RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No.1878
(H)

ICNAF Res.Doc.67/82

ANNUAL MEETING - JUNE 1967

Draft Review of Living Resources of the Northwest Atlantic Ocean Area

by J.A.Gulland[1]

The attached document is one of a series being produced by FAO as part of the study of the world's food resources under the Indicative World Plan. After a meeting of experts in Rome in December 1966 which discussed techniques and also sources of information, FAO staff members or consultants are preparing such preliminary surveys of the resources in each of the major ocean areas of the world. These preliminary drafts are being circulated for comment among scientists with experience in the area concerned. In order to take advantage of the 1967 meeting of ICNAF, and especially the advice and experience of the members of the Research and Statistics Committee, this draft has been prepared rather more hastily than is desirable; in particular some sections have not been completed and are only presented in outline. Nevertheless, it is hoped that in its present state it will be of interest to ICNAF and will provoke comments helpful in preparing a final draft.

1. TOPOGRAPHY

The area is the concern of the International Commission for the Northwest Atlantic Fisheries (ICNAF). This has divided the region in five subareas as follows (in brackets the area of bottom less than 100 fms):

1. West Greenland ( )
2. Labrador ( )
3. Newfoundland ( )
4. Nova Scotia and Gulf of St. Lawrence ( )
5. New England ( )

2. HYDROGRAPHY

(A general description, 1-2 pages, might be produced by ICNAF)

3. PRIMARY PRODUCTION

(There are very good observations in the southern part, but not much in the north areas 1 and 2; in parts, at least primary production is high. Someone experienced in the areas could produce a summary, 1-3 pages.)

4. SECONDARY PRODUCTION (ZOOPLANKTON AND BENTHOS)

(Some data are available, and should be summarized, dealing with standing stocks and annual production.)

5. FISH STOCKS AND FISHERIES

5.1 Statistics - Detailed statistics are published annually by ICNAF (Statistical Bulletin). The data are broken down by species, area, month, and year and include effort data. This is probably the best series of statistical data in any major sea area and is kept under regular review by ICNAF. Present (1965) catches by subarea and major species were (in thousands of tons):

[1]Chief, Fish Stock Evaluation Branch, Fishery Resources and Exploitation Division, Department of Fisheries, FAO, Rome.

Subarea	Green-land 1	Labrador 2	New-foundland 3	Nova Scotia 4	New England 5	Total[1]
Cod	360	333	496	225	42	1,463
Haddock	-	-	9	85	155	249
Silver hake	-	-	-	50	323	373
Redfish	19	23	112	68	8	231
Flounders	3	7	81	48	57	196
Halibut	-	1	2	2	-	5
Herring	-	-	8	180	74	263
Other groundfish	13	13	17	57	110	210
Other pelagic fish	-	-	1	13	9	23
Other fish	2	1	6	16	23	53
Total[2]	404	377	740	777	890	3,197

[1] Includes 10,000 tons, area not known
[2] includes shellfish

5.2 The fisheries - The main fisheries in the ICNAF Area are the demersal fisheries by trawls and lines. Three groups of species - cods, flatfishes, and redfish are mentioned in the ICNAF Convention as being of special interest to the Commission.

Cod (Gadus morhua) - This fishery is very old, and is carried out by large vessels from Europe, including an increasing number of large freezing and factory trawlers and smaller vessels from North America, using a range of gears, though with an increasing proportion of medium trawlers. The fisheries in Subareas 3 and 4 have always been large, but that in Subarea 1 has increased greatly in the last 10 years, while the trawl fishery in Subarea 2 has increased from very little in 1959 to one of the most important (300,000 tons) in 1965.

Haddock (Melanogrammus aeglefinus) - Until 1965 haddock were fished in quantity only by three countries: by US (and some Canadian) trawlers on Georges Bank (Subarea 5), and by Canada, Spain and US in Subareas 3 and 4; the catches in Subarea 3 depend greatly on the strength of year-classes; recent year-classes have been very weak, and catches have been low. In 1965, due in part to an outstanding year-class, there has been a large USSR fishery on Georges Bank.

Redfish (Sebastes) - Redfish are caught almost exclusively by trawl. In the southern areas, fishing by US and Canada has continued for many years without violent changes. In the northern areas, fishing by European trawlers started in the late 1950s and has fluctuated greatly; on a succession of individual grounds, catches built up very rapidly, lasted two or three years, and declined to a relatively low level. More recently catches seem to have been more stable.

