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United States Research Report, 1968

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The United States landed fish from ICNAF Statistical Subareas 3, 4, 5 and 6 and conducted research in subareas 1, 3, 4 and 5.

Subarea 1

The United States Coast Guard conducted oceanographic surveys in the neighborhood of Disko Island in conjunction with the International Ice Patrol West Greenland Glacier Survey. The Bureau of Commercial Fisheries cooperated to the extent of providing scientific personnel to collect benthic samples.

Twenty-one quantitative samples of the benthic fauna were obtained with a Van Veen grab sampler. Collections were taken at water depths from 72 to 747 meters. Common components were polychaete worms, bivalve mollusks, echinoderms, and bryozoans. A large proportion of the organisms were of small size, ranging from 5 to 20 millimeters. The fauna was judged to be typical of macrobenthic invertebrates previously reported from Arctic soft-bottom habitats in this depth range.

Subarea 3

A. Status of the Fisheries

I. Redfish

Redfish landings by the United States from Subarea 3 were slightly higher in 1968 than in 1967 (Table 3.1). Indications point to an increased abundance; however, with the relatively low effort, fishing success may not be a meaningful index of abundance.

Table 3.1 US redfish statistics, Subarea 3 (metric tons, round fresh).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/Day Fished</u>
1963	12,089	882	13.7
1964	4,692	364	12.7
1965	772	51	15.0
1966	346	38	9.1
1967	150	16	9.3
1968	198	15	13.1

Subarea 4

A. Status of the Fisheries

I. Haddock

Haddock landings by the United States were primarily from Division 4X. Landings decreased by almost two thousand metric tons (Table 4. 1). Southeastern Nova Scotia (Browns Bank) is the principal area of fishing by the US fleet within this Division. US landings in this area were slightly higher than in 1967 because of increased effort; abundance was reduced. Preliminary analysis of length frequencies and age data for this area for previous years show that the 1963 year class was fished heavily as 3- and 4-year olds (Table 4. 2). Also this year class might not have been relatively as strong here as on Georges Bank. This heavy cropping of the 1963 year class as it first became available to the fisheries and the failure of subsequent year classes to add materially to recruitment has resulted in the decreased abundance during 1968. Continued decreases are expected for at least two more years.

Table 4. 1 US haddock statistics, Division 4X (metric tons, round fresh).

Year	Division 4X Landings	Browns Bank		
		Landings	Days Fished	Landings/Day Fished
1963	7, 223	5, 277	812	6. 5
1964	8, 488	6, 978	930	7. 5
1965	3, 685	1, 786	275	6. 5
1966	2, 473	939	200	4. 7
1967	5, 014	2, 059	381	5. 4
1968	3, 156	2, 278	506	4. 5

Table 4. 2 Percent age composition of Browns Bank haddock.

Year	Age						
	3	4	5	6	7	8	9+
1963 ^{1/}	1. 5	26. 8	27. 3	17. 4	15. 4	8. 1	6. 4
1964 ^{1/}	2. 3	9. 2	47. 1	15. 9	7. 9	8. 0	9. 5
1965 ^{1/}	1. 0	4. 5	15. 4	39. 0	19. 2	7. 5	13. 5
1966	20. 9	22. 5	10. 5	11. 0	21. 8	5. 5	7. 3
1967	----	48. 4	31. 1	6. 6	4. 9	6. 0	2. 7
1968 ^{1/}	----	1. 4	58. 1	28. 7	4. 1	2. 3	5. 5

^{1/} Quarter 1 and 2 only.

II. Cod

In 1968 the US cod landings from Subarea 4 were 860 metric tons compared to 1, 435 metric tons in 1967. This decrease is probably related to the reduced effort for haddock over the year.

III. Redfish

Redfish landings from the Gulf of St. Lawrence (Division 4R, S, T) by the United States increased slightly in 1968 (Table 4. 3). Effort increased and abundance remained close to the 1967 level. US redfish landings and effort from the Scotian Shelf (Division 4V, W, X) continued to decline in 1968 (Table 4. 4). Because effort level was extremely low, landings per day fished may not be indicative of true abundance.

