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United States Research Report, 1964

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The United States landed fish from Subarea 3, 4 and 5 and conducted research in these three Subareas as well.

SUBAREA 3

A. Status of the Fisheries

I. Redfish

United States landings for Subarea 3 were mostly from the Grand Bank, Divisions 3N and 3O.

Landings in 1964 dropped sharply over the 1963 figure which, in turn, was somewhat lower than the preceding years. The sharp drop in landings in 1964 was the result of lowered effort. Landings per day fished increased slightly in 1964. (Table 1).

Table 1. --U.S. redfish statistics, Subarea 3, 1964 (metric tons, round fresh)

Year	Landings	Days Fished	Landings/Days Fished
1954	31,269	1786	17.5
1955	13,406	1126	11.9
1956	13,304	943	14.1
1957	4,797	289	16.6
1958	10,859	688	15.8
1959	16,871	1120	15.1
1960	15,393	1049	14.7
1961	16,706	1056	15.8
1962	14,257	898	15.9
1963	12,098	918	13.2
1964	4,692	328	14.3

B. Special Research Studies

I. Environmental Studies

The U.S. Coast Guard, as the agency operating the International Ice Patrol, examined the temperature and salinity distribution from the surface to 1500 meters in 5 network surveys of the Grand Banks region. The first survey, 15 March - 27 March covered the waters over and immediately seaward of the southern slopes of the Grand Banks from just westward of the Tail of the Banks northward to approximately 44°15'N. The second survey, 4 April-16 April, covered the waters over and immediately seaward of the eastern slope of the Grand Banks from 44°15'N northwestward and included Flemish Cap and the Bonavista Triangle. The third survey, 2 May-13 May, covered an area similar to the combined first and second up to Flemish Cap. The fourth survey, 27 May-30 May, covered the Bonavista Triangle and the waters eastward to approximately 47°40'W. On the fifth survey, 9 June-19 June, the waters to the south of Flemish Cap were covered as in the third survey. The post season survey, 17 July-28 July, occupied the Bonavista Triangle and the Labrador Sea section, South Wolf Island, Labrador, to Cape Farewell, Greenland, to within 20 miles of shore at Cape Farewell. A

24-hour period was spent on Ocean Station BRAVO 56°30'N 51°00'W. Six oceanographic casts were made in an effort to tie in the OSV time-series data with the general study of the Labrador Sea.

A ten-day project was carried out between the third and fourth surveys. During this time, iceberg drift and deterioration parameters were studied. Station buoys, drogues, bathythermograph drops and Nansen casts were utilized in the vicinity of an iceberg for this study.

A buoy was moored in 340 meters of water on the eastern slope of the Grand Banks at approximately 45°00'N. A continuous temperature pressure recorder was suspended at 50 meters below the buoy to monitor possible intrusions of the warm water to the east. The buoy was moored on 13 May 1964 and retrieved on 16 June 1964.

The season was characterized by a normal amount of sea ice and icebergs along the east Newfoundland coast. Labrador Current along the eastern slope of the Grand Banks was about 0.3°C colder than normal for the entire season above 100 meters, and less saline down to 500 meters by 0.05-0.10 °/oo. As the season progressed, conditions tended more toward the normal but still remained below normal. The Atlantic current intruded to the northwest more than normal giving severe horizontal temperature and salinity gradients as far north as 45°30'N.

In January 1964 the U.S. Coast Guard initiated the first of the long term time-series of oceanographic observations planned for all Ocean Stations at Ocean Station "BRAVO." A sufficient number of vessels having oceanographic installations and equipment were available to take stations during 6 three-week patrols in 1964. They were taken on three alternate patrols during the January-April period, and on three during the July-December period. During the first three patrols, thirteen bottle casts to 1500 meters were taken daily when weather permitted and twice during each patrol sampling was extended to the bottom. On the basis of the results of the first three patrols, the interval between stations was increased to three days. The temperature and salinity data have been processed by CGOU and deposited with the National Oceanographic Data Center. Reports containing the data with descriptive material on the patrols will be issued by the Coast Guard.

Utilization of the Ocean Station vessels for the study of the seasonal variation in flow and characteristics of the Labrador Current was begun in November 1964 in support of INTICEPAT research. The CGC MENDOTA occupied a series of 7 stations across the current in the vicinity of 44°30'N en route to OS CHARLIE.

SUBAREA 4

A. Status of the Fisheries

I. Haddock

United States haddock landings from Subarea 4 increased again in 1964 (Table 2). As has been true for the last 5 years, the United States effort was expended almost entirely in Division 4X. Catch-per-day fished regained its 1962 level after a small drop in 1963 (Table 3).

