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# MARINE SCIENCE AND TECHNOLOGY: SURVEY AND PROPOSALS

## Report of the Secretary-General

## Corrigendum

Annex XI, Part B

Replace all of part B by the attached text, renumber the paragraphs and make the corresponding changes in the table of contents.

GE.68-10951

## B. FAO and related organizations[1]

1. FAO, being concerned with world food supplies, human nutrition, and the well-being of rural communities, is responsible, within the United Nations family, for activities related to the development of fisheries. These responsibilities are executed through its Department of Fisheries, which came into being on 1 January 1966. From the time of FAO's foundation there had existed a Fisheries Division within its structure, and the creation of the new Department resulted from the decision of the 13th Session of the FAO Conference (1965) to upgrade the fisheries activities of the Organization with the intention of approximately doubling the available funds over the six-year period from 1966 to 1971. The overall functions of the Department have been defined generally as:

> "...promoting national and international action with respect to the development of the world's fisheries and the rational utilization of the living resources of marine and inland waters, especially to raise levels of protein nutrition generally, and also standards of living of fishing communities".
>
> Specific functions include:
>
> "Ensuring, through appropriate intergovernmental machinery, consultation and co-operation in the field of fisheries in regard to fishery problems of an international character," and
>
> "Assisting Member Governments with advice on fishery development-planning and research policies; on the assessment of living marine and inland aquatic resources; on their protection and development; on the maintenance of stocks at optimum level of yield; on marine and inland fishery biology, fish culture and environment studies; on problems of exploitation and fishing operations; on fishing vessels and gear technology; on the application of science and technology to fishery development work; on fishery economic analysis; on fish handling, processing, preservation, products development, marketing and distribution problems; on industrial development; on fishery institutions, co-operatives and credit; on statistical services, statistics and economic data; on fishery administration and services; and on education and training".

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(1) The following description has been prepared on the basis of the 1968 report by FAO to the ACC Sub-Committee on Marine Science and its Applications, the FAO Programme of Work and Budget, 1968-69, and documents of the FAO Committee on Fisheries.

The Department of Fisheries of FAO, which is headed by an Assistant Director-General, comprises two divisions, and also four departmental "service" offices. The Fishery Resources and Exploitation Division, apart from its Inland Fisheries Branch, is almost wholly concerned with promotion and application of marine science and technology in relation to the living resources of the sea and to their harvesting. The Fishery Economics and Products Division is also concerned with the technology, as well as the economics, of the utilization of the harvest, as well as with provision of basic statistical services required for assessments of the size and condition of the resources (see appended Structural Diagram). The Regular Budget of the Department is now currently of the order of $2.2 million annually (plus "common service" and related costs covered by the budgets of other Departments of the Organization, and which are estimated as just under $1 million). Of this sum perhaps two-thirds is devoted to activities considered to fall within the scope of General Assembly resolution 2172. The Department of Fisheries budget represents about 15 per cent of that for the technical and economic programmes of the Organization as a whole, which is itself about one half of the total regular programme budget. In addition FAO at present executes marine fisheries projects financed by UNDP, and to a lesser extent from other international funding sources, to a total annual budget of the order of $8.5 million (excluding national counterpart contributions the total of which exceeds this sum by about 25 per cent). The greater part of this latter expenditure is attributable to marine scientific and technological activities, including the survey and appraisal of fishery resources and related oceanographic and other research. Just under 90 per cent of this sum pertains to UNDP(SF) projects; the rest to UNDP(TA), FFHC and miscellaneous trust funds.

3. A second aspect of the recent strengthening of FAO Fishery activities was the creation, also in 1966 of the Inter-Governmental Committee on Fisheries (COFI) under Article V of the Constitution. COFI consists of senior fishery officials representing thirty-four States members of FAO, which are elected by the FAO Council. It meets annually (1st session in June 1966) to review the work programme of the Department of Fisheries, to consider fishery problems of an international character, and to promote international co-operation in fisheries.

Its sessions are attended also by observers and representatives from other nations and from international fishery organizations and bodies and in its activities it is instructed to supplement rather than to supplant those other bodies. COFI has established a sub-committee on the development of co-operation with international organizations concerned with fisheries, and has also taken the problems of education and training in the field of fisheries, appraisal of resources, and marine pollution, as meriting urgent attention.

4. FAO has established under its constitution a number of intergovernmental regional bodies concerned with marine fisheries. These are:

The Indo-Pacific Fisheries Council (IPFC) - established 1948 - 18 member countries
The General Fisheries Council for the Medn.(GFCM) " 1952 - 17 " "
The Southwest Atlantic Fisheries Advisory Comm.(CARPAS) 1961 - 3 " "
The Fishery Committee for the Eastern Central Atlantic (FCECA) - established 1967 - 15 " "
(as at 18.3.68)

The Indian Ocean Fishery Commission (IOFC) - established:
1967 - 20 member countries
(as at 18.3.68)

FAO provides the secretariat and operating funds for these bodies. In addition FAO took responsibility for the negotiation of a convention for the establishment of the International Commission for the Conservation of Atlantic Tunas (ICCAT,1966).

5. The current programme of work of FAO in the field of fisheries reflects directives of the FAO Conference "to meet the urgent world-wide need to identify and develop new sources of food, especially of high quality protein". It has been formulated in the light of the conclusions of the first session of COFI which

> ".... drew attention to opportunities open to Member Nations for the rapid development of the world's marine and inland fisheries and the need for assistance from FAO in this regard; and emphasized that this would involve an increased degree of international co-operation, alike in formulating and in carrying out co-ordinated programmes of exploration and research, and also in ensuring the rational exploitation of each resource, especially in international waters, to the end that each is utilized to its maximum productive capacity and maintained there". (Programme of Work and Budget, 1968-69).