Table 4. 3 US redfish statistics, Division 4R, S, T (metric tons, round fresh).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/Day Fished</u>
1963	4, 879	508	9. 6
1964	12, 278	735	16. 7
1965	17, 099	803	21. 3
1966	12, 766	608	21. 0
1967	15, 482	622	24. 9
1968	16, 437	740	22. 2

Table 4. 4 US redfish statistics, Division 4V, W, X (metric tons, round fresh).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/Day Fished</u>
1963	23, 282	3, 104	7. 5
1964	15, 636	2, 369	6. 6
1965	13, 082	1, 246	10. 5
1966	16, 680	1, 183	14. 1
1967	6, 407	593	10. 8
1968	4, 663	295	15. 8

B. Special Research Studies

I. Biological Studies

1. Haddock. Cooperative studies with Canadian scientists on the stocks of haddock in Division 4X have continued. Statistics and market samples of length and age frequencies for the period 1962-1968 are being analysed to obtain estimates of mortality and to determine the status of this fishery.

Analysis of data from the US research vessel surveys is also being carried on to provide a second, independent estimate of the state of the stocks.

These studies should be completed in 1969. Preliminary results indicate an increased mortality rate commensurate with increased removals in recent years. Abundance is decreasing and all year classes since that of 1963 are poor.

Subarea 5

A. Status of the Fisheries

I. Haddock

Georges Bank (Division 5Z) haddock landings by the United States continued their sharp decline due to decreased abundance (Table 5.1).

Age compositions (Figure 5.1) show 5- and 6-year olds (1963 and 1962 year classes) making up 71 percent of the catch in 1968. The fall groundfish survey by Albatross IV showed a below average 1968 year class; the fifth consecutive year of poor production (Table 5.2). A continued reduction in abundance on Georges Bank is expected through at least 1971.

A management program for this stock is urgently needed, and is being considered by the US and the Assessment Subcommittee (see biological studies).

Table 5.1 US haddock statistics, Division 5Y and 5Z (metric tons, round weight).

Year	Subarea 5	Div. 5Y	Div. 5Z		Landings/ Day Fished
	Landings	Landings	Landings	Days Fished	
1963	48,892 ^{1/}	4,742	44,126	10,029	4.4
1964	51,895	5,383	46,512	8,775	5.3
1965	57,027	4,204	52,823	9,432	5.6
1966	57,497	4,579	52,918	11,759	4.5
1967	39,580	4,852	34,728	9,370	3.7
1968	28,887	3,418	25,469	9,096	2.8

^{1/} Total includes a small amount for which the division of catch was unknown.

Table 5.2 Research vessel index of relative year-class abundance of Georges Bank haddock based on autumn catches of O-group fish.

Year	Index	Year	Index
1959	9.6	1964	2.0
1960	2.4	1965	1.2
1961	1.4	1966	1.5
1962	2.6	1967	0.0
1963	12.6	1968	1.0

II. Cod

Cod landings by the US in Subarea 5 for 1968 increased 2000 metric tons over 1967 (Table 5. 3). Although the landings per day fished are not a precise indication of abundance of cod in the subarea, it is slightly higher than in 1967.

Table 5. 3 US cod landings, subarea 5 (metric tons, round weight).

<u>Year</u>	<u>Landings</u>	<u>Landings/Day Fished</u>
1963	16, 734	1. 8
1964	15, 478	1. 0
1965	15, 011	0. 9
1966	15, 343	1. 1
1967	18, 057	1. 0
1968	20, 877	1. 4

III. Silver hake

Total silver hake landings from Subarea 5 by the United States was about 5, 000 metric tons above 1967 (Table 5. 4). Most of the increase was for the food fishery in the Gulf of Maine where the abundance trend increased markedly. Catch rate and landings remained near the 1967 level in the southern part.

Table 5. 4 US silver hake statistics, subarea 5 (metric tons, round weight).

