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Production of Fish Protein Concentrate

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POTENTIAL RAW MATERIAL SUPPLIES FOR THE INDUSTRIAL PRODUCTION OF FISH PROTEIN CONCENTRATE 1/

Prepared by the Food and Agricultural Organization

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POTENTIAL RAW MATERIAL SUPPLIES FOR THE INDUSTRIAL PRODUCTION OF FISH PROTEIN CONCENTRATES

INTRODUCTION

When disucssing fish protein concentrate (FPC) it should be understood that this term is not confined to one well defined commodity but covers a number of rather different products which can be divided into two main categories: feed grade FPC products which include products that have not been manufactured in accordance with the hygienic standards for human food; and food grade FPC products which cover products that have been manufactured under human food hygiene standards.

The first category includes fish meal for animal feeding with a fat content of [illegible] to [illegible] percent. It also includes fish meal with a substantially reduced fat content, e.g. by means of solvent extraction to eliminate the adverse effects of, e.g. fish oils and other solvent soluble components when the meal is fed to animals.

The second category includes products similar to those of the first category, both refined and unrefined. The most refined products have a fat content of [illegible] percent or less, a neutral taste and light colour. These products are for use as protein supplements to human foods in which a fishy taste is not desired. The refined FPC products may be flavoured after the fat has been extracted.

The [illegible] Drug Administration has issued regulations concerning the use, [illegible] territory, of refined solvent extracted FPC for direct human consumption. Under these regulations, only red hake [illegible] may be used as raw material for the production of food grade FPC.

The proteins of the flesh of all fish, however, have approximately the same [illegible] composition and a similar nutritive value [illegible]

suitable raw material on which to base an FPC industry. Each fishery must ascertain which species of fish can be landed at the required low cost. Another reason for the need for flexibility in the choice of raw material is that in many fisheries an adequate supply of raw material can only be ensured if a mixed catch can be used. In tropical countries, in particular, the landings which are likely to be used for the production of FPC will often consist of various species (trash fish from shrimp trawlers or from other fishing vessels, which are usually discarded).

There follows an account of some of the fishery resources which may be exploited for fish meal production.* Some of these resources may be used for the industrial production of solvent extracted FPC for direct human consumption if, in future years, there is a market for such products.

WORLD FISH PRODUCTION 1/

During the last [illegible] to 9 years the world catch has increased at an annual rate of 7.0 percent per year while the rate of increase in human population has been of the order of 2.0 percent per annum. The increase in the fish catch has been uneven both in terms of species and in respect of geographical distribution. A substantial part of this increase has been used for reduction to meal and oil.

Table 1 shows average fish landings for 1958 and total landings in the years 1965 to 1967. In addition, the rate of growth in world fish catch during these years is compared with the rate of growth during 1958 to 1965.

A high rate of increase in fish landings has been recorded in Northwest Europe, mainly due to technological developments in locating fish which have enabled a more economic exploitation of certain pelagic fish stocks, mainly for fish meal production. For a modern trawler the actual finding of the fish occupies about half the total time at sea, and for a purse seiner the proportion is even higher. Thus, the value of improvements in locating fish is obvious. The application of modern fishing techniques is one of the factors responsible for sustaining the extraordinarily high rate of expansion in the Peruvian anchoveta fishery which, in turn, has been mainly responsible for an annual average increase of fish catch in Latin America of 25.9 percent between 1958 and 1965, the highest increase over a period of 7 years recorded in the history of modern fishing.

Table 1

World Fish Catch up to 1967 and Rate of Growth 1958* - 1965* by Economic Region

	1958	1966	1967	196[illegible]	Annual average increase percent per year		
	'000 tons				58*/62	62*/65	58*/65*
WORLD TOTAL a/	33,800	57,300	60,500	[illegible]	[illegible]	[illegible]	7.[illegible]
Developed countries	17,682	22,690	23,541	24,866	3.[illegible]	[illegible]	3.0
North America: USA, Canada	3,804	3,[illegible]	3,673	3,932	1.3	(-)0.8	0.4
Europe	7,780	11,022	11,302	10,971	1.8	7.1	4.1
EEC	2,021	2,212	2,193	2,231	0.4	1.9	1.0
Northwest Europe	4,246	6,622	6,855	8,740	1.3	10.0	4.9
South Europe	1,513	2,188	2,255 b/		5.2	5.5	5.3
Other developed countries	6,104	7,779	8,866	9,963	5.3	-	3.0
Japan	5,599	7,102	7,814	8,670	4.8	6.1	2.8
Oceania	96	145	148 c/	160	3.2	6.3	4.5
Rep. of South Africa	409	532	904	1,133	12.0	2.0	5.5
Centrally planned countries	7,575	12,390	12,749	13,[illegible]	[illegible]	10.9	9.9
USSR	2,630	5,349	5,777	6,0[illegible]	[illegible]	11.2	9.9
Other European countries	297	661	692 d/	[illegible]	[illegible]	[illegible]	[illegible]
China (Mainland)	4,067	5,800 e/	5,800 e/	[illegible]	...	...	...
Other Asian countries	575	580 f/	580 f/	1,100	...	...	...
Developing countries	8,537	22,755	24,330	25,104	16.1	8.[illegible]	13.[illegible]
Latin America	2,154	11,610	12,720	13,480	[illegible]	10.[illegible]	25.9
Africa, South of Sahara	1,259	2,737	3,292	3,074	[illegible]	7.7	7.4
Near East and Northwest Africa	417	473	43[illegible]	280	[illegible]	[illegible]	6.[illegible]
Asia	4,707	7,938	8,366	[illegible]	[illegible].7	[illegible]	[illegible]

