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The United States landed fish from ICNAF Subareas 4 and 5, and Statistical Area 6. Research was conducted in 3, 4, 5, and 6.

Table 0.1 gives a summary of U.S. finfish and sea scallop landings for each Subarea for 1970 and 1971.

Table 0.1 -- United States finfish and sea scallop landings for 1970 and 1971 (metric tons, round weight).

SPECIES	YEAR	1	2	3	4	5	6 ^{1/}	TOTAL
Haddock	1971	-	-	-	1248	8486	1	9735
	1970	1	1	-	2319	9872	1	12194
Cod	1971	-	-	-	335	22983	125	23443
	1970	278	502	55	615	22347	364	24161
Redfish	1971	-	-	-	10967	16262	-	27229
	1970	-	-	-	9541	15534	-	25075
Pollock	1971	-	-	-	164	4724	2	4890
	1970	-	-	-	385	3592	-	3977
Yellowtail	1971	-	-	-	12	22312	2993	25317
	1970	-	-	-	21	31920	4050	35991
Silver Hake	1971	-	-	-	1	13325	542	13868
	1970	-	-	-	-	19379	2248	21627
Red Hake	1971	-	-	-	-	2783	356	3139
	1970	-	-	-	-	4281	659	4940
Sea Herring	1971	-	-	-	-	33884	263	34147
	1970	-	-	-	-	30484	708	31992
River Herring	1971	-	-	-	-	940 ^{1/}	5980	6920
	1970	-	-	-	-	1463	14858	16321
Menhaden	1971	-	-	-	-	6355	5148	11503
	1970	-	-	-	-	5122	218304	223426
Other finfish species	1971	-	-	-	322	31482 ^{1/}	3115	34919
	1970	1	2	-	352	40413	34771	75539
Total finfish	1971	-	-	-	13049	163536 ^{1/}	18525	195110
	1970	280	505	55	13233	184407	275962	474442
Sea Scallop	1971	-	-	-	-	14142	2285	16427
	1970	-	-	-	-	12938	8828	21766

^{1/} Landings incomplete for 1971

Subarea 3

Special Research Studies

The United States Coast Guard conducted oceanographic surveys in support of the International Ice Patrol in Divisions 3N, L, and O.

Subarea 4

A. Status of the Fisheries

I. Haddock

United States landings of haddock from Subarea 4 amounted to 1,248 metric tons, 46 percent below 1970 landings. U.S. landings from Division 4X were 751 metric tons, 57 percent lower than 1970 (Table 4.1). Landings from Browns Bank, the principal area fished by U.S. vessels in Division 4X, decreased 971 metric tons. Landings per day decreased again on Browns Bank and predictions are that no significant recruitment to the fisheries can be expected before 1975. The decrease in quota allowance for 1972 may prevent a further decline in abundance.

Table 4.1 -- United States haddock statistics, Division 4X (metric tons, round fresh).

Year	Division 4X Landings	Browns Bank		Landings/ Day Fished
		Landings	Days Fished	
1965	3,685	1,786	275	6.5
1966	2,473	939	200	4.7
1967	5,014	2,059	381	5.4
1968	3,156	2,278	506	4.5
1969	1,830	1,305	389	3.4
1970	1,744	1,576	493	3.2
1971	751	605	242	2.5

II. Cod

The United States fleet landed 335 metric tons of cod from Subarea 4, 280 tons less than in 1970. This decrease in landings is probably a reflection not only of reduced effort but also lower abundance.

III. Redfish

United States landings of redfish from the Gulf of St. Lawrence (Division 4R, S, and T) decreased by 38 percent (Table 4.2). Redfish landings by the United States from the Scotian Shelf (Divisions 4V, W, and X) increased 4312 metric tons (Table 4.3). Landings per day decreased for the Gulf of St. Lawrence, but was slightly higher for the Scotian Shelf. These indices, however, are probably not very sensitive measurements of abundance trends.

Table 4.2 -- United States redfish statistics, Division 4R, S, T
(metric tons, round fresh).

