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United States of America Report on Research in the Northwest Atlantic During 1980

by

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The United States of America (U.S.A.) landed fish from and conducted research in, NAFO Subareas 4-6. Table 1 summarizes U.S.A. finfish, squid, and sea scallop nominal catches in 1979 and 1980.

I. SUBAREA 4

A. Status of the Fisheries

1. Haddock

The U.S.A. landings for Subarea 4 increased from 69 MT in 1979 to 256 MT in 1980. These 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 U.S.A. landings of cod from Subarea 4 increased from 48 MT in 1979 to 74 MT in 1980.

3. Redfish

The U.S.A. redfish landings from Subarea 4 increased from 719 MT in 1979 to 883 MT in 1980. The entire catch was taken from the western portion of Division 4X in or north of the disputed zone.

4. Pollock

The U.S.A. landings from Subarea 4 increased from 121 MT in 1979 to 375 MT in 1980. This catch represents approximately 2% of the total U.S.A. landings for this species, and was taken in or north of the disputed zone.

B. Special Research Studies

Special research studies for Subarea 4 are combined with those for Subareas 5 and 6 and reported under "SUBAREA 6."

Table 1. U.S.A. finfish, squid, and sea scallop nominal catches for 1979 and 1980 [metric tons (MT), round fresh].

Species	Year	Subarea 4	Subarea 5	Subarea 6	Total
Haddock	1979	69	18,901	28	18,998
	1980	256	24,740	41	25,037
Atlantic cod	1979	48	44,030	295	44,373
	1980	74	53,371	210	53,655
Redfish	1979	719	14,722	-	15,441
	1980	883	10,084	-	10,967
Pollock	1979	121	15,412	8	15,541
	1980	375	17,900	3	18,278
Yellowtail flounder	1979	2	15,517	502	16,021
	1980	4	18,564	773	19,341
Other flounders	1979	20	28,796	14,082	42,898
	1980	28	34,761	12,216	47,005
Silver hake	1979	-	7,632	8,870	16,502
	1980	-	7,775	8,686	16,461
Red hake	1979	-	6,496	1,649	8,145
	1980	-	3,433	1,523	4,956
Atlantic herring	1979	-	64,899	155	65,054
	1980	-	83,249	211	83,460
Atlantic mackerel	1979	-	1,091	899	1,990
	1980	-	1,606	1,077	2,683
River herring[a]	1979	-	1,182	3,176	4,358
	1980	-	1,274	3,485	4,759
Atlantic menhaden	1979	-	58,728	271,571	330,299
	1980	-	68,669	271,767	340,436
Butterfish	1979	-	1,967	864	2,831
	1980	-	4,424	838	5,262
Other finfishes	1979	127	26,429	44,494	71,050
	1980	128	24,198	43,168	67,494
Total finfishes	1979	1,106	305,802	346,593	653,501
	1980	1,748	354,048	343,998	699,794
Loligo sp. squid	1979	-	2,951	945	3,896
	1980	-	2,393	1,461	3,854
Illex sp. squid	1979	-	1,560	33	1,593
	1980	-	301	33	334
Sp. not specified squid	1979	-	115	422	537
	1980	-	38	245	283
Sea scallop[b]	1979	36	59,107	59,640	118,783
	1980	11	62,207	42,464	104,682

[a]Combined alewife and blueback herring.

[b]In-the-shell weights.

II. SUBAREA 5

A. Status of the Fisheries

1. Haddock

Reported U.S.A. commercial landings for Subarea 5 increased from 18,897 MT in 1979 to 24,740 MT in 1980 (Table 2), largely due to recruitment of the 1978 year class on Georges Bank. The 1975 year class, which supported the fishery from 1977 to 1979 on Georges Bank and in the Gulf of Maine, has been much reduced in size, but the 1978 year class appears comparable to the 1975 year class on Georges Bank and is expected to dominate the Georges Bank fishery at least until late 1982. The bottom trawl survey abundance index for Division 5Y continued to decline in 1980, but still remained substantially higher than the 1971-77 average (Table 2). The index for Division 5Z also declined from 26.9 kg/tow in 1979 to 18.5 kg/tow in 1980. Young-of-the-year (YOY) indices for Division 5Y and 5Z increased, however (Table 2). The 1980 year class appears comparable to the long-term average on Georges Bank.

Table 2. U.S.A. haddock landings (MT, round fresh) and autumn bottom trawl survey abundance and young-of-the-year indices for Subarea 5.

	Division 5Y			Division 5Z			
Year	Landings	Survey abundance index[a]	YOY index[b]	Landings	Survey abundance index[a]	YOY index[b]	Total landings
1971	1,194	5.4	1.2	7,306	3.7	1.4	8,500
1972	909	2.0	1.0	3,869	5.6	2.1	4,778
1973	509	5.7	1.6	2,777	6.5	1.8	3,286
1974	622	2.2	1.0	2,396	2.6	1.3	3,018
1975	1,180	5.7	2.2	3,989	10.0	3.8	5,169
1976	1,865	5.3	1.7	2,904	23.7	1.7	4,769
1977	3,296	7.3	1.1	7,934	23.1	1.1	11,230
1978	4,538	18.2	1.1	12,160	15.2	2.3	16,698
1979	4,622	11.5	1.4	14,275	26.9	1.6	18,897
1980	7,270	8.2	1.6	17,470	18.5	2.8	24,740

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

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

[c]Includes Division 5NK.

2. Atlantic Cod

The U.S.A. commercial landings of cod from Subarea 5 increased 21% from 1979 to 1980 (Table 3). The autumn bottom trawl survey abundance index for Georges Bank decreased significantly from 1979 to 1980 and was the lowest since 1974.

3. Redfish

The U.S.A. commercial landings from Subarea 5 declined 31% from 1979 to 1980 (Table 4), the first decrease in landings since 1974. The U.S.A. commercial catch-per-unit-of-effort (C/E) abundance index declined during 1979-80, after a brief period of stabilization between 1976 and 1978. The index is now at an historically low level.

