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United States Research Report, 1970

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The United States landed fish from all ICNAF Statistical Sub-areas and conducted research in Subareas 1, 2, 3, 4, 5, and 6.

Table O.1 gives a summary of U.S. finfish and sea scallop landings for each Subarea for 1969 and 1970.

Table O.1.--United States finfish and sea scallop landings for 1969 and 1970 (metric tons, round weight).

SPECIES	YEAR	1	2	3	4	5	6 ^{1/}	TOTAL
Haddock	1970	1	1	-	2319	9850	1	12172
	1969	9	26	-	1830	18879	13	20757
Cod	1970	278	502	55	615	22039	101	23590
	1969	200	342	40	448	24513	426	25969
Redfish	1970	-	-	-	9541	15530	-	25071
	1969	5	7	33	13264	12038	-	25347
Pollock	1970	-	-	-	385	3577	-	3962
	1969	5	14	-	569	3507	2	4097
Yellowtail	1970	-	-	-	21	31893	1428	33342
	1969	-	-	-	19	33014	3886	36919
Silver hake	1970	-	-	-	-	19369	257	19626
	1969	-	-	-	-	20333	3165	23498
Red hake	1970	-	-	-	-	4281	248	4529
	1969	-	-	-	-	4926	759	5685
Sea Herring	1970	-	-	-	-	30483	700	31183
	1969	-	-	-	-	30747	1585	32332
River Herring	1970	-	-	-	-	1346	12726	14072
	1969	-	-	-	-	882	24352	25234
Menhaden	1970	-	-	-	-	5065	224813	229878
	1969	-	-	-	-	140	102338	102478
Other finfish species	1970	1	2	-	352	37902	32761	71018
	1969	13	2	3	237	43611	32673	76539
Total finfish	1970	280	505	55	13233	181335	273035	468443
	1969	232	391	76	16367	192590	169199	378855
Sea scallop	1970	-	-	-	-	12938	2/	-
	1969	-	-	-	-	12211	15794	28005

^{1/} Landings incomplete for 1970

^{2/} Not available

Subarea 1

A. Status of the Fisheries

The United States landed 277 metric tons of cod and one metric ton of haddock from the subarea during 1970, the second year of U.S. fishing this area. During 1969, 200 metric tons of cod were landed.

Subarea 2

A. Status of the Fisheries

The United States landed 502 metric tons of cod from this subarea during 1970, an increase of 160 metric tons over 1969 landings which were the first for the United States in this subarea. One metric ton of haddock was also landed during 1970.

B. Special Research Studies

The United States Coast Guard studied short term variations in the Labrador Current using moored buoys from 15 July to 11 August.

Subarea 3

A. Status of the Fisheries

United States landings from Subarea 3 amounted to only 55 metric tons of cod, caught in Division 3L, in 1970. In 1969 33 tons of redfish were landed.

B. Special Research Studies

The United States Coast Guard conducted oceanographic surveys in support of the International Ice Patrol in Divisions 3N, L, and O from 1 April to 30 June.

Subarea 4

A. Status of the Fisheries

I. Haddock

United States landings of haddock from Subarea 4 amounted to 2,320 metric tons, 491 tons above 1969 landings. For the first time in 11 years, U.S. vessels fished in Divisions 4V-W, from which 577 metric tons were landed. U.S. landings from Division 4X were 87 metric tons lower than 1969 (Table 4.1). Landings from Browns Bank, the principal area fished by U.S. vessels in Division 4X, increased about 2.6 thousand metric tons due to increased effort during November and December when the haddock quota had been reached on Georges Bank. Landings per day, however, were lower on Browns Bank and predictions are that no significant recruitment to the fisheries can be expected before 1975.

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

Year	Division 4X Landings	Browns Bank		
		Landings	Days Fished	Landings/ Day 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

II. Cod

The United States fleet landed 615 metric tons of cod from Subarea 4, 167 tons greater than in 1969. This increase in landings is probably a reflection of greater haddock fishing in the area by U.S. vessels.

III. Redfish

United States landings of redfish from the Gulf of St. Lawrence (Divisions 4R, S, and T) decreased by 37 percent (Table 4.2). Redfish landings by the United States from the Scotian Shelf (Divisions 4V, W, and X) increased 769 metric tons (Table 4.3). Landings per day decreased for both grounds; however, with low effort, these indices are probably not indicative of true 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

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	1,911	135	14.2

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

Assessment studies of haddock in Division 4X have continued with further analysis of data from commercial catch-effort statistics and Albatross IV groundfish surveys. The 1970 year class is judged to be poor on the basis of the autumn groundfish survey, thus recruitment to the fishery through at least 1974-75 will be low. The catch in 1970 of about 12,000 tons probably exceeded production by a substantial amount, and surplus production through the next several years will be 9,000 tons or less.