* Average of three years, i.e. 1958* indicates an average of 1957-1959

a/ Totals do not add due to rounding of data as indicated below

b/ Estimate; 1966 catch figures used for Greece, Portugal and Turkey

c/ Estimate; 1966 catch figures used for New Zealand

d/ Estimate; 1966 catch figures used for East Germany

e/ Estimate; 1960 figures

f/ Estimate; 1957 figures used for North Korea and 1962 figures for North Vietnam

While the application of modern fish location and fish catching methods was an important factor in stimulating the rapid expansion in Western South America, the most important factor was the market opportunity in the form of a rapidly increasing demand for fish meal, due to the expansion in developed countries of poultry and [illegible] breeding on an industrial scale.

Other important factors are the recent development of distant water fishing operations and the advances in freezing at sea and in producing fish meal on board fishing vessels. These developments are responsible for the sharp increase in fish landings in some Mediterranean countries, in Japan and in the U.S.S.R.

The rate of increase of fish landings in developing countries, in general higher than that in developed countries, shows great variation. In the case of Peru and Angola, it is due to the rapid development of reduction industries; in other cases it is the result of the motorization of traditional vessels and better technical equipment, the better training of fishermen and the expansion of fish marketing. In a few cases industrial high-seas [illegible] that while in the future the growth [illegible] growth rate in [illegible] increase.

Table [illegible] for the various [illegible] in Annex I, and gives the estimated [illegible].

The potentials of the [illegible] important groups of species are approximately as follows:

Large pelagic fish [illegible]	[illegible]	tons
Demersal fish [illegible], etc.	[illegible]	"
Shoaling fish [illegible] sardines, [illegible]	[illegible]	"
[illegible] [illegible] etc.	[illegible]	"
Cephalopods	[illegible]	"

'000 tons

	Cultivated		Total	
	[illegible]	Potential	[illegible]	Potential[2]

[2] Figures for potential do not add horizontally due to rounding

The figures of potential presented in Table 2 are almost certainly overestimates of possible harvests as each figure is the sum of the potential of a number of different stocks, assuming each is exploited at the optimum rate.

The estimated demand for fish for reduction to fish meal in 1985 may be 38,000,000 t and that for food fish 70,000,000 t. To satisfy this demand it will be necessary to develop unconventional resources such as small pelagic fish and Antarctic krill. The potential of the latter has been estimated at 50 million t and upwards.

RESOURCES FOR POSSIBLE INDUSTRIAL UTILIZATION

The Northeast Atlantic area[2] includes some of the fishing grounds with the oldest fishing tradition in the world, such as those off Iceland and Norway and in the North Sea and the Baltic Sea. An important development within the last 10 years has been the development of fisheries which catch specifically for the production of fish meal. The catches include herring, sprat, capelin and mackerel. In addition, the exploitation of the hitherto non-fished stocks of sand-eels (*Ammodytes* spp.) and Norway pout (*Trisopterus esmarkii*) has started.

Pelagic fish. In the countries adjoining the Northeast Atlantic Ocean herrings are mainly used for reduction to fish meal, although appreciable quantities are also used in some countries for direct human consumption. All stocks seem rather heavily fished with the exception of those in the waters west of the British Isles which have a potential of about 200,000 t.

Sprat fishing in the North Sea is coastal fishery and a great part of the catch is used for fish meal production. In some areas an increase in the catch may be possible. In 1965 75,000 t were caught but the total potential yield may be at least 150,000 t.

Mackerel stocks are commercially exploited in the Kattegat, the Skagerak and the southern waters of the North Sea. Owing to the expansion in the Norwegian purse seine fishery in 1965 and following years, there was a very large increase in mackerel catches (1964: 40,000 t; 1966: 500,000 t; 1967: 870,000 t; 1968: 730,000 t). The fish are mainly for reduction to fish meal. The fall in catches in 1968 suggests that the stocks off Norway are fully exploited, and the sustainable annual yield may be in the range of 500,000 to 700,000 t. Little is known about mackerel stocks in other parts of the Northeast Atlantic area, e.g. in the southern waters (ca 30,000 t, ICES statistics).

Horse mackerel landings in the North Sea amount to 5,000 t a year. This seems to be well below the sustainable yield. In the southern waters this species is of greater importance and in 1966 100,000 t were caught in the Bay of Biscay off the coast of Portugal. It is believed that catches could be moderately increased.

Other resources Increased production of fish meal will require the development of fisheries on less exploited and presently commercially unattractive species, such as capelin (*Mallotus* spp.), sand-eels (*Ammodytes* spp.), Norway pout (*Trisopterus esmarkii*), argentines (*Argentina* spp.), blue whiting (*Gadus poutassou*), macrurids, etc.

Capelin, a species of the northern part of the area, has been exploited in recent years for industrial purposes. In 1967 50,000 t were caught off Iceland, 300,000 t off North Norway and 500,000 tons off the U.S.S.R. In 1962 the total catch in the area amounted to only 3,500 t.