In this same document the objectives of the Department of Fisheries in promoting and recommending appropriate national and international action with respect to fishery development are described as being pursued

".... by closely integrating its Regular Programme, with the extensive operational field programmes. The Regular Programme provides the technical competence necessary to execute large and complex regional and country fishery development projects, which have already led to increased investment; provides basic information, through the Indicative World Plan and other activities, which assists Member Nations in framing their development and research policies in the field of fisheries; and, finally, covers all the actions necessary to carry out recommendations of the Committee on Fisheries in strengthening international co-operation.

In 1968-69 work is being intensified within the limits of available resources on training, statistics, marketing, inland fishery development and fish culture, marine pollution, the productivity of the tools of production (vessels and gear), exploration and assessment of fish stocks and improvement of marine and inland fishery resources, and economic aspects of resources management; a world appraisal of fishery resources has been launched, and other more specialized resource studies ...."

6. The scope of the problems with which FAO is concerned is illustrated by the fact that world production of fish, mainly from the oceans, has grown from less than 20 million tons annually in 1948 to over 50 million tons in 1965, and this growth is continuing. The rate of increase, which so far has more than kept pace with the rise of the world human population, has been maintained largely through the bringing under exploitation of more of the known stocks of fish over a wider area of the globe. Much the greater part of the total marine catch, by weight and value, is taken from waters beyond national jurisdictions or from stocks part of which inhabit high seas areas or which spend a significant part of their life cycle in such areas, and which are therefore accessible to, and exploited by, several nations. Furthermore, 40 per cent of the total catch, or the products from it, enter international trade, and this trade is valued at nearly $2500 million annually. In producing the increased harvest known fishing methods have been applied and adapted in new situations, extensive explorations undertaken on an ad hoc and on a systematic basis, as well as investigations directed to better utilization of a wider range of types of fish and other organisms. In addition, research has led to development of new methods of catching and of loacting and detecting fish. At the same time the tremendous increase in fishing activity, by more nations operating at greater and greater range, with larger and more mobile and adaptable vessels

"... has greatly intensified the problems of overfishing and the need for regulation and management, if fish is to continue to play an increasingly important part in supplying the world's protein needs. As recently as 1949, the only overfished stocks were those of a limited number of high-priced species, mainly in the North Atlantic and North Pacific. Of some 30 important stocks then believed to be underfished, about half are now in need of proper management. The urgency of proper international management is underlined by the industrial practice of moving from an overfished stock to other underexploited stocks, for within another 20 years very few unexploited stocks accessible to present types of fishing gear will remain.

The problems of overfishing, which arise because in general fishery resources have no ownership, are more complex when many countries are concerned in a fishery or when more than one species are caught. Biologically, it is necessary to understand the population dynamics of the stock, to measure the effect on the stock of changes in fishing, and to make quantitative assessments of the probable effect of regulatory measures on the stocks and on future catches. From the economic standpoint, the aim of regulation is to secure the best use of resources in terms of larger or cheaper supplies of fish for the consumer and better incomes for the fishermen".

7. The above quotation is taken from the special FAO study on "The Management of fishery resources" published in "The State of Food and Agriculture - 1967" where it is further pointed out that:

"Depletion of many of the most valuable fish stocks through the development of modern catching vessels and techniques has effectively disproved the old belief that the living resources of the sea were inexhaustible. On the other hand, restrictions on fishing activities brought about by war have indicated that the process of stock depletion can be reversed, and that by proper management policies stocks can build up again and be held at commercially attractive levels. In the absence of management, the industries exploiting overfished stocks have tended to turn to other more distant and less immediately attractive stocks. Although there are substantial stocks of fish which are still unexploited, these are generally species of small commercial value or species which are difficult to catch with present methods and equipment. Consequently in the absence of a technical breakthrough making the harvesting of new types of resource economically feasible, the present rate of expansion of world fish production is unlikely to be maintained for more than 10 to 15 years. It follows that the proportion of the total catch coming from heavily exploited stocks that are in need of proper management will rapidly increase."

8. Against this rather pessimistic picture must be put the positive aspects that:

(a) International management of fishing, can lead to maintenance of yields at much reduced cost;

(b) Within a management regime it is possible further to reduce costs and permit the continued and economic exploitation of reduced stocks by application of science and technology;

(c) Again, within a management regime, it is feasible to increase, by cultivation methods, the natural productivity of at least some of the marine resources - or even to create new ones - but this requires initially much more research in a wide range of scientific disciplines, as well as pilot studies; and

(d) Although the natural sustainable yields from resources of the types presently exploited are not likely to be more than, say, two to four times the present annual harvest, nevertheless very large harvests indeed, of a higher order of magnitude altogether, could be taken from populations of other, mainly smaller, organisms such as the Antarctic krill, squids, small oceanic fishes etc., provided effective mass catching methods can be developed and the catches economically utilized.

9. FAO's programme with respect to marine resources is based upon the above analysis. In this respect the essential needs for the promotion and application of science and technology are recognized, and directed to the following specific principal objectives:

(a) Reviewing the status of present knowledge of marine fishery resources in order to assist in the evolution of fishery policy and to identify gaps in knowledge as a guide to future national and international research programmes and actions;

(b) Better international exchange of scientific and technical information pertinent to fishery research and development;

(c) Improvement of the methods of research and of analysis and interpretation of data, and where desirable the inter-calibration and standardization of techniques;

(d) Investigation, protection and improvement of the marine enviornment;

(e) The training of fishery scientists and technicians;

(f) The improvement of fishing gears, methods and vessels through research;

(g) Improving the safety and efficiency of fishing operations through imparting technical knowledge to fishermen and providing services to them;

(h) Promoting, through fundamental studies, as well as broader application and adaptation of known methods, the better utilization of present types of catches; and the future utilization of new kinds of resources;

(i) Ensuring the existence of intergovernmental mechanisms to deal with fishery problems on a regional basis, and the provision to them of appropriate scientific and technical advice;

(j) Assisting developing countries in making fuller use of fishery resources accessible to them by arranging for collection and analysis of pertinent data, helping in the establishment of national institutions so that they may continue to meet national research needs, and also participate in and draw benefit from international activities.

