RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

ICNAF Res. Doc. 66-41

Serial No. 1629
(D. a. 65)

ANNUAL MEETING - JUNE 1966

United States Research Report, 1965

by Herbert W. Graham

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 Fisheries

I. Redfish

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

Landings in 1965 increased substantially over the 1964 figure, reversing the declining trend of the last few years. This was the result of increased effort as the landings per day fished declined somewhat over 1964.

Table 1. US redfish statistics, Subarea 3, 1965 (metric tons, round fresh)

Year	Landings	Days Fished	Landings/Day Fished
1961	16,706	1,057	15.8
1962	14,257	932	15.3
1963	12,089	882	13.7
1964	4,692	369	12.7
1965	7,100	617	11.5

B. Special Research Studies

I. Environmental Studies

In 1965 the US Coast Guard Oceanographic Vessel Evergreen conducted three cruises in the vicinity of the Grand Banks from March to June in support of the International Ice Patrol. Each cruise included an oceanographic survey to determine current conditions along the slopes of the Grand Banks and vicinity. A total of 173 oceanographic stations was occupied using Nansen bottle casts. An electronic BT was used as an aid to determine optimum sample levels. A PDP-5 computer was used very successfully aboard Evergreen for rapid data processing. Also included in the cruises were iceberg drift and deterioration studies and special studies of internal waves.

The Evergreen also conducted the 1965 post ice season cruise in July and August. The main objective of this cruise, which was conducted in the Labrador Sea, Hudson Strait entrance and Davis Strait, was to study the source and formation of the Labrador Current. A total of 100 oceanographic stations was occupied including 69 core and grab samples.

During 1965 time-series observations were made on ocean station BRAVO by seven Coast Guard cutters. The basic observational program on

BRAVO consisted of Nansen bottle casts to a depth of 1,500 m on alternate days, with sampling extended to near bottom twice during each 3-week patrol.

Subarea 4

A. Status of the Fisheries

I. Haddock

Almost all the US effort for haddock in Subarea 4 was concentrated in Division 4X (primarily Browns Bank). Landings dropped sharply in 1965 due to decreased abundance and decreased effort (Table 2).

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

Year	Landings	Days Fished	Landings/Day Fished
1961	9,306	1,389	6.7
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

The age composition of landings from Browns Bank for 1965 (Fig. 1) indicates that the 1959 year-class (6-year-olds) provided the bulk of the catch as it did in the previous year. The strong 1956 year-class is passing out of the fishery, its members are now included under age "9+". The 1960 year-class is only of moderate strength and there is no strong year-class indicated for Browns Bank until 1963. However, the 1962 year-class appears strong in other areas of Subarea 4 and may contribute substantially in 1967. However, abundance of haddock on Browns Bank is expected to decline until the 1963 year-class begins to make substantial contributions in 1967.

II. Cod

US landings of cod from the subarea were less than 1,000 metric tons and represented a by-catch of the haddock fishery in Division 4X.

III. Redfish

Landings from Divisions 4R, S, T (Gulf of St. Lawrence) in 1965 increased over the 1964 figure which was, in turn, almost three times the amount landed in 1963 (Table 3). This appears to be the result of increasing abundance as indicated by the catch per day index.

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

Year	Landings	Days Fished	Landings/Day Fished
1961	200	20	9.8
1962	68	8	8.7
1963	4,879	508	9.6
1964	12,278	735	16.7
1965	17,099	803	21.3

The catch from Nova Scotian Banks continued the downward trend started in 1963 in spite of an apparent increase in abundance as shown by the landings per day fished index (Table 4).

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

Year	Landings	Days Fished	Landings/Day Fished
1961	28,957	3,016	9.6
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

B. Special Research Studies

I. Biological Studies

The studies of the haddock fishery in 4X have continued during the year. This included the exchange of statistics and samples between the USA and Canada.

The life history of the argentine (Argentina silus) was investigated on the basis of collections made on the seasonal groundfish survey cruises of the Albatross IV. The largest catches were made off Browns Bank (Division 4X) between 160 and 200 m. Most argentines were between 20 and 35 cm in length. Otoliths were used to determine age. Fish of 3 to 6 years of age made up the greatest portion of the catch, with 5-year-olds predominating. Otoliths of fish over 8 years of age are difficult to read. Spawning appears to take place during the winter and early spring. Samples obtained on the 1966 winter survey showed that argentines over 27 cm in length were ripe and ready to spawn. Examination of stomachs showed that Crustacea were the major food item. Argentines in turn serve as food for such species for cod, skates, and several species of hakes.

