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by Dr. Herbert W. Graham.

Analysis of commercial landings statistics has been greatly facilitated by the installation of a data processing unit at the Woods Hole Laboratory of the Bureau of Commercial Fisheries. Analyses are now being made on a back log of data relating to species previously neglected and to many aspects of the major species which previously could not be trusted because of the enormity of the mass of data.

Surveys in Subareas 4 and 5 were made using primarily the Bureau's research vessel Delaware and to a lesser extent charter of small fishing vessels. Nine cruises, averaging two weeks each, were made by the Delaware in groundfish research, and two in herring research.

Haddock (*Melanogrammus aeglifinus* (L.))

The Fishery. Georges Bank is the main source of haddock to the US fishery. During the period 1957-61 about 75 percent of the landings came from Georges Bank (Subdivision 5Z), 10 percent from the Gulf of Maine (Subdivision 5Y), and 15 percent from Browns Bank (Subdivision 4X). Average landings from Georges Bank in this period were 79 million pounds. This was 10 percent below the 1931-60 average of 89 million pounds. In 1962, US landings from Georges Bank were 9.3 million pounds and from all areas 115 million pounds.

The comparatively high figure for Georges Bank in 1962 was probably due to an increased abundance over levels of the few years preceding. The mean catch per day for Georges Bank for the period 1931-60 was 13,000 pounds. For the period 1957-61 this had dropped to about 10,000 pounds. In 1961 the index was back up to 13,000 pounds per day and the estimated figure for 1962 is about the same. The fact that larger fish were landed in 1962 may indicate some change in fishing habit in reference to change in size composition of the populations.

These recent fluctuations in abundance have been due to variations in strengths of year classes (Fig.1). The lower figures for the period 1957-60 were due to a succession of weak or moderate year classes. The relatively strong 1958 and 1959 year classes account for the increased abundance in 1961 and 1962.

Abundance is expected to remain high until the summer of 1963 when scrod abundance probably will decline because of the apparently weak incoming 1960 year class. Catches of young-of-the-year haddock in the 1961 and 1962 fall surveys suggest that the broods for these years are also weak.

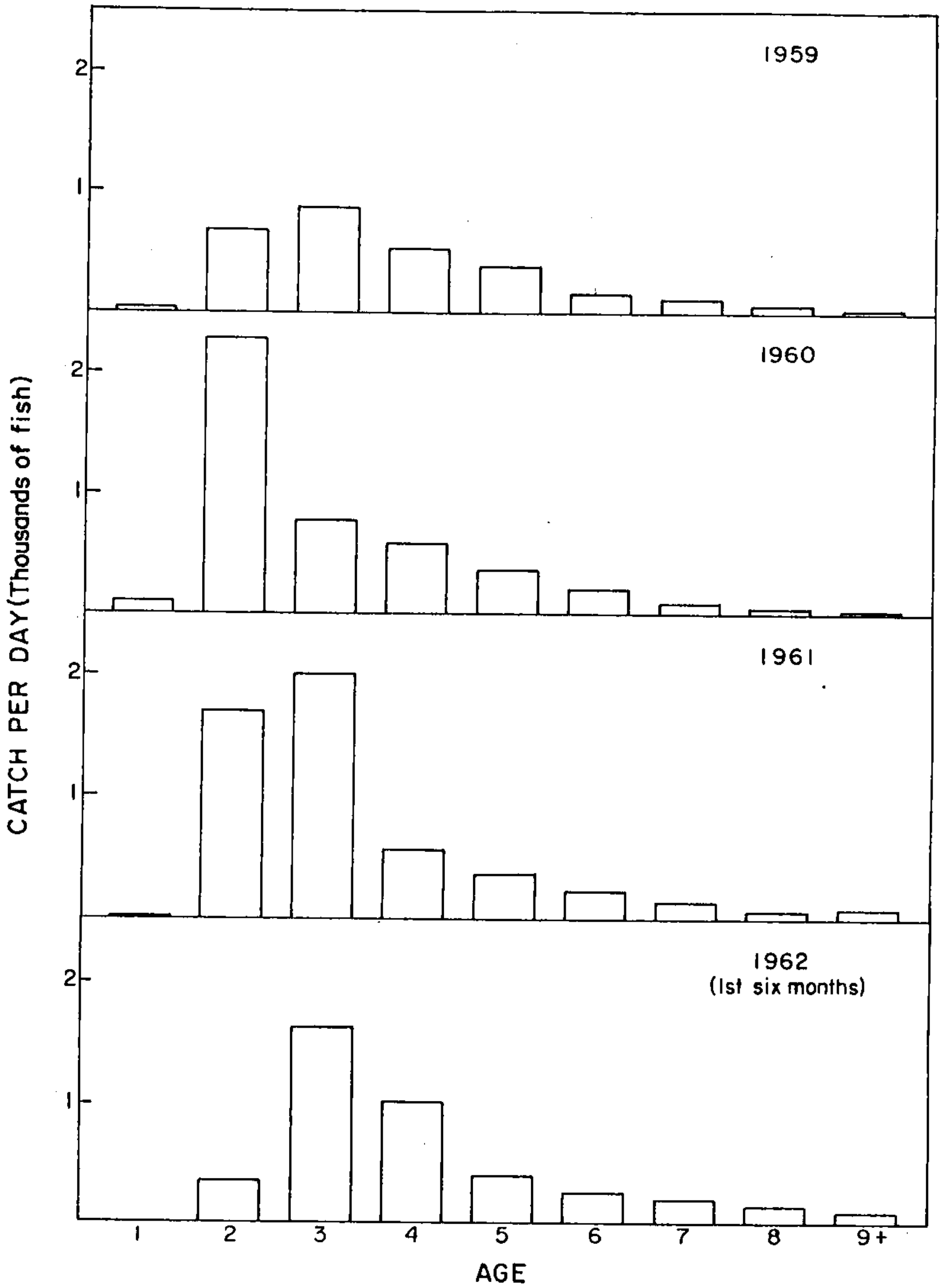

Fig. 1 Georges Bank Haddock. Catch per day (thousands of fish) at each age. 1959–1962

Canadian - United States 4X Program.

This program was started in 1956 and included the exchange of catch-effort statistics and size-age samples between the US and Canada, with the US assuming primary responsibility for analyzing commercial landings. During the initial stages of this program a backlog of otoliths accumulated. These have now been read and a preliminary analysis of all the data has been completed. A preliminary report has been discussed by Canadian and US biologists at a joint meeting and some of the findings are presented here.

The average age of haddock in the Browns Bank landings is higher than for Georges Bank. About 90 percent (by number) of first quarter landings from Browns Bank is composed of ages 4-8, whereas the same proportion of first quarter Georges Bank landings is composed of ages 3-7 (Fig. 2).

Catch curves based on first quarter age compositions show that recruitment into the spring fishery is completed between ages 4 and 5 on Georges Bank, and between ages 5 and 6 on Browns Bank (Fig. 3). After full availability to the gear, the relative abundance of comparable ages in the spring appears to be substantially higher on Browns Bank than on Georges Bank. The estimated total annual mortality rate for age 6 and older is 42 percent for Browns Bank as compared to 50 percent for Georges Bank.

Georges Bank haddock grow faster than Browns Bank haddock and the average difference in length increases with age (Fig. 4).

Cod (*Gadus morhua* L.).

The Fishery. The 1961 landings which amounted to 32 million pounds represented a 10-year high, exceeded only by the 36 million pounds landed in 1951 and the preliminary estimate for 1962 is somewhat higher than the figures for 1961.

Previous peak landings were recorded in 1958 and again in 1959 when the trawlers brought in more cod to compensate for the scarcity of haddock at that time. When haddock again became abundant, as in 1960, cod landings decreased slightly. It is interesting to note, however, that in 1961, when scrod haddock landings were the heaviest they had been in 5 years, cod landings also increased. This may have been due to an increased market demand for food fish of all species.

Studies of commercial landings and research vessel catches, and our knowledge of the biology of the species, suggest that cod will be abundant on the traditional New England fishing grounds in 1963. Our research in the coming year will be directed in part to monitoring the commercial landings, particularly the length and age composition of the catch.

Table 1.----Trends in the cod fishery (New England ports, gutted weight in 000's pounds).