Some recent and current examples of actions taken by FAO towards these objectives are summarized in the following paragraphs.

10. The "World Appraisal of Fishery Resources" (9a) is undertaken as an integral part of the Organization's "Indicative World Plan for Agricultural Development" (IWP). Projections of future yields, likely or potential, for the dates 1975 and 1985 are being made by staff in consultation with groups of experts, regional fishery organizations, governments and associations of scientists. The work is being done on the initiative, and under the general guidance, of the Advisory Committee on Marine Resources Research (ACMRR). This Advisory Committee, consisting of fifteen experts appointed annually by the Director-General in their individual capacities, was established in January 1963. It plays the key role in advising FAO on all aspects of marine fishery investigation, and also is advisory to the IOC under UNESCO on the fishery aspects of oceanography. The ACMRR conducts its work to a large extent through subsidiary working parties of experts on particular subjects, which also contribute effectively to the implementation, as well as the formulation, of these aspects of the work programme of the Department's Fishery Resources and Exploitation Division.

11. A similar, but much more specialized, function to that of the ACMRR is performed by the Expert Panel for Facilitation of Tuna Research (and its sub-Panels) which was established in June 1964 following a recommendation of the FAO Scientific Conference on the Biology of Tunas and Related Species, held in July 1962. This latter, and other world conferences such as those on sardines and related species (in September 1959) and on Shrimp and Prawn Biology and Culture (in June 1967) have summarized knowledge of particular kinds of resources, clarified research problems, and identified research needs. FAO has taken the responsibility and borne the costs for preparing and conducting such conferences, publishing the proceedings, and taking many of the follow-up actions on their recommendations. Such world conferences commonly follow one or more specialized regional symposia, especially

those convened under the auspices of a regional fishery council or commission. In other cases world conferences are convened by other authorities and with FAO participating.

12. Contributions to understanding of resource problems as a whole within particular areas are made by regional conferences or symposia. Some of these are convened by FAO regional fishery commissions and councils, but recently important joint actions have been taken in co-operation with the UNESCO/IOC and other bodies, and covering enviornmental studies and marine science broadly; examples are the UNESCO/FAO/OAU Symposium on Oceanography and Fishery Resources of the Tropical Atlantic (Abidjan, 1966) - at which were evalued the results of both OAU's "Guinean Trawling Survey", and the IOC's "ICITA" Co-operative expedition - and similar symposia in 1968 on the Caribbean and the Kuroshio regions in which FAO is co-operating with UNESCO in support of activities related to IOC projects.

13. In addition to symposia FAO, either alone or in co-operation with other fishery bodies, supports working parties which make regional assessments of the status of particular stocks, especially those considered likely to be in need of management measures. Recent examples include Antarctic baleen whales, sperm whales (both with the International Whaling Commission); Indian ocean fish stocks especially tunas (with IPFC); shrimp in the Arabian Persian Gulf; Atlantic tunas; demersal stocks of northwestern Africa (with ICES) and southwestern Africa etc. Also, staff collaborate in similar international studies, e.g. in the North Atlantic, in areas which are primarily the concern of other international fishery organizations such as ICNAF and ICES. In other cases assistance has been given, or major responsibility taken, for large, but essentially national, resource evaluation problems, as in the case of the anchoveta off Peru and northern Chile.

14. The FAO Regional Fishery Councils and Commissions, most of which publish periodical bulletins as well as proceedings of their meetings, have an important function in information exchange (para 9(b) but the Department devotes considerable efforts to the provision of a variety of world-wide series. These include the compiling and publication of Current Bibliography for Aquatic Sciences and Fisheries ten volumes having been issued in parts since 1967, averaging 15,000 annotated and comprehensively indexed references annually, and covering not only fisheries research strictly speaking but much of the related fields of marine biology and oceanography. In this work FAO co-operates with many other services, and is in the process of making the system fully computerized. On the advice of ACMRR and SCOR a monthly "Marine Science Contents Tables" was begun in 1966; it is distributed free to

fishery institutions throughout the world. FAO regularly contributes, by arrangement, material to the quarterly newsletter "International Marine Science" published by UNESCO. FAO has published for many years "World Fisheries Abstracts", in English, French, and Spanish editions, each annual volume in 6 or 4 parts, and containing informative abstracts mainly on technical subjects. It is now planned to replace or supplement the WFA by a series of review articles. This would be in addition to the special subject, area and species reviews and bibliographies already published frequently but irregularly in the series "FAO Fisheries Technical Papers" and "FAO Fisheries Biological Synopses". In this latter series there had been published, up to April 1968, 49 synopses of what is known about the biology of important commercial species of fish, shellfish etc., in standard format. These species synopses are prepared as part of a project of co-operation with leading national fishery research organizations and interested international bodies, some of which have, by agreement, established parallel series of publications. In 1967 the FAO Documentation Centre issued a 230-page computer-analysed indexed list of the fishery publications and documents issued by FAO between 1945 and 1966; supplementary and revised catalogues are to be issued from time to time. Copies or photocopies of listed documents are available to enquirers under stated conditions, and an additional service is an arrangement to provide, at cost, reprints or photocopies of articles referenced in the Current Bibliography for Aquatic Sciences and Fisheries.

15. A series of registers and inventories of information of various kinds are maintained. These include registers of marine scientists, of research and training institutions, of scientific periodicals, of research vessels, of commercially exploited species, and of names of marine organisms. From time to time information from them is published, in whole or in part, in the form of directories, lists covering specific topics or regions, or contributions to symposia etc. Most of the information in these registers is at present being converted to machine readable form.

16. Information concerning fish catches, expenditure of fishing effort, and available fishing power, which is pertinent to marine resource assessment, as well as to other purposes related to fishery development, is collected from countries. This information is compiled and published in a series of Year books of Fishery Statistics. Data for particular areas, types of fishery etc. are published from time to time as statistical bulletins. Some regional compilations are produced jointly with other fishery bodies (particularly with ICES and ICNAF for the North Atlantic, and special attention is given to statistics relating to areas or species groups with which FAO regional fisheries councils, commissions and committees are concerned.