Silver hake (Merluccius bilinearis) - For a long time there has been a US trawl fishery in Subarea 5, remaining rather stable around 440-50 thousand tons. Since 1962 a large USSR fishery has developed, first in Subarea 5 and later in Subarea 4, reaching over 300 thousand tons in 1965.

Flounders - These include several species. Much of the catch is taken incidentally by vessels trawling for cod and haddock, but a number of US and Canadian vessels, using trawls and Danish seines, fish specially for flounders, and these catches have recently been increasing quite rapidly.

Herring (Clupea harengus) - The inshore fishery by Canada and US with a variety of gears has fluctuated around 150 thousand tons for a long time. In 1960, an offshore trawl fishery by USSR developed in Subarea 5 reaching a peak catch of 160 thousand tons in 1961. A Canadian purse-seine fishery has been increasing recently.

Other fish - A variety of other fish are caught, especially in the southern areas. The more important of these are as follows: shark, swordfish and tuna, and hakes (Urophycis spp.)

5.3 Assessments - Regular assessments of the state of the important exploited stocks have been made by the Research and Statistics Committee of ICNAF, especially lately by its Assessment Subcommittee (see ICNAF Annual Reports, especially supplement to Vol.11 and scientific reports in the annual ICNAF Redbooks).

Cod - All the stocks in the ICNAF region are heavily fished; good assessments have been made for most stocks, though in Subarea 2 the recent and rapid development of the fishery has made good assessment difficult until the last year or two. The detailed results are given in numerous ICNAF documents, summarized in various reports of the Assessment Subcommittee. In no area can any substantial increase in sustained yield per recruit be expected from an increase in effort, but for few areas is the present fishing exactly at the maximum (if a maximum exists) in the yield per recruit curve. Some moderate increase in yield per recruit, perhaps of 10-20%, may, therefore, be achieved by proper management use of larger meshes, moderate reduction in fishing etc. as appropriate for each stock.

Fluctuations in recruitment are important in some areas, e.g. West Greenland, but do not cause any great variation in the total catch from the whole area. The potential annual yield is, therefore, slightly above the present annual catch - perhaps 1,500-1,750 thousand tons. However, it is possible that a small decrease in the water temperature at West Greenland could cause a substantial sustained decrease in year-class strength, which would reduce the total cod yield from the ICNAF region by 300-400 thousand tons.

Haddock - These stocks are also heavily fished and detailed assessments made especially of the Georges Bank (Subarea 5) stock (see several ICNAF documents and publications of US Bureau of Commercial Fisheries). A limited increase in yield per recruit could be achieved by suitable regulations.

Year-class fluctuations are, however, very important in these fisheries; Subarea 3 catches have reduced from 104 thousand tons to 9 thousand tons between 1955 and 1965 and Subarea 5 catches increased from 70 thousand tons in 1964 to 155 thousand tons in 1965, mainly due to changes in year-class strength. The causes of these changes are not knownn. Precise estimates of the potential yield, therefore, cannot be used, but if future year-classes are not very different from the average of those in the fishery between 1960 and 1964, then the potential yield would be a little above the 1960-64 average (149 thousand tons) i.e. 160-175 thousand tons.

Other species - Detailed assessments have not been made for other important fisheries some of which (e.g. silver hake and herring) have developed or increased very recently. There is a major uncertainty concerning the relation between the groups of redfish exploited on the banks, down to 300 fathoms, or rather deeper, and the stocks of redfish shown, by large catches of larvae, and occasional handline catches of adults, to exist in the deep waters of the North Atlantic. An examination of the statistics of catches of redfish, which rapidly increased from 120 thousand tons in 1956 to 390 thousand tons in 1959 and then declined to 190 thousand tons in 1963, suggests that the coastal stocks of redfish are not very large and have been heavily fished.

6. ESTIMATES OF POTENTIAL

6.1 Subarea 1 - West Greenland

Non-commercial catches - There are no data available of substantial catches of fish other than those already exploited. Commercial trawlers catch few fish other than cod and redfish, mainly Greenland halibut and wolffish.

Food of commercial species - Cod eat large quantities of capelin (*Mallotus villosus*) and sand-eel (*Ammodytes launces*) (Hansen 1949), though it is not certain what proportion of the total food of cod are these fish; cod also eat euphausiids, squid, etc.

Eggs and larvae - Data from NORWESTLANT surveys will soon be available and presumably give good information on the abundance of winter and spring spawns. (ICNAF could provide better information.)