II. Environmental Studies

The Albatross IV groundfish surveys, benthic studies and hydrographic surveys included a good part of Division 4X as well as Subarea 5 (see under Subarea 5).

Subarea 5

A. Status of the Fisheries

I. Haddock

The US landings of haddock from Georges Bank in 1965 were about 13% above those of 1964 (Table 5). The abundance index expressed as landings per day fished also showed an increase.

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

Year	Landings	Days Fished	Landings/Day Fished
1961	46,350	7,131	6.5
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

The age composition of the catch (Fig. 2) shows that the abundant 1958 and 1959 year-classes which have supported this fishery in recent years (now 6 and 7-year-old fish) are contributing less to the fishery than the incoming 1962 and 1963 year-classes.

The Albatross IV groundfish surveys in 1963 suggested that the Georges Bank haddock year-class of that year was the largest for many years. This year-class appeared in the fishery on schedule in 1965 and provided the bulk of very heavy scrod landings, particularly later in the year.

Normally, one would forecast high abundance for Georges Bank haddock in the immediate years ahead based on the relative abundance of the 1962 and 1963 year-classes which are now in the scrod market category. However, there is evidence that fishing effort on the Georges Bank haddock stock was unusually heavy in 1965 and the effect of this effort on the large year-classes needs to be investigated when all the statistics for 1965 have been submitted.

Research vessel surveys indicate that the 1964 and 1965 year-classes are very small (Fig. 3).

II. Cod

US landings of cod continued to decline in 1965 from the recent high in 1962. The landings per day fished dropped below the 1961 level, although it was still above the long term averages (Table 6).

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

Year	Landings	Landings/Day Fished [1]
1961	17,669	1.0
1962	18,626	1.2
1963	16,734	1.8
1964	15,478	1.0
1965	15,011	0.9

III. Silver Hake

US landings of silver hake declined in 1965, both the portion landed for food and the portion landed for industrial purposes (Table 7).

Table 7. US silver hake statistics, Subarea 5 (metric tons, round weight). [2]

Year	Landings (Food)	Landings (Industrial)	Days Fished	Landings/Day Fished (food only)
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

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

2) Amagansett, Long Island, industrial landings of silver hake included.

The index of food fish landings per day by US vessels continued to decline from the high attained in 1961.

In 1965, as in the years 1962-64, the US silver hake fleet did not fish much on Georges Bank, the area of intensive fishing by foreign fleets and an area previously important to the US fleet.

IV. Redfish

US landings of redfish from the Gulf of Maine dropped about 10% in 1965 continuing the decline started in 1961. This occurred in the face of an increased abundance as indicated by landings per day fished (Table 8). The decline was due to a decreased fishing effort.

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

Year	Landings	Days Fished	Landings/Day Fished
1961	14,040	3,120	4.5
1962	12,540	3,135	4.0
1963	8,871	2,164	4.1
1964	7,812	1,817	4.3
1965	6,977	1,026	6.8

V. Yellowtail Flounder

US landings of yellowtail flounder from Subarea 5 dropped about 5% in 1965 from the all time high established in 1964. Recent heavy landings were made possible by an increased abundance of fish as shown by the index of landings per day fished which reached a peak in 1963 both in southern New England and on Georges Bank. This index dropped in 1964 and 1965 (Table 9).

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

	Southern New England			Georges Bank	
Year	Total Landings	Days Fished	Landings/ Day Fished	Days Fished	Landings/ Day Fished
1961	16,626	4,686	2.5	1,816	2.4
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

Age compositions of the commercial landings for Subarea 5 are now available for 5 years (Fig. 4). The increase in landings, beginning in 1962, resulted from strong year-classes in 1959 and 1960. Fish from the 1959 year-class began making a large contribution to the catch in 1962. In 1963, when catch per day reached a peak, both the 1959 and 1960 year-classes were heavy contributors. In 1964 and 1965 catch per day declined since the strong year-classes were being diminished and the 1961 and 1962 year-classes following them were of only moderate strength. Landings have remained high in the 1964-65 period, despite a decrease in abundance, because there has been a substantial increase in effort.

VI. Industrial Fishery

Landings for industrial purposes increased 21% in 1965 over 1964, thus continuing the expansion of this fishery from its low point reached in 1960 (Table 10).

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

Year	Landings	Percent		
		Silver Hake	Red Hake	Other [2]
1961	22,111	---	---	---
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

1) Amagansett, Long Island, industrial landings not included

2) Each component species less than 7%

Silver hake and red hake comprise the major portion of these landings. The rest is composed of a large number of minor species.

