many countries, especially in Latin America, have had to scale back government-financed fishery development programs as a result of the world debt crisis. Many developing countries have benefited from commercial joint venture arrangements with distant-water fishing companies which in many cases have limited opportunities in their local fisheries and, as a result, have maintained their involvement in overseas fisheries.

The NMFS Branch of Foreign Fisheries Analysis has prepared this article based on the quantity of fish and shellfish harvested. Some of the conclusions based on catch trends would be radically different if the value of the catch was calculated. The Branch, however, has decided to deal only with the quantities involved.

This decision is based on several factors. First, the collection and assessment of value data is a much more difficult undertaking, and would require a research effort that cannot at this time be justified. Second, value data includes many nonfishery components such as prices, interest rates, and exchange rates. As a result, such a study would often show fluctuations because of a number of economic factors other than developments in the fishing industry.

[1]This report was prepared as a combined effort of the NMFS Branch of Foreign Fisheries Analysis. Dennis Weidner coordinated the project and was responsible for the world trend and Latin American sections. Other contributors included: Milan Kravanja (Soviet and Eastern European sections), Paul Niemeier (Asian, Oceanian, Japanese, and Chinese sections), William Folsom and Michelle Miller (Western Euopean section), Melissa Zajk (Canadian section), and Steve Wilkshire (African section). It is based on preliminary FAO data available in mid 1987. More recent FAO estimates suggest that the 1986 catch may have hit nearly 91.5 million tons.

[2]For the purpose of this study, the Branch had adopted the widely accepted FAO statistical conventions. Catch data is attributed to the flag of the fishing vessels harvesting the fish and not by the national coastal zone in which it was harvested. Thus, Soviet catches off the coast of Angola are considered Soviet and not Angolan catches. The primary source used for these statistics is the FAO, which in turn relies on each individual country to supply national data. The year 1980 was selected as the base year to focus this report on recent catch developments and to limit the amount of statistical data assessed. As appropriate, the authors have referred back beyond 1980 to explain important longer-term trends.



Major FAO fishing areas.

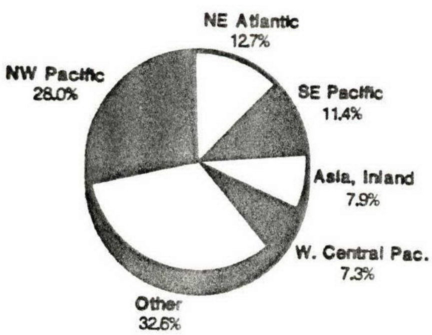


Figure 2.—World fisheries catch by fishing area, 1985.

For these and other reasons the authors have decided to focus this discussion primarily on catch trends. Readers should, however, be aware of the limitations of the data and conclusions presented in this report.

Fishing Areas

The world fisheries catch comes from three main geographic areas (Fig. 2). The two most important areas are located in the northern hemisphere: the Northwest Pacific, FAO area 61, and the North Atlantic, FAO area 27 (see map). Fishermen took about 34.6 million t of fish and shellfish from these two areas during 1985, over 40 percent of the world total and over 45 percent of total marine catch (Table 2)[3]. Both areas have large continental shelves supporting important fishery stocks, but their domination of world fisheries is also due to the fact that most of the major developed fishing countries (Japan, the U.S.S.R., China, the United States, South Korea (ROK), Norway, Denmark, Iceland, and Canada) are located in the two regions. The third major fishing area is the Southeast Pacific (FAO area 87), where coastal upwelling supports the massive fisheries for small pelagics off of Chile and Peru.

Table 2.—World fisheries catch, by principal fishing areas, 1985-86.

Region	FAO fishing area	Catch (10^6 t) 1985	1986	1986 Percentage
Northwest Pacific	61	23.8	24.1	27
Northeast Atlantic	27	10.9	10.8	12
Southeast Pacific	87	9.7	11.9	13
Asia, Inland	04	7.1	7.1	8
W. Cent. Pacific	71	6.2	6.5	7
Others		27.7	29.2	33
Total		84.9[1]	89.6	100

[1]This world 1985 catch figure has been updated by FAO to 85.5 million t (Table 1). The updated figure, however, was not used here as the revised breakdown by FAO area was not yet available.

Table 3.—World fisheries catch by major species, 1985-86.

Species	Catch (10^6 t) 1985	1986	1986 Percentage
Alaska pollock	6.1	6.6	7
Peruvian anchovy	1.0	5.1	6
Japanese sardine	4.7	4.8[1]	5
South American sardine	5.8	4.3	5
Capelin	2.3	2.2	2
Atlantic cod	1.9	1.9	2
Chilean jack mackerel	2.1	1.8	2
Chub mackerel	1.8	1.8	2
Atlantic herring	1.4	1.4	2
Other	57.8	57.0	
Totals	84.9[2]	89.6	

[1]Estimated

[2]This catch figure, published in the FAO "Yearbook of Fisheries Statistics," 1985, has been updated by the FAO to 85.5 million t (Table 1). The updated figure, however, was not used here as the revised breakdown by FAO species group was not yet available.

Species of Fish

Only about eight species are caught in quantities exceeding 1.0 million tons annually (Table 3). The world's single largest fishery in terms of quantity is Alaska pollock, *Theragra chalcogram-*

[3]The 1986 catch by area was not available when this article was written, but the basic pattern is unlikely to change significantly. The FAO data on which this article is based is catch data recorded by the flag of the vessel which caught it and can differ substantially from the area where it is eventually landed.

Table 4.—World catch by major FAO species group, 1980-86.

Name	FAO species group no.	Catch (10^6 t)						
		1980	1981	1982	1983	1984	1985	1986[1]
Small pelagics	35	15.5	17.0	17.9	17.6	19.7	21.2	
Cods	32	10.8	10.7	11.0	11.2	12.3	12.4	
Jacks/mullets	34	7.3	8.0	7.8	8.0	8.5	8.0	
Misc. freshwater[2]	13	5.2	5.5	5.7	6.2	6.5	7.2	
Redfishes	33	5.4	5.3	5.4	5.0	5.5	5.3	
Mackerel/snoeks	37	4.6	4.0	3.8	3.7	4.3	3.7	
Tunas	36	2.6	2.7	2.8	2.9	3.1	3.2	
Shrimp	45	1.7	1.6	1.7	1.8	1.8	1.9	
Others, combined		19.0	20.0	20.7	20.9	21.4	22.0	
Total[3]		72.1	74.8	76.8	77.3	83.1[4]	84.9[4]	89.6

[1]Species group data not available.
[2]Does not include other freshwater species groups: Carps (group 11), tilapias (12), and sturgeons (21); the combined total of these three groups in 1985 was 1.3 million t.
[3]Totals may not agree due to rounding.
[4]These world 1984 and 1986 catch totals have been updated to 83.4 million t and 85.5 million t, respectively in Table 6, but are not to be used here as the revised breakdown by FAO species group was not available.

Table 5.—World catch increase of major species groups, 1980-85.

Name	FAO species group	Changes 1980-85	
		Amt. (10^6 t)	Percent
Small pelagics	35	5.7	45
Other (unspecified)		3.0	23
Misc. freshwater	13	2.0	16
Cods	32	1.6	12
Jacks/mullets	34	0.7	5
Tunas	36	0.6	5
Shrimps	45	0.2	2
Redfishes	33	−0.1	−1
Mackerels/snoeks	37	−0.9	−7
Total		12.8	18

ma, and reported catches of that species totaled 6.6 million t in 1986. Most of the fisheries for these important species were little changed in 1986. The only major shift was a massive increase in the Peruvian anchovy fishery. Fishermen from Peru and Chile reported a 1986 catch of 5.1 million t, more than a 400 percent increase from the 1.0 million t reported in 1985.

North Pacific pollock fishermen reported the only other significant increase (+0.5 million t). Peruvian and Chilean fishermen reported the largest declines, in the sardine (−1.5 million t) and jack mackerel (−0.3 million t) fisheries.

The world catch is composed primarily of three species groups: Small pelagics, cods, and jacks, which had a combined catch of over 40 percent of the world catch for all species in 1985 (Table 4). The single most important group is small pelagics (anchovies, herrings, sardines, etc.) and catches of that group totaled 21.2 million t, nearly 25 percent of the world total for all species. About half of the increase in the world catch since 1980 has resulted from increased catches of these small pelagic species (Table 5). Other important increases were reported for various other marine fish and shellfish (up 23 percent), miscellaneous freshwater fish (up 16 percent), and cods (up 13 percent).