The age composition of landings for 1964 (Fig. 1) indicated that the 1959 year-class (5 year olds) provided the bulk of the catch. The strong 1956 year-class is still in evidence. The 1960 year-class appears relatively weaker as 4 year olds than the two year-classes that precede it; however, it may not yet be fully recruited. The 1959 year-class should continue to contribute heavily to the fishery in 1965, but the overall level of abundance of fish available to the fishery will probably show a decrease until the 1962 and 1963 year-classes are recruited into the fishery beginning in 1967.

Table 2. --U.S. haddock landings, Subarea 4 (metric tons, round weight)

Years	R-S-T	V	W	X	Total
1956	86	147	1661	12130	14024
1957	2	120	1533	7296	8951
1958	--	71	427	12141	12639
1959	5	270	4804	5465	10544
1960	--	24	127	8315	8466
1961	--	1	23	9306	9330
1962	--	1	51	6388	6440
1963	--	2	61	7223	7286
1964	--	11	42	8535	8588

Table 3. --U.S. haddock statistics, Subdivision 4X (metric tons, round weight)

Year	Days Fished	Catch per day
1956	1106	10.963
1957	871	8.377
1958	1389	8.739
1959	970	5.636
1960	1209	6.877
1961	1384	6.722
1962	869	7.343
1963	1117	6.464
1964	1133	7.498

II. Cod

United States landings of cod from the Subarea were up slightly again in 1964, but were still near the average of the last 10 years (Table 4). Cod are taken almost entirely within Division 4X as a by catch of the haddock fishery.

Table 4. --U.S. cod statistics, Subarea 4 (metric tons, round weight)

Year	Landings
1954	2659
1955	1371
1956	1624
1957	1083
1958	1147
1959	862
1960	1605
1961	1261
1962	1197
1963	1347
1964	1452

III. Redfish

Landings from Subarea 4 R, S, T, (Gulf of St. Lawrence) in 1964 were nearly three times the amount landed in 1963 (Table 5). This increase in landings from 4 R, S, T continues the trend begun in 1963. Catch-per-day fished increased considerably in 1964. The greater apparent abundance in this area undoubtedly caused a shift in effort from Subarea 3.

Table 5. --U.S. redfish statistics, Subarea 4, Divisions R, S, and T (Gulf of St. Lawrence). (Weights in metric tons, round fresh)

Year	Landings	Days Fished	Landings/Days Fished
1954	17,228	1517	11.3
1955	34,739	2397	14.5
1956	24,825	2024	12.3
1957	18,319	1960	9.3
1958	7,535	844	8.9
1959	5,406	572	9.4
1960	1,412	139	10.1
1961	200	20	9.8
1962	68	---	---
1963	4,879	474	10.3
1964	12,278	682	18.0

The catch from Nova Scotian Banks decreased in 1964, being almost 8000 metric tons less than in 1963 (Table 6). The decrease in landings seems due almost entirely to a decrease in fishing effort. Landings-per-day-fished in 1964 was about the same as 1963, but both years are somewhat lower than the previous years.

Table 6. --U.S. redfish statistics, Subarea 4, Divisions V, W, and X (Nova Scotian Banks). (Weights in metric tons, round fresh).

Year	Landings	Days Fished	Landings/Days Fished
1954	20895	1900	11.0
1955	9330	1100	8.5
1956	16313	1461	11.2
1957	21101	1896	11.1
1958	30768	2556	12.0
1959	25281	2448	10.3
1960	36612	3352	10.9
1961	28957	3000	9.6
1962	29375	2697	10.9
1963	23282	2836	8.2
1964	15475	1719	9.0

B. Special Research Studies

I. Biological Studies

The studies of the haddock fishery in 4X have continued during the year. Results of the studies for the years 1956-1961 were published this year in the first issue of the ICNAF Research Bulletin.

II. Environmental Studies

The Albatross IV surveys included part of Subarea 4X as well as Subarea 5 (see under Subarea 5).

SUBAREA 5

A. Status of the Fisheries

I. Haddock

The U.S. landings of haddock from Georges Bank increased slightly in 1964 (Table 7). The abundance index rose from 4.4 in 1963 to 5.3 in 1964. This is still lower than the values in 1961 and 1962.

