PART I
THE EXPERT CONSULTATION

1. OPENING OF THE SESSIONS

The Expert Consultation to Examine Changes in Abundance and Species Composition of Neritic Fish Resources was held in San José, Costa Rica, 18–29 April 1983. The sessions were attended by fifty-eight participants from eighteen countries and various regional and international organizations. A list of participants is given in Appendix 1. All participants attended the Expert Consultation in a personal capacity.

The opening ceremony was chaired by the Minister of Agriculture and Livestock of the Government of Costa Rica, Mr. Francisco Morales Hernandez, who inaugurated the Consultation and gave the opening speech on behalf of the host country. Dr. Armin H. Lindquist, Director of the Fishery Resources and Environment Division, FAO, gave the opening speech on behalf of the Director-General of FAO.

2. BACKGROUND OF THE EXPERT CONSULTATION

This Expert Consultation was one of the preparatory meetings for the FAO World Conference on Fisheries Management and Development, and was also a contribution to the Programme on Ocean Sciences in Relation to Living Resources adopted by the Intergovernmental Oceanographic Commission.

The Expert Consultation was organised by FAO with the support of: Intergovernmental Oceanographic Commission (IOC), Permanent Commission for the South Pacific (CPPS), Danish International Development Agency (DANIDA), International Center for Living Aquatic Resources Management (ICLARM), International Commission for the South East Atlantic Fisheries (ICSEAF), Inter-American Development Bank (IDB), Action Committee for Seafood and Freshwater Products of the Latin American Economic System (SELA), United Nations Educational, Scientific and Cultural Organization (Unesco) and World Meteorological Organization (WMO).

It is unlikely that such a collection of experts, most of them involved in basic and applied research relevant to the problems of fishery and related environmental sciences, and others involved in management, social and economical aspects of fisheries, could have been convened at a more appropriate time. The 1982–83 “El Niño” phenomenon was in full stride while the consultation was taking place, thus reinforcing everyone's concern about environmentally-induced resource fluctuations, and the need to understand and forecast these types of event.

Floods in Ecuador, northern Peru, Polynesia and U.S.A.; droughts in Indonesia, Philippines, Australia, New Guinea, Africa, southern India and southern China; unprecedented changes in fish populations throughout the Pacific basin and in seabird populations together with their stress-induced behaviour all became front-page news around the world. What had been considered a local phenomenon mainly affecting living marine resources off the northwestern coasts of South America became generally recognised for what it really is: an atmospheric-ocean phenomenon in the eastern equatorial Pacific, linked to major global-scale climatic perturbations, which affects the lives of many people throughout the Pacific basin and elsewhere around the world.

The latest “El Niño” phenomenon and other recent events which have affected the climate and biological production over extensive areas in the Atlantic and the Pacific Oceans have had a remarkable impact on the views of many fishery scientists and fishery administrations with regard to neritic fish resources, what to expect from them, how to investigate and monitor their fluctuations, and how to effectively manage their fisheries.

New concepts and alternative methods are needed to properly deal with fisheries and fishery resources which are high variable, clearly affected by environmental changes, and for which the conventional fishery monitoring systems and available measuring techniques can only provide short-term and limited space-scale forecasts, which result in a reduced number of possible management options usually limited to very short-term reactions.

Why do neritic fish resources vary? What is the role played by the environment in these fluctuations? What is the role of fishing? How intra- and inter-specific relations affect the stability of neritic fish resources? What are the short- and long-term effects of these fluctuations? What should be done to enable timely detection of major environmentally-induced changes in neritic fish resources? And, if major resource changes are imminent, what could fisheries management do to prevent failure of the fishery and its impact on the national economy and society? These are just some of the leading questions that motivated FAO to organise and convene this Expert Consultation.

This meeting was also a timely follow-up to the many related regional or topical symposia, workshops and research programmes which had been channelling the attention of the scientific community toward a more comprehensive approach to fishery sciences, particularly to fish resources variability, its causes and consequences. Some scientific events which more directly influenced this consultation were: Symposium of the International Council for the Exploration of the Sea (ICES) on the Assessment and Management of Pelagic Fish Stocks, held in Aberdeen in 1978 (Saville, 1980); analytical phase of the joint Canadian-Peruvian ICANE (Investigación Cooperativa de la Anchoveta y su Ecosistema) research project which culminated with a scientific workshop held in Callao in November 1979 (IMARPE, 1981); FAO Workshop on the Effects of Environmental Variation on the Survival of Larval Pelagic Fishes, held in Callao in 1980 (Sharp, 1981); and IOC Resolutions XI-17 and XII-1, adopted in Paris in 1979 and 1982 (IOC, 1980 and 1983), which provided the stimulus for giving appropriate consideration to the topic of Ocean Sciences in Relations to Living Resources (OSLR) in the international context.