The massive increases of small pelagics is significant because the expansion of these fisheries means that the increase of the world catch has not resulted in a corresponding increase in the production of edible commodities. A large portion of the small pelagic catch is reduced to fishmeal, used principally for animal feed[4]. Catches of all major species groups used for edible products have been increasing at very low rates or have actually declined (Table 5)[5]. It should also be noted that small pelagic fisheries are subject to sharp annual fluctuations. Overall fluctuations may be less likely in the 1980's as fishing effort is now divided over a number of different stocks. In the early 1970's, small pelagic fisheries were centered on a single species, the Peruvian anchovy. The catch of Peruvian anchovy in 1970 was 13.1 million t, 60 percent of the world small pelagic catch of 21.4 million t. Obviously, significant changes in that stock had a major impact on the total world catch of small pelagic species. Catches are now more widely diversified over several different stocks in different areas. The most important small pelagic taken in 1985 was South American sardine, but its catch of 5.8 million t was only 27 percent of the 21.2 million t of small pelagics taken worldwide. Various small pelagic species react differently to climatic changes. Thus, while Peruvian anchovy declined after the 1972 El Niño, stocks of sardine and mackerel increased. Thus, when stocks are more diversified, fluctuations of one species may, to some extent, be offset by countervailing fluctuations of other species.

Developed and Developing Countries

A major shift occurred in the harvest of world fishery resources during the 1980's. Developing countries replaced developed countries as the principal world harvesters of fishery stocks (Fig. 3)[6]. The developed countries have traditionally dominated world fisheries. In 1980, developed countries reported a catch of 38.4 million t, or 53 percent of the world total (Table 6). Since 1980, the developed countries have reported only a modest catch increase of 12 percent to 42.9 million t in 1986. The combined effect of overfishing in the coastal waters of developed countries (primarily in the North Atlantic and North Pacific) and the increasing restrictions, placed by developing countries on distant-water fishermen have limited the recent catch

[4]Eventually, of course, most of the animals are slaughtered for human consumption. so even fishmeal production does increase food production. The increase of poultry and livestock produced, however, will only be a fraction of the amount of fish used to produce the fishmeal.

[5]Cods are the only major species group used primarily for direct human consumption that has increased more than 5 percent since 1980.

[6]The FAO's definition of developed and developing countries is used. The FAO breakdown is detailed in Table A-5 of the 1985 "Yearbook of Fishery Statistics." Data submitted by some developing countries should be considered rough estimates as they are often computed without an extensive data collection system.

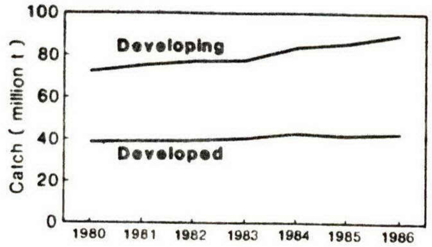


Figure 3.—Fisheries catch by type of country, 1980-86.

Table 6.—World fisheries catch, by type of economy[1], 1980-86.

Year	Catch (10^6 t) Developed	Underdeveloped	Total
1980	38.4	33.8	72.1
1981	39.0	35.8	74.9
1982	39.4	37.4	76.8
1983	40.4	36.9	77.3
1984	42.7	40.7	83.4
1985	41.9	43.6	85.5
1986	42.9	46.7	89.6

[1]Developed and developing countries are identified in Table A5 of the 1985 edition of the FAO "Yearbook of Fishery Statistics."

Table 7.—Catch and industry data for major fishing countries, 1986.

Country	Catch Amt. (10^6 t)	Share[1]	Type of industry
Japan	11.9	13%	Private
U.S.S.R.	11.1	12	State owned
China	7.3	8	State owned
Chile	5.6	6	Private
Peru	5.3	6	Mixed
United States	4.9	5	Private
Korea (ROK)	3.1	3	Private
India	2.8	3	Private
Indonesia	2.5	3	Private
Thailand	2.1	2	Private
Norway	1.9	2	Private
Philippines	1.9	2	Private
Denmark	1.8	2	Private
Korea (DPRK)	1.7	2	State owned
Iceland	1.6	2	Private
Canada	1.5	2	Private
Other	22.6	25	
Total	89.6		

[1]Percentage of the total world catch.

Table 8.—World fisheries catch of major fishing countries by economic organization, 1986.

Type of industry	Catch[1] (10^6 t)	Percentage
Private	41.6	62
State owned	20.1	30
Mixed	5.3	8
Total	67.0	100

[1]Only the catch of the major fishing countries detailed in Table 9 are computed in this table. These countries represent about 75 percent of the world catch.

increases of the developed countries. Developing countries, on the other hand, achieved a catch of 46.7 million t by 1986, or 52 percent of the world total. The 1986 catch of the developing countries was nearly 40 percent over 1980 levels. (From 1967 to 1971 the total catch of the developing countries increased sharply because of massive catches of Peruvian anchovy.) The steadily expanding catch of Chile and Peru and the rapidly expanding fisheries of several developing Asian countries account for most of the increase. Many developing countries, however, have not participated in this expansion. Few African countries, for example, have increased their catch since 1980, even though fish is a critical component of the diet in many of them.

Type of Industry

The economic organization of the major fishing countries varies sharply (Table 7). The two leading countries are classic examples of private (Japan) and state-owned (Soviet Union) fishing industries. Japan's fishing industry is the most modern in the world, efficiently providing food and jobs to Japan as well as tax revenues to the Government. In recent years, however, the Government has increasingly funded programs to assist Japanese fishermen adjusting to the ever tightening restrictions on distant-water fishing. The Soviet fishing industry, only slightly less productive than the Japanese, is markedly less efficient.

A rough estimate of the relative efficiencies of the two countries can be obtained by comparing their fleets. The Soviets, in 1986, reported a fleet of 2,800 fishing vessels totaling 3.7 million gross tons. The Japanese, on the other hand, exceeded the Soviet catch with a much smaller fleet, about 2,700 vessels totaling only 0.9 million gross tons. Precise data are not available on the profitability of the Soviet fishing industry, but it is widely believed that the real cost of the fish produced by the Soviets could not be justified by market-based prices. (An accurate comparison of the two countries would require a much more detailed assessment including differences in fleet deployment, target species, operating costs, markets served, and many other factors.)

The predominant pattern for fishing industries is private companies. Of the 16 leading countries in 1986, 11 with over 60 percent of the world catch had basically privately owned industries (Tables 7, 8). Three countries with 30 percent of the catch had state-owned industries. Only one major fishing country (Peru) had a mixed fisheries economy with ownership by both private and state-owned companies.

Pollution

Environmentalists warn that increasing levels of pollution may adversely affect fisheries production. The United Nations Environmental Program (UNEP) has attempted to address the oceanic pollution problem through its Regional Seas Program, but most observers continue to report rising levels of pollution in the world's oceans. Some small fisheries have been impaired, especially freshwater fisheries and estuarine-dependent coastal fisheries. Marine debris, especially "persistent" plastic materials, is causing increasing mortalities of several marine mammals, sea turtles, birds, and other marine life. Environmentalists, however, have not yet compiled conclusive evidence to substantiate their concerns regarding damage to the major marine fish stocks such as Alaska pollock, capelin, Japanese or Chilean sardine (FAO refers to some sardines as pilchards), or others as a result of marine pollution.

The world fisheries catch has expanded during the 1970's and 1980's despite increasing levels of pollution. Increases have been reported even in heavily polluted areas. For example, the Mediterranean is probably the FAO area most heavily polluted, but catches there increased from 1.6 million t in 1980 to 1.9 million t in 1985. Some observers warn that pollution is affecting fish stocks, but the impact, if any, has so far been masked by other factors. Fish stock abundance has apparently been affected less profoundly by pollution than the combined effects of increasing fishing effort and climatic variations. The effects of these two variables may be masking the more limited impact of pollution on important marine stocks. Considerable caution should be used in using global catch statistics to assess the impact of pollution. Most of the increased fisheries catch since 1980 has come from a small number of small pelagic stocks (Table 5). A thorough examination of the pollution problem would have to assess possible impact on the much larger number of traditional species for which catches have increased only marginally despite substantially increased fishing effort (Table 5).

While scientists have yet to prove that substantial declines in catches of major marine species have been caused by pollution, there is mounting evidence that some marine stocks are being affected. While the catch of cods as a group has increased since 1980 (Table 4), scientists are increasingly concerned over Atlantic cod (Table 3). Atlantic cod catches have declined from 2.2 million t in 1980 to only 1.9 million t in 1985.

Pollution does result in the contamination of some fishery resources. However, concerns over product safety are for the most part limited to freshwater fish and marine or near-coastal species subject to incidental exposure to industrial and agricultural chemicals such as PCB's and pesticides. It should be noted also that many of the species likely to be affected are caught by recreational fishermen and may not be of major commercial importance. Individual countries vary in the extent to which they are alert to these problems. Some countries provide effective consumer protection through the issuance of public health advisories and, if judged necessary, by closure of selected fisheries. Action levels for specific contaminants are set with the added insurance of large safety factors, usually several orders of magnitude.

Table 9.—World fisheries catch by regions, 1980-86.