Table 7.--U.S. haddock statistics,[1/] Subarea 5 (metric tons, round weight)

Year	Landings	Days Fished	Catch per Day
1954	53539	6702	7.9
1955	50344	6240	8.0
1956	58422	8122	7.1
1957	54702	9275	5.8
1958	44404	9802	4.5
1959	40548	10665	3.8
1960	45341	8462	5.3
1961	51681	7962	6.4
1962	54412	8646	6.2
1963	48868	11185	4.3
1964	49397	9368	5.2

The 1958 and 1959 year-classes, which have been the primary support of the fishery during the past four years, have lost their dominance. The 1962 year-class contributed heavily to the fishery in 1964 (Fig. 2). It is probable that the low abundance level of larger fish cause a concentration of effort on the incoming year-class, and that it was harvested at a higher rate than the previous incoming year-classes have been. The young-of-the-year abundance index obtained from survey cruises did not indicate a high abundance for the 1962 year-class.

The heavy contribution of the 1962 year-class to the catch in 1964 caused the average weight of the fish landed as scrod to be quite low. In the last quarter of the year it was only 1.6 pounds. The lower limit of the scrod class is normally 1.5 pounds. The shift towards the harvesting of young fish should continue in 1965 when the strong 1963 year-class is expected to enter the fishery.

The abundant 1963 year-class first observed as 0-age fish in the 1963 summer and fall groundfish survey cruises also was abundant when observed as one-year-olds in the 1964 surveys. Although firm comparative indices are not available for yearling fish, those of the 1963 year-class were extremely abundant in the survey trawl hauls, relative to other year-classes. The 1964 year-class, however, appears to have about the same, relatively low, strength as the 1962 year-class as 0-age fish (Fig. 3).

The U.S.S.R. and Canada both landed appreciable numbers of fish from Subarea 5 since 1962 (Table 8). This has caused a significant increase in the amount

Table 8.--Haddock landings and effort, Subarea 5, Canada, USSR, and U.S.

Year	U.S.	Canada	USSR	Total	Days fished	Catch per day
1961	51681	189	--	51870	7991	6.5
1962	54412	3568	1134	59114	9394	6.3
1963	48868	8382	2361	59611	13644	4.4
1964	49397	*	*	*	*	5.3

* Not yet available

of effort as estimated from the U.S. landings-per-day index. This effort was probably even greater in 1964. With this large effort, the haddock fishery in Subarea 5 will depend even more on the strength of the year-class just being recruited into the fishery. Also, this intensity exceeds by about 35% that which is estimated to correspond to the equilibrium maximum sustainable yield of about 45,000 metric tons.

II. Cod

United States landings of cod continued to decline in 1964 from the recent high in 1962. The catch-per-day-fished dropped to the 1961 level, although it was still above the 10-year average (Table 9).

Table 9.--U.S. cod statistics, Subarea 5 (metric tons, round weight)

Year	Landings	Days fished	Catch per day
1954	12237	10706	1.1
1955	12457	8942	1.3
1956	13238	8963	1.4
1957	13160	10023	1.3
1958	16252	15160	1.0
1959	16218	11568	1.4
1960	14282	10151	1.4
1961	17669	8532	2.0
1962	18626	8212	2.2
1963	16734	4983	3.3
1964	15086	7323	2.0

The limited length-frequency data available showed a shift toward larger fish in 1963 and 1964. Small fish were proportionately more abundant in 1961 and 1962. Apparently year-class strength has varied, although age readings are not available to confirm this.

III. Silver Hake

United States food fish landings of silver hake in 1964 remained near the recent stable level of 40,000 metric tons (Table 10), but the catch-per-day declined somewhat. The increase in total landings of about 12,000 tons over 1963 is due to

Table 10.--U.S. silver hake statistics, Subarea 5 (metric tons, round weight)

Year	For Food	For Industrial	For Animal Food	Total	Catch per day
1954	40823	9525	2722	53070	--
1955	50348	10433	4536	65317	--
1956	40370	13608	4989	58967	--
1957	45300	17200	7200	69700	--
1958	48500	10400	7700	66600	--
1959	49900	11800	9100	70800	--
1960	46700	2300	9100	58100	17.5
1961	38100	3200	4500	45800	23.8
1962	37200	3200	7200	47600	18.5
1963	39247	8477*	--	47724	17.4
1964	39479	20476*	--	59955	15.1

*Includes animal food

the increased industrial catch. This industrial catch is taken primarily from southern New England waters where the food fish fleet does not operate. The catch-per-day index is computed from food fishery vessels operating north of Georges Bank.

In 1964, as in 1963 and 1962, the United States silver hake fleet did not fish much on Georges Bank, the area frequented by foreign vessels, and previously of major importance to the United States fleet. Abundance and catch in 1964 was highest along the Maine Coast area (Table 11).

Table 11.--U.S. silver hake landings and catch per day in selected areas by the Gloucester fleet (metric tons, round weight).