<u>Year</u>	<u>Subarea 5</u>	<u>Subarea 5 North^{1/}</u>		<u>Subarea 5 South^{2/}</u>	
	<u>Landings</u>	<u>Landings</u>	<u>Landings/Day</u>	<u>Landings</u>	<u>Landings/Day</u>
1963	47, 737	39, 247	17. 4	8, 490	5. 9
1964	53, 145	39, 479	15. 1	13, 666	11. 5
1965	41, 809	33, 774	11. 3	8, 035	4. 4
1966	40, 200	37, 545	12. 7	2, 655	2. 0
1967	30, 947	27, 082	9. 3	3, 865	3. 9
1968	35, 842	32, 366	14. 0	3, 476	4. 0

1/ Primarily food fish from north of Cape Cod.

2/ Primarily for industrial use from south of Cape Cod.

IV. Redfish

Redfish effort and landings by the United States from Subarea 5 declined in 1968. Landings per day, however, were slightly higher. Abundance of this stock has apparently recovered markedly from its previous low state because of the reduced catches in recent years (Table 5. 5).

Table 5.5 US redfish statistics, Subarea 5 (metric tons, round weight).

Year	Total subarea 5		Div. 5Y (Gulf of Maine)	
	Landings	Landings	Days Fished	Landings/Day Fished
1963	8,871	6,785	1,655	4.1
1964	7,812	6,137	1,427	4.3
1965	6,986	5,045	742	6.8
1966	7,204	4,719	429	11.0
1967	10,442	6,746	649	10.4
1968	6,576	4,060	292	13.9

V. Yellowtail

Total US yellowtail landings in 1968 from Subarea 5 increased significantly from 1967 (Table 5.6). A rise in abundance accounted for the landings increase.

The age composition of yellowtail in 1968 (Figure 5.2) showed a dominance of two strong year classes: 1965 and 1964 (3- and 4-year olds). These two year classes along with a relatively good 1966 year class were responsible for the upswing in landings and abundance which should remain near the same level in 1969.

Table 5.6 US yellowtail statistics, Subarea 5 (metric tons, round weight).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/Day Fished</u>
1962	25,538	8,238	3.1
1963	35,220	9,031	3.9
1964	36,340	9,822	3.7
1965	37,190 ^{1/}	11,997	3.1
1966	31,020 ^{1/}	15,510	2.0
1967	25,376 ^{1/}	11,534	2.2
1968	32,564 ^{1/}	10,855	3.0

^{1/} 1965-1968 values include some landings for industrial purposes.

VI. Red hake

Red hake landings by the US in 1968 were about 500 metric tons greater than in 1967 (Table 5.7). Landings per day continued a slow increase that started in 1967.

Table 5.7 US red hake statistics, Subarea 5 (metric tons, round weight).

Year	Subarea 5	Div. 5Y	Div. 5Z ^{1/}		
	Landings	Landings	Landings	Days Fished	Landings/Day Fished
1963	3,166	579	2,584	165	15.7
1964	24,573	143	24,430	1,733	14.1
1965	13,493	192	13,301	1,462	9.1
1966	4,280	634	3,646	1,585	2.3
1967	5,759	92	5,667	1,012	5.6
1968	6,216	82	6,134	876	7.0

^{1/} Predominately industrial landings.

VII. Industrial Groundfish Fishery

New England industrial groundfish landings (Table 5.8) were slightly lower in 1968 than in 1967. Species composition remained relatively similar to 1966 and 1967 although red hakes did show some percentage increase, while the flounders decreased by an equal amount.

Table 5.8 New England groundfish landings from Subarea 5 for industrial purposes (metric tons, round weight).

