WOODS HOLE LABORATORY REFERENCE DOCUMENT NO. 86-09

REPORT OF SECOND NEFC STOCK ASSESSMENT WORKSHOP (SECOND SAW)

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National Marine Fisheries Service
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Woods Hole Laboratory
Woods Hole, Massachusetts 02543

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I. INTRODUCTION

The status of 13 important fishery resources in the New England and Mid-Atlantic regions were reviewed during a one-week workshop in early May 1986. Participants were from a variety of fisheries research and management agencies and East Coast academic institutions (Table 1). Assessment data and recent analyses were presented in unreviewed working papers by the scientific staff of the Northeast Fisheries Center as updates to previous stock assessment documents. This information was critically reviewed by the participants. Analytic difficulties and limitations were identified, additional analyses were undertaken, and the status of each of the stocks was determined. This document reports the results of that workshop, emphasizing the final consensus of the status and likely outlook for each stock. Scientific information needs are also identified.

The workshop format was a substantial departure from approaches that have been used in recent years to generate information on the status of the fish stocks in these regions. The possibility and need for adopting alternate approaches was discussed at a similar workshop in July 1985, here referred to as the First Stock Assessment Workshop (First SAW). Representatives of NEFC described some of the goals of changing to a workshop format, emphasizing the need (1) for greater peer review of the scientific and technical aspects, (2) for involving scientists from outside NEFC who had different perspectives and who have access to additional sources of assessment data not heretofore used in NEFC assessments, (3) to encourage the development of stock assessment expertise in state and academic institutions, and (4) for general review of biological and management terms of reference for stock assessment studies to make more efficient use of limited research resources.

NEFC representatives contrasted the roles of the several fishery agencies in generating stock assessment information using two system diagrams. The first (Figure 1) describes the existing routes by which information is obtained, emphasizing the central role of NEFC and the multiple information paths to the several management agencies. The second diagram (Figure 2) suggests how the present workshop might in the long term fit into a more integrated system, where most of the status of stocks information would be channeled into a series of assessment reports.

Representatives of NEFC suggested that the workshop proceed by reviewing the material presented in the working papers, in the sequence suggested in a draft agenda (Appendix). The procedure of having verbal presentations of the key points and assumptions in the data and analyses represented in the working papers, followed by in-depth review in a plenary session, was adopted. Additional analyses of data summaries suggested during the discussions were handled by establishing ad hoc working groups as needed (Appendix).

I. INTRODUCTION

Table 1. List of participants for the second Stock Assessment Workshop (SAW), May 5-9, 1986, Woods Hole, Massachusetts. Those individuals listed with an asterisk(*) participated in a portion of the meeting for specific topics.

NAME	AFFILIATION
Hader, Warren*	Mid-Atlantic Fishery Mgt. Council
Hoff, Tom	" " " " "
Kaifer, David*	" " " " "
Marchessseault, Guy*	New England Fishery Mgt. Council
Russell, Howard	" " " " "
Crecco, Vic	Connecticut DEP
Conover, David*	SUNY, Stony Brook
Degan, Linda*	U. Massachusetts - Amherst
Lynch, Tom*	Rhode Island DFW
Mason, John	New York DEC
Rothschild, Brian	U. Maryland - Solomons
Hoey, John	NMFS/SEFC - Miami
Colosi, Pete	NMFS/NER - Gloucester
Mahoney, Glen	" " "
Rehfus, Ruth	" " "
Seamans, Dick	" " "
Smolowitz, Ron	" " "
Testaverde, Sal	" " "
Mears, Harry	NMFS State/Federal Branch-Gloucester
Chang, Sukwoo	NMFS/NEFC - Sandy Hook
Almeida, Frank	" " - Woods Hole
Anthony, Vaughn*	" " - " "
Azarovitz, Tom*	" " - " "
Boreman, John*	" " - " "
Byrne, Chuck*	" " - " "
Clark, Steve*	" " - " "
Christensen, Darryl*	" " - " "
Doll, Jack*	" " - " "
Fogarty, Mike	" " - " "
Foster, Karen	" " - " "
Gabriel, Wendy	" " - " "
Goodale, Hannah*	" " - " "
Hennemuth, Dick*	" " - " "
Idoine, Joe*	" " - " "
Jearld, Ambrose*	" " - " "
Lange, Anne	" " - " "
Logan, Phil*	" " - " "
Mayo, Ralph	" " - " "
McBride, Margaret	" " - " "
Mello, Sue*	" " - " "
Morrissey, Tom*	" " - " "
Murawski, Steve	" " - " "
Overholtz, Bill	" " - " "
Parry, Betsy*	" " - " "

Table 1. Continued

Name	AFFILIATION
Pearce, Jack*	NMFS/NEFC - Woods Hole
Peterson, Allen*	" " - " "
Richards, Anne	" " - " "
Serchuk, Fred	" " - " "
Shepherd, Gary	" " - " "
Shepherd, Sue*	" " - " "
Smith, Mary Jane*	" " - " "
Smith, Tim (Chairman)	" " - " "
Waring, Gordon	" " - " "
Wigley, Sue*	" " - " "

The participants noted that both the working papers and the verbal presentations of recent analyses for each stock represented preliminary and unreviewed analyses. The working papers were labeled NOT TO BE CITED to reflect their preliminary nature. The participants emphasized that this disclaimer is required to facilitate scientists presenting the most current information without concerns of being quoted on preliminary and unreviewed analyses. The participants agreed that the working papers were for the use of the meeting only, and recommended no further distribution

The stocks to be reviewed were assigned to three groups, with plenary session reviews tentatively scheduled for Monday afternoon, Tuesday morning, and Wednesday morning. Other topics identified for discussion included review of methods of evaluating precision and accuracy of trawl surveys, description of existing trawl survey and stock assessment research programs, identification of biological and management information needs, and development of cooperative research programs. Time for working groups to meet was identified, and a plenary review of the draft report of the meeting was scheduled for Friday morning. Finally, the need to review the format of this series of workshops was identified in preparation for future workshops.

To be effective in the way suggested in Figure 2, the report of the workshop would need to describe the technical aspects of the assessment analyses without becoming too involved for direct use by management agencies. Additionally, the specific aspects of the status of the stocks discussed will need to be adjusted to the management needs of the relevant agency. Participants noted that this would be difficult, and several formats for the report were discussed. This topic was discussed at several points during the meeting, and the resulting report format was envisioned as possibly evolving substantially in future workshops.

The workshop participants noted that it would be useful for management agencies to develop terms of reference to meet their assessment information needs within the context of the envisioned series of workshops.

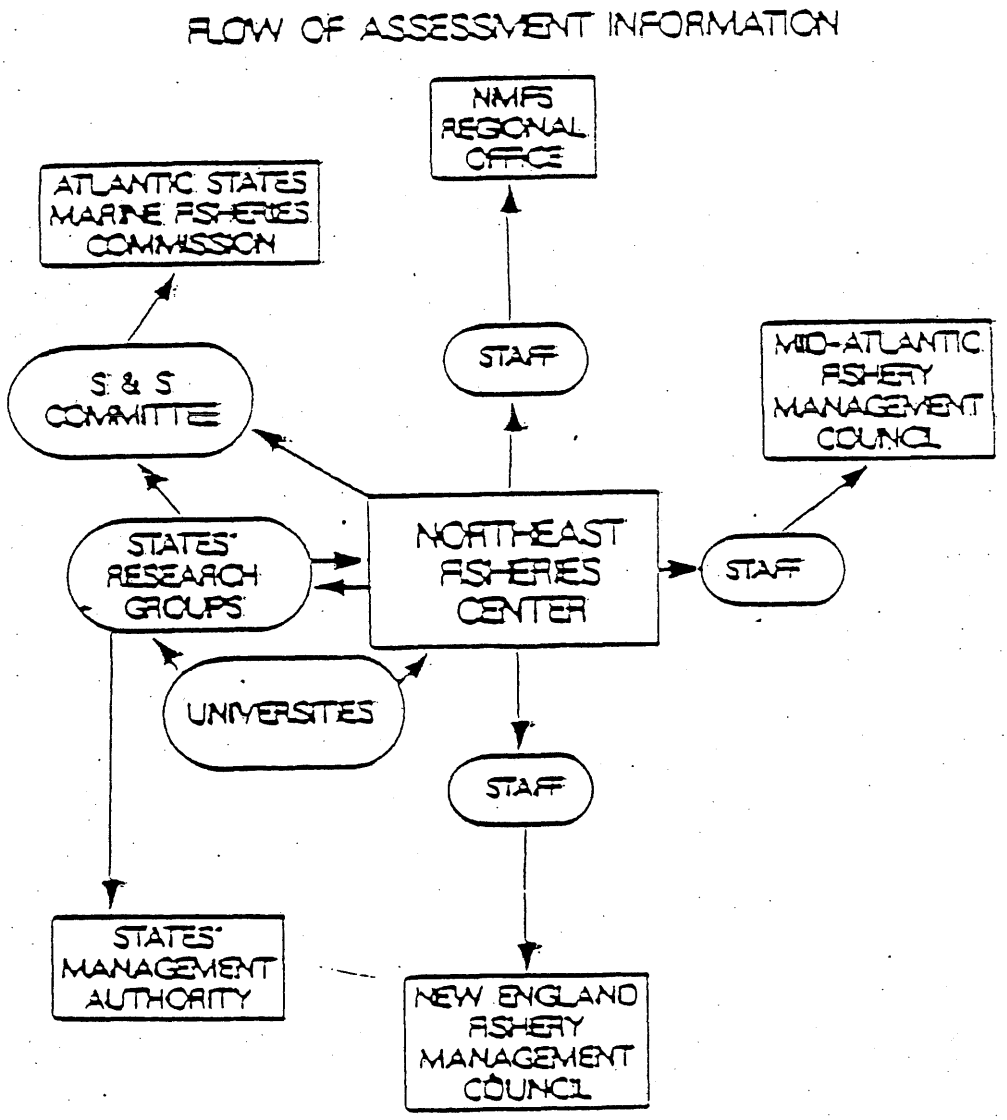


Figure 1. Illustration of flow of stock assessment information in the northeastern region of the US. Note central role of Northeast Fisheries Center in meeting the needs of five separate agencies, and the several independent information paths.

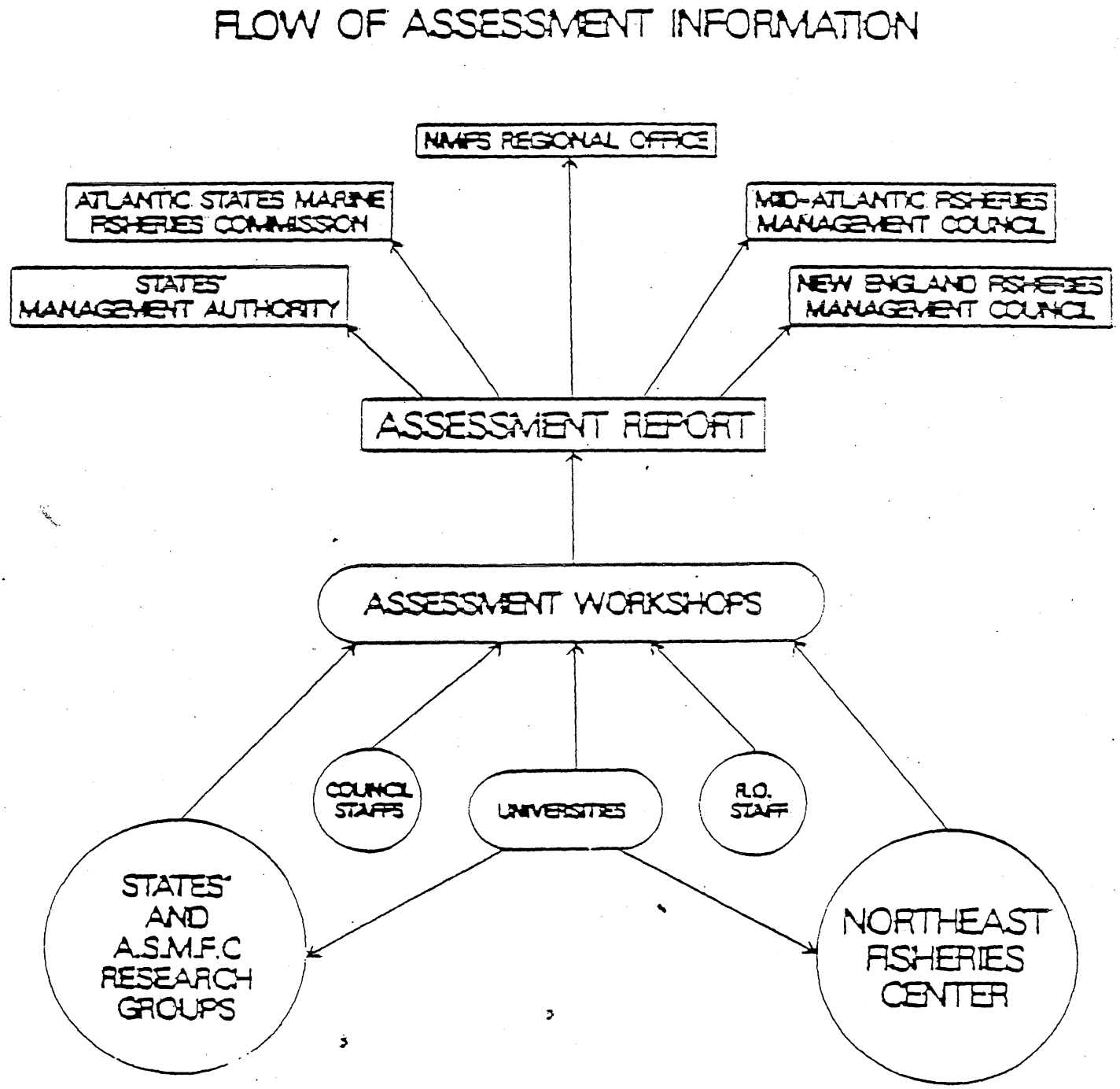


Figure 2. Illustration of alternate flow of assessment information in the northeastern region of the US. Note the reduced and noncentral role of Northeast Fisheries Center, the central flow of information, and the increase role of state and academic institutions.

II. SPECIES REVIEW

The participants agreed that the workshop's review and updating of assessments of most species could be most efficiently communicated in a report (1) by identifying the previous stock assessment report as a source document, and (2) by including only the data and analyses that are not in that source. Text was generated by the rapporteurs by editing and adding to the working papers. For some species an adequate reference document was not available (American plaice), or was up to date. For some species, new assessment documents were reviewed and completed during the workshop (scallops, mackerel). The detail and new data included for each species or stock in this report varies depending on the nature of the source document. Where a source document is available, only data and analyses not included are described. Where an up-to-date source document is available, only the discussion and research needs identified during this workshop are included. Most figures have not been updated, and some of the text refers to data included in the source documents and not repeated here; the source documents are available on request from the Population Dynamics Branch of the Conservation and Utilization Division of the Northeast Fisheries Center. The tables and figures for each stock are numbered separately from the tables and figures in the text in sections I, III, and IV of this report.

II. SPECIES REVIEW--HADDOCK

1. HADDOCK

Source Document: Overholtz, W. J., S. H. Clark, and D. Y. White. 1983. A review of the status of the Georges Bank and Gulf of Maine haddock stocks for 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-23, 31 p.

1.1 GULF OF MAINE HADDOCK

Nominal Catch and Catch at Age

USA haddock landings from the Gulf of Maine have declined steadily since 1980, reaching a low of 2,232 mt in 1985 (Table 1.1.1). Total catch (USA and Canada) peaked at 7,596 mt in 1983 and dropped to 3,023mt in 1985 (Table 1.1.1).

Age compositions for the Gulf of Maine haddock stock are shown in Table 1.1.2. The recent catch has been dominated by the 1978, 1979, 1980, and 1982 year classes.

NMFS and Massachusetts Survey Data

Autumn research surveys (NMFS) in the Gulf of Maine indicate a steady decline in abundance for this stock since 1978 (Table 1.1.3). Catch per tow (wt) declined from 18.2 in 1978 to 2.6 in 1984. Survey catch increased to 6.2 in 1985 (Table 1.1.3).