Year	Landings
1957	24,177
1958	29,857
1959	30,559
1960	26,117
1961	32,442
1962 (estimated)	32,713

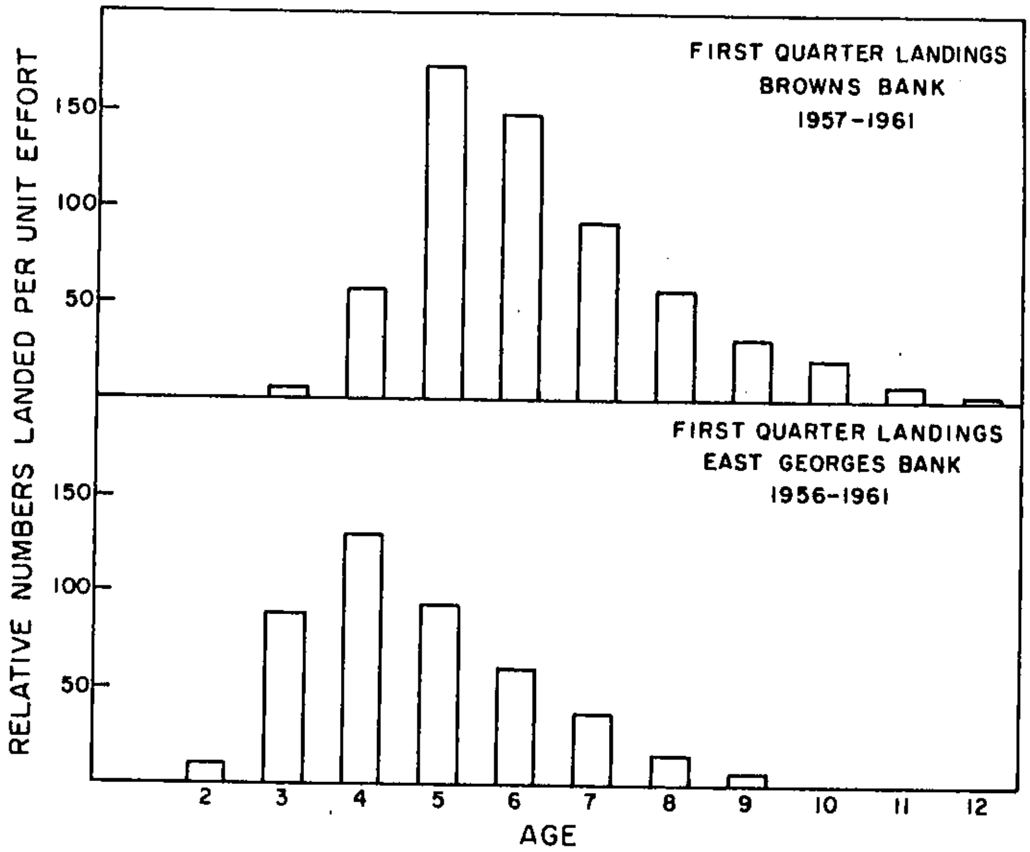

Fig. 2 Age composition of haddock landings from Georges Bank and Browns Bank.

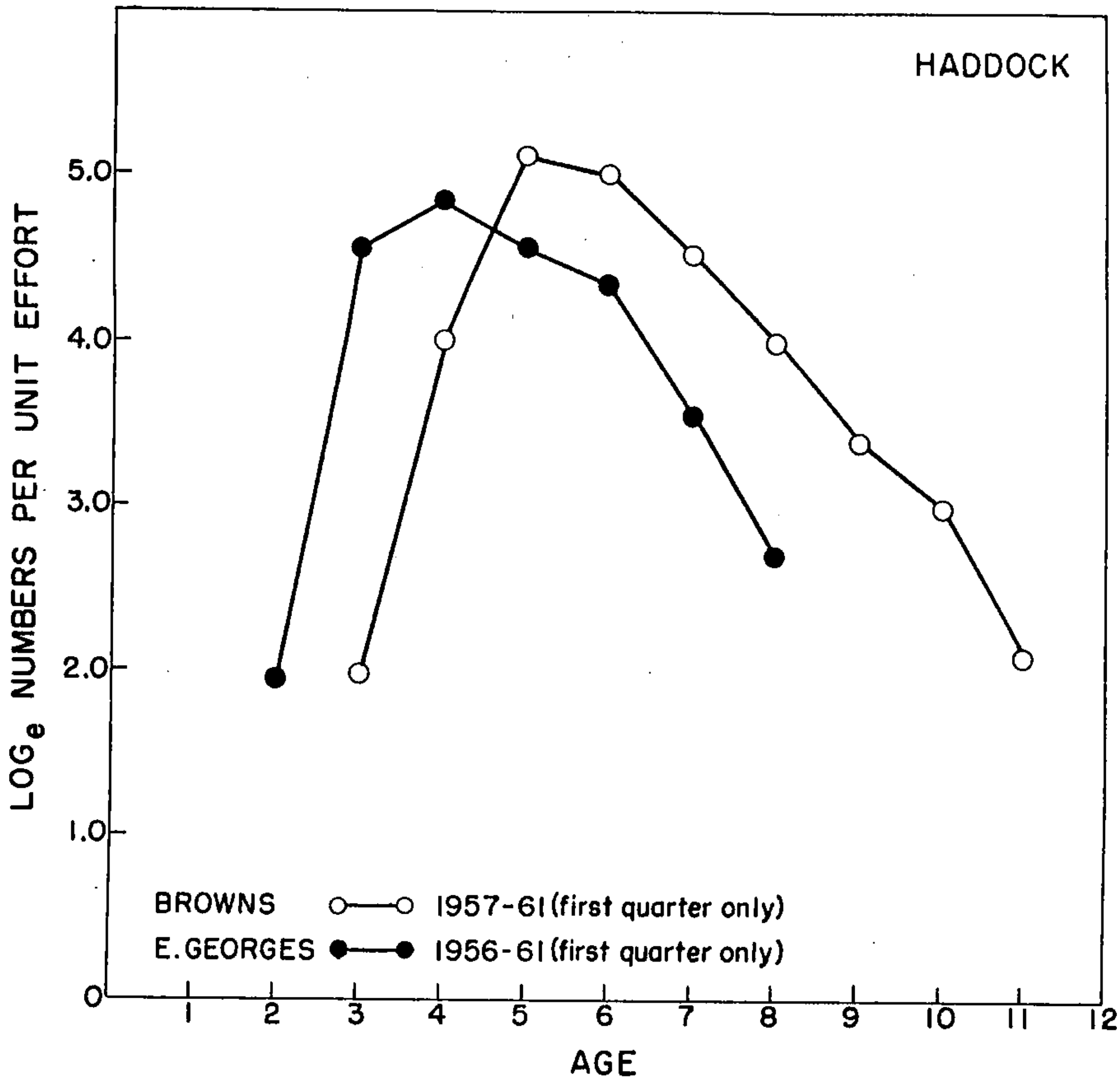

Fig. 3 Catch curves for haddock from Georges Bank and Browns Bank.

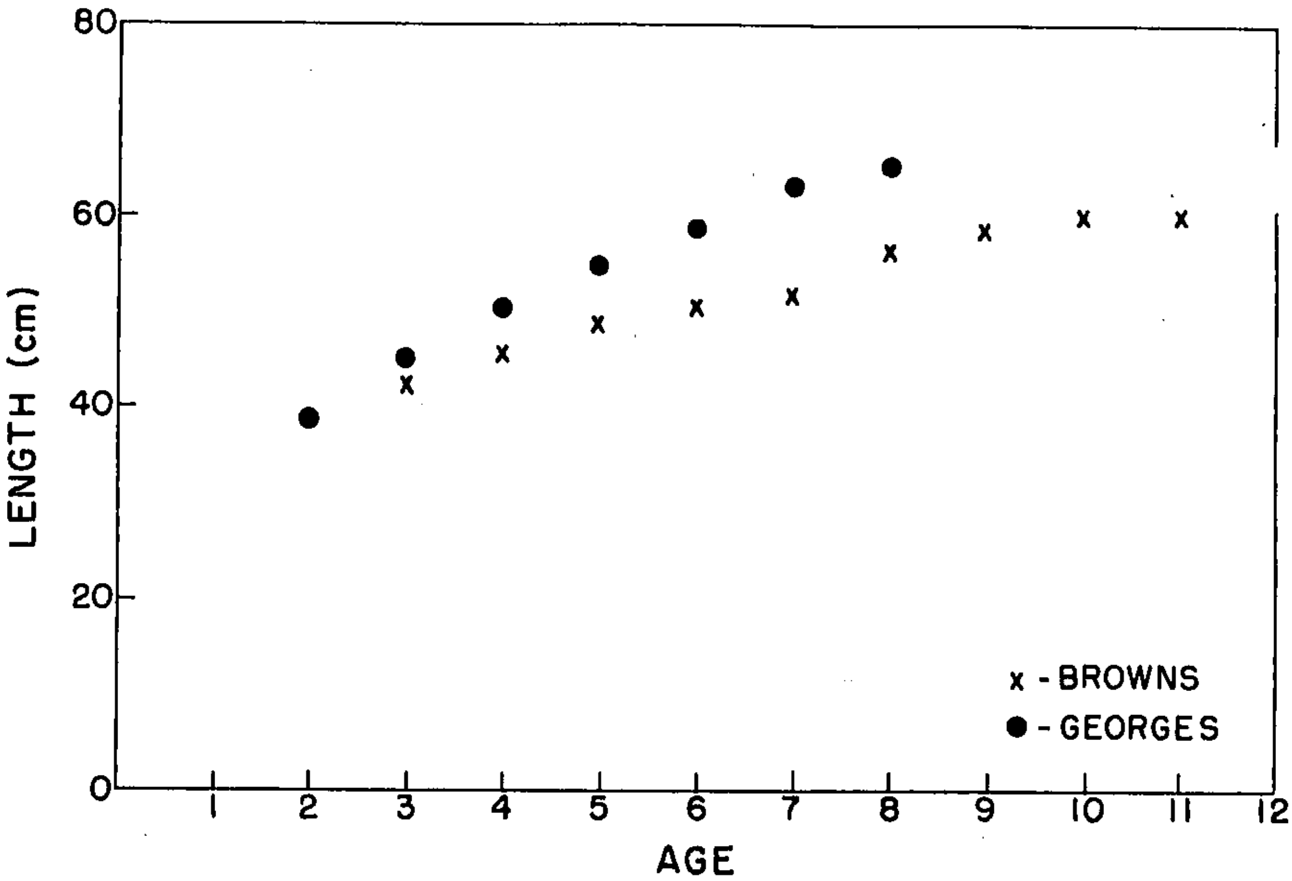

Fig. 4 Mean length at each age in commercial haddock landings from Georges Bank and Browns Bank.

Silver Hake (*Merluccius bilinearis* (Mitchill)).

