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United States of America Report on Research in the Northwest Atlantic During 1979

by

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The United States of America (USA) landed fish from, and conducted research in, NAFO Subareas 4 and 5 and Statistical Area 6. Table 1 summarizes USA finfish, squid, and sea scallop nominal catches in 1978 and 1979.

I. SUBAREA 4

A. Status of the Fisheries

1. Haddock

USA landings for Subarea 4 declined from 1,216 MT in 1978 to only 69 MT in 1979 due to closure of Subarea 4 to USA vessels. USA landings were taken in or north of the overlapping portion of the American and Canadian economic claim zones (the "disputed" zone), near the Subarea 4-5 boundary.

2. Atlantic Cod

The USA fleet landed only 48 MT of Atlantic cod from Subarea 4 in 1979, compared to 297 MT in 1978.

3. Pollock

The USA landings from Subarea 4 declined from 169 MT in 1978 to 121 MT in 1979. This catch represents approximately 1% of total USA landings for this species, and was taken in or north of the USA-Canada disputed zone near the Subarea 4-5 boundary.

B. Special Research Studies

Special research studies for Subarea 4 are combined with those for Subarea 5 and Statistical Area 6.

II. SUBAREA 5

A. Status of the Fisheries

1. Haddock

The USA reported commercial landings for Subarea 5 increased from 16,698 MT in 1978 to 18,897 MT in 1979 (Table 2). The strong 1975 year class has primarily supported the fishery since 1977 both on Georges Bank and in the Gulf of Maine. The 1978 year class appears comparable in size to the 1975 year class and is expected to increase spawning stock size in

Table 1. USA finfish, squid, and sea scallop nominal catches for 1978 and 1979 [metric tons (MT), round fresh].

Species	Year	Subarea or Statistical Area 4	5	6	Total
Haddock	1978	1,216	16,698	-	17,914
	1979	69	18,897	28	18,994
Atlantic cod	1978	297	38,741	264	39,302
	1979	48	44,024	294	44,366
Redfish	1978	2,147	13,992	-	16,139
	1979	719	14,721	-	15,440
Pollock	1978	169	17,535	10	17,714
	1979	121	15,411	8	15,540
Yellowtail flounder	1978	3	11,063	424	11,490
	1979	2	15,515	502	16,019
Other flounders	1978	45	28,148	10,465	38,658
	1979	20	28,666	14,079	42,765
Silver hake	1978	-	16,339	7,659	23,998
	1979	-	7,632	8,870	16,502
Red hake	1978	4	3,589	928	4,521
	1979	-	6,497	1,650	8,147
Atlantic herring	1978	-	50,337	187	50,524
	1979	-	64,880	154	65,034
Atlantic mackerel	1978	-	946	659	1,605
	1979	-	1,091	898	1,989
River herring[a]	1978	-	1,619	4,110	5,729
	1979	-	1,182	3,176	4,358
Atlantic menhaden	1978	-	43,454	219,982	263,436
	1979	-	58,727	225,868	284,595
Butterfish	1978	-	2,869	807	3,676
	1979	-	1,852	856	2,708
Other finfish	1978	89	23,282	43,245	66,616
	1979	126	26,757	42,810	69,693
Total finfishes	1978	3,967	268,600	288,741	561,308
	1979	1,105	305,852	299,193	606,150
Loligo sp. squid	1978	-	522	203	725
	1979	-	2,952	945	3,897
Illex sp. squid	1978	-	359	2	361
	1979	-	1,560	32	1,592
Sp. not specified squid	1978	-	44	546	590
	1979	-	114	421	535
Sea scallop[b]	1978	-	48,656	71,983	120,639
	1979	-	57,647	61,105	118,752

[a]Combined alewife and blueback herring.

[b]In-the-shell weights.

1981. The USA autumn bottom trawl survey abundance index for Division 5Y declined substantially in 1979, but was still considerably higher than the 1970-77 average (Table 2). The index for Division 5Z increased from 15.2 kg/tow in 1978 to 26.9 kg/tow in 1979, the highest value observed since 1965. The young-of-the-year (YOY) index for Division 5Y increased, while the index for Division 5Z declined (Table 2).

Table 2. USA haddock landings (MT, round fresh) and autumn bottom trawl survey abundance and YOY indices for Subarea 5.

	Landings			Abundance index[a]		YOY index[b]	
Year	Division 5Y	Division 5Z	Total	Division 5Y	Division 5Z	Division 5Y	Division 5Z
1970	1,457	8,415	9,872	4.9	8.9	1.0	1.0
1971	1,194	7,306	8,500	5.4	3.7	1.2	1.4
1972	909	3,869	4,778	2.0	5.6	1.0	2.1
1973	509	2,777	3,286	5.7	6.5	1.6	1.8
1974	622	2,396	3,018	2.2	2.6	1.0	1.3
1975	1,180	3,989	5,169	5.7	10.0	2.2	3.8
1976	1,865	2,904	4,769	5.3	23.7	1.7	1.7
1977	3,296	7,934	11,230	7.3	23.1	1.1	1.1
1978	4,538	12,160	16,698	18.2	15.2	1.1	2.3
1979	4,622	14,230	18,896[c]	11.5	26.9	1.4	1.6

[a]Stratified mean catch (kg) per tow.

[b]Mean number of YOY haddock per tow (retransformed from log scale).

[c]Includes landings from Division 5 NK (45 MT).

2. Atlantic Cod

The USA commercial landings of Atlantic cod from Subarea 5 in 1979 increased moderately from 1978 (Table 3). The USA autumn bottom trawl survey abundance index for Georges Bank decreased significantly from 1978, but remained higher than all other annual indices since 1973.

Table 3. USA Atlantic cod commercial landings (MT, round fresh), landings per day fished, and autumn bottom trawl survey abundance indices for Subarea 5.