Survey age compositions indicate that the adult stock (2+) has declined since 1978 (Table 1.1.4). The increase in catch per tow in 1985 appears to be a result of increased catches of the 1982 year class, but also could partially be due to a gear conversion to more efficient otter boards.

Autumn surveys conducted by the Massachusetts Division of Marine Fisheries have been useful for following recruitment trends in this stock (Table 1.1.5). The 1979, 1980, and 1982 year classes at age 0 appear to be relatively abundant and have been important in the commercial fishery at age 2 and 3 (Table 1.1.2). The 1983, 1984, and 1985 year classes seem to be very poor (Table 1.1.5). Spring surveys provide a similar outlook of year class strength at age 1 (Table 1.1.5). Haddock apparently migrate to deeper water bythe autumn of their first year and hence are unavailable in the Massachusetts survey.

DeLury Results

Results of a modified DeLury analysis (Collie and Sissenwine 1983) suggest that stock abundance peaked in 1978 and has declined precipitously since then (Figure 1.1.1). Age 2+ abundance peaked at 42 million fish in 1979 with an influx of fish from the 1975 year class and declined every year since then to a low of 10 million fish in 1985.

II. SPECIES REVIEW--HADDOCK

Discussion

Although several year classes are now supporting the fishery in the Gulf of Maine, they appear to be smaller than first indicated and future recruitment prospects are very poor. Fishing mortality is probably relatively high on this stock at the present time, but no formal analysis is available. Based on recruitment indices from the Massachusetts survey and commercial catches, it appears that large year classes from Georges Bank may spill over into some areas of the Gulf of Maine fishery at age 2-3+. This means that with present low recruitment from Georges Bank and very poor 1983-1985 year classes in the Gulf of Maine, this stock will probably be reduced to all time low levels in 1986-1987.

Higher 1985 abundance indices may reflect increased gear efficiency rather than actual increases in population abundance. Participants noted similar high 1985 values for other demersal species including haddock, redfish, flounders, and other principal groundfish species. A working group was appointed to collate 1985 abundance indices for all species. Considerable discussion took place on possible analytical procedures for correcting for this increased catchability including utilizing delta distributions and normalization procedures comparing standardized species cluster values with component individual species values. Mention was also made of a general need in future assessment analyses to include confidence intervals on all abundance indices. In particular, this would help interpretation of Gulf of Maine indices where small sample sizes associated with large sample strata seem to produce greater variability in abundance indices. Participants noted that although these discussions had emphasized variability in these indices the overall impression was that they were in fact highly reliable and had tracked historical abundance trends. It was felt that the potential analytical improvements discussed could reduce variability in the indices but that these corrections would be minor and would not change overall predicted trends.

Future work was suggested on landings data, especially Canadian landings from 1982, 1983, and 1984. It was noted that there was a possibility of misreporting in this case. Interest was also expressed in determining historical percentages of landings from areas now within Canadian jurisdiction. A review of U.S. landings data was also suggested to isolate "spill over" year classes from Georges Bank which would be reflected in landings attributed to the more southern areas of the Gulf of Maine rather than the rather than the traditional Gulf of Maine grounds.

Table 1.1.1 Commercial landings[1] of haddock (metric tons, live) from the Gulf of Maine, 1982-1985.

	Georges Bank			Gulf of Maine			Total		
Year	USA	Canada	Total	USA	Canada	Total	USA	Canada	Total
1982	12,567	4,921	17,488	5,623	1,127	6,755	18,195	5,902	24,097
1983	8,669	3,213	11,882	5,593	2,003	7,596	14,262	5,211	19,473
1984	8,300	1,463	10,263	2,792	1,245	4,037	11,592	2,708	14,300
1985[2]	4,272	3,484	7,756	2,232	791	3,023	6,504	4,275	10,779

[1]As reported to ICNAF/NAFO for Division 5Z and 5Y, respectively (5 NK landings have been assigned to Division 5Z).

[2]Provisional (incomplete).

Table 1.1.2 Percent age composition of haddock in commercial landings (all countries) from the Gulf of Maine, 1983-1985.

Year	2	3	4	5	6	7	8	9+
1983	13.9	29.2	23.7	10.8	4.9	9.1	5.4	3.0
1984	3.6	3.2	31.4	26.6	19.7	3.2	2.7	9.5
1985[1]	-	22.9	6.8	32.2	16.2	12.9	3.1	5.9

[1]Estimated.

Table 1.1.3 Stratified mean catch per tow in numbers and weight (kg) for haddock in NEFC offshore spring and autumn bottom trawl surveys in the Gulf of Maine[1], 1982-1985.

	Spring[2]		Autumn	
Year	Nos.	Wt. (kg)	Nos.	Wt. (kg)
1982	1.68	2.14	1.76	2.76
1983	2.47	2.36	1.74	3.46
1984	0.74	0.76	1.14	2.58
1985[3]	1.77	1.88	4.08	6.15

[1]Strata 26-28 and 36-40.

[2]Data for 1968-1972 and 1983-1985 were collected with a "36 Yankee" trawl, and the remaining years (1973-1981) with a "41 Yankee" trawl. No adjustments for trawl size differences were attempted. A conversion factor of 1.70, representing the surface area ratio of the "41 Yankee" to the "36 Yankee", was used in previous assessments.

[3]Starting in the spring of 1985 new otter doors were used. No adjustments for differences were attempted at this time.

Table 1.1.4 Stratified mean catch per tow at age (numbers) for haddock in NEFC offshore spring and autumn bottom trawl surveys in the Gulf of Maine[1], 1982-1985.

	Age												
Spring	0	1	2	3	4	5	6	7	8	9	0+[2]	1+[2]	2+
1982	-	0.04	0.34	0.79	0.37	0.14	0.05	0.01	0.00	0.00	-	1.74	1.70
1983	-	1.00	0.06	0.36	0.21	0.21	0.00	0.12	0.00	0.02	-	2.48	1.48
1984	-	0.01	0.35	0.06	0.19	0.06	0.00	0.00	0.03	0.00	-	0.74	0.73
1985[4]	-	0.00	0.38	1.01	0.04	0.16	0.11	0.05	0.02	0.00	-	1.77	1.77
Autumn													
1982	0.25	0.03	0.42	0.51	0.34	0.42	0.03	0.15	0.00	0.00	1.75	1.50	1.47
1983	0.00	0.37	0.04	0.41	0.33	0.25	0.11	0.05	0.12	0.04	1.75	1.75	1.38
1984	0.00	0.14	0.35	0.01	0.17	0.00	0.34	0.00	0.00	0.14	1.15	1.15	1.01
1985	0.00	0.09	0.66	2.51	0.05	0.16	0.17	0.39	0.00	0.05	4.08	4.03	3.99

[1]Strata 35-38 and 36-40.

[2]May not agree exactly with data in Table 3 because of rounding differences.

[3]Data for 1968-1977, and 1982 were collected with a "36 Yankee" trawl and the remaining years (1973-1981) with a "41 Yankee" trawl. No adjustments for trawl size differences were attempted. A conversion factor of 1.70, representing the surface area ratio of the "41 Yankee" to the "36 Yankee", was used in previous assessments.

[4]Starting in the spring of 1985 new otter doors were used. No adjustments for differences were attempted at this time.

Table 1.1.5 Stratified mean catch per tow in numbers and weight (kg) for haddock in Massachusetts spring and autumn inshore surveys in the Gulf of Maine, 1983-1985.

	Stratified mean catch per tow at age[1] (numbers)								Stratified mean catch per tow
Year	0	1	2	3	4	5	6+	Total	in weight (kg)
Massachusetts (Spring)									
1983	0.00	2.94	0.00	0.16	0.02	0.02	0.00	3.14	0.58
1984	0.00	0.04	0.25	0.10	0.10	0.04	0.00	0.53	0.42
1985	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.15	0.14
Massachusetts (Autumn)									
1983	0.41	0.03	0.00	0.00	0.00	0.00	0.00	0.44	0.01
1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[1]Obtained by applying combined NEFC age-length keys from offshore and inshore strata.

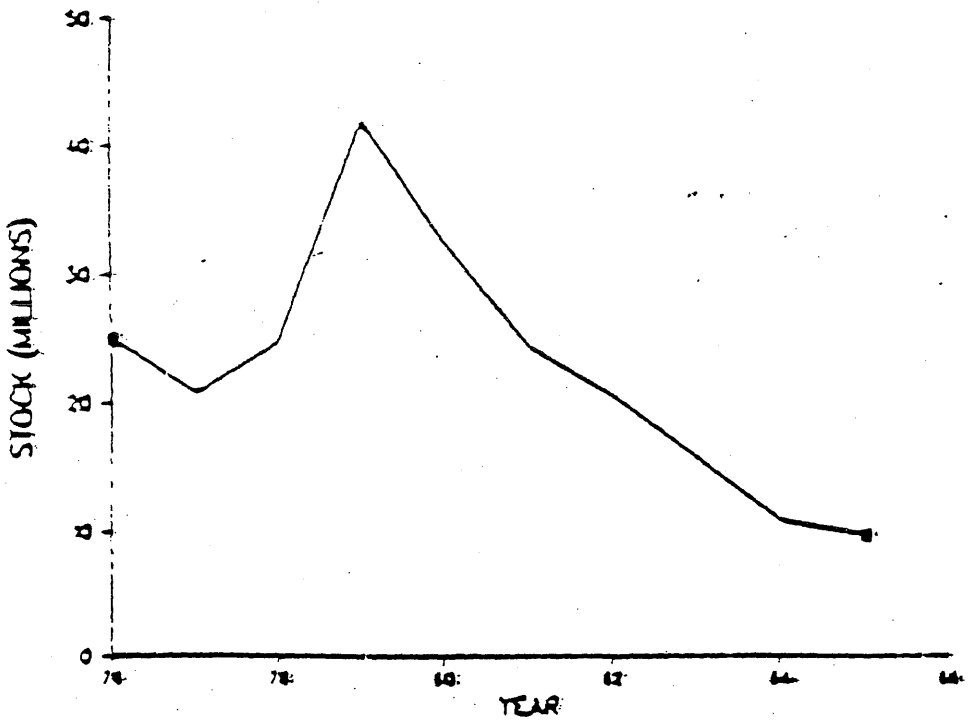


Figure 1.1.1. Stock size (millions, age 1+) for Gulf of Maine haddock calculated from the modified DeLury method, 1976-1984.

1.2 GEORGES BANK HADDOCK

Nominal Catch and Catch at Age

Haddock landings by the USA dropped to 4,272 mt in 1985, the lowest catch since 1977 (Table 1.2.1). Total catch (USA and Canada) declined to 7,756 mt in 1985, the fifth year of decreasing landings since the recent peak of 27,571 mt in 1980.

Catch compositions for the Georges Bank fishery in 1984 suggest that the fishery was supported by the 1980, 1978, and remnants of the 1975 year classes (Table 1.2.2). Preliminary catches from 1985 suggest that the 1983 and 1978 year classes are most important.

NMFS Research Survey Data

Spring and autumn survey catch per tow (wt and Nos) declined steadily after peaking in 1980 and 1979, respectively (Table 1.2.3), but increased in 1985. Preliminary estimates for spring 1986 were less than the 1985 values for weight and about half that for number (Table 1.2.3).

Autumn bottom trawl age compositions suggest that adult stock abundance is very low at this time (Table 1.2.4). Survey catch per tow (2+) has declined in every year since 1980. Increases in catch per tow in 1985 are due almost entirely to large catches of age 0 fish from the 1985 year class (Table 1.2.4). Catch per tow for the 1985 year class declined considerably in the spring 1986 survey, suggesting that it may be smaller than first anticipated (Table 1.2.4.).

VPA Results

A preliminary VPA with 1984 as the terminal year was completed with a starting F of 0.50 (Table 1.2.5). This value of F was the result of both USA and Canadian assessment work (Waiwood and Neilson 1985). Fishing mortality (3+) since 1980 has averaged about 0.40 on this stock (Table 1.2.5).

Stock size (2+) has declined steadily since 1980 from 117,947 mt to 23,318 mt in 1985 (Table 1.2.6). Spawning stock biomass (3+) has dropped in every year since 1978, reaching a low of 15,818 mt in 1985.

Short-term Outlook

Projections of catches in 1987 and spawning stock biomass in 1988 were made under several assumptions about the size of the 1985 year class, the likely levels of fishing mortality in 1987 and 1988, and the actual catch in 1986 (Table 1.2.8). The workshop participants noted that the virtual population analysis yielded F values at age 2 for the 1975 and 1978 year classes which were approximately double the overall mean F's across all ages in those years (Table 1.2.5), and suggested that this pattern could be used to adjust selectivity factors on the 1985 year class to refine these projections. Calculations were completed by a working group during the workshop assuming (1) that the 1986 catch would be 6,841 mt, (2) that the

1985 year class at age 2 would be either 30 or 60 million fish, and (3) that the fishing mortality in 1987 and 1988 would be either reduced to 0.1 or kept at current levels of 0.4, or alternately equal to 0.4 for all ages except twice as high for age 2 (Table 1.2.8).

These calculations suggest that lower levels of fishing mortality in 1987 and 1988 would result in a larger spawning stock biomass in 1988, but with a disproportionate reduction in catches in 1987. Assuming that the the 1985 year class produces 30 million fish at age 2, and that fishing mortality is reduced from the current 0.4 to 0.1, a 72% decrease in catch and a 61% increase in spawning stock biomass in 1988 would result. However, if F is 0.4 except that age 2 fishing mortality is elevated as was seen for the strong 1975 and 1978 year classes, there would be a 44% increase in catch and a 31% decrease in spawaning stock, respectively (Table 1.2.8).

If the year class is twice as large at age 2, then the corresponding impacts of an elevated fishing mortality at age 2 would be to increase catch by 96% and to decrease spawning stock by 36% (Table 1.2.8).

Discussion

At present only the 1983 and remnants of the 1978 year classes are supporting the fishery and spawning stock. Recruitment prospects for 1986 are very poor since the 1984 year class is one of the lowest on record. The size of the 1985 year class in 1987 will determine the extent of recovery in this stock. Under the current F scenario, and the 60 million fish option, this year class will be reduced quickly and perhaps will provide 2-3 years of moderate size yields. Conducting the fishery on a by-catch basis (F=.1) would produce a spawning stock of 80,000 mt in 1987. If the 1985 year class is smaller than suggested from the autumn survey then prospects for recovery of the spawning stock appear to be diminished.

As for the Gulf of Maine haddock stock the 1985 abundance index values were considered less reliable than previous indices. Future projections, however, would be influenced by the magnitude of the 1985 year class when it recruits to the fishery at age 2. Considerable discussion occurred on the apparent consistent pattern of increased fishing mortality on large year classes when they first recruit to the fishery at age 2. Results of the working group were presented. It was observed that there was nearly a one for one trade-off in catch and spawning stock when the 1985 year class recruits in 1987. The consensus of the group was that maintaining as much spawning stock as possible was important. Other discussion centered on the stock-recruit plot and the performance of the stock at various stock sizes.

Table 1.2.1 Commercial landings[1] of haddock (metric tons, live) from Georges Bank, 1982 - 1985.

YEAR	USA	CANADA	TOTAL
1982	12,567	4,921	17,488
1983	8,669	3,213	11,882
1984	8,800	1,463	10,263
1985[2]	4,272	3,484	7,756

[1] As reported to ICNAF/NAFO for Division 5Z and 5Y, respectively (5 NK landings have been assigned to Division 5Z).

[2] Provisional (incomplete).

Table 1.2.2 Catch (numbers, 000's) by age group for Georges Bank haddock from 1981 - 1984.

YEAR	Age Groups								TOTAL
	2	3	4	5	6	7	8	9+	
1981	1518.9	9525.0	743.1	711.5	2354.5	317.0	142.9	89.2	15,402
1982	1295.9	1622.3	2958.6	331.9	679.3	1492.2	132.2	118.7	8,512
1983	79.2	680.2	701.0	1928.7	279.8	221.9	905.4	92.6	4,796
1984	100.5	320.7	734.6	385.2	1531.5	204.7	313.4	456.0	3,591

Table 1.2.3 Stratified mean catch per tow in numbers and weight (kg) for haddock in NEFC offshore spring and autumn bottom trawl surveys on Georges Bank[1], 1982 - 1986.

