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

Subarea 3

A. Status of the FisheriesI. Redfish

United States redfish landings from Subarea 3 came mainly from the Grand Bank, Divisions 3N and 3P (Table 1).

Table 1. US redfish statistics, Subarea 3, 1966 (Metric tons, round fresh).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/ Day Fished</u>
1962	14,257	932	15.3
1963	12,089	882	13.7
1964	4,692	369	12.7
1965	772	51	15.0
1966	346	38	9.1

B. Special Research StudiesI. Environmental Studies

Oceanographic Programs of the United States Coast Guard Oceanographic Unit.

In 1966, the Coast Guard again had two major oceanographic efforts in the ICNAF area. The long standing program in support of International Ice Patrol was quite different from previous years because of the extremely light ice season and the availability of an Icebreaker for studies in the Baffin Bay - Nares Strait area. The Ocean Station program which was begun in 1964 was greatly expanded. The "on station" coverage was expanded to include work at all stations and a pilot program for the occupation of a series of standard sections across the Gulf Stream and Labrador Current was begun.

1966 was the lightest ice season in the history of INTICEPAT, not a single berg was sighted in the Labrador Current south of 48°N. and the requirement for direct oceanographic support was terminated on 25 April 1966. Consequently, only one survey of 43 stations, required by COMINTICEPAT was to determine the oceanographic conditions in the vicinity of the Grand Banks. In May and June an extensive, 103 station, survey was made of the Gulf Stream, Labrador Current System and the Labrador Sea from a point well south of the Grand Banks north to the INTICEPAT South Wolf Island, Labrador to Cape Farewell, Greenland Section. The purpose was to determine the extent of the unusually warm conditions observed in the Grand Banks area during the spring 1966. As in 1965, the normal post ice season cruise in July was again devoted to an extensive study of the contribution of the outflow of Hudson Straits to the Labrador Current. A total of 194 oceanographic stations were occupied during this program.

During August 1966, the CG Icebreaker EDISTO was utilized to make an oceanographic survey of the Baffin Bay - Nares Strait area between 77°30'N and 82°N. A Total of 119 stations were occupied. In addition, to serial temperature and salinity data, dissolved oxygen observations were made at 73 stations and 200-meter vertical plankton tows at 24.

The development of the Ocean Station program continued to be hampered by the shortage of reversing thermometers. However, coverage at BRAVO was increased to 9 patrols, which meant that data was taken during alternate three week patrols throughout the year. The program at station CHARLIE was begun in June and data were taken on 6 patrols during the remainder of the year. At station DELTA data were taken on 4 patrols between July and December at station ECHO thermometers were for only one patrol. The program at all stations except BRAVO consist of daily 13-15 bottle Nansen casts to 1500 meters with sampling being extended to as near the bottom as practicable at least once during the patrol. At BRAVO cast were made on alternate days.

The locations of the standard sections are shown on the attached chart, Fig. 1. Sections 1 through 4 are modifications of INTICEPAT sections. It is planned to occupy Sections 2 through 5 on a monthly basis, Sections 6 and 7 on at least seasonal basis and Section 1 monthly whenever ice conditions will permit. Sampling is to 1500 meters with near bottom samples interspaced at about 90 mile intervals. Station spacing is approximately 30 miles offshore and at 10-15 mile intervals in the Labrador Current. In addition, to the INTICEPAT coverage in 1966 mentioned above, Section 2 was occupied during March and November, Section 3 - 3 times (February, March and November), and Section 4 twice (October and November). Section 5 was occupied in November and Section 6 in both October and November.

Subarea 4

A. Status of the Fisheries

I. Haddock

United States fishing effort in Subarea 4 was concentrated mainly in Division 4X. Decreased landings were due to decreased abundance and effort (Table 2). No Age Compositions were available in 1966 because of lack of samples. The 1963 year class which was so strong on Georges Bank in 1965 and 1966 is expected to make its appearance on Browns Bank in 1967.

Table 2. US Haddock statistics, Division 4X (metric tons live weight)

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/ Day Fished</u>
1962	6,388	875	7.3
1963	7,223	1,111	6.5
1964	8,488	1,132	7.5
1965	3,685	567	6.5
1966	2,473	526	4.7

II. Cod

US cod landings showed no change from 1965. Less than 1,000 metric tons were landed.

III. Redfish

Gulf of St. Lawrence redfish landings (Divisions 4R, S, T) by the US in 1966 was less than in 1965 (Table 3). This seems to be a result of decreased effort. Redfish landings from the Nova Scotian shelf (Divisions 4V, W, X) on the other hand increased considerably in 1966 apparently the result of increased abundance (Table 4).