Studies on the spawning cycle and fecundity of haddock were conducted in Divisions 4X and W in cooperation with the St. Andrews Biological Station of the Fisheries Research Board of Canada. On Browns Bank (4X) spawning peaked in mid-May and was complete by mid-June. By the end of April, 46 percent of the females in 4W were spent.

Subarea 5

A. Status of the Fisheries

I. Haddock

Haddock landings in 1970 were limited by the 12,000 ton quota set by the Commission. The quota was nearly attained (97%). The 80 percent cutoff point was reached during October and the fishery closed for most of the third quarter. The U.S. landed 9,850 metric tons, about one half the 1969 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 (see 5.B.III).

Age composition for 1970, based on the first 6 months of commercial landings, indicate that the 7- and 8-year-old fish (1963 and 1962 year classes) continued to represent the majority of the 1970 catch (figure 5.1). The Albatross IV fall groundfish survey catches indicate an extremely small 1970 year class, which means poor production now extends to seven years (Table 5.2). This means that recruitment through 1972 will be very low and abundance will probably decline further under the 12,000 ton annual quota for 1971-72.

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

Year	Subarea 5 landings	Div. 5Y landings	Div. 5Zw landings	Division 5Ze	
				Landings	Adjusted landings/ 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	9,850	1,435	15	8,400	2.1

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	1.5
1961	1.4	1967	0.0
1962	2.6	1968	1.0
1963	12.6	1969	1.1
1964	2.0	1970	0.0