YEAR	SPRING[2] Nos.	SPRING[2] Wt. (kg)	AUTUMN Nos.	AUTUMN Wt. (kg)
1982	7.27	11.01	3.66	4.86
1983	3.77	8.75	5.37	3.81
1984	4.21	4.93	3.62	2.97
1985[3]	11.14	8.85	14.19	3.68
1986[4]	5.13	5.93		

[1] Strata 13-25, 29, and 30.

[2] Data for 1982-1984 were collected with a "36 Yankee" trawl.

[3] Starting in the Spring of 1985 new otter doors were used. No adjustments for differences were attempted at this time.

[4] Preliminary

Table 1.2.4 Stratified mean catch per tow at age (numbers) for haddock in NEFC offshore spring and autumn bottom trawl surveys on Georges Bank[1], 1983 - 1985.

	Age											Totals	
Spring	0	1	2	3	4	5	6	7	8	9+	0+[2]	1+[2]	2+
1983[3]	-	0.29	0.37	0.39	0.15	1.62	0.01	0.03	0.78	0.12	-	3.76	3.4
1984	-	1.40	0.79	0.43	0.42	0.39	0.48	0.05	0.03	0.20	-	4.19	2.7
1985[4]	-	0.00	4.96	0.76	0.40	0.87	0.34	1.17	0.10	0.25	-	8.85	8.8
Autumn													
1983	3.89	0.16	0.14	0.18	0.20	0.63	0.08	0.00	0.07	0.01	5.36	1.47	1.3
1984	0.02	2.23	0.59	0.16	0.19	0.04	0.30	0.00	0.00	0.08	3.61	3.59	1.3
1985	11.35	0.65	1.53	0.22	0.05	0.10	0.07	0.17	0.00	0.05	14.19	2.84	2.1

[1] Strata 13-25, 29-30.

[2] May not agree with data in Table 2 because of rounding differences.

[3] Data for 1982-1983 were collected with a "36 Yankee" trawl.

[4] Starting in the spring of 1985, new otter doors were used. No adjustments for otter door differences were attempted at this time.

Table 1.2.5 Fishing mortality (F) by age group and year for Georges Bank haddock from 1960 - 1984, derived from VPA.

1984 HADDOCK VPA

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	YEAR											
	FISHING MORTALITY											
2	0.184	0.124	0.117	0.151	0.124	0.467	0.534	0.059	0.473	0.041	0.237	0.473
3	0.216	0.241	0.280	0.290	0.253	0.591	0.866	0.454	0.371	0.542	0.077	0.414
4	0.246	0.225	0.294	0.316	0.307	0.531	0.552	0.437	0.426	0.433	0.351	0.280
5	0.285	0.246	0.292	0.396	0.437	0.515	0.583	0.444	0.408	0.451	0.313	0.302
6	0.190	0.279	0.279	0.308	0.543	0.716	0.463	0.549	0.495	0.543	0.259	0.800
7	0.253	0.199	0.402	0.307	0.534	0.844	0.591	0.582	0.478	0.434	0.419	0.650
8	0.233	0.250	0.290	0.326	0.384	0.603	0.708	0.490	0.579	0.512	0.378	0.517
9+	0.233	0.250	0.290	0.326	0.384	0.603	0.708	0.490	0.579	0.512	0.378	0.517
MEAN F	0.233	0.250	0.290	0.326	0.384	0.603	0.708	0.490	0.579	0.512	0.378	0.517
OF AGE	3+	3+	3+	3+	3+	3+	3+	3+	3+	3+	3+	3+

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	0.011	0.397	0.424	0.149	0.084	0.284	0.074	0.004	0.739	0.275	0.307	0.077
3	0.278	0.020	0.212	0.324	0.111	0.044	0.352	0.248	0.108	0.531	0.530	0.242
4	0.473	0.408	0.014	0.180	0.252	0.194	0.094	0.297	0.214	0.354	0.310	0.452
5	0.378	0.657	0.119	0.041	0.149	0.229	0.246	0.233	0.439	0.242	0.241	0.341
6	0.197	0.741	0.044	0.097	0.001	0.390	0.379	0.282	0.447	0.304	0.383	0.356
7	0.809	0.187	0.095	0.117	0.071	0.064	0.258	0.420	0.746	0.459	0.322	0.204
8	0.302	0.349	0.190	0.277	0.164	0.164	0.331	0.285	0.371	0.440	0.352	0.331
9+	0.302	0.349	0.190	0.277	0.164	0.164	0.331	0.285	0.371	0.440	0.352	0.331
MEAN F	0.302	0.349	0.190	0.277	0.164	0.164	0.331	0.285	0.371	0.440	0.352	0.331
OF AGE	3+	3+	3+	3+	3+	3+	3+	3+	3+	3+	3+	3+

AGE	1984
2	0.350
3	0.500
4	0.500
5	0.500
6	0.500
7	0.500
8	0.500
9+	0.500
MEAN F	0.500
OF AGE	3+

Table 1.2.6 Stock size (thousands) by age group and year for Georges Bank haddock from 1960 - 1985, derived from VPA.

STOCK SIZE

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
2	104775.3	100994.4	44408.9	31773.7	150574.3	348926.9	18076.4	3250.3	8699.0	302.2	822.3	3992.1
3	34464.2	71369.1	73045.0	32342.5	22368.9	108915.9	189276.3	8472.7	2509.0	4438.6	237.5	531.1
4	22984.9	22870.7	45007.1	45197.9	19811.5	14218.1	49369.2	65185.2	4508.7	1418.3	2113.9	180.0
5	13594.1	14714.9	14947.6	27463.9	26984.1	11928.1	6844.8	23243.7	34832.1	1974.0	759.4	1218.8
6	11388.3	8374.4	9423.6	9138.7	15128.9	14271.0	5833.1	3127.7	9809.8	15533.8	1029.8	454.6
7	3872.8	7710.6	5187.7	5837.3	5500.4	7199.5	5711.7	2460.7	1478.4	4894.7	7387.7	650.6
8	2147.4	2462.9	5173.3	2842.1	3514.4	2639.2	2533.9	2590.3	1124.2	614.6	2597.5	3978.1
9+	1840.6	3346.8	3920.4	4320.4	4554.3	3295.4	1732.6	1971.7	2093.3	1557.0	1415.6	2513.1
TOT NOS	195272.8	231845.7	201113.6	158914.4	248440.8	531394.0	279378.0	110522.1	63057.2	30735.2	16563.6	13518.4
WGHTUNAD	232444.5	269745.6	233679.3	205234.7	252776.6	427592.1	272301.7	144342.5	94338.8	57609.9	40628.5	29415.5
SPWN NOS	121927.9	161148.3	170027.4	136474.8	143038.8	273145.2	266724.6	108246.9	58967.9	30523.7	15987.9	10723.9
WGHTUNAD	149367.9	209652.8	211919.0	190557.2	183211.3	270060.7	266507.6	143113.9	89102.1	57421.7	40098.9	27437.9
3+ NOS	90494.4	130849.4	156704.7	127142.7	97866.5	162467.1	261301.6	107271.8	56358.3	30433.0	15741.2	9526.3
WGHTUNAD	142335.1	183898.7	202593.1	184266.0	153397.6	202547.0	264067.3	142587.4	86857.7	57341.0	39872.0	26491.7

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	209.4	6880.6	13703.4	8207.5	6337.4	86535.6	11392.0	4603.7	64492.1	6932.1	5382.9	1176.6
3	2036.1	169.7	3787.5	7344.4	5788.1	4762.0	53241.7	8641.1	3747.6	25300.9	4309.9	3242.5
4	235.4	1262.4	136.2	2509.5	4338.4	4243.1	3730.6	30663.3	5521.8	2755.4	12185.6	2076.0
5	111.4	120.2	687.3	109.7	1717.0	2760.4	2861.8	2779.4	10661.2	3443.4	1588.6	7318.0
6	738.1	62.5	51.0	499.6	86.3	1211.2	1796.6	1833.0	1803.2	9849.5	2342.9	1002.1
7	153.2	496.3	24.4	40.0	371.2	70.9	671.2	1006.8	1132.0	943.7	5948.0	1308.5
8	278.0	55.9	337.0	18.2	29.1	283.2	34.5	424.5	541.8	439.6	488.5	3529.1
9+	5206.0	1664.8	1583.3	399.9	815.3	806.0	260.7	203.4	286.8	274.4	438.6	360.9
TOT NOS	8967.6	10712.3	20310.0	19128.8	19482.6	100672.3	74009.1	50155.3	96386.6	50139.1	32684.9	20013.7
WGHTUNAD	25482.2	16743.1	26091.5	27830.4	34172.0	93873.6	99240.0	83523.5	117947.3	75714.4	63517.8	45846.3
SPWN NOS	8821.0	5895.9	10717.6	13381.5	15046.5	40097.4	66034.7	44932.7	51102.1	45286.6	28916.9	19190.1
WGHTUNAD	25363.4	12793.7	18801.3	22946.9	29824.5	50259.7	93410.7	83203.2	85342.4	72026.5	61256.9	45228.6
3+ NOS	8750.2	3831.7	6606.6	10921.2	13145.3	14136.7	62617.1	45351.6	31694.5	43207.0	27302.0	18837.1
WGHTUNAD	25312.5	11101.1	15676.9	20653.9	27941.4	31568.0	90923.8	82208.8	71368.9	70446.0	60288.0	44963.9

AGE	1984	1985
2	373.3	10000.0
3	891.9	215.4
4	2042.9	442.9
5	1071.2	1014.5
6	4259.1	532.0
7	569.3	2115.0
8	871.6	282.7
9+	1268.1	1062.5
TOT NOS	11347.4	15665.0
WGHTUNAD	27455.0	23318.4
SPWN NOS	11086.1	8665.0
WGHTUNAD	27259.0	18068.4
3+ NOS	10974.1	5665.0

Table 1.2.7 Data used for catch and spawning stock forecasting for Georges Bank haddock.

Age	Stock size '85 (000's)	Exploitation pattern	Mean Weight of the catch (kg)	Mean weight of the stock (kg)	Maturity ogive
2	10,900	0.7	1.14	0.52	-
3	215	1.0	1.65	1.54	1.0
4	443	1.0	2.11	1.98	1.0
5	1,015	1.0	2.54	2.39	1.0
6	532	1.0	2.94	2.77	1.0
7	2,115	1.0	3.31	3.12	1.0
8	283	1.0	3.64	3.45	1.0
9	308	1.0	3.96	3.75	1.0
10	669	1.0	4.24	4.03	1.0
11	32	1.0	4.51	4.29	1.0
12	53	1.0	4.75	4.53	1.0
13	11	1.0	4.97	4.76	1.0
14	11	1.0	5.18	4.97	1.0

Table 1.2.8 Projected 1987 catches and 1988 spawning stock biomass for Georges Bank haddock for different combinations of fishing mortalities in 1987 and 1988 (F) and 1985 year class strength at age 2 (RECRUITMENT), and assuming that the fishing mortality at age 2 (AGE 2) is either 70% of that at other ages (AVERAGE) or twice that at other ages (ELEVATED).

Recruitment	Age 2	F '87,'88	Catch '87 (mt)	Spawning STock '88 (mt)
30	AVERAGE	.1	3,409	47,446
	AVERAGE	.4	12,168	37,609
	ELEVATED	.4	21,856	26,014
60	AVERAGE	.1	5,563	83,655
	AVERAGE	.4	19,976	66,959
	ELEVATED	.4	39,150	43,010

II. SPECIES REVIEW--REDFISH

2. REDFISH

Source Document: Mayo, R. K., U. B. Dozier, and S. H. Clark. 1983. An Assessment of the Redfish, Sebastes fasciatus, Stocks in the Gulf of Maine - Georges Bank Region. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-22.

Commercial Fishery Trends

Landings of redfish from the Gulf of Maine have declined sharply from a recent maximum of 14,800 metric tons (t) in 1979 to 4,200 t in 1985 (Table 2.1). This fishery is conducted primarily by trawlers based in the northern New England ports of Rockland and Portland, Maine, and Gloucester and Boston, Massachusetts. Historically, these four ports have accounted for over 95% of USA redfish landings. Annual catches by distant water fleets have generally been less than 1,000 t except for a brief period during the early 1970's when catches approached 6,000 t. Since 1978, landings by non-USA vessels have averaged less than 100 t annually. The domestic redfish fishery in the Gulf of Maine - Georges Bank region has traditionally been conducted primarily in the central Gulf of Maine (Area 52) and in the Great South Channel (Area 51). Further details regarding the development of the New England redfish fishery, including trends in historical landings, may be found in the source document.

Between 1973 and 1977 this fishery was under a total allowable catch (TAC) management regime under the auspices of the International Commission for the Northwest Atlantic Fisheries (ICNAF). During this period, TAC's were adjusted downward from 30,000 t in 1973 to 9,000 t in 1977 in an attempt to reduce fishing mortality. The 1977 TAC was not implemented due to the USA's withdrawal from ICNAF and, since then, the stock has not been under any management regulations.

Estimates of mean weights at age (Table 2.2) and catch at age (Table 2.3) for this stock were obtained from length frequency samples weighted by area-specific monthly landings, and age/length keys based on otoliths collected by NMFS port samplers from 1969 through 1983. Numbers landed were computed by incorporating seasonal, areal, and sex-specific length-weight equations in the calculations. Age compositions for the years between 1969 and the mid-1970's indicated that the catch was composed of a broad spectrum of year classes with ages between 10 and 20 years well represented. With the recruitment of the 1971 year class in 1975 and 1976, combined with a lack of subsequent recruitment, the catch composition became increasingly dominated by this single year class through the early 1980's. Between 1978 and 1982, the 1971 year class accounted for over 50% of the total numbers landed, attaining a maximum representation of 63% in 1980 and 1981 (Table 2.3). In 1983, however, the 1978 year class recruited to the fishery in substantial numbers, accounting for approximately 15% of the total numbers landed while the 1971 year class percentage declined to 43%.

Periods of significant recruitment may also be discerned by examining trends in mean size of redfish landed over time. An overall increase in mean length, evident since the early 1960's, is caused by growth of individual

fish already recruited to the fishery, while periods of declining mean size, evident between 1975 and 1978, and 1983 and 1984, coincide with the entry of the 1971 and 1978 year classes, respectively.

Catch and Effort

Catch and effort data for this stock (Table 2.1) were obtained from the commercial fishery data base maintained at the Northeast Fisheries Center (NEFC), Woods Hole, Massachusetts. Standardized catch-per-unit-effort (CPUE) indices have been calculated from 1942 through 1985 with effort adjusted to a tonnage class 3 (51-150 gross registered tons) vessel. Until 1983 when the first analytical assessment was completed (Mayo et al. 1983), stock assessments were based primarily on analyses of catch and effort using general production models. Over the past two decades standardized CPUE has declined from a maximum of 6.4 t per day fished in 1966 to 0.9 t per day fished in 1985 (Table 2.1). During this same period estimated fishing effort increased from less than 2,000 days fished during the late 1960's to over 6,000 days fished in 1979 and 1980; since 1981 annual effort has remained between 4,000 and 5,000 days fished despite continued declines in landings (Table 2.1).

Analysis of catch and effort has become increasingly difficult due to recent declines in the directed component of the redfish fishery. For example, between 1964 and 1979, directed redfish trips (those landings 50% or more redfish) consistently accounted for 25-35% of all trips landing redfish, and the amount of redfish landed on these trips represented 80-90% of the Gulf of Maine - Georges Bank total. Beginning in 1980, the directed trip percentage declined to 11.9% and the landings percentage to 57.7%; in 1985 the corresponding figures were only 3.4 and 19.7%, respectively (Table 2.4).

Research Vessel Surveys

Bottom trawl surveys have been conducted by the NEFC in offshore waters of the Gulf of Maine and Georges Bank during autumn and spring since 1963 and 1968, respectively. Results for redfish (Tables 2.5 and 2.6) reveal an approximate tenfold decline in abundance (stratified mean number per tow) and biomass (stratified mean weight per tow) since the middle to late 1960's, coinciding with previously noted decreases in commercial CPUE indices (Table 2.1). Plots of mean lengths of redfish, particularly from inshore strata, also illustrate patterns of recruitment to the research trawl gear. Declines in mean size coincide with the appearance of the dominant 1964, 1971, and 1978 year classes at age 0 during the autumn cruises.