	Statistical Subareas							
	Inshore Waters						Offshore	
Year	Maine Coast		Cape Cod Bay		Nausets		Georges Bank	
	Landed	C/D	Landed	C/D	Landed	C/D	Landed	C/D
1960	6099	15.6	7258	12.2	4082	12.9	13154	28.2
1961	6046	16.7	7711	18.4	7258	24.0	5897	47.8
1962	8172	32.9	6350	11.7	9979	30.2	2268	12.0
1963	6222	27.7	9979	15.0	6804	21.9	3175	17.9
1964	12473	23.1	6350	11.6	4990	18.2	91	2.6

Fishing off Nauset was successful only in the early part of the season. Total food fish landings were maintained at normal levels by the diversion to Maine Coast and by an unusually good fall fishery in Cape Cod Bay.

IV. Redfish

The U.S. redfish landings and landings-per-day were somewhat lower than in 1963 (Table 12). The low value of landings-per-day reflects primarily a decrease during the latter half of the year, and may be caused more by diversion of fishing effort than by lowered abundance.

Table 12.--U.S. redfish statistics, Subarea 5 (Gulf of Maine), metric tons, round weight

Year	Landings	Days fished	Catch per day
1954	12988	3859	3.3
1955	13914	3089	4.5
1956	14388	3267	4.4
1957	16468	3862	4.2
1958	16112	3636	4.4
1959	14435	3329	4.3
1960	10716	2799	3.8
1961	14040	3077	4.5
1962	12540	2634	4.7
1963	8871	2764	3.2
1964	7807	3123	2.5

The stocks of redfish off New England have, for the most part, followed the expected course of reaction to exploitation. Abundance and, to some extent size of fish, declined as fishing intensity and landings increased during the early exploitation stages. In the early 1950's, stock abundance had apparently reached the level at which it was becoming uneconomic to fish. The evidence indicates somewhat greater catches could have been obtained, at least in the short run. Fishing effort declined thereafter, but since redfish are a slow growing stock, many years are required for the stocks to rebuild. The continued decline in intensity over the past decade has resulted in a general recovery of stock levels, at least up to 1962.

V. Yellowtail Flounder

The United States yellowtail fishery established a new peak of landings in 1964 (Table 13), due primarily to the continued increase in landings from the Georges Bank area. Estimated landings-per-day also remained at a high level.

Table 13. --U. S. yellowtail flounder statistics, Subarea 5 (metric tons, round weight)

	S. New England Grounds		Georges Bank		Cape Cod Grounds	
Year	Landings	C/D	Landings	C/D	Landings	C/D
1954	1515	1.3	2887	2.1	1120	1.3
1955	2180	1.4	2946	2.4	1304	1.3
1956	3542	1.5	1594	2.0	1472	1.1
1957	5441	2.3	2302	2.8	2357	1.6
1958	8907	2.4	4534	3.2	1613	1.7
1959	7738	1.6	4130	2.1	1526	2.0
1960	7843	1.8	4447	2.2	1812	1.6
1961	11632	2.5	4248	2.4	1880	2.0
1962	15669	3.3	7769	3.3	1973	1.7
1963	21500	4.1	10659	4.0	2722	2.1
1964	18962	4.5	14914	4.2	1860	2.0

VI. Industrial Fishery

Landings in the industrial fishery increased 36% over 1963 (Table 14). The variations in industrial landings over the past 9 years is related to production factors within the industry rather than changes in the abundance of the species caught.

Table 14. --U. S. landings of industrial trawl fish from Subarea 5 (metric tons, round weight

Year	Landings
1956	110786
1957	97736
1958	88927
1959	75706
1960	24492
1961	32132
1962	30094
1963	41414
1964	56130

A limited sampling program during the months of June, July and August of 1964 enabled a rough estimate of species composition to be made (Table 15). As in 1963, the industrial fishery was concentrated in areas where silver and red hake were abundant. The size composition of landings of these species is shown in Figure 4.

VII. Herring

The Maine fishery landed 26,244 metric tons of herring; only slightly more than the poor catch of 1961 - 24,154 metric tons. The annual catch has averaged 50,000 metric tons, with the 1962 and 1963 catches at 67,000 metric tons and 69,000 metric tons, respectively. Effort decreases from 1963 to 1964 were 141 to 108 stop seines, and 74 to 64 weirs. The effort of purse seines increased because of the poor success of stop seines and weirs in the inshore waters.

Table 15. --Species composition of industrial trawl fish caught in Subarea 5, 1963-1964.

