

ANNUAL MEETING - MAY/JUNE 1960Stocks of the Important Commercial Species
of Fish of the ICNAF Convention Area

by John P. Wise and Albert C. Jensen

INTRODUCTION

In thinking about populations or stocks of fish, there is unfortunately a tendency to consider them static entities, much as philosophers previous to the eighteenth century thought of the features of the earth as instantaneously created and almost immutable. Of course, biologists know from the paleontological record that the fish of today did not always exist, nor did the oceans in their present form. Even with this knowledge, because of the short lifetime of any one man and the extreme brevity of our records, it is difficult to realize that change is a universal constant in the dynamics of fish populations.

Yet a real understanding of the distribution of stocks of fish can only be gained if they are considered plastic and transient. Some far-seeing fishery biologists have recognized this view in the past. Taning pointed out:

"... Even if we do not know whether we are now at the close of a warm period, or in the middle, or whether the warm period will continue into the distant future, it is evident that it may be of far-reaching importance to future exploration... As far as we know these causes have - by short term as well as long term changes - produced the observed fluctuations in the stocks of fish, changes in the course of migration, etc. These are matters of the greatest importance to [the] fishery and detailed knowledge of them may in future to some extent make it possible for fishery biologists to predict changes in the great fisheries..."

Those who do consider changes in fisheries and in fish stocks tend to think primarily of diminution or disappearance (such as we see in the history of the New England mackerel fishery and often attribute it to the predation of man), and less often perhaps of increases such as have been shown in the cod fisheries of West Greenland and Spitzbergen. This is understandable from the point of view of the man who is actively engaged in a fishery and whose livelihood is threatened, but the biologist should, while considering the unfortunate facts of disappearances and decreases in abundance, try to keep in mind the world-wide and more long-term view.

With these points in mind, the authors present the following information about stocks of the important commercial fishes in the ICNAF Convention Area as the best they can assemble at present. We acknowledge our great debt to the authors of far more precise and detailed studies and realize that this is at best a "snapshot" of a dynamic situation, obsolete in many respects even as these words are being written.

.../2

Physiography of the Convention Area

The important species of fish in the Convention Area are all to a greater or lesser degree demersal. That is, they are dependent upon finding suitable ocean bottom for the completion of at least one phase of their life history. Consequently, their distribution and their division into populations or stocks is conditioned by the physiography of the area. Only the continental shelf and its slope provide suitable habitats; thus to a fish the Convention Area would look rather like Figure 1. This approximately equal-area projection shows the