Virtual Population Analysis

Estimates of instantaneous fishing mortality (F) (Table 2.7), stock size (Table 2.8) and stock biomass (Table 2.9) were obtained by virtual population analysis (VPA) of the catch at age matrix (Table 2.3) assuming an instantaneous natural mortality rate (M) of 0.05. Terminal F in 1983 (0.167) was computed from the functional relationship between F and fishing effort given by Mayo et al. (1983) using 1983 effort of 4,440 standard days fished (Table 2.1). Partial recruitment in 1983 was assumed to follow the pattern exhibited during the most recent years with full recruitment occurring at age 9.

Recruitment at age 1 for 1980-1984 was estimated based on average levels computed over the 1969-1978 period (1.94 million fish) excluding the strong 1971 year class. Age-specific stock biomass estimates were derived from stock size estimates by applying commercial mean weights at age as given in Table 2.2.

VPA results suggest that F declined to approximately 0.15 between 1974 and 1976 but increased thereafter to a level between 0.23 and 0.26 during the 1977-1981 period (Table 2.7). These recent levels of F are approximately three times the $F_{0.1}$ level (0.07) and 70-80% greater than the estimate of F_{max} (0.14) reported by Mayo et al. (1983). The 1980 F (0.24) estimated by the current VPA was only slightly above the estimate of 1980 terminal F (0.22) used in the previous assessment.

Exploitable (age 5+) stock size declined steadily from 492 million fish in 1969 to 172 million in 1975, increased to 323 million in 1976 when the 1971 year class recruited to the fishery, but has since declined sharply to an estimated 94 million fish in 1984 (Table 2.8). Estimates of exploitable stock biomass (Table 2.9) are less variable, exhibiting a steady decline from 138,000 t in 1969 to 34,000 t in 1984. It should be noted that the recruitment of the 1978 year class at age 5 in 1983 provided only minimal increases in exploitable stock size and biomass estimates, compared to previous increases generated by the 1971 year class during 1976-1979. The 1978 year class appears to be considerably weaker than its relatively strong predecessor. Trends in exploitable stock size and biomass parallel those shown by number and weight-based commercial CPUE indices.

Catch and Stock Size Projection

Stock sizes were projected on a short-term basis using the 1984 age-specific stock sizes as a base level, with 1984 and 1985 F's estimated from fishing effort adjusted to yield the observed 1984 and 1985 catches of 4,722 and 4,162 t, respectively. Partial recruitment and natural mortality were assumed above, and recruitment at age 1 in 1985 and 1986 were set at the mean level (1.94 million fish) computed for 1980-1984, given the lack of evidence of relatively strong recruitment subsequent to the 1978 year class. Stock biomass and catch weights were computed by applying an average of the 1981-1983 mean weights at age. Long-term equilibrium projections were also performed with the same set of assumptions with recruitment at age 1 set equal to the overall 1969-1979 average of 25.4 million fish.

Projections based on observed catch levels provide F's of 0.163 and 0.173 for 1984 and 1985, respectively (Table 2.10). Stock size declined from 101 million fish in 1984 to an estimated 72 million in 1986, while stock biomass declined from 37,000 t to 27,000 t (Table 2.10). Results of the long-term equilibrium projections (Table 2.11) suggest that fishing at $F_{0.1}$ (0.07) would provide a catch of 4,287 t from a stock biomass of 75,000 t; a maximum long-term yield of 4,935 t may be obtained from a stock biomass of 49,000 t at an F of 0.16 (Table 2.11), the approximate current fishing mortality rate.

Thus, continued fishing at the current level of F (0.16) would provide only marginal increases in yield (+15%) over that which would be obtained by fishing at the lower $F_{0.1}$ level (0.07) but stock biomass would remain at a level approximately 35% below that which would be maintained by fishing at $F_{0.1}$.

Discussion

The general conclusions that CPUE, catch, and stock size were at record low levels was not extensively discussed by the workshop. It was recognized that it would take 20-30 years for the stock to recover even with a fortuitous recruitment event. The first biological term of reference from last year's workshop, reliability of CPUE indices, results from the shift from a primarily directed fishery to a by-catch or "top off" fishery which now accounts for about 80% of total reported landings. Although the CPUE index appears to track stock abundance, concern was expressed regarding the lack of directed catch and effort involved in recent CPUE indices. A potential avenue for investigation involves tracking individual vessels targeting on redfish through time. It was also noted that increased electronic sophistication of the fleet has probably increased catchability while stock size has declined. The second and third terms of reference from the first workshop, 1960's catch at age and refined growth curves, were identified as potential projects which could be started this year.

Discussions on management terms of reference identified the redfish assessment as a unique set of information which could be used to examine the difficulties inherent in projecting effects of regulations on a long-lived species with infrequent high recruitment events. The effectiveness of regulations designed to influence F levels on a by-catch fishery might also be investigated with respect to this fishery. Fine-scale spatial distributions were identified as a fruitful area for research.

Table 2.1 Nominal redfish catches (metric tons), actual and standardized catch per unit effort, and calculated standardized USA and total effort for the Gulf of Maine - Georges Bank redfish fishery.

Year	Nominal Catch (Metric tons) USA	Others	Total	USA Catch per Unit Effort (tons/day) Actual	Standard	Calculated Standard Effort (days fished) USA	Total
1981	7896	19	7915	2.7	1.4	5640	5654
1982	6735	168	6903	2.7	1.5	4490	4602
1983	5215	113	5328	2.1	1.2	4346	4440
1984	4722	-	4722	1.9	1.1	4293	4293
1985	4162	-	4162	1.4	0.9	4624	4624

Table 2.2 Average weights (kg) at age for redfish in the Gulf of Maine - Georges Bank commercial fishery in 1981-1983.

AGE	Year 1981	1982	1983	1981-1983 Mean
3	.081	.015	—	.048
4	—	.142	.107	.125
5	.117	.203	.172	.164
6	.150	.256	.198	.201
7	.143	.242	.249	.211
8	.195	.252	.329	.259
9	.247	—	.252	.250
10	.318	.383	.368	.356
11	.374	.395	.396	.388
12	.466	.491	.425	.461
13	—	.563	.381	.472
14	.532	.383	.471	.462
15	.592	.544	.504	.547
16	.543	.475	.595	.538
17	.528	.540	.722	.597
18	499	.504	.579	.527
19	.537	.564	.639	.580
20	.550	.583	.580	.571
21	.594	.592	.614	.600
22	.617	.563	.647	.609
23	.560	.621	.622	.601
24	.633	.499	.630	.587
25	.552	.535	.741	.609
26+	.650	.699	.682	.677

Table 2.3 Catch at age matrix (Thousands of Fish) for redfish in the Gulf of Maine - Georges Bank Region, 1969-1983.

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	YEAR											
	Catch at Age Matrix (Numbers, 1000's)											
1	1.0	1.0	1.0	25.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0
2	1.0	1.0	1.0	1.0	50.0	2.0	1.0	1.0	1.0	1.0	1.0	12.0
3	1.0	1.0	1.0	1.0	1.0	308.0	1.0	1.0	1.0	1.0	1.0	1.0
4	22.0	1.0	1.0	1.0	1.0	105.0	493.0	198.0	1.0	1.0	1.0	1.0
5	431.0	144.0	1.0	1.0	1.0	1.0	72.0	8961.0	234.0	1.0	25.0	1.0
6	439.0	4055.0	72.0	1.0	1.0	12.0	11.0	439.0	14747.0	271.0	205.0	132.0
7	1008.0	4040.0	1941.0	931.0	232.0	8.0	1.0	1.0	311.0	24569.0	849.0	175.0
8	6045.0	1020.0	4430.0	3294.0	2483.0	174.0	30.0	1.0	1.0	215.0	23739.0	1110.0
9	2513.0	9492.0	1534.0	7401.0	7930.0	1084.0	124.0	21.0	1.0	1.0	152.0	14900.0
10	6717.0	3321.0	7907.0	1712.0	8391.0	4724.0	1944.0	48.0	1.0	34.0	117.0	200.0
11	2640.0	8151.0	2747.0	7580.0	2201.0	2945.0	4360.0	447.0	81.0	33.0	48.0	44.0
12	3975.0	2734.0	6504.0	2782.0	7337.0	2435.0	2154.0	2704.0	2127.0	182.0	140.0	46.0
13	3207.0	4702.0	3000.0	2084.0	2070.0	1709.0	1932.0	3375.0	1262.0	1489.0	541.0	217.0
14	2221.0	2672.0	4267.0	1994.0	3100.0	1115.0	1442.0	1702.0	4012.0	1484.0	1226.0	491.0
15	2020.0	2302.0	1400.0	3531.0	2374.0	1302.0	1009.0	1725.0	1823.0	2948.0	1972.0	830.0
16	1340.0	3409.0	2095.0	2449.0	2024.0	935.0	1344.0	1300.0	2747.0	1740.0	1299.0	1221.0
17	751.0	1770.0	2204.0	1205.0	1799.0	1454.0	1360.0	1233.0	1444.0	1310.0	1500.0	860.0
18	524.0	1440.0	2745.0	1274.0	1300.0	910.0	1235.0	1144.0	1190.0	844.0	903.0	444.0
19	404.0	393.0	1347.0	2245.0	844.0	440.0	945.0	1424.0	1044.0	899.0	845.0	564.0
20	424.0	642.0	1143.0	734.0	933.0	621.0	1112.0	400.0	461.0	1203.0	1000.0	452.0
21	451.0	368.0	540.0	1011.0	411.0	509.0	400.0	749.0	704.0	895.0	790.0	473.0
22	345.0	539.0	1040.0	1172.0	590.0	730.0	807.0	481.0	541.0	734.0	594.0	370.0
23	469.0	573.0	559.0	710.0	424.0	271.0	492.0	321.0	117.0	500.0	532.0	349.0
24	30.0	400.0	202.0	530.0	295.0	205.0	294.0	472.0	571.0	192.0	530.0	294.0
25	100.0	44.0	130.0	1200.0	289.0	250.0	298.0	94.0	1013.0	530.0	427.0	265.0
26	847.0	1743.0	2439.0	2874.0	1977.0	1755.0	1202.0	2011.0	2157.0	2220.0	2504.0	1300.0
TOTAL	38050.0	54713.0	51599.0	47445.0	47142.0	25212.0	23441.0	30014.0	38437.0	42408.0	40155.0	26989.0

AGE	1981	1982	1983
	Year		
1	1.0	1.0	1.0
2	1.0	1.0	1.0
3	21.0	1.0	1.0
4	1.0	271.0	11.0
5	7.0	123.0	1487.0
6	40.0	46.0	159.0
7	57.0	92.0	44.0
8	47.0	30.0	43.0
9	221.0	1.0	84.0
10	12306.0	15.0	49.0
11	84.0	7240.0	141.0
12	23.0	56.0	1959.0
13	1.0	32.0	58.0
14	44.0	31.0	106.0
15	317.0	128.0	64.0
16	354.0	105.0	43.0
17	1274.0	502.0	85.0
18	504.0	452.0	419.0
19	534.0	840.0	270.0
20	396.0	324.0	551.0
21	318.0	501.0	169.0
22	361.0	484.0	224.0
23	304.0	301.0	314.0
24	324.0	134.0	195.0
25	150.0	104.0	131.0
26	1540.0	2270.0	1817.0
TOTAL	19413.0	14279.0	11529.0

Table 2.4 Domestic Landings of redfish (metric tons) and number of fishing trips on which redfish were caught for total and directed (50% redfish) fishing activity.

	Landings (metric tons)			Number of Trips		
Year	Total Landings	50% Trip Landings	Percent of Total	Total Trips	50% Trips	Percent of Total
1983	5120.2	818.7	16.0	3687	106	2.9
1984	4620.7	983.4	21.3	3981	134	3.4
1985	4087.3	806.5	19.7	4551	153	3.4

Table 2.5 Autumn NEFC bottom trawl survey stratified mean catch per tow indices, mean weights, and mean lengths of redfish in the Gulf of Maine - Georges Bank region.

	INSHORE				OFFSHORE				COMBINED	
	Stratified Mean Catch per Tow		Ave. Wt.	Ave. Length	Stratified Mean Catch per Tow		Ave. Wt.	Ave. Length	Stratified Mean Catch per Tow	
Year	Number	Kg	Kg	Cm	Number	Kg	Kg	Cm	Number	Kg
1983	30.2	8.7	.289	24.8	6.5	3.3	.509	29.1	10.0	4.1
1984	7.7	3.2	.416	27.9	7.8	4.1	.521	29.0	7.8	3.9
1985	7.2	2.1	.285	24.8	14.0	6.3	.451	28.0	13.0	5.7

Inshore Strata Set: 26, 27, 39, 40
Offshore Strata Set: 24, 28-30 36-38
Combined Strata Set: 24, 26-30, 36-40

Table 2.6 Spring NEFC bottom trawl survey stratified mean catch per tow indices, mean weights, and mean lengths of redfish in the Gulf of Maine - Georges Bank region.

	INSHORE				OFFSHORE				COMBINED	
	Stratified Mean Catch per Tow		Ave. Wt.	Ave. Length	Stratified Mean Catch per Tow		Ave. Wt.	Ave. Length	Stratified Mean Catch per Tow	
Year	Number	Kg	Kg	Cm	Number	Kg	Kg	Cm	Number	Kg
1983	4.8	0.9	.198	21.6	10.7	7.0	.649	31.0	9.9	6.1
1984	5.4	1.6	.300	25.1	4.9	2.9	.587	30.2	5.0	2.7
1985	1.2	0.4	.308	24.8	13.6	7.7	.567	30.1	11.7	6.6

Inshore Strata Set: 26, 27, 39, 40
Offshore Strata Set: 24, 28-30, 36-38
Combined Strata Set 24, 26-30, 36-40

Table 2.7 Estimates of instantaneous fishing mortality (F) derived from Virtual Population Analysis for redfish in the Gulf of Maine - Georges Bank region, 1969-1983.