General - There is not enough data for any good assessment, but the observations of Horsted and Smidt (1965) on capelin coming into the fjords suggest that an industrial fishery for these species might not be impossible. If 50% of the food of cod is capelin and sand-eel and the consumption of cod is five times the present annual catch, then cod eat not much less than 1 million tons of capelin and sand-eel.

6.2 Subarea 2 - Labrador

Lightly fished stocks - Apart from cod and redfish, species caught in the area are wolffish (Anarhicas spp.) and flounders (probably mostly Greenland halibut, Reinhardtius hippoglossoides, and American plaice, Hippoglossoides platessoides). It is unlikely that the stock of wolffish is very large, but the potential catch of flounders might be quite large.

Food of commercial species - Cod have been reported feeding on capelin and lancet fish (Paralepis coregonoides) (Templeman 1965), as well as on invertebrates, including shrimp (Pandalus) (UK Research Report for 1962). No quantitative data are available.

Eggs and larvae - Serebryakov (1965) reported catching eggs and larvae of myctophids, as well as cod, redfish and American plaice, in Subarea 2, but without details of how many of the numerous eggs and larvae of the latter caught in the whole ICNAF Area were in Subarea 2.

6.3 Subarea 3 - Newfoundland

Lightly fished stocks - Other than cod, haddock and redfish, demersal catches include substantial quantities of flounders, especially American plaice (Hippoglossoides platessoides). Assessments of these have not been completed, but studies now in hand and the recent increases in fishing will soon produce reasonable assessments. Length data showed that, at least until recently, only the biggest fish caught were landed; this suggests that the stock as a whole was only incompletely utilized. Squid are sometimes caught in quantities by trawl incidentally to other fish, as well as by jigging; the resource seems large.

Food of commercial species - (The literature for this area has not been properly examined.)

6.4 Subareas 4 and 5

Lightly fished stocks - There are several stocks now yielding quite large catches from which it is possible that increased sustained catches can be taken. The most important of these are the silver hake and herring, but the other hakes also yield large catches. Detailed assessments for these stocks have not yet been made, but in view of the intense fishing on these resources, especially silver hake, it seems unlikely that very greatly increased catches can be taken. Age data show that the recently expanded fisheries have been based on only one or two year-classes; therefore, there seems to be no reason to doubt that the catches can be maintained at least at the level of recent years.

Catches of trawlers fishery for the traditional species for human consumption (cod, haddock, redfish) have often taken quantities of the above species, but no other species have been taken in quantities which support the existence of major unexploited resources.

Food of commercial fish - (Data on this has not been examined.)

6.5 Eggs and larvae (all areas) - Serebryakov (1965) gave summaries of the catches of USSR surveys in March, April and May in Subareas 2-5. The most numerous species were as follows:

	Subareas in which caught	Eggs	Larvae	1965 catches (thousand tons) Total	Subarea 2	3	4	5
Ammodytes spp.	3,4	-	12,500	-	-	-	-	-
Redfish	2,3,4,5	-	2,725	212	23	112	68	8
Cod	2,3,4,5	11,759	110	1,096	333	496	225	42
Myctophids	2,3,4,5	-	190	-	-	-	-	-
Capelin	3	-	162	5	-	4	1	-
Chirolophis ascanii	4,5	-	57	-	-	-	-	-
Herring	5	-	52	262	-	8	180	74
American plaice	2,3,4,5	2,090	18	69	-	50	15	4
Neoliparis atlanticus	4	-	51	-	-	-	-	-
Yellowtail flounder (Limanda ferruginea)	3,4,5	1,250	3	45	-	3	5	37
Silver hake	3,4,5	467	20	373	-	-	50	323
Haddock	3,4,5	390	6	249	-	9	85	155
Witch (Glyptocephalus cynoglossus)	3,4	405	10	15	-	2	11	2
Cusk (Brosme brosme)	4,5	426	-	6	-	-	5	1
Pollock (saithe)	3	2	12	38	-	1	28	9
Urophycis spp.	4,5	11	5	92	-	2	15	75
Halibut	4	10	18	5	1	2	2	-

No other species occurred in quantity either in the plankton or in the commercial catches.

For those species which are known or believed to be rather fully exploited (cod, haddock, silver hake, some flounders) there is a degree of agreement between the numbers of eggs and/or larvae and the catches. Quantitatively for these species, the ratio of the catch in tons to the number of larvae varied from between 4,000 (for American plaice) and 40,000 (for haddock). For no species were there large catches without there being also a substantial catch of larvae. Equally, abundant larvae correspond either to a major established fishery, or belong to species which are at present not commercially attractive. The exception is the halibut, which is heavily fished, but has relatively large numbers of larvae, though this may well be a sampling effect.