		Division 5Z				
			Subdivision 5Ze			Total
Year	Division 5Y landings	Subdivision 5Zw landings	Landings	Landings /day fished	Abundance index[a]	landings for Subarea 5
1970	7,812	1,182	13,353	2.1	17.1	22,347
1971	7,380	796	14,999	2.0	13.4	23,175
1972	6,564	662	12,478	2.6	31.3	19,704
1973	6,063	1,092	14,846	4.2	42.0	22,001
1974	7,426	1,220	16,645	3.9	11.2	25,290
1975	8,676	644	14,594	3.8	19.1	23,915
1976	9,879	280	13,940	3.9	24.0	14,664
1977	12,894	779	19,576	5.0	25.4	33,249
1978	12,426	1,643	23,787	5.8	47.3	38,741[b]
1979	11,679	789	30,918	-[c]	33.5	44,024[d]

[a]Stratified mean catch (kg) per tow.

[b]Includes landings from Division 5NK (885 MT).

[c]Data on which to base index no longer available.

[d]Includes landings from Division 5NK (637 MT).

3. Redfish

The USA redfish commercial landings from Subarea 5 increased from 1978 to 1979 (Table 4), marking the fifth consecutive year of increases in landings. The USA landings per day fished in the Gulf of Maine (Division 5Y) declined in 1979 following 3 yr of increases. Historically, this index is one of the lowest observed.

It is now evident that the 1971 year class, after having been subjected to relatively high exploitation rates during the past several years, is not able to support the fishery at current levels of catch. Continued decline in population abundance will be expected due to poor recruitment.

Table 4. USA redfish commercial landings (MT, round fresh) and commercial abundance indices for Subarea 5.

	Division 5Y		
Year	Landings	Landings/day fished	Total landings for Subarea 5
1970	13,551	9.2	15,534
1971	12,541	7.4	16,267
1972	7,150	6.3	13,161
1973	7,008	6.0	11,922
1974	5,464	5.4	8,690
1975	5,961	4.4	9,075
1976	7,985	4.7	10,131
1977	9,854	5.0	13,012
1978	11,360	5.1	13,992
1979	9,612	3.9	14,721

The USA autumn bottom trawl survey abundance index for the Gulf of Maine (Division 5Y) also declined in 1979 (Table 5). USA commercial and bottom trawl survey length-frequency samples indicate continued dominance of the 1971 year class in both the catch and the population in 1979. In the Georges Bank area (Subdivision 5Ze), where most of the redfish inhabit the Great South Channel between Cape Cod and the Bank, the survey index also declined in 1979.

Table 5. USA redfish autumn bottom trawl survey abundance indices for Subarea 5.[a]

	Division 5Y		Subdivision 5Ze	
Year	Weight	Number	Weight	Number
1970	74.5	96.3	10.2	13.3
1971	56.0	50.8	4.1	6.2
1972	55.0	54.8	8.5	10.8
1973	38.2	39.8	5.8	6.2
1974	58.2	51.0	4.1	6.1
1975	91.1	78.8	11.4	8.0
1976	37.4	31.8	1.4	1.4
1977	32.7	38.3	12.9	9.5
1978	42.5	41.7	12.3	12.4
1979	31.8	26.8	9.9	7.3

[a]Stratified mean catch per tow in weight (lb) or numbers.

4. Yellowtail Flounder

The USA commercial catch of yellowtail flounder from Subarea 5 increased from 11,063 MT in 1978 to 15,515 MT in 1979 (Table 6), due in part to increased catch quotas. The USA landings per day fished increased slightly from 1978, but still remained near the lowest observed level

(Table 6). Food landings in 1979 increased 47%, discards increased 404%, and industrial landings decreased 91% from 1978. Sampling data indicated that the 1976 year class largely supported the fishery during the first quarter of 1979, whereas the 1977 year class dominated catches during the remainder of the year.

The USA autumn bottom trawl survey abundance index declined from 1978 for both the Southern New England stock (Division 5Z west of 69°) and the Georges Bank stock (Division 5Z east of 69°) (Table 7). However, the 1979 summer bottom trawl survey suggested an increased abundance for the Southern New England stock.

A special bottom trawl survey conducted in January 1980 in the Southern New England area by the State of Rhode Island's Division of Fish and Wildlife, the National Marine Fisheries Service's Northeast Fisheries Center, and the fishing industry employing a commercial vessel indicated catch rates comparable to those observed in the 1960's when the stock was in good condition. It does appear that the stock is at a somewhat higher level of abundance than is indicated by research vessel bottom trawl surveys.

The 1977 year class appears to be strong in comparison to those of the past several years, whereas the 1978 year class is not considered strong. The Southern New England stock is currently comprised largely of only several year classes, compared to previous periods of high abundance when the stock and fishery were supported by at least three or four year classes.

Table 6. USA yellowtail flounder landings (MT, round fresh) for Subarea 5.

Year	Food landings	Estimated discards	Estimated industrial landings	Total catch
1970	29,825	10,689	2,095	42,608
1971	21,700	7,124	397	29,221
1972	23,886	3,100	327	27,313
1973	24,710	1,086	343	26,139
1974	23,145	993	22	24,160
1975	18,857	1,246	35	20,138
1976	16,538	951	15	16,900
1977	15,742	257	57	16,056
1978	10,625	371	67	11,063
1979	15,509	1,869	6	17,384

Table 7. USA yellowtail flounder autumn bottom trawl survey abundance indices for Division 5Z.[a]

	Division 5Z west of 69°		Division 5Z east of 69°	
Year	Weight	Number	Weight	Number
1970	24.7	39.8	8.6	13.4
1971	20.2	41.7	11.0	15.2
1972	44.3	73.3	10.9	14.6
1973	5.0	7.9	9.5	13.1
1974	14.1	6.9	6.3	10.0
1975	1.6	2.9	4.0	7.7
1976	6.5	10.7	2.6	2.5
1977	3.3	5.0	5.6	5.4
1978	6.6	11.4	4.8	7.2
1979	5.7	9.0	3.1	3.9

[a]Stratified mean catch per tow in weight (lb) or numbers.

5. Silver Hake

The USA commercial silver hake landings from Subarea 5 dropped sharply in 1979 to their lowest level in the past decade (Table 8). Landings from Subdivision 5Ze underwent the sharpest decrease (86%), while food landings in Subdivision 5Zw increased 24%. Landings per day fished in 1979 decreased in all areas with Subdivision 5Ze recording the greatest decrease (Table 8).