At an early stage in the preparations for this Expert Consultation it became clear that a multidisciplinary approach was essential in order to properly address the problems of highly variable fish resources. There was a need to assemble the experiences gained in several important neritic fisheries of the world and to cover several fields of interest ranging from fishery biology to resource evaluation, fishery management, oceanography, meteorology, sociology, economy, industry and finance; and this was one of the main criteria for choosing most of the participants in this consultation. After selecting such an heterogeneous and highly specialised group of experts, it was encouraging to note that there was no problem whatsoever in communication during the consultation, facilitating an easy and very active exchange of experiences which it is hoped will continue. The impossibility of having more of the front-line fishery researchers and managers was regretted, but facilities and time were limited. In any case it was felt that the fisheries community would appreciate the efforts of those who had the opportunity to contribute in extending our knowledge and abilities to measure, monitor and assess the impacts of the various system perturbations on fishery resources and, thus, on human activities.

3. OBJECTIVES OF THE CONSULTATION

The central theme of the consultation was the variability of neritic fish resources; their changes in abundance, species composition, distribution, behaviour, productivity, etc.; their causes and impacts on fishery and fishery related human activities. The specific objectives of the consultation were:

- to document the changes that have occurred in each region, in the environment, in the abundance and distribution of fish populations, and in the fisheries, including societal and economic effects;
- to identify the objectives of decision-makers and document how these were affected by changes in fish resources;
- to provide an opportunity for comparison between regions, and to establish the similarities and differences, as a basis for improved understanding of the events in each individual region;
- to promote the inter-disciplinary study of the neritic systems, bringing together experts in the fields of oceanography and meteorology, basic biology, fishing industry, resource assessment and monitoring, and fishery management;
- to increase the understanding of the general processes involved in the dynamics of neritic fisheries, which might lead to improved ability to predict significant changes in the system, hence allowing more time and options for the decision-making process;
- to provide a better scientific basis for the development of a management strategy which would take account of the best current knowledge as well as the possibility of large-scale changes in the natural system.

4. ORGANIZATION

The Expert Consultation took place in two phases: the first week was characterised by symposium-type sessions where individual background and review papers were presented and discussed; and the second week consisted of working sessions of four working groups set up to review and discuss specific topics and to produce the draft versions of the four reports of the Expert Consultation presented in this volume. The agenda and time-table of these two-week sessions are given in Appendix 2.

The introduction to the first week of technical presentations was made by J. Csirke and G.D. Sharp, FAO Fishery Resources Officers and Technical Secretaries of the consultation. This included a global review of the scale and magnitude of landing variations of major neritic fisheries of the world, as well as some overall views of symptoms and responses of changing ecosystems. This was followed by individual presentations and discussion of fifty-three papers and by an informal round-table discussion on objectives of fishery management and decision-making processes. This informal round-table was chaired by M.H. Glantz and comprised various interest groups available among the participants, i.e. industry scientists, international investment bank representatives, fishery managers, multinational fish buyer-processors, social scientists, and fishery biologists. Short statements were made on the kinds of information each considered to be important for their specific decision-making, which were followed by comments and questions from the other participants. This produced a broader dialogue, emphasised some of the conflicts of interest characterising the different factions involved in fishery decision-making, and provided stimulus for many participants in choosing their own emphasis in the working groups for the following week.

A list of the documents submitted during the sessions of the first week is given in Appendix 3. All papers are published in full and/or in summarised form in the Proceedings of the consultation. The regional reviews describing environmental and resource changes and related fishery responses are published in FAO Fisheries Report No. 291, Volume 2; while papers providing localised and comparative studies, papers on impacts on human communities, and papers on application of methods and theory are published in the FAO Fisheries Report No. 291, Volume 3. A short summary review of the first week's technical presentations and discussions is also given here to provide readers of this volume with some essence of the basis of the discussions during the first part of the consultation. A full account of the results of the working sessions during the second week is given in the reports of the four working groups, which are included in full as main chapters of this volume.

5. SUMMARY REVIEW OF TECHNICAL PRESENTATION

The Technical Secretaries of the Expert Consultation opened the presentations to the technical sessions by introducing general topics of environmentally-induced changes exhibited by living marine resources in neritic environments, and the fishery, science and management problems which present themselves as these resources respond in various ways to the continuous barrage of natural and man-induced environmental changes.