The 1971 year class, after having been subjected to relatively high exploitation rates during the past several years, is no longer able to support the fishery at 1977-79 catch levels. A continued decline in abundance is expected due to poor year classes following 1971.

The bottom trawl survey abundance index for Subarea 5 also continued to decline, particularly in the offshore areas of the Gulf of Maine where the major portion of the commercial catch is taken (Table 5). Commercial and survey length-frequency data indicate continued dominance by, and dependence of the fishery upon, the 1971 year class.

Table 3. U.S.A. Atlantic cod commercial landings (MT, round fresh) and autumn bottom trawl survey abundance indices for Subarea 5.

Year	Division 5Y landings	Division 5Z: Subdivision 5Zw landings	Division 5Z: Subdivision 5Ze: Landings	Division 5Z: Subdivision 5Ze: Survey abundance index[a]	Total landings[b]
1971	7,380	796	14,999	6.1	23,175
1972	6,776	662	12,478	14.2	19,916
1973	6,069	1,095	14,838	19.1	22,002
1974	7,639	1,228	16,642	5.1	25,509
1975	8,903	645	14,594	8.7	24,491
1976	10,172	279	13,941	10.9	24,664
1977	12,426	779	19,576	11.5	33,248
1978	12,426	1,643	23,787	21.5	38,741
1979	11,679	789	30,918	15.2	44,023
1980	13,527	659	38,393	6.2	53,370

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

[b]Includes Division 5NK.

Table 4. U.S.A. redfish landings (MT, round fresh) and commercial catch-per-unit-of-effort abundance indices for Subarea 5.

Year	Division 5Y landings	Division 5Ze landings	Subarea 5: Landings	Subarea 5: C/E abundance index[a]
1971	12,541	3,726	16,267	3.3
1972	7,150	6,007	13,157	3.0
1973	7,001	4,953	11,954	2.7
1974	5,457	3,220	8,677	2.3
1975	5,961	3,114	9,075	2.0
1976	7,989	2,142	10,131	2.0
1977	9,848	3,157	13,005	2.1
1978	11,352	2,632	13,984	2.0
1979	9,606	5,109	14,715	1.6
1980	7,807	2,277	10,084	1.4

[a]Landings (MT) per standardized day fished.

Table 5. U.S.A. redfish autumn bottom trawl survey abundance indices for Subarea 5[a].

Year	Inshore: Weight	Inshore: Number	Offshore: Weight	Offshore: Number	Total: Weight	Total: Number
1971	4.7	20.7	26.7	52.8	23.4	48.0
1972	6.6	36.4	27.8	58.9	24.6	55.6
1973	2.1	26.2	19.7	41.4	17.0	39.2
1974	4.7	44.2	27.6	49.0	24.2	48.3
1975	6.0	45.7	45.9	79.9	39.9	74.8
1976	2.5	11.6	17.5	31.9	15.3	28.9
1977	12.3	54.6	18.1	37.9	17.3	40.4
1978	5.5	20.4	23.4	49.5	20.7	45.2
1979	2.1	6.2	18.4	32.8	16.0	28.9
1980	6.2	20.6	13.8	20.6	12.6	20.6

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

4. Yellowtail Flounder

The U.S.A. catch of yellowtail flounder from Subarea 5 increased from 17,199 MT in 1979 to 20,502 MT in 1980. Food landings increased from 15,485 MT in 1979 to 18,548 MT in 1980; this represents an increase of 67% from 1978 to 1980 (Table 6).

Discard has been estimated as a fixed percentage of food landings since 1977 due to unavailability of samples and to misreporting, and recent levels may be much higher than indicated.

The autumn bottom trawl survey abundance index decreased for Southern New England (Division 5Z west of 69°) and increased for Georges Bank (Division 5Z east of 69°) (Table 7). The spring bottom trawl survey indicated high proportions of 1976, 1977, and 1978 year-class fish for Southern New England; autumn bottom trawl survey catches from this area were dominated by the 1978 year class. On Georges Bank, both the spring and autumn surveys indicated a predominance of the 1977 and 1978 year classes.

A cooperative bottom trawl survey conducted in February 1980 and in 1981 in the Southern New England area by the Rhode Island Division of Fish and Wildlife, the National Marine Fisheries Service's Northeast Fisheries Center, and the fishing industry indicated relatively constant levels of abundance from 1980 to 1981. The 1980 catch was dominated by the 1977 year class, whereas the 1981 catch was dominated by the 1979 year class. The 1979 year class was also well represented in commercial landings during the latter half of 1980.

Table 6. U.S.A. yellowtail flounder landings, estimated discards, and total catch (MT, round fresh) from Subarea 5.

Year	Food landings	Estimated discards	Estimated industrial landings	Total catch
1971	21,762	7,124	397	29,283
1972	23,901	3,100	327	27,328
1973	24,773	1,086	343	26,202
1974	23,159	993	22	24,174
1975	18,861	1,246	35	20,142
1976	16,885	951	15	17,851
1977	15,999	257	57	16,313
1978	10,999	1,177	67	12,243
1979	15,485	1,657	57	17,199
1980	18,548	1,938	16	20,502

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

Year	Division 5Z west of 69°		Division 5Z east of 69°	
	Weight	Number	Weight	Number
1971	9.2	41.7	5.0	15.2
1972	20.1	73.3	5.0	14.6
1973	2.3	7.9	5.1	14.8
1974	2.1	7.3	2.9	10.0
1975	0.7	2.9	1.8	7.7
1976	3.0	10.7	1.2	2.5
1977	1.5	5.0	2.6	5.4
1978	3.1	11.4	2.2	7.2
1979	2.6	9.0	1.4	3.9
1980	2.0	7.3	6.1	12.7

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

5. Silver Hake

The U.S.A. commercial landings of silver hake from Subarea 5 remained at about the same level in 1980 as in 1979 after dropping sharply from 1978 (Table 8). Landings from Division 5Y increased 45% from 1979 to 1980, landings from Subdivision 5Ze increased 31%, but landings from Subdivision 5Zw decreased 32%. The U.S.A. commercial catch-per-unit-of-effort abundance index increased from 1979 to 1980 in Division 5Y and Subdivision 5Ze, but decreased in Subdivision 5Zw (Table 8).