Year	Landings	Days Fished	Landings/ Day Fished
1965	17,099	803	21.3
1966	12,766	608	21.0
1967	15,482	622	24.9
1968	16,437	740	22.2
1969	12,122	689	17.6
1970	7,592	593	12.8
1971	4,706	490	9.6

Table 4.3 -- United States redfish statistics, Division 4V, W, X
(metric tons, round fresh).

Year	Landings	Days Fished	Landings/ Day Fished
1965	13,082	1,246	10.5
1966	16,680	1,183	14.1
1967	6,407	593	10.8
1968	4,635	297	15.8
1969	1,142	75	15.3
1970	1,949	135	14.2
1971	6,261	404	15.5

B. Special Research Studies

I. Environmental Studies

Environmental studies in Division 4X are part of a larger program carried out in Subareas 5 and 6. They are reported under Subarea 5.

II. Biological Studies

Haddock

Monitoring of haddock stocks in Division 4X through commercial catch-effort statistics and ALBATROSS IV groundfish surveys show stock abundance to have declined to the lowest level recorded during the 1956-1971 period. Estimates of the strength of the 1971 year-class showed only a slight improvement over the extremely poor year-classes of 1964-1968, and 1970. Thus, although the 1971 quota of 18,000 tons was reduced to 9,000 tons for the 1972 catch, a significant improvement in recruitment and stock abundance cannot be expected prior to 1976 at the earliest, and then only if the 1972 year class is very large.

Studies on sexual maturity and spawning cycles continued jointly with the St. Andrews Biological Station, Fisheries Research Board of Canada. Over 1,000 haddock were examined; samples were taken through April in 4W and through May in 4X. Spawning in Division 4X and W began in early March and the 50 percent spawned-out point was reached in mid-May. Spawning probably ended in June.

Herring

Studies on herring in Division 4X are reported under Subarea 5.

Subarea 5

A. Status of the Fisheries

I. Haddock

Haddock landings in 1971 were limited by the 12,000 ton quota set by the Commission. Only 80 percent of this quota was attained. The U.S. landed 8,486 metric tons, about 1,386 tons less than the 1970 landings (Table 5.1). Landings per day figures in Table 5.1 were adjusted for effects of closure by deleting March, April, and calendar quarter 4 when fishing was curtailed in 1970, and were calculated using a two-factor AOV model.

Age composition for 1971, based on commercial landings, indicate that fish eight years old and greater (predominantly 1963 and 1962 year classes) continued to represent 50 percent of the 1971 catch (Figure 5.1). The ALBATROSS IV fall groundfish survey catches indicate a slight improvement in the 1971 year class over 1970; however, the index continues low. Poor reproduction now extends to eight years (Table 5.2), and recruitment through 1973 will be very low.

Table 5.1 -- United States haddock statistics, Subarea 5 (metric tons, round weight).

Year	Subarea 5 landings	Div. 5Y landings	Division 5Zw landings	Division 5Ze	
				Landings	Adjusted landing/ standard day fished
1965	57,027	4,204	26	52,797	5.6
1966	57,497	4,579	31	52,887	5.2
1967	39,580	4,852	37	34,691	4.0
1968	28,887	3,418	16	25,453	3.2
1969	18,858	2,402	15	16,441	2.5
1970	9,872	1,457	15	8,400	2.1
1971	8,486	1,180	5	7,301	1.6

Table 5.2 -- Research vessel index of relative year-class abundance of Georges Bank haddock based on autumn catches of 0-group fish.

<u>Year</u>	<u>Index</u>	<u>Year</u>	<u>Index</u>
1959	9.6	1965	1.2
1960	2.4	1966	1.7
1961	1.4	1967	1.0
1962	2.6	1968	1.0
1963	12.6	1969	1.1
1964	2.0	1970	1.0
		1971	1.4