The Fishery. Landings of silver hake have shown a steady decline since 1959 due first to a decline in the industrial fishery and then to a decrease in landings for food (Table 2). A good index of abundance for this species has not yet been developed but there is no reason to believe that abundance has changed markedly over the last few years.

Research. Silver hake undergoes a pronounced seasonal migration, retreating to deeper offshore waters in the winter which results in extreme variations in availability. The fishery accordingly is markedly seasonal. More information is needed on the winter distribution of the species and on the relation of this species to depth, temperature, and other ecological factors. This kind of information is now emerging from an analysis of past survey cruises which are conducted mainly in summer and fall but will not be adequate until the new year round program of groundfish surveys is initiated.

Table 2. -- Trends in the New England silver hake fishery. (millions of pounds)

Year	For Food	For Industrial	For Animal Food	Total
1957	117	38	16	171
1958	107	23	17	147
1959	110	26	20	156
1960	103	5	20	128
1961	84	7	10	101
1962	60	7	16	83

Flounder.

The Fishery. The high level of New England flounder landings in recent years has been due largely to increases in yellowtail flounder abundance (Table 3). Of particular importance to the high yellowtail landings for 1962 were contributions from the strong year classes of 1958 and 1959. Landings of fluke dropped sharply in 1962. (Fluke length and age data now available are insufficient to show the reason for this decline.)

Table 3. -- Flounder landings. (millions of pounds)

Species	1958	1959	1960	1961	1962[1]
Yellowtail flounder (*Limanda ferruginea*)	32.8	29.0	29.9	37.1	53.1
Blackback (*Pseudopleuronectes americanus*)	14.1	14.3	17.1	17.5	16.3
Fluke (*Paralichtys dentatus*)	5.5	5.5	6.7	6.3	4.2
Dab (*Hippoglossoides platessoides*)	3.0	3.1	3.0	3.5	4.0
Graysole (*Glyptocephalus cynoglossus*)	3.1	2.9	3.1	2.6	2.2
Total:	58.1	54.8	59.8	67.0	79.8

1) Preliminary

Yellowtail fishing effort and relative abundance, as shown by landings per day for the three New England grounds, was calculated from fishing trip weighout schedules for the port of New Bedford for 1943-61. Fluctuations in landings were found to be largely related to abundance changes. Shifts in fishing effort generally followed the changes in abundance. Relative abundance was highest from Georges Bank, an offshore ground, and lowest from the Cape Cod ground, which is inshore. Trends in abundance were similar on all three grounds, suggesting that factors affecting year class strength operated on all grounds simultaneously.

Tagging Experiments. Of the 4,960 yellowtail flounder tagged in 1955, 1957, and 1959; 1020 tagged fishing representing 20.6 percent of those released, were recaptured. Analysis of the returns show a definite seasonal pattern of movement which repeated in each of the three years. There is an easterly migration in the spring and summer and a westerly return in the fall and winter.

The high abundance of yellowtail flounder in 1962 was due to the presence of three strong year classes: 1958, 1959 and 1960. These year classes will continue to support the fishery in 1963 so this year should also be a good one for the yellowtail fishery.

Redfish (*Sebastes marinus*)

The Fishery. Judged from preliminary catch data, the 1962 United States redfish landings will total approximately 122 million pounds, the lowest annual total since 1944 (Fig. 5). This represents a continuation of the steady decline in United States redfish landings since 1951, to a level of about half the average annual landings for 1948-51, the peak period in the fishery.

Abundance Studies in the Gulf of Maine. United States landings from the Gulf of Maine have declined steadily since the peak year of 1941 (Fig. 6). Landings and fishing effort data for the entire Gulf of Maine do not show evidence of replenishment of the redfish stocks as would be expected to result from an extended period of diminished fishing effort following the initial reduction of the accumulated fish stocks. Detailed studies of the data from smaller areas within the Gulf were undertaken to determine the effect of heavy exploitation on small, isolated redfish stocks that were fished heavily in the early years of the fishery, and then received several years of light fishing intensity (Fig. 7).

Data from US statistical subarea XXII F (groundfish unit area F of ICNAF Sub-division 5Y) are representative of trends in other areas in the Gulf (Fig. 8). The fishery began there in 1936, rose rapidly to a peak of 70 million pounds by 1941, and declined quickly to less than 21 million pounds by 1949. Landings from that area have fluctuated between 12 and 25 million pounds each year since that time.

Growth of Tagged Fish. A tagging experiment is currently in progress at Eastport, Maine, on the redfish stock that occurs there. Results during the past year have demonstrated dramatically the effect that different types of tags can have on the growth rate of tagged fish.

Earlier experiments had shown the growth rate of fish to be reduced to about 1 mm. per year when they were first tagged with Petersen disc tags on the opercle. After two or three years of living with the opercle discs, the growth rate slowly increased toward the normal growth rate of the untagged fish. In the present work, we were able to remove Petersen disc tags from fish that had carried them for years and replace them with small plastic dart tags placed in the flesh of the dorsum. The recapture of a large number of these fish has shown them to be growing at the same rate as fish tagged for the first time with dart tags (Fig. 9), and very close to the rate of growth of the untagged fish.

