A matter of human survival

MASTERING RESOURCE MANAGEMENT

In the following article, Gunnar Saetersdal, one of the main authorities on the question of resource management and honorary director of the Institute for Oceanographic Research of Bergen (Norway), takes us on a voyage through the history of world fishe-ries. On the way he describes the many hurdles faced by scientists and fishermen in their effort to make use of an important source of human nourishment in a rational manner: *fish*.

The article (1) contains the main part of the treatise presented by Gunnar Saetersdal in course of the Symposium on Marine Environment and the Future of Fishworkers.

In our efforts to use the living resources of the sea to provide food for us, which fishing is mainly about, we encounter various types of problems.

One very basic difficulty which underlines all of man's use of living rene-wable resources is to ensure that in their use, we still preserve them as lasting resources for an indefinite future. This must be accomplished through proper management of the fisheries, and since the fish stocks are remote and the sea inaccessible and vast the art of biological fishery management is complex and has been developed only fairly recently.

A second important set of problems is related to the simple question : who owns the fish in the sea? After it has been caught it usually belongs to the fisherman or the vessel owner, but for the resources existing in the sea there are problems of deciding on who should be given access to them and how this access should be allocated. These problems exist on a global level, between economic classes of nations, between neighbouring states, between types of fisheries e.g. industrial versus small scale and even at the level of single fishermen. It is not possible in this brief review to deal exhaustively with these problems of allocation of the fisheries wealth of the sea, but I will try to look at larger scale implications of the Law of the Sea (LOS) régime after its introduction about ten years ago.

Finally there is a set of problems related to which usage is being made of the fish that is taken from the sea. The availability of food is insufficient for many groups of people in the world today and the future food situation globally is uncertain. Fish is first and foremost food and we should ask how our usage of it could in the best possible way contribute to alleviate problems of nutrition, now and in the future.

When industrial fisheries migrate towards the South

Most of the statistical information for this section derive from FAOs Year-books of Fishery Statistics.

Starting with the history of world fisheries we should note that while artisanal coastal fisheries have existed since prehistoric times, industrial fisheries on a large scale are a recent almost post-war phenomenon. The growth of the global fish production from about 20 million tons in 1950 to 80 million tons in 1986 (91 million with inland fisheries included) is shown in the figure.(Figure 1) Presented on a logarithmic scale we see some clear trends. The two first decades 1950s, and 1960s of very rapid growth can be ascribed to the effects of introduction of new fishing technologies, synthetic fibres for the gears, stern trawling, ring netting and tuna long lining combined with a spread of industrial fisheries from nuclei in the North Atlantic and North Pacific to lower latitudes. This process included the creation of distant water fleets by high technology fishing nations, notably Japan, USSR, other East European nations, Spain and Korea which for their production depended on resources outside the home waters of these countries.

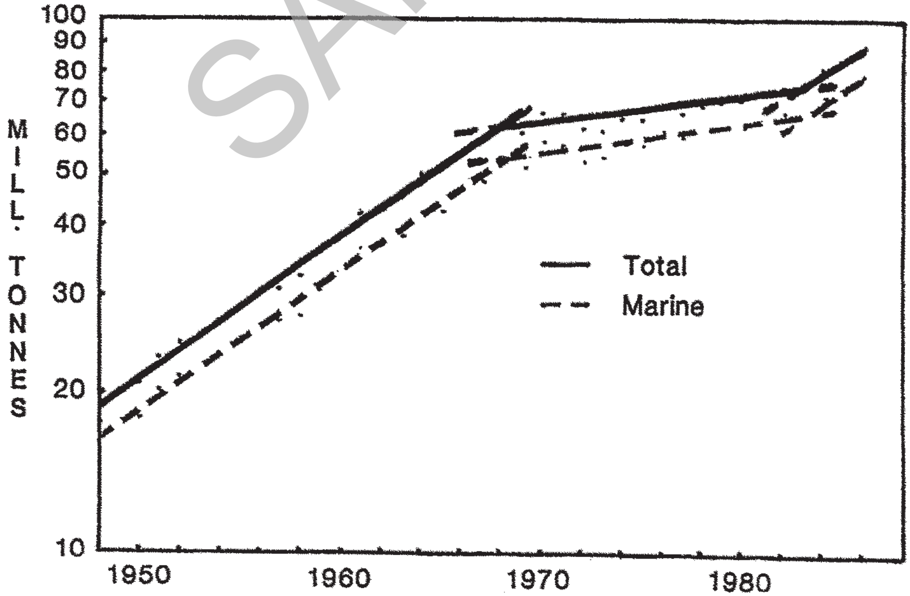


Figure 1. World fish landing, 1948-1986.