The term neritic refers to the portion of the sea lying above the continental shelf; therefore all fish populations which are found and can be exploited in the marine habitat shoreward of the 200 m isobath can be categorised as neritic fish resources. This encompasses most of the highly productive fisheries of the world, and allows the inclusion of species with riverine, estuarine, lagoon or even oceanic life history phases, but which are fished primarily in the shallow margins of the sea, around islands or large areas like the Seychelles-Mauritius plateau, and enclosed seas such as the North Sea-Baltic complex or the South China-Sulu-Banda-Arafura Sea region. The latter resembles more a large estuary in species composition than an ocean-adjacent sea, and in most fishery contents is quite unlike many of the other broad shelf areas.

Figure 1 gives an equal-area review of the global distribution of neritic habitats in relation to land masses and also gives forty important riverine inputs which provide nutrients and nursery or feeding habitats for a large proportion of neritic fishery resources.

There is obviously more to fisheries catch than just shelf area in each country, and the importance of cultures, environmental features and accessible markets which are too often neglected, were also pointed out as major determinants of fishery evolution and of limitation to development.

During the overall habitat description, reference was also made to the always important early life history processes which set the long and very short term opportunities and abundance potentials for each species and, subsequently, for their fisheries. The relative importance of climate-ocean properties to local and regional zoogeographic characteristics was also emphasised. Long-term climatic, larger-scale changes are reflected in general north-south movements of the boundaries between tropical, temperate and boreal habitats. The transition zones are quite important features, with strong annual and inter-annual variations which are reflected in changes in species' compositions on those time scales when measured from specific geographic contexts. Transition zone fisheries exhibit the widest variations.

Reference was made to changes presently occurring in fisheries science, and particularly to the extended recognition that fish stocks do not live in isolation but form part of a larger ecological system, which have motivated part of the fisheries science community to reassess their conventional approaches for the purpose of reclassifying fishery resources into categories that more appropriately describe their expected patterns of variation and responses to system perturbations, and in order to investigate alternative management, monitoring and assessment techniques. Some of these concepts were discussed and several examples were presented at the end of the introduction by the Technical Secretaries, and some questions were posed about the underlying premises of conventional fishery assessment methods; one of the most important being whether it was possible to manage a fishery on a sporadically-peaking resource in such a fashion as to increase the long-term catch and decrease the short-term losses (often due to over-capitalisation and optimistic decision-making based on other than fishery and biological concerns).

The contributions from Japan, California, Peru and other eastern boundary current systems, and from the North Sea and the north Atlantic fisheries were particularly important in addressing this question and in documenting relevant fishery related changes and responses.

An informative example of the complexities observed in neritic fish resources as composition of species changes was provided by Kawai and Isibasi. From Figure 7 of their paper it is interesting to note that in different fisheries around Japan, the relative oscillations of each species increased with

increased fishery landings during the early 1950's. Kawasaki also showed (Figure 1 of his paper) the catch pattern of three Pacific sardine species for the period 1900 to present, which speaks clearly for an underlying natural cause of the blooms, peaking and general return to very low levels of these resources. It is unfortunate, but quite evident, that current assessment and management methods cannot explain the bloom phase or manage fishing in a way that would sustain the peak period. In fact it is less a fishery management problem than was previously assumed, and the specific states in such a cycle where management intervention might be appropriate are well described in the reports of the working groups included in this volume.

Specific examples of oceanographic and meteorological variations directly related to system productivity, fishery changes or early life history successes or failures were described in the majority of the presentations. The topics of some more specific papers ranged from fishery independent variations in abundance to seasonal dependence of monsoon-dominated fish spawning cycles. Documented changes in species' composition due to species' interactions, predation and competition in the man-induced perturbations of the Great Lakes' systems, along with the specifics of the relatively successful rehabilitation of these once-threatened environments and their present inhabitants, were also described. In addition, short and long-term climatic and meteorological changes inducing fishery related changes in resource populations were discussed, tracing their respective ocean-wide or local-scale effects on fisheries.