Species	1963 Metric tons	1963 %	1964 1/ Metric tons	1964 1/ %
Red hake	17933	43.3	23914	42.6
Silver hake	8477	20.5	16783	29.9
Sea robin	2793	6.7	56	0.1
Skates	2327	5.6	4715	8.4
Flounders	1795	4.3	8139	14.5
Other	8086	19.6	2526	4.5
Total	41414	100.0	56130	100.0

1/--Preliminary estimated

The causes of the catch declines in 1961 and 1964 are difficult to determine at the present time. Low availability is a possible explanation.

VIII. Sea Scallops

United States landings of 6,424 metric tons of sea scallop meats from Division 5Z in 1964 were 23% less than in 1963; and the lowest since 1952 when they were 5,500 metric tons (Table 16). The drop in landings is the result both of lowered abundance (Fig. 5) on the grounds and of decreased effort.

Table 16. --Landings of sea scallop meats from Division 5Z, 1955-1964 (metric tons)

Year	United States Days fished	United States Landings	Total Landings (U.S. & Canada)
1955	11619	8300	8437
1956	12256	7938	8256
1957	10500	7847	8664
1958	8775	6532	7711
1959	8480	8482	10478
1960	8039	9934	13336
1961	8671	10705	15286
1962	9070	9934	15604
1963	7718	7983	13926
1964	6656	6424	12020

The 50% decrease in effort by the United States fleet since 1955 has been paralleled by an increase in effort by Canadian vessels on these grounds. This additional fishing effort, plus the recruitment of a strong year-class in 1959, caused total landings to rise for a few years, but they now seem to be dropping back towards the levels which prevailed in the 1950's (Fig. 6).

B. Special Research Studies

I. Biological Studies

1. Haddock. The United States is re-working in detail the early (1916-1931) data on commercial catch and effort in order to obtain more information on the relation between abundance, effort, and yield. This period is important because it covers the early phase of exploitation of the Georges Bank stocks.

2. Silver Hake. Studies on estimating abundance of silver hake from commercial fleet statistics have continued. Stratification of catch and effort by month, depth zone, and vessel tonnage is the approach which seems to promise the best results.

Otoliths have been exchanged with Canada and the U.S.S.R. in an attempt to further studies of ageing silver hake. The United States has over the year collected a large sample of otoliths from fish of all sizes and areas in order to validate ageing procedures.

Experiments on the selectivity of nylon nets of 30 to 73 mm have been completed. These indicate that the 50 mm nylon codend now in prevalent use by the industry provides a satisfactory escapement of small silver hake (less than 25 cm). Codends of 73 mm allow excessive escapement of fish between 25 and 35 cm which form the bulk of the fishery.

3. Redfish. Studies of methods of estimating redfish abundance from commercial catch and effort data were begun. This study impinges upon the more general problem of measuring relative abundance in a mixed-species fishery. This study is continuing.

4. Yellowtail Flounder. Research in 1964 was centered on studies of age determination and estimating growth rate of fish from three subpopulations in Subarea 5. Data collected in 1955-1964 are being used. Results indicate that there are small growth rate differences between subpopulations.

5. Winter Flounder. Approximately 9,000 winter flounder were tagged on Massachusetts inshore grounds, and on Nantucket Shoals and Georges Bank during March-May 1964, in a cooperative program with the Massachusetts Division of Marine Fisheries. Aims are: 1) to more clearly define seasonal and long term movements; 2) to identify, from tag returns and meristic studies, sub-populations that may be present in these areas; 3) to obtain information on the origin of the Georges Bank stock of winter flounder; and 4) to obtain exploitation level data by sport and commercial fishermen.

6. Herring.

a. Age Compositions. In 1964, 35 samples (2,549 fish) were obtained from Georges Bank and 46 samples (3,565 fish) from the coastal Gulf of Maine. The 1960 year-class was dominant in both areas. On Georges, this year-class was dominant in all months sampled, and the rank in percentage occurrence of the other year-classes remained constant throughout the year. In coastal Gulf of Maine, the 1958 year-class was dominant during the first four months of the year, and the 1960 year-class dominant during the remaining eight months. The rank in percentage occurrence of other year-classes varied considerably throughout the year, and the variation was different in the two areas. The average age composition and the length frequencies are shown in Figure 7.

b. Larval Studies. Herring larval studies were conducted in the offshore waters of Georges Bank and in the Gulf of Maine during the September, October and November research cruises. Number of larvae per tow, their mean lengths, and their distribution have been compared with results in 1956-1957. Though differences in mean length occurred, the distribution of larvae in time and space was similar in both periods.

c. Behavior Studies. Behavior studies are being carried out to learn some of the responses of herring to variations in environmental conditions which the fish might reasonably be expected to encounter in their coastal habitat. One example is the condition of supersaturation of oxygen in the water, which in extreme cases can be fatal to fish, and which occurred at several localities along the coast in the spring and summer of 1964. Laboratory experiments are designed to test the responses of fish to certain conditions which can be controlled and measured, either singly or in combinations; and have been essentially tests of "preference" or "avoidance" by the fish. Effects on basic physiological processes, such as respiration, have also been studied.