17. A Fishery Data Centre is maintained. This was established in 1966 in response initially to a suggestion from the IOC regarding the need for storage of fishery data from the International Indian Ocean Expedition. The FAO Fishery Data Centre, although as yet little more than a nucleus, is a depository for original fishery data, or copies, from the IIOE and other IOC co-operative expeditions, from certain international projects - such as the Guinean Trawling Survey - conducted under other auspices, and from FAO national and regional field projects for fishery resource exploration and investigation. The Centre is designated as a specialized world centre within the World Data Centre (Oceanography) system. It is expected that the Centre will be a repository for marine (and freshwater) biological data coming from the International Biological Programme under ICSU, which FAO is supporting. For certain kinds of information the Centre, while not holding the data themselves, is maintaining an inventory of such data; particularly important in this connexion is an inventory of the regular biological sampling and monitoring being undertaken, of exploited fish stocks and catches, on a national or regional basis. This is a continuing project in which member countries and institutions are collaborating by submitting information in standard format.

18. The Organization also maintains a registry of national legislation and international actions pertaining to living marine resources and their exploitation. Summaries and analyses of these materials are prepared and issued from time to time as occasion demands.

19. With respect to improvement of methods of research and data analysis (9c) FAO has taken a series of ad hoc actions, through working parties of experts, seminars and preparation of analytical reviews, with respect to a number of subjects and problems considered at the time to have high priority for research attention. Again many of these actions have been taken jointly with other organizations concerned. Recent examples include assessment of fishery resources by the methods of population dynamics; studies of scientific criteria for resource management, including the inter-relation of biological and economic considerations; treatment of marine biological data and collections (with SCOR); methods of sampling and application of statistical methodology in fishery science (with ICES); methods of assessing fish stocks by use of special calibrated echo-sounding equipment and other technical

means such as underwater photography and television, sound reception, aerial survey and conduct of egg and larva surveys (an ACMRR initiative); methods of fish tagging, especially sardines (with GFCM) and tunas; methods of identifying sub-populations of fishes; methods of fish measurement, gonad stage classification etc.; A series of "Manuals for Fishery Science" is published to record the results of these studies. The subject of methods in acquatic biology is of course of great concern also to the IBP, and FAO is collaborating with that Programme with respect, for example, to methods of resource survey and of sampling benthos.

20. Environmental investigations (9d) are of increasing importance to fisheries. Although, with respect to the marine environment the leading role among the organizations of the UN family is taken by the IOC under UNESCO, FAO is contributing substantially in this field both through its collaboration with the IOC (including the special advisory role of the ACMRR) and separately. Thus, an ACMRR Working Party contributed a special chapter to the General Scientific Framework for World Ocean Study (GSF). Subsequently, another ACMRR group studied and defined in detail the needs for synoptic oceanographic data for fisheries purposes including research. FAO co-sponsored, with UNESCO, the Second International Oceanographic Congress, held in Moscow, 1966, and arranged the attendance at it of 28 fishery scientists from developing countries. A pattern of collaboration in regional co-operative studies has grown up with participation by FAO and its appropriate regional bodies (IPFC, GFCM) in, for example, the Co-operative Study of the Kuroshio and the projected IOC projects in the Mediterranean and Caribbean. The regional fishery bodies themselves are, of course, also concerned with environmental studies conducted and reported by their members, and reviews of the results of such studies and their implications for fishery research and development have been or are being prepared for, for example, the Mediterranean (with GFCM and CIESMM), North Sea (with ICES), and upwelling areas generally (in connexion with the IWP).

Atlases of environmental data have been prepared for certain regions, most recently for the Peru Current and Indian Ocean, the latter using data obtained by the IIOE. Support is being given to the "Serial Atlas of the Marine Environment", internationally sponsored and published by the American Geographic Society, with special attention to the North Atlantic. With respect to the

atmosphere over the oceans co-operation with WMO has included the encouragement of collection and transmittal of meteorological observations by fishing vessels.

21. Protection of the marine environment and its living resources from pollution and other disturbances of human origin is an activity of growing concern to the world community and one in which FAO has in recent years become deeply engaged. Urgent attention is being given to the pollution problem by the ACMRR and by COFI; on the initiative of FAO concerted action is being taken through the ACC and its subcommittee on Marine Science and its Applications, and the IOC has become engaged with the oceanographic aspects of the problem. Bibliographies and reference files of scientific and technical publications, pertinent national legislation and listings of research workers, institutions and their activities are maintained.

Establishment of a joint advisory group of experts on marine pollution is being negotiated with IMCO and UNESCO. Co-operation is extended to the IBP (for which the problem of pollution is a major interest), with the International Association for Water Pollution Research (IAWPR) and with other non-governmental bodies and agencies concerned. It is planned to convene in 1969, with the co-operation of these other bodies, an FAO Conference on Marine Pollution and its effects on Fishery Resources and Fisheries. This is expected to lead to proposals for research planning and to clarification of specific needs for further international legislation. With respect to pollution by oil, and also by other noxious substances in so far as they originate from ships, close contact is maintained with IMCO which has statutory responsibilities in this regard.

22. A further aspect of environmental research, in the broadest sense, relates to a growing interest in the prospects of improving marine fishery resources. The various suggestions for doing this include stocking areas with artifically reared young, transplantation to better growing areas, transplantation of species from one region to another, fertilizing to increase primary productivity and hence fish crops; control of predators, introduction of food organisms; study of fish diseases, breeding, installation of devices to restrict movement of stocks etc. These suggestions and the fundamental research related to them are kept under constant review. Under the work connected with the IWP opportunities for, for example, shellfish and seaweed culture are being identified. In 1968, in co-operation with ICES, a symposium on "Marine Food Chains" is being convened to

examine the present understanding of ecological mechanisms which is one of the essential elements of successful "mariculture". A world conference of broader scope is planned for a future biennium, and meanwhile studies of shrimp and prawn culture were undertaken in connexion with the FAO Conference on this subject held in Mexico in 1967.