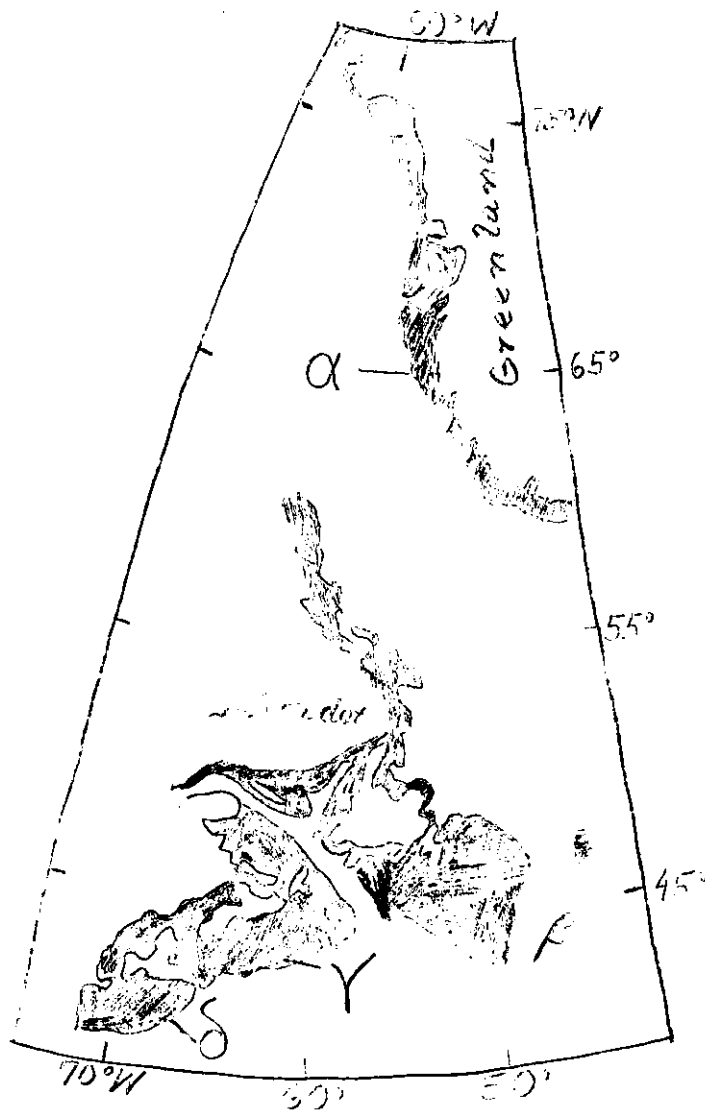


Figure 1. The ICNAF Convention Area, with ocean areas of less than one hundred fathoms shown in black. The Greek letter designations are discussed in the text.

habitable waters, but differs from the usual map or chart in taking into consideration that it makes very little difference to a demersal fish whether barriers are land masses or the oceanic abyss.

The figures makes it immediately apparent that there are two major groupings of suitable habitat. Region α (Greek letters are used to avoid confusion with standard terminology of Subareas and Subdivisions) is far removed from the rest of the Convention Area,

.../3

and little or no mixing or interchange of fish populations would be expected. Regions β , γ , and δ are much closer to each other than the closest of them is to α . However β is farther and more distinctly separated from γ than γ is from δ . Thus, intermixing of populations is more likely on a purely geographical basis between γ and δ than between γ and β . These conclusions are shown below as largely true; of course, they were taken into consideration in making the original divisions of the Convention Area into its component Subareas.

Statistics

The crudest, but at the same time most dramatic, evidences of presence, absence, or changes in fish populations are statistics of the landings. From the founding of the International Commission, statistics have been assembled and published; Table 1 shows an abstract of these statistics. The primary information concerning fish populations which may be derived from this table is that all of the four principal species, cod, haddock, redfish, and halibut, have been recorded as caught in each of the five Subareas at some time in the eight years 1951-1958.

Table 1. Landings of the principal species of fish from Subareas of the ICNAF Convention Area, 1951-1958, in thousands of metric tons, round fresh.

Year	Subarea 1				Subarea 2				Subarea 3				Subarea 4				Subarea 5				Totals			
	Cod	Had	Red	Hal	Cod	Had	Red	Hal	Cod	Had	Red	Hal	Cod	Had	Red	Hal	Cod	Had	Red	Hal	Cod	Had	Red	Hal
1951	169	+	+	1	29	-	-	+	277	23	17	3	116	42	84	2	18	53	30	+	829	138	132	6
1952	253	+	+	1	54	-	+	+	308	28	46	1	131	53	34	2	14	49	21	+	918	142	102	3
1953	205	+	13	1	109	+	+	-	324	38	46	1	148	44	29	2	11	45	17	+	812	127	104	4
1954	302	+	15	1	22	+	-	-	472	55	37	1	149	50	55	2	12	54	13	+	969	159	120	4
1955	265	+	32	1	26	-	-	-	429	104	18	1	159	43	60	2	12	51	14	+	892	198	123	4
1956	321	+	14	1	34	-	-	-	382	80	17	1	198	51	63	2	13	58	14	+	949	191	109	5
1957	269	+	28	1	32	-	-	+	449	68	58	2	188	48	55	3	13	55	18	+	958	171	159	6
1958	304	+	15	1	38	+	71	+	286	41	157	2	209	49	55	3	16	45	16	+	860	134	315	6

Notes: The symbol (+) signifies less than 500 tons, while (-) signifies no landings reported.

Totals may contain landings whose area of origin is not known.

Year 1958 figures are preliminary.

While changes in fishing effort, differing market demands, etc., of course, have marked effects on the landings of fish, the following conclusions concerning fish populations and fisheries may be drawn from the table:

1. The major exploited stocks of cod occur in Subareas 1 and 3, with stocks of secondary importance in Subarea 4.
2. Haddock in commercial quantities are present in Subareas 3, 4 and 5. Within 4 and 5 the stocks support a relatively stable fishery, while in Subarea 3 either the abundance of fish or the fishery (or both) is variable.
3. The stocks of redfish important to the fishery occur in Subareas 3, 4 and 5.
4. Halibut support small, stable, but relatively insignificant fisheries in all but Subarea 2.
5. Subarea 2 is either lacking in important fish populations or is grossly underexploited. Cod landings in 1953 of 109 thousand tons lead us to suspect that the latter is more nearly true.