Autumn bottom trawl survey abundance indices for silver hake (Table 9) decreased in 1979 in Subdivisions 5Ze and 5Zw after increases in 1978. In Division 5Y, the index increased slightly in 1979 after decreasing in 1977 and 1978. Indices from the spring bottom trawl survey reflect the same changes as indicated in the autumn survey, with an increase in Division 5Y and a decrease in Subdivisions 5Ze and 5Zw.

Table 8. USA silver hake commercial landings (MT, round fresh) and landings per day fished for Subarea 5.

	Division 5Y		Division 5Z					
			Subdivision 5Ze		Subdivision 5Zw			Total
Year	Landings	Landings /day fished	Landings	Landings /day fished	Food landings	Landings /day fished[a]	Industrial landings	landings for Subarea 5
1970	11,384	7.7	4,238	23.8	2,539	7.7	1,218	19,379
1971	8,263	8.6	3,069	17.4	1,077	4.9	923	13,332
1972	5,570	7.1	879	8.7	1,488	6.2	117	8,054
1973	8,347	9.9	5,698	22.6	1,119	4.8	795	15,959
1974	4,635	6.3	2,283	15.0	1,985	4.3	669	9,572
1975	8,042	7.8	4,588	22.7	2,035	5.7	1,522	16,187
1976	9,759	16.7	3,793	46.1	2,667	6.6	1,216	17,435
1977	8,728	15.9	3,749	31.6	1,914	7.6	1,113	15,504
1978	6,195	7.6	6,393	20.2	2,902	8.4	835	16,339[b]
1979	2,635	7.3	893	17.4	3,601	7.6	489	7,618[b]

[a]Include Division 6A statistics also.

[b]Includes landings from Division 5NK (14 MT).

Table 9. USA silver hake autumn and spring bottom trawl survey abundance indices for Subarea 5 and Division 6A.[a]

	Division 5Y		Subdivision 5Ze		Subdivision 5Zw (and Division 6A)	
Year	Spring	Autumn	Spring	Autumn	Spring	Autumn
1970	0.7[b]	3.0	1.8[b]	1.3	4.0[b]	2.6
1971	0.8[b]	2.7	1.8[b]	1.2	8.8[b]	4.6
1972	4.1[b]	6.5	1.2[b]	1.3	5.5[b]	4.0
1973	4.4	4.2	5.1	1.8	7.2	3.2
1974	4.5	3.8	2.1	1.1	10.4	1.4
1975	14.9	9.1	2.5	2.0	19.1	2.8
1976	14.2	10.9	2.5	4.4	12.2	3.9
1977	6.2	7.2	7.8	1.9	7.2	3.1
1978	0.7	6.2	4.5	3.0	11.3	4.6
1979	2.9	6.5	2.1	1.7	4.6	3.4

[a]Stratified mean catch (kg) per tow.

[b]Spring survey cruises made with Yankee No. 36 trawl have been adjusted to the Yankee No. 41 trawl.

6. Red Hake

USA red hake commercial landings from Subarea 5 increased 81% from 1978 to 1979 (Table 10). The 1979 USA autumn bottom trawl survey abundance index exhibited decreases in the Gulf of Maine (Division 5Y) and on Georges Bank (Subdivision 5Ze), while increasing in Southern New England (Subdivision 5Zw) (Table 11). The spring bottom trawl survey abundance index displayed a reverse trend with increases in Division 5Y and Subdivision 5Ze, while decreasing sharply in Subdivision 5Zw (Table 11).

Table 10. USA red hake landings (MT, round fresh) and landings per day fished for Subarea 5.

	Food fish			Industrial fish	Total
Year	Division 5Y landings	Subdivision 5Ze landings	Subdivision 5Zw landings	Subdivision 5Zw landings	landings for Subarea 5
1970	249	100	333	3,599	4,281
1971	268	111	149	2,255	2,783
1972	367	160	109	1,067	1,703
1973	279	74	151	2,226	2,730
1974	480	77	148	1,245	1,950
1975	395	55	367	944	1,761
1976	618	37	433	1,572	2,660
1977	801	95	177	1,196	2,269
1978	1,073	151	70	2,295	3,589
1979	1,252	272	244	4,729	6,497

Table 11. USA red hake autumn and spring bottom trawl survey abundance indices for Subarea 5.[a]

	Division 5Y		Division 5Z			
			Subdivision 5Ze		Subdivision 5Zw	
Year	Spring	Autumn	Spring	Autumn	Spring	Autumn
1970	0.7[b]	0.2	1.4[b]	1.0	3.8[b]	3.9
1971	0.9[b]	1.0	2.4[b]	2.1	8.5[b]	3.4
1972	2.1[b]	1.8	1.7[b]	1.2	8.8[b]	6.6
1973	3.6	0.6	1.8	3.0	6.4	3.1
1974	2.0	0.5	0.7	1.6	4.8	0.6
1975	3.5	1.0	1.3	7.6	4.3	4.3
1976	2.8	1.1	1.4	4.4	10.6	3.4
1977	2.2	2.8	0.2	5.0	3.1	3.2
1978	1.5	2.2	0.2	4.6	10.8	2.1
1979	2.0	1.1	0.8	2.5	2.6	4.0

[a]Stratified mean catch (kg) per tow.

[b]Spring surveys made with Yankee No. 36 trawl have been adjusted to the Yankee No. 41 trawl.

7. Pollock

Reported USA commercial landings of pollock from Subarea 5 for 1979 totaled 15,411 MT (Table 12), compared to 17,535 MT for 1978. The USA landings per day fished declined from 7.3 MT/day fished in 1978 to 6.4 MT/day fished in 1979 (Table 12), while the USA autumn bottom trawl survey abundance index (Table 12) declined from 6.2 kg/tow in 1978 to 4.8 kg/tow in 1979.

Table 12. USA pollock commercial landings (MT, round fresh), landings per day fished, and autumn bottom trawl survey abundance indices for Subarea 5.

Year	Landings	Landings/day fished[a]	Abundance index[b]
1970	3,592	5.9	2.2
1971	4,727	6.0	4.0
1972	5,242	7.7	4.9
1973	5,728	7.8	3.9
1974	8,050	7.6	3.5
1975	8,573	6.3	2.1
1976	10,241	6.6	19.3
1977	12,722	8.2	9.5
1978	17,535	7.3	6.2
1979	15,411	6.4	4.8

[a]Calculated from USA catch and effort data for medium and large [>50 gross (English) tons (GT)] otter trawlers in Subareas 4 and 5.