Table 3. US redfish statistics, Divisions 4R, S, T (Gulf of St. Lawrence), (metric tons, round fresh).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/ Day Fished</u>
1962	68	8	8.7
1963	4,879	508	9.6
1964	12,278	735	16.7
1965	17,099	803	21.3
1966	12,766	608	21.0

Table 4. US redfish statistics, Subarea 4, Divisions V, W, and X (Nova Scotian Shelf), (metric tons, round fresh).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/ Day Fished</u>
1962	29,375	3,376	8.7
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

B. Special Research Studies

I. Environmental Studies (See under Subarea 3).

II. Biological Studies

1. Haddock. Study comparing ages from scales and otoliths from Division 4X was undertaken to determine feasibility of using scales in place of otoliths for routine age studies. Agreement of 465 scale-otolith comparisons was 76%. Scale readings were consistently lower than otolith readings and these differences were significant in all age groups beyond about 5 years. Study is being continued to determine reasons for disagreement between scales and otoliths.

The abundance index for haddock in Subarea 4 is normally calculated from boats that fished the entire trip in the subarea. Because haddock abundance on Browns Bank was relatively low, few boats fished the entire trip in the subarea and the abundance index was considered weak. Comparisons were made between indexes based on pure and split trips in subarea 4 and no significant differences were found. Therefore, catch per day for vessels fishing partial trips as well as those fishing an entire trip on Browns Bank are now used in calculating the index.

Subarea 5

A. Status of the Fisheries

I. Haddock

US landings from Georges Bank in 1966 were the same as in 1965 (Table 5). The abundance index showed a slight decrease but increased effort maintained the same level of landings.

Table 5. US haddock statistics, Georges Bank (metric tons, round weight).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/ Day Fished</u>
1962	49,378	7,838	6.3
1963	44,126	10,029	4.4
1964	46,522	8,778	5.3
1965	52,677	9,407	5.6
1966	52,735	9,948	5.1

Age compositions (Fig.2) show 3 year olds (1963 year class) contributing about 60 percent of the catch. ALBATROSS IV groundfish surveys show that subsequent year classes, (1964, 1965, and 1966) are weak ones (Fig. 3). For this reason forecasts are for decreased haddock abundance on Georges Bank through 1968 and 1969.

II. Cod

Generally cod abundance and landings (Table 6) remained steady in 1966. The 1966 abundance index, however, indicates slightly higher abundance than in 1965.

Table 6. US cod statistics, Subarea 5 (metric tons, round weight).

<u>Year</u>	<u>Landings</u>	<u>Landings/ Day Fished</u> <u>1/</u>
1962	18,626	1.2
1963	16,734	1.8
1964	15,478	1.0
1965	15,011	0.9
1966	15,343	1.1

1/ Calculated from the amount of cod caught incidentally by Boston haddock study fleet. Most cod landed in the US from Subarea 5 is a by-catch of vessels engaged in other fisheries.

III. Silver Hake

Landings of silver hake by the US (Table 7) have decreased in 1966. This decrease is accounted for in the lower catch of silver hake in industrial landings. Food Fish landings actually increased in 1966, but the abundance was unchanged.

Table 7. US silver hake statistics, Subarea 5 (metric tons, round weight). 1/

<u>Year</u>	<u>Landings (Food)</u>	<u>Landings (Industrial)</u>	<u>Days Fished</u>	<u>Landings/Day Fished (food only)</u>
1962	44,271	5,333	2,393	18.5
1963	39,247	8,490	2,256	17.4
1964	39,479	13,666	2,615	15.1
1965	33,774	8,035	2,639	12.8
1966	37,545	2,655	3,004	12.5

1/ Amagansett, Long Island, industrial landings of silver hake included.

IV. Redfish

US redfish landings were about the same in 1966 as in the previous year (Table 8). Landings per day, however, increased for the fourth year indicating that redfish abundance in Subarea 5 (Gulf of Maine) is definitely on the increase.

Table 8. US redfish statistics, Subarea 5 (Gulf of Maine), (metric tons, round weight)

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/Day Fished</u>
1962	12,540	3,135	4.0
1963	8,871	2,164	4.1
1964	7,812	1,817	4.3
1965	6,986	1,027	6.8
1966	7,075	643	11.0

V. Yellowtail

US yellowtail flounder landings in 1966 decreased about 18 percent compared to 1965 (Table 9). Landings per day on both Georges Bank and Southern New England grounds decreased in 1966 showing reduced abundance of yellowtail.

Age compositions of yellowtail landings show about 50 percent of the catch were 3 year olds in 1966 (Fig. 3). The poor showing of 2 year olds in the catch indicates further decreases in yellowtail abundance in 1967.

Table 9. US yellowtail statistics, Subarea 5, (metric tons, round weight), (Food Fish only).

Year	<u>Southern New England</u>			<u>Georges Bank</u>	
	Total Landings	Days Fished	Landings/ Day Fished	Days Fished	Landings/ Day Fished
1962	25,565	4,748	3.3	2,354	3.3
1963	35,220	5,244	4.1	2,317	4.6
1964	35,930	5,099	3.7	3,535	4.2
1965	34,234	6,010	3.1	4,486	3.2
1966	28,079	7,110	2.1	5,671	2.0

VI. Industrial Groundfish Fishery

New England industrial landings (Table 10) decreased about 18 percent in 1966. This decrease was due to a marked decrease in red hake and silver hake abundance. Red hake normally make up 40-45 percent of the industrial catch. In 1966 the percentage dropped to 10 percent. Silver hake usually comprise 20 percent of the catch but accounted for only 10 percent of the catch in 1966.