VII. Herring

The US catch of herring in 1965 was 32,000 metric tons and was characterized by a poor catch in western Maine and a higher than usual catch in eastern Maine. The harvest was dominated by fish of the 1963 year-class, which contributed 90.2% of the total catch. The 1964 and 1962 year-classes contributed 2.6% and 6.1% respectively.

The two major types of gear, stop seines and weirs, have decreased in number along with the catches in recent years. The number of weirs has decreased steadily from 135 in 1960 to 63 in 1965, while the number of stop seines had decreased from 165 in 1960 to 104 in 1965. The total units of gear since 1959 have been: 1960 - 304; 1961 - 240; 1962 - 278; 1963 - 224; 1964 - 181; 1965 - 179. The yearly average catch from 1947 through 1960 was 60,000 metric tons as compared with 35,000 metric tons for the years 1961 through 1965. The 1965 catch was only a slight improvement over 1961 (25,000 tons) and 1964 (27,000 tons).

VIII. Sea Scallops

US landings of sea scallops from Georges Bank in 1965 dropped drastically from the 1964 figure (Table 11). This was due to the diversion of effort to more southern grounds outside the Convention area where good catches could be made more easily than on Georges Bank where abundance has been increasing.

Table 11. US sea scallop statistics, Subarea 5 (metric tons, meat weights).

Year	Landings	Days Fished	Landings/ Day Fished	Research Vessel Index
1961	10,656	8,880	1.2	92.6
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

Research vessel abundance indices are now available for the last 5 years (Table 11). These indicate a continuous decrease since 1961. The landings per day fished, which is not considered a very reliable index because it sometimes depends upon the shucking rate rather than the catch rate, nevertheless shows a general downward trend during the same period.

B. Special Research Studies

I. Biological Studies

1. Haddock. Serological studies have continued in an attempt to differentiate stocks of haddock from various areas. Basic work on maximizing rate of antibody production in individual fish was conducted on blackback flounder. New rabbit anti-haddock sera were developed and will be tested on various haddock stocks.

2. Silver hake. Considerable work was done on validation of scale and otolith age determinations. There is little difficulty in determining the age of fish in the first and second years, but there appears to be a different pattern in fish from different areas. Additional work will be required before age reading can be put on a routine basis.

The exchange of otoliths among Canada, USSR, and the USA created problems which were alleviated by the exchange of photographs in addition to the otoliths themselves. Dr R. Blacker of Lowestoft, England, provided the photographs.

Silver hake data collected on the groundfish survey cruises of the Albatross IV indicate that it may be possible to obtain a valid index of abundance of young of the year silver hake from such surveys.

3. Redfish. Tagged redfish remain plentiful in the stock at Eastport, Maine, where a tagging experiment was started in 1956. During a field trip in October 1965, only 54 redfish were caught, but 21% of these were tagged fish. Many more tagged redfish could be seen in the water around the docks, but the high abundance of small cod which were feeding voraciously on euphausiids at the surface made it very difficult to catch redfish on hook and line.

Most of the recaptured redfish carried plastic spaghetti tags, and their growth averaged about 15 mm per year, nearly the normal growth rate for untagged fish. Of three fish tagged with Petersen discs on the opercle, one had been tagged for more than 9 years, the longest survival of a tagged fish recorded at Eastport so far. It was the sixth recapture for this fish whose growth rate was about 3.6 mm per year, slow growth typical of redfish tagged with the Petersen opercular tag. The periodic measurements of this fish disclosed that its rate of growth had been remarkably steady during the 9-year period.

4. Herring

a. Age and Maturity. In 1965, 32 herring samples (2,048 fish) were obtained from Georges Bank and 71 herring samples (4,833 fish) from coastal Gulf of Maine. On Georges Bank, 48.8% of the fish were from the 1960 year-class, followed in percentage occurrence by the 1961, 1962, 1959, 1963, 1958, and 1957 year-classes. In coastal Gulf of Maine, 43.6% of the fish were from the 1960 year-class, followed in percentage occurrence by the 1962, 1961, 1959, 1958, 1963, and 1957 year-classes. In both areas the 1960 year-class was dominant in all months sampled except February (Georges Bank) and April (coastal Gulf of Maine). In these 2 months the 1962 year-class was dominant. Fish of the 1963 year-class were obtained during four of the nine sampling months, and were collected in the vicinity of Cultivator Shoals and the southwest part of Georges Bank.