23. FAO's part in the training of fishery scientists and technicians (9e) is fully covered in the relevant chapter of the main body of this report (Part I - the Survey of Activities). It should be mentioned here that the programme in this respect, while limited by the availability of funds, derives its impetus to a large extent from the other, substantive activities in the field of marine science and technology which are described above and in the following paragraphs. This is true equally of the preparation of manuals concerning research methods, a primary purpose of which is training, and of the country and regional field programmes an important outcome of which is the creation of a nucleus of better trained and experienced investigators in the developing maritime countries. Complementing the publication of teaching materials, and in-job training in projects, are the award of fellowships and the conduct of training centres, seminars and study tours described elsewhere. Further, it is recognized that while specialized training in fishery research techniques is needed, at the present stage of development of fishery science no complete separation of such training and education from that of marine scientists generally - or for that matter of biologists, statisticians, chemists etc. - is possible or desirable. Consequently co-operation with UNESCO is particularly close in this field, and also with such national bodies having global interests in assisting in the specialized training of marine biologists in developing countries, on both a national and a regional basis.

24. Of the 148 regional training centres and seminars convened by FAO in the decade 1950-1960 (the subject of a special study published in 1961), and in which 5,000 fellows participated, seventeen were in the field of fisheries, and 427 fellows participated in these. All but three of these were concerned with marine fisheries, two exclusively with fishery biology and oceanography (thirty-eight fellows), four partially with these subjects (137 fellows) and three with fishery statistics (seventy-eight fellows). Since 1960 this regional training programme has continued at a rather higher level; in the 1966-1967 biennium five training centres and study tours were made in the field of marine science and technology (ninety fellows), as well as others for fishermen's training, food technology and inland fisheries.

25. Activities relating to the improvement of fishing methods and equipment through the application of science and technology (9f) are varied. Most fishing gears have evolved by trial and error and some over a long period of time. Following the introduction of steam, then diesel and gasoline engines, and of deck machinery for handling gears, the evolution of fishing gears has speeded up, but only in recent years have scientific studies begun with a view to systematic improvement of existing gears and invention of new ones. Declining stocks give an impetus to the maintenance of catch rates through use of more efficient gears, and to the adaptation of these gears to new circumstances through their use in areas other than those in which they were originally used, and for different species of fish. Much can be done simply by better engineering but it is increasingly realized that rapid advance will come only from exploitation of the fact that fish capture is a process involving an active relation between fish and gear and therefore that joint "biological" and "mechanical" investigations are required. Indeed, many of the ancient and "primitive" fish capture methods are based on specific behavioural characteristics - individual or collective - of certain kinds of fish. In 1967 a major conference was convened by FAO in Bergen, Norway, on Fish Behaviour in Relation to Fishing Techniques and Tactics precisely for the purpose of bringing together people with scientific and engineering skills, research and industrial experience. This Conference was part of a series of activities which included a group fellowship Study Tour in the Soviet Union (under UNDP(TA)), and its recommendations are now being followed up. In recent years two large Congresses had been held mainly for the purpose of exchanging and discussing technical information and related research results concerning fishing methods, and it is planned to convene in future more specialized meetings to examine particular classes of advanced fishing techniques, such as sonar-guided purse seining, as well as the related subjects of fish detection and location.

26. In addition to the conferences referred to above, a seminar on Instrumentation and Methodology in Fishing Technology was held in 1966. From time to time catalogues of fishing gear designs are published and also manuals on the design and construction of particular kinds of gear. FAO staff participate in the work of other international technical groups which are conducting co-operative field studies in this subject, making studies of standards for net materials etc.

27. Similar kinds of activities are undertaken with respect to fishing craft. Three World Fishing Boat Congresses have been held at approximately six year intervals, and their proceedings published. In addition conferences and symposia have been held on particular problems, and especially in relation to research vessels. A second World Fishery Research Craft Conference, to be held at Seattle, Washington, USA, in 1968 will consider a range of problems of design, construction, equipping and operation of such craft, including submersibles, aircraft and other platforms as well as ships. Extensive data catalogues of research vessel designs and of designs of fishing boats, have been published. Computer studies, and tank tests, undertaken in co-operation mainly with the National Physical Laboratory (United Kingdom) have led to development of more precise methods of calculating and predicting hull resistance and hence laid a scientific basis for improved fishing vessel design. Such studies are now being oriented also towards stability analysis. In this connexion reference should be made to the joint work with IMCO on the specification of stability criteria for fishing vessels as well as on other safety aspects of their design.

28. Recently attention has been given to the use of new materials for fishing craft construction. For example a review has been published on the use of ferroconcrete for this purpose, and design and construction of prototypes begun. FAO, being concerned to a large extent with industries based on small craft, even canoes, has for many years devoted attention to the technical problems of mechanizing these, and replacing traditional craft by new designs. A most recent development is the planning of a "small fishing craft design centre" to be established at FAO Headquarters to provide a service for member countries, and, inevitably to undertake or arrange related general studies. The imminent installation in FAO of a large computer system will facilitate this, as it will also many of the other scientific and technical investigations and services described here. FAO has been instructed, by its 14th General Conference to give more attention in future to problems of machinery and automation on fishing vessels, as well as to operational research.

29. Some of the Organization's work regarding the safety and efficiency of fishing operations (9g) is comprised in the above descriptions relating to gears and vessels. A broad code of safe practice, including technical considerations, is being drawn up in co-operation with ILO and IMCO. Through the ACMRR and COFI requirements for improved weather forecasting for fisheries purposes have been drawn up in response

to a WMO request concerning the World Weather Watch (WWW). Similar actions are being taken concerning forecasting of ocean characteristics, and their synoptic presentation, in co-operation with WMO and IOC. Booklets have been produced for fishermen on the elements of maritime meteorology and of oceanography (in consultation with WMO and UNESCO respectively) and these subjects, as well as other aspects of marine science, are included in the curricula of fishermen's training courses and schools with which FAO is concerned.