.../4

COD STOCKS

Subarea 1

The cod of West Greenland are at the northern limit of the range of the species in the Western Atlantic. Consequently, they demonstrate the "edge effect" described by many ecologists and undergo wide fluctuations with changes in environment. Since about 1924 the cod have been abundant enough to support important fisheries, although for almost seventy-five years previously they were unknown or extremely scarce in the area. Where the cod which were abundant in the late 1840's came from or went to we can only speculate, but it is well demonstrated that the cod presently on the West Greenland banks are derived from and related to Icelandic fish rather than to other Western Atlantic stocks. An occasional cod marked at the Lofotens has been recovered in West Greenland, but so far as we know these are only stragglers.

The present northern limit of cod is about 72°N. or 73°N., although there is little or no fishing north of about 71°N. From these limits south to Cape Farewell, the West Greenland cod may be divided into two major stocks, an indigenous one found mostly from Lille Hellefisk Bank (approx. 65°N.) north, and another group distributed from Store Hellefisk Bank (approx. 68°N.) southward to Cape Farewell, and more or less related to the East Greenland and Iceland cod. These two groups intermingle to a limited extent, and the southern one maintains its relations with East Greenland and Iceland in a variable fashion. In some years the southern fish may migrate to East Greenland or even all the way to Iceland to spawn, and there is evidence that some year classes (e.g. 1945, 1947) may leave the West Greenland banks and move out to East Greenland or Iceland.

The distribution of West Greenland cod is influenced during the year by secular environmental changes. In spring, fish are found mainly in deeper waters, especially on the western edge of the banks where the Irminger Current is predominant. In summer, when the deepest parts of the banks are covered by cold water, cod are found on the shallower parts and even become pelagic in the warm upper 50 meters.

There are local fjord populations of cod which mingle little or not at all with each other or with the two bank stocks - these are of importance only to local fisheries of the natives.

Subarea 2

Cod are distributed all along the Labrador coast and on the offshore banks at least as far as Cape Chidley (about 60°N). Around the turn of the century at least they were reported as found along the east coast of Ungava Bay to the mouth of George River.

There can be little doubt that the Labrador cod are distinct from those of West Greenland, and they maintain their identity from the main stock of the Grand Bank. However, there is some inter-mixture of Labrador fish with those of the Newfoundland northeast coast and the northern Grand Bank (Subarea 3). And it would seem probable that in the Belle Isle Straits area, a crossroads where Subareas 2, 3 and 4 come together, there may be some slight mixing with the fish of north-eastern Subarea 4.

Information about the stocks of cod of Labrador is slight compared to that of other areas because of the small amount of fishing currently being carried on. However, there is strong evidence that

the low level of fishing effort in the Subarea is due to economic factors rather than to a decline in the abundance of fish. It has been shown that the Labrador fishery of the Newfoundlanders decreased from its production of almost 80,000 tons per year (cf. Table 1) for some years in the 1930's to its present low level of around 10,000 tons per year primarily because of economic factors rather than because of a decrease in the abundance of cod. Evidence for this argument is borne out by the statistics for 1953, when southern European trawlers turned their attention to the Subarea and produced almost 100,000 tons.

Subarea 3

The cod of Subarea 3 may be divided into two major groups, the more or less inshore fish of the Newfoundland east and south coasts, and the banks fish. As mentioned in the discussion of Subarea 2, the cod of the northeastern coast are more or less distinct from other fish of the region, although there is some slight inter-mixture with Labrador fish.

Cod of the southern part of the east coast and on the southern coast of Newfoundland move onto the northern and northwestern edge of the Grand Bank for spawning in the autumn and winter, and inshore during the summer to feed on capelin. However, the cod on the southeastern Grand Bank seem independent of this group, as would be expected from the presence of a marked hydrographic barrier under the influence of the Labrador current.

On St. Pierre bank there is evidence of a distinction into a northern stock more closely related to the inshore fish and a southern stock of more purely bank fish.

Subarea 4

Subarea 4 is unequally divided by the Laurentian Channel into a northeastern part composed of the west coast of Newfoundland and the south coast of Quebec, and a much larger southwestern part composed of the southwestern Gulf of St. Lawrence, the Scotian Shelf and the Bay of Fundy.

The fish of the northeastern part of Subarea 4 mix little or none with those of the southwestern part. In the northern section of this area there is a seasonal admixture of cod from the northern part of the east coast of Newfoundland (Subarea 3) and the possibility mentioned above of some interchange with the Labrador cod (Subarea 2). Cod of the southern part of the west coast of Newfoundland move out of the Gulf of St. Lawrence toward St. Pierre Bank (but do not reach it) in winter.

