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The fish supplies of the world

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In a world whose population has increased from about 2169 millions in 1937 to 2734 millions in 1956 (United Nations Organization: Department of Social Affairs, 1956; United Nations Organization, 1957; United Nations Organization: Statistical Commission, 1957) it is not surprising that the attention of scientists is becoming more and more focused upon the food supplies that are and may be harvested from the sea and the inland waters of the world.

As pressure of population forces agriculture more and more into the production of crops for primary consumption, which has long been the pattern in Asia and the Far East (where fisheries supply most of the animal-protein intake), so will man be driven towards the sea and waters of the world for his supply of animal protein. If populations continue to expand—and as yet there seems to be no down turn in the curve—this movement will progressively develop unless some synthetic process of developing adequate and economic substitutes for animal protein is found.

In many ways the sea presents the last frontier, the last common in which we can observe the beginnings of enclosure. Perhaps the property concept that might follow, or intelligent agreement amongst nations, might give rise to the application of the concept of production management to secure optimum harvests from the pasture that is owned by no one or everyone.

Although such a régime might be said to be in its initial stages and will undoubtedly develop, it does not obtain today. Therefore the account of fish production which follows is very largely the account of what man has achieved by methods of hunting rather than of husbandry.

Catch

I shall begin by dealing with the gross world supplies, the composition of the catch, its disposition and consumption *per caput*. Finally, I shall deal with the prospects for increase in the supply of aquatic foods. Space does not allow for anything but a summary treatment of these subjects but I trust that they will serve the purposes of this Symposium.

The sources used are mainly from the *Yearbook of Fishery Statistics* 1955–6 (Food and Agriculture Organization of the United Nations, 1957). The amounts are expressed as 'live weight' through the employment of appropriate conversion factors, and the metric system is followed. The world coverage of this book is fairly complete, but can never be any better than the official returns of governments from which it is compiled. Certain material is included from mainland China and more complete sets of data are included for the U.S.S.R. than was formerly possible.

There is one type of data about which there is uncertainty, and that is subsistence and sport fishing—or the product which never enters the channels of trade. Estimates have been made to cover it but, if anything, they err on the side of conservatism.

Total world catch. The total world catch of fish, crustaceans and mollusks in 1956 was 29·33 million metric tons* as compared with 20·47 in 1938 and 19·16 in 1948, which represents an increase of about 43% above the prewar catch in 1938 and 53% above the immediate postwar catches in 1948. Over the period covered this increase has taken place at the rate of between 5 and 7% or of over one million tons per annum. This is graphically illustrated in Fig. 1.

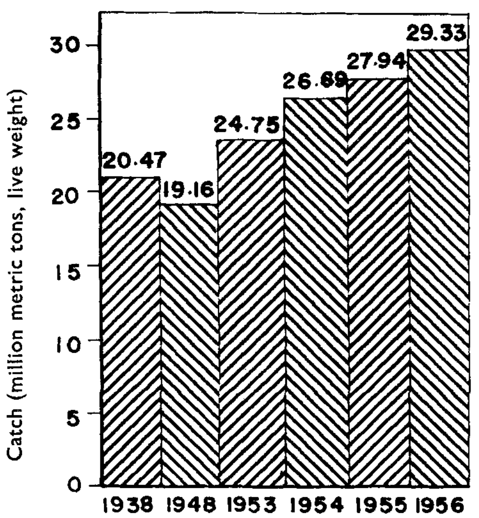

Fig. 1. Total world catch of fish, crustaceans, mollusks (Food and Agriculture Organization of the United Nations, 1957).

Catch by regions. The regional contributions to the 1956 total are shown in Table 1, from which it can be seen that Asia produces about 40%, or almost 12 million tons, of the world's catch and that most of this (11·5 million tons) is produced in south-

*Fish, crustaceans and mollusks will hereafter be called 'fish' and metric tons, 'tons'.

east Asia and the Far East. Europe is next with about 27% (7·970 million tons), North America catches about 14% (4·180 million tons) and U.S.S.R. 9% (2·620 million tons).