Region	Catch (10^6 t)							Percent increase 1980-86
	1980	1981	1982	1983	1984	1985	1986	
Asia	30.1	31.5	32.3	34.0	36.0	36.7	38.2	27
Latin America	9.6	10.3	11.4	9.2	12.0	13.6	15.6	62
Europe	12.5	12.5	12.2	12.6	12.9	12.6	12.3	−2
U.S.S.R.	9.5	9.6	10.0	9.8	10.6	10.5	11.1	17
North America	5.1	5.3	5.5	5.7	6.2	6.3	6.6	29
Africa	4.1	4.3	4.1	4.4	4.1	4.1	4.2	2
Middle East	0.8	0.9	0.9	1.0	1.0	1.0	1.0	25
Oceania	0.5	0.5	0.5	0.6	0.6	0.6	0.6	20
Total[1]	72.1	74.9	76.8	77.3	83.4	85.5	89.6	24

[1]Totals may not agree because of rounding.

Geographic Regions

The world fisheries catch is dominated by Asian[7] fisheries (Table 9). Asian fishermen caught 38.2 million t of fish and shellfish in 1986, nearly 40 percent of the total world catch (Fig. 4). The most rapidly growing area, however, is Latin America, and catches in that region, especially in the Pacific, have grown over 60 percent since 1980 (Table 9a), primarily because of steadily increasing catches of small pelagic species by Chile, Peru, and Ecuador. Major developments in each of the important world fishing regions are given below.

Table 9a.—World fisheries catch increase, 1980-86.

Region	Percent increase (1980-88)	Region	Percent increase (1980-86)
Latin America	62	U.S.S.R.	17
North America	29	Africa	2
Asia	27	Europe	−2
Middle East	25		
Oceania	20	World average	24

Asia

Asian countries dominate the world fishing industry, accounting for over 40 percent of the total world catch in 1986 (Table 9). The Asian catch increased by 4 percent over the 1985 catch and has increased by over 25 percent since 1980. One of the most significant developments in Asia during the 1980's has been the steady increase of important aquaculture industries. At first, farmers in developing countries targeted low-valued species for local consumption, but many others increased the production of high-valued species for luxury markets. The most spectacular development has been the massive expansion of the pond-shrimp industry. The Branch estimates that Asian shrimp farmers harvested about 260,000 t of shrimp in 1986, nearly a 400 percent increase from the 55,000 t harvested as recently as 1982. The leading shrimp farming countries

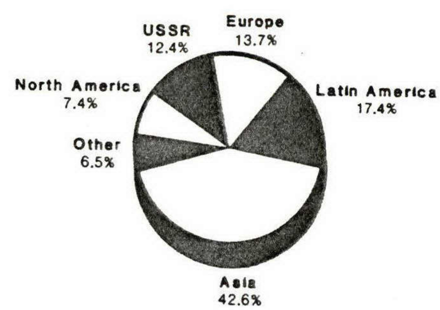


Figure 4.—World fisheries catch by region, 1986; total for 1986 was 89.6 million t.

[7]The Branch has chosen to assess fishery catch developments by continent because of interest in national developments. Such an analysis, however, is not a good way of organizing biological trends, especially for regions such as Asia and Latin America which have coasts spanning two or more oceans. An assessment by ocean region could provide useful insights, but for the purposes of this study this subject has been addressed only briefly. Note also that the following data is calculated on the basis of the flag of the fishing vessel, and not where the fish was caught. In some regions, especially Africa, the regional catch total would be much higher if the catch of the distant-water countries operating off Africa was added to the regional total.

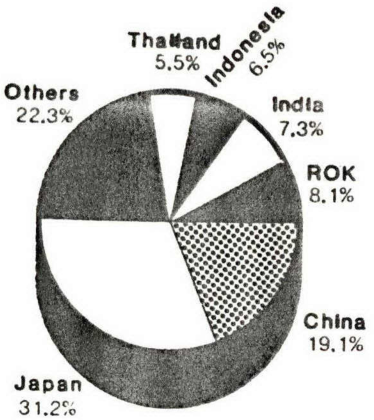


Figure 5.—Asian fisheries catch by country, 1986; total for 1986 was 38.2 million t.

are China, Taiwan, Indonesia, the Philippines, and India.

Japan is the single most important Asian fishing country, but the region's catch is divided among seven other major countries: China, South Korea (ROK), India, Indonesia, Thailand, the Philippines, and North Korea (DPRK) (Fig. 5). Eight of the world's 16 leading fishing countries are Asian (Table 7). These eight countries accounted for 87 percent of the 1986 regional catch. All of these countries, except for Thailand and the Philippines, reported catch increases in 1986. The fishing industry plays a much more important economic role in these countries than is the case for the United States or European countries. In Japan, for example, about half of the animal protein consumed is derived from marine organisms.

Asian countries reported several major developments in 1986. Japan harvested a near record 11.9 million t and reported increased aquaculture production and offshore catches, especially of sardines. China reported steady growth in all sectors of the fishing industry. The 7.9 million t catch increased 7 percent and included impressive increases in marine and freshwater fisheries and aquaculture. Chinese Government officials are projecting a catch of 9 million t by 1990, primarily as the result of increased aquaculture production. The ROK 1986 catch totaled 3.1 million t, an impressive 15 percent increase over 1985 results. Much of the ROK increase was due to the country's expanding U.S. joint venture fishery and entry into the squid fisheries of the North Pacific and Southwest Atlantic. The country's aquaculture industry has also continued to grow steadily.

India's catch of 2.8 million t has changed little since 1984, with most of the marine catch coming from heavily exploited inshore waters. The Indian Government has been trying to promote a deep-sea fishery since 1968, but has had only limited success. Indonesia reported a 1986 catch of 2.5 million t, an increase of 9 percent over the 1985 catch. Indonesia, like India, depends on artisanal fishermen using traditional methods for most of its catch. The 1986 increase was primarily due to the gradual mechanization of the Indonesia fleet, extending its range to more distant coastal fishing grounds. Government officials believe that the country can significantly expand the fisheries catch to as much as 8 million tons.

Thailand and the Philippines both experienced slight declines in 1986. Thai grounds are heavily fished and Thai fishermen are having increasing difficulty maintaining their fisheries off other countries. Filipino fishermen have some of the same problems and may be feeling the effect of using such destructive fishing practices as using dynamite and cyanide. Much of the decline in the Filipino catch is being offset by the steady growth in the country's aquaculture industry.

Latin America

Latin American countries report the world's second most important fisheries catch, representing nearly 20 percent of the world total. Over 80 percent of the Latin American catch is taken in the Pacific. Catches totaled 15.6 million t in 1986, a 15 percent increase over the 13.6 million t taken in 1985. The 15.5 million t total does not include the more than 1.0 million t taken by distant-water countries (primarily the U.S.S.R., Poland, and Japan) off various Latin American countries (primarily Argentina, Chile, and Peru). Latin American catches increased in 1986 to a level approaching the record regional catch levels taken before the collapse of the Peruvian anchovy fishery in 1972.

Two countries, Peru and Chile, dominate Latin American fisheries (Fig. 6). Chile is the leading country with a catch

The Taiwanese Fishing Industry

Taiwan's 1986 fisheries catch totaled a record 1,095,000 t, nearly a 6 percent increase over the 1985 catch of 1,038,000 t. The value of the 1986 catch increased even more (by over 18 percent) to almost $2 billion. The deep-sea fisheries catch, over 45 percent of the total, was nearly 500,000 t. Inshore, coastal, and aquacultural production totaled 276,000 t, 55,000 t, and 266,000 t, respectively.

Taiwan exported 265,000 t of seafood in 1986, valued at $1.2 billion, an increase of 19 percent by quantity and 43 percent by value over 1985 exports. (The large increase in value reflects, in part, the fact that the new Taiwan dollar appreciated by 13 percent against the U.S. dollar in 1986.) Shrimp, eel, and tuna continued to be the three major fishery export commodities, comprising a combined 43 percent by quantity and 76 percent by value of total 1986 fishery exports. Japan was by far the largest purchaser of Taiwan's fishery products, followed by the United States, Australia, Saudi Arabia, Hong Kong, Italy, and the Federal Republic of Germany. The American Institute in Taiwan has prepared a 28-page report on Taiwan's fishing industry in 1986-87 containing a general outline and sections on the fisheries catch, fleet, processing capability, development plans, trade, and international agreements. The report also includes a brief section describing opportunities for U.S. exporters of fishery products and equipment. U.S. companies can obtain a copy of this report for $12.95 plus a $3.00 handling fee (personal check or money order) by ordering report number PB88-209002/GBA from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161.