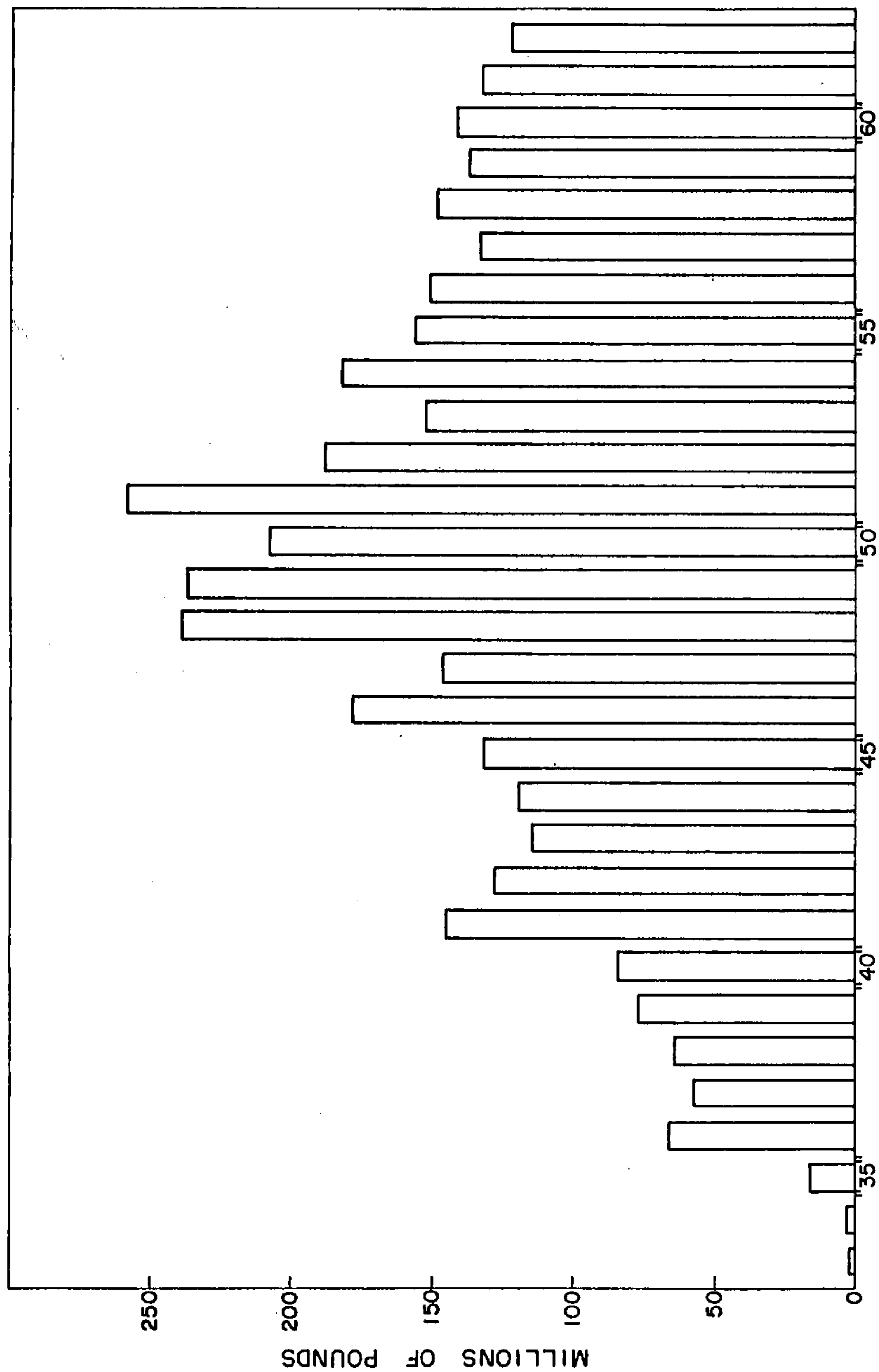

Fig. 5 United States Redfish Landings – 1933 – 1962

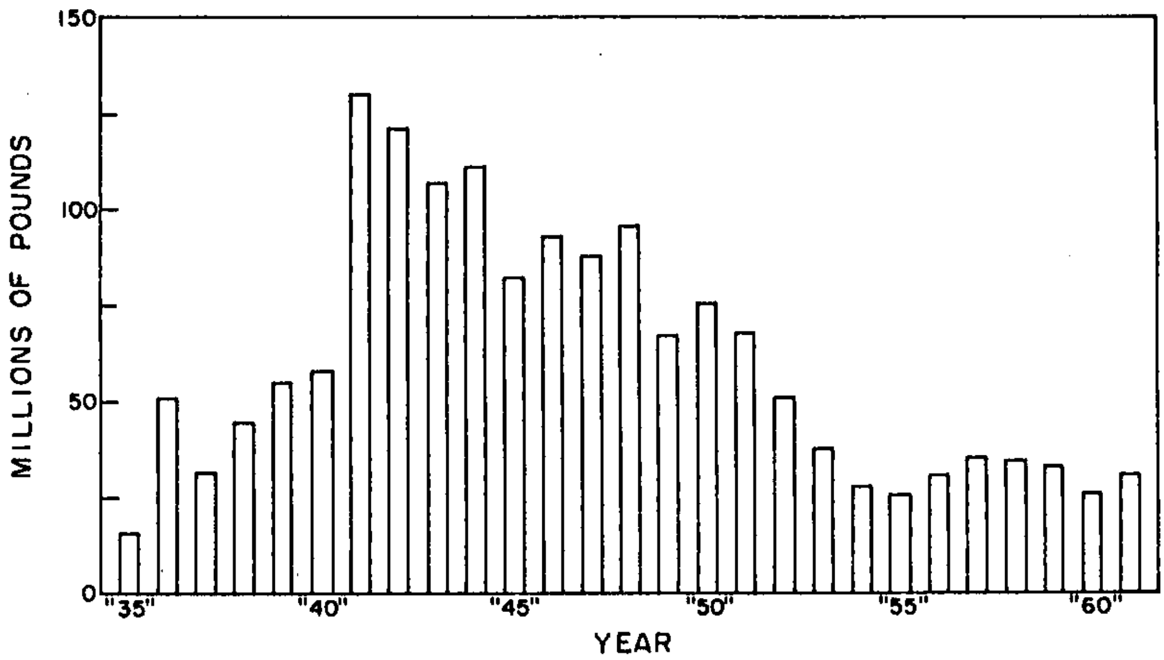

Fig. 6 Trends in Redfish fisheries – Gulf of Maine landings.

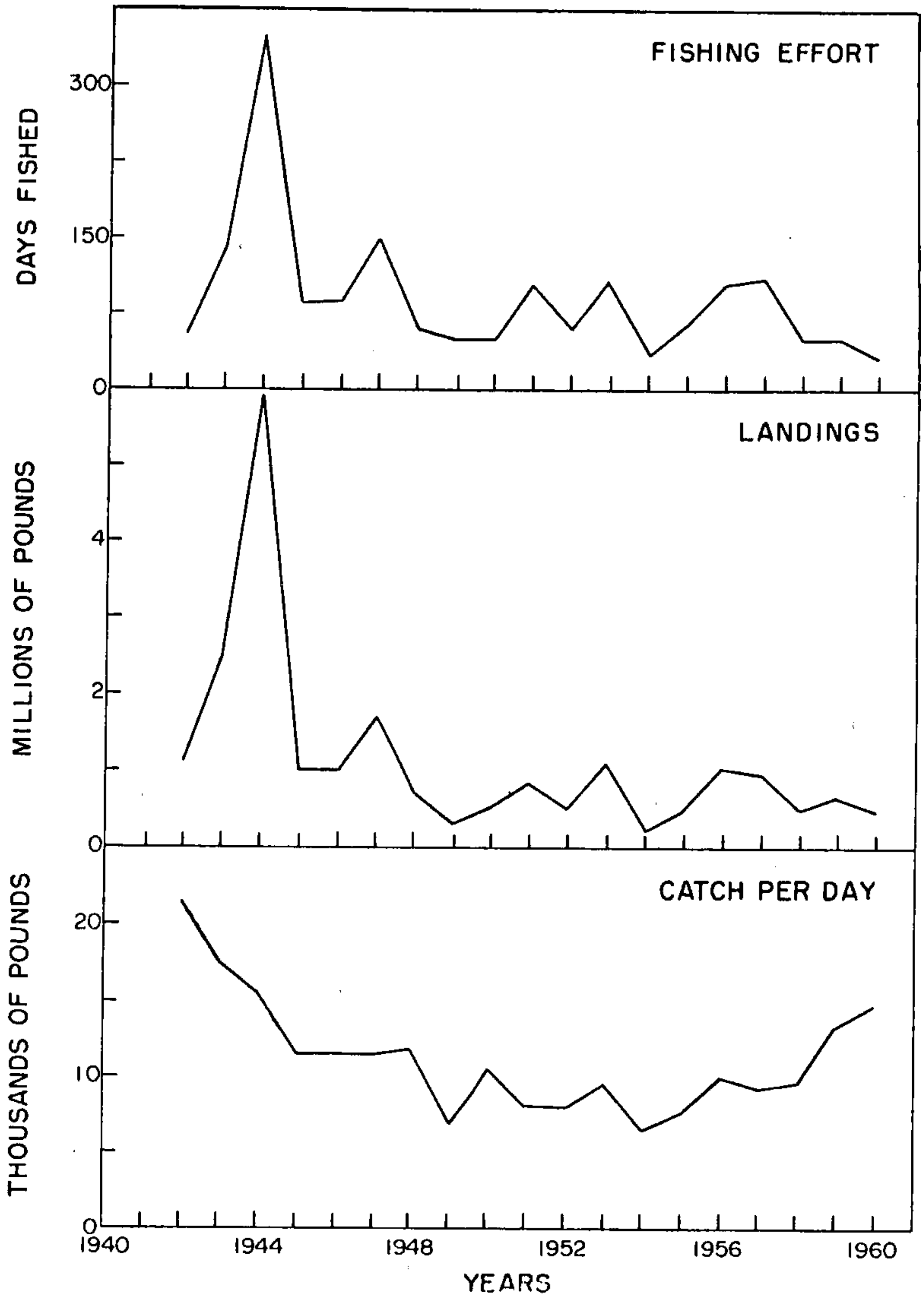

Fig. 7. Redfish catch and effort data for small interview area (42-68 B,C,D-1) of U.S. statistical area XXII F (groundfish unit area F of ICNAF subdivision 5Y) in central Gulf of Maine, 1942-1960.

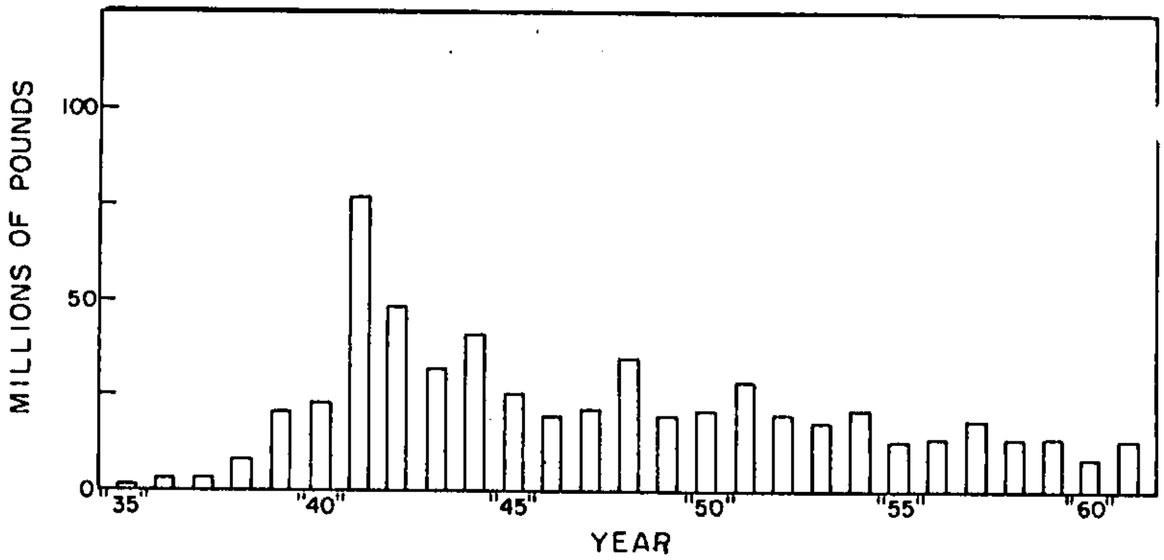

Fig. 8 Trends in Redfish fisheries – landings from U.S. statistical subarea XXII–F (groundfish unit area F of ICNAF sub-division 5Y)