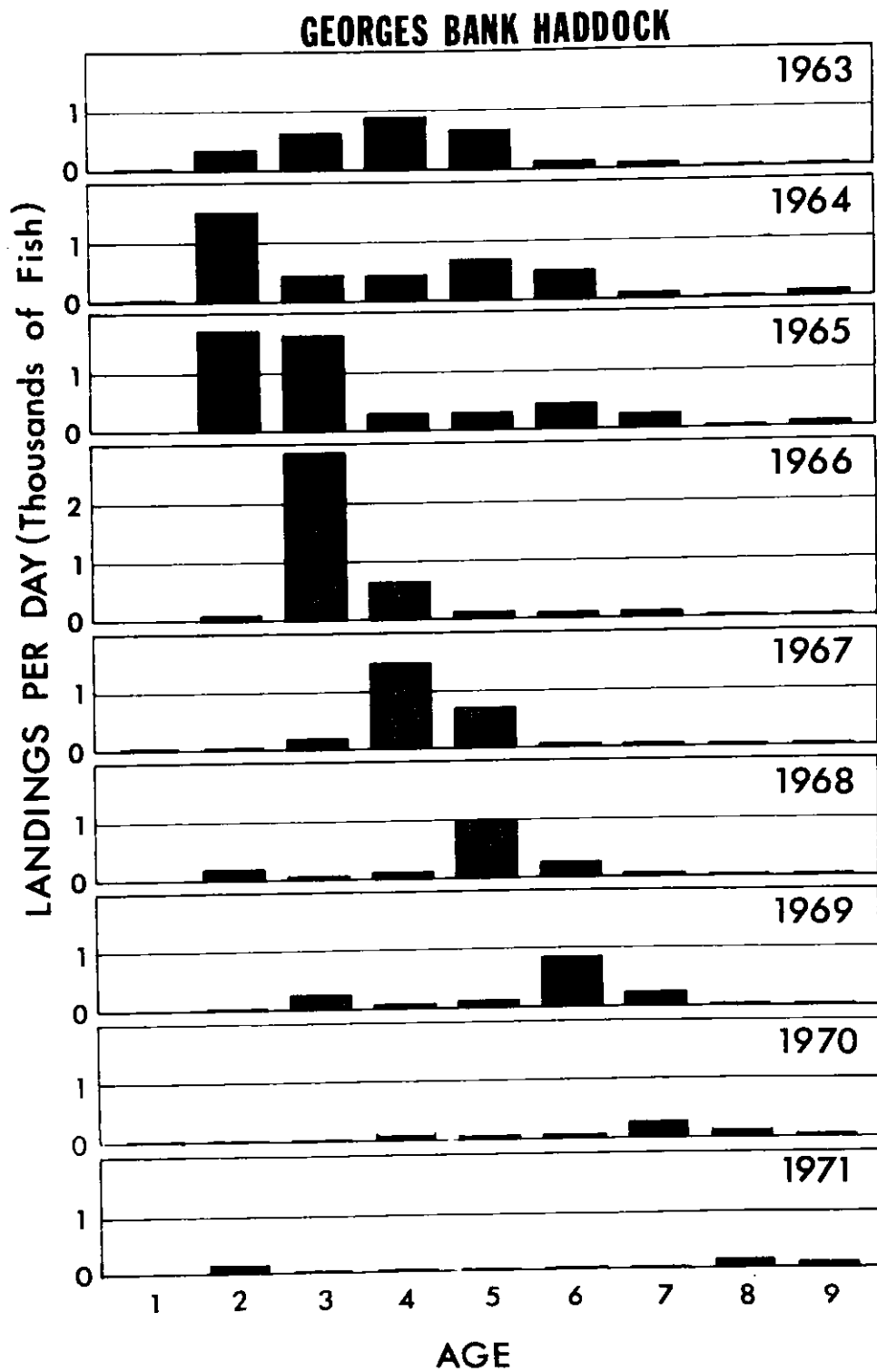


Figure 5.1 -- Age composition of Georges Bank haddock

II. Cod

Cod landings by the U.S. in Subarea 5 for 1971 were similar to 1970 landings (Table 5.3). Total catch over the last several years by all countries (1968: 49,176; 1969: 45,376) has been considered higher than the sustainable yield. Although the U.S. commercial abundance index remained unchanged, research surveys indicate a slight decrease and it is probable that abundance has declined in 1971. The lack of decrease in the commercial index may be due to changing fishing practices causing greater directed effort for cod.

Table 5.3 - United States cod landings, Subarea 5 (metric tons, round weight).