Table 10. New England groundfish landings for industrial purposes, (metric tons, round weight). 1/

Year	Landings	Percent		
		Silver Hake	Red Hake	Other <u>2/</u>
1962	26,666	---	---	---
1963	26,020	19.5	43.7	36.8
1964	27,899	20.0	42.6	37.4
1965	34,049	20.4	38.0	41.6
1966	28,337	9.6	10.2	80.2

1/ Amagansett, Long Island, industrial landings not included.

2/ Each component species less than 7%.

VII. Herring

The Maine catch of herring for 1966 was 27,200 metric tons, the second lowest in 20 years. The landings, normally heavier in western Maine, were heaviest in eastern Maine, which produced, for the second year in a row, the best catches since 1958. There was no indication of an unusually high mortality to account for the lack of fish during the past year. Temperatures, however, were unusually low in the winter of 1965. A possible explanation of nonavailability to the inshore fishery is that zooplankton was very high. During August dissolved gases in the water were the highest for the 3-year period that records have been kept and very few fish were caught at this time. In September and October, dissolved gases were the lowest recorded and catches improved measurably. A cursory examination of samples collected along the entire coast in 1966 indicated no unusual occurrence of disease, parasites or reduced growth.

Effort units for 1966 increased slightly in the eastern area (from 67 weirs in 1965 to 76 in 1966) but fell in central and western Maine as herring fishermen turned to other species.

Age composition of the Maine sardine landings (Table 11) show three year old fish most abundant in 1966, the first year on record in which age-group II has been outnumbered. Age-group I, usually abundant from September onward, was also scarce. Herring were scarce in Central and Western Maine during 1966, and catches in Eastern Maine and Canada accounted for nearly 75 percent of the fishery. Fish of the 1961 year class

dominated the samples from Georges Bank, while fish of the 1960 year class dominated the samples of coastal Gulf of Maine and Nova Scotia. The contribution of the 1963 year class was higher on the Banks and coastal Gulf of Maine than in Nova Scotia. The range in length of herring (age-groups III to VIII) from Georges Bank, coastal Gulf of Maine and Nova Scotia was 18.0 to 33.6, 19.7 to 34.2, and 21.3 to 33.9 cm., respectively. The mean lengths of fish from a given year class for a particular month did not differ between the areas.

Table 11. Age composition of Maine sardine fishery in 1966.

<u>Age group</u>	<u>Year class</u>	<u>Percent</u>
I	1965	5.1
II	1964	42.4
III	1963	49.3
IV	1962	1.6
V	1961	1.0
VI	1960	0.6

On Georges Bank in 1966, the onset of spawning was later than in coastal Gulf of Maine and Nova Scotia. Spring spawning (although less than 2 percent) was evident in coastal Gulf of Maine and Nova Scotia and not evident on Georges Bank.

VIII. Other Pelagic Species

Tagging of Bluefin Tuna, Skipjack, and White Marlin was continued. Of 3,958 tuna tagged in 1966, 531 were recaptured. Of 1,672 tagged in 1965, 59 were recaptured in 1966, 12 of them in the Bay of Biscay. There were no recoveries in 1966 from the 465 releases in 1964.

There were 8 recaptures of 790 skipjack released in 1966 but no recaptures of 438 fish released in 1965. No returns resulted from 64 white marlin releases in the Montauk - Martha's Vineyard area but other taggings south of this area strengthened the concept of a clockwise migratory pattern between Georges Bank and the tropics for this species.

IX. Sea Scallops

US landings of sea scallops from Georges Bank were even less in 1966 than in 1965 which was the lowest on record (Table 12). As in 1965, the drop was caused by diversion of effort to grounds off the Middle Atlantic states outside the convention area.

The research abundance index shows an increase after several years of decline. It is somewhat less reliable than in former years, however, since it is based on a smaller sample.

Table 12. US sea scallop statistics, Subarea 5, (metric tons, Meat weights).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/ Day Fished</u>	<u>Research Vessel Index</u>
1962	9,687	8,806	1.1	99.1
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

X. Lobsters

The US catch of lobsters in 1966 was about 14,000 tons approximately the same in 1965. About 15 percent of the catch was taken in the offshore fishery.

B. Special Research Studies

1. Environmental Studies

Sea-bed drifters. Sea-bed drifter recoveries from the Gulf of Maine-Georges Bank area reveal a general parallelism between the near bottom and surface drift. The Georges Bank gyre appears both at the surface and near the bottom. A westward flowing current south of Cape Sable persists through the spring at the surface and near the bottom. Near-bottom current velocities in these cases were of the same order of magnitude as those at the surface, i.e. several miles per day.