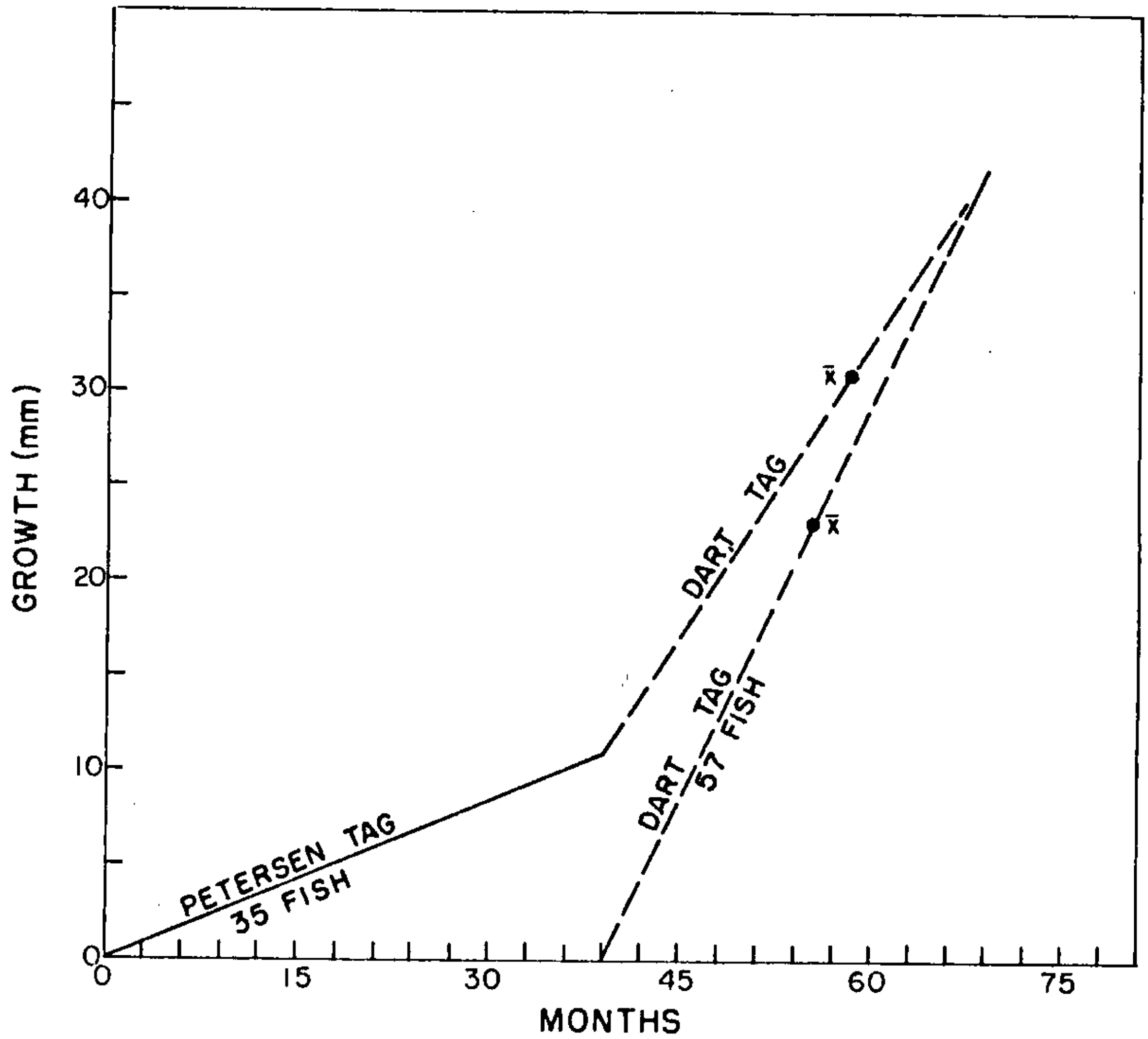

Fig. 9 Comparative growth rates of redfish tagged with two types of tags.

Thirty-five fish tagged initially with Petersen discs on the opercle grew an average of 11 mm. in 39 months. When the tags were removed and plastic dart-spaghetti tags were inserted in the flesh of the dorsum, growth rate increased to an average of 20 mm. in 19 months. The higher growth rate approached that of a group of 57 fish tagged with dart tags from the outset.

In this instance it would appear that the influence of the tag has been primarily caused by the position of attachment rather than any special attribute of the tag. The Petersen tag clearly inhibits growth, whereas the dart tag does not.

Groundfish Ecology.

This program depends largely upon surveys conducted by research vessels operating throughout the area of interest through all seasons of the year for a number of years. Analysis of the accumulated data is not a simple task. For example, it has been found that comparisons of abundance of young of the year haddock cannot be made between years without taking into consideration the relative number of tows made at night and in the daytime since there appears to be a diurnal difference in availability of these fish on the bottom.

Table 4 shows a comparison of abundance indices for day and night tows for haddock of different ages. It is evident that haddock under 2 years of age are more available to an otter trawl in the night time while haddock over 2 years of age are more available during daylight hours. The latter observation is known to the commercial fisherman.

Further investigation of the ecology of groundfish will undoubtedly reveal other environmental factors which must be taken into consideration in refining our estimates of abundance which are based on comparative data.

Table 4. -- Comparison of day and night catches of haddock. Research vessel tows during September, 1953, and 1955, November, 1956, and September-October, 1958.

		Day (0730-1629)			Night (1930-0429)		
		Number of Tows	Number of Fish	C/T	Number of Tows	Number of Fish	C/T
Age Group 0	1953	35	30	0.9	24	32	1.3
	1955	46	218	4.7	53	732	13.8
	1956	34	72	2.1	37	58	1.6
	1958	46	264	5.7	50	1216	24.3
	Total	161	584	3.6	164	2038	12.4
Age Group I	1953	38	33	0.9	24	2	0.1
	1955	42	45	1.1	54	349	6.8
	1956	35	74	2.1	37	48	1.3
	1958	46	286	6.2	50	548	11.0
	Total	161	438	2.7	162	947	5.8
Age Groups II and Greater	1953	28	33	1.2	24	17	0.7
	1955	42	466	11.0	51	256	5.0
	1956	35	285	8.1	37	212	5.7
	1958	46	958	20.8	50	732	14.6
	Total	161	1753	10.9	162	1217	7.5

Population Dynamics

The Woods Hole Laboratory has recently installed an automatic data processing unit which has greatly increased the Laboratory's ability to analyse the accumulation of back data as well as the voluminous quantity of current data which flows in from the fishing ports.

In our population dynamics studies emphasis has been placed on developing methods for computing indices of abundance and effort, for estimating size and age compositions of stocks; and in investigating mathematical models to which these variables may be applied to describe the effects of fishing.

Abundance indices. A proper, standard measure of catch-per-unit of fishing effort is needed to provide a relative index of abundance of commercial stocks, and to provide a means of measuring total effective fishing intensity. Our investigations depend quite critically upon this index. We are, therefore, devoting time to study and further development of such indices for the various species of commercial importance.

Of particular concern in our mixed fishery is the problem of species directed fishing effort. Because of differential temporal and spatial variations in distribution of the various species, the fisherman can direct, to some degree, his efforts so that the probability of catching one species or another is substantially increased. A common procedure has been to use, for calculating relative abundance of a given species, only those trips for which the amount landed is greater than some arbitrarily chosen proportion of the total. The proportion of the catch made up of a species is related to the abundance of the species itself, however, and there is a definite upward bias introduced which is particularly important when the range of abundance experienced is great. An illustration of this effect is provided by comparing the landings-per-days-fished of silver hake by medium-sized otter trawlers landing in Gloucester, 1960, as estimated from (A) all trips and (B) those trips in which silver hake were greater than 50 percent of the total (Fig. 10). The A index is generally lower and indicates a sharper seasonal index of what we purport to measure; the magnitude of the stock at the time and in the area concerned.

Mesh Assessment. We have continued to study the effects on yield of changing the size of mesh in cod ends of trawl nets. This work is co-ordinated by the mesh assessment working group of ICNAF. Most of the results of these studies are summarized in the "Report of Working Group of Scientists on Fishery Assessment in Relation to Regulation Problems" published this year by ICNAF as a supplement to the Annual Proceedings, Volume 11, and will not be repeated here. The main conclusion is that in most instances very moderate increases (on the order of 5 percent) in yield-per-recruit would be obtained by increasing mesh size beyond that now in use. A rather more important aspect is the effects on yield of increasing fishing intensity being experienced in Northwest Atlantic waters, and the working group is now emphasizing studies of this.

Haddock yield. Data on the landings of haddock caught on Georges Bank have been collected since 1931. These data have enabled us to calculate an index of apparent abundance, in terms of landings-per-standard days fished, and estimate the total effort experienced in each year since 1919. A standard day is that fished by a selected group of large otter trawlers fishing in depths of 30 to 60 fathoms.

Landings-per-days-fished in a given year has been plotted against the two year average of days fished culminating in the given year (Fig. 11a). The observed relationship between these two variables indicates a definite drop in apparent abundance with increasing fishing intensity. A straight line was fitted to these data to approximate the equilibrium, or long-term average relationship. The landings are also plotted against effort, and fitted with a curve derived from the linear relationship above (Fig. 11b).