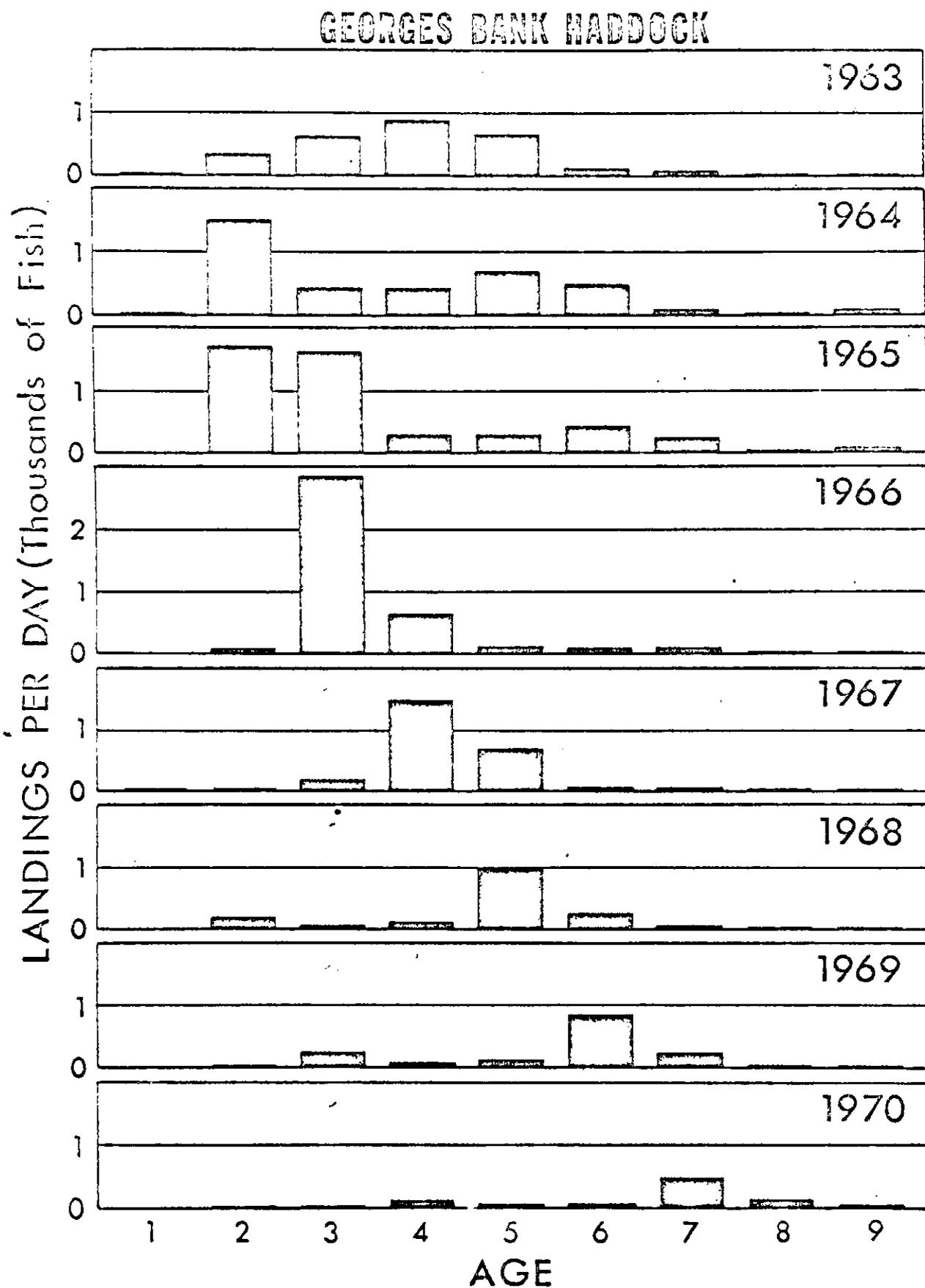


Fig. 5.1--Age composition of Georges Bank haddock
(Note: 1970 uses first 6 months only.)

II. Cod

Cod landings by the U.S. in Subarea 5 decreased in 1970 after several years of increasing landings (Table 5.3). Although landings per day increased, it is doubtful that this represents any significant increase in abundance of stock because of changes in fishing strategy of the fleet. It is probable that the total catch by all countries (1969 total was 45,376 metric tons) is higher than the sustainable yield and if maintained or increased could seriously reduce abundance of this cod stock.

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

<u>Year</u>	<u>SA 5 landings</u>	<u>Div. 5Y landings</u>	<u>Div. 5Zw landings</u>	<u>Division 5Ze</u>	
				<u>Landings</u>	<u>Landings/day fished</u>
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	21,917	7,504	1,060	13,353	2.1

III. Silver hake

Total U.S. landings of silver hake from Subarea 5 in 1970 decreased 1,000 metric tons from 1969 (Table 5.4). Food fish landings from the Gulf of Maine (Div. 5Y) again decreased while landings from Georges Bank (Div. 5Ze) increased. Landings from Division 5Zw, which are predominantly for industrial use, declined slightly from 1969.

Abundance is still low in the Gulf of Maine due to poor recruitment and on Georges Bank because of heavy fishing and below average recruitment. Abundance for Division 5Zw, as obtained from survey cruises, has shown a slight downward trend since 1968 and catches are not expected to improve in 1971.

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

<u>Year</u>	<u>SA 5 landings</u>	<u>Food Fish</u>			<u>Industrial Fish</u>	
		<u>Div. 5Y landings</u>	<u>Div. 5Ze landings</u>	<u>Landings/day</u>	<u>Div. 5Zw landings</u>	<u>Landings/day</u>
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	19,332	11,374	4,238	3.7	3,720	2.2

IV. Redfish

United States landings of redfish from Subarea 5 in 1970 increased 3,000 metric tons over 1969. (Table 5.5). Effort continued an increase which began in 1969. Although landings per day declined from 1969, abundance is considered relatively high and prospects of good catches in 1971 are bright.

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	15,530	13,547	1,473	9.2

V. Yellowtail flounder

Total U.S. yellowtail flounder landings for food increased about 1,000 metric tons in 1970 over 1969 landings (Table 5.6), because of increased effort, particularly in Division 5Zw. Yellowtail landings for industrial purposes declined in 1970.

Commercial landings per day continued to decline and age composition data indicate that the fishery has become dependent on fewer year classes than formerly. Groundfish survey indices substantiate a decrease in abundance in Subarea 5 (Table 5.7). For 1971, abundance will probably be lower especially in Division 5Zw.

A quota of 29,000 tons on catch of yellowtail has been set by the Commission (16,000 for 5Ze and 13,000 for 5Zw) for 1971.

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

<u>Statistic</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
Food landings	36,218	28,656	20,819	28,645	28,739	29,445
Landings/day fished	3.1	2.0	2.2	3.0	2.7	2.5
Estimated discard	12,893	8,253	14,407	10,627	5,202	10,129
Industrial landings	972	2,364	4,587	3,939	4,265	2,095
TOTAL CATCH	50,083	39,273	39,813	43,211	38,206	41,669

Table 5.7.--Albatross IV fall relative abundance index for yellowtail flounder.