Analysis of maturity stages indicated that in offshore and inshore areas the onset of fall spawning occurred during late August, the peak of spawning during October. On Georges Bank, recently spawned fish were obtained in February, while in the coastal Gulf of Maine, recently spawned

fish were obtained in late March and early April. At the onset of fall spawning, the mean length of Georges Bank herring was 29.2 cm, the mean length of coastal Gulf of Maine herring was 28.8 cm. At the peak of spawning the mean length of Georges Bank herring was 28.4 cm, the mean length of coastal Gulf of Maine herring, 29.4 cm. There was no evidence of spring spawning on the Banks, but a few spring spawners were obtained from samples collected in the coastal Gulf of Maine waters.

b. Racial Studies. Research on blood types and serum differences of herring has been continued. The phenomenon of unagglutinable cells, which occurs in some herring making them impossible to type, was further investigated. This phenomenon apparently is due to the presence of large numbers of immature red cells in the blood of herring because of temperature stress.

Blood samples were obtained from herring in the Gulf of St. Lawrence, Nova Scotia, Georges Bank, and coastal Gulf of Maine areas. These samples were typed with ten rainbow trout isoimmune sera. Significant differences in the frequency of individuals reacting with six of the ten sera were obtained. The data are being further analyzed to determine their possible genetic significance.

Fin ray counts (right pectoral and dorsal) of Maine sardines show that significant differences occur between sections of the Maine coast and between year-classes. Vertebral means show no significant section differences, but show significant differences between year-classes. Counts for the 1960 year-class were appreciably higher for all three meristic characters. This year-class was dominant in the inshore fishery during 1962 and 1963 and was dominant in the Georges Bank fishery during 1963, 1964, and 1965.

c. Behaviour Studies. Studies are being made of the behaviour of juvenile herring (sardines), in relation to their seasonal movements in coastal waters. Laboratory experiments to determine their responses to templerature and salinity gradients are providing information about the possible effects of hydrography on distribution and movements. The results of these experiments seem to indicate an aversion to temperature above 15°C. The possible effects of dissolved atmospheric gases on herring distribution are also being studied, since recent observations have shown that coastal waters are sometimes highly supersaturated with these gases in the spring when the young herring appear in shallow water.

5. Atlantic Salmon. Sport catches of Atlantic salmon were below average this year because of low water levels in the streams. Trap catches in the fall, when stream discharge increased, indicated that abundance of fish was average. Counts of upstream migrants continued on the Narraguagus and Machias Rivers. Two new Denil fishways on the St. Croix River were completed and operative in the spring.

A total of 165,000 smolts were marked with double fin clips and released during the spring, and 195 adult salmon were tagged with an adipose fin tag, the type previously recovered in West Greenland. Plans for 1966 include tagging of 100,000 smolts.

6. Plankton. A pictorial key to the identification of planktonic eggs and larvae of the common fishes of the Gulf of Maine is nearing completion. It will treat the 30 species most frequently encountered in plankton studies in the waters from Cape Sable, Nova Scotia, to Block Island, Rhode Island.

Overnight sets of buoyed and anchored tidal nets containing meters were made during the spring within the Sheepscot estuary of Maine to examine the relation of tidal excursions to catches of herring larvae. It was found that there was a statistically significant correlation between the length of the tidal excursion and the depth of herring larvae.

Monitoring of zooplankton seasonal abundance and composition in Gulf of Maine coastal waters continued. Mean seasonal volumes were significantly higher in 1965 than in the previous 2 years, due primarily to a marked increase in abundance of the copepod Calanus finmarchicus. Initial investigations of the inshore-offshore distributions of copepods indicated that occurrences were discontinuous for several species. The sharpest changes occurred within 5 km of the coastal headlands, in the immediate vicinity of the 32 ‰ isohaline. Calanus finmarchicus, Metridia lucens, Centropages typicus, and Acartia longiremis were most numerous seaward of the 32‰ isohaline, and are grouped as outer-neritic forms. Centropages hamatus, Acartia clausi, Tortanus discaudatus, Eurytemora herdmani, and Eurytemora affinis occurred in greatest concentrations shoreward of 32‰ salinity, and are considered inner-neritic forms. Little variation was shown in the distributions of four common species - Pseudocalanus minutus, Temora longicornis, Oithona spinirostris, and Oithona similis - grouped as general-neritic.

7. Benthic Studies. The program of collecting, sorting, and analyzing quantitative samples of benthic invertebrates from the Continental Shelf and Slope off the US East Coast was continued. A total of 2,000 samples have been collected and processed since 1957. Charts of Subarea 5 and vicinity are being prepared to show the density distribution of each of the 42 major taxonomic groups (phyla, classes, orders). Densities are illustrated in terms of (1) weight and (2) number of individuals, per unit area of bottom.