Plankton ecology. In a study of the short term changes which occur as a result of the growth of plankton populations, a September study in the Gulf of Maine by the Woods Hole Oceanographic Institution produced these preliminary results:

little net change in the size of the phytoplankton population
" " " " " distribution of nutrients, oxygen,
chlorophyll or particulate organic carbon
carbon fixation of about 700 mg/m²/day

If this rate of photosyntheses were reflected in plant growth, the amount of particulate carbon would have doubled in 10 days and of particulate phosphorous in 5-7 days. Since the net changes were small, the population must be maintained at this time of year by rapid recycling of elements in situ.

Plankton sampling procedures. Studies of comparisons of different kinds of plankton samplers and plankton sampling design are reported elsewhere.

Hydrographic studies. Three quarterly environmental surveys of Continental Shelf waters between Nova Scotia and Long Island were completed (Albatross IV Cruise 66-2, March 2-14, 1966; Albatross IV Cruise 66-7, May 24 - June 7, 1966; Albatross IV Cruise 66-12, September 8-25, 1966). The sampling depths were 1, 10, 20, 30, 40, 50, 75, 100, 150, 200, and 250 meters. The properties measured were temperature, salinity, dissolved oxygen, and chlorophyll. Laboratory references have been prepared summarizing these data in tabular and graphic form and distributed to interested parties.

A summary of bathythermograph and hydrographic station temperature data collected between 1940 and 1960 in an area bounded by latitude 39°00'N and 45°30'N and longitudes 64°00'W and 72°00'W is nearing completion. The data (comprising some 75,000 observations) have been tabulated on a basis of 30-minute quadrangles at depths of 1, 10, 20, 30, 40, 50, 75, 100, 150, 200, and 250 meters. Horizontal plots of monthly mean values at specific depths, profiles of selected sections and temperature anomaly charts are being prepared in an effort to establish temperature norms for specific areas and depths to which specific cruise data may be compared.

Coast Guard hydrographic studies (see under Subarea 3).

Intensive hydrographic studies were continued along the Gulf of Maine in connection with the herring studies carried out in that area. Plankton studies were conducted in the same waters. Copepods were the dominant zooplankters during all seasons. Mean annual volumes were highest in the western area and lowest in the eastern. Zooplankton volumes were generally lower in 1966 than in 1965.

Benthic studies. Studies of the macrobenthic fauna of the New England Continental Shelf and Slope were continued this year. Particular emphasis was devoted to summarizing the distributional relationships of 42 major invertebrate taxa. An analysis of 1,100 samples has revealed interesting relationships between the abundance of these taxa and the water depths and bottom sediments they inhabit.

The bathymetrical analyses indicate that a large proportion of the benthic invertebrate taxa occur in highest densities in shallow water and lowest densities in deep water. The particular pattern of density in relation to water depth, however, varies from group to group. For example, in the coelenterate group, hydroids were most numerous in depths less than 40 meters, whereas alcyonarians occurred at depths from 60 to 2,000 meters. Priapulids were found only at depths greater than 1,000 meters. Sipunculids were rather uniformly distributed; they averaged between 1 and 9 specimens per m² at all depths from 2 meters to 4,000 meters. Amphipods, one of the more abundant invertebrate groups, averaged more than 500/m² from the shoreline out to the edge of the continental shelf, but were relatively sparse in deeper waters. Pelecypods were most numerous (500/m²) at depths less than 25 meters, and they were moderately common

(175/m² or more) at all depths on the continental shelf. Beyond the continental shelf their density was greatly reduced and averaged only 25/m² on the continental rise. Pogonophora were generally sparse, deepwater inhabitants - none were taken at depths less than 100 meters and their highest densities were found on the continental slope.

A special study was conducted comparing quantitative estimates obtained from dredge samples and from sea-bottom photographs. Our evidence indicates that density estimates derived from photographs are substantially more accurate than values based on dredge-collected samples from a measured area of sea bottom.

II. Biological Studies

Haddock. Haddock abundance (catch per day) is presently being calculated for Div. 5Z from "study boats", selected large otter trawlers (OTL) fishing depth zone 2 (30-60 fathoms) on Georges Bank. Since 1940 the number of study vessels has decreased from 29 to 15. Investigations of catch per day for various combinations of vessel classes were initiated in 1966 to determine if the present calculation of abundance index is still valid. Comparisons were made of the study vessels catch per day for depth zone 2 with catch per day of all OTL's fishing Georges Bank. It was found that all OTL's displayed less variation. Presently, investigations are underway using each vessel class and depth zone as determinant factors.

Predictions of haddock year class strength using the Grosslein Index continues to be useful. Comparison of indices and abundance of two-year old and three-year old fish are given in Fig.3 for the year classes 1955 to 1964.

Silver hake. Growth studies and validation of age readings have been completed. Silver hake from the Gulf of Maine and from southern New England grounds show different growth patterns during their first year of growth.