Year	SA 5 landings	Div. 5Y landings	Div. 5Zw landings	Division 5Ze	
				Landings	Landings/ day fished
1965	15,011	3,780	215	11,016	0.9
1966	15,343	4,008	345	10,990	1.1
1967	18,057	5,527	684	11,846	1.0
1968	21,045	6,360	836	13,849	1.4
1969	24,175	7,823	1,143	15,209	1.7
1970	22,347	7,812	1,182	13,353	2.1
1971	22,983	7,188	728	14,999	2.0

III. Silver hake

Total U.S. landings of silver hake from Subarea 5 in 1971 decreased 6,000 metric tons from 1970 (Table 5.4). Food fish landings from the Gulf of Maine (Div. 5Y) and Georges Bank (Div. 5Ze) decreased moderately. Landings from Division 5Zw, which are predominantly for industrial use, decreased sharply.

Abundance has been low; however current research cruise data indicate significant increases in pre-recruit (i.e. ≤ 10 cm.) numbers which would improve abundance by 1973 if fishing levels do not increase greatly on the small fish.

Table 5.4 - United States silver hake statistics, Subarea 5 (metric tons, round weight).

Year	SA 5 landings	Food Fish			Industrial Fish	
		Div. 5Y landings	Div. 5Ze landings	Landings/ day	Div. 5Zw landings	Landings/ day
1965	41,809	22,605	11,169	11.3	8,035	4.4
1966	40,771	21,323	16,222	12.7	3,226	1.4
1967	30,986	14,390	12,692	9.3	3,904	3.4
1968	35,919	24,706	6,451	14.0	4,762	4.0
1969	20,333	14,609	1,654	4.9	4,070	4.6
1970	19,379	11,384	4,238	3.7	3,757	2.2
1971	13,325	8,256	3,069	2.6	2,000	3.4

IV. Redfish

United States landings of redfish from Subarea 5 in 1971 increased slightly over 1970 (Table 5.5). Landings from Division 5Y, however, declined by 1,000 metric tons. Effort continued an increase which began in 1969. Landings per day declined from 1970, and abundance is possibly lower, although good fishing does occur in many areas.

Table 5.5 -- United States redfish statistics, Subarea 5 (metric tons, round weight).

Year	Total Subarea 5 Landings	Division 5Y (Gulf of Maine)		
		Landings	Days Fished	Landings/Day Fished
1965	6,986	5,045	742	6.8
1966	7,204	4,719	429	11.0
1967	10,442	6,746	649	10.4
1968	6,576	4,060	292	13.9
1969	12,038	9,637	824	11.7
1970	15,534	13,551	1,473	9.2
1971	16,262	12,536	1,694	7.4

V. Yellowtail flounder

Total U.S. catch in Subarea 5 for 1971 was about 29,000 metric tons (Table 5.6), which equaled the quota set by the Commission. This represented a 31 percent decrease from 1970. Yellowtail landings for food were lower by 26 percent while landings of yellowtail for industrial purposes, mainly from Division 5Zw, declined 84 percent. Regulations limiting catch of yellowtail to 10 percent of the total for vessels not fishing the regulation mesh size, contributed to the great decrease in industrial landings.

Commercial landings per day declined on both major fishing grounds (Georges Bank and southern New England). Survey cruise data also reflect lower relative abundance, particularly for southern New England (management area W of 69°) (Table 5.7).

Age composition of commercial data show that three and four year old fish made up about 66 percent of the landings. Survey cruise data indicate continued below average pre-recruits. Assessments based on fall survey cruises and 1971 catches suggest that 1972 abundance will be about the same or slightly less than in 1971.

Table 5.6 -- United States Yellowtail flounder statistics, Subarea 5, (metric tons, round weight).

Year	Food Landings	Landings per Estimated		Est. Indus. landings	Catch
		day fished	discard		
1965	36,218	3.1	12,893	972	50,083
1966	28,656	2.0	8,253	2,364	39,273
1967	20,819	2.2	14,407	4,587	39,813
1968	28,645	3.0	10,627	3,939	43,211
1969	28,739	2.7	5,202	4,265	38,206
1970	29,825	2.5	10,689	2,095	42,609
1971	21,970	2.1	7,106	342	29,418

Table 5.7 -- Yellowtail flounder abundance indices from United States survey cruises.