Recently, new fisheries have started, especially in the North Sea, to exploit stocks of sand-eel and Norway pout for industrial purposes. Catches have fluctuated, with a peak in 1967 of 210,000 t while in 1965 catches were under 70,000 tons. There seem to be other promising stocks of sand-eels west of the British Isles and off the North coast of Scotland. Catches of Norway pout (possibly including some haddock), reached a little under 500,000 t in 1968.

One of the presently commercially unattractive species is the blue whiting, with a suggested potential of about 300,000 tons in the area northwest of Ireland and northeast of Scotland. Argentines (*A. silus* and *A. sphyaena*) are other unexploited species in the North Sea. Argentines and macrurids have been found in depths between 200 and 1,000 m in the waters west of the British Isles, but the likely catch rates do not seem high enough to support a fish meal fishery.

The *Eastern Central Atlantic area*[2] includes the Moroccan coast in the north and the waters around the Cape Verde Islands and the Gulf of Guinea in the south.

Pelagic fish. The catches of pelagic fish in the northern area, from the Strait of Gibraltar to Dakar, were as follows:

Small pelagic fish:	[illegible] t – principally sardine landed in Morocco but also small quantities of *Sardinella* spp. landed in Senegal.
Medium pelagic fish:	[illegible] t – principally horse mackerel (*Trachurus* spp.), blue fishes (*Temmodon saltator*) and mackerels (*Scomber* spp.), mostly caught by trawlers from the U.S.S.R. and other East European countries.
Caphalopodes:	150,000 t – these are taken mainly by Spanish and Japanese vessels and include squid, cuttlefish and octopus.

In the southern area (Dakar to Congo) the pelagic inshore fisheries are based mainly on bonga (*Ethmalosa fimbriata* and *Sardinella*). The presence of *Sardinella* spp. is correlated with the presence of upwelling. *Sardinella* are, therefore, abundant mainly off Senegal, Ivory Coast, Ghana, Gabon and the Congo, and in Northern Angola. Increased fishing on *Sardinella* seems possible. Studies on pelagic species, especially *Sardinella*, are now being carried out by a group of FAO/UNDP Special Fund Projects in several West African countries.

Quantitative estimates of the potential of pelagic resources are difficult although it seems that some of these were fully exploited. Catches of sardine (pilchard) off Morocco increased in 19[illegible] to [illegible],000 t (1[illegible],000 t in previous years), but it is too early to say what effect this increase has had on the stock. The potential of the sardine stocks south of Gibraltar is estimated at [illegible],000 t. The other pelagic stocks of the Eastern Central Atlantic may have a similar potential of some hundreds of thousands of tons but probably not millions of tons. In Table 3 the estimates of the potential of pelagic fish species are summarized.

Table 3

Estimates of potential of pelagic fish in the Eastern Central Atlantic area

Catches ('000 t)	[illegible]		[illegible]	
	Present	Potential	Present	Potential
	1960		[illegible]	
Sardines	280	[illegible]	-	-
Anchovy	-	400	-	(± 100)
Sardinella	30	100 (?)	7[illegible]	(± 100)
Mackerels, horse mackerels, etc.	100	200-300	-	-

Increased catches could probably be possible from the stocks of mackerel, horse mackerel and other [illegible]. These fisheries, however, have recently been expanding rapidly and more data are required for better estimation of the influence of the present catches on the stocks. The present catches of mackerel, horse mackerel, etc. can most likely be increased 2 to 3 times, i.e. to a total of 200,000 to 300,000 t.

Anchovy stocks off Ghana and the Ivory Coast (*Anchoviella guineensis*) and others are untouched. Detailed exploratory fishing is required to determine whether the fish can be landed at a sufficiently low cost to support a fish meal industry.

Other resources. Among the demersal stocks are many of low economic value, e.g. elasmobranches, some croakers in the north and *Brachydenterus auritus* in the south, which could be the main raw material for a fish meal industry if they could be fished economically. [illegible] and small fish such as myctophids are important and still unexploited resources of the open ocean.

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]
Pilchard	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Anchovy	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Maasbanker	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mackerel	-	(± 10)	[illegible]	150	[illegible]
Sardinella	(1,000)	(± 10)	[illegible]	1,000	-
Round herring	-	-	(± 100)	[illegible]	-
Sand-eels	-	-	(± 10)	50	-
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Other resources [illegible] species which are not yet exploited commercially, such as saury (Scomberesox saurus), myctophids and the squid (Loligo reynaudi) [illegible] not confined to waters [illegible] the coast, as are the species discussed above. The extent to which these stocks [illegible] exploited depends [illegible] the possibilities to extend fishing. The resources of myctophids is large but its commercial exploitation would require some technological advances to make it economically feasible

The [illegible] of the [illegible] may be [illegible]

[illegible]

[illegible]

[illegible] larger [illegible] greatest [illegible] in the [illegible] ocean, and [illegible] knowledge of [illegible] processing and marketing.