Scup. Growth rate of young-of-the-year scup and occurrence of the first annulus has been determined. The first year ring on southern New England scup occurs at about 10-12 cm, and the first strong ring observed is the first winter zone. No accessory annulus was noted.

Haddock, redbfish, silver hake, yellowtail flounder. A study was undertaken to evaluate the differences between calculated average weight, from the length-weight formula and average weights taken from commercial samples. There were significant differences within years and areas for three species - haddock, redbfish and silver hake - which suggests that our method of determining the estimated total number of fish landed should be revised to use sample mean weight rather than the calculated mean weight now used in our computer program.

Groundfish surveys. Stratified estimates of catch per tow of haddock by age groups for the nine seasonal groundfish survey cruises, 1963-66 have been completed. A preliminary analysis of these data shows the effect of heavy fishing by the USSR in 1965. There are, however, several aspects of these data that will require study. First, there are strong seasonal trends which must be adjusted for, and the appearance of upward swings in abundance during the first quarter for even the immature fish indicates that something more than spawning concentrations are involved. Secondly, the overall estimated total mortality rate is about 1/2 that obtained from the commercial data.

Herring. Racial studies on herring, using a variety of biochemical and serological methods was continued. Blood typing indicated that adult herring from Nova Scotia, Georges Bank, and eastern Gulf of Maine belong to separate subpopulations.

A study of fecundity of herring from Georges Bank, coastal Gulf of Maine and Nova Scotia was initiated in 1966. Preliminary analysis from 440 fish suggests that there is a direct relationship between number of eggs and the length, age, and the index of maturity (gonad weight/body weight). The number of eggs is apparently fixed by stage III of gonadal development. The mean range of fecundity for age groups IV through VII was 40-65,000; 75-85,000; 90-120,000; and 100-125,000 respectively. Our data show that fish (of a given age-group) from weak year classes (1959) have more eggs than fish from strong year classes (1960).

The sampling for herring larvae on the western coast of the Gulf of Maine indicated two major periods of spawning, one in early September and another in October. The growth rate of larvae during the winter was well below that observed in previous years.

Salmon. Restoration and management of Atlantic salmon resources continued during 1966 with activities centered in the State of Maine. Drought conditions affected the sport catch and delayed ascending migrants. Natural production of the salmon streams was reduced but compensated for by the planting of 439,000 hatchery-reared fish. Over 300,000 of these were smolt-sized. Finclipping as a means of later identification of stocks was supplemented by the release of 83,000 tagged smolts in the spring of 1966.

During 1966 ten post-kelt tags were returned from convention waters with two of these fish taken in the Greenland fishery. Majority of the tags are taken in the shore-based Newfoundland fisheries.

Tagging studies were expanded during 1966 to include the Machias River and over 700 adults were tagged as they ascended the stream. In addition, 82,000 smolts have been tagged for release in the spring of 1967. Tagged smolts are one-year and two-year hatchery-reared fish and this will enable us to compare ages as well as stocks.

Lobster. Five lobster cruises were conducted in 1966 and covered the area from Corsair to Hudson Canyons along the edge of the continental shelf. Commercial landings also were sampled. Most of the lobsters were taken in depths between 70 and 200 meters. The carapace length ranged from 5 to 21 cm and the weight from 0.2 to 13.0 kg. Mean length from the research cruises averaged 13 cm and mean weight almost 3 kg. In contrast, lobster from the inshore fishery average about 9 cm and weighed less than 1 kg.

Over 60% of the offshore lobsters were females; their dominance was greatest during the winter. The sex ratio of lobsters between 5-7 cm was 1:1. The ratio of females increased with size, accounting for 70% in some samples of large lobsters (14-16 cm). The carapace length of the smallest egg-bearing female was 9 cm. Between 12-17 cm, 50% of the females were egg-bearing in summer and autumn samples.

Lobster parasites were identified and enumerated and blood samples were collected to determine the relationship of inshore and offshore stocks.