Year	Southern New England (W of 69°)		Georges Bank (E of 69°)	
	Nos. per tow	Weight* per tow	Nos. per tow	Weight* per tow
1963	50.6	32.1	30.1	22.0
1964	60.8	41.9	22.5	23.4
1965	38.7	28.0	15.0	15.7
1966	50.2	20.8	14.8	6.7
1967	57.7	31.0	18.6	13.0
1968	40.2	22.1	25.6	18.1
1969	54.7	31.7	23.1	15.9
1970	49.5	30.1	16.0	11.6
1971	33.9	21.0	15.3	11.1

*Weight in pounds.

VI. Red hake

Red hake landings by the U.S. from Subarea 5 in 1971 were 2,783 metric tons, a decline of 35 percent from 1970 (Table 5.8). This decrease was associated with a general reduction of landings by the industrial fishery. The commercial landings per day index was greatly improved in 1971 and survey cruise data showed increases in pre-recruits. Abundance should improve by 1973.

Table 5.8 -- United States red hake statistics, Subarea 5 (metric tons, live weight).

Year	SA 5 landings	Food Fish		Industrial Fish	
		Div. 5Y landings	Div. 5Ze landings	Div. 5Zw landings	Landings/ day
1965	13,493	192	385	12,916	9.1
1966	4,280	634	845	2,801	2.3
1967	5,759	92	169	5,498	5.6
1968	6,216	82	161	5,973	7.0
1969	4,923	140	225	4,558	8.2
1970	4,281	249	100	3,932	6.3
1971	2,783	268	111	2,404	8.4

VII. Industrial groundfish fishery

New England industrial groundfish landings from Subarea 5 declined significantly in 1971 (Table 5.9). The decline was attributable to general market conditions. Species composition in commercial landings reflect increases in importance of the hakes, while flounder, particularly yellowtail, decreased in importance.

Table 5.9 -- New England groundfish landings from Subarea 5 for industrial purposes (metric tons, round weight).

Year	Total Landings	Species Composition (%)				
		Silver hake	Red hake	Flounder	Eel pout	Other
1965	33,990	20.4	38.0	6.9	1.8	32.9
1966	27,461	9.6	10.2	18.2	25.0	37.0
1967	37,400	10.2	14.7	18.5	18.9	37.7
1968	34,729	9.9	17.2	16.5	24.2	32.2
1969	26,813	9.5	17.0	21.3	20.8	31.4
1970	20,696	6.3	17.9	16.7	28.3	30.8
1971	8,823	10.5	26.2	6.6	30.4	26.3

VIII. Sea scallops

United States Sea scallop landings from Georges Bank increased slightly in 1971 over 1970 landings (Table 5.10). Because of relatively low abundance the characteristics of the fishing fleet have changed considerably in the past few years, and the number of U.S. vessels fishing for this species has declined significantly.

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

Year	Landings	Days Fished	Landings/Day	Research
			Fished	Vessel Index
1965	1,509	2,156	0.7	33.5
1966	901	1,001	0.9	48.0
1967	1,309	1,870	0.7	63.0
1968	1,163	1,938	0.6	44.7
1969	1,465	2,930	0.5	- 1/
1970	1,553	2,588	0.6	- 1/
1971	1,697	3,394	0.5	- 1/

1/ There were no research vessel cruises for scallop abundance estimate since 1968.

IX. Herring

The herring catch from Division 5Y for 1971 was 31,400 metric tons, about equal to 1970. This fishery is now primarily harvesting adults (age 4+ and older). Only 23 percent of the 5Y catch in 1971 consisted of juvenile fish. Prior to 1967, the fishery was about exclusively juvenile fish.

U.S. catch in 5Z was 2,400 metric tons, 84 percent above the 1970 landings.

B. Special Research Studies

I. Environmental studies

Data gathered in 1971 at the environmental recording unit at Boothbay Harbor showed that annual mean water temperature was slightly lower (0.2°C) than in 1970, while that for air temperature was slightly higher. The total precipitation for 1971 was 25 percent below normal, while the mean annual salinity was 0.2 parts per mille lower than those recorded for 1969 and 1970.

The Albatross IV made temperature observations on all cruises conducted in the area. Quantitative plankton samples were taken at all trawl stations on the groundfish surveys (spring and fall).