Year	Total Landings	Species Composition (%)				
		Silver hake	Red hake	Flounder	Eel pout	Other
1963	26,020	19.5	43.7	4.4	2.1	30.3
1964	27,899	20.0	42.6	11.6	0.9	24.9
1965	34,044	20.4	38.0	6.9	1.8	32.9
1966	28,337	9.6	10.2	18.2	25.0	37.0
1967	38,688	10.2	14.7	18.5	18.9	37.7
1968	36,139	9.9	17.2	16.5	24.2	32.2

VIII. Herring

The catch of Maine sardines continues below average. The catch of 7,100 metric tons in western Maine in 1968 was the third lowest in the 22 years of record keeping. The catch of 11,300 metric tons in central Maine was the fourth lowest in 22 years. An hypothesis that the sardine distribution was recently shifted eastward is supported in 1968 with the largest catch in eastern Maine since 1958. Although this catch of 9,300 metric tons is relatively small, compared to the catches of 15,000 to 30,000 metric tons of the late 1940's and early 1950's, it may be a significant increase.

The number of cases of sardines packed (1,630,000) for 1968 was the largest number of cases packed since 1962 when the dominant 1960 year class entered the fishery. The large pack was made possible by imports from Canada. The purse seine catch, which had increased steadily from 1963 to 57 percent of the total catch in 1967, declined to 28 percent in 1968.

The age composition of the 1968 sardine fishery of Maine, based upon an analysis of 355 samples (8875 otolith pairs) is shown in Table 5.9. Immature herring formed 99 percent of the fish used. In 1968, 4-year-old fish were only .5 percent of the catch in contrast to 1967 when they contributed 15 percent, the highest on record.

Table 5.9 Age composition of the Maine sardine landings in 1968.

Age group	Year class	Percentage
I	1967	2.3
II	1966	83.6
III	1965	13.2
IV	1964	0.5
V	1963 or earlier	0.4

Sampling of the offshore herring fishery was limited to two autumn cruises, and among the fish obtained for study from the Georges Bank area, the 1962 year class was most numerous. In the Gulf of Maine, the 1961 year class was most numerous.

The gonadal condition of the specimens showed that spawning generally took place earlier this year than in 1967. Larval herring were captured in September on Georges Bank, indicating spawning in early September.

Fish in age groups III-VIII from Georges Bank, the coastal Gulf of Maine, Nova Scotia and Subarea 6 ranged in length from 23.8-33.7; 19.6-35.1; 18.5-34.5; 12.9-33.7 cm respectively.

A substantial fishery for reduction developed during the year in the Jeffreys Ledge area of the Gulf of Maine. US and Canadian catches in this area approximated 30,000 tons. Vessels from other countries also fished in this area during late October.

IX. Sea scallops

United States sea scallop landings from Georges Bank declined in 1968 (Table 5.10) despite an increased effort. The research vessel index showed a sharp decline from 1967, while the commercial landings per day fished reflected only a slight decrease.

Table 5.10 US sea scallop statistics, Subarea 5 (metric tons, weight of adductor muscle only).

Year	Landings	Days Fished	Landings/Day Fished	Research Vessel Index
1963	7,906	7,906	1.0	45.4
1964	6,296	6,296	1.0	40.0
1965	1,509	2,156	0.7	33.5
1966	901	1,001	0.9	48.0
1967	1,309	1,870	0.7	63.0
1968	1,163	1,938	0.6	44.7

B. Special Research Studies

I. Environmental Studies

Hydrographic Studies. The Albatross IV made temperature observations on all cruises conducted in the area. The U. S. Coast Guard conducted two hydrographic cruises in Subarea 6, 5, and southern part of 4. Results are reported in other research documents. In general, the declining temperature trend observed over the past decade appears to have stopped or reversed.

The U. S. Coast Guard is now conducting oceanographic projects at all North Atlantic Ocean Stations manned by U. S. Coast Guard cutters as reported in separate document.

At the Bureau of Commercial Fisheries, Boothbay Harbor Laboratory, daily, monthly, and annual means of Boothbay Harbor air and water temperatures are available since 1905. Throughout the year, continuous recordings were made of surface sea temperature (-5.5 ft. MLW), air temperature, and precipitation at Boothbay Harbor. In addition, continuous recordings were made of bottom sea temperature (-22 ft. MLW), salinity, tide level, wind speed and direction, dew point, and barometric pressure.

Surface water temperatures during 1968 were generally higher than in recent years. The annual mean was 8.1° C., the highest since 1964, and the greatest upswing in one year since the downward trend started in 1951.