The remainder of the Gulf of St. Lawrence stocks appear to be mostly homogenous; recent tagging experiments have shown a mass movement of at least some of them out of the Gulf in winter along the western side of the Laurentian Channel to and beyond Cape Breton. It is difficult to determine whether any substantial portion of this group remains in the Gulf during the winter, since both commercial and experimental fishing are precluded by ice conditions. However, size distribution of the recaptured fish are approximately the same both inside and outside the Gulf; this is evidence that the movement is not restricted to particular age-groups. Incidentally, a few fish from these experiments were recaptured on the west coast of Newfoundland, but not enough to suggest anything more than a slight scatter of the western Gulf fish to the eastern side of the Gulf. None were recaptured from other parts of Subarea 3.

.../6

On the offshore banks of the Scotian Shelf there appear to be resident populations and others which move in along the Nova Scotian shore in summer. Along the shore there are resident populations, some of them very well defined, with a more mobile pattern of life found in the eastern area than in the central and western portions. Near western Nova Scotia the fish appear most sedentary of all the Subarea 4 stocks.

For reasons not very clear, cod do not penetrate much beyond the mouth of the Bay of Fundy.

Subarea 5

While cod is the subject of the major fishery in the Convention Area and yearly landings of cod usually surpass those of all other species combined in Subareas 1, 2, 3, and 4, they are of subordinate importance in Subarea 5. In addition, about one-half or two-thirds of the cod landings in Subarea 5 are incidental to the haddock fishery. These facts have functioned to de-emphasize cod research in the Subarea; for about twenty-five years following 1930 there was no research in progress.

However, since the resumption of cod studies in late 1955, some thousands of fish have been marked and some hundreds recovered, so that we are beginning to get a current view of the cod stocks of the area. The most important single population is that of eastern Georges Bank, which apparently mixes little with the more westerly and northerly groups, although some of the larger and older fish do appear to wander off to join the populations of western Nova Scotia (Subarea 4).

West of the shoals of Georges Bank (about 68°W.) there is another population which summers in the Great South Channel (about 69°W.), particularly on the western side, and which spends the better part of the rest of the year inshore in the Nantucket Shoals-Chatham region. North of this group of fish are those of the Gulf of Maine, one or more sedentary stocks.

Joining the Nantucket Shoals-Chatham fish in the summer are fish whose winter habitat is outside the Convention Area. They migrate along the Rhode Island, Long Island and New Jersey shores in the autumn, some years reaching as far as North Carolina (about 35°N.), then return in spring to summer in southern New England waters again.

Dominant Year Classes

Since the turn of the century, year classes of cod stronger than average have been recorded in the literature from many areas. Table 2 shows these year classes as we have been able to find reference to them in the literature.

This tabulation has some major weaknesses that should be taken into consideration in drawing any conclusions from it:

1. A strong year class in West Greenland may be much more or less numerous than a strong year class on the Grand Bank. Choosing a universal standard for this purpose seems nearly impossible. Consistency of evaluation of the strength of year classes can at best be hoped for within any one area.
2. We have had to evaluate the evaluations of other biologists who used descriptive terms such as "very strong", "excellent", "abundant", etc.

.../7

Table 2. Strong year classes of cod at Iceland and in the Western Atlantic since 1909 (from various sources).

Year	Iceland	East Green-land	South Green-land	West Green-land	Labrador	South Georges Bank	Gulf of St. Lawr.	Nova Scotia	New Eng-land
1909				+					
1910									
1911									
1912	+			+					
1913	+								
1914									
1915	+								
1916									
1917	+			+					
1918									
1919	+								
1920									
1921	+	**							**
1922	+	+		+					+
1923									+
1924	+	+		+					+
1925									
1926	+	+		+				**	
1927	+							+	
1928								+	
1929				+				+	
1930	+								
1931				+					
1932				+					
1933									
1934				+					
1935				+					
1936				+					
1937						**			
1938						+			
1939					**				
1940									
1941									
1942				+	+				
1943									
1944			**						
1945	+	+	+		+				
1946						+			
1947		+		+	+				
1948					+				
1949	+	+	+			+			
1950	+	+	+	+	+				
1951									
1952					+	+	**		
1953			+	+	+	+	+		
1954							+		
1955									+
1956			+						
1957				+					

** No data found for this or preceding years.

3. There is no doubt that some strong year classes have gone unrecorded or that we did not find references to them in the literature - there are suspicious gaps in the columns for Iceland, Nova Scotia and New England, for instance.
4. These year classes have been evaluated during the course of a fishery. No allowance can be made for year classes which were more abundant than normal but which suffered excessive mortality before they were fished, or for the possibility of year classes which for one reason or another were never recruited to a fishery. This consideration also makes it certain that the table is badly behind the current situation, particularly in areas where the fish are slow growing and recruited at later ages.