[b]Stratified mean catch (kg) per tow.

8. Atlantic Herring

The USA catch of Atlantic herring in Division 5Y increased greatly (Table 13), due primarily to increased catches in the juvenile fishery. As in 1977 and 1978, concentrations of spawning herring did not appear on the traditional autumn spawning grounds on Georges Bank (Subdivision 5Ze).

The USA autumn bottom trawl survey abundance index (Table 14) declined substantially in 1979 to 1975-77 levels. The spring bottom trawl survey abundance index increased substantially due to the strong 1976 year class.

Table 13. USA Atlantic herring landings (MT, round fresh) for Subarea 5.

Year	Division 5Y landings	Division 5Z		Total landings for Subarea 5
		Subdivision 5Ze landings	Subdivision 5Zw landings	
1970	29,181	272	1,031	30,484
1971	31,491	1,194	1,205	33,890
1972	38,211	11	2,251	40,473
1973	21,601	162	3,912	25,675
1974	29,356	171	2,866	32,392
1975	31,591	3	4,088	35,681
1976	49,398	40	507	49,953
1977	50,291	1	315	50,607
1978	48,416	2	1,912	50,337[a]
1979	63,764	5	1,057	64,880[b]

[a]Includes landings for Division 5NK (7 MT).

[b]Includes landings for Division 5NK (54 MT).

Table 14. USA Atlantic herring autumn and spring bottom trawl survey abundance indices for Division 5Z.[a]

Year	Subdivision 5Ze autumn abundance index	Subdivision 5Zw spring abundance index
1970	0.7	34.7
1971	2.2	4.1
1972	1.1	5.7
1973	0.1	19.9
1974	0.1	9.9
1975	<0.1	0.3
1976	<0.1	2.0
1977	0.0	3.2
1978	1.7	12.2
1979	0.0	19.2

[a]Stratified mean catch per tow in numbers.

9. Atlantic Mackerel

The USA commercial landings of Atlantic mackerel in Subarea 5 increased from 946 MT in 1978 to 1,091 MT in 1979 (Table 15). The USA landings per day fished for Subarea 5 and Statistical Area 6 increased from 0.5 MT/day in 1978 to 0.7 MT/day in 1979. The USA autumn and spring bottom trawl survey abundance indices both decreased from 1978 to 1979, although the 1979 indices were higher than in 1977 (Table 16).

Table 15. USA Atlantic mackerel commercial landings (MT, round fresh) and landings per day fished for Subarea 5.

Year	Landings	Landings/day fished[a]
1970	3,092	2.1
1971	1,593	1.3
1972	1,025	0.8
1973	621	0.5
1974	475	0.2
1975	547	0.5
1976	1,044	0.6
1977	694	0.5
1978	946	0.5
1979	1,091	0.7

[a]Includes Statistical Area 6 values also.

Table 16. USA Atlantic mackerel autumn and spring bottom trawl survey abundance indices for Subarea 5.[a]

Year	Spring	Autumn
1970	2.0	0.1
1971	2.0	0.1
1972	1.3	0.1
1973	0.7	<0.1
1974	0.8	0.1
1975	0.3	<0.1
1976	0.3	<0.1
1977	0.2	<0.1
1978	0.4	0.2
1979	0.2	0.1

[a]Stratified (spring strata = 1-25 and 61-76; autumn strata = 1,2,5,6,9, 10,13,16,19-21,23,25, and 26) mean catch (kg) per tow in Subarea 5 and Statistical Area 6 (to some extent).

10. Industrial Groundfish Fishery

Landings for industrial purposes from Subarea 5 (predominantly Subdivision 5Zw) continued to increase in 1979 from a low in 1976 (Table 17). Percentage composition for red hake increased dramatically from 42% in 1978 to 72% in 1979.

Table 17. USA landings for industrial purposes (MT, round fresh) from Subarea 5.

Year	Total landings	Species composition (%) for Subdivision 5Zw				
		Silver hake	Red hake	Flounders	Ocean pout	Others
1970	20,696	6.3	17.9	16.7	28.3	30.8
1971	8,823	10.1	25.8	6.6	33.7	26.3
1972	5,944	2.1	17.9	10.3	35.3	35.8
1973	11,854	7.4	20.8	10.4	26.2	35.2
1974	10,121	7.0	12.9	5.0	29.6	45.5
1975	4,250	35.8	22.2	8.8	4.9	28.3
1976	4,012	30.3	39.2	5.5	1.8	23.2
1977	4,292	25.9	27.9	6.7	7.3	32.2
1978	5,429	15.4	42.3	6.3	7.6	28.4
1979	6,592	7.4	71.7	3.3	2.9	14.7

11. Squid

The USA commercial landings of long-finned (Loligo sp.) squid increased over threefold from 1978 to 1979 as well as from the 10-yr average (Table 18), whereas landings of short-finned (Illex sp.) squid more than quadrupled from 1978 to 1979 (Table 18) and nearly tripled the 10-yr average.

The USA autumn bottom trawl survey abundance index for Loligo sp. was greater in 1979 than in 1978 in both numbers and weight for Division 5Y and Subdivision 5Ze (Table 19). The Subdivision 5Zw and Statistical Area 6 combined index was up from 1978 in numbers but down in weight, indicating smaller individuals in 1979 (Table 19).

The USA autumn bottom trawl survey index for Illex sp. was significantly greater in 1979 than in 1978 and in comparison to the 10-yr average in both numbers and weight for Division 5Y (Table 20). The Subdivision 5Ze index, however, was slightly lower than in 1978 in both numbers and weight. The combined index for Subdivision 5Zw and Statistical Area 6 was above both the 10-yr average and the 1978 index in both numbers and weight.

Table 18. USA squid landings (MT, round fresh) by species[a] for Subarea 5 and Statistical Area 6.[b]

Year	Loligo sp.	Illex sp.
1970	652	408
1971	727	455
1972	742	472
1973	1,100	530
1974	2,141	148
1975	1,620	108
1976	3,229	601
1977	1,474	1,079
1978	1,291	385
1979	4,379	1,645

[a] Includes estimated breakdown of catches of unspecified squid species.