8. Groundfish Surveys. Three groundfish surveys during the past year completed a 3-year series of seasonal surveys of the continental shelf between Hudson Canyon and the Bay of Fundy. On each survey about 180 stations were sampled according to a stratified random sampling plan employing 42 strata whose boundaries are based on hydrographic factors, primarily depth (Fig. 5). At each station length frequency and total weight of each species were recorded in addition to bottom temperature and bottom sediment type. Stomach contents of many species were also examined.

One of the major objectives of these surveys is to describe the seasonal distribution and relative abundance of all groundfish available to the trawl in order to get a more complete picture of the structure of the demersal community. These data may be of considerable importance in the long term as an ecological "benchmark" against which future changes in the composition of groundfish populations may be compared.

The use of a stratified random sample design easily provides abundance estimates (weighted according to area of each stratum) for any combination of strata, accompanied by appropriate measures of statistical precision (variance). However, the volume of data has permitted only preliminary analysis to date. Detailed analysis awaits completion of computer programs which will permit rapid computation of a variety of abundance indices and associated variances (e.g. for individual strata or groups of strata within a cruise, cruises within a year, individual species or groups of species, weight or numbers of each species in any size interval, etc.). Quantitative measures of species composition will also be computed.

Studies are in progress on the general problem of obtaining meaningful measures of statistical precision of abundance indices. Preliminary analysis of special sampling cruises has indicated that relative variance (on log scale because of contagious distribution of fish) tends to decline with increase in size of the sampling unit (either with longer tows or a larger net). Whether the increased cost per tow in terms of time (either towing time or time to process the catch) would offset the gain in precision has not yet been determined. It appears that a point of diminishing returns is rapidly reached in the relation between variance and sample size (number of tows) and therefore longer and fewer tows, for example, might result in a net gain in precision.

Another objective of the surveys is to monitor the strength of incoming year-classes. Young of the year haddock (1965 year-class) were extremely scarce in all parts of the study area during the past year. The few fish caught on each survey were in the southern portion of the sampling area, mostly south of Block Island and Long Island westward to Hudson Canyon. The index of abundance for the 1965 haddock brood is the lowest index recorded since this sampling began. A report reviewing the problem of recruitment in New England haddock stocks is submitted as a separate meeting document.

Data from earlier groundfish surveys were published during 1965 in Folio 10 of the Marine Environmental Atlas of the American Geographical Society. It is entitled "Autumn Distribution of Groundfish Species in the Gulf of Maine and Adjacent Waters, 1955-1961".

9. Environmental Studies. The Gulf of Maine, Georges Bank and adjacent continental shelf waters between 64°30'W and 72°30'W were surveyed every 3 months during 1965 with the Albatross IV to measure seasonal and annual variations in temperature, salinity, dissolved oxygen, and chlorophyll. Between 75 and 90 stations were occupied during each cruise. A typical cruise track is shown in Fig. 6.

Results of each cruise are summarized in mimeographed reports that include the original station data and charts of the north-south transects for each variable measured. Further analysis of the data will be made when the 2-year series of surveys is completed in September 1966.

Distributions of temperature, salinity, water transparency, and currents within Gulf of Maine coastal water were analyzed from 21 stations located between Cape Ann, Massachusetts (44°41'N and 70°35'W) and Machias Bay, Maine (44°40'N and 67°20'W). During all seasons there was an eastward reduction in the vertical ranges of temperature and salinity, and the water column to the east was subject to greater mixing. This areal trend was especially marked in the spring and summer. In the western area isolines of temperature, salinity, Secchi disc reciprocals, and extinction coefficients showed departures from an alongshore contour pattern, and appeared related to river discharge along the coast. Surface drift bottles, Seabed drifters, and calculations relative to the 30-m depth were used to study currents. Recoveries of drift bottles and Seabed drifters indicated some of the major circulation features common to the Gulf of Maine, while contours of dynamic height anomalies (direction only) indicated portions of eddies or meanders in the western areas and an alongshore westerly current in the eastern areas.

The Woods Hole Oceanographic Institution monitored temperature and salinity at lightships and towers in Subarea 5. Drift bottle and seabed drifter studies of residual drift in the Georges Bank/Gulf of Maine area were continued.