While thus in the early period by far the major part of the world catch came from the Northern parts of the Atlantic and Pacific oceans, by the 1960s there was an expansion Southwards. An example is the Eastern Pacific where, following the collapse of the Californian sardine stock in the 1950s, fish meal plants and fleets were moved Southwards to Peru and created the start of the great fishery which developed on the anchoveta stock of that country.

And as other resources in the Northern areas became fully utilised the expanding fishing industries of many nations moved on to other regions, notably the high productive coastal areas at lower latitudes such as the shelves off the Southwest and Northwest Africa. And increasing demands for tuna and shrimp created global fisheries for these high-valued resources.

Around 1970 a number of large pelagic stocks, among them the Peruvian anchovy, collapsed and the trend of the slower growth of the world catch during the 1970s is at least to some extent the result of such resource failures. The resumed higher rate of growth in recent years results partly from resource variability from natural causes, partly from a better use of known resources, perhaps as a consequence of improved conditions for management under the LOS regime. It is, however, unlikely that this recent high rate of growth of world fisheries will continue for yery long. I will return later to the question of the total potential of the world fish resources, but we can already now state that further substantial growth of world catch will be restricted by resource limitations. In most of the worlds important fishing areas we are approaching a full utilization of the fish stocks.

It is of interest to consider briefly the geographical distribution on a global scale of the fish resources and the fisheries. As all fishermen know there are parts of the sea where fish are plentiful and other parts where you will never make a catch. On a larger scale the distribution and abundance of fish is closely related to the level of primary production, the production of plants in the sea. The basic requirement for plant growth is as on land light and nutrient salts, and areas of high production in the sea are found where water with high nutrient content is brought up to the surface layers. At higher latitudes by convection caused by winter cooling, at lower latitudes by upwelling of subsurface water caused by prevailing wind and current Systems and partly by river discharges.

The rate of plant production in the various parts of the oceans can be measured. A yery significant feature of these measurements indicate the generai low productivity found in the open seas, large parts of them are nearly a kind of ocean deserts. Most areas of high productivity are found over the continental shelves, but there are large variations also within the shelf regions. True tropical areas with nice blue warm water are in generai low-productive.

The high productivity of the northern parts of the oceans is evident, and we can see from the table of the distribution of the world catch (Figure 2) that these areas prqvide the highest contributions of the catch. The central regions corne next while fish production in the Southern part of the globe is low, especially in the vast Southern Ocean, mainly because few fish stocks have been able to inhabit this region where the continental shelf area is so limited.

Figure 2. WORLD MARINE FISH CATCH 1986 BY MAJOR FISHING AREAS.

ATLANTIC OCEAN	24.3 MILL TONNES
PACIFIC OCEAN	51.0 MILL TONNES
INDIAN OCEAN	4.5 MILL TONNES
SOUTHERN OCEAN	0.5 MILL TONNES
NORTHERN REGIONS	42.5 MILL TONNES
CENTRAL REGIONS	20.9 MILL TONNES
SOUTHERN REGIONS	17.0 MILL TONNES

The enrichments of the surface waters by the upwelling process is a remarkable phenomenon, which is the basis of existence for some of the worlds largest and most well known fish stocks such as the Peruvian anchoveta and the Californian, Morroccan and Namibian Sardines as well as the other associated resources in these regions. (Figure 3) Roughly 20 million tons of the world catch of 80 million cornes from the Eastern margin upwelling systems which are associated with the tradewinds, the Peru, Californian, Canary and Benguella Current systems. As most of these border developing fishing nations it is perhaps more significant to note that these 20 million tons represent about half of the total global catch landed in developing countries.