---

a/ FAO [illegible]

[illegible], on the other hand, is one of the abundant [illegible] the vicinity of [illegible] an [illegible] in [illegible] has been decreasing [illegible] in [illegible]

[illegible] which [illegible] tential [illegible] are the [illegible]

[illegible] interest [illegible]

[illegible]

[illegible]

[illegible]

The Northwest Atlantic area[10/11] includes the Eastern seaboard of Canada where it is planned to set up a plant for the production of food grade FPC with a capacity of 200 t raw material a day. It is intended to use fillet trimmings from cod as the main source for this production. Other resources for FPC production could be in-shore species now landed for reduction to fish meal, mainly herring, sand-eels and trash fish caught in the trawl fisheries for cod, etc. At present trawlers discard commercial species which are below marketeble size and many unmarketable species such as skates, dogfish, red hake, eelpouts, grenadiers, sea ravens, sculpins and others. In addition, there are resources of sand-eels and argentines and in the deep water further exploitation of grenadiers, latern fishes, barracudinas, etc. is possible. The deep water species, however, could only be taken at high cost. Further research would be required to make exploitation of these stocks economic.

In the Western Central Atlantic area[12] which includes the Gulf of Mexico, the Caribbean and the Atlantic coasts of South America, there is again the problem of utilizing trash fish caught by shrimp trawlers. The quantity taken and discarded by U.S. shrimp trawlers may be as much as 600,000 t. A similar quantity may be caught by shrimp vessels of other nations.

The entire catch of the U.S. menhaden fishery in the Gulf of Mexico is used for the production of fish meal. While peak landings are over 1 million t, the stocks are declining. Anchovy and thread herring stocks seem to be large but are unexploited. The total potential annual catch of pelagic fish is estimated at 1 million t in the Gulf and 750,000 t off the U.S. Atlantic coast.

The Caribbean appears less productive than the Gulf of Mexico, except for the eastern part of the South American coast.

The main fishery for pelagic fish (excluding tuna) is along the coast of Venezuela where some 40,000 t of sardine (*Sardinella anchovia*) and smaller quantities of anchovy (*Cetengraulis edentulus*) and round herring (*Opisthonema oglinum*) are caught annually. There is no evidence that the sardine cannot be further exploited but it is probable that other pelagic species offer better possibilities for major expansion in catches.

In the area off the U.S. coast sand-eel (*Ammodytes americanus*) could provide large catches.

THE PLACE OF FISH PROTEIN CONCENTRATES IN THE DEVELOPMENT OF PROCESSED FISHERY PRODUCTS

The foregoing fairly comprehensive survey should give an idea of the magnitude of the problem of supplies when considering the development of fish processing industries in various parts of the world, including developing countries. Knowledge of the resources must be supplemented by knowledge of the facilities available for catching and landing and the cost of the raw material. The status of technology and of technological education in a country must be considered.

In considering fish protein concentrates, another most important and complex problem is marketing. As already mentioned, FPC covers a broad range of products with completely different markets. For this reason, the establishment of appropriate product specifications is an essential first step.

Fish meal is the most common feed grade FPC product with a world production of almost 5 million t in 19[illegible]. Its market is increasing, mainly due to its use in formulated feed mixtures. In Japan compound feed mixtures for animals accounted for 3[illegible]2,[illegible]39 t of fish meal in 19[illegible] and [illegible] t in 19[illegible]. In addition, an estimated quantity of [illegible]5,000 t of fish meal was used in compound feeds for fish. Only about 50,000 t of fish meal were used for direct feeding by farmers in 196[illegible].

According to Prospects for world fishery development in 19[illegible] [illegible] [1] the demand for fish meal will gradually outstrip the supply, particularly if the price in relation to competitive products remains fairly stable. The projected total world demand for fish meal for 1985 amounts to [illegible] t. The consumption in developing countries was 3[illegible],000 t in 19[illegible] and the estimated demand for 1985 is 1,5[illegible]0,000 t. Recently developed products with a limited but obviously growing market are solvent extracted feed grade FPC products made from fish meal or raw fish. This feed grade FPC need not be completely tasteless.

As far as food grade FPC is concerned, there is as yet no market in the food sector and there is no information available which would allow market possibilities for a refined FPC product for direct human consumption to be