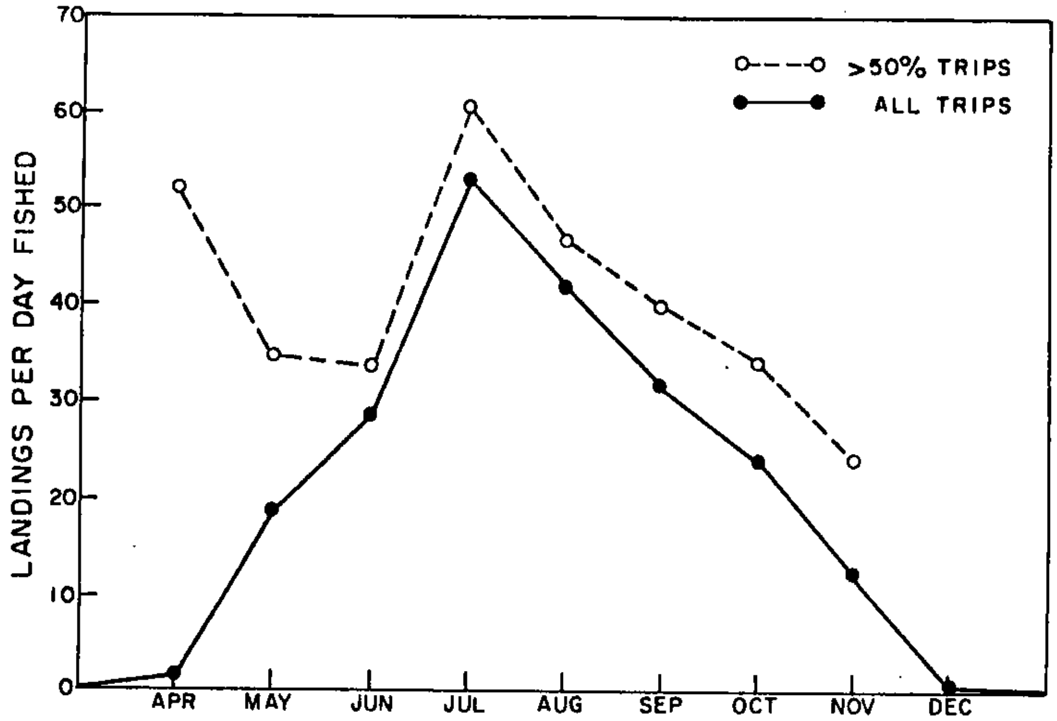

Fig. 10 Silver Hake Gloucester OTM 1960

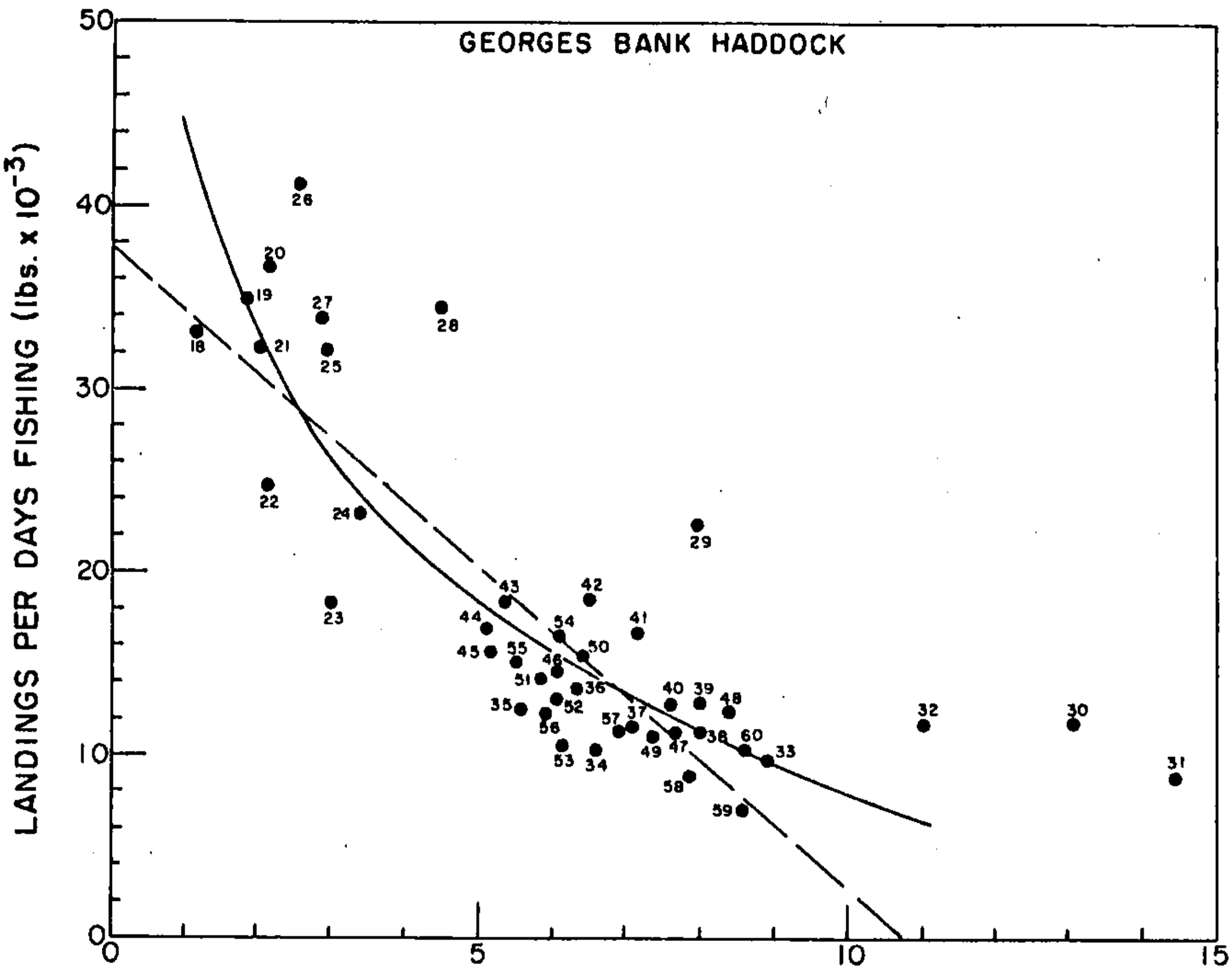

Fig. 11a Two year average days fishing ($x10^{-3}$)

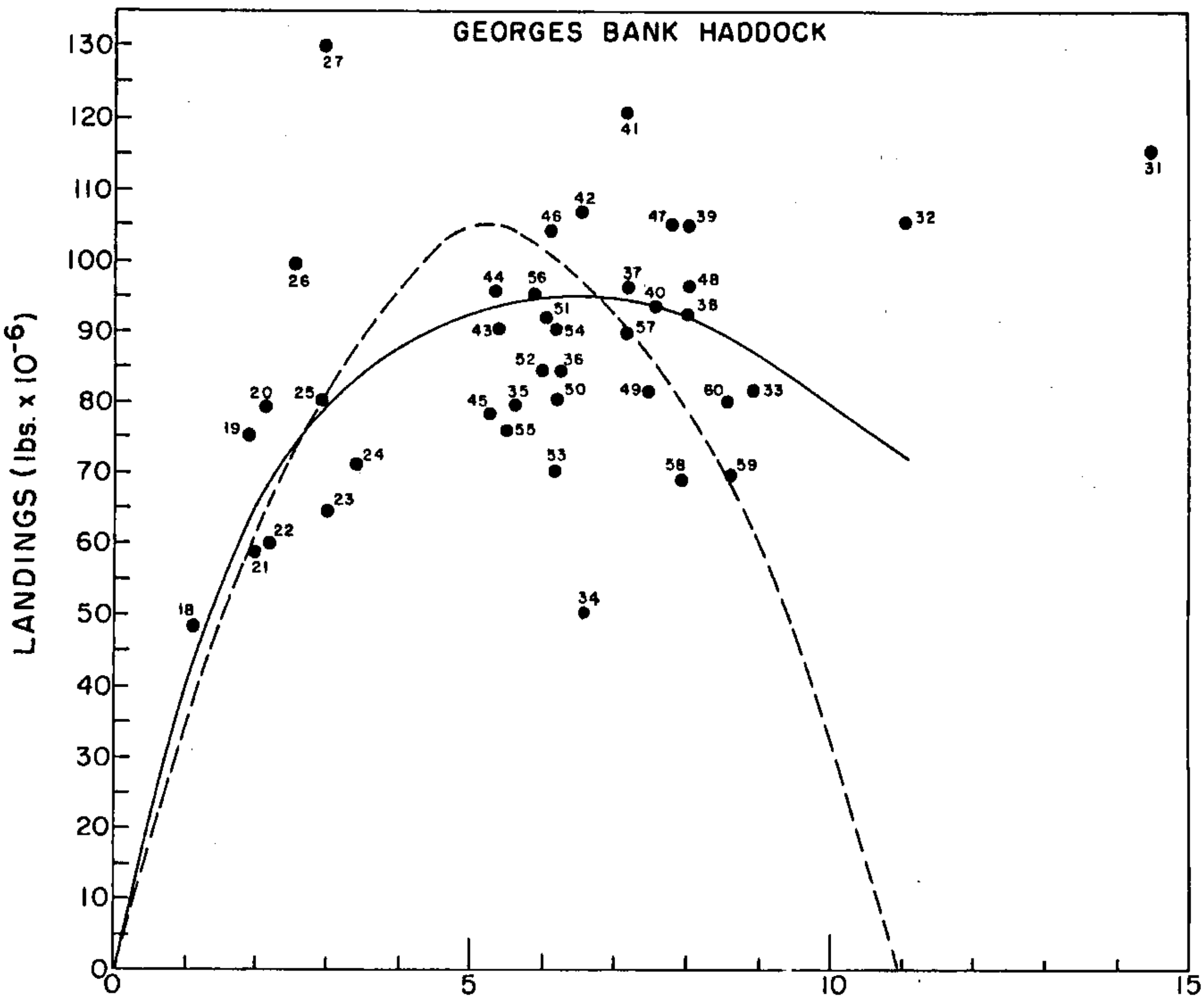

Fig. 11b Two year average days fishing ($x10^{-3}$)

The analysis indicates that the maximum equilibrium yield is in the neighbourhood of 100 million pounds annually, and at the level of 5 to 6 thousand standard days fishing. A curved line was also drawn in by size, because the landings-per-day and effort variables may be more closely related by a slightly survilinear relationship, although the variability of the data precludes a more refined estimation at the present time. The curvilinear fit would have the effect of lowering somewhat the maximum yield and increasing the effort level at which it would be obtained to between 6 and 7 thousand standard days.

In either case, recent levels of effort of over 8 thousand standard days exceed that corresponding to the maximum yield, and further increases in fishing intensity would not, in the long run, increase landings; rather, it seems more likely the landings would decrease.