Even with all of these limitations in mind, some interesting evidence on the biology of stocks in the Convention Area may be deduced. Notice, for instance, the rather close correspondence between good year classes at Iceland and in the various Greenland areas and the lack of correspondence of these with other areas. Note also the change in the pattern of West Greenland year classes from approximately alternate good and poor years in the 1920's and mid-1930's to good year classes about every fourth year in the period since. This tendency will be even more serious if the 1957 year class does not live up to its early promise to fill in the gap since the truly remarkable 1950 year class and the less notable 1953 year class.

HADDOCK STOCKS

Introduction

The distribution of haddock in the Northwest Atlantic has undergone a marked change within the past century. A warming trend seems to have extended the northern distribution of the species and at the same time reduced the southern distribution. Toward the end of the 19th Century, haddock were reported as far south as Cape Hatteras (about 35°N.) with important shore and vessel fisheries for the species in the offing of Long Island and New Jersey. The northern limit was at the Strait of Belle Isle. In recent years, however, catches have been reported from West Greenland, whereas the catch off New York and New Jersey has diminished to a scant few hundred pounds per year and the former intensive fishery for haddock on Nantucket Shoals no longer exists. Some of the changes in distribution and abundance may be masked by (or attributed to) technological or economic factors since the absence of a haddock catch has significance only where a fishery exists using gear that will catch haddock. Nevertheless, the evidence generally supports the hypothesis that the range of the haddock has moved northward.

In the areas where haddock have been intensively studied, biologists note the existence of several discrete stocks with little mixing between the stocks and only seasonal migrations. The haddock is not a wanderer as is the cod, for example, and is usually a resident on the grounds where encountered.

Subarea 1

Haddock are new to the fish fauna of West Greenland, or at least have been recorded from the area only once or twice during the last century. They were taken for the first time at Sydprøven, at the southern tip of Greenland in 1929 and since then several appearances

.../9

of haddock have been reported. A catch of haddock was reported in 1944 from Disko Fjord. In recent years (cf. Table 1) small amounts of haddock have been landed from West Greenland every year.

Subarea 2

Haddock are occurring in negligible quantities in the waters off Labrador. Nothing is known about the stock or stocks in this Subarea.

Subarea 3

In the Newfoundland area, haddock are found in abundance only on the southern part of the Grand Bank and on St. Pierre Bank. Haddock, perhaps a separate stock, are found on Flemish Cap. As yet this stock has not been adequately identified, although the fish have a growth rate pattern distinctly different from either the Grand Bank or St. Pierre haddock. Another small stock is found off the southwestern corner of Newfoundland, but in general haddock are not abundant in the waters adjacent to the island. A few haddock are taken each year in inshore cod-traps, probably seasonal migrants from the offshore banks. At one time large numbers of fingerling haddock were netted in Hermitage Bay, suggesting that perhaps the bays are nursery grounds for the fish.

There is some question about the stocks on the Grand Bank and on St. Pierre Bank. Growth rate studies show the two stocks to be different but vertebral studies have shown no distinction between them. Tagging experiments on the Grand Bank yielded no returns, thus have not been adequate to clarify the stock differentiation problem. The Grand Bank population may be composed of several groups with considerable mixing between them while the St. Pierre stock is probably a non-migrating stock with negligible movement of other haddock into the area. There appears to be some intermingling of Grand Bank and St. Pierre Bank haddock south of Green Bank.

Subarea 4

The haddock stocks in Subarea 4 for the most part are distinct from those of Subareas 3 and 5, separated from them by the Laurentian Channel, the Fundian Channel and the deep water of the Gulf of Maine. The one exception is the group of fish in the Bay of Fundy (particularly from the Passamaquoddy Bay region) which are almost certainly related to the New England stock and migrate into the Fundy area during the summer months. Haddock are abundant all along the Nova Scotian coast, both inshore and offshore, but landings are very small from the Prince Edward Island, New Brunswick, Quebec and Newfoundland areas of the Gulf of St. Lawrence.

An eastern Nova Scotian stock extends east to the Laurentian Channel and west to the Scotian Gulf. The inshore group on Canso Bank and Middle Ground may be distinguished from the offshore group on Emerald, Sable Island and Quereau Banks, and in the Gulf of St. Lawrence. Marking experiments have confirmed the identity of this stock. Haddock tagged in the summer at Ingonish and Petit de Grat migrate into the Gulf of St. Lawrence in the spring. The fish remain there until the late fall then migrate offshore, to spend the winter on the eastern banks. There is evidence that the eastern Nova Scotian stock may be related to the haddock taken off the west coast of Newfoundland.