Table 1. *Catch by regions* (*Food and Agriculture Organization of the United Nations*, 1957)

Region	Catch: Million metric tons	Catch: Approximate percentage of total
Asia	11·83	40
Europe	7·97	27
N. America	4·18	14
U.S.S.R.	2·62	9
Africa	1·81	6
S. America	0·80	3
Oceania	0·12	1

Of the world total of 29·33 million tons, 23·45 million tons, or slightly over 80%, are produced in the northern hemisphere. About 11% of the total comes from the inland waters, mostly north of the Equator.

Composition of catch. The composition of the catch in 1956, by and large, followed that of the previous years. Almost 7 million tons consisted of herrings, sardines and clupeoid fishes. The next group, the cods, haddocks and hakes, accounted for about 5 million tons, followed by freshwater fish with 3·07 million tons, miscellaneous marine teleosteans with 2·73 million tons, mollusks and crustaceans with 2·63 million tons, tunas and mackerels 1·71 million tons, salmons, halibut and flat fish with 1·33 million tons, and mixed and unidentified fish with 5·24 million tons (Table 2).

Table 2. *Composition of catch* (*million metric tons*) (*Food and Agriculture Organization of the United Nations*, 1957)

	1938	1948	1953	1954	1955	1956
Aquatic animals, not elsewhere specified	0·06	0·03	0·05	0·06	0·07	0·07
Sharks, rays	0·23	0·35	0·31	0·30	0·28	0·28
Aquatic plants	0·49	0·18	0·36	0·38	0·40	0·40
Flounders, halibut, soles	0·33	0·48	0·53	0·53	0·60	0·64
Salmons, trouts, smelts	0·85	0·47	0·58	0·56	0·68	0·69
Crustaceans	0·49	0·51	0·65	0·76	0·74	0·78
Tunas, bonitos, mackerel	0·92	0·90	1·33	1·46	1·52	1·71
Mollusks	1·14	1·28	1·68	1·83	1·87	1·85
Miscellaneous teleosteans	0·86	1·08	2·22	2·30	2·64	2·73
Freshwater fishes	2·30	1·96	2·61	2·87	3·04	3·07
Cods, hake, haddock	3·20	3·51	3·78	4·18	4·67	4·88
Mixed, unidentified	4·26	3·59	4·41	4·77	5·02	5·24
Herrings, sardines, anchovies	5·34	4·82	6·24	6·69	6·41	6·99

Over the years the increases in catch have occurred fairly evenly over these various species, which can be taken to indicate that the increase is due to a generally heightened effort and heightened interest.

Disposition of catch. By 'disposition' is meant the way in which raw material is utilized. In order to make data comparable, quantities entering these disposition channels are converted into the live weight of the raw material utilized. Table 3 shows the quantities on a live-weight basis and the percentage of the total catch used.

Table 3. *Disposition of catch (A, in million metric tons; B, as percentage of total catch) (Food and Agriculture Organization of the United Nations,* 1957)

	1948		1953		1954		1955		1956	
	A	B	A	B	A	B	A	B	A	B
For marketing fresh	9·8	51	11·0	44	11·5	43	12·1	43	12·3	42
For freezing	1·0	5	1·5	6	1·7	6	1·9	7	2·2	8
For curing and salting	4·5	24	6·3	26	6·7	25	7·0	25	7·1	24
For canning	1·4	7	2·0	8	2·2	8	2·3	8	2·6	9
For reduction to meal and oil	1·5	8	3·0	12	3·6	14	3·6	13	4·1	14
For miscellaneous purposes	1·0	5	1·0	4	1·0	4	1·0	4	1·0	3
Total	19·2	100	24·8	100	26·7	100	27·9	100	29·3	100

From Table 3 it can be seen that the largest proportion of the catch is marketed in the fresh state but percentagewise there was a slight but persistent decline in it from 51% in 1948 to 42% in 1956.