It is of interest to note the rapid increase in landings and effort from 1926 to 1932, apparently stimulated, at least in part, by an increase in abundance in 1926 and 1927. The high effort levels quickly produced a drop in landings-per-day and landings in the years 1930-34, so that by 1935 all three variables had returned to a point close to the estimated equilibrium condition. Because of the non-equilibrium state, the data points for the years 1926-33 were not used in fitting the curves.

Herring.

United States research on herring in the past has been concentrated on the younger stages which support the sardine industry, but recently attention has been directed toward the larger problems of the populations throughout the Gulf of Maine and on Georges Bank.

A statistical system set up in 1947 is providing detailed information on the US landings, some of which is imported from Canada.

Abundance of the sardines is difficult to estimate since there is evidence that availability to the traps or inshore seines is extremely variable. Success has been achieved in age reading of otoliths so that age determinations can now be made of fish three years old and younger. The US catch is being sampled for age composition of the sardine sizes.

Subpopulations of herring are studied through serological techniques and some meristic work. A new blood group has been found which is a valuable addition to the many factors which must be used to differentiate the subpopulations in the Gulf of Maine. So far nothing has been found to associate the Maine sardine definitely with Georges Bank herring.

Offshore populations are studied for age structure and other population characteristics of all known spawning groups, and sampling of the Georges Bank area for adult and larval herring is under way.

Behaviour and migration studies concentrate on understanding the nature of and reasons for the inshore movements of immature herring. The final experimental phases in development of a suitable long-term herring tag should be completed this winter, and a major tagging effort is planned.

Studies designed to shed light on the environmental factors that contrd or affect the abundance and availability of herring are divided into two parts: (1) surveys in the Sheepscot-Boothbay-Damarascotta area of Maine where 18 stations are established in three somewhat different environments: Lower estuary, Bay area, and combined weak lower estuarine and Bay, and (2) surveys inshore along the Maine Coast. Measurements are made of temperature, salinity, density, currents, transparency, and plankton collections are made monthly. There appears to be a peak in abundance of larvae during the period September-November and sometimes a secondary peak. The collected data are being analyzed to determine the critical period in the life history as related to environmental conditions.

Serology.

In the summer of 1961 attention was directed toward developing a technique for distinguishing haddock blood groups. Blood samples have been processed from about 700 haddock and although problems still remain with storage and processing techniques, some encouraging results have been obtained in finding blood groups.

Tests for isoagglutinations, haddock blood cells vs. haddock blood serum, were run using more than 3600 individual cross-matches with practically no differential results. It was concluded that naturally occurring isoagglutinins in haddock have a low frequency of positive tests and are low in strength of reaction or titre. Consequently isoagglutination tests are not a useful tool in haddock serology.

Heteroagglutinations, haddock blood vs. blood of other species have been made between haddock blood cells and/or sera and a variety of potential agglutinins such as seed extracts and blood serum from other marine organisms, including four arthropods and 21 fish species. Among these, the best differential agglutinations were obtained in several experiments with inshore blackback flounder serum, and at least three distinct antigen types were distinguished by the absorption technique in one sample of 20 haddock. Problems in obtaining samples and storage of blood made it desirable to seek other reagents, and further tests have not been made with blackback serum.

Tests were conducted with anti-haddock serum from rabbits and chickens, but so far no differential results have been obtained. Still another test matched blood sera from 90 haddock against Hemantigen (a commercially available product containing human type-O cells with many known secondary groupings) with only one questionable agglutination.

Best results have been obtained between haddock cells and rabbit anti-scup serum; every sample tested so far has yielded highly differential agglutinations. Recent tests on 204 haddock from several locations in the Gulf of Maine suggest that there might be gene-frequency differences between areas. Attempts will be made to test anti-scup serum with haddock blood samples from major haddock spawning grounds in March 1963, and also from the waters of eastern Nova Scotia and Newfoundland.

A final technique has been the electrophoretic separation of hemoglobin proteins. With this technique evidence has been reported for a simple two-allele system of hemoglobin types in whiting and cod in the Northeast Atlantic. Hemoglobin patterns have been obtained on 77 Gulf of Maine haddock and in virtually every case an identical 2-band pattern was observed.

Sea Scallops (*Placopecten magellanicus*)

The Fishery. Pertinent statistics regarding the Georges Bank sea scallop fishery are presented in Table 5. It will be noted that the total landings (United States and Canadian combined) increased markedly in 1959, and continued to increase through 1962; the 1962 figure being more than double that of 1959. This phenomenal and unprecedented increase was due to an increased abundance of the shellfish and an increased effort on the part of the Canadians. The days fished by US vessels actually dropped in 1959 and 1960, although US landings increased somewhat due to the high abundance of the scallops.

Abundance. The rather sudden increase in abundance that occurred in 1959 was due to an unusually large year class of scallops that arrived at commercial size that year. This year class supported the fishery for four years. It is now declining and we see no similar year classes coming along.

We have three methods for estimating relative abundance; comparison of quantitative research vessel samples, landings per day on the grounds for the fleet, and Canadian records of catch per minute towed on commercial vessels carrying sea samplers. For various reasons none of these gives a very precise estimate, but all of them show a decline for the marketable sizes (greater than 95 mm.) of about 30 percent in 1962, as compared with 1961.

Table 5. -- Statistics of the Georges Bank Sea Scallop Fishery.

	United States		Canada		Total	Average US Fleet	
Year	Landings lbs x 10^6	Effort Days	Landings lbs x 10^6	Effort Days	Landings lbs x 10^6	Landings Per day	Gross Stock Per day
1953	16.3	10031	0.3	180*	16.6	1627	$717
1954	15.5	9343	0.2	120*	15.7	1671	748
1955	18.3	11619	0.3	190*	18.6	1570	821
1956	17.5	12246	0.7	490*	18.2	1442	778
1957	17.3	10500	1.8	1197	19.1	1650	800
1958	14.4	8775	2.6	1598	17.0	1637	793
1959	18.7	8556	4.4	2098	23.1	2187	1057
1960	21.9	8039	7.5	2601	29.4	2722	949
1961	23.6	8671	10.0	3147	33.6	2719	1030
1962	21.9	9070	13.0*	5400*	34.9	2410	980

* Estimated

None of these methods gives even an approximate measure of the strength of the pre-recruit year classes. We can say, however, that nowhere on the grounds sampled with the research vessel in 1962, was the year class to be recruited during 1963 present in large numbers. It is possible, but we believe unlikely, that there are any large concentrations of this year class in areas that we did not investigate.

Benthic Studies

Principal work performed by the Benthos Program during the past year was the quantitative benthic fauna study of: (1) the northern Gulf of Maine, and (2) the continental shelf south of Marthas Vineyard and Nantucket Island. Based on the analysis of 100 samples from the northern Gulf of Maine, the macroscopic benthic fauna was found to average 80 grams per square meter of bottom. The fauna was particularly dense (300-1000 g/m^2) off Penobscot Bay, Maine. Moderately dense concentrations occurred on Cashes Ledge and adjacent areas north and east of Cashes. In general, the benthic biomass in the western section of the Gulf of Maine was considerably lower than that occurring in the central and eastern parts of the Gulf. General comparisons indicate that the Gulf of Maine benthos is only about half as dense as that occurring on Georges Bank. Analyses of the samples from south of Marthas Vineyard and Nantucket have not yet been completed. However, preliminary results indicate the presence of 5 macro-benthic faunal communities. Biomass at the shallow, inshore stations was moderately low (20-40 g/m^2), whereas over most of the shelf the biomass was moderate to very rich (50-300 g/m^2). Exceedingly high faunal density (over 1000 g/m^2) occurred at a few localities, usually associated with aggregations of mollusks. From the analyses made so far, the biomass and faunal composition in this area appears to be generally comparable to that occurring on Georges Bank.

The benthic studies program is providing a rich body of information on the distribution and abundance of bottom fauna which will be used in preparing charts of faunal types, and in providing very useful knowledge for an understanding of the nutritional support of our commercial bottom fish as well as an understanding of the ecosystem dynamics of the area.

Hydrography - by Dean F. Bumpus, Woods Hole Oceanographic Institution.

WHOI under contract with the USBCF has continued the Oceanographic Observation Post program throughout 1962 from Maine to Georgia at 15 offshore locations (lightships and towers) and at several shore stations. The drift bottle and sea bed drifter program has also been continued.

According to the data so far received from the oceanographic observation posts at Mt. Desert Light, Portland, Boston and Nantucket Lightships, Texas Towers Nos. 2 and 3 (Georges Bank and Nantucket Shoals), and Woods Hole, the temperatures of eastern New England waters were near normal during most of the year 1962. At Woods Hole the water was colder than normal in both November and December and this may prove to be the case also at the other stations when the data for those months are received.

In comparison with 1961 the temperatures of 1962 tended to be somewhat higher during the first half of the year and slightly lower in the latter half.

That the water temperatures remained near normal is perhaps surprising in view of the cold air temperatures which prevailed in New England. Boston, for example, had its coldest year since 1940, the average air temperature being only 49.8°F as compared with a normal of 51.4°F. Nine months, including the last six were colder than normal.

Salinity followed its usual course at most stations; higher in the cold months and lower in the summer and early fall.

At Portland lightship, where the minimum salinities normally occur in the spring following the maximum river runoff, the minimum average salinity was 30.68 o/oo for the month of May following the maximum of river runoff in April at the representative station on the Pemigewasset River. An unusual second peak in the runoff curve in October was followed by a freshening of the water at Portland lightship from 31.67 o/oo in September to 31.24 o/oo in November. No salinity data are available as yet for October or December so that it is not possible to ascertain the minimum month.