Spring and autumn bottom trawl survey abundance indices for silver hake (Table 9) both underwent increases from 1979 to 1980 in Division 5Y and Subdivision 5Ze, but declined in Subdivision 5Zw.

Table 8. U.S.A. silver hake commercial landings (MT, round fresh) and catch-per-unit-of-effort abundance indices for Subarea 5.

	Division 5Y		Division 5Z					
			Subdivision 5Ze		Subdivision 5Zw			
Year	Landings	C/E abundance index[a]	Landings	C/E abundance index[a]	Food landings	C/E abundance index[a,b]	Industrial landings	Total landings
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	8,727	15.9	3,749	31.6	1,914	7.6	1,103	15,493
1978	6,195	7.6	6,393	20.2	2,902	8.4	835	16,339[c]
1979	2,636	6.4	893	17.4	3,600	7.6	489	7,632[c]
1980	3,812	7.7	1,166	21.0	2,503	6.0	291	7,775[d]

[a]Landings (MT) per standardized day fished;

[b]Includes Division 6A.

[c]Includes Division 5NK (14 MT).

[d]Includes Division 5NK (3 MT).

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

			Division 5Z			
	Division 5Y		Subdivision 5Ze		Subdivision 5Zw[b]	
Year	Spring	Autumn	Spring	Autumn	Spring	Autumn
1971	0.8[c]	2.7	1.8[c]	1.2	8.8[c]	4.6
1972	4.1[c]	6.5	1.2[c]	1.3	5.5[c]	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
1980	6.8	7.7	6.8	2.1	3.9	3.1

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

[b]Includes Division 6A.

[c]Spring survey catches made with Yankee No. 36 trawl have been equilibrated to the Yankee No. 41 trawl.

6. Red Hake

The U.S.A. commercial landings of red hake from Subarea 5 decreased 47% from 1979 to 1980 (Table 10), but were still the third highest since 1970. Autumn bottom trawl survey abundance indices for red hake increased in all areas from 1979 to 1980. Spring survey abundance indices increased in Division 5Y and Subdivision 5Zw and remained the same in Subdivision 5Ze (Table 11).

Table 10. U.S.A. red hake commercial landings (MT, round fresh) for Subarea 5.

		Division 5Z			
			Subdivision 5Zw		
Year	Division 5Y	Subdivision 5Ze	Food landings	Industrial landings	Total
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	1,253	271	243	4,729	6,496
1980	840	240	241	2,112	3,433

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

			Division 5Z			
	Division 5Y		Subdivision 5Ze		Subdivision 5Zw	
Year	Spring	Autumn	Spring	Autumn	Spring	Autumn
1971	0.9[b]	1.0	2.4[b]	2.1	8.5[b]	3.4
1972	2.1[b]	1.8	1.7	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
1980	4.0	2.5	0.8	4.3	4.4	5.7

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

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

7. Pollock

Reported U.S.A. commercial landings of pollock from Subarea 5 for 1980 totalled 17,900 MT (Table 12), compared to 15,419 MT for 1979. The U.S.A. commercial catch-per-unit-of-effort abundance index increased from 6.4 MT in 1979 to 7.6 MT in 1980 (Table 12), while the bottom trawl survey abundance index (Table 12) declined from 5.8 kg/tow in 1979 to 4.6 kg/tow in 1980.

8. Atlantic Herring

The U.S.A. landings of Atlantic herring from Division 5Y increased from 63,764 MT in 1979 to 81,932 MT in 1980 (Table 13). Increases occurred in both the juvenile and adult fisheries. For the third consecutive year, concentrations of spawning herring did not appear on the traditional autumn spawning grounds on Georges Bank (Subdivision 5Ze).

The autumn bottom trawl survey abundance index (Table 14) showed no change from the 1979 index. The spring bottom trawl survey abundance index declined slightly from the 1979 level, but is still above the 1971-80 average.

Table 12. U.S.A. pollock commercial landings (MT, round fresh) and commercial catch-per-unit-of-effort and autumn bottom trawl survey abundance indices for Subarea 5.

Year	Landings	C/E abundance index[a]	Survey abundance index[b]
1971	4,727	6.0	4.0
1972	5,242	7.7	4.4
1973	5,728	7.8	4.7
1974	8,050	7.6	3.2
1975	8,573	6.3	2.0
1976	10,241	6.6	16.7
1977	12,722	8.2	8.8
1978	17,535	7.3	5.8
1979	15,419	6.4	5.8
1980	17,900	7.6	4.6

[a]Landings (MT) per standardized day fished as calculated for medium and large [>50 gross (English) tons] otter trawlers in Subareas 4 and 5.

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

Table 13. U.S.A. Atlantic herring landings (MT, round fresh) from Subarea 5.

Year	Division 5Y	Division 5Z Subdivision 5Ze	Division 5Z Subdivision 5Zw	Total
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	1,076	64,899[b]
1980	81,932	165	1,153	83,250

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

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

Table 14. U.S.A. 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
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
1980	0.0	17.8

[a]Stratified mean catch per tow in numbers.

9. Atlantic Mackerel

The U.S.A. commercial landings of Atlantic mackerel from Subarea 5 increased 47% from 1979 to 1980 (Table 15) and were the highest since 1970. The U.S.A. commercial catch-per-unit-of-effort abundance index doubled from 1979 to 1980 (Table 15). The spring bottom trawl survey abundance index increased from 0.2 in 1979 to 0.4 kg per tow in 1980 (Table 16). The autumn survey abundance index remained the same from 1979 to 1980.

Table 15. U.S.A. Atlantic mackerel commercial landings (MT, round fresh) and catch-per-unit-of-effort abundance indices.

Year	Landings	C/E abundance index[a]
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
1980	1,606	1.4

[a]Landings (MT) per standardized day fished; includes Subarea 6.