The trend of quantities used for freezing was upward both percentagewise and in absolute weight, the percentage moving from 5 in 1948 to 8 in 1956 and the weight from 1·0 to 2·2 million tons in the same period.

The quantities used for curing, e.g. for salting, drying, smoking, have maintained an even percentage but increased absolutely from 4·5 to 7·1 million tons from 1948 to 1956.

There has been a marked and steady increase in the quantities used for meal and oil, from 8 to 14% and from 1·5 to 4·1 million tons over the 1948–56 period.

The picture thus presented reflects the use of a better technology of fish finding and catching, better floating equipment, and capital investment in these, as well as growth of the export trade.

Consumption

Even in countries with advanced statistical services many assumptions have to be made and in others no means yet exist to even approximate the necessary data. Statistical sampling methods are being developed and FAO has been applying them to matters of food consumption but there is still a long way to go, especially in the underdeveloped areas.

It can be seen, however, that if the available fish were distributed evenly amongst the population, after deduction of that processed for the production of oil and meal, each person would have the equivalent of about 10 kg/annum—something less than 30 g/day. This calculation, one must remember, is on the live-weight basis and when waste and inedible portions are deducted, the value would be reduced to an actual consumption level approximating 15 g.

However, patterns of consumption of fish are uneven. There are hundreds of millions of people who live in the interior of continents where lack of transportation and communications deprives them of fish food. Most fish is consumed near the sources of supply, the borders of the sea and inland water systems.

The *Second World Food Survey* (Food and Agriculture Organization of the United Nations, 1952) shows that in terms of recent averages at the retail level fish consumption was 26 kg/person/annum in the United Kingdom, 17 kg in Venezuela and 2 kg in India. Even the highest consumption amounts to only a fraction of 1% of the total diet.

The same study gives data from which Table 4 has been compiled.

Table 4. *Gross food supplies (kg/head/annum) of animal-protein foods* and fish, 1946–50† by regions*

(Computed from Food and Agriculture Organization of the United Nations, 1952)

Region	Animal-protein foods	Fish	Fish as percentage of animal-protein foods
Far East	34·5	6·6	19·1
Near East	110·2	2·8	2·5
Africa	68·6	2·4	3·5
Latin America	141·1	4·9	3·5
Europe	174·7	13·6	7·8
North America and Oceania	502·9	5·2	1·0

*Animal-protein foods include meat, fish, milk (as fluid milk) and eggs.
†Extreme limits of the period observed for all regions.

Though these data deal with conditions from 1946 to 1950, it is thought that the pattern still obtains in 1956.

Prospects for an increase in aquatic food

This matter was dealt with by Finn (1954) and the considerations mentioned in that paper still hold. The paper pointed out that Sverdrup (1952) and others believe that the total primary production of the sea is about equal to that of the land. But a much smaller fraction of the sea's primary production is used than of that from the land, which produces plants for direct consumption, whereas that utilized from the sea is mainly animal protein.

Phytoplankton, seaweeds and zooplankton. It is certain that the sea could yield considerably more food in the form of plant material than it does. The statistics show that during 1956 only 0·4 million tons were produced, mostly in the Far East. Woodward (1952) estimates that 60 million tons of brown seaweed grow on the coasts of Norway, France, the British Isles, Canada and U.S.A. The indirect use of aquatic plants and phytoplankton as manure also is capable of development, which also applies to zooplankton though the use of such would depend upon the evolution of suitable economic means of collecting the material.

Marine fish. In 1953 the Food and Agriculture Organization ventured the opinion that the yields of food from the waters of the world could be increased by 50%

without endangering the stocks. Since 1953 the catch has increased by over 18% and the rate of this increase may be expected to persist as stocks and species now unused or only partially so come under exploitation (Marshall, 1952; Walford, 1951).