[b] Landings for Loligo sp. and Illex sp. are given for Subarea 5 and Statistical Area 6 combined as statistics for some previous years were not available for each separate area.

Table 19. USA Loligo sp. squid autumn bottom trawl survey abundance indices for Subarea 5 and Statistical Area 6.[a]

	Weight			Number		
Year	Division 5Y	Subdivision 5Ze	Subdivision 5Zw and Statistical Area 6	Division 5Y	Subdivision 5Ze	Subdivision 5Zw and Statistical Area 6
1970	<0.1	1.1	4.1	1.5	49.4	105.4
1971	<0.1	1.1	4.0	0.6	34.1	234.2
1972	0.0	1.1	9.4	0.2	39.3	389.9
1973	<0.1	4.5	14.2	0.9	60.9	542.9
1974	<0.1	2.2	11.4	0.8	62.1	355.9
1975	0.8	1.8	13.6	0.8	102.6	895.5
1976	0.4	3.1	15.8	12.7	103.5	579.8
1977	<0.1	1.0	11.9	0.8	43.8	577.9
1978	<0.1	1.6	5.7	0.2	45.6	198.4
1979	<0.1	2.0	4.7	0.7	76.1	258.3

[a]Stratified mean catch per tow in weight (kg) or numbers.

Table 20. USA Illex sp. squid autumn bottom trawl survey abundance indices for Subarea 5 and Statistical Area 6.[a]

	Weight			Number		
Year	Division 5Y	Subdivision 5Ze	Subdivision 5Zw and Statistical Area 6	Division 5Y	Subdivision 5Ze	Subdivision 5Zw and Statistical Area 6
1970	0.3	0.2	0.3	0.8	2.6	3.8
1971	0.4	0.5	0.3	1.8	1.7	2.0
1972	0.2	0.2	0.5	0.8	1.1	4.9
1973	0.6	0.5	<0.1	2.0	2.5	0.6
1974	1.2	0.2	0.2	3.9	1.1	4.1
1975	2.7	1.1	1.0	7.3	6.4	15.7
1976	4.2	14.8	6.2	13.8	45.0	19.8
1977	2.2	5.0	4.5	7.2	15.8	15.8
1978	1.9	12.2	2.6	5.8	44.7	19.5
1979	4.4	11.2	7.4	11.3	37.5	29.1

[a]Stratified mean catch per tow in weight (kg) or numbers.

12. Sea Scallops

The USA sea scallop landings reached their highest level in the past decade (Table 21). Effort increased dramatically while, with the continued presence of the strong year class recruited in 1976, catch increased but at a much lower rate. Catch per unit of effort declined to the 1975 level and is expected to decline further in 1980.

Table 21. USA sea scallop landings (MT of meats) and landings per day fished for Subarea 5.

Year	Landings	Landings/day fished
1970	1,553	0.6
1971	1,697	0.5
1972	1,347	0.5
1973	1,543	0.6
1974	1,153	0.7
1975	1,650	0.8
1976	2,061	1.1
1977	5,003	1.2
1978	5,841	1.1
1979	6,920	0.8

B. Special Research Studies

Special research studies for Subarea 5 are combined with those for Statistical Area 6.

III. STATISTICAL AREA 6

A. Status of the Fisheries

1. Silver Hake

The USA commercial landings of silver hake for food purposes from Statistical Area 6 decreased in 1979 after reaching their highest level in the past decade in 1978 (Table 22). Landings for industrial purposes continued to decline in 1979 after recording consistent levels from 1975 to 1977 (Table 22).

Table 22. USA silver hake commercial landings (MT, round fresh) for Statistical Area 6.

Year	Food landings	Industrial landings	Total landings
1970	2,134	114	2,248
1971	2,749	240	2,989
1972	3,899	48	3,947
1973	4,085	99	4,184
1974	4,455	91	4,546
1975	4,513	208	4,721
1976	5,399	229	5,628
1977	6,148	277	6,425
1978	7,609	50	7,659
1979	8,852	18	8,870

2. Red Hake

The USA food landings of red hake from Statistical Area 6 increased significantly from 1978 to 1979 (Table 23) and continued well above the 10-yr average. Industrial landings increased in 1979 after reaching their lowest level in the past decade in 1978 (Table 23).

Table 23. USA red hake landings (MT, round fresh) for Statistical Area 6.

Year	Food landings	Industrial landings	Total landings
1970	476	183	659
1971	502	319	821
1972	550	267	817
1973	706	520	1,226
1974	531	258	789
1975	565	189	754
1976	1,156	743	1,899
1977	655	464	1,119
1978	866	62	928
1979	1,463	187	1,650

3. Atlantic Herring

The USA landings of Atlantic herring from Statistical Area 6 decreased from 187 MT in 1978 to 154 MT in 1979 (Table 24). The USA spring bottom trawl survey abundance index decreased tenfold from 1978 to 1979 (Table 24).

Table 24. USA Atlantic herring landings (MT, round fresh) and spring bottom trawl survey abundance indices for Statistical Area 6.

Year	Landings	Spring abundance index[a]
1970	-[b]	1.2
1971	-[b]	3.9
1972	-[b]	2.6
1973	529	5.6
1974	278	3.5
1975	488	<0.1
1976	187	1.5
1977	46	0.3
1978	187	1.1
1979	154	0.1

[a]Stratified mean catch per tow in numbers.

[b]Quality of data not equivalent to that collected after 1972.

4. Atlantic Mackerel

The USA commercial landings of Atlantic mackerel from Statistical Area 6 increased from 659 MT in 1978 to 898 MT in 1979 (Table 25). The landings per day fished increased from 0.5 MT/day in 1978 to 0.7 MT/day in 1979. The USA autumn and spring bottom trawl survey abundance indices decreased from 1978 to 1979 (Table 16 contains indices based on strata in both Subarea 5 and Statistical Area 6), but were higher than in 1977.

Table 25. USA Atlantic mackerel commercial landings (MT, round fresh) and landings per day fished for Statistical Area 6.