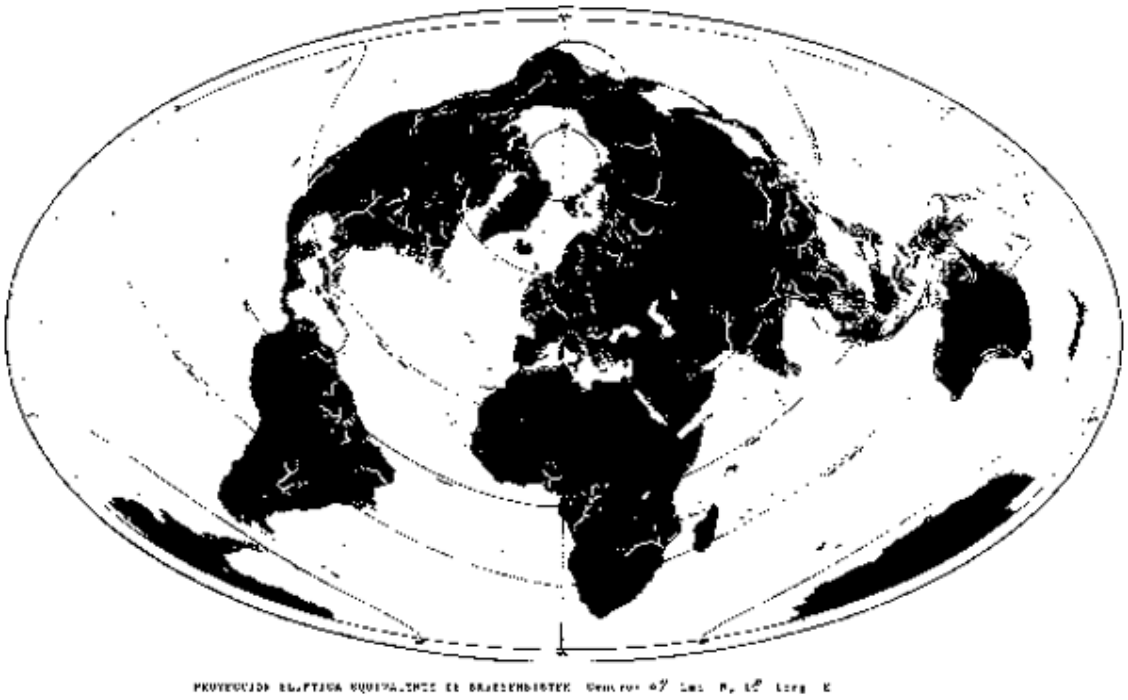

Fig. 1. Distribution of the world's neritic habitats in relation to the land masses and forty important river inputs

The consultation brought together the available expertise on eastern boundary current fisheries and oceanography, and their contributions alone form an invaluable collection of historical perspective, system description and comparisons of these, the world's most volatile and productive fishery systems. Several of the papers presented dealt with the eastern boundary current systems and their dominant anchovy, sardine, horse mackerel, hake, mackerel and bonito faunal complexes, thus extending the information available for an analogy of the type proposed by Bakun and Parrish (1980). Parrish, Bakun, Husby and Nelson reviewed and compared physical oceanography and fish reproduction of the four major eastern-boundary-current systems: California current, Peru current, Canary current and Benguela current. Their comparisons show that the four systems have superficial similarities related to seasonal latitudinal shifts of the atmospheric

pressure systems of the sub-tropical transition zone and the relations between these and the continental topography.

There are also obvious system differences. For example, the minimum layer of oxygen off Peru is very shallow compared to that of the other three systems, and effectively excludes significant competition of mesopelagic species with those from above the thermocline-oxycline. In each system there are areas of intense wind-driven mixing which seem to be avoided by the pelagics, and the spawning grounds appear to be characterised by weak to moderate wind strengths, supporting Lasker's (1978) mechanism inducing survival (or destratification related mortality) of larval engraulids and other species. It was also pointed out that the spawning grounds of the major populations in these systems tend to be located downstream (equator-ward) of upwelling centres, and that smaller populations are supported pole-ward of the major upwelling centres, or in areas where upwelling is seasonal and spawning occurs when circumstances reduce the effects of offshore transport and mixing of the surface layers by the wind. In areas where other water-column-stabilising features are found, such as in the Columbia River plume area off the northwestern coast of the U.S.A., anchovy populations may take advantage of these and spawn out of phase with the other populations in the system. Larval fish transport processes are usually related to gyres in the systems but, as noted by Shelton and Hutchings (1982), off the southernmost tip of Africa, between Cape Agulhas and Cape Columbine, there is a coastal jet current which transports larvae from spawning areas to onshore nursery grounds.

Three types of fishery resources were identified in relation to the four major eastern boundary current upwelling areas:

a. Stocks pole-ward of the local summer upwelling maxima (with total potential yields of 100 000 to 400 000 tons per year);
b. stocks equator-ward of the summer upwelling maxima (with total potential yields of 800 000 to 2 000 000 tons per year); and
c. stocks equator-ward of winter upwelling maxima (only in Peru, with total potential yield in excess of 10 000 000 tons per year).