The United States Coast Guard conducted two extensive surveys (spring and fall) covering the area from Nova Scotia to Cape Hatteras. Results of these cruises will be published in U.S. Coast Guard Bulletins.

The Oceanographic Observation Post Program was continued through the cooperation of the Woods Hole Oceanographic Institution and the United States Coast Guard. Oceanographic observations are made continually at 11 lightships and light stations situated off the east coast of the United States. Analysis of the data is made by the Oceanographic Institution and published by the Coast Guard.

II. Biological studies

Groundfish surveys

Research vessel surveys of groundfish stocks were conducted in the spring (March-April) and fall (October-November) from Cape Hatteras to central Nova Scotia. The fall survey was again conducted jointly with the USSR from Cape Hatteras to Georges Bank; also the USSR conducted a survey of the Scotian Shelf in August and these data were incorporated into the joint USA-USSR series. Finally, joint USA-USSR trawl comparison studies were carried out in September in a continuing effort to develop a better survey trawl. The USA-USSR studies are reported in other documents of the 1972 annual meeting.

Haddock spawning

The progress of haddock spawning in Subarea 5 was monitored from 2,137 samples collected by commercial and research vessels. The curve for Georges Bank females shows spawning began in late February, was 50 percent completed in mid-April, and ended in early June. This curve is similar to the 1970 curve.

Since 1969 we have been studying fecundity of the 4X and W and 5Z haddock stocks with the St. Andrews Biological Station of the Fisheries Research Board of Canada. In 1971 the United States agreed to take over the Georges Bank part of the study while St. Andrews continues to cover Subarea 4. United States activity in 1971 primarily involved (1) subsampling preserved ovaries of known volume by removing plugs with cork borers, and (2) cleaning and preparing subsamples for egg counting.

Herring

During the autumn of 1971 the United States took part in the ICNAF joint survey to estimate the dispersion of larval herring in Divisions 4X, 5Y, and 5Z. The United States research vessels Delaware II and Albatross IV participated.

During the first of these offshore cruises from 21 September to 4 October all the herring larvae taken were located in two distinct geographical areas; northern Georges Bank and off the southwest coast of Nova Scotia. The largest concentration was found on Georges Bank where the larvae fell into two size groups; one with a mode at 6 mm, the other with a mode at 15 mm. In the group of larvae off Nova Scotia, only a single size group occurred with a mode at 12 mm.

During the last of these cruises (Albatross IV Cruise 71-7, 2-17 December) larval herring were found at all inshore stations (7,200 m) from eastern Nova Scotia to Cape Cod. The most extensive concentration and largest catches of larval herring occurred in an area extending from the eastern part of Georges Bank to Nantucket Shoals. The northern, eastern, and southern boundaries of this concentration were roughly delineated by the 100 m isobath. Herring larvae ranged in length from approximately 8 to 30 mm, with the mean length increasing from east to west in both the Gulf of Maine and on Georges Bank.

Four consecutive coastal cruises from Massachusetts Bay to Machias Bay were made on the M/V Rorqual as part of the cooperative survey of larval herring. Preliminary analysis of the collections showed that larval herring appeared first in the catches obtained in the eastern sector of the Maine coast during late September and their numbers increased progressively westward with time. This shift in distribution was attributable to the occurrence of larval concentrations ($1000/1000\text{m}^3$) within three locations along the coast; 1) between Penobscot and Machias Bays, 2) between Penobscot Bay and Cape Ann, and 3) east of Cape Ann. In the first location, larvae were abundant during the second and third cruises; and in the third location, only during the third cruise. Usually, larval catch rates were lowest at the offshore stations and frequently no larvae were captured beyond the 50-fathom isobath. Isolines of catch rates often paralleled this isobath and the coastline during the first three cruises, but the distribution of isolines was complicated during the final cruise in early November. The larvae concentrated in location 1 were not recently hatched and their source cannot be definitely established, but the concentrations in locations 2 and 3 contained larvae sufficiently small to be considered as recently hatched.

During the year, samples were obtained from fisheries taking primarily adult herring from ICNAF division 5Z, 5Y, 4X and subarea 6 for comparative studies of year-class contribution, length and gonadal development. In addition, some samples were obtained from cruises of research vessels in the offshore waters of these areas. Although fish of age-group II are immature, those present in the samples (primarily collected from the research vessels) were included to encompass the entire age-group composition.