Year	Landings	Landings/day fished[a]
1970	957	2.1
1971	813	1.3
1972	981	0.8
1973	715	0.5
1974	567	0.2
1975	1,113	0.5
1976	1,302	0.6
1977	682	0.5
1978	659	0.5
1979	898	0.7

[a]Subarea 5 values also included.

5. Sea Scallops

Landings decreased noticeably from 1978 to 1979 (Table 26). Effort increased greatly, resulting in a decrease in catch per unit of effort to below the 1974 level; catch per unit of effort is expected to continue decreasing in 1980.

Table 26. USA sea scallop landings (MT of meats) and landings per day fished for Statistical Area 6.

Year	Landings	Landings/day fished
1970	1,059	0.5
1971	895	0.4
1972	1,306	0.5
1973	857	0.5
1974	1,568	0.8
1975	2,706	0.9
1976	3,288	1.2
1977	5,780	1.3
1978	8,641	1.2
1979	7,336	0.7

B. Special Research Studies

1. Environmental Studies

a) Hydrographic Studies

Preliminary results of current-meter studies in the Northeast Channel [the relatively deep passage separating Georges Bank (Subdivision 5Ze) from the Scotian Shelf (Division 4X)] indicate twice as much inflow into the Gulf of Maine (Division 5Y) as previously thought. Current meters now have been deployed across the continental shelf from Nantucket Shoals to the 800-m contour (the boundary area between Subdivisions 5Ze and 5Zw, in order to determine the nature and extent of alongshelf flow between the Middle Atlantic Bight (Statistical Area 6) and the Georges Bank - Gulf of Maine region (Subarea 5).

Initial findings of meteorological-hydrological interrelationship studies, based on historical records, show large annual variations in prevailing winds, and in wind effects on the direction and magnitude of surface currents, for the Northwest Atlantic's continental shelf (Subarea 5 and Statistical Area 6).

Satellite infrared imagery has revealed significant yearly changes in the Northwest Atlantic's continental shelf-slope water mass boundary (Subarea 5 and Statistical Area 6), and in the formation rate, movement, and persistence of warm-core eddies originating as cutoff Gulf Stream meanders (Subarea 5 and Statistical Area 6). The role of oceanic fronts on coastal hydrologic processes was also studied.

An analysis of several years of temperature transects indicates large annual variations in the temperature regime of the Northwest Atlantic (Divisions 4X, 5Y, 5Z, 6A, 6B, and 6C).

b) Plankton Studies

A third consecutive year of intensive bimonthly plankton surveys from the Scotian Shelf to Cape Hatteras (Divisions 4X, 5Y, 5Z, 6A, 6B, and 6C) yielded 3,000 samples. From these samples; the size of the adult yellowtail flounder population was calculated from the occurrence of their eggs; the morphological development of larval hakes and sand lances was described; and an illustrated guide to Northwest Atlantic larval fishes was prepared.

Larval and juvenile American shad surveys in the Connecticut River (Division 6A) continued. These surveys relate the relative abundance, food habits, growth, and mortality of young shad to the distribution and abundance of their zooplanktonic prey during and after the spawning season. The results should better explain the fluctuating recruitment of year classes to the oceanic population.

The third year of American lobster larval abundance surveys in Southern New England waters (Subdivision 5Zw) has shown densities as high as one individual per cubic meter in Buzzards Bay. This is an apparent record density, pointing to the likely importance of Buzzards Bay in the early life history of Southern New England lobsters.

Sample analysis from 1971-77 larval Atlantic herring surveys (Subarea 5 and Statistical Area 6) indicated a spawning shift in Georges Bank (Subdivision 5Ze) herring from northeastern Georges Bank to Nantucket Shoals. This shift was associated with the 1976 collapse of the eastern Georges Bank fishery and larval production.

Lab work with ichthyoplankton included: (1) development of a model which relates feeding behavior to growth/starvation in larval Atlantic herring; (2) calculation of daily mortality rates during the critical first-feeding period of larval Atlantic herring, winter flounder, and summer flounder; and (3) development of techniques to determine biochemical indexes of larval food utilization and growth.

Sample analysis from a 1978 larval Atlantic herring patch study showed that zooplankton patches on Georges Bank (Subdivision 5Ze) remained in the shallow waters in spite of strong currents, perhaps by migrating daily to the bottom where currents are weak. Such retention in shallow waters which are nutrient rich is believed to be related to the survival, growth, and production of not only zooplankton, but also the ichthyoplankton feeding on it. The seasonal residence or drift of Georges Bank ichthyoplankton is thus now being estimated from satellite-monitored, drogued buoys.

The development of an image-scanning system for counting and measuring zooplankton progressed--preserved zooplankton can now be counted and measured 70-80% faster than before.

Phytoplankton research focused on: (1) phytoplankton productivity in New York Bight (Division 6A) coastal waters; (2) tidal effects on phytoplankton distribution in shallow seas; and (3) phytoplankton succession under coastal eutrophication.

c) Benthic Studies

Sample analysis of benthic invertebrates from Subarea 5 indicated that they greatest macrobenthic biomass is in the coastal Gulf of Maine (Division 5Y), southwestern Georges Bank (Subdivision 5Ze), and waters south of Nantucket (boundary between Subdivisions 5Ze and 5Zw). A special program to survey the submarine canyons of the Northwest Atlantic with deep submergence research vessels continued, with the focus on the analysis of recent observations from Oceanographer Canyon (Subdivision 5Ze). Information was developed on the species composition/diversity, depth distribution, and habitat preference of that canyon's megabenthic fauna. Also, a benthic species inventory was conducted in the lower bay of New York Harbor (Division 6A).

Benthic crustacean research included: (1) deep-sea red crab tag-return analysis showing slow growth--some had not molted in 5 yr; (2) submarine canyon surveys showing the burrowing activities of benthic crustaceans as an important food-gathering and shelter-procurement mechanism, and, especially for deep-sea red and jonah crabs, as an erosive force of canyon walls with glacial clay depositions; and (3) preparation of a major report on Georges Bank (Subdivision 5Ze) and Middle Atlantic Bight (Statistical Area 6) amphipod distribution and abundance.