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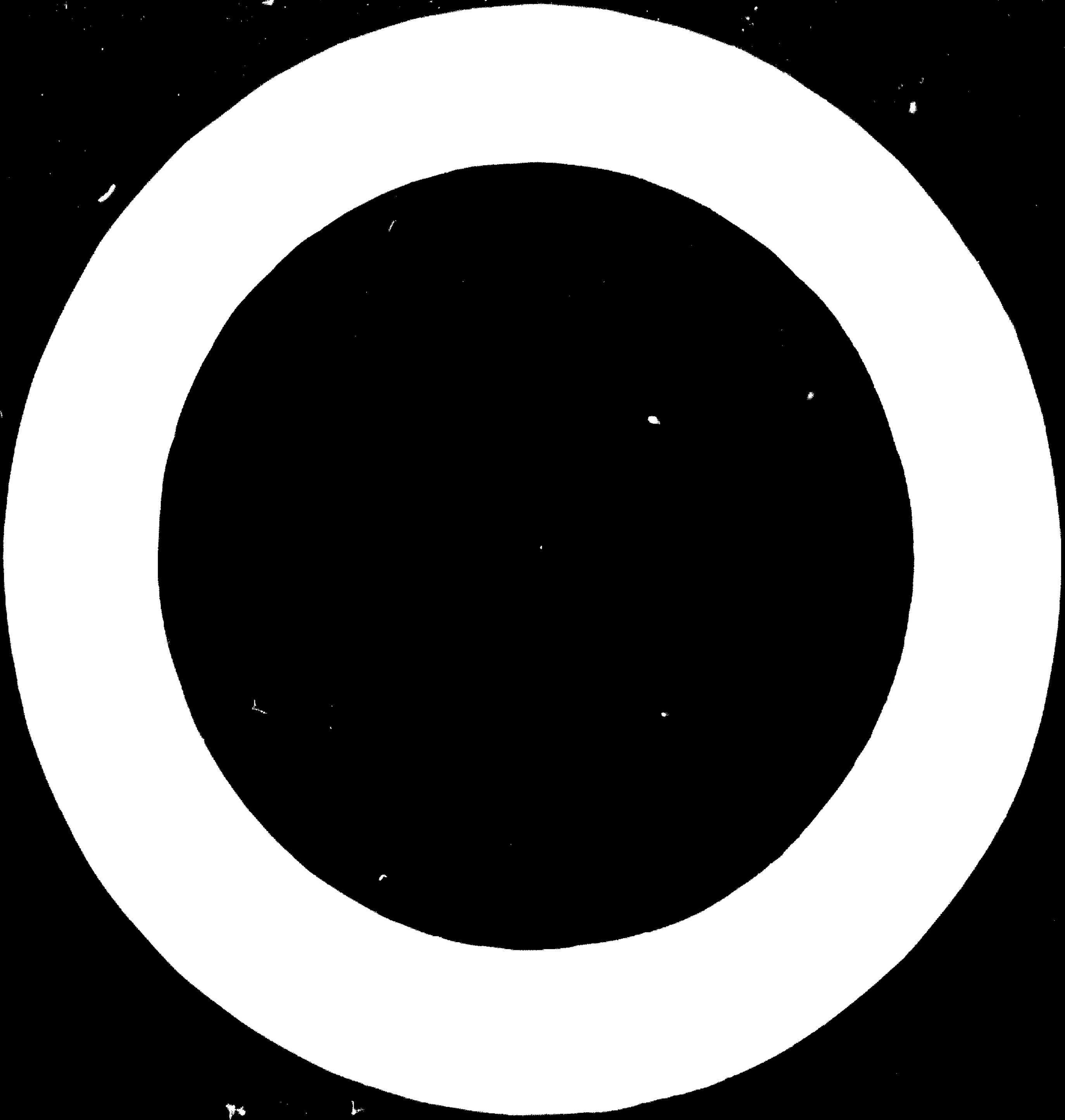
11. [illegible]

12. FAO [illegible] of the world's Ocean [illegible]

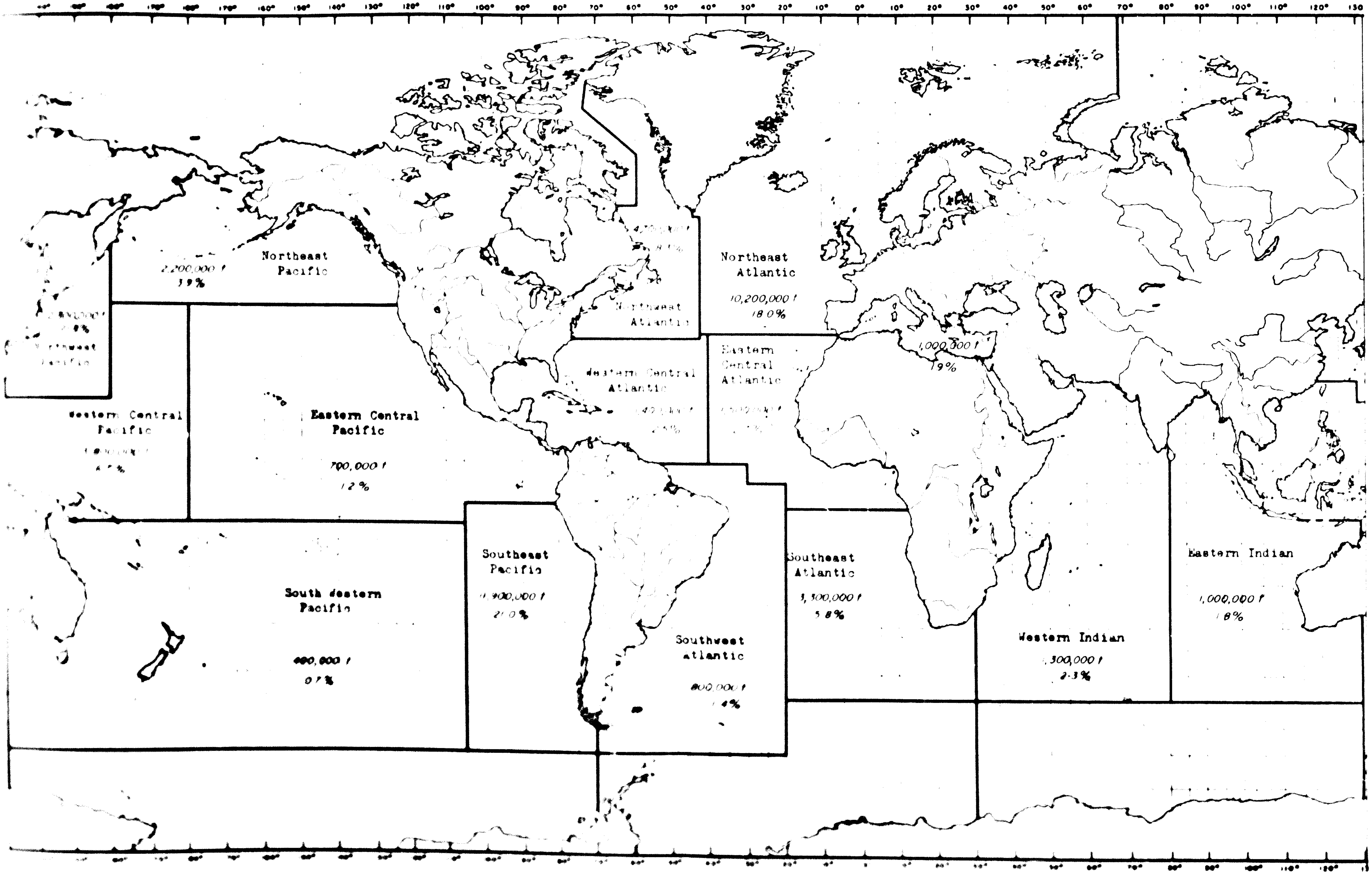
13. FAO [illegible]