Three-year-old fish (1968 year-class) dominated the samples from 5Z (primarily Georges Bank) and subarea 6. Fish of age-group VIII+ (1962 year-class and older) dominated the samples from Jeffreys Ledge (5Y), while fish of age-group VI (1965 year-class) were dominant in the samples from the remainder of 5Y and from 4X.

Data on gonadal maturity indicated that the onset of spawning in 5Z, 5Y (exclusive of Jeffreys Ledge) and 4X occurred in late August. The onset of spawning on Jeffreys Ledge occurred in September. The peak of spawning in all the areas was reached in October. A few spring spawned fish were collected from 5Y (Provincetown, Massachusetts), while spring spawners were prominent in 4X (St. Mary's Bay area - Nova Scotia). No spring spawned fish were collected from 5Z and Jeffreys Ledge.

In 5Z herring (age-groups II-VIII+) ranged in length from 12.7 to 34.7 cm; herring from Jeffreys Ledge (age-groups II-VIII+) ranged in length from 11.8 to 40.0 cm; herring from the remainder of 5Y (age-groups II-VIII+) ranged in length from 19.7 to 36.8 cm; herring from 4X (age-groups III-VIII+) ranged in length from 20.7 to 36.5 cm; and herring from Subarea 6 (age-groups II-VIII+) ranged in length from 10.9 to 34.2 cm.

The United States continued biochemical studies on the stock structure of herring in the Gulf of Maine, Georges Bank, and adjacent areas. Included were studies of the genetic inheritance and variation of phosphohexose isomerase (PHI) enzymes found in adult herring from those areas. We concluded that the three major spawning groups (S.W. Nova Scotia, N.E. Georges and S.W. Gulf of Maine) are discrete populations and, also, that the overwintering fish in the Mid-Atlantic Bight appear to conform to the Georges Bank stock. Analysis of variance of the PHI allele frequencies (angular transformation) indicates that there is little variation between spring and fall (spawning) adult herring taken from the three spawning areas. Continuing the search for additional enzymes which are capable of discriminating between stocks of fishes, gels were stained for hexokinase. A new staining method has revealed the presence of hexokinase polymorphisms in adult herring tissue homogenates.

Ichthyoplankton

An atlas summarizing the distribution of the common fish eggs and larvae in Continental Shelf waters, Nova Scotia to Long Island, is nearing completion. This atlas will include monthly distribution charts for 10 species of eggs and 30 species or genera of larvae and is based on collections obtained on 46 cruises conducted during the period 1953-71.

With the aid of Dr. Carl Price of Rutgers University, we have established that fish eggs and larvae may be separated from the bulk of invertebrate zooplankton by isopycnic centrifugation in gradients of silica (Ludox AM). A zonal rotor is currently being constructed that will accept up to one liter of a standard plankton sample and will provide semi-automatic sorting of ichthyoplankton. We propose to extend these studies to the resolution of invertebrate zooplankton into classes, the continuous flow harvesting and resolution of phytoplankton, and the integration of these techniques into systems suitable for shipboard operations.

Food Habits

Stomach contents were examined from 6,000 specimens, representing 16 species of fish. They were collected during the spring and fall groundfish survey cruises of Albatross IV. Areas sampled were Nova Scotian Shelf, Gulf of Maine, Browns Bank, Georges Bank, and southern New England, south to Cape Hatteras.

As expected, the diet varied enormously from one species to another. Also, it was not uncommon to find substantial differences in diet within species that were collected from widely separated geographical areas. Considering all species, the major foods were: crustaceans, polychaete worms, fish, mollusks, and echinoderms. The crustacean components that were especially common were: shrimps, crabs, euphausiids, and amphipods.

Research on the offshore benthic invertebrate communities continues. Distribution of the benthic biomass in relation to geographic locations and depth of water was emphasized. A review and analysis of the commercially important benthic invertebrate

resources (with the exception of mollusks) in New England waters was completed.

Subarea 6

Biological studies on herring in Subarea 6 are reported under Subarea 5.