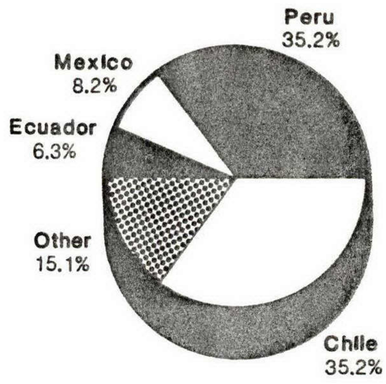


Figure 6.—Latin American fisheries catch by country, 1986; total for 1986 was 15.6 million t.

totaling 5.6 million t in 1986, followed by Peru with a catch of 5.3 million tons. The two countries combined accounted for 70 percent of the regional total. Almost all of the Latin American 1986 increase was the result of increased harvests by these two countries. Over 90 percent of the Chilean and Peruvian catch is sardine, anchovy, jack mackerel, and horse mackerel which is reduced to fishmeal. Peru reported substantially increased anchovy catches in 1986. Anchovy was the mainstay of the Peruvian fishing industry during the 1960's and early 1970's, but had declined to negligible levels in 1985. The Chilean increase was also due to increased anchovy catches, as the sardine and jack mackerel declined. Other important fishing countries in the region include: Mexico (1.3 million t), Ecuador (1.0 million t), Brazil (0.9 million t), and Argentina (0.4 million tons).

A few species dominate the Latin American catch. Latin American countries primarily harvested massive quantities of the reduction species mentioned above. Fishermen also conduct smaller fisheries, but in some cases more valuable ones, for hake, tuna, shrimp, and lobster. A wide variety of other species are caught in smaller quantities.

Several countries reported major fishery developments in 1986. Mexico significantly expanded its tuna industry, and now operates one of the world's most modern tuna fisheries. Ecuador reported record results in its pond shrimp industry which allowed it to become the second most important source of shrimp imported by the United States. Many observers believe that Ecuador may replace Mexico as the major source of U.S. imported shrimp in 1987.

Argentina achieved encouraging results because of a strengthening international market for groundfish, the country's principal fishery, but fishermen reported a declining shrimp catch. Argentine companies complained of increasing competition with the foreign companies operating off the Falklands. The British announced in 1986 that they planned to begin managing fishery resources off the Falklands. Chilean farmers have begun to harvest salmon; while harvests are still small, some observers believe it could develop into an important new fishery. Peru reported a sharp drop in its new scallop fishery, but Panama reported an increase. At the end of 1986, several Eastern Pacific countries began to report a mild El Niño event, but it apparently had little impact on year-end results. The event was centered in waters off Ecuador and northern Peru. Preliminary reports suggested that the 1987 catch of several countries might have been significantly affected.

Europe

European fishermen caught 12.3 million t of fish and shellfish in 1986, making Western Europe the third most important fishing area in the world. European catches, unlike those of many other regions, have remained stable during the past 7 years, ranging from a low of 12.2 million t in 1982 to a high of 12.9 million t in 1984. The major fishing countries are the Scandinavian countries and Spain (Fig. 7).

Eastern Europe

Eastern European countries harvested almost 1.4 million t of fish and shellfish in 1986, or over 35 percent more than in 1970 when the total catch amounted to only 1.0 million tons (Table 10). The most important country is Poland, which harvested 0.6 million t, nearly half of the total for the entire region. The Poles consume about 17 kg per capita of fishery products annually,

Peruvian Fisheries, 1986-87

Peru's 1986 fisheries catch totaled 5.5 million t, a 34 percent increase over the 1985 catch, mostly generated by a 300 percent increase in the anchovy catch. The catch of other major species declined. Fishery exports in 1986 were 780,000 t, an increase of 13 percent, mostly because of increased fish meal production. Fish meal exports accounted for about 8 percent ($200 million) of Peru's total 1986 export earnings. The Peruvian Government, in early 1987, initiated a Fisheries Reactivation Fund aimed at rebuilding the fleet and upgrading the equipment of the artisanal fishermen. The Fund will be financed by a 5 percent tax on the fishmeal exports earnings of the private companies.

The Government plans to increase nontraditional exports, including frozen shrimp and scallops, by making credit available and improving the management of these resources. The Peruvian Government is also promoting domestic consumption of fishery products by creating a state-owned fishing fleet (FLOPESCA) and negotiating joint venture agreements with distantwater-fishing countries. The U.S. Embassy in Lima has prepared an 18-page report reviewing the status of the Peruvian fishing industry in 1986 and 1987. The report covers the 1986 fisheries catch, impact of the fishing industry on the economy, state-owned companies, domestic consumption, modernization of the fleet, fishmeal production, new initiatives (shrimp and scallops), joint ventures (Cuba and the U.S.S.R.), 1987 projections, and implications for U.S. exporters. The report includes statistical tables, with data available up to June 1987. U.S. companies can obtain a copy of the report "Peru: Annual Fisheries Report, 1986-87" for $12.95 and a $3.00 handling fee (total $15.95, personal checks or money orders only) by ordering report PB88-205422/GBA from NTIS, Springfield, VA 22161.

the highest in Eastern Europe. Most of the Polish catch is taken by the country's distant-water fleet which extended its operations in the southern Atlantic. The Poles currently conduct a major fishery for squid and southern blue whiting off the Falklands.

Bulgaria, East Germany (GDR), and Romania also obtain most of their fisheries catch from distant-water operations. Most of the Eastern European catches peaked in 1975 before the extention of 200-mile zones by many coastal countries. The major exception is Romania, whose catch has more than doubled since 1975. Yugoslavia and Albania, unlike the other Eastern European countries with marine coasts, fish primarily in coastal Adriatic waters. Both countries report only small catches. The isolationist tendency of Albania has discouraged the development of a fishing industry. Landlocked Hungary and Czechoslavakia harvest a

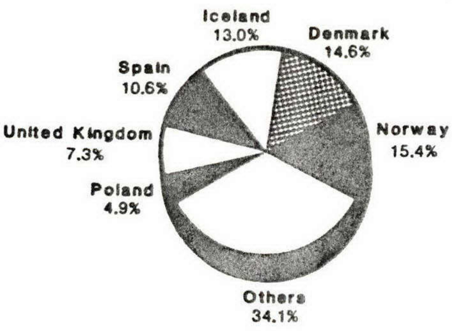


Figure 7.—European fisheries catch by country, 1986; total for 1986 was 12.3 million t.

Table 10.—Eastern European fisheries catch, 1970-86.

Country	Catch (10^3 t) 1970	1975	1980	1985	1986	Population in millions (1986)	Consumption (kg per capita)
Poland	469.3	800.7	640.6	683.5	645.2	37.2	17.3
Romania	58.6	136.6	173.6	237.6	271.1	22.7	11.9
E. Germany (GDR)	321.8	376.2	235.3	197.7	208.9	16.7	12.5
Bulgaria	95.6	158.1	126.4	100.2	109.2	9.0	12.1
Yugoslavia	46.2	56.6	58.4	75.0	77.6	23.1	3.4
Hungary	26.0	30.8	33.7	36.9	36.1	10.6	3.4
Czechoslovakia	13.4	16.9	16.0	19.8	20.7	15.5	1.3
Albania	4.0[1]	4.0[1]	4.0[1]	4.0[1]	4.0[1]	3.1	1.3
Total	1,034.9	1,579.9	1,288.0	1,354.7	1,372.8	137.9	10.0

[1]Estimated

FRG SEAFOOD MARKET, 1986

The demand for fishery products in the Federal Republic of Germany (FRG) has increased from $1.0 billion in 1985 to $1.5 billion in 1986, and could exceed $2.0 billion by by 1990. German per capita consumption of fishery products rose from 11.8 kg in 1985 to 13.2 kg in 1986 because of greater consumption of frozen fish by private households, institutions, and "fast-food" restaurants. In 1986, frozen fish outsold fresh fish for the first time. Purchases of frozen fish products, particularly frozen fish sticks and fish fillets, are expected to continue and to contribute to growth in the German fish consumption.

Landings by the FRG fleet during 1986 decreased to 201,000 t from 229,000 t in 1985. Fishery landings are expected to decline to 185,000 t by 1990 due to the reduction of the fleet, which now consists of 7 fresh fish trawlers and 5 stern factory trawlers. As a result, imports will continue to supply most of the rapidly increasing German demand for fishery products. Fish and seafood imports in 1987 are expected to reach $1.1 billion compared with $0.6 billion in 1985. Imports of fishery products from the United States amounted to only $8 million in 1986. On the other hand, the United States imported $75 million worth of fishery products from the FRG in 1986. The U.S. Consulate General in Hamburg has prepared a 9-page report reviewing the market for fishery products in the FRG. The report includes statistical tables of landings, trade, and consumption, and lists of trade fairs, trade associations, and trade publications. U.S. companies can obtain a copy of "The Federal Republic of Germany's Seafood Market, 1986" for $9.95 and a $3.00 handling fee (total of $12.95, personal checks or money orders only) by ordering report PB88-114582/GBA from NTIS, Springfield, VA 22161.