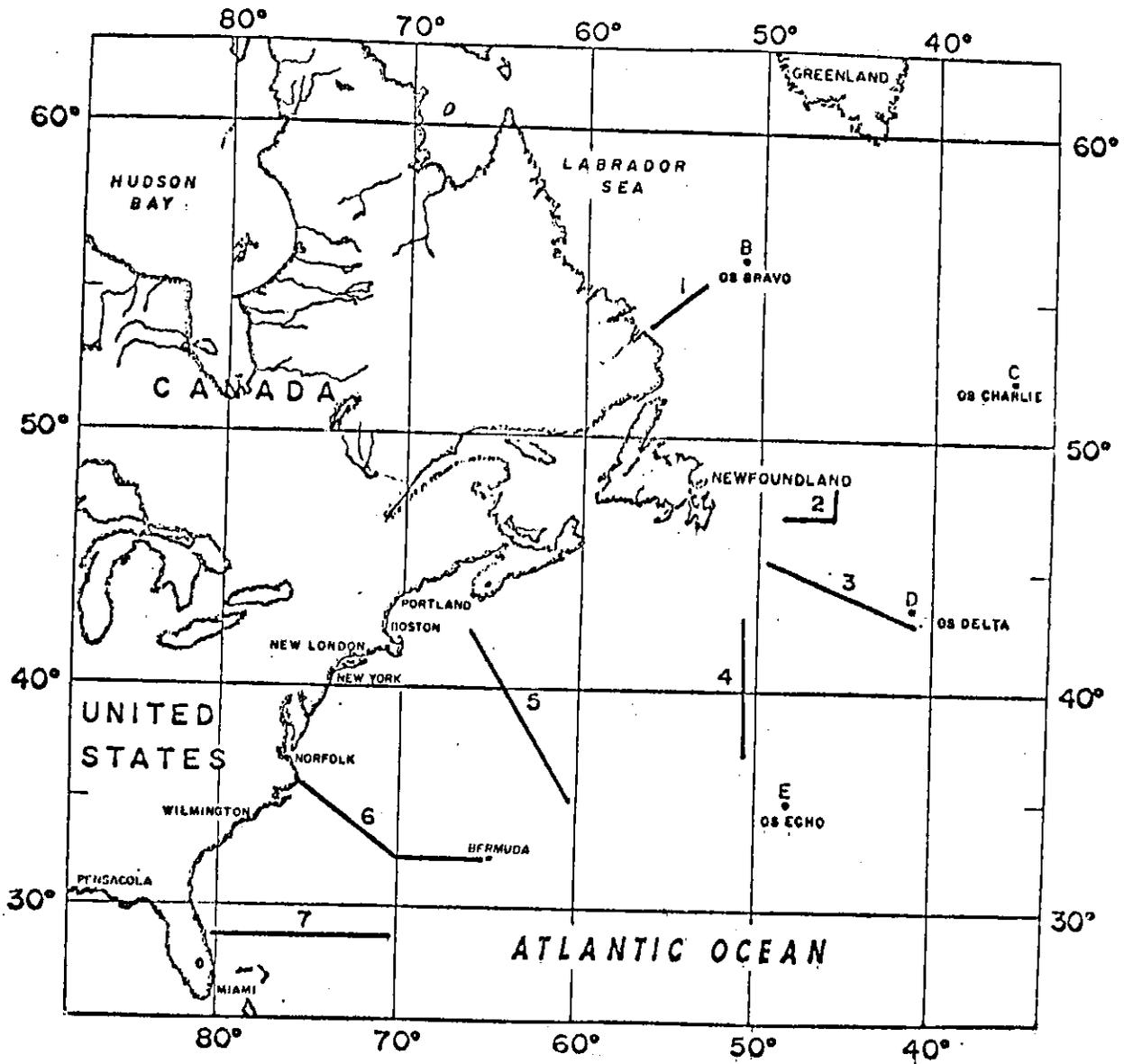


Fig. 1. Standard sections and ocean stations occupied by US Coast Guard.