30. Although it is a very important item of FAO's work in the field of marine fisheries, the better utilization of catches (9h) is perhaps rather marginal to the scope of the present review. The importance of fundamental biochemical and other research in this respect has not been neglected; a symposium on the Significance of Fundamental Research in the utilization of fish was held in 1964 at Husum (Germany), and its recommendations are being actively followed up. Attention is given both to fish preservation techniques and to product development, and in the latter respect to the development of protein concentrates, and the special treatment of tropical products. Preparation of codes of good practice for handling fish at sea as well as on shore, and for manufacture of products are an important side of work in this field. In the future more attention will be given to the special problems of processing at sea, and to the utilization of unconventional resources. As with other technical matters described in earlier paragraphs, world and regional conferences have been held (e.g. on Freezing and Irradiation of Fish, Madrid 1967), reviews and manuals issued, methods and standards investigated, and training activities undertaken (e.g. Group Fellowship Study Tour on Freezing and Canning of Fish and Industrialization of By-products, 1967).

31. The work of FAO relating to international machinery for dealing with fishery problems, regionally, and on a basis of scientific considerations (9i) cannot, of course, be entirely separated from the other activities described here. Among those bodies listed in paragraph 4 the IPFC and the GFCM were established early in the history of FAO's fishery activities, under Article XIV of the Constitution which provides for regional agreements for intergovernmental bodies, which are essentially advisory in nature, and to which States members of FAO and of the organizations of the United Nations family may adhere. These two bodies are broad in scope by subject, covering economics and administration etc. as well as science and technology, and in principle both marine and inland fisheries. In addition

the IPFC deals with an extremely large sea region. These bodies meet biennially, conduct symposia, publish proceedings of their meetings, technical papers and newsletters, and conduct their business through committees of intergovernmental nature and working groups of experts appointed in their individual capacities. While their secretariats and small working budgets are provided by FAO they may also receive direct contributions from their member countries, although in practice no use has been made of this statutory provision. Thus while they have had, and continue to have, notable achievements in facilitating communication, information exchange and discussion among their members, the extent of their work has been determined by, among other things, the limited financial support which it has been possible for FAO to give them, and they have not engaged directly in, for example, co-operative investigations of resources. As mentioned elsewhere, however, these bodies have in recent years begun to work in close association with the IOC under UNESCO on the fishery aspects of environmental investigations initiated by that body, in the Kuroshio area and the Mediterranean. Both the GFCM and the IPFC have recently undertaken changes in their committee organization, and actions are in progress tending to narrow their responsibilities. In the case of the IPFC this may involve a contraction of the geographic area of interest in view of the establishment of the Indian Ocean Fishery Commission (IOFC); in the case of the GFCM, its interests in inland fisheries are being largely taken over by the European Inland Fisheries Advisory Commission (also an FAO body), and it is establishing closer working arrangements with the non-FAO body concerned with marine biology and oceanography in the same area - the International Commission for the Scientific Exploration of the Mediterranean Sea (CIESMM).

32. A second group of FAO fishery bodies are the Commissions established under Article VI of the constitution. These are regional with respect to their responsibilities and may either be regional in their membership, as is CARPAS, or open to membership by all members of FAO, as is the IOFC. These bodies, as will the Fishery Committee for the Eastern Central Atlantic - a body of selected member nations of FAO very recently established also under Article VI of the Constitution - operate in much the same way as the two Fisheries Councils although they do not have provision for separate budgets, and their subjects of interest are defined or interpreted rather more narrowly.

33. Unlike the bodies referred to above, the Atlantic tuna convention provides for the Commission under it to have responsibility for management measures as well as consideration of scientific investigations. While FAO took the initiative and provided most of the means for its negotiation, this convention is established outside the framework of the FAO constitution. It does however provide for FAO to have a continuing special relationship with the Commission, including, it is envisaged, the provision of statistical and related services.

34. Whereas the initiative with respect to Atlantic tunas was taken directly by the FAO Council, similar initiatives are being taken by the Committee on Fisheries (COFI) since it was established. In addition to preparing the establishment of the IOFC and the FCECA, it is now taking the loading role in actions, endorsed by the FAO conference, towards creation of regional fisheries management bodies for stocks in the south-eastern and south-western Atlantic. Meanwhile COFI's standing Sub-Committee on the Development of Co-operation with International Bodies concerned with Fisheries is maintaining a continuing review of needs for further actions of similar nature as well as of needs for statutory changes that could facilitate speedier and more effective actions.

35. The means of providing adequate scientific advice to the regional and specialized fishery bodies is a matter currently under active consideration with respect not only to the new bodies associated with FAO but also to other international fishery commissions. Pertinent to this question is the series of reviews being made (and published) jointly by the Department of Fisheries and FAO's Legislation Branch, in consultation with the bodies concerned, of the structure and activities of existing regional fishery bodies. The ACMRR is reviewing this entire complex subject and is meanwhile active in arranging, through working parties of experts, for the scientific reviews of resource situations which are so important in determining priorities among needs for international action, and in providing material for the first session of new bodies; thus when ICCAT, the IOFC and the FCECA first meet, and the conferences of plenipotentiaries for the eastern and western South Atlantic convene, they will already have before them reports on the conclusions from research so far, the needs for further research, and possibly, in some cases, suggestions for management actions.