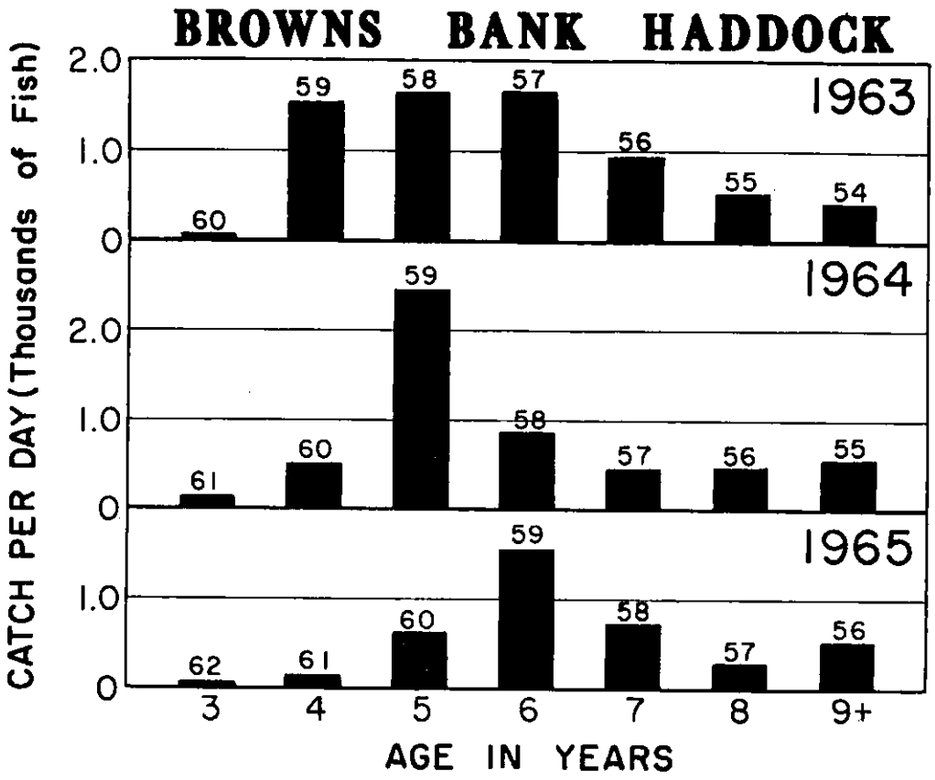

Fig. 1. Age composition of US landings of haddock from Div. 4X (Browns Bank).

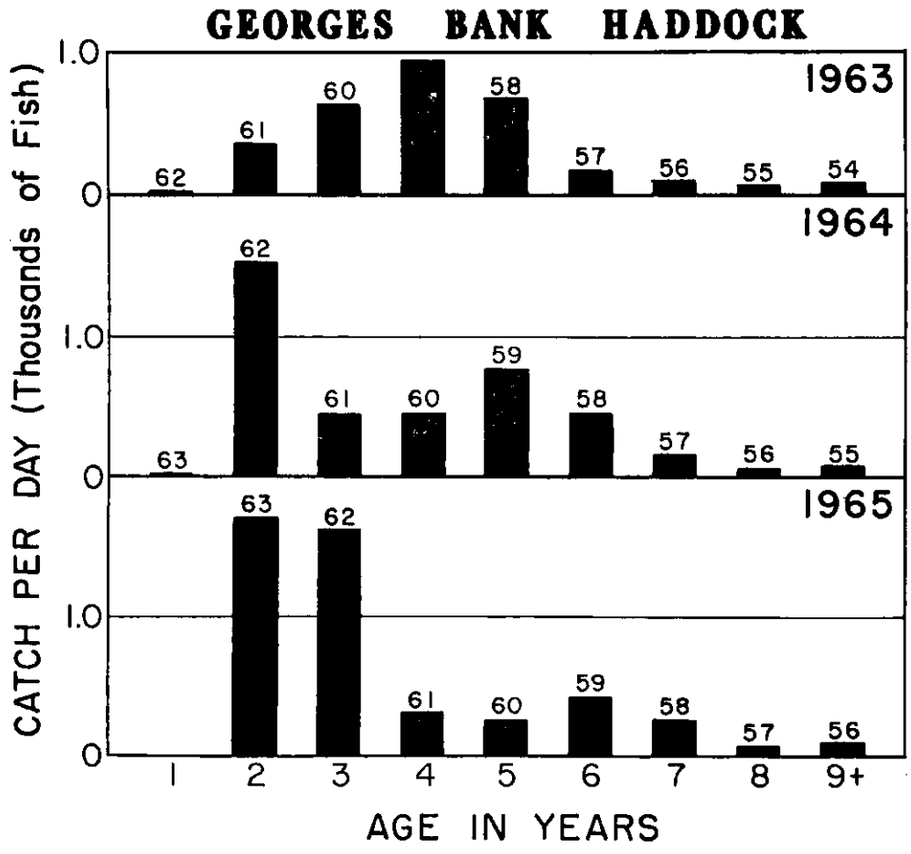

Fig. 2. Age composition of US landings of haddock from Georges Bank.