Vertebral counts have identified the central Nova Scotian stock composed of the St. Margaret's Bay and Sambro Bank groups, resident in the vicinity of the Scotian Gulf.

.../10

A western Nova Scotian stock resides in the region bounded on the east by the Scotian Gulf and on the west by the Fundian Channel. This stock includes fish from Lockeport and Digby, LaHave, and Browns Banks. The haddock taken off Lockeport in the summer migrate offshore and spend the winter on LaHave and Browns Banks. Shelburne haddock tend to remain there throughout the year, although there is some eastward drift, not related to season, with an occasional fish going as far as Sable Island. Seal Island haddock also demonstrate an eastward drift. An influx of large and medium haddock, identified as fish of the New England stock (Subarea 5), in 1938 caused a 50 percent increase in landings in the Digby-Yarmouth-Shelburne area.

Vertebral counts have indicated a relationship between the fish inhabiting grounds west of the Fundian Channel and those on Georges Bank. There is some mixing with the New England (Subarea 5) stock. Haddock present in the southern Bay of Fundy in the summer, move southward in the winter. Passamaquoddy Bay haddock migrate to Jeffreys Ledge and South Channel in the winter.

Subarea 5

Haddock in Subarea 5 are abundant on Georges Bank and South Channel while small seasonal fisheries exist off Maine and Massachusetts. The Georges Bank haddock are clearly different from the closest Subarea 4 stock on Browns Bank, and probably distinct from the haddock found along the New England coast. Only a very few of the Georges Bank haddock migrate to Browns or to the coastal New England areas.

There are spring concentrations of haddock in the Cape Cod area off Chatham and Provincetown, and off Cape Anne. Apparently, these are spawning concentrations. During the summer and fall the fish are scattered northward along the coast, with a few fish migrating to Georges Bank. In the spring they return to the coastal spawning grounds.

Thus, there are two groups separated by the Great South Channel and the deep water of the Gulf of Maine: (1) the haddock of eastern Georges Bank, and (2) the haddock of coastal New England and western Georges Bank, relatively distinct, although there is some mixing.

REDFISH STOCKS

At present not enough is known of the distribution and biology of the redfish to make as detailed an inventory of the stocks as we have been able to do for cod and haddock. Perhaps the best we can say is that redfish are found in all of the Subareas, in the deeper waters of the slopes of the banks and wherever "holes" occur in the shelf.

In Subareas 3 and 5 all of the redfish appear to be of the same type, as they do on the Scotian Shelf (Subarea 4). From the Gulf of St. Lawrence portion of Subarea 4 to the northernmost parts of the Convention Area, there seem to be two types, a large-eyed and a small-eyed. The questions of speciation or subspeciation are beyond the scope of this paper.

The evidence suggests three non-migratory stocks within the Convention Area. The first of these lives in waters comprising Subareas 4 and 5, and Subdivisions 30 and 3P, the southwest Grand Bank and westward to the Gulf of Maine and including the Gulf of St. Lawrence. The second stock lives in Subdivisions 3K, 3L and Subarea 2, the northern Grand Bank, the Newfoundland Shelf, and the coast of Labrador. These two stocks may intermingle on the southeastern Grand Bank but this situation is not yet clear. The third stock is found on the Flemish Cap. Hydrographic conditions contribute to the isolation of the populations of

.../11

redfish, e.g., the Gulf Stream waters exert a restrictive influence on the eastward drift of viable larvae in the south.

Most evidence such as stages of maturity, parasite infestation, etc., points to highly localized groups within these stocks, moving less than a very few miles. There is always the possibility, however, that the fisheries are prosecuted on the fringes of an oceanic demersal or pelagic population, and such phenomena as the tremendous catches made in 1958 (cf. Table 1) in Labrador on stocks which had completely vanished from the area by the summer of 1959 leave many questions to be answered.

HALIBUT STOCKS

We have been unable to find any clear-cut descriptions of halibut stocks of the Convention Area. There appears to be a definite change in the behavior patterns of halibut with age, and it seems probable that there are well-defined and local groups in various places which break up and scatter, mostly to the eastward, as the fish grow older. Long migrations by larger fish are common in the few marking experiments which have been conducted - from the Gulf of St. Lawrence (Subarea 4) to Iceland, and, in our own work, from Georges Bank (Subarea 5) to the Grand Bank.