One of the objectives of this consultation was to examine the effects of varying fishery resources on various sectors of society: fisherman, communities, investors, industry interests, governments, scientists, etc. A detailed description of specific, documented responses to the fishery collapses in eastern boundary current systems, with particular reference to the Peruvian fishery, was provided by Glantz. His review considered the individual's, the state's and international perspectives. Several falacies or mythologies in applied fishery science were also addressed in this review.

The rehabilitation procedures of the Great Lakes were reviewed in an informal presentation by Magnuson, who introduced the concept of users and losers. The relative risks and socio-economic considerations relative to various characteristic fishery resource types were described by Beverton, who also discussed the role of scientists in international fishery management, and the general deterioration of related fora since their politicisation over the last decades.

The informal round-table on fisheries management and decision-making was held in the middle of the first week. It was initiated by a brief statement by the appointed chairman and by statements or comments from the other panel members, after which the floor was open to all participants for questions or comments. This gave rise to very interesting discussions which provided useful arguments for discussion during the working sessions of the following week.

The remaining sessions of the first week were devoted to specific research topics related to variations in parameters of interest to traditional conventional resource assessment, or to presently evolving multispecies and ecosystem approaches to resource monitoring and management. Evidence was presented for variations in growth rates; natural mortality or survival rates; distribution of eggs, larvae and adults on inter-annual and annual time-scales on distances as limited as a few hundred miles within a specific fishery population. The wisdom of employing

constants in assessments in lieu of monitoring these variables was explored. Also certain indicators of stress were identified. For example, it was noted that anchovy populations from both the Peru and Benguela current systems somehow presaged environmental perturbations like the “El Niño”. This has been shown by changes in fish reproductive behaviour and oil content, which are usually observed months or seasons prior to environmental phenomena being observed by man.

The problems of monitoring adequately such variations in complex fishery systems were discussed and the scales relevant to various important processes were defined. Finally, the first week's discussions were brought to a close with a summarisation of the various life history parameters, their variations and the relevance of certain procedures which have become rituals in stock assessment, in lieu of more informative and more empirical approaches to interpreting historical information. Considerable discussion was evoked and further development of ideas and queries about where specific approaches were appropriate, and where they were not, brought the consultation to a point where better understanding of the problems proposed in the introductory session was possible. Given a specific fishery, operating in a general system context: What were the major perturbing factors? What roles do man's activities play? and what specific measuring and monitoring methodologies would be necessary to adequately resolve the management alternatives available in order to sustain viable fishery resources and substantial, beneficial fisheries in the face of varying environmental conditions?

6. WORKING GROUP SESSIONS

Four major topics that reflected the available expertise at the consultation were chosen as a basis for setting up four working groups which met during the second week. These major topics were: resource studies and monitoring; environmental studies and monitoring; societal implications of varying fishery resources; and management implications and interactions.

A.D. MacCall was appointed chairman of the Working Group on resources study and monitoring (Working Group No. 1); A. Bakun was appointed chairman of the working group on environmental studies and monitoring (Working Group No. 3); M.H. Glantz was appointed as chairman of the working group on societal implications of varying fishery resources (Working Group No. 2); and J. Csirke was appointed chairman of the working group on fisheries management, implications and interactions (Working Group No. 4).

The chairmen of the four working groups were given the task of extracting relevant topical information from the presentations and discussions of the first week. They then opened the sessions of the second week with overview presentations of each of the above topics, followed by questions and discussions in plenary. The four working groups were then formed and scheduled in such a way as to allow a certain degree of interaction.

Each working group produced a draft report illustrating the results of its discussions, and conclusions and recommendations where applicable. These draft reports were presented and discussed in plenary at the end of the consultation, and are presented in final form here.

These four working group reports reflect the main results of this Expert Consultation. They address the problems associated with fish resource variability from different perspectives and contexts, and offer substantial directions and specific recommendations where appropriate. An important consideration while reading these reports is that they progress generally from consideration of single species fishery contexts in the biological section to wider context. The environment section necessarily incorporates physical, chemical and biological (predator and prey) considerations. The societal and, finally, the management implications sections address the more complex, but usually even less measured or monitored, human and political interactions.

In reading these reports, it is imperative to recognise that the sea, without man's influence, varies and that all resources in the sea are finite. Man is only one more very efficient predator, who at present is barely capable of effectively manipulating his own harvests.

7. REFERENCES

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