Fish Consumption Grows in France

French consumption of fresh, frozen, and otherwise processed fish and shellfish during 1984 increased to some 680,000 t, or 11 kg per household. This 4 percent increase continues an upward trend observed since 1979. Sales of frozen seafood increased by 10 percent, while sales of smoked, dried, or salted seafood rose by 4 percent. Of the total fishery market, whole fresh fish represent over half of sales. Particularly important species are whiting, pollock, cod, hake, and sardines. Traditional methods of marketing fish in France (fishmongers, open markets) have given way to dominance by large supermarkets. During 1984, supermarkets handled more than one-fourth of all the whole fresh fish sold in France and 37 percent of the fresh fillets.

Despite steadily decreasing inflation in France since 1982, the average retail price for fish has increased more than 18 percent from 1984 to 1985, due to higher transportation and storage costs. The U.S. Embassy in Paris has prepared a 9-page report reviewing the French market for fishery products during 1984, including data on sales, pricing, and distribution of seafood. U.S. companies can obtain a copy of "The French Fishing Industry, 1984" for $9.95 and a $3.00 handling fee (total $12.95, personal checks or money orders only) by ordering report PB88-114640/GBA from NTIS, Springfield, VA 22161.

small catch from inland waters and growing fish culture operations.

Western Europe

Increases in catches have taken place mostly in Iceland, the Netherlands, and Ireland, while decreasing in Norway, the Federal Republic of Germany, Spain, and Portugal. The decline in the Western European catch was caused by overfishing, stricter enforcement of regulations in the heavily fished European waters, and the loss of traditional distant-water fishing grounds. Of particular concern to many European nations has been the decline in popular species such as Atlantic cod, saithe, and haddock catches in the North Sea. The discovery of rich squid fishing grounds off the Falkland Islands has helped maintain catch levels for the Spanish fleet, which has been particularly hard-hit in recent years. The European Community (EC) is actively seeking new fishery agreements with developing nations around the world which will permit EC vessels to continue fishing.

Table 11.—The U.S.S.R. fisheries catch, 1976-86.

Year	Catch (1,000 t)	Change[1]	
		Tonnage	Percentage
1976	10,121	157	1.6
1977	9,351	-770	-7.6
1978	9,000	-351	-3.8
1979	9,049	49	0.5
1980	9,476	427	4.7
1981	9,546	70	0.7
1982	9,957	411	4.3
1983	9,757	411	-0.2
1984	10,593	836	8.6
1985	10,523	70	-0.1
1986	11,100	567	5.4
10-Year change		+979	+9.7

[1]Change from previous years, in 1,000 t and percentage.

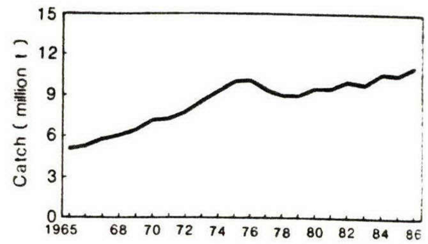


Figure 8.—Soviet Union fisheries catch 1965-86.

U.S.S.R.

The U.S.S.R. is the world's second most important fishing country. The Soviets reported a 1986 catch of 11.1 million t, a 6 percent increase from the 10.5 million t reported in 1985. (This does not include the fish taken by U.S. fishermen and then sold over-the-side to the Soviets. These joint venture purchases provided the Soviets an additional 223,000 t in 1986.) The Soviet Union has invested massively in developing its high-seas fisheries for both economic and strategic reasons.

From a relatively small catch of about 1 million t in the 1920's, Soviet fishermen expanded their operations into all of the world's oceans and harvested over 11 million t of fishery products in 1986 (Table 11). The Soviets first reached the 10 million t harvest in 1975, before most major coastal countries extended their fisheries jurisdiction to 200 miles (Fig. 8). In the years that followed, many coastal fishing countries severely limited (the United States and Canada) or prohibited (the EC) Soviet fishing operations. Soviet fishermen developed a reputation for ruthless exploitation of fishery resources and many coastal countries extended their coastal jurisdiction to 200 miles to protect their coastal resources from Soviet and other distant-water fishermen. As a result, the Soviet fisheries catch decreased by over 11 percent during 1977-78 and did not reach the 10 million t level again until 1984 (Table 11).

The Soviets were much slower than the Japanese in countering the limiting effects of extended jurisdiction by concluding joint-venture and fisheries-assistance agreements. Their state-owned company, Sovrybflot, though ad-

Norwegian Salmon Exports

Norwegian fish farmers seem set to break all previous records in farmed salmon exports. Total exports for 1988 could well outstrip last year's figures by as much as US$166 million, according to the Norwegian Information Service, Norinform. Production and exports have soared so far this year, and the final export figure for 1988 will be between US$500 and 590 million.

First quarter sales figures showed a first-hand turnover of US$107 million, compared with US$67 million last year. Production in the same quarter was 15,625 tons, against 11,720 million tons in the same period last year. Information officer Odd Ustad in the central sales organisation for fish farmers says that favorable temperatures have stimulated growth, and that the major disease problems appear to be under control. Demand in the markets is high, with France retaining its first place as recipient of Norway's farm salmon.

Norwegians Target Antarctic's Krill

Three Norwegian firms are planning to harvest the bountiful supplies of krill in the Antarctic to sell to the United States, Great Britain, and Japan, according to the Norwegian Information Service. Millions of dollars will be invested in projects which are scheduled to be under way as early as autumn 1988, when giant factory ships will move south to start the fishing.

The high-protein, shrimplike krill can, according to Norwegian sources, be eaten plain, ground into forcemeat, or served as krill "sticks." It can also be used as a coloring matter for other foods such as trout, salmon, and sausages. Furthermore, krill oil, rich in polyunsaturates, could be useful to the pharmaceutical industry, as a possible rival to cod liver oil, Norinform reports. About 200-250 tons of krill per day is believed a realistic target and the Norwegians believe that there will be no danger of depleting the enormous resources for "many years." However, they also warn that if the supplies of krill, the main food of seabirds and whales, were to be threatened, the entire ecological balance of the oceans could be disrupted.

ministered by capable and experienced managers, was saddled with numerous regulations and bureaucratic inefficiencies that are so prevalent in Soviet operations with foreign companies. This may change now that former Minister of Fisheries (V. M. Kamentsev) was appointed by General Secretary Gorbachev to become not only a member of the Soviet Council of Ministers, but also Chairman of the Federal Foreign Economic Commission. In this latter capacity, Kamentsev will oversee and determine the policy of joint ventures with foreign countries and companies.

One important trend in Soviet fisheries since 1980 has been an increasing reliance on coastal waters. Soviet catches in coastal waters (FAO areas 18, 27, and 61) totaled 6.7 million t in 1985, a 30 percent increase over the 5.1 million t reported in 1980. All of the increase has occurred along the Soviet Pacific coast as catches along the heavily fished Atlantic and Barents Sea coast have declined and catches along its northern Arctic coast are negligible. The Soviets have also shifted their fishing industry from the Atlantic to the Pacific (Fig. 9). Soviet fishery harvests (by FAO fishing area) have changed greatly during the last decade. In 1975, the Soviet Atlantic catch (5.0 million t) was more than twice the Pacific catch (2.2 million t). By 1985, this relationship had totally changed and the Soviet Pacific catch, at 6.2 million t was 50 percent larger than the Atlantic catch of 4.1 million t (Table 12).

The Soviet Atlantic catch has decreased in all regions, except the Southeast Atlantic (FAO area 47) off Namibia and Angola where the Soviets operate under the International Commission for Southeast Atlantic Fisheries (ICSEAF) regulations. In the Northwest Atlantic (FAO area 21), the Soviet catch has declined over 1.0 million t between 1975 and 1985 as the United States and Canada extended their fisheries jurisdiction to 200 miles and severely reduced distant-water fishing. In the Northeast Atlantic (FAO area 27) the Soviet catch has declined another 1.2 million t because of declining stocks and the fishing regulations enforced by the European Community (EC) and several

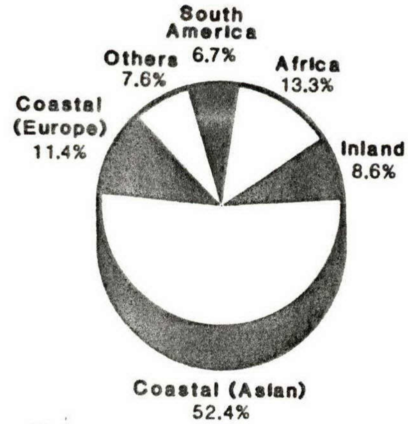


Figure 9.—Soviet Union fisheries catch by area, 1985; total for 1985 was 10.5 million t.

coastal countries. The Soviet fishery in that area is now limited to the Barents Sea and international waters between Iceland and the Svalbard Islands. Worried by a tottering resource base and the Soviet penchant for relentless overfishing, the EC has permitted no Soviet fishing since extending their coastal zone to 200 miles in 1977.