The increase in runoff is attributable to high rainfall in October and November (as much as 300 % of normal in some areas in October) and in particular to a storm on October 5-7 which broke all existing records in eastern sections of New England.

One end product of the drift bottle program will be a series of charts depicting the non-tidal drift along the east coast of North America from Cabot Strait to the Straits of Florida. The reduction of the data for the years 1959, 1960 and 1961 to chart form is now completed. These charts will show on a monthly basis the direction and speed of the drift and also per cent recovery from 30 minute rectangles. The data for 1962 must be added to make the charts reasonably complete. It is apparent that departures from the normal condition of drift are quite frequent. For example, off the coasts of the Mid-Atlantic states the percent recovery of drift bottles released by lightships was higher this year, 1962, and also a large percentage of the bottles released during June and July at the lightships off that coast was recovered to the north, suggesting that the normal non-tidal drift to the south was interrupted and reversed from time to time, Figures 12 and 13. These data require further analysis as to the causes.

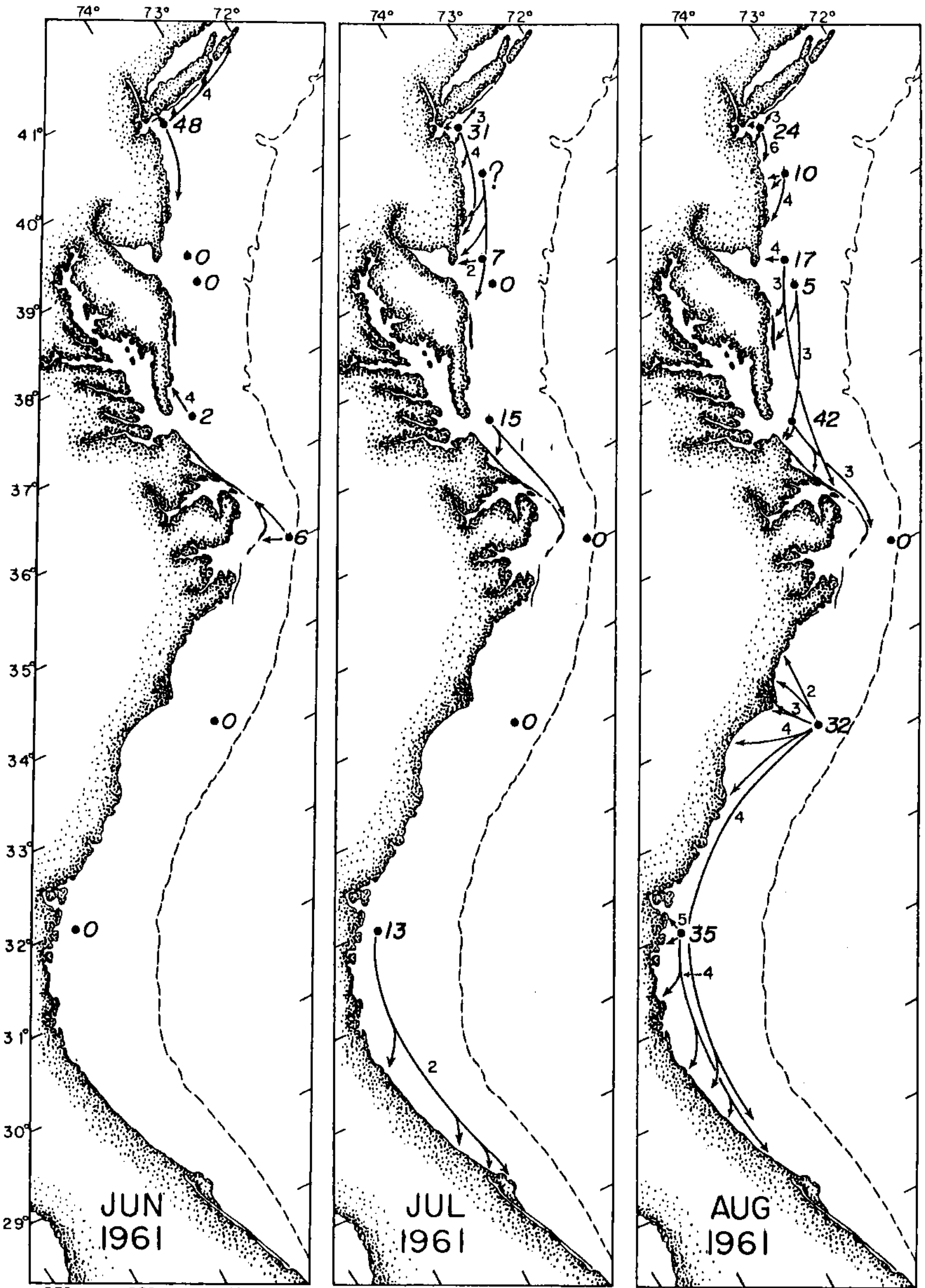

Fig. 12. Recovery of drift bottles released by lightships off the coast of the Mid-Atlantic states, 1961.

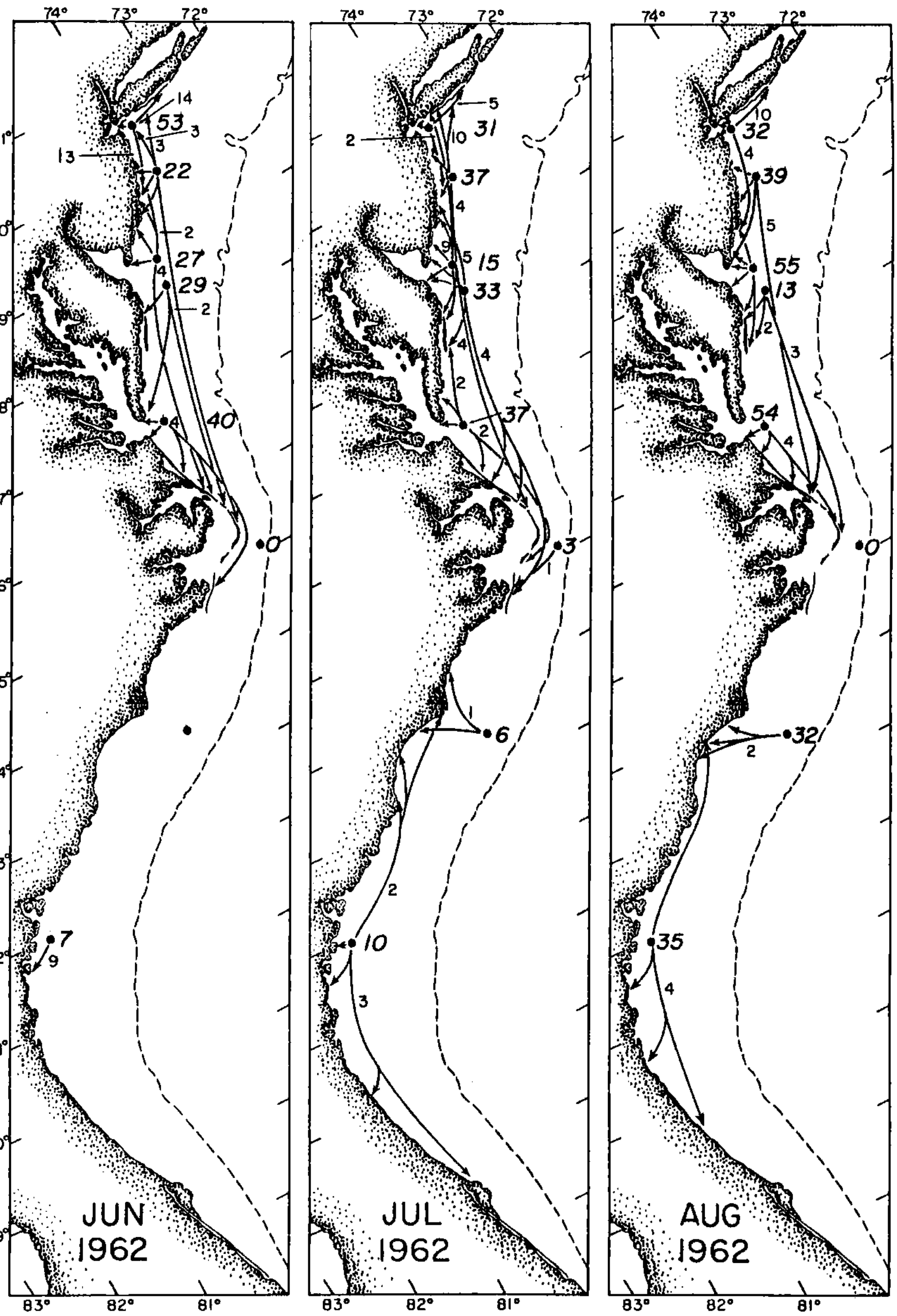

Fig. 13. Recovery of drift bottles released by lightships off the coast of the Mid-Atlantic states, 1962.

Sea bed drifters have become a really useful tool during the past year. Results suggest that the non-tidal drift along the bottom in the Gulf of Maine area is in the same direction, in general, as the surface drift, but about one tenth as fast. /

In all this work we have received excellent co-operation from FRBC Biological Station, St. Andrews; USFWS Biological Laboratory, Boothbay Harbor; USFWS Biological Laboratory, Woods Hole; USWB, Atlantic Weather Project, Boston; USFWS Biological Laboratory, Sandy Hook, N. J.; Virginia Institute of Marine Science; USFWS, Biological Laboratory, Beaufort, N.D.; USC&GS, USCG Lightships and Towers; USAF Weather Observers on Texas Towers.