Coastal plankton. As in previous years since 1963, quarterly cruises were made to monitor the distribution, abundance, and composition of the zooplankton in coastal waters of the Gulf of Maine. The mean-annual volumes were not significantly different from that in 1967. The predominant zooplankters in the samples were copepods.

Experiments were continued on the catching efficiencies of the Gulf III and Bongo plankton samplers. Simultaneous collections were made with both samplers in winter, spring, summer, and autumn to sort out the effects of the variations in the different sizes of zooplankters occurring in the different seasons. Both samplers were fitted with 0.366 netting as in earlier experiments. From these recent experiments and earlier testing of the hydrodynamics of the Gulf III, it was concluded that the high mesh velocity of the Gulf III results in significant extrusion of the smaller zooplankters.

Cooperative environmental research between the US, Canada, and the USSR is reported in other documents.

Benthic Studies. The Woods Hole Laboratory continued its studies of the bottom invertebrates in the Gulf of Maine-Georges Bank area. Analyses of the quantitative aspects of 1100 samples from the continental shelf and slope off New England were summarized during the year. A special study was made of the relation of faunal composition to depth. In shallower depths mollusks comprise 57 percent of the biomass but only four percent in depths greater than 2000 meters. Echiurids constitute less than one percent of the biomass in shelf waters but nearly one-third at depths greater than 1000 meters. A study of the life histories of some of the mysids important in groundfish diet was completed.

Samples were collected in the peripheral coastal zone of the Gulf of Maine to complete the coverage of the general area. Although all of the samples have not been analyzed, more than 15 communities of benthic invertebrates were encountered during this cruise. Some of the richest and most varied assemblages occurred in rocky areas along the Maine coast, off western Nova Scotia, and in the vicinity of Nantucket Shoals.

II. Biological Studies

Haddock. Because of the critically low level of the Georges Bank haddock stock, the United States intensified its studies of the dynamics of this population.

Utilizing commercial fishery statistics collected since 1932, we have defined for the equilibrium state corresponding to the maximum harvestable surplus, in terms of numbers of fish, the average population density, fishery removals and recruitment. Overexploitation and abnormal recruitment in the past few years have caused an extreme departure from equilibrium and led to a very low stock density in 1968. Some form of regulation of fishing mortality is required to prevent establishment of an equilibrium at this low level of harvestable surplus. We have, therefore, attempted to estimate the current and short-term projected densities and recruitment rates in order to establish a basis for management; i. e. estimates of the numbers of fish in the population which are available as surplus production. This task is complicated because of the lack of data on current total removals, and because the structure of the US fishing fleet has changed radically thus altering the past relationship between fishing success and stock density and distribution.

Approximate estimates of the current status have been obtained, and reported to the assessments subcommittee of ICNAF. In brief, the information to date indicates that if removals in 1968 were about 31,000 metric tons, as seems likely, a catch in 1969 of 5000 tons or more would probably exceed the recruitment of young fish. Thus, a rather severe reduction in removals is required to begin the process of rebuilding the stock to levels providing maximum surplus production.

Because of the changing nature of the fishing fleets it has been necessary to develop new techniques for estimating haddock abundance. A least squares analysis routine is being used for

testing an additive factorial model with two sets of parameters (vessel class and depth). Hypothesis testing was virtually completed for the years 1962-1968 and it is planned to begin work on point estimations during 1969.

The study of the timing and distribution of haddock spawning is now in its second year. Mature haddock are sampled from the commercial landings and research vessel surveys for stage of development of gonads. Material is preserved for research being carried out by Canadian biologists studying fecundity.

A second phase of the study, this year being carried out jointly with biologists of the Soviet Union, is concerned with the distribution of eggs and larvae in the surface waters.

At the time of this writing (April) it is apparent that haddock spawning in 1969 is earlier than observed in 1968. This is correlated with higher water temperatures in the Gulf of Maine. This study will be continued with the objective of defining the various factors that determine both the timing and the effectiveness of spawning.