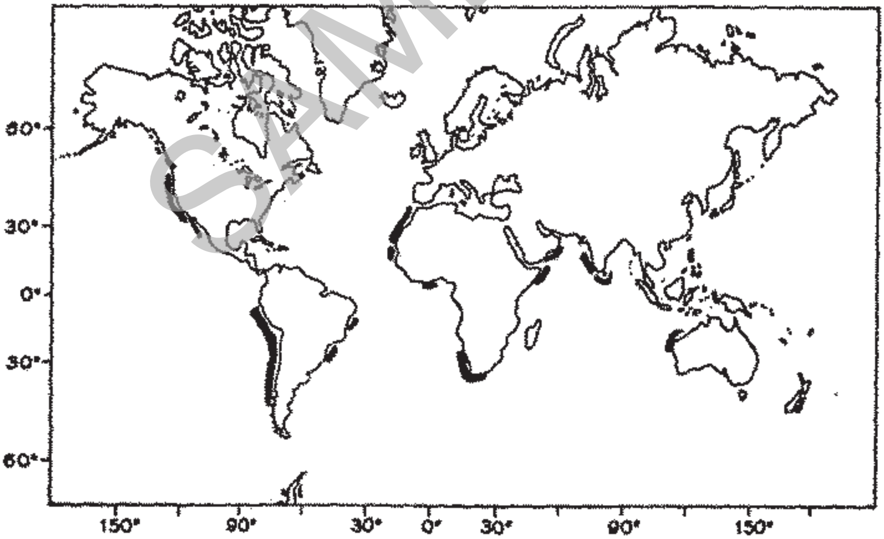


Fig. 3. Distribution of phosphatic deposits. Adapted from Tooms (1967).

A relatively small number of countries stand out as the dominating fishing naons of the world.(Figure 4) Japan and the USSR top the list with the great home waters as well as global fisheries. China is known for its highly developed inland fisheries and aquaculture production and Chile and Peru for their

Catch in	Catch in 1986 (tons)	Place	Catch in 1985 (tons)	Place
Japan	11,966,819	1	11,408,883	1
USSR	11,259,955	2	10,522,831	2
China	8,000,063	3	6,778,819	3
Peru	5,609,588	4	4,135,718	6
Chile	5,571,638	5	4,804,430	4
USA	4,943,213	6	4,765,303	5
South Korea	3,102,542	7	2,650,026	8
India	2,925,347	8	2,824,347	7
Indonesia	2,521,190	9	2,339,068	11
Thailand	2,119,050	10	2,225,204	9
Phillipines	1,916,347	11	1,864,990	12
Norway	1,898,383	12	2,119,011	10
Denmark	1,871,349	13	1,752,559	14
North Korea	1,700,000	14	1,700,000	13
Iceland	1,657,068	15	1,680,405	15
Canada	1,466,635	16	1,418,455	16
Mexico	1,303,720	17	1,226,244	18
Spain	1,303,488	18	1,337,738	17
Taiwan	1,200,000	19	1,100,000	19
Ecuador	1,019,304	20	946,999	20
United Kingdom	855,891	21	898,443	22
France	850,000	22	844,318	23
Brazil	847,889	23	839,224	24
S.Africa & Namibia	829,949	24	756,374	27
Viet Nam	800,000	25	780,000	25
Bangladesh	793,982	26	773,979	26
Poland	645,220	27	683,455	28
Burma	643,750	28	643,750	29
Malaysia	616,280	29	631,685	30
Morocco	595,868	30	473,160	34
Turkey	579 844	31	578,069	31
Italy	547,606	32	574,998	32
Netherlands	454,778	33	504,181	33
Argentina	420,306	34	406,391,	36
Pakistan	414,895	35	408,404,	35
Portugal	389,571	36	298,648	39
Faroe Islands	353,668	37	372,889	37
New Zealand	339,563	38	304,550	38
Ghana	390,157	39	274,219	41
Venezuela	283,636	40	264,767	42
Romania	271,126	41	237,637	45
Nigeria	268,482	42	241,634	44
Senegal	255,381	43	255,300	43
Cuba	244,600	44	219,831	48
Ireland	228,910	45	229,856	46
World total	91,456,800		85,626,100	

Figure 4.

large fisheries of small pelagics. Ten countries have total catches exceeding 2 million tons and they account for some 56 million of the 91 million global catch. There are as we see a number of developing nations among the top fishing countries, they are in fact in majority. I will later examine more closely the North - South relation in world fishing.