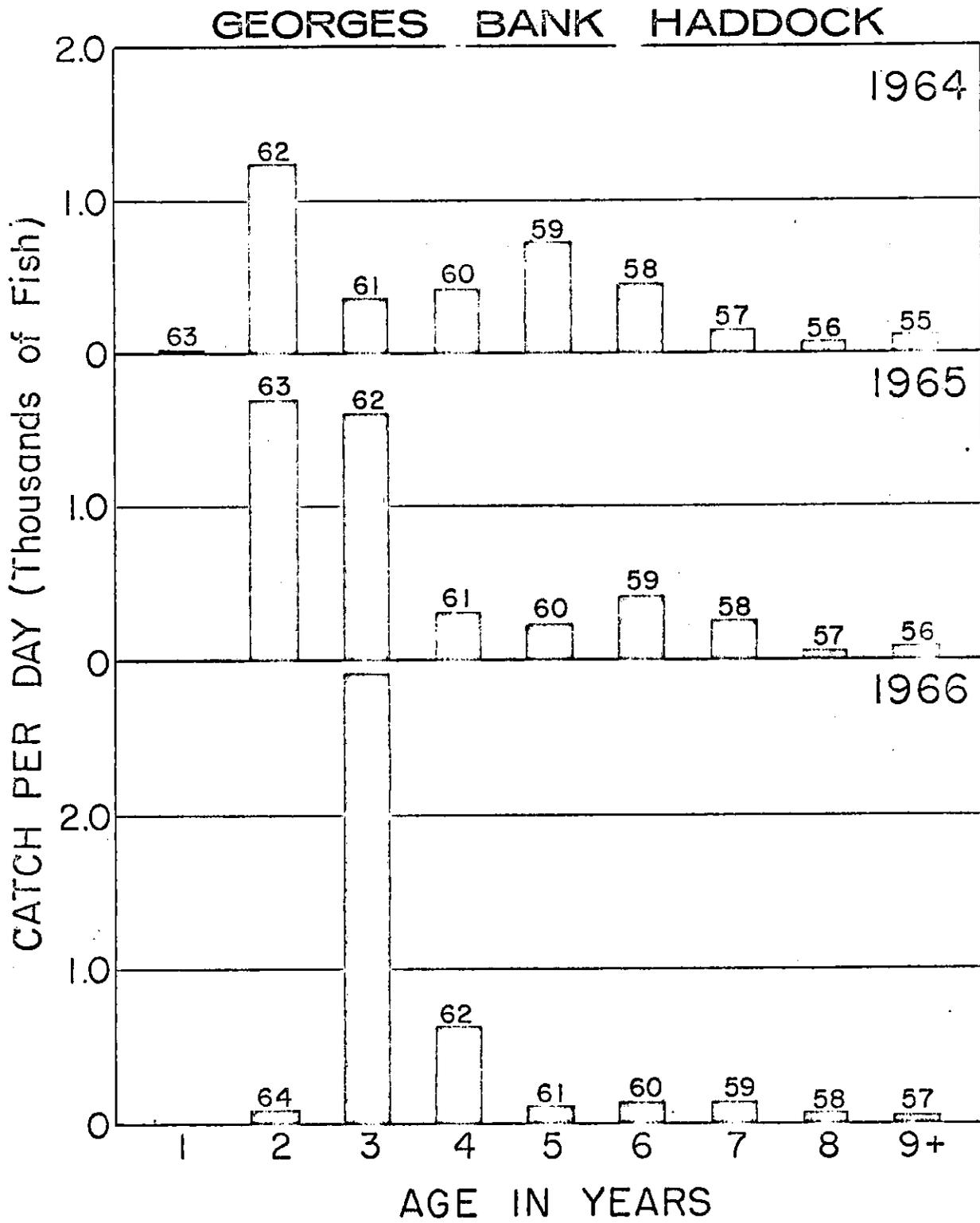


Fig. 2. Age composition of Georges Bank haddock.