Appendix I

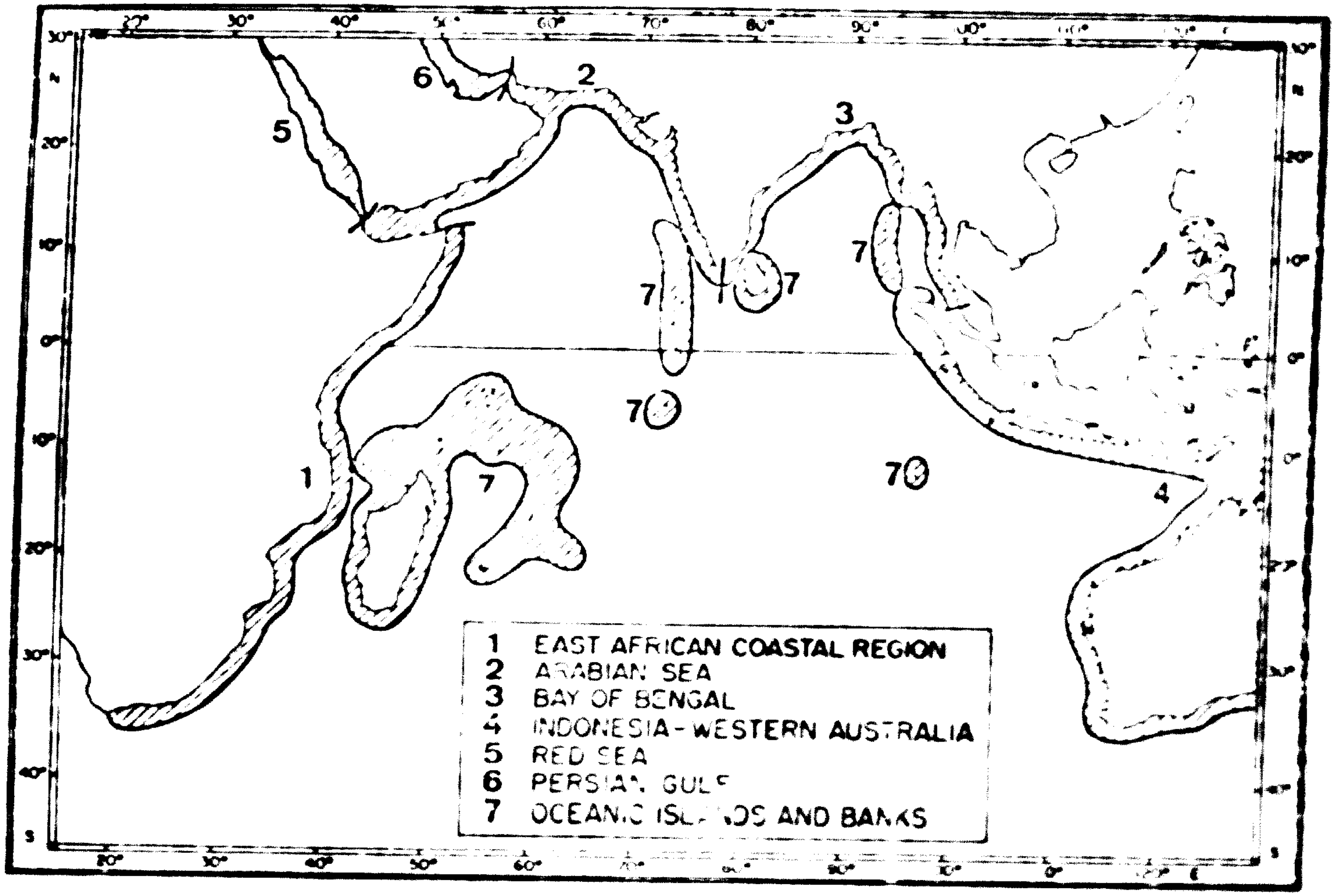
WORLD CATCH 1968

by major fishing areas



Appendix II

Coastal waters of the Indian Ocean