Year	Div. 5Ze		Div. 5Zw	
	Nos.	Wt.	Nos.	Wt.
1965	15.0	15.7	38.7	28.0
1966	14.8	6.7	50.2	20.8
1967	18.6	13.0	57.7	31.0
1968	25.6	18.1	40.2	22.1
1969	23.1	15.9	54.7	31.7
1970	12.2	8.3	39.2	23.9

VI. Red hake

Red hake landings by the U.S. from Subarea 5 in 1970 were 4,281 metric tons, about the same as in 1969 (Table 5.8). The commercial catch-per-day was lower in 1970 than in 1969. Research vessel surveys in Division 5Zw indicated a marked decrease in abundance in 1966 and recovery to date has been slow. Continued low abundance through 1971 is indicated.

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	3,698	6.3

VII. Industrial Groundfish Fishery

New England industrial groundfish landings from Subarea 5 declined for the third straight year (Table 5.9). The decline was attributable to market conditions and somewhat lower abundance for the hakes and yellowtail flounder. Species composition in commercial catches showed silver hake and flounders losing and eel pout gaining 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

VIII. Sea scallops

United States sea scallop landings from Georges Bank increased slightly in 1970 over 1969 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).

<u>Year</u>	<u>Landings</u>	<u>Days Fished</u>	<u>Landings/Day Fished</u>	<u>Research Vessel Index</u>
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/

1/ There were no research vessel cruises for scallop abundance estimate in 1969 and 1970.

IX. Herring

The 1970 catch of herring along the Maine coast was 17,000 metric tons; down from 25,000 tons in 1969 and the lowest catch since 1938. Most of the fish were larger (ages 4-8) than formerly and, reflecting a wider search, 75 percent were taken by purse seines. Ten years ago, over 99 percent of the catch was made by weirs and stop-seines.

The offshore fishery for adult herring in the area around Jeffreys Ledge amounted to 12,200 tons in 1970 as compared to 4,100 tons in 1969.

B. Special Research Studies

I. Environmental Studies

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.

Recording of a number of environmental factors was continued at the National Marine Fisheries Service laboratory at Boothbay Harbor, Maine. The mean sea surface temperature in 1970 was 8.9° C, the same as 1969 and breaking the upward trend that started in 1967.

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 and fall between Cape Hatteras and Nova Scotia. The fall survey was conducted jointly with the USSR. In addition to the survey, cooperative studies were conducted with the USSR to compare the results of using different trawls. These US-USSR studies are reported in other documents of this meeting.

Haddock Spawning - The progress of haddock spawning in Sub-area 5 was again monitored from samples collected by commercial and research vessels. Spawning was essentially complete by late April, about 2 weeks earlier than 1969.

Yellowtail flounder - Length-frequencies collected on research vessel cruises since 1963 were analyzed to determine population change in relation to fishing rate and recruitment. For Georges Bank no consistent change was evident over the period. However, for Southern New England waters (west of 69°W), numbers of larger fish have been significantly reduced in recent years, reflecting the heavy fishing pressure. In addition, poor recruitment in 1968-1970 is indicated by the relatively low numbers of age group I fish appearing in the length group from 15-20 cm. in the autumn (Table 5.11).

Table 5.11.--Relative abundance index of age group I+ yellowtail flounder from research vessel surveys.

<u>Year</u>	<u>Southern New England</u>	<u>Georges Bank</u>
	<u>Index</u>	<u>Index</u>
1963	16.3	12.7
1964	18.5	2.2
1965	11.7	1.3
1966	34.4	9.9
1967	19.9	7.7
1968	9.0	9.7
1969	7.9	6.0
1970	8.3	4.5

Generalized production models indicate that the maximum sustainable yield is about 16,000 tons for Southern New England, and about 12,000 tons for Georges Bank. At the 1968 stock level, a fishing mortality rate of 0.8 yields 18,000 tons from Southern New England and 12,000 tons from Georges Bank. Catch quotas should therefore be about 25-30,000 tons. This is discussed in detail in a document of this meeting.

Herring - Studies on the structure of herring populations in the Gulf of Maine and adjacent areas continued, using meristic and biochemical methods. In addition to esterase and lactic dehydrogenase, another enzyme (phosphohexose isomerase) has shown a significant difference of frequencies between stocks of adult herring. Another enzyme (tetrazolium oxidase) was found to be polymorphic in herring and its variation between stocks is being tested.