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

Year	Spring	Autumn
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	0.1
1979	0.2	0.1
1980	0.4	0.1

[a]Stratified (spring strata = 1-25 and 61-76; autumn strata = 1-42 and 49) mean catch (kg) per tow in Subareas 5 and 6.

10. Industrial Groundfish

Landings for industrial purposes from Subarea 5 (predominantly Subdivision 5Zw) decreased 53% from 1979 to 1980 (Table 17). In the absence of sufficient sampling in 1980, the species composition was assumed to be the same as in 1979.

11. Squid

The U.S.A. landings of long-finned (Loligo sp.) squid from Subareas 5 and 6 declined 4% from 1979 to 1980, and landings of short-finned (Illex sp.) squid declined 79% from 1979 to 1980 (Table 18). The 1979 and 1980 landings of Loligo sp. greatly exceeded previous levels.

The autumn bottom trawl survey abundance index for Loligo sp. was greater in 1980 than in 1979 in both numbers and weight for Division 5Y, Subdivision 5Ze, and Subdivision 5Zw-Subarea 6 (Table 19).

The autumn bottom trawl survey abundance index for Illex sp. declined in 1980 for all three areas in terms of weight, while in numbers the index declined only in Subdivision 5Zw and Subarea 6 (Table 20).

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

Year	Total	Species composition (%) for Subdivision 5Zw				
		Silver hake	Red hake	Flounders	Ocean pout	Others
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
1980	3,070	7.4	71.7	3.3	2.9	14.7

Table 18. U.S.A. squid landings (MT, round fresh) by species[a] from Subareas 5 and 6.[b]

Year	Loligo sp.	Illex sp.
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	4,297	1,558
1980	4,136	334

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

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

Table 19. U.S.A. Loligo sp. squid autumn bottom trawl survey abundance indices for Subareas 5 and 6.[a]

Year	Division 5Y		Subdivision 5Ze		Subdivision 5Zw and Subarea 6	
	Weight	Number	Weight	Number	Weight	Number
1971	<0.1	0.6	1.1	34.1	4.0	234.2
1972	0.0	0.2	1.1	39.3	9.4	389.9
1973	<0.1	0.9	4.5	60.9	14.2	542.9
1974	<0.1	0.8	2.2	62.1	11.4	355.9
1975	0.8	0.8	1.8	102.6	13.6	895.5
1976	0.4	12.7	3.1	103.5	15.8	579.8
1977	<0.1	0.8	1.0	43.8	11.9	577.9
1978	<0.1	0.2	1.6	45.6	5.7	198.4
1979	<0.1	0.7	2.0	76.1	4.7	258.3
1980	0.5	8.6	4.8	144.8	17.7	744.8

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

Table 20. U.S.A. Illex sp. squid autumn bottom trawl survey abundance indices for Subareas 5 and 6.[a]

Year	Division 5Y		Subdivision 5Ze		Subdivision 5Zw and Subarea 6	
	Weight	Number	Weight	Number	Weight	Number
1971	0.4	1.8	0.5	1.7	0.3	2.0
1972	0.2	0.8	0.2	1.1	0.5	4.9
1973	0.6	2.0	0.5	2.5	<0.1	0.6
1974	1.2	3.9	0.2	1.1	0.2	4.1
1975	2.7	7.3	1.1	6.4	1.0	15.7
1976	4.2	13.8	14.8	45.0	6.2	19.8
1977	2.2	7.2	5.0	15.8	4.5	15.8
1978	1.9	5.8	12.2	44.7	2.6	19.5
1979	4.4	11.3	11.2	37.5	7.4	29.1
1980	4.1	11.3	9.2	42.4	1.4	12.7

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

12. Sea Scallops

The U.S.A. sea scallop landings from Subarea 5 in 1980 reached their highest level since 1963 (Table 21). Effort increased dramatically while catch per unit of effort declined to the 1972 level and is expected to decline further in 1981.

Table 21. U.S.A. sea scallop landings (MT of meats) from Subarea 5 and catch-per-unit-of-effort abundance indices.

Year	Landings	C/E abundance index[a]
1971	1,698	0.5
1972	1,348	0.5
1973	1,544	0.6
1974	1,152	0.7
1975	1,653	0.8
1976	2,136	1.1
1977	5,199	1.2
1978	5,841	1.1
1979	7,100	0.8
1980	7,468	0.5

[a]Landings (MT of meats) per standardized day fished.

B. Special Research Studies

Special research studies for Subarea 5 are combined with those for Subareas 4 and 6 and reported under "SUBAREA 6."

III. SUBAREA 6

A. Status of the Fisheries

1. Silver Hake

The U.S.A. commercial landings of silver hake from Subarea 6 declined only slightly (2%) from 1979 to 1980 (Table 22), with the 1979-80 level being the highest since the early 1960's.

Table 22. U.S.A. silver hake commercial landings (MT, round fresh) from Subarea 6.

Year	Food landings	Industrial landings	Total
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
1980	8,650	36	8,686

2. Red Hake

The U.S.A. commercial landings of red hake from Subarea 6 decreased 8% from 1979 to 1980 (Table 23), but were still the third highest since the 1960's.

Table 23. U.S.A. red hake landings (MT, round fresh) from Subarea 6.

Year	Food landings	Industrial landings	Total
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
1980	1,219	304	1,523

3. Atlantic Herring

The U.S.A. landings of Atlantic herring from Subarea 6 increased from 154 MT in 1979 to 210 MT in 1980 (Table 24). The U.S.A. spring bottom trawl survey abundance index in 1980 remained at about the same low level as observed in 1979 (Table 24).

Table 24. U.S.A. Atlantic herring landings (MT, round fresh) and spring bottom trawl survey abundance indices for Subarea 6.

Year	Landings	Survey abundance index[a]
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
1980	210	0.2

[a]Stratified mean catch per tow in numbers.

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

4. Atlantic Mackerel

The U.S.A. commercial landings of Atlantic mackerel from Subarea 6 increased 20% from 1979 to 1980, continuing an upward trend of the last several years (Table 25). The U.S.A. commercial catch-per-unit-of-effort abundance index doubled from 1979 to 1980 (Table 25).