At the beginning of this paper reference was made to the concept of the management of harvesting to bring about a continuity of optimum yields. There can be no doubt, as scientists have shown and are showing, that it, if it could be adopted amongst fishing nations, would increase yields in the long run. As was said at the outset, fishing is largely a hunting operation, just as the securing of food from land areas was thousands of years ago. Biological and oceanographical science of modern fishing is steadily placing at man's disposal the information he needs to enable him to manage his take of the crop in such a way that more fish could be obtained for less effort (Ministry of Agriculture and Fisheries, 1953). The problems still to be overcome are not so much scientific (although there is still a great deal to be done) as they are political, economic and social.

Inland fisheries. Inland fisheries seem amenable to considerable development. This statement not only applies to the proper management of the wild stocks in lakes and rivers which is steadily becoming more possible, but also to the development of methods of fish culture in enclosed bodies of water such as are to be found in ponds, reservoirs and irrigation systems. In 1956 slightly over 3 million tons came from the inland waters, over half coming from Asia. It is likely that much more than this quantity was produced since the vast operation of fish culture or peasant farming in such countries as China, Indonesia, Thailand and south-east Asia generally is in the class of subsistence fishing. Fish culture which has been known since antiquity was an art. It is steadily becoming a science, and thus the technique may spread to places where it was not formerly known. It is particularly useful in areas where poor transportation, storage and marketing methods deprive peasants of an adequate intake of animal protein.

One of the most promising fields of endeavour throughout the inland fisheries is the application of genetics. The selective breeding of stocks is giving rise to fish with more rapid growth rates, resistance to disease and greater tolerance to environmental changes, all of which ultimately add to yields. These and the great opportunities which exist for education and training of peasants and farmers in this respect and the possibility for better management of wild stocks lead to the belief that the inland fisheries can greatly be expanded.

Thus we come to the belief that fisheries production in the world can be increased greatly and that the role of FAO is to assist in this development by collecting, summarizing and disseminating information, assisting Governments to become aware of the possibilities and, when necessary, to implement forward policy and to encourage agreements for national and international action directed to these ends.

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The food supplies of the fish

By J. H. Fraser, *Scottish Home Department Marine Laboratory, Aberdeen*

The food of fish and where their food supplies come from is very much to the point as essential background in a symposium on world fish supplies.

The more food there is available for fish the bigger and better they grow, within limits, age for age. For example, a 5-year-old haddock living on the moderately good food supplied by the central North Sea grows to a length of 31·6 cm, but a 5-year-old haddock from the rich feeding in Icelandic waters grows to about 55 cm (Thompson, 1929) which is about five times the weight. If there is too much competition for food, fish do not grow so well and are of poor quality. This may happen in underexploited areas and, as more fish are taken from such grounds, quality improves. What happens when there is overexploitation is the subject of the next paper (Gulland, 1958), but it is obvious that no amount of conservation can increase the total weight of fish available beyond the limits imposed by its own food supply—though efforts can be directed to help ensure that the available food is used to the best advantage.

Productivity in the sea

With that in mind we can then consider the nature of this food and trace the food up from the fundamental source in the green photosynthetic plants. The main difference between the agricultural and aquatic environments is that on the land the water is in dark interstitial cavities between fairly stable soil particles and the light is in the air above; in the sea there is no such stability and no such division. Light for effective photosynthesis will not penetrate far enough to reach the bottom except in very shallow areas around the sea coast—a much too small a fraction of the total surface of the sea to concern us in this question, and one that we can ignore. There can be no holdfast in the open sea and the plants must float in the light zone, and floating be carried by the water movements from place to place both horizontally in the currents and vertically in areas of turbulence. As many of these small autotrophic plants cannot photosynthesize in an excess of light it may be just as unproductive for them to be brought too near the surface as to be taken down too deep. Their growth is, of course, dependent upon the dissolved nutrient salts and metabolites as well as the light. The greatest bugbear for the research worker in these

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