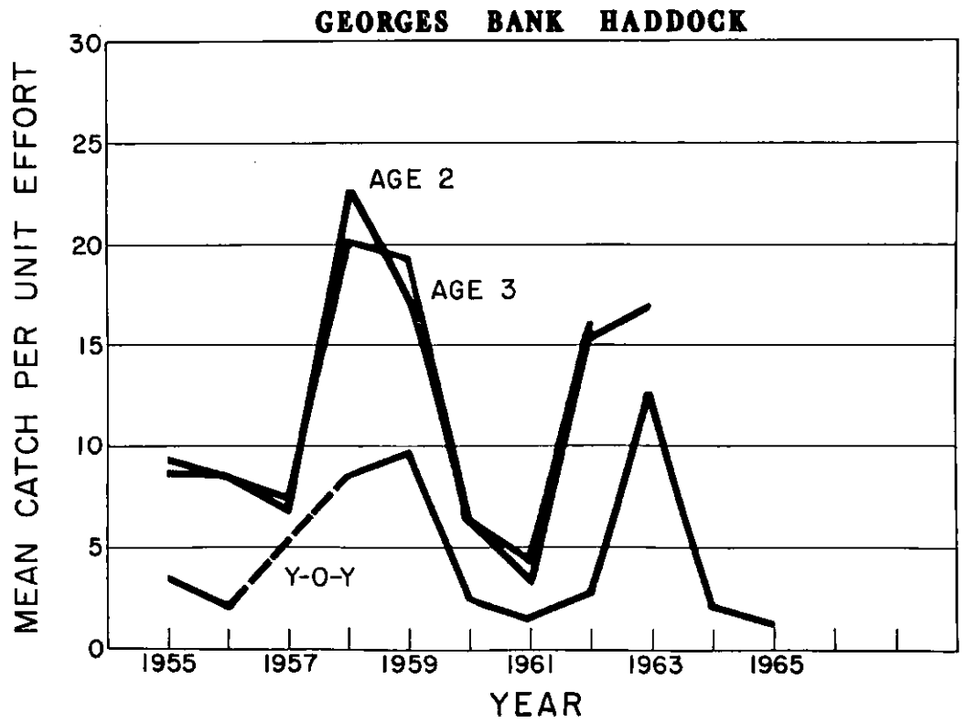

Fig. 3. Indices of abundance of year-classes. Young of the year research vessel index compared with indices of 2-year-olds and 3-year-olds in commercial landings.

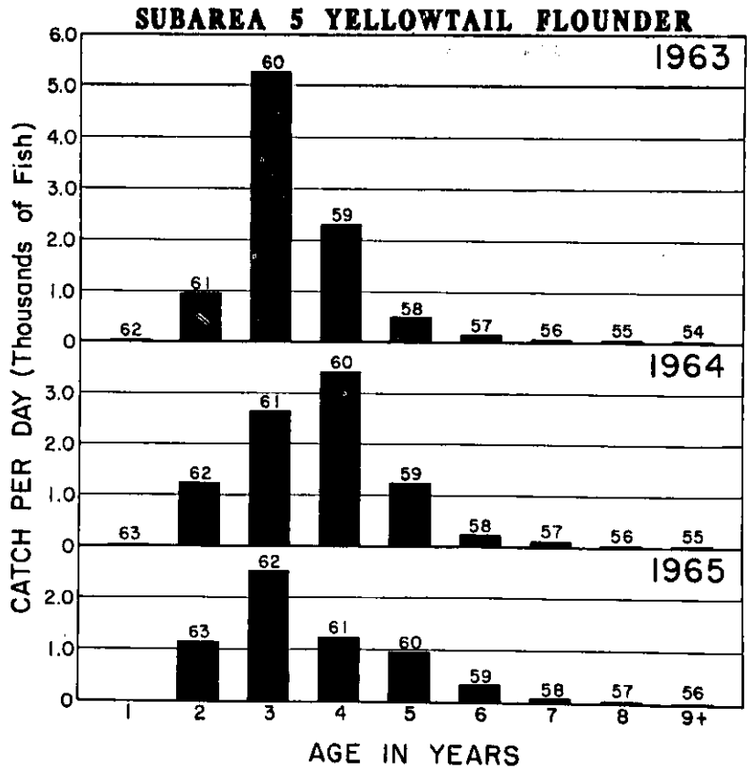

Fig. 4. Age composition of US landings of yellowtail flounder from Subarea 5.