Table 25. U.S.A. Atlantic mackerel commercial landings (MT, round fresh) and commercial catch-per-unit-of-effort abundance indices for Subarea 6.

Year	Landings	C/E abundance index[a]
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
1980	1,077	1.4

[a]Landings (MT) per standardized day fished; includes Subarea 5.

5. Sea Scallops

The U.S.A. landings decreased noticeably (31%) from 1979 to 1980 (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 1981.

Table 26. U.S.A. sea scallop landings (MT of meats) and catch-per-unit-of-effort abundance indices for Subarea 6.

Year	Landings	C/E abundance index[a]
1971	895	0.4
1972	1,307	0.5
1973	857	0.4
1974	1,569	0.8
1975	2,769	0.9
1976	6,576	1.2
1977	5,904	1.3
1978	8,641	1.2
1979	7,336	0.7
1980	5,098	0.5

[a]Landings (MT of meats) per standardized day fished.

B. Special Research Studies

1. Environmental Studies

a) Hydrographic studies

A 13-mo study of a cross-shelf transect south of Nantucket showed the mean alongshelf flow to the westward at 4×10^5 m^3/sec, but varying with storms, Gulf Stream eddies, etc. Further analysis should show cross-shelf transport of mass, heat, salinity, and nutrients.

A 2-yr study of the Northeast Channel showed a remarkably uniform transport of nutrient-rich slope water into the Gulf of Maine at 2.5×10^5 m^3/sec. Winter flow was vigorous, but fluctuated wildly in response to storms; summer flow was weaker, but remained very steady. Nutrient influx accounted for 40% of that needed for primary production on Georges Bank.

A study was begun to determine the flux of mass, heat, salinity, nutrients, and primary productivity into and out of Chesapeake Bay. Another study was begun to determine the source of low-frequency, nontidal currents in central Long Island Sound.

Documented was a delayed fall overturn in Southern New England waters. Also documented was a persistent, record-diameter, warm-core eddy in the Middle Atlantic Bight. For the 73rd consecutive year, recordings were made at Boothbay Harbor (40°10'N, 69°43'W) of air/surface/bottom temperatures, salinity, barometric pressure, precipitation, tide level, wind speed/direction, and dew point.

Publications covered variations in shelf-water fronts from Georges Bank to Cape Romain, passage of Gulf Stream eddies off the northeastern U.S.A., mean monthly water temperatures at 30 m in coastal waters of the eastern U.S.A., sea-surface temperatures in the Northwest Atlantic, temperature variations on the continental shelf and slope south of New England, variations in water-column thermal structure and cold-cell formation off Sandy Hook, and the fifth and final reporting in an annual series (1974-78) portraying natural environmental variations in U.S.A. coastal waters.

b) Plankton studies

Six surveys, half joint efforts with Poland and the Union of Soviet Socialist Republics (U.S.S.R.), comprised the fifth year of ichthyoplankton surveys between the Scotian Shelf and Cape Hatteras. (These surveys simultaneously monitored chlorophyll-a, dissolved oxygen, carbon-14, nitrate, nitrite, ammonium, silicate, phosphate, temperature, salinity, marine mammals, and marine birds.) Survey-collected eggs were used to estimate spawning stock biomasses of yellowtail flounder, silver hake, haddock, and bluefish. Survey samples also revealed an 86% decline in the estimated abundance of sand lance from 1979. (The 1980 winter moderated after the cold winters, anomalous winds, and below-normal water temperatures of 1976-79, the latter four years associated with tremendous sand lance populations.) Specialized ichthyoplankton surveys included an Atlantic herring larval survey in the Sheepscot Estuary (Gulf of Maine) from October to March, a striped bass egg and larval survey in major Virginia rivers, and an anadromous fish egg and larval survey in the Meherrin and Cape Fear Rivers (North Carolina) to determine spawning areas.

Continuing analysis of the 39 ICNAF larval Atlantic herring surveys on Georges Bank and Nantucket Shoals during the 1971-77 spawning seasons resulted in seasonal abundance estimates by 1-mm length classes, age/length-specific instantaneous mortality rate estimates for fully vulnerable length classes, and initial larval abundance estimates.

Basic biological research on ichthyoplankton included the biomolecular monitoring of survey-collected larval fish (as a means of determining condition) being expanded to include lipids and carbohydrates as well as proteins and RNA/DNA, thus allowing better association of energy reserve mobilization with embryonic and larval growth and survival. Other such research focused on the feeding strategies of post-larval spot in Chesapeake Bay eelgrass beds, the development and early feeding of several sciaenids, and the osteological development of larval American shad.

An effort has begun to extend isoelectric focusing methodology to the identification of larval fish, emphasizing the "fingerprinting" or direct electrophoretic extraction of proteins for each species.

Macrozooplankton surveys from the Scotian Shelf to Cape Hatteras showed 80 taxonomic categories occurring in these coastal waters, but with only three copepods dominating the community -- Pseudocalanus minutus, Calanus finmarchicus, and Centropages typicus. Specialized zooplankton surveys included three monitoring cruises in lower Chesapeake Bay, and an assessment of the zooplankton community in the oligohaline portion of Chesapeake Bay.

A prototype system was developed for increasing the efficiency of zooplankton analysis using electronic image scanning and pattern recognition techniques.

Studies on the relationships between ichthyoplankton and zooplankton included integrated analysis of the aforementioned ichthyoplankton and macrozooplankton surveys revealing synchrony between copepod production and fish spawning -- Atlantic herring with P. minutus in the Gulf of Maine; haddock and Atlantic cod with Calanus finmarchicus on Georges Bank; yellowtail flounder, Atlantic mackerel, and silver hake with Centropages typicus in Southern New England waters; and bluefish with C. typicus in the Middle Atlantic Bight. Concurrently, we are continuing to integrate larval fish survival and growth on the nursery grounds with the abundance and availability of zooplanktonic prey.