Silver hake. Length-weight studies are continuing. These will be used to define and compare parameters for different segments of the Subarea 5 stocks.

Age validation studies, particularly emphasizing problems in aging young fish--through their second year of life--have been completed.

Joint US-USSR Groundfish Studies. The US Albatross IV and the USSR Blesk conducted joint trawling operations in October-November 1968, which were similar to those reported for 1967 but extended over a larger area. A comprehensive survey using the same sampling design employed in 1967, was conducted in statistical Subarea 6 and Division 5Z. Albatross IV then continued its standard fall survey in Divisions 5Y and 4X, and Blesk conducted limited trawling operations in the same areas using a new US trawl. Additional vessel-gear comparison studies were conducted including measurements of trawl dimensions during towing.

Operations again went smoothly and a preliminary report of the studies is included in the Research Document series.

Herring. Four years of winter mortality estimates for larval herring have been determined. They suggested that 1) the mortality for larvae in the Sheepscot estuary varies greatly from year to year (22 percent to 52 percent) and is sufficiently severe to govern the subsequent spring abundance of larvae; and 2) the estimates of larval abundance should be made after the winter mortality to provide better comparisons between the strength of year classes and the recruitment of herring to the coastal sardine

fishery. Increased mortalities were correlated with a decline in the condition factor of the larvae during winter. The 1964 year class suffered the highest winter mortality, had the lowest maximum abundance in spring and the greatest decline in the condition factor in winter.

Examinations were made on the seasonal variations in the food of juvenile herring in coastal waters of the Gulf of Maine. Only five zooplankton taxa occurred commonly in the alimentary tracts: copepods, cirriped larvae, cladocerans, decapod larvae, and pelecypod larvae. Copepods were the most important food; in all seasons. They increased in importance from a low incidence in 55 percent of the feeding juveniles in spring to 100 percent in winter. Cladocerans occurred most commonly in summer (in 69 percent of the feeding herring), and autumn (76 percent). Among the other taxa, larval cirripeds were in 48 percent of the feeding fish in spring and 41 percent in summer.

Salmon. Figures for the Greenland fishery in 1967 are now complete and 41 tags of Maine origin were recovered in Subarea 1. Thirty-six of the tags were applied to smolts and five to kelts. Tag recovery figures from this fishery indicate that 40 percent of the kelt tags recovered in Subarea 1 are of Maine origin.

Tag recoveries in 1968 from all areas north of 5Y stands at 118 tags with four recovered in Subarea 1. An additional 164 tags were recovered in home waters. Tag returns for 1968 are incomplete.

Tagging studies are continuing with 76,600 tagged smolts released in the spring of 1968 and an additional 77,000 smolts tagged for release in the spring of 1969.

Preliminary data reveals a higher survival for two-year-old hatchery-reared smolts. A comparison of one- and two-year-old smolts further indicates that fish must exceed 18 centimeters in total length if suitable returns are to be expected.

Home river catches were reduced in 1968. In the five-year period 1964-68 the average annual sport catch has decreased 36 percent as compared to the average annual catch for the preceding five-year period.

Lobster. Studies are underway to identify the major stocks and subpopulations within the lobster resource. Major emphasis is placed on the relationships between offshore stocks on the outer continental shelf and those of immediate US coastal areas. Four approaches, namely, biochemistry, parasitology, tagging, and bio-statistics, are directed toward fuller understanding of stock identity. Additional studies include migratory behavior, growth, natural mortality, and rate of exploitation. Seasonal abundance and distribution of planktonic larval stages will also be studied as part of a broader coastwide and offshore program.

In July 1968 a preliminary "aquaculture" program was commenced with the northern lobster, *Homarus americanus*. The objective of the program will be to obtain the information necessary to evaluate the economic feasibility of lobster culture. At present, studies are underway to determine the ecological requirements necessary for hatching lobster eggs under laboratory conditions. The ecological and nutritional requirements of laboratory-reared larvae and juveniles are being investigated also, with a view to increasing growth rate and molting frequency, and decreasing the high mortality suffered during these early stages.