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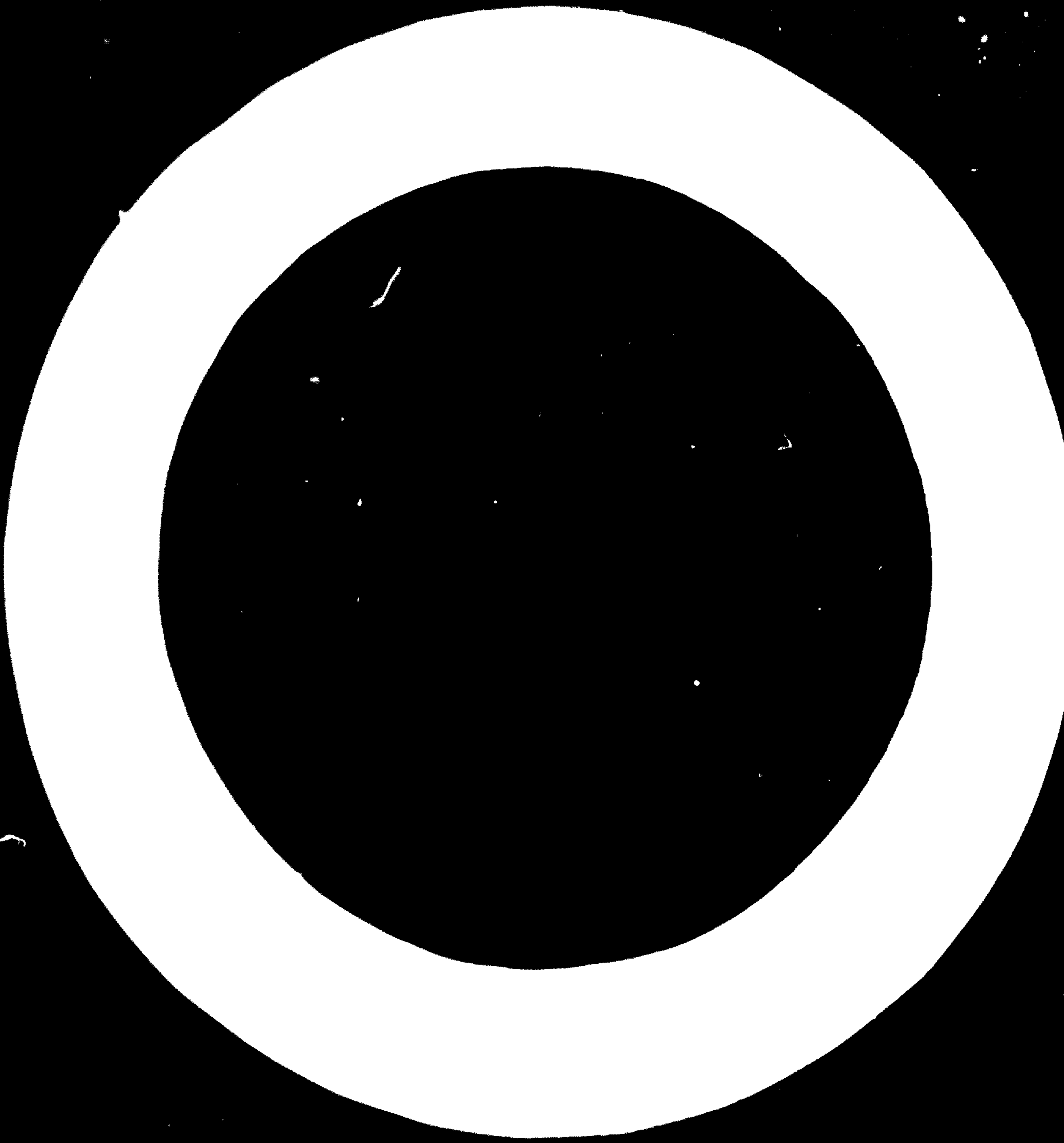
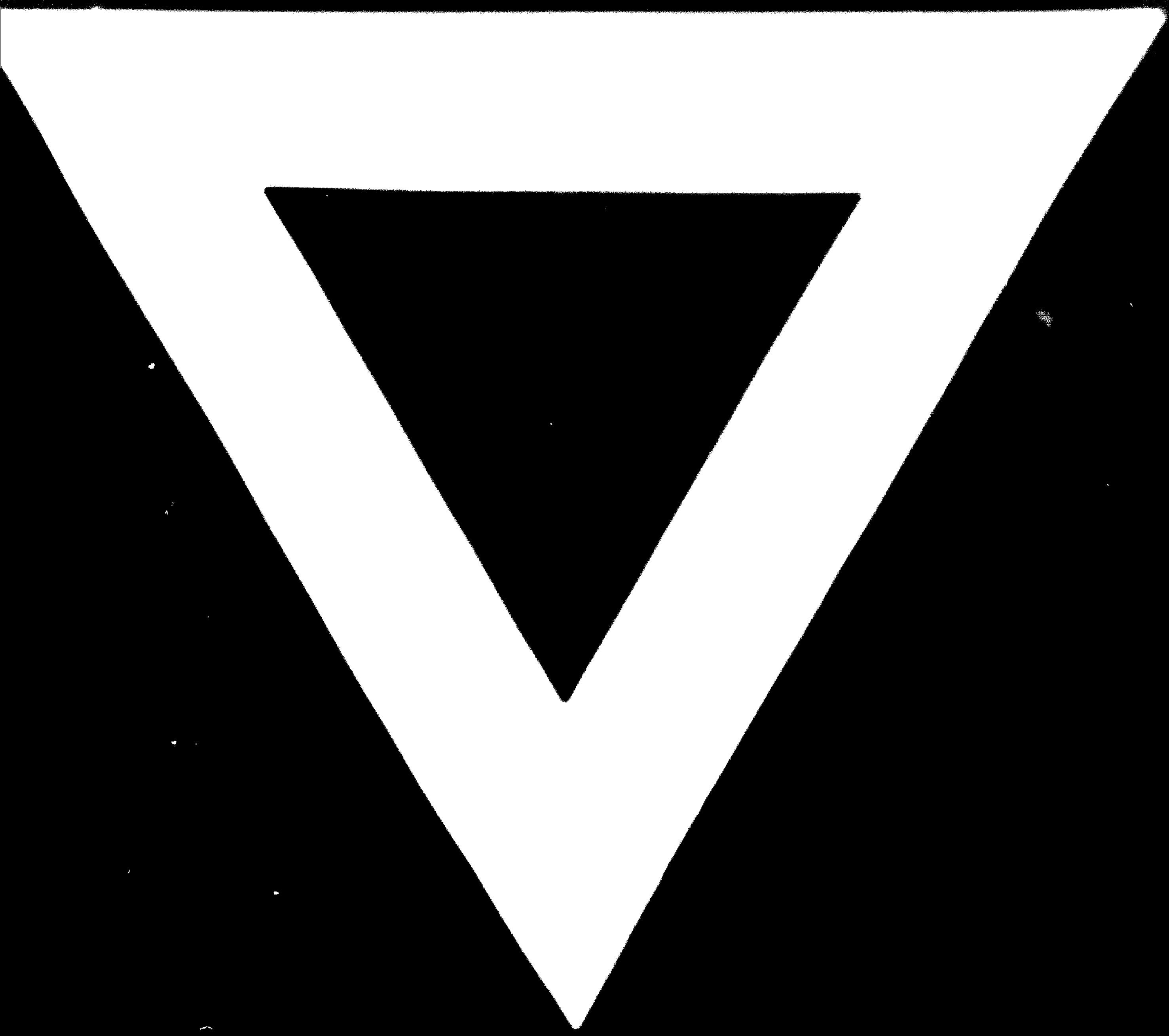