The composition by major groups of fish of the world catch is shown in this table (Figure 5). The pelagic schooling fish dominate and represent as a whole nearly half the catch by weight. Except for tuna they are mostly of lower market value than the demersal fish, but for this reason they are in many areas important as cheap and nutritious food.

Figure 5. MAJOR GROUPS OF FISH IN WORLD CATCH, MILL. TONNES

HERRINGS, SARDINES, ANCHOVIES	23.9
CODS, HAKES etc.	13.5
HORSE MACKERELS, JACKS, SAURIES	7.2
REDFISHES, BASSES, CONGERS	6.0
MACKERELS, SNOEKS, HAIRTAILS	4.0
TUNAS, BONITOS, BILLFISHES	3.4
SHRIMPS, PRAWNS	1.9
SQUIDS, CUTTLEFISH, OCTOPUSES	1.7
FLOUNDERS, HALIBUTS	1.3
SALMON, TROUTS, SMELTS	1.0
SHARKS, RAYS	0.6

Of special interest are the nearly 2 million tons of shrimps and prawns which are of high market value and mostly caught at lower latitudes (Figure 6). Also tuna and important parts of the cephalopods belong in the central parts of the oceans and represent resources with a high availability for developing nations, but these are to a larger extent than the shrimps exploited by the distant water fleets from industrial fishing nations.

A scientific base : the main priority now!

In its broad sense fishery management may serve a variety of purposes and have objectives of economic and social nature within the fisheries sector, but its most fundamental objectives follows from the fact that fisheries represent a utilization of biological renewable resources which must be preserved for indefinite use. This basic biological objective is often defined as highest sustainable physical yield , but it is at times modified e.g. highest economic value or highest profit. Taking account of special aims of the community in protecting certain groups of fishermen other levels of yield can be specified as long as resource conservation is ensured by not exceeding the limits set by the potential of stock. In the history of fisheries there are unfortunately many examples of excess of exploitation which has caused depletion of resources.

Figure 6. DISTRIBUTION OF WORLD SHRIMP FISHERIES AT LOW LATITUDES BY MAIN REGIONS AND FISHING COUNTRIES, 1986.

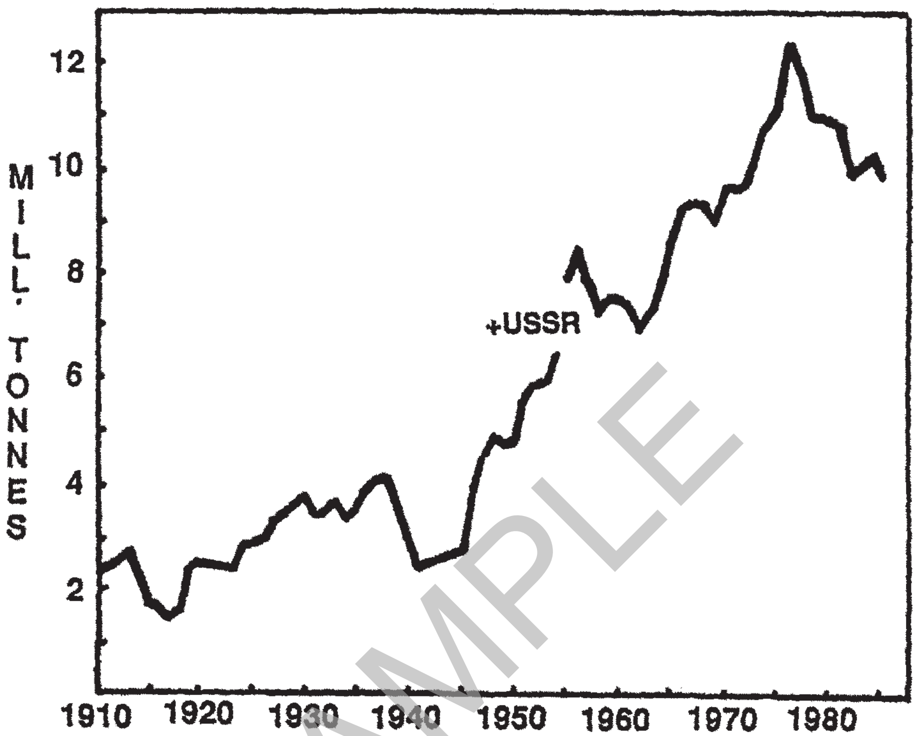
REGION	**CATCH 1000 TONS**	**MAIN FISHING COUNTRIES**
31 WESTREN CENTRAL ATLANTIC	202	USA, MEXICO
51 WESTERN INDIAN OCEAN	238	PERSIAN GULF STATES, INDIA
71 WESTERN CENTRAL PACIFIC	404	THAILAND, INDONESIA,MALAYSIA, PHILLIPINES
61 NORTH-WEST PACIFIC	411	CHINA, VIETNAM, JAPAN, KOREA
77 EASTERN CENTRAL PACIFIC	139	MEXICO
WORLD TOTAL	1954	