36. Scientific information on which international actions can be based is essentially derived from national research activities, even though it is supplemented in some areas by research undertaken by the international fishing bodies themselves. There

is, further, a considerable and growing need for co-ordination of the national investigations, involving in some cases co-operative studies, in other cases some agreed division of responsibilities, or acceptance by one or a group of nations of responsibility for investigations broader than they would otherwise undertake. It is an accepted general principle in this regard that all countries interested in a high seas fishery resource have a responsibility to contribute to investigations oriented to its rational exploitation and if necessary, management, and this principle imposes a heavy burden on the increasing number of developing countries having such interests. At the same time more and more of these developing countries are in need of the results of scientific investigations as a basis for proper formulation and implementation of their own marine fishery development programmes, whether these concern their coastal waters, offshore waters, or both. Thus a responsibility falls to these organizations charged with the administration of bilateral or multilateral technical assistance to such countries to assist as far as possible in developing continuing national fishery research structures, encouraging and facilitating their participation in international actions so that both contribute to them and draw benefit from them, and at the same time, as far as means permit to promote the acquisition and dissemination of pertinent knowledge by any means and by any countries, but as soon as practicable, so that new investments in fisheries now being made or contemplated are optimally placed. It is important to note, in this connexion, that the assessment of a marine fishery resource is, unlike say, a forest survey, essentially a research activity, and a continuing one. This fact derives from the present stage of development of fishery science and it imposes rather special features on FAO's field programme in this sector.

37. FAO is now very vigorously pursuing the above aims (9j). Advice and assistance in this field to Member States, both developing ones, and even to the more developed ones, by regular professional staff has always been, and will continue to be, a feature of the Organization's work. While it is significant this is, however, small compared with the scale of assistance provided through the deployment of supplementary funds derived principally from the UNDP. Although these activities have been left to the end of this report, their present importance is shown by the over-all budget figures quoted in paragraph 2. It is not practicable to describe here all these activities and only a summary of them is given.

The situation of international field staff for the Department of Fisheries as a whole, as at the beginning of 1968 was as shown in the table below:

| | Staff | | | Unfilled posts in approved SF projects | Total posts |
|---|---|---|---|---|---|
| | Staff in post* | | | | |
| | Total | (SF) | (TA) | | |
| Marine scientists (biologists and oceanographers) | 25 | (18) | ( 7) | 18 | 43 |
| Fishing gear and methods specialists | 32 | (23) | ( 9) | 39 | 71 |
| Naval architects, marine engineers, port engineers | 4 | ( 2) | ( 2) | 6 | 10 |
| Fish processing experts | 18 | (12) | ( 6) | 2 | 20 |
| All other specializations (inland fisheries; and marketing, statistics, economics, administration, law) | 43 | (21) | (22) | 16 | 59 |
| Managers of UNDP(SF)/FAO fishery projects | 24 | (24) | - | 5 | 31 |
| TOTALS | 146 | (100) | (46) | 86 | 234 |

* includes also Associate Experts, but excludes short term consultants and national counterpart staff in Special Fund Projects.

38. Since the initiation of the United Nations Expanded Programme of Technical Assistance (EPTA, now UNDP(TA)) in 1949 (the first fishery project was initiated in 1950), FAO has issued 140 reports relating to marine (as against fifty-seven inland) fisheries, based on the work of nearly 100 technical assistance experts who worked in 60 countries. (This is rather less than 10 per cent of the reports of UNDP(TA) projects issued by FAO as a whole). Of these thirty-nine concerned scientific investigations of resources, thirty-seven the exploration of resources and experimental fishing or both, and seventeen the design and construction of fishing boats; forty-nine were general in nature, or dealt with fish processing, or with marketing and other non-scientific/technical matters. During that time over 100 training fellowships were awarded, usually to counterparts of FAO field experts (this number does not include the shorter-term fellowships to provide for participation in regional training centres and seminars). Of the twenty-four

UNDP(TA) marine fishery experts currently (January 1968) employed in the field on technical matters, seven are marine scientists concerned with resource investigations (biologists and oceanographers), nine others are involved in conduct of exploratory and experimental fishing, two in boat design and construction, and six in fish processing studies. The corresponding fellowship programme has in recent years been at the level of six to twelve fishery awards annually, of which the majority are for study of scientific subjects, or technology.

39. As indicated in paragraph 2 the fishery projects executed by FAO under the UNDP Special Fund are now of much greater magnitude and over-all impact. This programme has been growing rapidly since 1960. As at January 1968, two marine projects had been concluded, and twenty-two projects (nineteen marine) were operated. All but three of these involved marine resources research and exploration. At the same time thirteen projects had been approved but were not yet in operation; of these ten concern marine fisheries, and all but one of them involve research and exploration. A further eight project requests had been submitted (nine marine, all but two involving research and exploration) and eleven are under consideration (nine marine). The Department of Fisheries participates in seventeen other FAO projects not primarily oriented to fisheries development; two of these are concerned with marine fisheries.

40. Most of the above projects are national ones and several involve the establishment of permanent institutions for research and development. Two are regional (Central America and Caribbean) while others are co-ordinated regionally. In the case of several projects in West African countries special arrangements have been made for them to support a regional investigation of the important Sardinella stocks. Those projects which include an element of marine science and technology, and which are now in operation or are approved, range in duration from one year (one only) to six years, with an average of four years. Projects are in operation or approved in all continents, with a total financial support of $92 million ($37 million UNDP(SF) contribution, $55 million government contribution). They involve the employment, among other international professional field staff, of thirty-six marine fishery biologists and oceanographers and sixty-two masterfishermen, fleet managers and gear technologists. In addition, especially where, as in several cases, resources investigations are predominant in the work of the project the project managers themselves are fishery scientists - biologists or oceanographers; these number nine.

The preparation of projects, negotiation of plans of operation, formulation of work plans, selection, recruitment, briefing and assistance to field staff, and the other administrative, and technical and scientific aspects of the implementation of the projects, occupy the staff of the Field Project Co-ordination office of the Department of Fisheries and also about 50 per cent of the time of professional staff in the various units of the two Divisions.