Research in Statistical Subarea 6

The joint US-USSR groundfish surveys extended as far south as Cape Hatteras.

The Sandy Hook Laboratory of the Bureau of Sport Fisheries and Wildlife continued its aerial temperature surveys in cooperation with the United States Coast Guard covering the area from Cape Cod southward each month of the year.

The Laboratory is analysing samples collected on a plankton survey covering the area from Cape Cod to Cape Lookout, North Carolina. Larval hakes occur in these collections during the period May to December.

A special study of water circulation in the area 12 miles off Sandy Hook, New Jersey, by means of drift bottles and seabed drifters indicated a strong movement of bottom water to the north and northeast associated with strong prevailing northwest winds throughout November and December.

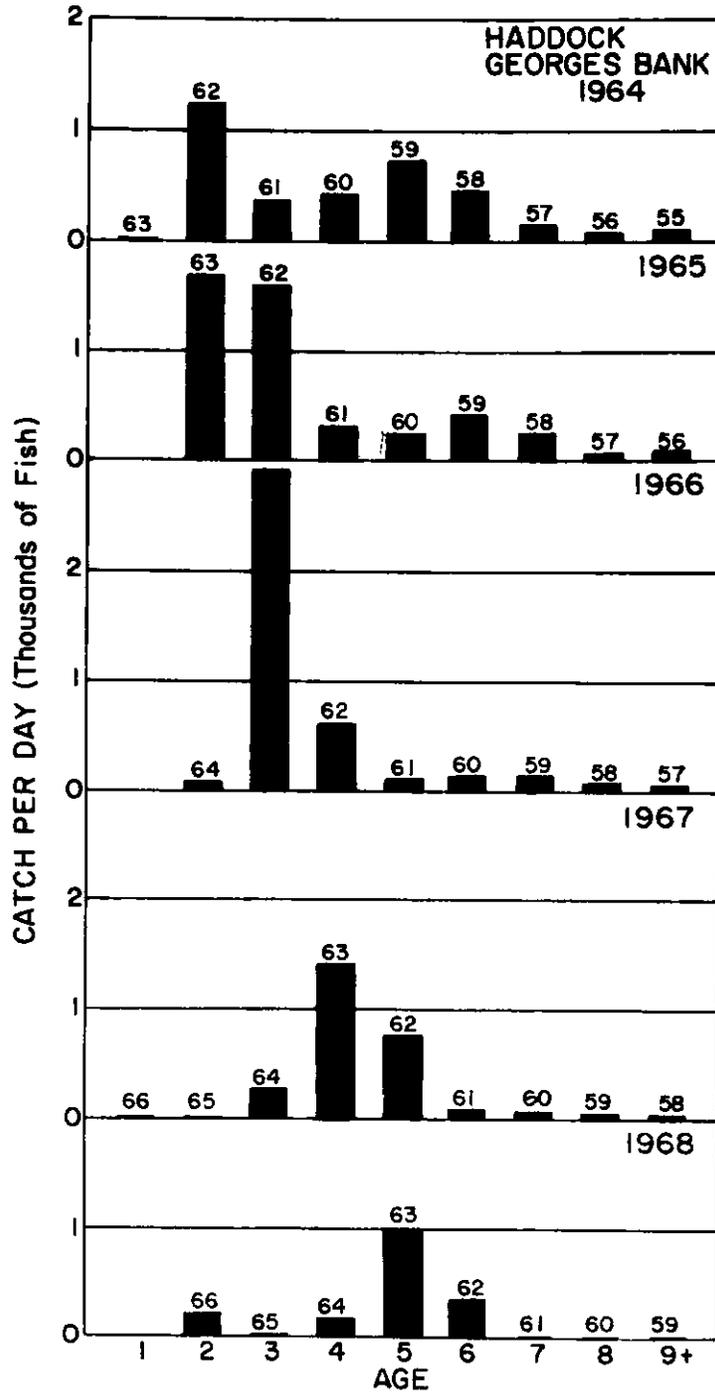


Fig. 5.1. Age composition of Georges Bank haddock.