Along these lines, analysis of the aforementioned ICNAF larval Atlantic herring surveys (in which survival rates were compared with initial and subsequent abundance of larvae; spawning time and location; larval size, growth, condition, and prey selection; recruitment; and hydrographic and climatic regimes) showed an association between high larval survival and high abundance of P. minutus. A further detailed examination was begun of prey selection and morphological condition for the 1974-76 spawning seasons -- the 3 yr showing the most diverse environmental conditions. (Also begun was a study of the composition, distribution, and abundance of the total ichthyoplankton/zooplankton community for these latter 3 yr.)

Experimental studies on the relationships between ichthyoplankton and zooplankton included using an in-situ environmental-control chamber in the Pettaquamscutt Estuary (Southern New England waters) to relate the daily growth and survival of first-feeding winter flounder to zooplanktonic prey concentration, temperature, salinity, and dissolved oxygen. (Daily mortality experiments on larvae from the same spawn were run in the lab for comparative purposes.) Other lab work established daily mortality rates for larval summer flounder, winter flounder, and haddock, at constant temperature and varied prey concentrations, and determined biochemically the nitrogen budget for larval summer flounder, allowing estimation of food assimilation for growth and subsequent survival.

By taking part in 15 monitoring surveys, we continued to establish baseline phytoplankton biomass (chlorophyll-a) and organic production between the Scotian Shelf and Cape Hatteras. Three areas -- New York Bight, off Chesapeake and Delaware Bays, and central Georges Bank -- were documented as having high phytoplankton abundance. In fact, the data show the abundances to be as much as twice as high as previously thought.

Continuing reduction and analysis of phytoplankton data collected on monitoring surveys since 1977 have resulted in separating the Scotian Shelf-to-Cape Hatteras region into 17 subregions, and beginning an analysis for seasonal trends in species composition, distribution, and abundance in each such subregion.

An algal bioassay using Thalassiosira pseudonana has been developed to determine the relative fertility of various areas from the Scotian Shelf to Cape Hatteras for phytoplankton production. Early observations show that although nitrogen is usually most limiting, other nutrients, vitamins, and trace metals often rivaled or exceeded nitrogen limitation.

c) Benthic studies

In continental shelf waters from the Scotian Shelf to Cape Hatteras, distribution and abundance surveys were conducted, throughout the natural ranges, for surf clams, ocean quahogs, sea scallops, red crabs, and northern deepwater prawns. Surveys limited to the Gulf of Maine were conducted for sea scallops, green crabs, Jonah crabs, Atlantic rock crabs, American lobsters, and northern deepwater prawns. Surveys limited to North Carolina estuarine waters were conducted for blue crabs, brown shrimp, white shrimp, and pink shrimp (the latter three species belonging to the genus Penaeus). Surveys limited to the Virginia waters of Chesapeake Bay and the Middle Atlantic Bight were conducted during May through July and October through December for juvenile blue crabs.

Assessments were performed for the various stocks of surf clams, ocean quahogs, sea scallops, red crabs, American lobsters, and northern deepwater prawns located between the Scotian Shelf and Cape Hatteras. An assessment limited to Southern New England waters was performed on Jonah crabs.

Basic biological/ecological studies included the recapture phase of an ocean quahog mark-recapture experiment to determine growth rates in the New York Bight; field observations on the factors influencing the setting, growth, and mortality of surf clams; studies on the movement of blue crabs off North Carolina; the identification and characterization of a bacterium suspected of causing large opaque lesions in adductor muscles and viscera of sea scallops in the inshore Gulf of Maine; and a natural history study of the knobbed whelk (Busycon carica).

Major publications and reports were: a report on 25 yr of data collection on the quantitative distribution of macrobenthos in the Middle Atlantic Bight; a report on the quantitative distribution of bivalve mollusks along the American East Coast; a report describing the quantitative distribution of 97 species (includes five previously undescribed species) of gammaridean amphipods on Georges Bank; a (nearly completed) comprehensive illustrated guide to the temperate-water decapod crustaceans of the American East Coast; a monograph on the benthic macrofauna of the New York Bight; an atlas on the distribution and abundance of benthic invertebrates in the New York Bight; manuscripts (submitted for publication) on the benthic macrofaunal assemblages of Long Island and Block Island Sounds; publications on new species of polychaetes and amphipods; a new checklist (soon to be published) of the benthic invertebrates of Chesapeake Bay; a book, Histology of the Blue Crab, Callinectes sapidus: a Model for the Decapods, which is the first complete study on the histophysiology of a decapod species, and which includes comparisons with what is known of the histophysiology of other decapod species; a manuscript (soon to be published) reviewing the viral rickettsial, bacterial, and fungal diseases of crustaceans, to be included in a multivolume treatise on the Biology of Crustacea; and a manuscript (soon to be published) resulting from a cooperative study with Canada on the histopathology of gaffkemia of American lobsters.

d) Environmental quality studies

Studies on the relationships between fossil fuels and marine fisheries included a cytogenetic examination of yellowtail flounder and fourbeard rockling eggs after a gasoline barge spill in Block Island Sound; severe short-term direct effects and possible long-term maternal effects were demonstrated.

Finfish and shellfish collected from continental shelf waters from the Scotian Shelf to Cape Hatteras were analyzed for petroleum hydrocarbons as well as polychlorinated biphenyls (PCB's). Contaminated fish were collected out to the shelf-slope break, with silver hake having significantly higher concentrations than expected.

Monitoring continued of proposed oil and natural gas drilling sites on Georges Bank. Four weeks of manned submersible operations established predrilling baselines for benthic habitats and for the community structure, abundance, behavior, and contaminant load of benthic macrofauna. A report was issued for such work during 1978-80.

Laboratory research included documenting the normal behavior of juvenile red hake in order to evaluate later the effects of drilling muds. Other research showed that blue crabs and red hake can avoid oil-contaminated sediments, but that ability can be overridden by shelter requirements.

An assessment was made of the potential effects of coal-waste disposal in continental shelf waters.

Studies on the relationships between industrial chemicals and marine fisheries included a collection of finfish samples from relatively impacted and nonimpacted sites on the continental shelf of the American Atlantic and Pacific coasts for PCB analysis. The PCB levels were correlated with species, sex, age/size, and location.