Benthic mollusk research included preparation of a major report on the distribution and abundance of American East Coast (Subarea 5 and Statistical Area 6) bivalve mollusks, and studies on the reproductive cycle, fecundity, and adult-larval cannibalism of hard clams. An annotated bibliography of hard clam scientific literature was also prepared.

d) Other Environmental Studies

Four major cruises were conducted and over a half-dozen contracts were let to academic institutions in the third year of the Ocean Pulse Program. Ocean Pulse is a long-term effort to monitor and assess the health of contin-

ental shelf habitats and resources between the Canadian border and Cape Hatteras (Subarea 5 and Statistical Area 6) through ecological, physiological, biochemical, genetic, and bacteriological measurements taken several times a year from sediments, waters, and key indicator species at over two dozen polluted and relatively unpolluted (control) sites. This effort detects natural and man-induced changes, reveals causes of such changes, and provides baselines to assess environmental damage.

Two "Large Area Marine Productivity and Pollution Experiments (LAMPEX)" were conducted. Up to two dozen government and academic institutions conducted cruises to measure (for sea-surface truth) chlorophyll, turbidity, and other variables, while U-2 and C-130 aircraft and satellites simultaneously made remote-sensing measurements of these same variables, over the continental shelf from Cape Hatteras to the Canadian border (Subarea 5 and Statistical Area 6). Major reports have ensued on this pioneering effort.

Through LAMPEX, the Ocean Pulse Program, the bimonthly plankton surveys noted earlier, and other cruises, the distribution and abundance of nutrients and chlorophyll over the continental shelf from Cape Hatteras to the Canadian border (Subarea 5 and Statistical Area 6) have been mapped for the first time. Preliminary analysis of the taxonomic makeup of the phytoplankton populations indicates a dominance shift in the past decade from large diatoms to smaller phytoplankters. Research is underway to see if this shift is related to pollution. Along these lines, studies are focusing on the differences in water-column and seabed respiration between heavily polluted and relatively unpolluted areas.

Levels of dissolved oxygen and other environmental factors were again assessed off Long Island and New Jersey (Division 6A) where the anoxia (dissolved oxygen depletion) occurred in summer 1976, killing a significant portion of the resident biological community. Enough data now have been accumulated and correlated to permit the prediction of the likelihood of future such instances. A book on this topic, Anoxia in the New York Bight, will soon be published.

Research on the pollution effects of petroleum hydrocarbons has included: (1) measuring the ability of blue crabs, Dungeness crabs, and red hakes to detect and avoid petroleum hydrocarbons; (2) noting the effects of oiled sediments on the detection and location of food and on the use of shelter by the red hake; and (3) analyzing the risks associated with oil and gas development on Georges Bank (Subdivision 5Ze), particularly for the tracts in Lease Sale No. 42. Various aspects of designating the latter area as a marine sanctuary also were addressed, especially from the standpoint of developmental activities and safeguards to be employed to protect living marine resources and associated fisheries.

The National Registry of Marine Pathology was enlarged by, among other material, 150 microslides of histologic lesions of marine finfish and shellfish cultured in Japan. The registry was also enlarged by a listing of 2,500 abstracted citations on diseases of North American fishes, crustaceans, and mollusks. This listing was further summarized as to geographic distribution, host species, gross and microscopic lesions, and causative agents.

A project was begun to examine the fish caught in bottom trawls during research cruises for the incidence of fin rot, skeletal anomalies, tumors, and ulcers. Almost 19,000 groundfish (Atlantic cod, haddock, pollock, red hake, white hake, silver hake, Atlantic herring, yellowtail flounder, summer flounder, winter flounder, and American plaice) were examined; few abnormalities showed up. Along these lines, over 900 American sand lance were examined for skeletal anomalies-- the 12% incidence exceeded the known levels of almost all other fish.

The viral agent which causes spinning disease in Atlantic menhaden has been isolated. Infection was induced in the lab through inoculation and water exposure. American shad are also susceptible to the lethal virus.

Disease studies of marine arthropods focused on American lobsters, rock crabs, blue crabs, euphausids, Latreutes shrimps, Idotea isopods, and copepods. Histological examination of American lobsters suffering from

gaffkemia confirmed: (1) that the causative agent (Aerococcus viridians var. homari) is neither invasive of tissues nor lytic in effects; (2) that severe glycogen depletion is a major pathological effect; and (3) that infected individuals do not have access to other reserves like hepatopancreatic lipids. A 5-yr study of the incidence of black gill disease in rock crabs collected from coastal waters of the Middle Atlantic Bight (Statistical Area 6) showed that 10% of the crabs from sewage-impacted areas had the disease while none from control sites were so affected. A manuscript, under preparation for several years, was completed on the histology of the blue crab--providing baseline information on healthy tissues. Several hundred euphausids, Latreutes shrimps, Idotea isopods, and copepods collected from Deepwater Dumpsite 106 (Division 6A) showed significantly higher prevalence of some pathological abnormalities in some organisms than specimens collected over the whole continental shelf from Cape Hatteras to the Canadian border (Subarea 5 and Statistical Area 6).

Disease studies of marine mollusks revealed a new snail host for a parasitic nematode of calico scallops. The host, Hunter's banded tulip (Fasciolaria lilium hunteria), is a recognized predator on scallops in the southeastern United States. A system was developed to correlate quickly molluscan pathologic lesions with infectious diseases and environmental degradation; subsequently, no adverse pathological effects were noted for kepone-contaminated American oysters from the James River [Virginia (Division 6B)]. Along these lines, mutagenic assays of molluscan tissues indicated good correlation of pollution with mutagenicity.

A 2-yr study of the distribution of potentially pathogenic amoebae in polluted marine sediments indicated that these organisms are important indicators of sewage sludge persistence in the marine environment. Additionally, two new genera and species of marine amoebae were described.