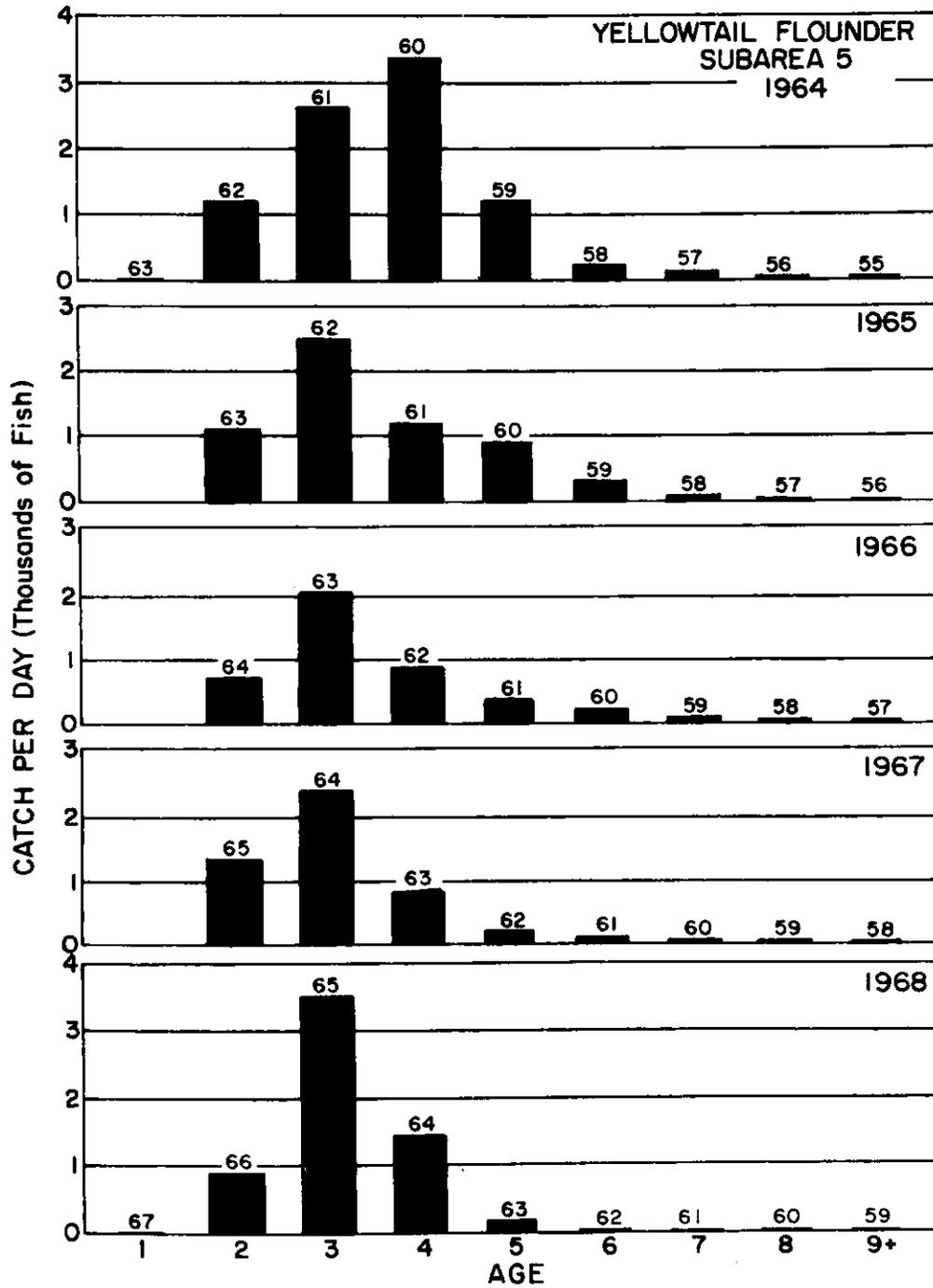


Fig. 5.2. Age composition of Subarea 5 yellowtail flounder.