In the Western Central Atlantic (FAO area 31), the Soviet catch has always been small and proved such an economic burden that they abandoned it in 1977. The Soviets, however, retain a vessel repair and transshipment operation in Havana, Cuba. In the Eastern Central Atlantic (FAO area 34), the Soviets conduct one of their most important distant-water operations aided by bilateral agreements with several African countries and by fishing in the coastal waters of several countries with which they have no such agreements. Few African countries have effective surveillance and enforcement capabilities.

In the Pacific, the largest Soviet fishery has historically been conducted off their own coasts and the adjacent waters of the Bering Sea and Northwest Pacific (FAO area 61). The catch in this area has doubled during the past 10 years, but it remains greatly, and possibly dangerously, dependent on a single species, the Alaska pollock. The Soviet pollock catch, amounting to 3.3 million t in 1985, or 30 percent of the entire Soviet catch in that year. It is landed in Siber-

Table 12.—U.S.S.R. fisheries catch for selected years by major fishing areas, 1970-85.

Fishing grounds	FAO area	Catch (1,000 t)			
		1970	1975	1980	1985
Inland waters	7	855	944	753	906
Black Sea	37	303	350	391	345
Atlantic					
Northwest	21	812	1,167	108	133
Northeast	27	1,566	2,406	1,984	1,239
W. Central	31		69		
E. Central	34	613	1,166	942	708
Southwest	41	421	9	28	71
Southeast	47	423	421	825	698
Subtotal		4,993	6,532	5,031	4,100
Indian Ocean					
Western	51			37	32
Eastern	57				1
Subtotal				37	33
Pacific					
Northwest	61	1,448	2,719	3,196	5,462
Northeast	67	748	573	59	11
W. Central	71			4	10
E. Central	77	20	31		1
Southwest	81		45	70	66
Southeast	87			552	624
Subtotal		2,216	3,368	3,881	6,174
Antarctic					
Atlantic	48			424	188
Indian Ocean	58			103	28
Pacific	88				
Subtotal				527	216
Grand total		7,209	9,900	9,476	10,523

Source: FAO "Yearbook of Fishery Statistics," various years.

ian ports and then primarily shipped by rail to population centers in the western part of the country where it is marketed to Ryba and other retail stores. Few other Pacific grounds are important to Soviet fishermen, except for the Southeast Pacific where the Soviets fish outside the 200-mile zones of Peru and Chile. Efforts to gain access to coastal waters failed when the Allende Government fell in Chile during 1973 and when the Peruvians refused to renew joint venture agreements in 1985.

In the Antarctic, the Soviets have attempted to initiate a krill fishery, and catches reached a record 0.5 million t in 1982. The operation, however, proved difficult and costly, and Soviets had difficulty marketing krill products. Catches declined sharply in 1983 and in 1985 totaled only 0.2 million tons. The Soviets announced in late 1987 some technical innovations which they believe will make it easier to process krill. If successful, these innovations may justify an increase in Antarctic fishing effort in coming years.

In the Black Sea and inland waters, the Soviet fishery has stagnated. The Soviet Union has the potential to become a major producer of cultured fish, yet inland fisheries and cultured production have actually declined in recent years.

North America

The North American catch totaled 6.6 million t in 1986, a 5 percent increase over the 6.3 million reported in 1985. Data on the U.S. and Canadian fish catch are illustrated in Figure 10. Geographically, Mexico is located on the North American continent, but for sociological reasons, the Mexican catch has been included in the Latin American totals.

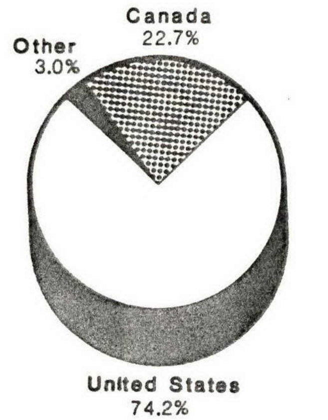


Figure 10.—North American fisheries catch, 1986; total for 1986 was 6.6 million t.

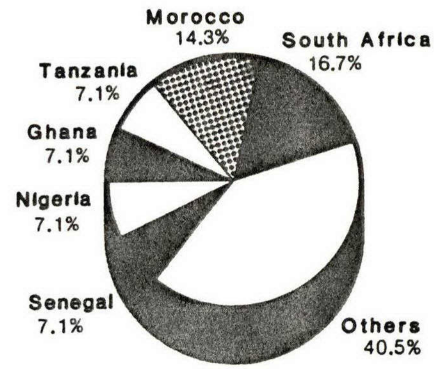


Figure 11.—African fisheries catch, 1986; total for 1986 was 4.2 million t.

United States

The U.S. fish catch hit 4.9 million t in 1986, a 2 percent increase from the 4.8 million t reported in 1985[8]. While the overall catch increase was not large, specific fisheries exhibited some sharp fluctuations. Catches of Alaska pollock, shrimp, and crab increased, but catches of other important species such as menhaden, Pacific salmon, and cod declined. A variety of resource and marketing problems caused most of the declines. The salmon catch declined after records set in previous years, but 1986 was still above normal.

Canada

Canada's fisheries catch is slowly recovering, following a period of decline caused by heavy fishing off Canada's Atlantic coast. During 1986, Canadian fishermen caught 1.4 million t of fish and shellfish, an increase of 16 percent over the 1.2 million t caught in 1980. Canada's most important fishing grounds lie off the Atlantic coast, contributing 1.2 million t, or two-thirds of the total catch. Top groundfish and pelagic species landed in 1986, by quantity, were Atlantic cod (457,000 t), Atlantic herring (177,000 t), various flatfishes (85,000 t), redfish (75,000 t), and capelin (65,000 t). The top mollusk and crustacean species, by quantity, were scallops (56,000 t), snow crab (42,000 t), and lobster (35,000 t).

The International Court of Justice decision to award the disputed rich fishing grounds off Georges Bank to Canada (prior to this decision, both the United States and Canada were allowed to fish in the contested area off of Georges Bank), strict enforcement measures on fishing by domestic and foreign fleets in Canadian waters, and rigid management plans imposed on the stocks, have helped to increase Canadian catches in recent years, although many stocks remain depressed. Despite lower catches, the value of Canadian fishery landings has helped produce record incomes for Canadian fishermen, thanks to the strong demand for fishery products in the United States and on world markets. In 1986, the Canadian catch was valued at almost C$1 billion.

Africa

The African fisheries catch has fluctuated between 4.1 and 4.4 million t since 1980. The 1986 catch was 4.2 million t, up slightly from the figure reported in 1985. African countries report a very small part of the world fisheries catch. In 1986, the African catch comprised only 5 percent of the world total, down 6 percent from 1980. The decline is a result of expanded fisheries in other areas, while African fisheries have experienced little growth. African catch data, however, do not include the extensive distant-water catch of the Soviet Union and other countries off the continent. The distant-water catch in 1985 totaled about 2.8 million t, which comprises about one-third of the total catch taken from African waters.

Seven countries (South Africa, Morocco, Tanzania, Ghana, Nigeria, Senegal, and Uganda) comprised nearly 60 percent of the 1986 African catch (Fig. 11). South Africa and Morocco are the two most important countries, and they accounted for about 25 percent of the African total, with 1986 catches of 0.7 million t and 0.6 million t, respectively. In 1985, Cape hake accounted for about 25 percent and anchovy about 40 percent of the South African catch; presumably, the composition of the 1986 catch is similar. In 1986, the sardine fishery supplied over 40 percent of the Moroccan catch, with mackerel accounting for nearly 20 percent. The remaining five countries each had 1986 catches in excess of 0.2 million tons each. South Africa's catch was stable, increasing by only 1 percent in 1986. Morocco's 1986 catch increased 25 percent, primarily because because its leading fishery for sardines increased an

---
[8]The preliminary U.S. catch data reported by FAO differs from "Fisheries of the United States, 1986," primarily because FAO calculates the live weight of mollusks while the United States calculated only the weight of the edible meats.

impressive 50 percent, according to statistics supplied by Morocco's Institute Scientifique des Peches Maritimes.

Middle East

Middle Eastern fishermen reported a catch of only about 1 million t in 1986. The small Middle Eastern catch is probably a combination of limited resources and lack of interest in developing the available resources. While small by world standards, the 1986 Middle East catch represented an increase of 25 percent over the 0.8 million t taken in 1980. Most of that increase occurred by 1982 and since then the catch has been stable at about the 1 million t level. The leading country in the region is Turkey, with a 1986 catch of 0.6 million tons. The Turkish catch has increased by nearly 35 percent from the 0.4 million t reported in 1980. European anchovy and horse mackerel made up about 70 percent of the catch in 1985.