Analysis of maturity stages indicated that fall spawning occurred from early September to late November. The peak of spawning occurred earlier in coastal Gulf of Maine (September) than on Georges Bank (October). On Georges, the last spawning noted was during early February, while in coastal waters spawning fish were obtained during late March and early April. In both areas, fall spawning fish averaged 26.5 cm long. There was no evidence of spring spawning on Georges, but spring spawning was recorded from the western waters of the Gulf of Maine. Spring spawners averaged 29.5 cm long.

In the spring, adult herring were found dispersed throughout Georges Bank, while in the fall they were found congregating on the northern portion. In coastal Gulf of Maine, adult herring were found both inshore and offshore throughout most of the year. Sardines on Georges Bank were found only in the vicinity of Cultivator Shoals, where the depths are 20 fathoms or less and where temperatures are warmer than those of the deeper waters.

d. Racial Studies. In the 1964 report of the Herring Subcommittee, it was recommended that increased research effort be made to determine the identity of the herring stocks in the Gulf of Maine and on Georges Bank. Following this recommendation, three aspects of the serological and biochemical studies on herring at the Boothbay Harbor Laboratory were expanded. These expanded aspects involved the development of better methods for preserving blood to allow more extensive testing; testing the blood samples with many new blood typing reagents, especially antisera developed in rainbow trout; and expanded studies on serum protein differences by starch gel electrophoresis and immunodiffusion.

Preliminary analysis of the blood typing data obtained from repetitive samples taken on Georges Bank has not indicated that more than a single population of herring was sampled. Analysis of the data obtained from inshore samples has been complicated by the discovery that herring cells change in the agglutinability. Many of the herring sampled in the western Gulf of Maine had blood cells which could not be agglutinated by any reagent. Experiments on herring held in the laboratory indicate that herring change with respect to agglutinability of their red cells. This change is apparently due to, or associated with, exposure to high temperatures. A more complete investigation of this phenomenon, necessary for the interpretation of blood group work on herring, is being conducted. Other serological techniques have also been investigated.

e. Plankton Studies. Zooplankton collections were made along the coast of Maine from inshore to the 90-meter isobath. Zooplankton volumes in 1964 followed the pattern of areal variation found in 1963, with highest mean-annual volumes occurring in the western region, moderate volumes in the central area, and low volumes in the eastern sector of the coast. Decreased river runoff in 1964 resulted in higher seasonal salinities, which may have affected the abundance of C. finmarchicus (outer-neritic species) and C. typicus (inner-neritic species).

f. Benthic Studies. The U.S. continued its analysis of benthic samples collected along the Atlantic Continental Shelf, particularly in Convention Subarea 5. The density of individual invertebrates in this area is much higher than in areas to the south, although the biomass is the same from north to south.

g. Environmental Studies. The Albatross IV made four seasonal hydrographic surveys throughout Georges Bank and the Gulf of Maine determining temperature, salinity, oxygen and chlorophyll.

The Woods Hole Oceanographic Institution monitored temperature and salinity at lightships in Subarea 5. Drift bottle and sea-bed drifter studies of residual drift in connection with studies of herring life history, and in relation to changes in the circulation pattern induced by changes in river runoff, have been continued.

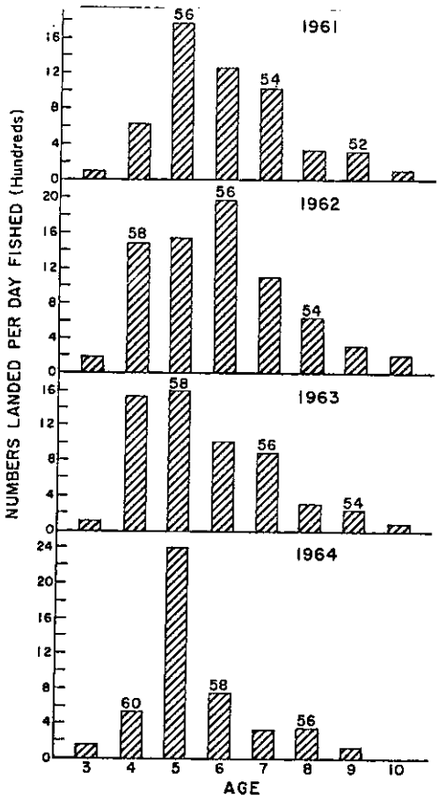

Figure 1. Age composition of U. S. landings of haddock from Division 4X.