A study was nearly completed on the maternal effects of contaminants (emphasizing PCB's) on the growth, survival, and biochemical condition of striped bass eggs from East Coast rivers.

A cruise was conducted in the New York Bight to determine the levels of PCB's, polyaromatic hydrocarbons, heavy metals, and the sewage-pollution-indicator coprostanal in sediments, finfishes, and shellfishes. A similar cruise was conducted at Deepwater Dumpsite 106, also in the New York Bight, to look at

sediments, epifauna, and meio/macrofauna. Further work at Deepwater Dumpsite 106 was a continuing effort to monitor the parasites and pathologic lesions of planktonic crustaceans.

A study was undertaken to determine the effect of Kepone on the vertebral development of young spot.

Studies on the relationships between heavy metals and marine fisheries included 15 monitoring surveys between the Scotian Shelf and Cape Hatteras to continue establishing spatial and temporal baseline concentrations. We analytically determined the concentrations of six metals (lead, mercury, cadmium, copper, nickel, and chromium) in sediment samples from four 1978-79 surveys.

In studies of Raritan Bay, an area with high levels of heavy metals, copper contamination of American cupped oyster tissue was correlated with acute inflammation and diapedesis. Blue mussels from Raritan Bay were also found with increased mucous cells in the gills, and without the common parasites Nematopsis ostrearum and Bucephalus cuculus, but no correlation with copper contamination has been established yet.

Laboratory studies have measured the effects of lead, cadmium, copper, and silver on the blood biochemistry, oxygen consumption, and muscle enzymes associated with carbohydrate and nitrogen metabolism for American lobsters, winter flounder, windowpane flounder, sea scallops, blue mussels, American cupped oysters, and slipper limpets (Crepidula fornicata). Other laboratory studies have measured the effects of copper on olfactory tissue and the chemosensory food-finding ability of larval summer flounder, winter flounder, and haddock. The latter studies have yielded no definite results yet.

To test the effects of heavy metals on the growth of Middle Atlantic Bight bloom-associated phytoplankton, the flagellate Olisthodiscus luteus was exposed to those metals in those concentrations found in the Bight. Nickel, copper, iron, and lead inhibited growth at the higher concentrations.

Studies on the relationships between sewage dumping and marine fisheries included analytically determining the concentrations of organic contaminants and coprostanol in Middle Atlantic Bight sediments. Highest concentrations were located in the New York Bight apex. We began associating these concentrations with the species composition, diversity, and abundance for benthic communities.

Red hake with integumental ulcers continued to be collected from Raritan Bay and sewage sludge dumpsites for histopathological and chemical analysis. Atlantic rock crabs continued to be collected at the Philadelphia-Camden sewage sludge dumpsite for monitoring gill discoloration and blackening; 10% of the 1980 collection was so affected. A manuscript was prepared on the gill-fouling community associated with black-gill disease in Atlantic rock crabs.

A manuscript was published on the pollution-associated diseases of marine finfish and shellfish as applied to the sewage-polluted New York Bight.

Testing began on the responses of red hake, tautog, winter flounder, sand lance, and juvenile bluefish to low dissolved oxygen concentrations as found in the New York Bight. Cruises during March and September between the Scotian Shelf and Cape Hatteras began baseline monitoring of seabed oxygen consumption. As expected, the highest rates were in the New York Bight apex.

Reports were prepared on historical changes in phytoplankton distribution and abundance as correlated with changes in environmental quality. Changes in phytoplankton species composition were strongly correlated with estuarine influence and entrained pollutants.

Eleven months of monitoring were conducted for the dinoflagellate Ceratium tripos which contributed to the 1976 anoxia off New Jersey. The 1980 abundance, though, was only five percent of the 1976 abundance. Five surveys were also conducted between the Scotian Shelf and Cape Hatteras to begin monitoring those large net phytoplankters which can contribute to decreased habitat quality.

Three experiments were undertaken in the Chesapeake and Delaware Bay plume to determine its role in providing nutrients and pollutants to the Middle Atlantic Bight and to develop an ability to remotely sense such environmental quality parameters. The experiments measured temperature, salinity, dissolved oxygen, chlorophyll-a, phaeophytin, and total plankton respiration. Although the total plankton respiration was lower than that in the Hudson River plume, its influence extended as far south as Cape Henry in a low runoff year. During the experiments, ships made direct measurements while high-flying aircraft and satellites remotely sensed the configuration and location of the plume and the total suspended matter within it. The remotely sensed data correlated well with the directly measured data.

Work continued on developing cytological and cytogenetic means of measuring pollutant effects in marine organisms. Practical results from the cytogenetic work was the documentation that during 1974, 1977, and 1979, Atlantic mackerel egg development was poorer the closer to the highly polluted New York Bight. Also, field and laboratory appraisal of the micronucleus test on fish blood cells as a means of measuring contaminant impact, has initially shown high levels in Atlantic cod and red hake.

Work on indicator species and conditions for monitoring habitat quality included x-raying 2,500 sand lance, collected between the Scotian Shelf and Cape Hatteras during 1979-80, for vertebral anomalies. No acute disease was evident, but higher incidences of anomalies occurred at inshore and shallower stations. Also, an excellent association was shown between human-pathogenic amoebae (Acanthoamoeba spp.) and fecal coliform and streptococcal bacteria. Since amoebae produce cysts which survive several years, they could be good indicators of the spread or persistence of sewage sludge deposits.