2. Biological Studies by Species

a) Silver Hake

A method was developed for distinguishing different populations within a species by histochemical staining of enzymes separated by agarose gel isoelectric focusing. This method, simpler and faster than others, has already detected a difference in the silver hake landed in Gloucester, Massachusetts (Division 5Y), and Pt. Judith, Rhode Island (Subdivision 5Zw).

b) Spanish Mackerels

A report was prepared on the 18 species of Spanish mackerel, summarizing the primary diagnostic characters and distribution of each species, and including a key for distinguishing the seven American species.

c) Bluefish

Behavior studies of juvenile bluefish so far indicate they can avoid stressful low temperatures, but will enter and feed briefly in nearly fatal low temperatures.

d) Tilefish

Behavior studies of tilefish in Oceanographer, Block, and Hudson Canyons were conducted via 29 submersible dives. Following freshly baited longline gear from two commercial fishing vessels, observations were made on tilefish catch over time, bait loss to scavengers, and a unique type of burrowing activity.

e) Scup

A workshop was held to evaluate the aging techniques for this species.

f) Sharks, Tunas, and Billfishes

A field guide to sharks, billfishes, and tunas caught on longlines in the Northwest Atlantic (Subarea 5 and Statistical Area 6) was prepared. Stomach analyses showed that mako sharks feed primarily on bluefish while inshore and on cephalopods while offshore, and that blue sharks feed primarily on teleosts (mostly Atlantic herring, butterfish, and hakes) and cephalopods. New histological techniques were developed for aging lamnid sharks--mako and white sharks now appear to grow 30-40 cm/yr while young. Sonic tracking of mako, white, and blue sharks and swordfish tagged with temperature sensors showed diurnal vertical movements from the surface at night to 600 m during the day. Makos were less diurnal, but were able to raise muscle temperatures 3-5°C above ambient. White sharks were not diurnal, but were able to raise muscle temperatures 2°C above ambient. Basic biological data were collected on spiny dogfish in Division 6A.

3. Gear and Selectivity Studies

a) Fishing Gear Studies

A scallop-gear performance and gear-related scallop behavior cruise was conducted. Through underwater viewing by SCUBA divers riding the scallop drag, and shipboard viewing of color television pictures from diver-held and gear-mounted cameras, the first observations were made on the undersea operation of scallop gear in New England waters. The cruise provided valuable observations on the efficiency of the drag for remaining on the bottom, capturing those scallops in its path, damaging those not caught, and retaining smaller-sized specimens.

The types and rates of damage induced by otter trawls on the catch of American lobsters were evaluated in Subdivision 5Zw waters. A seasonal pattern of trawl-induced damage, closely related to molting periods, was described.

b) Fishing Operations Studies

A thorough description of the fisheries off Delaware (Division 6B) was prepared. An account of the historical exploitation and the current fishery for striped bass has been developed. An analysis of the sociological structure of the Atlantic menhaden fishery labor force, and an inventory of that industry's operating costs, were performed. With information from a logbook reporting system, numerous analyses of the financial condition of the surf clam and ocean quahog fishery were prepared.

4. Miscellaneous Studies

Spring, summer, and fall bottom trawl surveys from Cape Sable, Nova Scotia, to Cape Fear, North Carolina (Division 4X, 5Y, 5Z, 6A, 6B, and 6C), yielded over 5,000 biological specimens, even more samples, and considerable information. The States of Maine, Massachusetts, and Rhode Island developed supplementary inshore bottom trawl survey programs. Surveys were also conducted specifically for sea scallops, surf clams, and ocean quahogs. Also, 18 sea-sampling trips aboard 16 commercial fishing vessels were conducted.

A sport fisheries survey was conducted to monitor the catch, catch per unit of effort, and fishing effort of all fish species taken throughout Long Island Sound (Division 6A). The sampling mode consisted of personal interviews subdivided into shore-based and boat fisheries. This information, in conjunction with commercial logbook data, will be used to determine for each species the proportion of the total landings attributed to sport and commercial fishing.

Processing continued for specimens, samples, and observations collected from commercial landings and research surveys. Species abundance indices were updated and 60,000 finfish and shellfish age determinations of 11 species were completed. New aging techniques were developed for sea scallops and surf clams, and a study of an automated aging method for haddock was completed and a contract was awarded for the necessary computer software.

Stock assessments were performed for the following species (stocks): Atlantic cod (Gulf of Maine, Georges Bank/Southern New England/

Middle Atlantic); haddock, redfish, silver hake (Gulf of Maine, Georges Bank, Southern New England/Middle Atlantic), and red hake (Georges Bank, Southern New England/Middle Atlantic), pollock, yellowtail flounder (east of 69°W, west of 69°W), summer flounder, flounders except yellowtail and summer flounder, Atlantic herring (Maine juveniles, Gulf of Maine adults, Georges Bank adults), Atlantic mackerel, river herring, scup, weakfish, butterfish, bluefish, white hake, skates, other finfish, squid (Illex, Loligo), total finfish and squid, American lobster, northern shrimp, deep-sea red crab, surf clam, ocean quahog, and sea scallops.

Calculations of the food requirements of fish stocks in the Northwest Atlantic based on an examination of 70,000 stomachs from both demersal and pelagic species, when compared to the estimates of food production by plankton and benthos in those waters, revealed a large surplus of food production. Whale, bird, and other nonfish populations cannot account for this surplus. Thus, these ecosystems could support larger fish stocks, and thus larger fish catches, through careful management. Accordingly, a multispecies model of fish production for Georges Bank (Subdivision 5Ze) is being developed to achieve these ends. So far, for instance, it appears that reducing the population of silver hake, a major predator of juvenile fish like haddock, could boost the overall catch significantly.

To determine the total production of fish stocks on Georges Bank (Subdivision 5Ze), an energy budget was developed. This energy budget shows ecosystem production (phytoplankton, zooplankton, benthos, and fish) exceptionally high. Compared to the North Sea, for example, phytoplankton production is 300% higher and fish production is 100% higher. More refinement of the energy budget will show the long-term effects of various management strategies on the sustained productivity of this ecosystem.

Efforts are continuing on the restoration of American shad, alewives, and blueback herring, and on the introduction of the coho salmon, to New Hampshire streams (Division 5Y). Successful restoration/introduction would result in increased oceanic populations of these anadromous species.

An economic study, "A Short Run Economic Impact Analysis of the U.S.-Canadian Agreement on East Coast Fishery Resources," was prepared for the U.S. Congress. The study supports the June 1979 bilateral agreement on that subject.