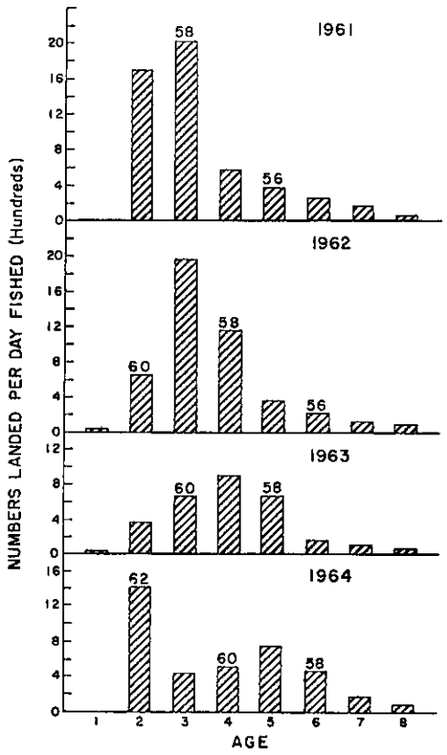

Figure 2. Age composition of U. S. landings of haddock from Subarea 5.

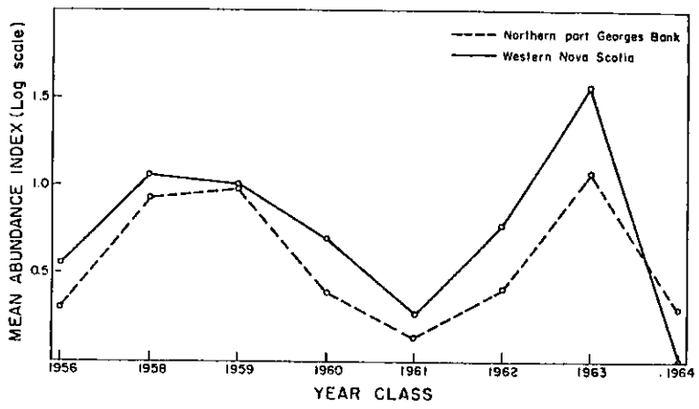

Figure 3. Index of abundance of 0 - age haddock derived from research vessel surveys.

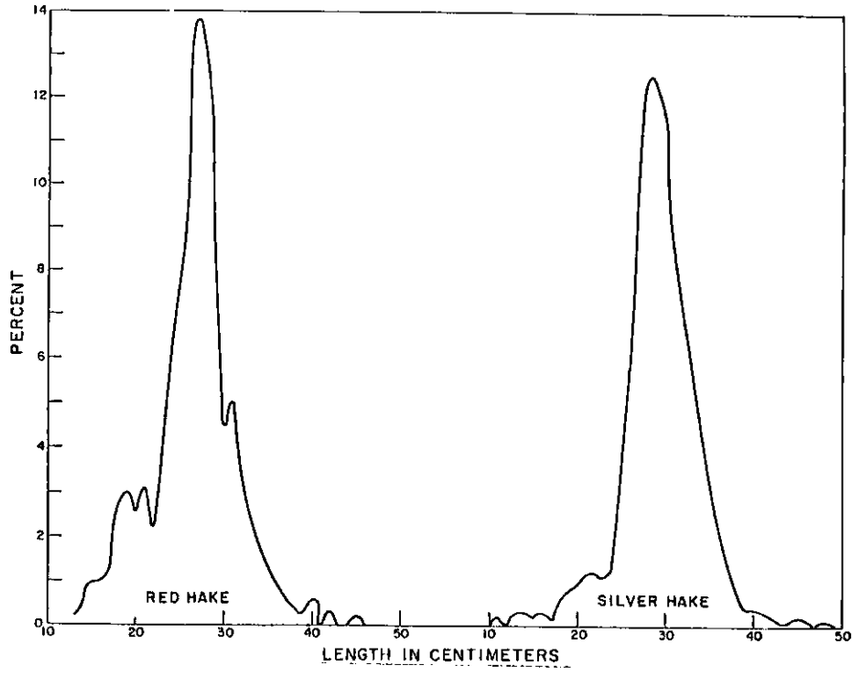

Figure 4. Length frequency of red and silver hake in Subarea 5 industrial landings.