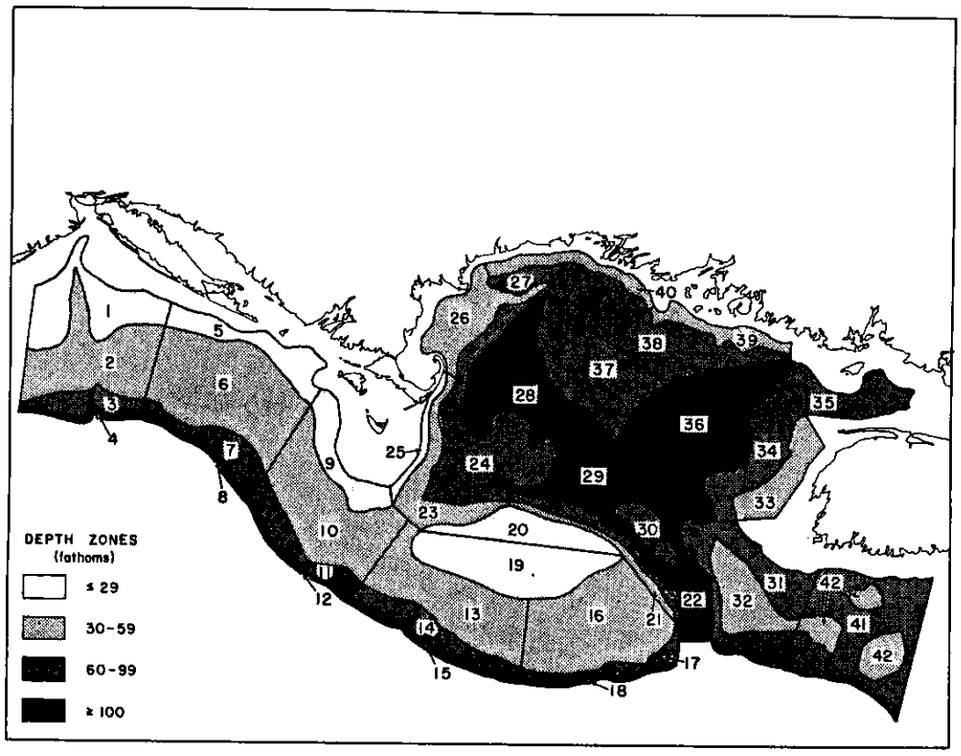

Fig. 5. Sampling strata of US groundfish surveys by Albatross IV.

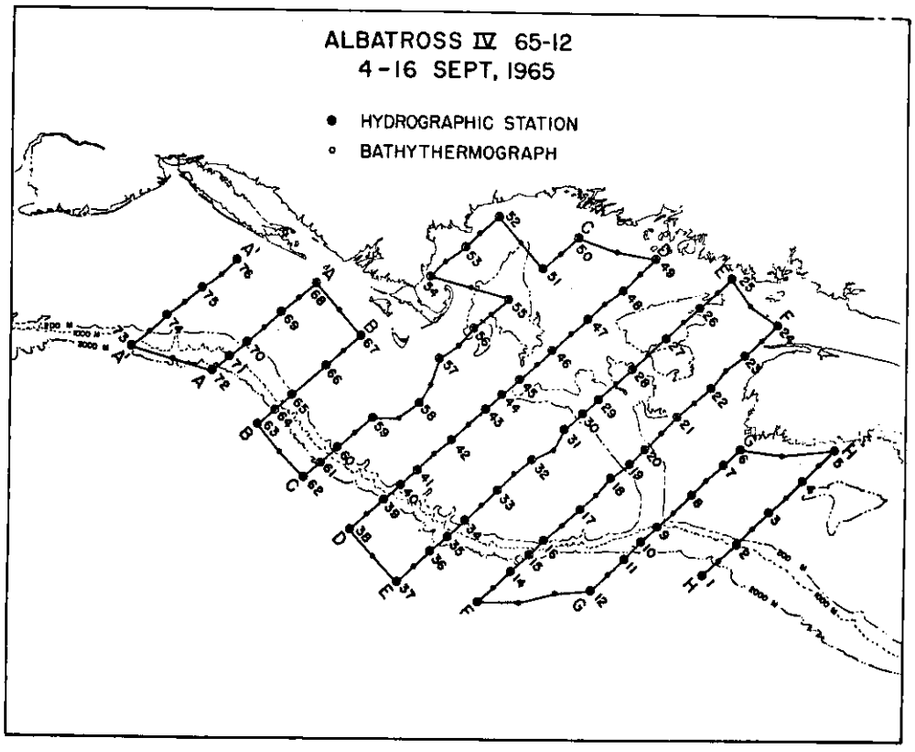

Fig. 6. Typical cruise track — Albatross IV hydrographic surveys.