During the year, samples of adult herring were obtained from subareas 4 and 5 for comparative studies of year class contribution, length, and gonadal development. Four-year-old fish (year class 1966) dominated the samples from Georges Bank and coastal Gulf of Maine, while fish older than 8 years (mostly year classes 1960 and 1961) were dominant in the samples from Nova Scotia and the Jeffreys Ledge area.

Data on gonadal maturity indicated that the onset of spawning occurred in late August on Georges Bank, coastal Gulf of Maine, and Jeffreys Ledge. Peak spawning was reached in October. Limited samples from Nova Scotia indicated some spawning from June through September and suggested a peak in October.

The study of fecundity of herring from the western North Atlantic is continuing and a study of the seasonal distribution and growth of larval herring from the same area, including data taken from November 1962 through April 1970, has been completed.

Lobster - An extensive tagging program on offshore lobsters was continued. By the end of 1970, 641 returns had been made from the 5,710 released. The distribution of tag returns indicates that deep-water lobsters move into shoal water in the spring and early summer and back into deep water in the fall and early winter. Of the 499 returns for which locations of recapture are known, 20 percent had moved distances less than 10 nautical miles, 60 percent between 10 and 50 miles, and 20 percent in excess of 50 miles. Lobsters demonstrating the most extensive migrations were predominantly females. The migratory behavior of these "offshore" lobsters contrasts markedly with that of "inshore" lobsters which are essentially non-migratory.

A study of the effects of exploitation on size composition and sex ratio of the offshore lobster stocks was completed. Differences in size-composition and sex ratio among offshore fishing grounds are hypothesized as due to differences in the rate of exploitation.

Parasitological examinations of over 3,000 lobsters have shown qualitative and quantitative differences between offshore and coastal lobsters. Consistent differences in rates of occurrence of certain parasites suggest that the two segments of the lobster resource are relatively isolated from each other except in summertime when offshore adults migrate shoalward, presumably for reproductive purposes, and overlap the range of coastal stocks in several areas south of Cape Cod.

Ichthyoplankton - A successful international attempt was made to observe the extent of demersal patches of herring eggs and watch the behaviour of the hatching larvae on Georges Bank. The USSR research vessel ALFERAS searched the area until she found concentrations of newly hatched larvae and set a buoy. The U.S. research vessel Albatross IV homed in on the buoy, confirmed the presence of larvae, and then put over the Canadian research submersible PISCES. During the next 5 days, 12 dives were made on the spawn beds. Details of these operations are reported in other documents of this meeting.

Progress is being made in compiling a monthly atlas showing the distribution of the various species of fish eggs and larvae in Subareas 5 and 6 in order to delimit spawning areas and times. About 250 ichthyoplankton samples are routinely collected on the Albatross IV groundfish surveys twice a year. These collections are being filled in from the literature and unpublished records of other organizations.

Food habits - Studies on the food habits of 14 important species of fish have been expanded in Subareas 4, 5, and 6. Preliminary results show that fish make up 88 percent of the diet of silver hake while spotted hake ate 52 percent crustaceans and only 37 percent fish.

Studies of the benthic invertebrate fauna which is a major source of food for the groundfish continues. The biomass and numbers of 45 major taxa are being related to depth, sediment type, temperature, and area. A study of one of the major components, the mysids, was completed.

Automated age reading - The development of an automated, computer based scale reading system was continued. Scales have been successfully scanned by a high resolution optical system with a digitized output. These signals are then processed to count circuli and measure inter-circuli distances.

III. Gear and Selectivity Studies

Standardized Fishing Effort. Development of an analysis of variance model to obtain estimates of standardized fishing effort proceeded in 1970 to testing vessel size, depth and vessel-depth interaction effects for the New England haddock fleet. The main effects are highly significant and vary from season to season. Interaction was significant in several sets of data and testing of residuals from the fitted model is being done to examine the consistency of interactions and proportions of the variance which is accounted for by the model. Preliminary estimates of landings per standard day fished were found to be comparable to the "study fleet" index which has been used for many years.

Fishnet Bathykymograph. Tests of the accuracy and reliability of the FBK, which produces a record of the duration and depth of each otter trawl haul have continued on 23 prototype units. All malfunctions have been minor and easily corrected. We expect that a mass production unit suitable for large scale use will be available soon.