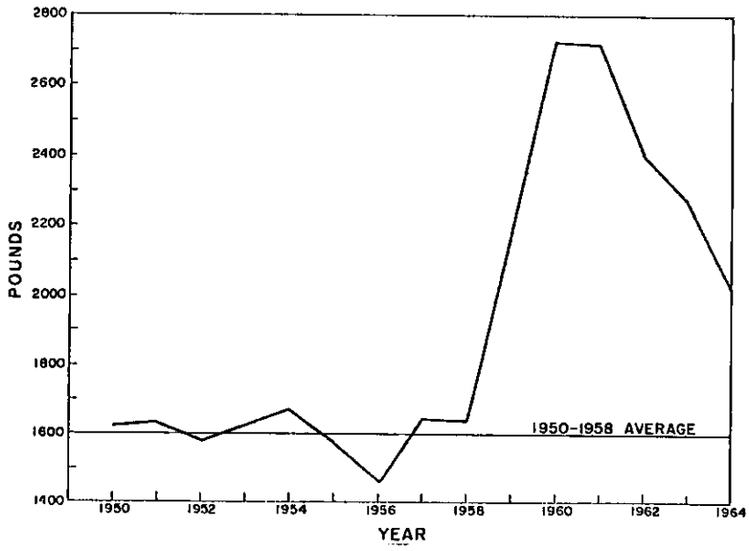

Figure 5. Relative abundance of sea scallops from Georges Bank (catch per day of U. S. fleet).

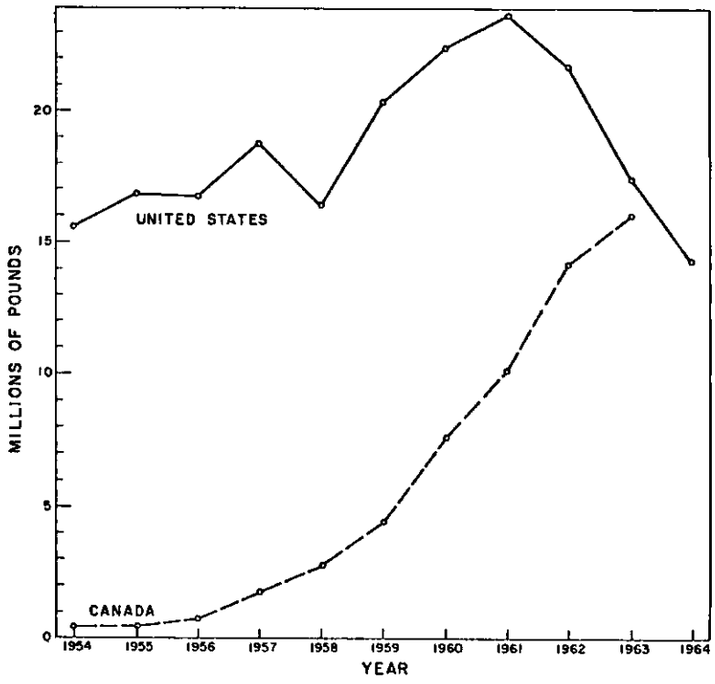

Figure 6. Landings of meats of scallops caught on Georges Bank.

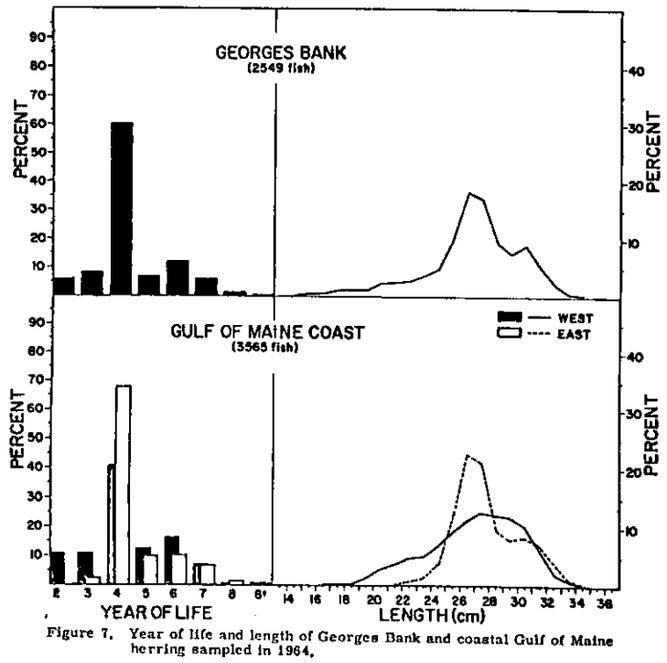

Figure 7. Year of life and length of Georges Bank and coastal Gulf of Maine herring sampled in 1964.