41. The decision to give fisheries development sufficiently high priority to qualify for consideration for UNDP(SF) support is, of course, a function of national governments - sometimes acting through regional economic organizations to which they belong - as also is the basic decision regarding priorities for example of marine vis-à-vis inland fisheries. FAO does however, on request, assist in the formulation of viable projects, and in the consideration of the broad scope and specific orientation of such projects. For such tasks several means are used, including the recruitment of consultants and the participation of staff in FAO missions or joint UNDP/FAO missions to countries. Such missions may either be concerned with study of special fisheries problems alone, or may occasionally consider fisheries in the context of agricultural or industrial development as a whole.

42. An important aspect of the UNDP(SF) marine fishery projects is the provision to them of sea-going facilities. In some cases this is achieved by the government or other national institutions providing the required vessels, or by chartering. Most often it has however been considered more practical to provide the projects with their own vessels. The cost of these and their equipment is in such cases a large element in the UNDP(SF) contribution, and their running costs and maintenance in the corresponding government contribution. FAO undertakes the design and arrangements for construction and delivery of such vessels, and has established a special headquarters unit for this purpose. The research and exploration vessels at present either commissioned or under construction number 7 under 50 gross tons (GT) and 15 over 50 GT; these are assigned to thirteen countries and to three regional projects. There are, in addition to these, five training ships - the largest being 318 GT - assigned to three projects in two countries.

43. It is perhaps useful to outline here some examples of particular projects having a large element of scientific and technical investigations. In Peru, under a Special Fund fisheries project started in 1960, an Institute for Marine Research

was established. Investigations concentrated on mapping the stock of anchoveta - on which resource is based the world's largest single species fishery, the catch being of the order of 10 million tons annually; on studying its relation with the oceanographic features of the South-east Pacific; and on assessing the magnitude of the stock and the sustainable yield that can be taken from it. During the course of these investigations collaboration was established, and co-operative investigations made, with other countries and institutes interested in the Peru Current environment, and especially the "El Nino" phenomenon which from time to time greatly affects the productivity of the fishery and the stocks of guano birds which also subsist mainly on the anchoveta.

The annual catch of anchoveta has now been shown to be near to the maximum sustainable yield of the stock and attention has turned to the formulation of effective management measures. The first Peru project terminated in 1966, but the Institute continues and is now supported by a second, follow-up project which is concentrated on continuing resource assessments and related economic studies.

44. In West Africa a group of six Special Fund projects is concerned mainly with an assessment of the large Sardinella stocks and development of means for exploiting them. At present they are exploited along only certain sections of the West African coast and for a rather short season; these features of the fishery are determined by oceanographic characteristics of the area, namely the locations and times of upwelling and thermocline movements which cause the Sardinella to be both near the surface - vulnerable to purse-seines - and near the coast - and thus vulnerable to bottom trawls. The stocks do, however, inhabit a much wider area, and might be vulnerable to mid-water trawls, or to fishing with lights which concentrate them and bring them closer to the surface where they can be caught by purse-seines. The research needed therefore comprises oceanographic studies, fish behaviour studies in the field, investigations in the realm of gear technology, and assessment of stocks by direct methods, principally by echo-survey. To this end research vessels are assigned to the national projects but in addition a vessel working with and on behalf of all the projects collectively will conduct an extended survey of the region. As in other regions which have recently been surveyed extensive use will be made of calibrated echo-sounders, as well as other fishery biological and oceanographic methods.

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45. In the region of the Caribbean, Gulf of Mexico and adjacent waters a large group of projects is being executed and co-ordinated, although the projects there are more heterogeneous among themselves - to meet specific national or local situations and needs - than are those in West Africa. Two regional projects involving, respectively six central American countries and thirteen Caribbean Island States and territories, are concerned mainly with exploratory fishing, and with associated biological studies. Other projects in Colombia, Venezuela and Mexico (as well as UNDP(TA) projects in Cuba) have their main emphasis on scientific resources investigations. When all are operational about eleven project vessels will be working in the area.

46. Investigation of fishery resources of the Indian Ocean (especially the Arabian Sea) is a subject of approved or submitted national Special Fund projects in Somalia, the Federation of South Arabia, Madagascar and Mauritius, and India.

47. Finally, reference should be made to field activities not associated with UNDP, and funded from other sources. No marine research is being conducted under the Freedom from Hunger Campaign, although there are a number of technical assistance projects involving the mechanization of small fishing craft. The Special Fund projects themselves, being, by definition, "pre-investment" projects are producing results of interest to funding agencies such as the International Bank for Reconstruction and Development (IBRD) and to the several regional development banks. The Department of Fisheries is engaged in preparing reviews of existing knowledge in connexion with investment proposals, and participates in missions for the collection and evaluation of facts about fishery development opportunities, which devote considerable attention to forecasts of resource availability and stability. The Department as a whole is involved in this work, but three additional professional staff are funded under the FAO/IBRD co-operative programme. A more recent step is the association between development banks and FAO in the pre-investment investigations. A specific example is a systematic exploration of the unexploited shrimp resources along the coast of West Africa now being planned, with the support of the African Development Bank. This follows the discovery of shrimp stocks in some areas - by existing FAO/SF projects among others - and the rapid development of local industries for these, and is based on the expectation of the existence of stocks in other areas, from knowledge of bottom topography and types, the oceanographic and hydrological regime, and incidental catches that have been made.

FAO DEPARTMENT OF FISHERIES - ABBREVIATED STRUCTURAL DIAGRAM

(The diagram shows all units at Branch level but does not include subsidiary units which are concerned with inland fisheries or with essentially non-technical industrial and administrative activities. Units concerned entirely or mainly with one or other aspect of marine science and technology are double-boxed. Structure is as approved at 1 January 1968. At that date the professional staff financed under the Regular Programme totalled 66, with a further nine posts programmed for 1968-1969. This number includes ten regional officers, eight of whom are outposted to FAO's regional offices in Accra, Nairobi, Cairo, Santiago, Rio de Janeiro, Bangkok, and is supplemented by about thirteen professionals paid from other sources of funds).