FISH MEAL AND SOLUBLES PRODUCTION
FROM OILY FISH AND RAW MATERIAL USED IN 1967

Country	Type of raw material	Raw material (live weight) (thousand tons)	Production of meal and solubles (thousand tons)
World total	Various oily fish	[illegible]	4[illegible]
Peru	Anchoveta	[illegible]	[illegible]
Norway	Herring, mackerel	[illegible]	[illegible]
Japan		[illegible]	[illegible]
USSR	offal	[illegible]	20[illegible]
USA	Menhaden, tuna, mackerel, herring, other	[illegible]	[illegible]
Denmark	[illegible]	[illegible]	[illegible]
South Africa	[illegible] anchovy	[illegible]	[illegible]
South West Africa	Pilchard	[illegible]60.5	[illegible]
Chile	Anchoveta, pilchard, other	[illegible]	[illegible].4
Iceland	Herring, capelin	[illegible]	[illegible]
Germany, F.R. of	Herring, others	[illegible].5	60[illegible]
Canada	Herring, others	[illegible]1.0	[illegible]
Angola	Horse mackerel, sardinella, [illegible] other	[illegible]	40.4
Morocco	Sardine, mackerel, horse mackerel	[illegible]	[illegible]
Spain	[illegible] mackerel, anchovy, [illegible] tuna, [illegible] other	[illegible].5	[illegible]
Poland	offal [illegible] other	[illegible].0	21.4
France		[illegible].0	[illegible]
Panama	Anchoveta, herring	[illegible].0	[illegible]
Mexico		[illegible]	[illegible]
Faeroe Islands	Herring	51.0	10[illegible]
Senegal		[illegible].0	[illegible]
Netherlands	Herring, other	[illegible].0	8.[illegible]
Portugal		5.	[illegible]
Sweden		[illegible].0	7.[illegible]
Venezuela		[illegible]	[illegible]
Brazil	Sardine	[illegible]1.5	4.[illegible]
Ecuador	Thread herring, anchovy, skipjack, yellowfin tuna	[illegible].0	[illegible].6
U.K.	Herring	12.0	2.[illegible]
Italy		10.[illegible]	2.0
Ireland		7.5	1.5
Malaysia (West)		7.5	1.5
Ethiopia	Sardine, anchovy	[illegible].0	1.[illegible]
Argentina	Anchoveta	4.5	0.[illegible]
Belgium	Herring, other	4.0	[illegible].6
Greece		2.0	0.[illegible]
Cape Verde Islands		1.[illegible]	.2
El Salvador		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]

[illegible] FAO [illegible]



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