AGE	YEAR 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	Fishing Mortality											
1	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.002	0.001	0.000	0.000	0.001
2	0.001	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.002	0.001	0.000	0.000
3	0.000	0.001	0.001	0.001	0.000	0.002	0.001	0.001	0.001	0.002	0.002	0.000
4	0.001	0.000	0.001	0.001	0.001	0.042	0.004	0.043	0.001	0.001	0.002	0.002
5	0.000	0.006	0.000	0.001	0.001	0.001	0.031	0.053	0.056	0.001	0.027	0.002
6	0.007	0.006	0.003	0.000	0.001	0.020	0.000	0.220	0.113	0.073	0.203	0.164
7	0.035	0.069	0.042	0.044	0.040	0.006	0.001	0.001	0.212	0.204	0.287	0.340
8	0.102	0.040	0.006	0.000	0.134	0.049	0.025	0.001	0.001	0.180	0.242	0.411
9	0.085	0.198	0.044	0.172	0.244	0.123	0.039	0.019	0.001	0.001	0.167	0.254
10	0.143	0.127	0.200	0.000	0.254	0.210	0.151	0.016	0.001	0.050	0.116	0.303
11	0.104	0.244	0.131	0.266	0.120	0.113	0.256	0.043	0.029	0.033	0.079	0.050
12	0.136	0.126	0.204	0.160	0.371	0.140	0.094	0.212	0.233	0.073	0.200	0.007
13	0.140	0.199	0.174	0.166	0.146	0.117	0.156	0.182	0.123	0.240	0.269	0.357
14	0.124	0.137	0.236	0.138	0.329	0.093	0.116	0.170	0.207	0.176	0.242	0.340
15	0.172	0.156	0.240	0.244	0.205	0.121	0.097	0.148	0.234	0.297	0.313	0.216
16	0.001	0.205	0.252	0.210	0.201	0.099	0.150	0.160	0.366	0.309	0.174	0.274
17	0.049	0.125	0.247	0.134	0.199	0.104	0.173	0.149	0.314	0.251	0.422	0.142
18	0.092	0.122	0.245	0.187	0.190	0.125	0.199	0.104	0.207	0.161	0.254	0.264
19	0.091	0.082	0.119	0.270	0.159	0.108	0.157	0.316	0.119	0.202	0.197	0.192
20	0.078	0.115	0.310	0.075	0.146	0.149	0.233	0.122	0.142	0.370	0.306	0.131
21	0.118	0.074	0.115	0.404	0.647	0.110	0.148	0.211	0.172	0.339	0.347	0.194
22	0.035	0.160	0.220	0.112	0.365	0.094	0.203	0.243	0.191	0.230	0.331	0.226
23	0.292	0.045	0.228	0.252	0.151	0.239	0.073	0.090	0.051	0.220	0.219	0.270
24	0.082	0.464	0.035	0.300	0.133	0.132	0.360	0.115	0.192	0.095	0.343	0.154
25	0.110	0.174	0.193	0.187	0.220	0.135	0.154	0.162	0.214	0.232	0.264	0.230
26+	0.110	0.174	0.193	0.187	0.220	0.135	0.154	0.162	0.214	0.232	0.264	0.230
Mean F for Ages	0.110 91	0.174 91	0.193 91	0.187 91	0.220 91	0.135 91	0.154 91	0.162 91	0.214 91	0.232 91	0.264 91	0.230 91

AGE	YEAR 1981	1982	1983
1	0.001	0.001	0.001
2	0.001	0.001	0.001
3	0.001	0.002	0.001
4	0.000	0.002	0.007
5	0.117	0.050	0.042
6	0.001	0.120	0.084
7	0.004	0.222	0.117
8	0.125	0.050	0.134
9	0.176	0.093	0.167
10	0.252	0.015	0.167
11	0.153	0.194	0.167
12	0.037	0.132	0.167
13	0.002	0.043	0.167
14	0.092	0.047	0.167
15	0.332	0.350	0.167
16	0.110	0.276	0.167
17	0.423	0.247	0.167
18	0.099	0.219	0.167
19	0.285	0.201	0.167
20	0.170	0.237	0.167
21	0.169	0.283	0.167
22	0.260	0.203	0.167
23	0.242	0.264	0.167
24	0.377	0.139	0.167
25	0.243	0.167	0.167
26+	0.233	0.192	0.167
Mean F for Ages	0.233 91	0.196 91	0.167 91

Table 2.0 Estimates of stock size (thousands of fish) derived from Virtual Population Analysis for redfish in the Gulf of Maine - Georges Bank region, 1969-1983.

AGE	YEAR 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	Stock Size (Numbers, 1000's)											
1	1114.9	1738.2	2048.3	213599.6	5394.4	1079.7	1145.5	575.0	743.4	2490.4	40249.4	1940.0
2	1427.8	1068.4	1427.8	2771.3	205047.8	5258.6	1036.1	1114.9	445.3	707.5	2429.3	47323.6
3	4882.5	1553.9	1015.4	1553.9	2490.4	194203.5	5003.1	984.3	1048.4	610.8	675.0	2441.5
4	25441.4	4440.4	1484.3	947.7	1484.3	2421.0	107364.5	4801.8	941.1	1015.6	503.0	445.3
5	77797.9	24571.9	4158.0	1424.4	924.1	1404.9	2391.3	177438.5	4374.4	892.0	947.7	554.7
6	64454.0	50684.2	23240.9	4772.2	1367.5	900.2	1341.8	2205.1	140221.6	3915.1	850.1	894.2
7	30391.3	41828.4	44245.8	22074.1	4736.9	1376.3	826.7	1288.2	1889.9	134083.8	3479.8	869.3
8	64225.9	27922.6	54847.7	40207.7	20092.6	3708.3	1246.1	783.1	1204.6	1285.1	105505.0	2403.0
9	51580.3	55164.1	28829.5	47877.2	35038.5	18713.2	3357.7	1152.5	748.8	1152.1	1013.2	77243.3
10	45424.6	27391.1	43050.7	22700.3	33332.1	25595.6	14060.4	3071.4	1079.7	711.9	1092.3	815.7
11	27599.4	36855.9	23109.5	33247.4	20009.2	28200.6	19744.6	11400.5	2870.5	1031.6	444.0	925.1
12	32005.5	23650.6	24923.7	19285.9	24241.8	16007.2	24030.9	14534.5	10463.8	2459.8	949.3	565.8
13	25701.3	23647.0	19841.3	19275.7	15634.1	15915.6	13491.0	20740.8	11109.5	7001.5	2352.7	739.1
14	19454.3	21321.4	20744.4	15044.0	15525.9	12045.8	13423.8	11140.8	14467.6	9414.1	5051.5	1711.0
15	18033.8	16341.1	17677.7	15597.0	13146.9	11748.6	11132.9	11411.5	8939.3	11757.0	7509.0	4369.6
16	17718.0	14405.6	13301.1	13230.0	11397.0	10191.0	9904.7	9607.2	9173.9	8727.1	8312.3	5222.2
17	14104.1	15541.1	10305.6	9632.2	10190.9	8840.9	8702.9	8113.8	7708.3	6851.8	6494.6	6441.1
18	5093.6	14507.9	13049.5	7451.2	8177.8	7948.7	7019.6	7029.3	6514.6	5978.3	4400.6	2929.4
19	7164.7	5093.9	13270.4	9719.5	6036.5	6434.1	6424.2	5424.0	5550.5	5039.1	4042.9	3304.6
20	5848.1	6224.6	4442.5	10367.1	7058.7	4900.2	5476.8	5427.8	3820.1	4241.0	3917.5	3701.4
21	4133.2	5147.7	5275.9	3112.2	8147.1	5005.3	4017.3	4141.5	4570.8	3104.3	2706.8	2244.6
22	10199.0	3495.1	4537.6	4423.0	1976.2	8301.5	4940.1	3229.1	3190.4	3659.9	2157.5	1873.8
23	1893.9	9364.5	2809.0	3395.5	3113.4	1305.3	7105.5	3042.2	2408.2	2507.6	2266.3	1473.8
24	471.1	1344.7	8350.5	2127.1	2435.4	2546.5	977.7	6155.5	3340.6	2172.0	1890.2	2113.1
25	918.5	411.1	804.3	7669.6	1499.7	2029.3	2144.6	643.7	5390.5	2621.3	1803.7	1201.7
26+	7779.7	11195.3	14212.6	17220.7	10259.1	14245.4	9224.3	13771.4	11478.2	10900.0	11055.4	6324.2
Totals												
Age 1+	525225.8	468441.3	400100.3	549507.3	474390.6	413123.7	366250.2	330672.8	285066.2	235006.4	231149.0	180957.3
Age 5+	491959.2	459420.3	393122.2	330414.7	259949.6	207800.9	171679.0	323094.8	282467.9	229974.1	179012.3	128603.9
Age 9+	328288.0	294413.3	246284.9	242435.9	233224.8	200570.8	165079.1	141201.9	114993.2	87777.7	68209.7	124063.0

AGE	YEAR 1981	1982	1983	1984
1	1940.0	1940.0	1940.0	1940.0
2	1843.5	1843.5	1843.5	1843.5
3	45248.7	1751.9	1751.9	1751.9
4	2330.5	44449.2	1663.1	1664.8
5	415.3	2352.6	42042.7	1571.0
6	520.3	510.2	2032.5	38347.3
7	723.9	423.6	426.9	1768.9
8	409.2	633.1	351.3	361.2
9	1282.1	343.4	572.9	292.3
10	57011.6	1002.3	326.4	441.1
11	521.3	42170.9	939.2	242.7
12	837.1	463.5	33032.9	756.0
13	493.4	774.9	384.3	24509.2
14	493.0	469.6	702.1	311.0
15	1149.4	435.1	426.3	548.4
16	3337.9	284.7	279.8	341.2
17	3778.1	2029.9	564.2	225.2
18	5479.2	2353.7	2124.9	455.8
19	2119.8	4710.9	1798.5	1710.4
20	2593.9	1515.2	3670.3	1447.7
21	3158.5	2081.6	1125.7	2954.4
22	2142.9	2494.4	1493.1	906.1
23	1425.0	1674.8	2091.6	1201.0
24	1052.0	1054.6	1298.9	1603.6
25	1723.2	692.8	872.6	1045.6
26+	7583.9	13062.1	12103.4	10444.8
Totals				
Age 1+	150915.3	132955.2	115054.3	100906.9
Age 5+	98554.4	82770.6	100857.7	93704.8
Age 9+	94277.9	79111.8	63814.3	51450.3

Table 2.9 Estimates of stock biomass (Tons) derived from Virtual Population Analysis for redfish in the Gulf of Maine - Georges Bank region: 1969-1983.

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
						YEAR						
						Stock Biomass (Tons)						
1	11.1	17.4	20.5	2136.0	54.0	10.0	11.7	6.7	7.4	27.0	402.5	19.4
2	32.6	21.4	32.6	55.4	1101.4	165.2	20.7	22.3	12.9	14.2	52.6	946.5
3	253.9	80.8	52.8	80.0	140.3	12542.1	195.1	51.3	25.6	31.8	35.1	127.0
4	2897.5	428.8	134.7	89.0	136.7	209.7	10361.9	344.9	86.6	93.4	53.6	59.4
5	6175.3	4226.4	601.8	192.3	124.8	189.7	385.0	23981.2	393.9	120.4	130.6	74.9
6	9200.6	8515.0	3998.8	730.3	233.8	171.7	296.5	438.8	27718.3	531.3	170.1	94.0
7	5132.1	10510.8	10711.6	4348.7	670.5	197.5	140.0	246.9	480.9	20441.5	664.6	106.6
8	12524.1	5277.4	13302.7	9449.0	4279.7	844.0	477.2	191.9	295.6	305.6	26401.7	466.0
9	6916.1	12195.7	6765.3	12304.4	9004.4	4512.6	1171.8	399.0	207.4	319.2	300.0	21059.9
10	11062.9	6512.1	13007.4	6502.8	10771.3	8344.1	4457.2	854.4	320.7	221.4	322.2	302.6
11	8831.8	10680.2	7695.5	11104.6	6863.2	9163.5	6752.7	3390.2	1007.5	395.1	159.7	309.5
12	10877.0	8020.3	9934.8	7077.9	8246.4	6303.4	9471.3	5043.5	4321.5	1244.8	301.6	204.0
13	9436.0	9406.3	7916.7	7691.0	6003.6	6350.3	5462.7	8203.7	4610.1	3160.3	1195.2	313.5
14	7059.5	7035.0	9074.9	6773.9	6241.4	5405.2	5459.0	4333.0	4710.8	4074.3	2261.9	776.0
15	7664.4	5556.0	7066.6	7034.2	6136.0	5375.1	5121.1	4631.6	3870.7	4973.2	3559.3	2211.0
16	8300.3	6031.5	6224.9	6244.5	5174.2	4504.4	4646.2	4102.3	4165.0	3001.0	4600.1	2496.2
17	7971.5	6236.0	4403.7	4017.8	5099.5	4461.1	4681.3	4146.1	3597.3	3334.5	2470.4	3113.9
18	2493.4	6369.5	2079.2	3941.4	4023.5	4109.0	3699.4	3296.8	3479.8	3013.1	2433.0	1517.4
19	4220.0	2664.1	6[illegible]	4947.2	3157.0	3474.4	3483.9	2966.9	2900.6	2650.5	2660.4	1030.8
20	2904.5	3604.6	2457.8	3026.3	3705.8	2760.6	3023.3	2806.2	2330.3	2320.9	2417.1	2251.1
21	2130.2	2599.6	2711.0	1008.2	4830.8	3047.8	2410.4	2145.3	2130.0	1665.4	1050.4	1775.0
22	6058.2	1572.8	3468.5	2537.2	1266.7	4790.2	2703.6	1702.4	1890.3	1935.4	1200.0	1244.2
23	1115.5	4345.1	1632.0	1996.5	1970.8	763.6	4275.4	2478.5	1471.4	1507.3	1560.5	927.0
24	332.1	440.1	4014.6	1040.3	1303.[illegible]	1632.3	593.4	3667.1	1012.3	1199.5	1140.4	1265.7
25	450.1	141.0	380.4	4295.0	979.3	1284.5	1421.9	404.3	2925.6	1500.5	1060.1	872.0
26+	4597.0	6026.7	7474.8	11503.4	6360.7	9145.2	6107.8	6874.0	6944.3	7030.2	7152.0	4396.7
Totals												
Age 1+	140014.8	130032.7	135053.0	124796.5	101100.0	100094.4	95053.6	80630.1	81097.2	73407.9	65512.0	49847.1
Age 5+	137319.7	129484.4	133302.4	122435.2	96255.3	87203.6	76464.2	80104.9	83735.3	73321.6	64000.2	46694.9
Age 9+	104505.7	100954.7	105902.4	107513.9	91446.8	85783.7	75145.4	63326.1	54046.4	43042.0	37441.1	47949.0

AGE	1981	1982	1983	1984
	YEAR			
1	19.4	19.4	19.4	19.4
2	36.9	36.9	36.9	36.9
3	4299.7	91.1	91.1	91.1
4	214.4	6311.8	170.0	170.1
5	23.0	457.2	7231.3	270.2
6	79.3	136.6	400.8	7592.0
7	102.5	112.2	102.3	440.4
8	79.8	159.5	115.2	110.9
9	116.7	95.1	144.4	93.7
10	10139.7	383.9	120.1	169.7
11	314.4	12657.5	371.9	104.0
12	396.1	337.2	14039.0	321.3
13	158.3	436.3	147.2	16130.5
14	261.2	179.9	332.5	142.5
15	280.5	231.3	213.9	282.4
16	1817.9	322.7	165.5	204.3
17	1994.0	1520.1	279.7	111.2
18	2234.1	1102.2	1230.3	253.9
19	1149.1	2441.5	1149.3	1093.0
20	1426.2	803.4	2120.8	839.7
21	1076.3	1232.3	591.2	1814.0
22	1325.5	1517.1	925.4	586.3
23	796.3	1039.5	1301.0	747.0
24	673.3	556.2	816.3	1060.7
25	951.4	370.6	514.0	415.8
26+	4929.5	9130.4	8254.5	7123.3
Totals				
Age 1+	43172.2	45970.3	41040.0	34430.9
Age 5+	40261.8	35519.1	40723.7	34113.4
Age 9+	39042.[illegible]	30459.6	32849.0	25491.3

Table 2.10 Catch and stock size projections for the Gulf of Maine - Georges Bank redfish fishery, 1984 - 1986.

	Year		
	1984	1985	1986
Reported Landings (metric tons)	4,722	4,162	—
Fishing Effort (days fished)	4,293	4,624	—
Predicted F	0.163	0.173	—
Short-Term Projections			
Stock Size (numbers, 1000's)	100,912	87,691	72,016
Stock Biomass (metric tons)	36,596	29,793	26,686
Catch (metric tons)	4,723	4,165	3,784
Projected F	0.162	0.172	0.172

Table 2.11 Equilibrium catch and stock size projections for the Gulf of Maine - Georges Bank redfish fishery.

	Stock Size		Catch	
F	Number (1000's)	Biomass (tons)	Number (1000's)	Biomass (tons)
F0.1 (0.07)	260,000	75,000	10,721	4,287
Fmax (0.16)	207,000	49,000	14,230	4,935

3. RED HAKE

Source Document: Almeida, F. P., and E. D. Anderson. 1981. Status of the Red Hake Resources off the Northeast Coast of the United States-1981. NMFS, NEFC Woods Hole Lab. Ref. Doc., No. 81-37, 48 p.

The source document for red hake used different stock definitions than are currently thought to be correct (NEFC unpublished data). The assessment updates have treated the red hake as two stocks, one including the Gulf of Maine and northern Georges Bank and the other including southern Georges Bank and the Middle Atlantic area.

3.1 GULF OF MAINE-NORTHERN GEORGES BANK RED HAKE

Catch History

Total nominal catches of red hake from the Gulf of Maine - northern Georges Bank stock in 1985 were 991 mt, taken exclusively by the U.S. (Table 3.1.1). This catch represented a 6% decrease from 1984 and a continuation of the low levels reported since 1977. Trends in total catch from this stock have shown three distinct periods. The first period, from the early 1960's through 1971 was characterized by relatively low catches, ranging from 1,000 to 5,000 mt. Catches during the second period rose sharply to a high of 15,300 mt in 1973 but declined to a series low of 890 mt by 1977. During this period, large catches averaging about 93% of the total annual catch were taken by the distant water fleet (DWF) on northern Georges Bank. From 1977 to the present, catches have averaged only 1,100 mt due primarily to the displacement of the DWF from these waters.