2. Biological Studies

a) Systematics

Work continued on an annotated list of commercial and potentially commercial gadiform and scombroid fishes of the world. Work also continued on the anatomy and systematics of Spanish mackerels.

b) Stock definition

Collection of silver hake was completed and analysis of their morphometric characteristics was begun to delineate better the various stocks of that species.

c) Distribution

The seasonal distribution of Atlantic butterfish will be documented for waters off Virginia.

d) Age/growth

More than 50,000 age determinations were made in total for Atlantic cod, haddock, redfish, silver hake, red hake, pollock, yellowtail flounder, winter flounder, summer flounder, southern flounder, scup, white hake, Atlantic herring, Atlantic butterfish, alewife, American eel, American shad, Atlantic croaker, blueback herring, hickory shad, spot, squeateague, striped bass, white perch, and large Atlantic sharks.

e) Reproduction

Maturity observations were recorded for more than 60,000 finfishes collected during bottom trawl surveys between the Scotian Shelf and Cape Hatteras. A subset of these specimens, composed of haddock, silver hake, yellowtail flounder, summer flounder, tilefish, bluefish, Atlantic herring, Atlantic mackerel, and Atlantic croaker, were analyzed for fecundity.

Special studies covering several aspects of reproductive biology were conducted for large Atlantic sharks and spotted weakfish.

A study was undertaken on the management consequences of sequential hemaphroditism in black seabass.

f) Food habits

A report was prepared on the prey of 15 species of gadiforms; it described each species/stock as either piscivore, invertebrate feeder, or mixed. A similar report was prepared for eight species of pleuronectiforms. Analyses continued of the food habits of 17 species of finfishes collected on bottom trawl surveys between the Scotian Shelf and Cape Hatteras during 1973-76, and of potential predators of Atlantic herring eggs collected on Jeffreys Ledge during 1977-78. Data continue to be collected on the food habits of finfishes collected on bottom trawl surveys, and of large Atlantic sharks.

A digestion study was conducted with winter flounder and juvenile white hake in order to convert field data on predator-prey relationships into estimates of predation rates and daily rations. An exponential digestive process model was used on silver hake and Atlantic cod to estimate daily rations. A radio-tracking experiment, a first of its kind, was done on blue sharks to determine digestion rates in free-swimming individuals.

g) Movements

Studies continued on the migrations and movements of large Atlantic sharks. Five thousand fish representing 20 species were tagged in the Atlantic, Gulf of Mexico, and Mediterranean Sea. Of the 100 returns, some demonstrated transatlantic movement of more than 3,000 mi.; some were at liberty for 13 yr.

Tagging studies were conducted in the Gulf of Maine for Atlantic herring, rainbow smelt, American plaice, Atlantic cod, pollock, and haddock, and off North Carolina for striped bass and southern flounder.

h) Diseases/parasites

Enumeration continued of integumental lesions observed on all finfish sampled on bottom trawl surveys between the Scotian Shelf and Cape Hatteras. There were 29,876 fish examined in 1980, including Atlantic cod, summer flounder, haddock, Atlantic herring, American plaice, pollock, red hake, white hake, silver hake, winter flounder, and yellowtail flounder. Data have been collated on 27,433 of the observations; 1.13% had lesions (0.56% fin rot, 0.21% skeletal anomalies, 0.20% ulcers, and 0.16% lymphocystis). Fin rot was most evident on Atlantic cod and winter flounder.

Studies continued on the infectious pancreatic necrosis virus of marine and anadromous clupeids and osmerids. Emphasis shifted from etiology and pathology to epizootiology. Juvenile American shad appear as susceptible as Atlantic menhaden, while blueback herring and rainbow smelt may be somewhat more resistant. In Chesapeake Bay the virus affects mostly age I Atlantic menhaden. In the enzootic area in 1980, age I+ Atlantic menhaden had a five percent mortality rate -- a low annual figure.

In other work, Gulf of Maine fish were examined for piscine erythrocytic necrosis, Chesapeake Bay commercially important fish were analyzed for the effects of parasites, and a literature survey was conducted on known parasites of American eels.

i) Environmental factors

Studies were completed on effects of thermal fronts on distribution and activity of juvenile bluefish. They showed the ability to enter and feed in potentially lethal cold temperatures, although this activity varies seasonally, perhaps reflecting changing ecological requirements associated with fall migratory movements. Studies also continued on the relationship between thermal fronts on the distribution of large Atlantic sharks.

A study began on the relationships between temperature and winds fields on the one hand and Atlantic mackerel abundance and timing of migration on the other hand. Another study began on the effects of climatic variables on Atlantic croaker abundance in Chesapeake Bay.

Research was undertaken on the importance of eelgrass beds to the survival and growth of young Chesapeake Bay fishes. Other research looked at the impact of water quality on the spawning of alewives and blueback herring in North Carolina.

j) Miscellaneous

A monograph was prepared on the general biology of Middle Atlantic Bight fishes, and a study continued of the general biology of deepsea fishes from the Middle Atlantic Bight and Bermuda area.

3. Gear and Selectivity Studies

Exploratory fishing operations were conducted along the North Carolina coast out to the 200-m contour using bottom trawls. Species of interest were the calico scallop and rock shrimp (Sicyonia brevirostris).

An international meeting was held on hydroacoustic methods for population size estimation. Out of the meeting came a publication critically reviewing hydroacoustical methods.

Various sizes of cod-end mesh were evaluated for retention and gilling of various species in the 1979-80 winter bottom trawl fishery off North Carolina. Also, hydrodynamic studies, including towing geometry and flow patterns within the net, were conducted with an Isaacs-Kidd midwater trawl.

A new sea scallop drag was designed and built to test solutions to problems of size selection by existing gear and of mortality of unharvested animals overrun by the gear. Development and refinement continued of a deepwater hydraulic dredge for surf clam and ocean quahog assessment. Work continued on a manuscript on underwater observations on the performance and environmental effects of an hydraulic clam dredge in a high density area off southwestern Long Island.

Research has continued on scup pot design.

4. Miscellaneous Studies

Evaluation continued of the success of stocking coho and chinook salmons in New Hampshire waters. The evaluation involves percentage return to the fishery and fishways.

Evaluation continued of the success of restoring American shad in New Hampshire waters. The evaluation involves fall netting of downstream migrants, percentage return to fishways, and catch statistics.

Evaluation continued of the success of restoring alewives and blueback herring to their former distribution and abundance in New Hampshire waters. Restoration efforts involve passing adults above dams for spawning and transferring fish from rivers with abundant runs to those with few or none. The evaluation involves percentage return to fishways and catch statistics.