SUMMARY

A review of the preceding sections on the populations or stocks shows a rather definite correlation between the intensity of the fishery on a species within a Subarea and the knowledge of the stocks of the species within the Subarea. From the point of view of one interested purely in the biology of fish, this is unfortunate - from the point of view of the practical fisherman and the fishery biologist, it is inevitable.

We apologize for the unevenness of our treatment of various species and Subareas. This seems inescapable, however, when it is taken into consideration how little is known in many cases. Another contributing factor to brief treatments is actual or supposed simplicity in the distribution and relations of some stocks.

The single glaring ignorance that seems most serious to us is that concerning redfish. The very many fine scientists who have worked with this species in the past and who do so at present are not to blame for this state of affairs. Rather the apparent complexity of the biology of the animals and their extraordinary recalcitrance to the time-honored methods of fishery biology make us feel humble that so much has been accomplished under such trying conditions.

BIBLIOGRAPHY

- Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. First Revision. U.S. Fish and Wildl. Serv., Fish. Bull. 74 vol. 53:1-577.
- Clark, J.R. 1959. Sexual maturity of haddock. Trans. Amer. Fish. Soc., 88 (3): 212, 213.
- Clark, J.R. and V.D. Vladykov. 1960. Definition of haddock stocks of the Northwestern Atlantic. U.S. Fish and Wildl. Serv., Bur. Com. Fish., Bull. 169, vol. 60: 283-296.
- Fleming, A.M. 1952. A study of the age and growth of the cod (Gadus callarias L.) in the Newfoundland area. Master's thesis, University of Toronto, 119 pp. and appendix.
- Fleming, A.M. 1958. Differentiation of cod groups in the Newfoundland and Labrador region. (Author's abstract) ICNAF Spec. Pub. 1: 331.
- Goode, G.B. 1887. Natural history of useful aquatic animals, Pt. 3; The food fishes of the United States, In Goode, The Fisheries ... of the United States.
- Goode, G.B. and J.W. Collins. 1887. The Labrador and Gulf of St. Lawrence cod fisheries. In Goode, The Fisheries...of the United States.
- Hachey, H.B., F. Hermann and W.B. Bailey. 1954. The waters of the ICNAF Convention Area. ICNAF Ann. Proc. 4(4): 67-102.
- Hansen, P.M. 1949. Studies on the biology of the cod in Greenland waters. ICES Rapp. et Proc.-Verb. 123: 1-77.
- Hansen, P.M. 1958. Greenland stock. Cod investigations in the coastal waters and on the offshore banks of West Greenland in 1956. Ann. Biol., Copenhagen 13: 132-137.
- Huntsman, A.G., W.B. Bailey and H.B. Hachey. 1954. The general oceanography of the Strait of Belle Isle. J. Fish. Res. Bd. Canada, 11(3): 198-260.
- Jeffers, G.W. 1932. Fishes observed in the Strait of Belle Isle. Contrib. Canadian Biol. and Fish., n.s. 7(16): 205-211.
- Jensen, A.S. and P.M. Hansen. 1931. Investigations on the Greenland cod (Gadus callarias L.) with an introduction on the history of the Greenland cod fisheries. ICES Rapp. et Proc.-Verb. 72(1): 1-41.
- Low, A.P. 1895. Report on explorations in the Labrador peninsula. Canada. Geological Survey. Annual Report. 8(L), 387 pp.
- Martin, W.R. 1953. Identification of major groundfish stocks in Subarea 4 of the Northwest Atlantic Convention Area. ICNAF Ann. Proc. 3(3): 57-61.
- Martin, W.R. 1959. Canadian research report, 1958; Subareas 4 and 5. ICNAF Ann. Proc. 9: 26-31.
- Martin, W.R. and F.D. McCracken. 1950. Movements of halibut on the Canadian Atlantic coast. Fish. Res. Bd. Canada, Prog. Rept. Atl. Biol. Sta. 50: 3-8.