U.S. catches were at their peak in 1960 when 3,800 mt were reported taken by the U.S. fishery (Table 3.1.1). Catches dropped steadily to only 152 mt in 1965, rose to an average of 490 mt during 1966-1976, then increased again and have averaged 1,100 mt during 1977-1985.

Distant-water-fleet catches were relatively low during the early part of the foreign fishery in this area, averagine 2,200 mt during 1963-1969. The foreign catch rose sharply to 14,700 mt in 1973, but declined steadily to 5,600 mt in 1976. During 1977, the last year foreign fleets were allowed to fish on the northern portion of Georges Bank, only 2 mt of red hake were taken.

Abundance Indices

Research Vessel Mean Catch Per Tow

The NEFC spring bottom survey mean weight per tow index (kg, linear) increased from low levels during 1968-1971 (average of 0.6 kg) and reached a peak of 2.2 kg in 1973 before dropping steadily to 1.2 kg in 1979 (Table 3.1.2). The index then increased sharply to a series high of 4.1 kg in 1981, declined in 1982, but has risen fairly steadily to 3.9 kg in 1985. The autumn survey has reflected a trend similar to the spring, but has shown more

variability in recent years. This index also increased from low levels in the 1960's, decreased through 1982 but has risen steadily to a series high of 4.9 kg/tow in 1985.

Catch per tow in numbers (linear) for this stock has shown remarkably similar trends to the weight per tow indices in both the spring and autumn (Table 3.1.2). The spring index increased from low levels in the late 1960's to average 6.4 fish/tow during 1972-1976, decreased to 3.5 in 1979, increased to a series high of 13.2 in 1981, declined in 1982 and has averaged 9.2 during 1983-1985. The autumn index increased from low levels in the mid-1970's to a high in 1981, declined in 1982 but has steadily increased to a series high of 18.2 in 1985.

Coefficients of variation (CV) calculated for the mean weight per tow indices averaged 0.23 for both the spring and autumn surveys. Average CV's for the mean number per tow indices were 0.23 and 0.27 for the spring and autumn surveys, respectively.

Commercial CPUE indices for this stock are not available due to the by-catch nature of the fishery.

Mean Catch per Tow at Age

Mean catch-per-tow-at-age data (numbers, linear) indicate that relatively small changes in year-class strength have occurred during the 1970's and 1980's as compared to other species (Table 3.1.3). The relative strength of the 1970-1985 year classes shifted rank order from ages 0 to 7. For example, the 1976 year class was moderately strong at age 0, weak at age 1, and the second strongest at age 4. The reasons for these noticeable shifts in year-class strength with age are unclear. One possibility is that red and white hake are misidentified as ages 0 and 1. Another is that the catchability of certain age groups may be size-specific. Fluctuations in commercial catch were probably due more to market trends or the availability of other, more desirable species to the DWF than to fluctuations in the stock size of red hake. The data indicate that the 1973-1974 and 1980-1981 year classes were stronger than other years. The 1985 year class may also be strong given the second highest age 0 autumn index in the time series.

Discussion

The combination of minimal fishing pressure, combined with average to above average year classes produced since 1980 have resulted in an increase in stock size as indicated from NEFC bottom trawl surveys. It is unlikely that this stock will undergo any major declines in 1986 if catches remain at or somewhat above the levels reported since 1977. Low catch levels preclude using VPA, as recommended in the first SAW. Growth rates need to be reevaluated.

Table 3.1.1 Red hake catches (mt) from the Gulf of Maine - Northern Georges Bank stock.

Year	Bulgaria	Canada	Cuba	GDR	Japan	Poland	Romania	Spain	USSR	USA	Total
1960	-			-	-	-	-	-	-	3,792	3,792
1961	-		-	-	-	-	-	-	-	3,276	3,276
1962	-	-		-	-	-	-	-	-	1,911	1,911
1963	-		-	-	-	-	-	-	2,056	1,225	3,281
1964	-	3	-	-	-	-	-	-	1,209	197	1,409
1965	-	1	-	-	-	-	-	-	2,572	152	2,725
1966	-	4	-	-	-	-	-	-	4,484	885	5,373
1967	-	13	-	-	30	-	-	3	1,232	577	1,863
1968	-		-	2	-	-	-	-	2,073	597	2,672
1969	-		-	-	-	-	-	-	1,875	146	2,021
1970	-			-	-	-	-	-	771	261	1,032
1971	510	-	33	2	-	-	-	-	3,883	377	4,805
1972	385	-	-	1	70	4	-	-	14,020	526	15,014
1973	103		-	-	-	130	-	3	14,690	355	15,281
1974	40		-	-	-	-	100	30	6,146	560	7,332
1975	11	-	-	-	1	-	-	4	8,235	450	8,701
1976	-		110	-	-	-	7	-	5,567	653	6,337
1977	-		-	-	-	-	-	-	2	089	091
1978	-			-	-	-	-	-	-	1,223	1,223
1979			-	-	-	-	-	-	-	1,523	1,523
1980	-		-	-	-	-	-	-	-	1,029	1,029
1981	-		-	-	-	-	-	-	-	1,246	1,246
1982	-		-	-	-	-	-	-	-	1,210	1,210
1983	-			-	-	-	-	-	-	074	074
1984	-		-	-	-	-	-	-	-	1,059	1,059
1985	-		-	-	-	-	-	-	-	991	991

Table 3.1.2 Stratified mean catch per tow in numbers and in weight (kg) of red hake from the Gulf of Maine - northern Georges Bank stock (strata 20-30, 36-40) from NEFC bottom trawl surveys in the spring and autumn with accompanying standard deviations.

Year	Number Per Tow	Standard Deviation		Weight Per Tow (kg)	Standard Deviation
			SPRING		
1968	1.34	.39		.37	.21
1969	1.33	.49		.49	.19
1970	1.11	.27		.41	.13
1971	2.15	.53		.54	.14
1972	5.46	1.36		1.24	.24
1973[1]	7.90	2.76		2.16	.75
1974[1]	4.75	1.17		1.21	.26
1975[1]	6.96	.86		2.13	.32
1976[1]	6.83	.39		1.69	.30
1977[1]	4.63	.68		1.33	.24
1978[1]	4.21	.62		1.29	.18
1979[1]	3.45	.89		1.20	.34
1980[1]	6.97	1.59		2.43	.45
1981[1]	13.17	4.69		4.09	1.25
1982	6.53	1.68		2.14	.45
1983	10.02	2.94		2.94	.85
1984	7.31	1.14		2.37	.37
1985	10.22	1.59		3.91	.66
			AUTUMN		
1963	9.10	1.36		4.56	1.59
1964	3.02	.87		.93	.18
1965	2.08	.60		.97	.28
1966	1.79	.40		.72	.17
1967	1.05	.43		.39	.13
1968	.76	.27		.20	.06
1969	3.30	1.04		.55	.18
1970	3.53	1.18		.45	.12
1971	5.02	2.17		1.12	.19
1972	7.36	1.72		1.84	.45
1973	5.58	1.37		1.22	.36
1974	2.26	.51		.53	.10
1975	6.27	1.23		1.39	.23
1976	5.54	1.20		1.35	.28
1977	10.19	1.45		3.50	.47
1978	10.98	2.20		3.07	.55
1979	3.20	.95		1.69	.32
1980	12.93	3.16		3.77	.37
1981	13.70	6.27		2.53	.41
1982	5.55	1.73		1.33	.43
1983	8.17	1.24		3.27	.30
1984	3.00	1.62		2.31	.54
1985	18.24	3.17		4.86	.66

[1]Adjusted from #41 trawl catches to equivalent #36 trawl catches using a .633:1 ratio.

Table 3.1.3 Stratified mean catch per tow (numbers) at age for red hake from the Gulf of Maine - northern Georges Bank stock (strata 20-30, 36-40) from NEFC bottom trawl surveys in the spring and autumn.

	Age													Total		
Year	0	1	2	3	4	5	6	7	8	9	10	11	12+	0+	1+	2+
							Spring									
1970	-	.07	.20	.31	.03	.02	.13	.02	.12	.03	.06	.01	-	1.11	1.11	1.04
1971	-	.03	.56	.92	.30	.11	-	-	-	-	.00	-	-	2.15	2.15	2.12
1972	-	.19	1.81	2.01	.81	.41	.03	.00	.03	-	-	.06	-	5.46	5.46	5.27
1973[1]	-	.13	3.99	1.51	.91	.70	.20	.26	-	.10	.02	-	-	7.90	7.90	7.77
1974[1]	-	1.41	.47	.00	1.25	.21	.30	.13	.00	-	-	-	-	4.75	4.75	3.34
1975[1]	-	.50	1.93	2.19	.97	1.13	.14	-	.09	-	-	-	-	6.96	6.96	6.46
1976[1]	-	.50	2.76	1.51	.63	.59	.55	.14	.11	.03	.01	-	-	6.03	6.03	6.33
1977[1]	-	.24	.05	1.75	1.75	.23	.03	.09	.01	.02	.01	-	-	4.43	4.43	4.39
1978[1]	-	.21	.77	1.26	1.10	.50	.00	.05	.04	.01	.01	-	-	4.21	4.21	4.00
1979[1]	-	.11	.38	1.40	.56	.39	.20	.07	.01	.05	-	-	-	3.45	3.45	3.34
1980[1]	-	.73	1.75	.39	1.20	1.00	.62	.25	.40	.30	.22	.03	-	6.97	6.97	6.24
1981[1]	-	.97	3.99	4.05	1.91	.90	.59	.37	.20	.07	.01	-	-	13.17	13.17	12.20
1982	-	.56	2.26	1.02	1.15	.60	.47	.15	.11	.17	.01	-	-	6.53	6.53	6.03
1983	-	1.45	2.07	2.96	1.20	.65	.45	.11	.19	.04	.02	-	-	10.02	10.02	8.57
1984	-	.11	1.04	1.91	2.11	.77	.34	.10	.03	.04	.03	-	.03	7.31	7.31	7.20
1985[2]		.21												10.22	10.22	9.99
							Autumn									
1970	1.36	.91	.66	.35	.04	.06	.01	.01	.09	.04	-	-	-	3.53	2.17	1.26
1971	2.07	.53	1.20	.20	.49	.05	.03	.05	.00	.04	.10	-	.02	5.02	2.95	2.42
1972	1.20	1.41	2.36	.05	.72	.60	.01	.04	-	.05	.03	-	.07	7.36	6.16	4.73
1973	1.07	.53	1.06	.07	.06	.21	.10	.06	.02	-	-	-	-	5.30	4.23	3.98
1974	.70	.59	.29	.25	.31	.00	.01	-	-	-	-	-	-	2.24	1.54	.97
1975	.32	3.14	1.62	.66	.10	.13	.11	.07	.04	-	-	-	-	6.27	5.95	2.81
1976	1.13	1.03	1.44	.02	.61	.29	.15	.07	-	-	-	-	-	5.54	4.41	3.38
1977	.13	.72	1.05	2.39	1.14	.54	-	.24	.04	.09	.05	-	-	10.19	10.06	9.34
1978	1.07	2.53	1.09	1.90	1.99	.92	.21	.27	.14	.06	-	-	-	10.98	9.11	6.58
1979	1.02	.00	.00	.59	.49	.64	.45	.14	.04	.05	.01	.01	-	5.20	4.18	3.30
1980	1.18	2.07	1.41	3.00	2.22	.09	.21	.40	-	.16	.49	-	-	12.93	11.75	8.68
1981	8.02	1.67	1.50	.91	.71	.24	.20	.19	.09	-	.01	-	-	13.70	12.22	10.55
1982	.93	1.07	1.72	.73	.20	.17	.06	.10	.02	.01	-	-	-	5.01	4.08	3.02
1983	.05	2.07	1.05	1.95	.94	.69	.20	.22	.03	.09	-	-	-	8.17	8.12	6.05
1984	.04	1.32	1.52	1.96	1.37	.54	.18	.10	.09	.03	.03	-	-	8.08	7.14	5.82
1985[2]	4.72													18.24	13.52	

[1] Adjusted from 41 trawl catches to equivalent 36 trawl catches using a .63311 ratio.
[2] Preliminary estimate.

3.2 SOUTHERN GEORGES BANK-MIDDLE ATLANTIC RED HAKE

Catch History

The total international catch from the Southern Georges Bank-Middle Atlantic stock of red hake for 1985 was 934 mt. This was the lowest catch reported in the 1960-1985 time series and continues the trend of decreasing catches which began in 1977 (Table 3.2.1). Total catches rose dramatically with the introduction of the DWF, from 4,600 mt in 1960 to a high of 108,000 mt in 1966. Catches subsequently declined to 18,700 mt in 1968, increased to 53,400 mt in 1969, dropped to only 11,900 mt in 1970 then decreased to 61,400 mt in 1972. Since 1972, there has been a steady decline in catches, due initially to modest declines in DWF catch, and later to a sharp drop following the exclusion of the U.S.S.R. from the fishery.

U.S. commercial catch increased from 4,300 mt in 1960 to a high of 32,600 mt in 1964 then declined rapidly to 4,000 mt in 1966. This decline was followed by a period of relative stability during 1967-1979 when catches averaged 4,100 mt annually. Since 1979, U.S. catch has steadily declined to only 827 mt in 1985.

Estimates of U.S. recreational catch in 1960, 1965, 1970, 1974-1977, and 1980 were obtained from marine angler surveys. Estimates of recreational catches in the remaining years were obtained by applying ratios between recreational and U.S. commercial catch to the U.S. commercial catch. Each of the ratios were applied to the catch in the preceding and succeeding two years during 1966-1974. The 1980 ratio was used to estimate catches for 1981-1985. The recreational catch from this stock has been minimal, ranging from 31 to 971 mt and averaging 380 mt per year during 1960-1985. The 1985 catch was estimated to be only 31 mt.

Distant-water-fleet catches rose from 2,200 mt at the beginning of the fishery in 1963 to 104,000 mt in 1966 but subsequently declined to 6,800 mt by 1970. Catches then rose to 59,200 mt in 1972, then steadily declined to only 57 mt in 1984. The 1985 DWF catch was 76 mt, taken primarily as by-catch in the foreign squid fishery.

Abundance Indices

Research Vessel Mean Catch Per Tow

Spring and autumn NEFC bottom trawl survey indices were calculated using inshore/offshore data combined and the #36 Yankee trawl as the standard gear. The spring catch-per-tow index (kg, linear) increased from 0.8 kg in 1969 to an average of 2.4 during 1971-1973, then declined and fluctuated between 1.2 and 3.3 during 1974-1978 before dropping to 0.9 kg in 1979 (Table 3.2.2). The index then increased steadily to 3.1 kg in 1982, subsequently declined to 0.9 kg in 1984 then rose slightly in 1985 to 1.2 kg.

The autumn index declined steadily from 7.6 kg in 1963 to 1.2 kg in 1967 and then remained fairly steady during 1968-1973 averaging 2.0, before dropping to a series low of 0.6 kg in 1974. The index increased sharply in 1975, remained fairly steady during 1976-1982 (average of 2.1 kg), increased to 4.1 kg in 1983, dropped sharply to 0.8 in 1984 and increased to 2.1 in 1985. Catch per tow in numbers (linear) have indicated trends similar to the weight per tow indices in recent years with the exception of the autumn 1985 index. This index was the highest in the time series and indicates the possibility of a strong 1985 year class (Table 3.2.2).

Commercial CPUE indices for this stock are not available due to the by-catch nature of the fishery.

Mean Catch Per Tow at Age

Mean catch per tow at age in numbers (linear) data indicates that the 1974 and 1979-1981 year classes were stronger than other years with the 1974 cohort being the strongest (Table 3.2.3). Other year classes since 1970 appear to be of average strength. However, the autumn 1985 index was the second highest in the series, after 1974, and indicates that the 1985 year class may be quite strong. Noticeable shifts in the relative strength of the 1970-1985 year classes from ages 0 to 7 makes catch curve analysis impossible.