Oceania

Fishermen in Oceania reported a catch of about 0.6 million t in 1986. The two major fishing countries are New Zealand (0.3 million t) and Australia (0.2 million t). New Zealand fishermen have reported steady growth since the early 1970's and achieved a new record catch in 1986. Much of the recent increase has come from expanding fishing effort to offshore fisheries and by careful management of the heavily fished coastal resources. Australian fishermen reported catch declines in 1985 and 1986. New management measures enacted to protect heavily fished stocks account for much of the decline.

Major Countries

World fisheries are dominated by 16 major countries which accounted for 75 percent of the catch in 1986 (Table 7). The two leading countries were Japan (11.9 million t) and the Soviet Union (11.1 million t). Other leading countries included China (7.3 million t), Chile (5.6 million t), Peru (5.3 million t), and the United States (4.9 million t). All have reported catch increases since 1980. The Soviet and Japanese increases are interesting as both countries heavily fish their own coastal waters and have also had to adjust to restrictions on their distant-water grounds by many coastal countries. The large increases reported by Peru and Chile were primarily due to a resurgence of the anchovy stock. While most of the principal fishing countries have reported catch increases in 1986, a few countries have reported declines: Norway (−10 percent), Iceland (−6 percent), and Thailand (−5 percent). The Norwegian trend in particular continues a trend begun in 1978. Major fishery developments in Japan, China, Chile, and Peru follow (U.S.S.R. developments were reported in a previous section).

Japan is the world's leading fishing nation, harvesting over 11.9 million t in 1986 (12.6 million t according to preliminary Japanese Government statistics), 13 percent of the world's catch. The 1986 catch is nearly a 4 percent increase over the 1985 catch of 11.5 million t and is second only to Japan's all-time record catch of 12 million t in 1984. Japan's catch has remained relatively stable since 1983, averaging about 11.7 million t annually.

Increasing enforcement of foreign 200-mile exclusive economic zones has kept Japan's distant-water catch fluctuating around 2.1 million t since 1979, with little possibility for growth. This factor has forced Japan to reevaluate its fishing strategy and to begin to fully develop its offshore and coastal resources, take a renewed look at aquaculture, and seek new fishing agreements with other countries. Although coastal production remained stable in 1986, marine culture and offshore fisheries grew by 9 percent and 5 percent, respectively. Sardines accounted for the largest increase in Japan's 1986 catch. Japanese fishermen caught about 4.5 million t, 9 percent more than in 1985. Sardine harvests in the waters off eastern Hokkaido and northern Honshu (both in the Sea of Japan and the Pacific) increased significantly in 1986. Other important species were Alaska pollock (1.4 million t), and Spanish mackerel (955,000 t); skipjack tuna registered the largest percentage increase in 1986, up 34 percent to 420,000 t.

China is the third largest fishing

Iceland's Fish Catch Steady, Value Climbs

Iceland's fisheries catch reached 1.7 million t in 1986, slightly less than Iceland's record 1985 catch. The value of the catch increased from $312 to $458 million. The cod catch again proved plentiful (366,000 t vs. 323,000 t) and the shrimp harvest rose by 44 percent from 25,000 t to 36,000 t, while the capelin catch (used mostly for reduction) declined from 993,000 t to 895,000 t. Large catches, high world prices, low oil prices, and a relatively low rate of inflation made 1986 a prosperous year for the Icelandic fishing industry. The debate over the pros and cons of fresh fish sales to Western Europe continued as representatives of the freezing industry expressed concerns over declining supplies of raw materials to meet demand for processed fishery products, mostly in the United States.

The U.S. market declined to 25 percent of the value of total Icelandic fish exports in 1986, while the continued growth in Icelandic sales to the United Kingdom makes it Iceland's most important market. The U.S. Embassy in Reykjavik has prepared an 11-page report reviewing Iceland's fisheries in 1986. The report includes sections on Iceland's fish, catch, the debate over fresh versus frozen fish sales, the growth of the United Kingdom market, foreign fishing in Icelandic waters, and the outlook for 1987. The report also includes statistical tables on Iceland's fish catch and how it is utilized, exports of fishery products by destination, exports by product form, exports to the United States, and Iceland's fishing fleet and number of fishermen. U.S. companies can obtain a copy of "Iceland's Fisheries, 1986" for $9.95 and a $3.00 handling fee (total of $12.95, personal checks or money orders only) by ordering report PB88-114566/GBA from NTIS, Springfield, Virginia 22161. (The handling fee is per order, regardless of how many reports are ordered.)

nation in the world, behind the Soviet Union, with a catch of over 7.3 million tons in 1986. The Chinese reported steady growth in all sectors of its fishing industry in 1986. The marine fisheries catch increased by 12 percent, to 3.9 million t. Principal marine species caught were croaker, hairtail, filefishes, mackerel, and shrimp. Equally spectacular growth was recorded by the freshwater fishery sector (+12 percent to 530,000 tons), marine aquaculture (+12 percent to 797,000 t), and freshwater aquaculture (+24 percent to 2.9 million t). Although China is a relative newcomer to high-seas fishing, its distant-water fleet has grown from about a dozen vessels fishing off West Africa in 1985 to over 30 fishing in the economic zones of seven countries by the end of 1986.

Despite this development, the prognosis is not overly optimistic for continued growth of China's marine fisheries sector. China's 1987 marine fisheries catch was expected to remain about the same as the 1986 catch. Chinese Government officials have predicted that fisheries production would reach 9 million t by 1990, with most of the increase coming from aquaculture. The breakthrough is expected to come in marine farming, with an estimated growth rate of over 11 percent per year. Major cultured marine species will include giant sea perch, shrimp, abalone, clams, mussels, scallops, sea cucumbers, and kelp. The main species used in freshwater culture are carp and tilapia.

Chile is the fourth most important fishing country with a 1986 catch of 5.6 million t. The fishing industry has been the fastest growing sector of the Chilean economy over the past 10 years. Officials were relieved that the 1986-87 El Niño did not adversely affect the 1986 catch, but were concerned about declining catches in 1987. Catches of the two most important species over the past few years (sardines and jack mackerel) declined in 1986, but were more than offset by increased anchovy catches. Most of the catch is reduced to fish meal, and Chile has become the world's leading fish meal exporter. Most companies are reporting good results, even though fish meal prices were substantially below 1980 price levels in constant dollars. While the large fish meal companies reported good results, Chilean fishermen reported declining catches in several traditionally important fisheries (shrimp, sea snails, sea urchins, langostinos, and several other valuable shellfish) in 1986. Other fishermen reported several promising developments in 1986, including expanded harvests of cultured salmon, small-scale surimi production, increased krill landings, and expanded landings of high quality fresh fish for the export market.

Peru was the fifth leading fishing country in 1986 with a catch of 5.3 million t. Peruvian fishermen reported a massive 25 percent increase over their 1985 catch. The increase was primarily due to the resurgence of anchovy stocks. Fishermen in northern Peru were affected by the 1986-87 El Niño beginning in late 1986. Fishermen along the central and southern coast did not begin to report catch declines, however, until mid-1987. (It is not known to what extent the declining 1987 catches in Peru and Chile were due to El Niño or other factors such as overfishing.) While the El Niño was affecting 1987 catches, most of Peru's reduction plants and canneries reported substantially improved results for 1986. The Government gave special priority to efforts aimed at increasing the catch of edible fish to increase supplies to the domestic market. An agreement was signed with Cuba to permit Cuban distant-water trawlers to operate in Peruvian waters and land their catch in Peru. The Government also provided funding so that the state food fish company, the Empresa Publica de Servicios Pesqueros (EPSEP), could acquire its own fishing fleet. Even though catches increased sharply, several long-standing problems plagued the industry in 1986, including labor strife, unused canning capacity, the inability to reach an agreement with the Soviets on joint ventures, high interest rates, low fish meal prices, and a sharp decline in scallop catches.

Aquaculture

While some have predicted that aquaculture, sometimes referred to as the "blue revolution," would rapidly replace wild capture fisheries (which many expected to decline), this has not proven to be the case. Capture fisheries have not declined, nor has aquaculture begun to account for more than a small share

---

Atlantic Canada's Aquaculture Industry

Atlantic Canada's 33 commercially viable fish farms produced 1,800 t of mussels, 500 t of salmon, and 110 t of trout in 1986. The leading province in Atlantic Canada's aquaculture industry is Nova Scotia (11 farms), followed by New Brunswick (9 farms), Prince Edward Island (6-8 farms), and Newfoundland (5 farms). In 1986, these aquaculture facilities generated about C$9 million and it is projected that this amount could be increased 30 times in 10 years.