If we go back in time, and in some areas we need not go back very many decades we can see that as fisheries developed beyond the small scale the need for a scientific basis for the exploitation of fish stocks became urgent.

As an introduction to the subject, both technically and historically it may be useful to reyiew briefly the development of this fishery science in the Northeast Atlantic, an area of both ancient fisheries and of early development of science. Historically both fisheries technology and principles for biological management have spread from this area to other parts of the world. The long time series of data we have from this region also makes it of special interest for studies. These series are due to the formation by the scientists of the region of an international body for cooperation, ICES (2) already at the start of this century and through its published records we can follow the events both in the fisheries and in the science.

The landings of this region (Figure 7) show an increase from about 2 million tons in 1910 to 10-12 million in recent years. This growth resulted mainly from a process of taking into exploitation an increasing number of fish stocks up to about 1970. Since then one can say that all stocks are fully utilized and some overexploited.

Figure 7.



Fish landings in the Northeast Atalntic, 1910-1985

But already at the start of this period, at the beginning of the century there was concern for some of the stocks. For some fisheries this concern was caused by great fluctuations in the yield between periods of years, and in the poor years the coastal fishermen suffered seriously. And in the rapidly developing trawl fisheries of the North Sea the often large by-catches of undersized juvenile fish gave cause for concern for the stocks. Would this cause depletion of the resources in the long run?

The period of the war years 1914-1918 and 1939-1945 provided the scientists with some important information of the effects of the fisheries on exploited stocks. We see from the landing records that the catches dropped markedly in these periods, an effect of reduced effort of fishing caused by the war. This reduced effort caused however also changes in the fishstocks themselves. Both their density as well as the proportion of large sized fish increased as shown by the records of catch per days absence of trawlers and the proportion of size categories in the catch from the North Sea before and after the first world war.

Another important finding from these early years was made through a technique which enabled the aging of fish. It was then discovered that there is often a variation, some times very great in the results of the annual reproduction of fish stocks, and this was shown to be the main the underlying cause of good and bad years experienced by the fishermen.

These discoveries led the scientists onto a path of considering the fish stocks as populations, like human populations, whose reproduction, growth and mortality could be measured and analysed. Through this approach the fate of the stocks under various conditions of nature and different forms and levels of exploitation could be assessed and even predicted. By about 1950 great advances had been made in the creation of this special science dealing with the exploitation of fish resources. But the political international instrument for making use of the advice from the scientists lagged behind. It was also in this early period that one of the pioneers of fishery science, Michael Graham of Lowestoft in England, formulated his "Great Law of Fishing" which says that unlimited fisheries become unprofitable.

"Because of increased fishing effort resulting from improved efficiency and addition of capital, industrial fisheries will, if left to themselves move in a self defeating process towards a marginal state". This represents a version of the Tragedy of the Commons (3) and is still of considerable actuality.