Discussion

As with the northern stock of red hake, there has been minimal fishing pressure exerted on this stock in recent years, allowing the age structure to remain fairly stable with 3-4 year classes contributing strongly to the survey indices. However, the survey does indicate that the stock has declined somewhat in recent years. If the 1985 year class is as strong as the autumn 1985 survey index has indicated, then an increase in stock biomass will be expected in the next 1-2 years. As for the northern stock of red hake, the use of VPA analysis is not possible because of the low catch levels and the growth rates also need to be revised.

Table 3.2.1 Red hake catches (mt) from the southern Georges Bank - Middle Atlantic stock.

Year	Bulgaria	Cuba	GDR	Italy	Japan	Mexico	Poland	Romania	Spain	USSR	USA Commercial	USA Recreational	Total
1940	-	-	-	-	-	-	-	-	-	-	4,284	317[1]	4,603
1941	-	-	-	-	-	-	-	-	-	-	8,305	412	8,717
1942	-	-	-	-	-	-	-	-	-	-	11,845	892	12,737
1943	-	-	-	-	-	-	-	-	-	2,189	29,712	770	32,671
1944	-	-	-	-	-	-	-	-	-	10,751	32,422	848	44,221
1945	-	-	-	-	-	-	-	-	-	47,744	25,244	434[1]	93,434
1946	-	-	-	-	-	-	-	-	-	103,937	3,905	94	108,014
1947	-	-	-	-	-	-	41	-	-	31,958	4,744	145	38,948
1948	-	-	-	-	-	-	-	-	-	11,137	7,001	575	18,713
1949	121	-	-	-	-	-	-	-	-	47,248	5,539	489	53,417
1950	232	-	-	-	-	-	-	-	-	4,543	4,479	410[1]	11,044
1951	1,590	-	9	-	8	-	-	-	-	30,300	3,227	287	35,421
1952	817	-	45	-	945	-	3	49	-	37,299	1,995	177	41,371
1953	375		-	-	2	-	35	-	-	47,447	3,403	317	51,479
1954	446	-	-	-	-	-	-	37	-	23,943	2,183	191[1]	26,834
1955	31	-		-	-	-	-	-	1	17,884	2,045	32[1]	20,028
1956	-	-	-	-	-	-	-	49	-	18,491	3,905	445[1]	23,110
1957	22	10		1	8	-	-	-	-	1,448	2,522	750[1]	7,812
1958	-	-		56	9	1	-	-	3	2,073	1,327	971	4,434
1959	-	-	-	180	13	40	-	-	45	470	4,424	245	7,845
1960	-	14	-	42	37	12	-	1	49	-	3,927	144[1]	4,224
1961	-	-	-	37	15	-	-	-	144	-	2,124	79	2,349
1962	-		-	41	21	-	-	-	115	-	2,993	111	3,281
1963	-	-	-	34	10	-	-	-	41	-	1,334	49	1,490
1964	-	-	-	11	1	-	-	-	43	-	1,214	45	1,314
1965	-	-	-	31	4	-	-	-	41	-	827	31	934

[1] From marine mammal survey recreation years are estimated.

Table 3.2.2 Stratified mean catch per tow in numbers and in weight (kg) of red hake from the southern Georges Bank - Middle Atlantic stock (offshore strata 1-19, 61-76, inshore strata 1-46, 52, 55) from NEFC bottom trawl surveys in the spring and autumn with accompanying estimates of standard deviations.

	Year	Numbers Per Tow	Standard Deviation	Weight Per Tow (kg)	Standard Deviation
SPRING	1968[1]	.96	.25	4.61	1.31
	1969[1]	.77	.16	4.21	.81
	1970[1]	1.23	.19	7.05	.97
	1971[1]	2.54	.66	18.10	5.61
	1972[1]	2.56	.86	13.14	4.70
	1973[2]	2.11	.37	10.02	1.71
	1974[2]	1.28	.25	6.61	1.25
	1975[2]	1.43	.46	6.52	2.17
	1976[3]	2.39	1.31	10.60	5.16
	1977[3]	1.21	.19	5.40	.87
	1978[3]	3.34	.74	16.39	3.92
	1979[3]	.39	.22	4.14	1.11
	1980[3]	1.32	.27	6.36	1.13
	1981[3]	2.53	.67	13.27	3.44
	1982	3.05	1.15	13.04	3.66
	1983	1.50	.38	3.22	1.97
	1984	.91	.41	5.09	2.00
	1985	1.20	.31	6.31	1.52
AUTUMN	1963[4,5]	7.58	2.19	32.45	9.12
	1964[4,5]	3.22	.79	15.58	4.31
	1965[4,5]	3.32	1.02	20.34	4.47
	1966[4,5]	2.13	.38	17.36	3.98
	1967[4]	1.16	.30	5.23	1.48
	1968[4]	2.14	.45	9.94	2.03
	1969[4]	2.19	.44	10.38	2.14
	1970[4]	1.33	.23	10.16	1.57
	1971[4]	1.77	.31	11.68	2.01
	1972[4]	2.62	.56	17.08	4.27
	1973[4]	1.60	.42	12.35	3.69
	1974	.63	.22	14.36	2.95
	1975	3.55	.66	22.36	4.53
	1976	2.30	.44	14.43	2.66
	1977	2.17	.50	8.34	1.71
	1978	1.62	.31	7.71	1.39
	1979	2.03	.36	11.14	1.65
	1980	2.69	.59	16.00	2.98
	1981	2.01	.45	12.52	2.23
	1982	2.11	.49	9.27	2.42
	1983	4.09	1.19	19.34	5.39
	1984	.30	.31	4.98	1.30
	1985	2.05	.60	34.04	12.26

[1] Adjusted from offshore #36 trawl catches to equivalent inshore-offshore #36 trawl catches using a .907:1 ratio.

[2] Adjusted from offshore #41 trawl catches to equivalent inshore-offshore #36 trawl catches using a .374:1 ratio.

[3] Adjusted from inshore-offshore #41 trawl catches to equivalent inshore-offshore #36 trawl catches using a .633:1 ratio.

[4] Adjusted from offshore #36 trawl catches to equivalent inshore-offshore #36 trawl catches using a .862:1 ratio.

[5] Strata 1-19 sampled only.

Table 3.2.3 Stratified mean catch per tow (numbers) at age for red hake from the southern Georges Bank - Middle Atlantic stock (offshore strata 1-19,61-76; inshore strata 1-14,52,53) from NEFC bottom trawl surveys in the spring and autumn.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12+	Total 0+	1+	2+
						Spring										
1970	-	1.44	2.09	1.47	.94	.32	.31	.01	.04	.01	-	-	-	7.03	7.03	3.41
1971	-	.40	11.85	2.20	1.22	1.41	.29	.47	.03	.01	-	-	-	18.10	18.10	17.71
1972	-	.27	3.80	5.92	.59	1.14	1.24	.18	.01	-	-	-	-	13.14	13.14	12.87
1973	-	.42	2.20	2.51	1.44	2.44	.09	.31	.01	-	-	-	-	10.02	10.02	9.60
1974	-	1.07	1.41	1.01	.38	1.08	.83	.42	.01	-	-	-	-	4.41	4.41	3.34
1975	-	.75	1.47	1.70	1.29	.48	.08	.53	-	-	-	-	-	4.52	4.52	3.77
1976	-	1.23	2.28	2.49	1.80	1.24	.55	.49	.12	-	-	-	-	10.40	10.40	9.17
1977	-	.94	.53	2.50	.84	.14	.38	.01	-	-	-	-	-	5.40	5.40	4.44
1978	-	3.30	5.52	3.32	3.34	.70	.27	.09	.01	.02	-	-	-	14.59	14.59	13.29
1979	-	.41	.82	.78	.81	.71	.53	.05	.03	-	-	-	-	4.14	4.14	3.70
1980	-	2.03	1.15	1.71	.83	.02	.77	.21	.14	-	-	-	-	4.84	4.84	4.03
1981	-	2.94	3.29	3.11	2.25	1.38	.44	.35	.04	-	.01	-	-	13.27	13.27	12.47
1982	-	.61	4.90	3.07	1.91	1.24	.74	.13	.24	.09	-	.01	-	13.04	13.04	12.20
1983	-	1.90	2.44	1.43	1.38	.55	.18	.14	.10	.03	.03	-	-	8.22	8.22	4.32
1984	-	1.42	1.50	.82	.47	.40	.15	.07	.05	-	-	-	.01	5.09	5.09	3.67
1985[1]	-	.98												4.31	4.31	3.33
						Autumn										
1970	.15	4.80	1.18	1.11	.74	.10	.05	-	.01	.02	-	-	-	10.14	10.01	3.21
1971	1.20	4.34	2.70	2.01	.92	.13	.34	.01	.03	-	-	-	-	11.48	10.48	4.14
1972	.13	4.80	5.91	2.07	.72	.78	.44	.20	.01	-	-	-	-	17.08	16.95	10.15
1973	2.49	1.58	2.79	1.80	.43	.13	.22	.01	-	-	-	-	-	12.85	10.16	3.58
1974	12.08	.44	1.08	.44	.58	.03	.01	-	-	-	-	-	-	14.84	2.76	2.34
1975	2.40	11.41	5.34	2.02	.49	.11	.33	-	.03	.01	-	-	-	22.34	19.94	8.53
1976	3.28	2.24	7.04	1.27	.32	.15	.12	-	.01	-	-	-	-	14.43	11.15	8.91
1977	.74	1.24	2.42	2.44	.65	.23	.08	.07	.01	-	-	-	-	8.34	7.60	4.34
1978	.51	1.99	2.12	1.09	1.48	.34	.10	.05	.01	-	-	-	-	7.71	7.20	5.21
1979	1.89	2.25	2.79	2.23	.70	.91	.25	.10	.02	-	-	-	-	11.14	9.25	7.00
1980	2.92	4.13	3.93	1.53	2.29	.40	.27	.02	-	-	-	-	-	14.00	13.08	8.95
1981	3.25	3.13	2.83	1.19	.79	.99	.14	.15	.02	.01	-	-	-	12.52	9.27	6.14
1982	.52	2.34	3.30	1.95	.94	.58	.39	.08	.04	.01	-	-	-	10.27	9.75	7.41
1983	.20	2.34	4.83	4.24	2.70	.84	.40	.34	.05	.04	-	-	-	19.34	19.14	13.80
1984	.41	2.39	.71	.54	.49	.19	.11	.09	.05	-	-	-	-	4.98	4.57	2.18
1985[1]	10.68													34.04	23.34	

[1] Preliminary estimate.

4. SILVER HAKE

Source Document: Almeida, F. P., and E. D. Anderson. 1981. Status of the Silver Hake Resource off the Northeast Coast of the United States-1981. NMFS, NEFC Woods Hole Lab. Ref. Doc., No. 81-36, 67 p.

The source document for silver hake uses different stock definitions than are currently thought to be correct (Almeida 1984).

Preliminary assessment results using the two new definitions of stocks for silver hake inhabiting the waters off the northeast coast were presented at the workshop. Several concerns identified by participants were examined during the workshop, but it was not possible to complete needed reanalyses in the time available.

It was agreed that the reanalysis of the data and revised VPA's for both stocks would be completed and reviewed later. Due to the low levels of fishing pressure the two stocks are under at the present time, the delay in assessment information would not be critical to management needs for the next several months.

II. SPECIES REVIEW--YELLOWTAIL FLOUNDER

5. YELLOWTAIL FLOUNDER

Source Document: Clark, S. H., M. M. McBride, and B. Wells. 1984. Yellowtail flounder assessment update--1984. NMFS, NEFC Woods Hole Lab. Ref. Doc. No. 84-39, 30 p.

The Fishery

Yellowtail flounder (*Limanda ferruginea*) populations are fished on five grounds in subareas 5 and 6: off Southern New England, on Georges Bank, off Cape Cod, in the Gulf of Maine, and in the Middle Atlantic. In recent years landings of yellowtail flounder increased from 15,600 mt in 1981 to 33,100 mt in 1983. They have since declined precipitously to only 7,300 mt in 1985 (Table 5.1), 72% below the long-term average for the (NEFC 1960-1984) time series. The current decline reflects both reduction of the 1979-1981 year classes by fishing and poor recruitment from subsequent year classes; this fishery is now almost completely dependent upon incoming recruitment.

E of 69° W (Georges Bank)

Nominal catches declined from an average of 14,700 mt during 1972-1976 to only 4,500 mt in 1978. Landings increased gradually from an average of 6,100 mt from 1979-1981 and then rose sharply to 11,400 mt in 1983, the highest since 1976 (Table 5.1). Landings have since, however, dropped to only 2,500 mt in 1985; the 1980 year class dominated commercial landings in 1982 and 1983; it contributed substantially in 1984 as well. The commercial abundance index (mt/day fished) for Georges Bank declined to minimal levels in the late 1970's and then increased with improving recruitment; values for 1982-1983 were the highest observed in recent years, but remained consistently below peak levels observed during the early to mid-1960's. Values for 1984 and 1985 Table 5.3) are at or near the lowest in the time series. Discard rates on a per-trip basis were reported to be as high as 30% of the landed total (by weight) in 1982, but have since declined.

NEFC spring and autumn survey results (Table 5.5) also suggest an increasing trend into the early 1980's, but since 1982 indices have declined with 1985 indices representing the lowest in the time series. Survey catch-per-tow-at-age data indicate that recent year classes have been relatively weak. The pre-recruit (age 1) index for the 1985 autumn survey (Table 5.5) shows a noticeable increase but remains below the long-term average. Fishing mortality has exceeded the F_{max} level considerably in recent years.

W of 69° W (Southern New England, Mid-Atlantic, and Cape Cod)

Nominal catches declined from an average of 11,600 mt during 1972-1976 to 6,400 mt in 1978; landings then rose to 13,800 mt in 1982 and then to 21,300 mt in 1983. They have since declined sharply to 4,700 mt in 1985. Again, the 1980-1981 year classes have predominated in the subsequent year's landings. Recruitment in more recent years has been poor, however, the fishery continues to be heavily reliant upon 2 and 3 year old fish. Hence, the 1984-1985 decline reflects both the reduction of these year classes due to heavy fishing pressure and poor recruitment from subsequent year classes. Reported trip

discard levels ranged from 25-85% of the landed total by weight in 1982; since that year discard appears to have declined.

For Southern New England, commercial and survey indices declined to very low levels in the mid-1970's. Indices then increased gradually until 1982 with recruitment of the 1980-1981 year classes (the strongest in recent years). Since that year abundance has declined dramatically and now appears to be at a historic low point (Tables 5.3 and 5.4). Research vessel survey catches of pre-recruits (age 1 or 1984 year class) as reflected in the 1985 NEFC autumn survey (Table 5.4), again shows some increase over that of 1984, however, it does not approach the long-term historic average. The 1980-1981 year classes have been reduced severely by fishing and are not expected to contribute appreciably to the fisnery in the future. Fishing mortality has again substantially exceeded F_{max} in recent years.

Trends for the Mid-Atlantic have been generally similar to those observed for Southern New England. NEFC spring and autumn (Table 5.8) survey indices declined to very low levels in the mid-1970's, followed by a sharp increase in 1981-1982. Since 1982, abundance has again declined sharply; the increase in nominal fishing catch in 1984 over 1983 levels reflected an increase in fishing effort. Landings in 1985 are down from the 1983-1984 level.

The Cape Cod yellowtail fishery has generally been more stable than that of other areas. Nominal catch averaged between 1,000-2000 mt from 1960 through 1975 and then increased to over 5,000 mt in 1980. Since that year, landings have declined steadily to only 1,000 mt in 1985 (Table 5.1). Commercial and NEFC research vessel survey indices increased somewhat during the late 1970's and early 1980's; more recent data have again indicated a declining trend. Massachusetts Division of Marine Fisheries' spring and autumn inshore surveys (Table 5.7) through 1985 have in all cases corroborated indices of abundance and biomass (stratified mean catch per tow in numbers and weight in kilograms, kg) obtained from NEFC spring and autumn offshore surveys.

Landings for the Gulf of Maine in 1985 totaled 200 mt, falling slightly below the long-term average of 250 mt (1969-1984 time series).