Many Canadian fish farmers are short on working capital and technical knowledge. Provincial governments have limited themselves to providing technical aid, but not funding. Future expansion of aquaculture facilities is expected to be opposed by homeowners living near potential aquaculture sites. The region has limited access to processing facilities and the severity of Canadian winters are factors that need to be examined before Atlantic Canada's aquaculture industry can meet its full potential. The U.S. Consulate General in Halifax has prepared a 9-page report reviewing Atlantic Canada's aquaculture industry. The report includes sections on the scope of the industry, aquaculture legislation, funding programs, public opposition, technical problems, and comments. The report also includes list of Federal and provincial legislation in the field of aquaculture. U.S. companies can obtain a copy of "Atlantic Canada's Aquaculture Industry, 1986" for $9.95 and a $3.00 handling fee (total of $12.95, personal checks or money orders only) by ordering report PB88-114574/GBA from NTIS, Springfield, VA 22161. (The handling fee is per order.)

of the world's fisheries production. The combined total of cultured production and freshwater fisheries was only 8.4 million t in 1985, about 10 percent of the world total[9]. For the foreseeable future, fishermen will be able to catch most species in larger quantities and more cheaply than fish farmers will be able to culture them. Fish farmers have, however, reported some successes. The greatest commercial successes have come from efforts to culture high value species for luxury food markets. Efforts to culture salmon and shrimp have been particularly noteworthy. The Branch of Foreign Fisheries Analysis estimates that fish farmers harvested about 70,000 t of salmon and 310,000 t of shrimp in 1986. While small in quantitative terms, these are particularly valuable species and many observers believe that production will increase far beyond current levels. Other fish farmers have reported success with catfish, trout, mullet, oysters, and mussels. Experimental work is currently underway on a wide range of other species. In some cases, however, fish farmers will not increase the total world supply of food. Many fish farmers, for example, use low-value fish to feed the species which they are culturing. The operation is profitable, but may not result in a net increase of edible commodities. Several developing countries have pursued projects to culture tilapia, carp, mullet, and various other species. Some of these projects have resulted in increases of edible commodities. Increases in carp and tilapia catches and Asian catches of a wide variety of freshwater species suggest that aquaculture is gradually increasing the production of edible fish in developing countries, although statistical data separating aquaculture and freshwater fisheries is not readily available.

Potential

The world potential fish catch of edible species has been debated for some years. One widely accepted—although not undisputed—estimate in the world fisheries community, is that the world catch will continue to increase until about the year 2000 when it could total 100-120 million t of conventional species, a figure that many experts believe is the approximate maximum world yield. These estimates may have to be revised. If current trends continue, the 100 million t figure could be reached as early as 1990. However, several Latin American countries have reported declining catches in 1987, principally due to El Niño. Year-end results for the entire world may be about the same as or a small decline from 1986 figures.

Projections of future fish catches, however, are tenuous at best. A wide variety of factors will affect actual increases: Fuel prices, interest rates, national management and development measures, fish prices, technological developments, interest rates, and other developments. Many biologists currently believe that conventional stocks will not support catches significantly beyond the 120 million t level.

Further increases could, however, come from species not currently being utilized. If profitable ways of utilizing Antarctic krill, for example, could be developed, the world catch could expand significantly beyond the 100-120 million t level. Some experts have projected that an intensive krill fishery could double or triple the world catch, but more recent assessments have been more conservative. The 1985 krill catch was less than 0.2 million tons, mostly taken by the Soviets who have been

[9] Precise data on cultured harvests are not readily available, but the Branch believes that a rough estimate of aquaculture trends can be obtained by following catch trends in inland areas reported by FAO.

The Latin American Shrimp Culture Industry

Latin America is a leading world producer of cultured shrimp. Shrimp farmers in the region harvested over 50,000 t of shrimp in 1985, a 40 percent increase over the 37,000 t of shrimp cultured in 1985. Ecuador dominates the region's shrimp culture industry—nearly 85 percent of the Latin American harvest was produced in that country. The industry continues to expand in Ecuador and is rapidly growing in several other countries as well. Prospects for the development of important shrimp culture industries are especially good in Brazil and Colombia.

Ecuador reported major increases in pond harvests during 1987. Several other countries also reported substantial, if less spectacular, 1987 harvests. Based on these increases and continuing expansion of the industry, the NMFS Branch of Foreign Fisheries Analysis conservatively estimates that the cultured shrimp harvest in Latin America could reach nearly 115,000 t by 1990. That projection is based primarily on one country (Ecuador) and one species (*Penaeus vannamei*). As more countries enter the industry and technical advances enable farmers to increase yields and perhaps use different species of shrimp, it is likely that production will continue to increase during the 1990's. Many observers are unsure, however, about the impact of rising world production on the international shrimp market. If substantially lower prices result from the increased production, profit margins could be significantly affected. If so, many farmers may have to adjust their production and expansion plans.

The NMFS Branch of Foreign Fisheries Analysis has prepared an 80-page report reviewing the current status of the shrimp culture industry in Latin America. The report covers: harvest levels, the regional importance, traditional fisheries, quality/size control, species, government support, postlarval seedstock, variables (economic, technical, environmental, and political), investments, and a separate section on each country. The report includes extensive statistical appendices on harvests and exports and is a slightly updated version of the Latin American section in the U.S. Department of Commerce's "Aquaculture and Capture Fisheries: Impact in U.S. Seafood Markets," published earlier in 1988. U.S. companies can obtain a copy of "Latin American Shrimp Culture Industry, 1986-90" for $14.95 and a $3.00 handling fee (total $17.95, personal checks or money orders only) by ordering report PB88-210745/GBA from NTIS, Springfield, VA 22161.

reducing fishing effort in recent years.

Even within existing catch levels, the production of edible products could be substantially increased. Production of edible products from fisheries could be expanded by better utilizing existing catches. About 30 percent of the catch is currently used for reduction fisheries producing fish meal and oil. Animal feed, of course, is not lost to human consumption as most of the animals will be slaughtered for food. The amount of protein available, however, would be increased if the fish were consumed directly instead of being used for fish meal production. Perhaps as much as 10 percent of the world catch is lost as a result of poor handling and processing procedures. Many fishermen discard large quantities of unwanted fish at sea. Suggestions concerning utilization of fish currently reduced to fish meal, landing species currently discarded, improved handling, and other measures to increase food production are often presented in unrealistic terms. They must be tempered by economic reality. Processors must be able to produce a product that will appeal to consumers at affordable prices. (Source: IFR-87/63.)

Argentine Fisheries See Good Growth

Argentine fishing companies reported an excellent year in 1986. Higher international prices and the emergence of Brazil as a major buyer in the third quarter of 1986 were crucial factors in Argentina's improved 1986 export performance. Argentine fishery exports totaled $219 million in 1986, an 110 percent increase over the $104 million exported in 1985. Several long-term difficulties still plagued the Argentine fishery industry in 1986: An outdated fleet, limited port facilities, outmoded processing plants, and inefficient infrastructure, all of which prevented an even better performance. The Argentine Government has instituted some assistance programs for the fishing industry. Several companies were able to put vessels back into service during 1986 by taking advantage of a new credit line offered by the Argentine Development Bank which was designed to promote the renovation of the fleet. The Government also signed fishery agreements with Bulgaria and the Soviet Union which, it hopes, will result in export sales to the Soviet Union and Eastern Europe.

The U.S. Embassy in Buenos Aires has prepared a 24-page report reviewing the current status of Argentina's fishing industry. The report includes sections on landings, industry performance, economic conditions, foreign fishing, port facilites, fishing fleet, markets, and production. The report also includes extensive tables, including data on catch, exports, biomass, maximum sustainable yields, and fleet. There is also a list of Argentine fishery associations. U.S. companies can obtain a copy of "The Argentine Fishing Industry, 1986" for $11.95 and a $3.00 handling fee (total $14.95, personal checks or money orders only) by ordering report PB88-114475/GBA from NTIS, Springfield, VA 22161.

Open-Sea Salmon Farm Is Started off Norway

What Norwegian authorities describe as the world's first fish farm for salmon in the open sea, began operation in late April to the west of the island of Værøy, one of the Lofoten Islands off north Norway. The small fry have to be set out in June, and the first artificially cultivated deep sea salmon should be on the market next year, reports Norinform.

The development of the farm, budgeted at US$670,000, was planned in cooperation with industry in north Norway, and based on the technology used in the offshore sector. The depth of water at the farm will be more than 100 m, and waves up to 13 m in height have been measured at the location. The plant has therefore been dimensioned to tolerate wave heights up to 22 m. The facilities will comprise 20 enclosures firmly anchored to the seabed by heavy weights, and totalling 23,000 m^3, vs. the normal coastal farm size of 8,000 m^3. A ship anchored at the plant will steer operations.

The initiators took advantage of the fact that the location of the farm is outside the 4-mile concession limit. A spokesman for the Ministry of Fisheries has stated that the ministry may consider changes in legislation so that farms outside normal 4-mile limits also must comply with regulations. Free access for the establishment of fish farms in open sea conflicts with the intention of the law, which is to regulate such establishments out of consideration to public interests, says Gunnar H. Gundersen of the Ministry of Fisheries.