Eventually a convention for the regulation of fisheries was agreed by the European fishing nations, a fishery commission was established and from the mid 1950s on various measures to safeguard stocks and ensure lasting yields were introduced in the fisheries. This commission regime lasted about 20 years until it was replaced by the present LOS regime, but its history was not to be a happy period for Northeast Atlantic fisheries. In spite of the efforts by the scientists and the Commission the period ended with most of the main resources in a state of overexploitation and for some even depletion. Although this is now history and we have left this regime of open access behind us it may still be of interest to examine the causes of failures during that time.

First we should note that this was a period of very great advances in fishing technology. One of the results was the creation of an entirely new type of fisheries: open sea ring netting for pelagic schooling fish, herring and mac-kerel. These stocks had previously been exploited mostly in the coastal areas and with far less efficient gears. The new and expanding fisheries created problems for the scientists. Their experience had mainly been built on trawl fisheries, and while the mean catch per hours trawling is a fair measure of the abundance of a stock, the mean catch per set of a ring net is of little or no value for estimating stock abundance. New methods had to be developed for the pelagic stocks and looking at this first period as a race between technology and science one can say that in the first instance this was won by fishing technology. The dramatic results of this can perhaps best be demonstrated by reviewing the fate of the Norwegian Spring Spawning stock of herring. This stock was reduced from a 10 million tonne biomass in the 1950s to virtually zero in 1970. The advice submitted in 1965 when the stock had all but collapsed was that the exploitation is still at a level where no benefit for total landings can be expected from any regulatory measure. No restrictions on fishing was advised until 1970 and the collapse of the stock only came to be fully recognized over the years 1970 - 1975 with a total ban on fishing advised in 1975.

Only towards the end of the 1960s did the scientists develop the capability to diagnose the state of these types of pelagic stocks and submit appropriate advice. It was by then too late to save the Norwegian herring, but another great herring stock, that of the North Sea on which the new fishing started somewhat later had not entirely collapsed by 1970. But in spite of a series of timely and appropriate recommendations from the scientists from 1970 onwards the Commission was not able to obtain agreements among its members to reduce the excessive rate of exploitation on this stock and also this herring was slowly depleted.

This failure of international management by NEAFC (4) and other similar bodies under the open access conditions was not caused by faulty procedures or an inadequate convention. The solution of the problem was not on the technical, but on the moral plane. The parties concerned were unable to act in unison for a common benefit against short term individual interests. This impasse is an example of "the tragedy of the commons", a state which covers a number of fundamental issues becoming of increasing importance in man's usage of the global commons of the biosphere and which eventually perhaps will be decisive for our survival on this planet.

In our fisheries world the many failures of management under the open access, "commons" regime represented an important argument in favour of the extension of coastal state jurisdiction in the preparations for the new Law of the Sea Convention. And with this we enter the present LOS regime which with its Exclusive Economic Fishing Zones has been the framework for fisheries management since about 1977. The LOS Convention dates from 1982, but most coastal states extended their fisheries jurisdiction through national legislation in the late 1970s on the basis of an agreed draft text of the Convention. Under this new regime the responsibility for management with reference to certain standards is in principle shifted onto the coastal states.

In the Northeast Atlantic a major part of the management problems are, however, still of an international nature because the distribution of a majority of the stocks, representing some 80 per cent of the resources covers more than one economie zone. The limits of the EEZs in many cases split the sea areas and thus the stocks belonging there. Similar conditions are found in many parts of the world including developing regions. In this sense open access still remains and there is a need to reach agreement on objectives and standards of management and to adjust national fisheries policies to international fisheries. And new problems are created of allocation of the shared resources among the parties concerned.

As expected the new regime brought about considerable improvements in the conditions for management, the main reason being that the responsibility for management is now clearly placed on the coastal state and much fewer parties are now involved where international agreements are needed for shared stocks. In the Northeast Atlantic this has led to improved states for some stocks, especially the pelagic fish. For most demersal stocks there is not much change, perhaps mainly because of excessive fleet capacity.

There are, however, some recent developments in science which may lead us towards new approaches to management.The stocks have under the