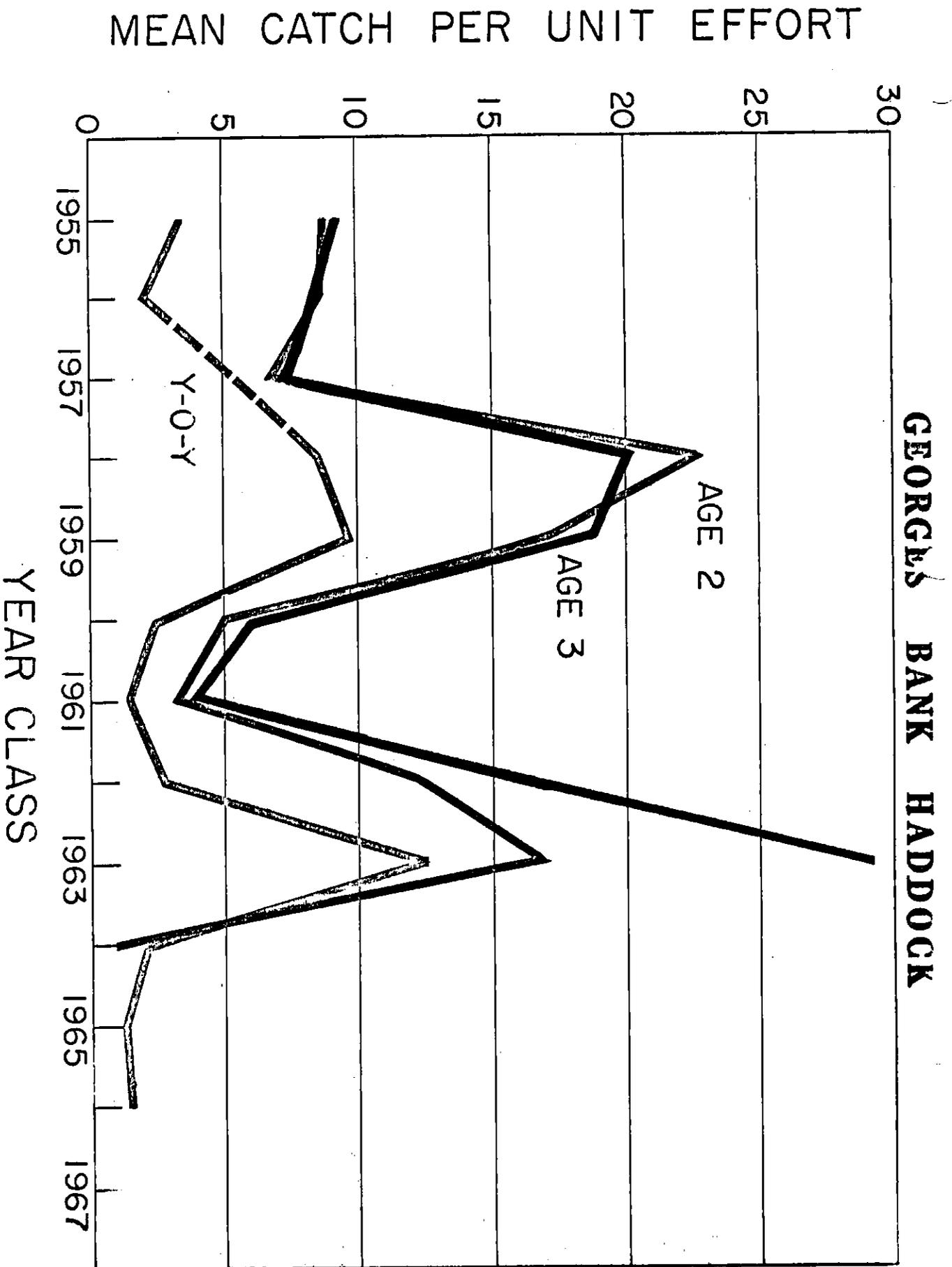


Fig. 3. Relative strength of year classes - Georges Bank haddock.

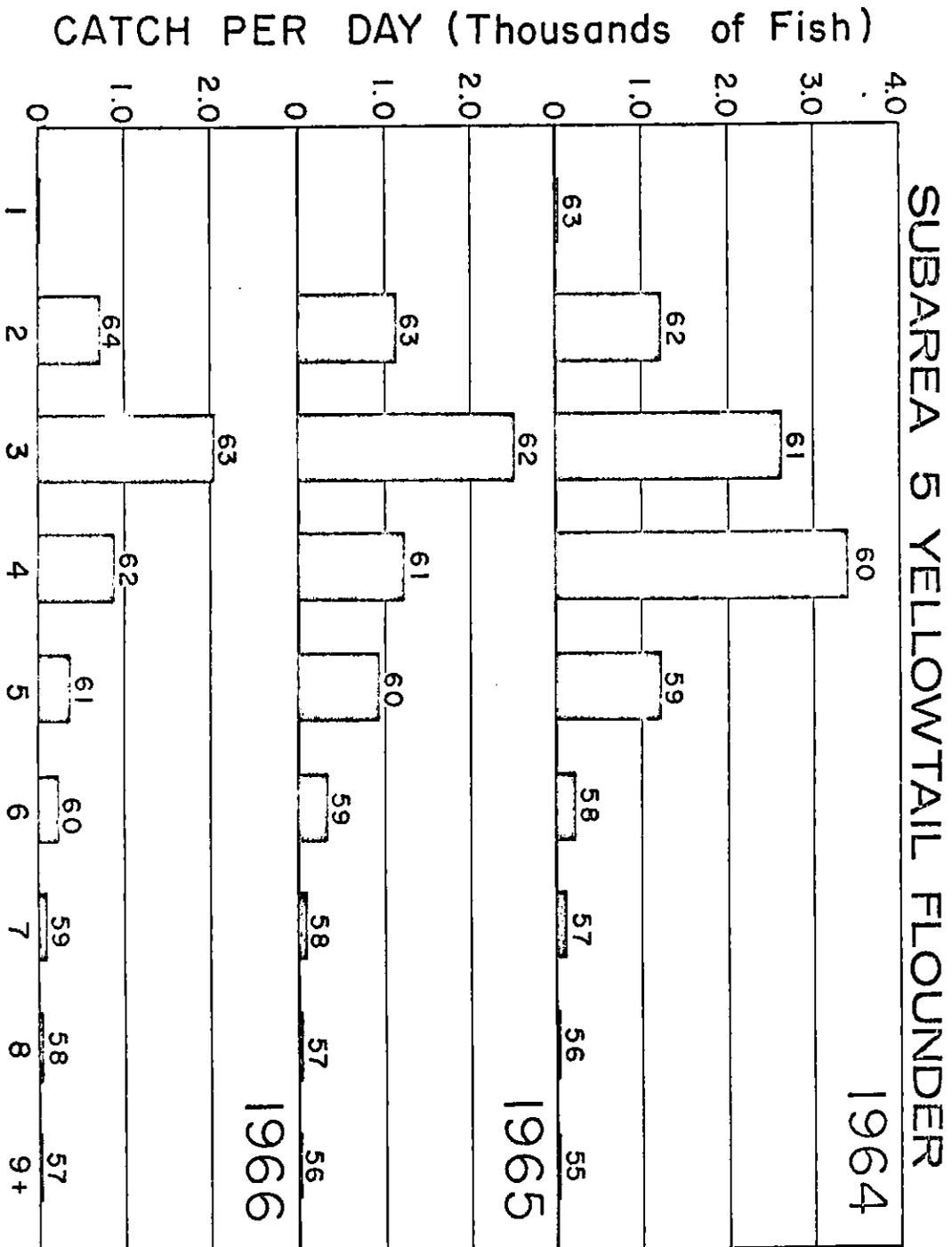


Fig. 4. Age composition of Subarea 5 yellowtail flounder.