.../13

- May, A.W. 1959. Cod investigations in Subarea 2 - Labrador, 1950 to 1958. ICNAF Ann. Proc. 9: 103-105.
- McCracken, F.D. 1956. Cod and haddock tagging off Lockeport, N.S. Fish. Res. Bd. Canada, Prog. Rept. Atl. Biol. Sta. 64: 10-15.
- McCracken, F.D. 1958. On the biology and fishery of the Canadian Atlantic halibut, Hippoglossus hippoglossus L. J. Fish. Res. Bd. Canada, 15(6): 1269-1311.
- McCracken, F.D. 1959. Cod tagging off northern New Brunswick in 1955 and 1956. Fish. Res. Bd. Canada, Prog. Rept. Atl. Biol. Sta. 72: 8-19.
- McKenzie, R.A. 1938. Canadian Atlantic "bank" cod migrations. Fish. Res. Bd. Canada, Prog. Rept. Atl. Biol. Sta. 22: 3-6.
- McKenzie, R.A. 1956. Atlantic cod tagging off the southern Canadian mainland. Bull. Fish. Res. Bd. Canada, 105: 93 pp.
- McKenzie, R.A. and R.E.S. Homans. 1939. Increased haddock landings in southwestern Nova Scotia, 1938. Fish. Res. Bd. Canada, Prog. Rept. Atl. Biol. Sta. 24: 12-15.
- McKenzie, R.A. and G.F.M. Smith. 1955. Atlantic cod populations along the southern Canadian mainland as shown by vertebral count studies. J. Fish. Res. Bd. Canada, 12(5): 698-705.
- Needler, A.W.H. 1929. Studies on the life history of the haddock (Melanogrammus aeglefinus Linnaeus). Contrib. Canadian Biol. and Fish., n.s. 4(20): 267-285.
- Needler, A.W.H. 1930. The migrations of haddock and the inter-relationships of haddock populations in North American waters. Contrib. Canadian Biol. and Fish., n.s. 6(10): 243-313.
- Needler, A.W.H. 1931. Statistics of the haddock fishery in North American Waters. Rept. U.S. Comm. Fish. for 1930, Appendix 2: 27-40.
- Perley, M.H. 1852. Reports on the sea and river fisheries of New Brunswick. (Second Edition) Queen's Printer (J. Simpson), Fredericton. 294 pp.
- Schmidt, J. 1931. Racial investigations. X. The Atlantic cod (Gadus callarias L.) and local races of the same. Compt. Rend. Lab. Carlsberg. 18(6): 72 pp.
- Schroeder, W.C. 1942. Results of haddock tagging in the Gulf of Maine from 1923 to 1932. Sears Foundation, Jour. Mar. Res., 5(1): 1-19.
- Schuck, H.A. and E.L. Arnold, Jr. 1951. Comparison of haddock from Georges and Browns Banks. U.S. Fish and Wildl. Serv., Fish. Bull. 67, vol. 52: 177-185.
- Taning, Å.V. 1953. Long term changes in hydrography and fluctuations in fish stocks. ICNAF Ann. Proc. 3(5): 69-77.
- Taning, Å.V. 1958. Observations on supposed intermingling or a certain connection between some stocks of boreal and subarctic demersal food fishes of the eastern and western Atlantic. ICNAF Spec. Pub. 1: 313-325.

- Templeman, W. 1953. Knowledge of divisions of stocks of cod, haddock, redfish and American plaice in Subareas 3 and 2 of the Northwest Atlantic Convention Area. ICNAF Ann. Proc. 3(4): 62-66.
- Templeman, W. 1958. Distribution of the inshore catch of cod in Newfoundland and Labrador waters in the years 1947 to 1949. Fish. Res. Bd. Canada, Prog. Rept. Atl. Biol. Sta. 70: 3-9.
- Templeman, W. and A.M. Fleming. 1953. Long-term changes in hydrographic conditions and corresponding changes in the abundance of marine animals. ICNAF Ann. Proc. 3(5): 79-86.
- Templeman, W., H.J. Squires and A.M. Fleming. 1957. Nematodes in the fillets of cod and other fishes in Newfoundland and neighbouring areas. J. Fish. Res. Bd. Canada, 14(6): 831-897.
- Thompson, H. 1938. Comparative studies of the fluctuations of year-classes of certain fishes of the Western Atlantic. A. Cod. ICES Rapp. et Proc.-Verb. 101, (4) (2): 7.
- Thompson, H. 1939. The occurrence and biological features of haddock in the Newfoundland area. Newf. Dept. Nat. Res., Res. Bull. 6: 1-31.
- Thompson, H. 1943. A biological and economic study of cod (Gadus callarias L.). Newf. Dept. Nat. Res., Res. Bull. 14: 160 pp.
- Vladykov, V.D. 1934. Young haddock in the vicinity of Halifax, N.S. Contrib. Canadian Biol. and Fish., n.s. 8(29): 411-419.
- Wise, J.P. and A.C. Jensen. 1959. Movement of tagged halibut off New England. Trans. Amer. Fish. Soc., 88(4): 357-358.

--ooOoo--