The table suggests very strongly that there are several species which can supply greatly increased catches, especially launce (Ammodytes spp.), myctophids (if they can be effectively harvested) and capelin. A comparison with other species suggests that the catches of launce might be of the order of millions of tons and of the other species of hundreds of thousands of tons. Redfish stocks may be particularly difficult to assess in this way. Redfish larvae are second only to Ammodytes in abundance; however, because there are no losses in the egg stage, the numbers of redfish larvae in the sea per unit weight of adult females may be considerably greater than for egg-producing species. Cod eggs were much more abundant than redfish larvae (about in proportion to the catch) and the production per unit weight of larvae by redfish may be more nearly equal to the production of eggs by cod than of larvae by cod. More studies are needed on both fecundity and survival of eggs and larvae. Also much more needs to be known about the relation of the redfish larvae - most of which are caught over deep waters (Henderson 1965) - to the stocks of redfish presently exploited on the continental shelf.

On the other hand, the table shows that in relation to the number of larvae, catches of hake (both silver hake, and other hakes - Urophycis spp.) are already high. This suggests that these stocks may now be rather fully exploited.

6.6 Seals. Large stocks of seals exist in the ICNAF Area, and are the object of important fisheries. Assessments have been made both of the size of the stocks and of the sustainable yields from them (see 1967 ICNAF meeting documents).

Analyses of the seal stocks, and their food, should be made to determine:

(a) whether the stomach contents suggest the existence of important fish stocks which might be exploited directly by man, other than those already outlined in previous sections:

(b) quantitative estimates of the fish eaten by seals, and studies of the interaction of seals and fishing on the same stocks. This would include estimates of both how a reduction in predation by seals might increase the sustainable catch of fish by man, and how the recent

6.7 Crustaceans and molluscs. These are to be the subject of separate analyses under the ocean resources side of IWP which will deal with entire world resources of these groups; the crustacean analysis is almost complete, and will be discussed and revised at the world meeting on shrimp biology at Mexico City in June. In the ICNAF Area the most promising unexploited resources are probably of Pandalus in all the northern subareas.

7. SUMMARY

7.1 Estimates of potential yield. Parts of the area are very highly productive and this is reflected in the importance of the area as a fishing ground to many nations. However, many of the stocks are now heavily exploited, and many of the lightly exploited stocks are less immediately attractive. The probable sustainable yields of the more important species may be (with 1965 catches in brackets) (in thousands of tons).

Species	1965 catch	Potential catch	Note
Cod	(1,463)	1,600-1,800	Fully used, some increase by better management.
Haddock	(249)	150	Fully used. Actual catch depends on year-classes.
Silver hake	(373)	400-800 ?	May already be fully exploited.
Redfish	(231)	250- ?	Major uncertainty concerning oceanic stock.
Herring	(262)	300-1,000	No good information.
Urophycis	(92)	100-200	Larvae catches do not suggest a big stock.
Pollock	(38)	50-100	
American plaice	(69)	100-300	Incidental catches, and larvae data suggest a moderately large stock.
Yellowtail Flounder	(45)	50-100	
Witch	(15)	20-50	
Ammodytes	-	1,000+	Very big larval catches (? found in stomach of larger fish)
Capelin	(5)	1,000+	Big stock; feasibility of economic harvesting seems to depend on annual changes in distribution (Templeman 1948)
Myctophids	-	500 +	
Squid	-	1,000 + ?	No data for quantitative assessment.
Saury (Scomberesox saurus)	-	?	The existence of a major oceanic resource of this species has been suggested (cf. Ricker 1962) but there is no firm evidence.

These totals, however, should not be considered as simply additive; large catches of capelin, for example, will tend to decrease the food supply to, and hence ultimately the catches from, the cod stock. They do, however, suggest that while the catches of the traditional species may not be greatly increased, the total catch from the ICNAF Area might well be doubled in weight (though not in value) by fishing for other species. Apart from the myctophids, which would present some technical problems of both catching and processing, the most promising species, or closely related species (capelin, Ammodytes and quid), are the objectives of major fisheries in other areas. For many of these, a closer examination of the data presently available on distribution and likely density and a comparison with other areas should provide better estimates than the rough figures above.

7.2 Comparison with total primary production

(This will be done when primary production section is written.)