II. SPECIES REVIEW--YELLOWTAIL FLOUNDER

Grand Banks of Newfoundland

As of quarter two 1985 U.S. landings of yellowtail flounder have been supplemented by effort on the Grand Banks (SA3). The 1985 landings for this area totaled 3,800 mt, contributing 34% to the total U.S. yellowtail flounder landings.

Discussion

There was general agreement that fishing mortality rates, particularly on the Southern New England stock, have been substantially in excess of F_{max} for at least a decade. Perhaps more importantly, there have also been declines in the age at entry and number of ages in the stock, symptoms of recruitment overfishing, which would lead to increased risk of recruitment failure. The effects of temperature on recruitment of yellowtail flounder makes precise evaluation of this risk difficult, however. It was agreed that the temperature relationship should be followed up, placing emphasis on the specific causal mechanism.

There was not unanimity on the issue of whether analytical assessments may be required; all indications are consistent in showing that the stocks are in poor shape. However, it was pointed out that analytical assessments would promote ecological research (e.g., temperature-recruitment) and would allow evaluation of absolute fishing mortality rates at age. Poor estimates of discards have stood as a major impediment. The use of alternate strategies in approaching such analysis is essential and is presently being addressed.

Finally, several minor inconsistencies were observed in the survey catch per tow data, suggesting the possible existence of problems with fish aging or catchability (by age group within year and/or between years) and/or availability. Evaluation factors affecting growth variation are under way. Research on stock-recruitment to define spawning stock biomass per recruit targets is needed. Research on changes in fishing power in the fleet are addressed in a recent study by O'Brien and Mayo (1985).

Table 5.1 Commercial catch of yellowtail flounder (000's of metric tons) from the Southern New England, Georges Bank, Cape Cod, Mid-Atlantic, and Gulf of Maine areas[1], 1983-1985.

	Southern New England					Georges Bank					Cape Cod				
	Nominal Catch[2]			Estimated		Nominal Catch			Estimated		Nominal Catch			Estimated	
Year	USA	Foreign	Total	USA Discard	Total Catch	USA	Foreign	Total	USA Discard	Total Catch	USA	Foreign	Total	USA Discard	Total Catch
1983	17.9	-	17.9	2.5	20.4	11.4	<0.14	11.	0.8	12.2	1.9	-	1.9	0.3	2.2
1984	8.5	-	8.5	-	-	5.8	<0.1	5.8	-	-	1.1	-	1.1	-	-
1985	2.8	-	2.8	-	-	2.5	<0.1	2.6	-	-	1.0	-	1.0	-	-

	Mid-Atlantic					Gulf of Maine					Grand Total				
	Nominal Catch			Estimated		Nominal Catch			Estimated		Nominal Catch			Estimated	
Year	USA	Foreign	Total	USA Discard	Total Catch	USA	Foreign	Total	USA Discard	Total Catch	USA	Foreign	Total	USA Discard	Total Catch
1983	1.6	-	1.6	0.2	1.7	0.3	-	0.3	<0.1	0.3	33.0	<0.1	33.0	3.8	36.8
1984	2.2	-	2.2	-	-	0.2	-	0.2	-	-	17.8	<0.1	17.8	-	-
1985	0.9	-	0.9	-	-	0.2	-	0.2	-	-	7.4	<0.1	7.4	-	-

[1] Statistical areas 526 and 537-539, 522-525, 514 and 521, 611+, and 511-513 and 515, respectively.

[2] Live weight equivalent of landings, excluding discard. USA data include food and industrial landings. Food landings taken from New England weighout files, state bulletins, and annual canvas data; industrial landings estimated from interview data and biological sampling of industrial catches.

Table 5.2 Estimated age composition (percent landed at age) plus total numbers of Southern New England and Georges Bank yellowtail in USA commercial landings, 1983-1984.

Year	Percent Landed at Age								Total Landed (000's)
	1	2	3	4	5	6	7	8+	
Southern New England									
1983	0.1	28.4	65.9	5.0	0.5	0.2	-	-	51016
1984	0.2	10.3	56.3	28.8	3.3	1.0	-	-	23668
Georges Bank									
1983	0.9	27.5	60.1	8.7	2.3	0.4	0.1	-	25925
1984	2.0	14.2	32.5	36.3	12.4	1.9	0.4	0.3	13075

Table 5.3 Commercial catch (000's tons), days fished (000's) and catch per day (tons)[1] of yellowtail flounder for the Southern New England, Georges Bank, and Cape Cod grounds.

Year	Southern New England			Georges Bank			Cape Cod		
	Total Catch	Days Fished	Catch/ Day	Total Catch	Days Fished	Catch/ Day	Total Catch	Days Fished	Catch/ Day
1984[2]	7.9	5.69	1.4	5.8	6.65	0.9	1.1	1.24	0.9
1985[2]	2.7	3.45	0.8	2.5	3.27	0.8	1.0	1.53	0.7

[1]Calculated for USA trawlers of 5-104 GT using trip data for which 50% of the total catch consisted of yellowtail.

[2]Nominal catch/minus estimated discard.

Table 5.4. Southern New England: Stratified mean catch per tow in numbers, numbers at age, and total weight (kg) for yellowtail founder in NEFC offshore[1] spring and autumn bottom trawl surveys, 1984-1985.

Year	Age 0	1	2	3	4	5	6	7	8+	Total No.	Total Wt. (kg)
	Spring[2]										
1984	0.00	0.00	1.36	3.73	2.20	0.51	0.23	0.00	0.00	8.03	2.85
1985	0.00	0.07	0.70	0.37	0.27	0.43	0.09	0.00	0.00	2.47	0.67
	Autumn										
1984	0.00	0.54	1.82	1.97	0.54	0.00	0.00	0.00	0.00	4.91	1.37
1985	0.00	1.20	0.53	0.17	0.16	0.00	0.00	0.00	0.00	2.06	0.44

[1]Offshore strata 5, 6, 9, and 10.

[2]Data adjusted by factors of 1.76 (numbers) and 1.73 (weight) to account for differences in fishing power between the "36 Yankee" and the "41 Yankee" trawls (Sissenwine and Bowman 1978).

Table 5.5. Georges Bank: Stratified mean catch per tow in numbers, numbers at age, and total weight (kg) for yellowtail flounder in NEFC offshore[1] spring and autumn bottom trawl surveys, 1984-1985

Year	Age 0	1	2	3	4	5	6	7	8+	Total No.	Total weight (kg)
	Spring[2]										
1984	0.00	0.00	0.95	1.25	1.23	0.65	0.05	0.00	0.00	4.13	2.21
1985	0.00	0.00	2.13	0.21	0.28	0.15	0.00	0.00	0.00	3.00	0.99
	Autumn										
1984	0.00	0.48	0.34	0.25	0.20	0.06	0.01	0.00	0.01	1.46	0.46
1985	0.00	1.40	0.57	0.18	0.05	0.08	0.00	0.00	0.00	2.29	0.73

[1]Offshore strata 13-21.

[2]Data adjusted by factors of 1.76 (numbers) and 1.73 (weight) to account for differences in fishing power between the "36 Yankee" and the "41 Yankee" trawls (Sissenwine and Bowman 1978).

Table 5.6. Stratified mean catch per tow in nubbers and weight (kg) for yellowtail flounder in NEFC offshore[1] spring and autumn bottom trawl surveys, 1984-1985.

	Spring[2]		Autumn	
Year	Nos.	Wt(kg)	Nos.	Wt (kg)
1984	1.18	0.36	2.24	1.03
1985	0.95	0.27	3.20	0.83

[1]Offshore strata 24-26.

[2]Data adjusted by factors of 1.76 (numbers) and 1.73 (weight) to account for differences in fishing power between the "36 Yankee" and the "41 Yankee" trawls (Sissenwine and Bowman 1978).

Table 5.7. Stratified mean catch per tow in numbers, numbers at age, and total weight (kg) for yellowtail flounder in Massachusetts inshore spring and autumn bottom trawl surveys[1] from Cape Cod to Massachusetts Bay, 1984-1985.

Season/ year	Stratified mean catch per tow at age[1] (numbers)										Stratified mean catch/ tow in weight(kg)
	0	1	2	3	4	5	6	7	8+	Total	
Spring											
1984										29.15	7.38
1985										20.29	5.35
			DATA NOT AVAILABLE								
Autumn											
1984										6.33	1.18
1985										8.35	1.16

[1]Regions 3, 4, and 5 (strata 17-21, 25-30, and 31-36).

Mid Atlantic:

Table 5.8. Stratified mean catch per tow in numbers and weight (kg) for yellowtail flounder in NEFC offshore[1] spring and autumn bottom trawl surveys, 1984-1985.

	Spring[2]		Autumn	
Year	Nos.	Wt(kg)	Nos.	Wt(kg)
1984	6.18	1.73	1.68	0.18
1985	4.15	1.07	1.42	0.15

[1]Offshore strata 69, 70, 73-74, 1, and 2.

[2]Data adjusted by factors 1.76 (numbers) and 1.73 (weight) to account for differences in fishing power between the "36 Yankee" and the "41 Yankee" trawls (Sissenwine and Bowman 1978).

II. SPECIES REVIEW--WHITE HAKE

6. WHITE HAKE

Source Document: Burnett, J., S. H. Clark, and L. O'Brien. 1984. A Preliminary Assessment of White Hake in the Gulf of Maine - Georges Bank area. NMMFS, NEFC Woods Hole Lab. Ref. Doc. No. 84-31, 33 p.

Commercial Fishery Trends

Landings of white hake from the Gulf of Maine have increased sharply from less than 500 metric tons (t) in 1967 and 1968 to approximately 7,000 t annually since 1982 (Table 6.1). Between 1960 and 1965, white hake landings had remained relatively stable, ranging from 3,015 t to 4,280 t. Recent landings (t) are as follows:

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
USA	4115	5283	5089	4095	4819	5706	5984	6168	7491	6376
Total	4310	5791	5273	4350	5125	6160	6750	6981	7504	--

The fishery is conducted almost exclusively by vessels based in Maine and Massachusetts (Table 6.2). Between 1970 and 1983, approximately 60% of the landings were taken by trawlers and 30% by gill nets; in 1984 and 1985, however, the otter trawl percentage increased to approximately 75%, while the gill net share declined to 20% (Table 6.3). In 1985, a fleet of automatic longline vessels began operating in the Gulf of Maine and adjacent waters; white hake landings by this gear type were minimal.

Catch and Effort

Although commercial catch-per-unit effort (CPUE) indices have been calculated for white hake, interpretation of trends in abundance is difficult since the species is taken primarily as by-catch on trips directed towards other species. In addition, significant discard of white hake appears to occur on trips directed towards redfish in the Gulf of Maine due to depths and locations fished and mesh size used. Commercial CPUE indices for white hake (landings per day fished for trips comprising 40% or more white hake by weight) have generally fluctuated without any discernible trends since 1975; estimated fishing effort, however, appears to have increased in recent years coincident with landings. Recent increases in the number of large tonnage class 4 trawlers (151-500 gross registered tons) (Table 6.4) landing white hake suggests the possibility that effective fishing effort on white hake has increased substantially (Table 6.5).

Size Composition of Landings

Sampling of commercial landings has been minimal since almost all white hake are landed with heads removed. This practice, while making length measurements difficult, is also responsible for virtually all landings being reported as "unclassified" despite the existence of nine market categories.

Thus, samples collected aboard vessels during sea sampling trips provide the only indication of commercial size composition of landings, and in addition provide information on discards (Figure 6.1).

Research Vessel Surveys

Bottom trawl surveys have been conducted by the NEFC in offshore waters of the Gulf of Maine and Georges Bank during autumn and spring since 1983 and 1968, respectively. Distribution data indicate a movement towards shallower depths during autumn and an offshore movement during winter and spring. This pattern may be related to spawning activity, although it has been suggested that white hake do not spawn successfully in the Gulf of Maine and that the population is sustained by larval recruitment from the Scotian Shelf. This hypothesis is supported by maturity observations from NEFC bottom trawl surveys which reveal very few ripe fish in the Gulf of Maine during the presumed spawning season.

Bottom trawl survey results for white hake (Table 6.6) are extremely variable, although the autumn survey weight per tow index appeared to follow landings trends reasonably well at least through 1980. The recent decline in the survey biomass index coincident with continued high landings levels may suggest an increase in the rate of exploitation. Recent declines in spring survey indices since 1981 may result as much from changes in the survey sampling gear in 1982 as from declines in stock abundance (Burnett et al. 1984).

Length frequency measurements obtained from bottom trawl surveys provide evidence of relatively strong recruitment of age 2 fish in 1981 which may have contributed to the increase in landings observed in the fishery since then. Subsequent recruitment, except for a possible 1983 year class, does not appear to be significant.

Discussion

Landings of white hake have risen sharply since the late 1970's due, in part, to recruitment of the relatively strong 1979 year class at age 2 in 1981. Recruitment of subsequent year classes, however, has not been detected in the fishery. Although calculated commercial CPUE indices have fluctuated without any definite trends, estimated fishing effort has increased coincident with landings. Recent declines in NEFC autumn bottom trawl survey abundance indices relative to landings levels suggests a possible increase in the rate of exploitation. Given the lack of significant recruitment since 1981, further increases in landings are not anticipated unless fishing effort increases substantially or is re-directed towards white hake.

White hake has historically been a by-catch species. However, the most recent abundance indices exhibit a decline while landings have increased, suggesting increases in exploitation. It was also suggested that possible declines in mean length of fish taken in the trawl surveys may indicate increasing exploitation rates.

II. SPECIES REVIEW--WHITE HAKE

There was some discussion of the implications of the possible lack of significant spawning activity among fish in the Gulf of Maine population. Although the Gulf of Maine population of white hake may at least partially result from spawning on the Scotian Shelf, the consequences of basing management on that assumption could be severe.

Attempts are currently being made to improve size composition estimates of the landings. Other areas needing further work are age and growth, mortality, and stock identification.

Table 6.1 Nominal white hake catches (metric tons), by country from the Gulf of Maine to Cape Hatteras (NAFO Subareas 5 and 6), 1984-1985.

	NAFO Subarea/Division							
	5Y		5Z		6	Totals		
Year	Canada	USA	Canada	USA	USA	Canada	USA	TOTAL
1984	479	4996	534	1458	12	1013	6491	7504
1985	---	5108	---	1258	10	----	6376	

Table 6.2 USA Nominal white hake catches (metric tons) by state from the Gulf of Maine, 1984-1985.

	State			
Year	Maine	Mass.	Others	TOTAL
1984	3877	2448	442	6767
1985	3185	3009	243	6437

Table 6.3 USA Nominal white hake catches (metric tons), by gear from the Gulf of Maine, 1984-1985.

	Gear				
Year	Line Trawl	Bottom Trawl	Sinking Gill Net	Others	TOTAL
1984	5	5162	1486	114	6767
1985	17	4861	1221	338	6437

Table 6.4 USA Nominal white hake catches (metric tons), by vessel tonnage class from the Gulf of Maine, 1984-1985.

Year	Tonnage Class 2	3	4	TOTAL
1984	2377	2733	1628	6767
1985	1852	2668	1917	6437

Tonnage Class
2 = 5-50 GRT
3 = 51-150 GRT
4 = 151-500 GRT

Table 6.5 Nominal catch (C), days fished (DF), and catch per day fished (C/DF) by vessel tonnage class for trips in which white hake were landed, and trips for which 40% or more of the total catch consisted of white hake, 1984-1985.

	Tonnage Class								
	2			3			4		
Year	C	DF	C/DF	C	DF	C/DF	C	DF	C/DF
					All Trips				
1984	887	1,625.5	0.55	4,148	4,722.1	0.88	2,698	3,389.9	0.79
1985	601	1,276.7	0.46	4,123	5,033.4	0.82	3,138	3,352.8	0.95
					40% Trips				
1984	123	44.2	2.78	212	50.4	4.21	13	2.3	5.75
1985	164	76.4	2.16	495	141.7	3.48	416	77.3	5.38

Table 6.6 Stratified mean catch per tow in numbers and weight (kg) of white hake from NEFC offshore spring and autumn bottom trawl surveys in the Gulf of Maine and on Georges Bank, 1985.

Year	No.	Wt.	No.	Wt.
1985	4.33	5.38	9.38	9.74

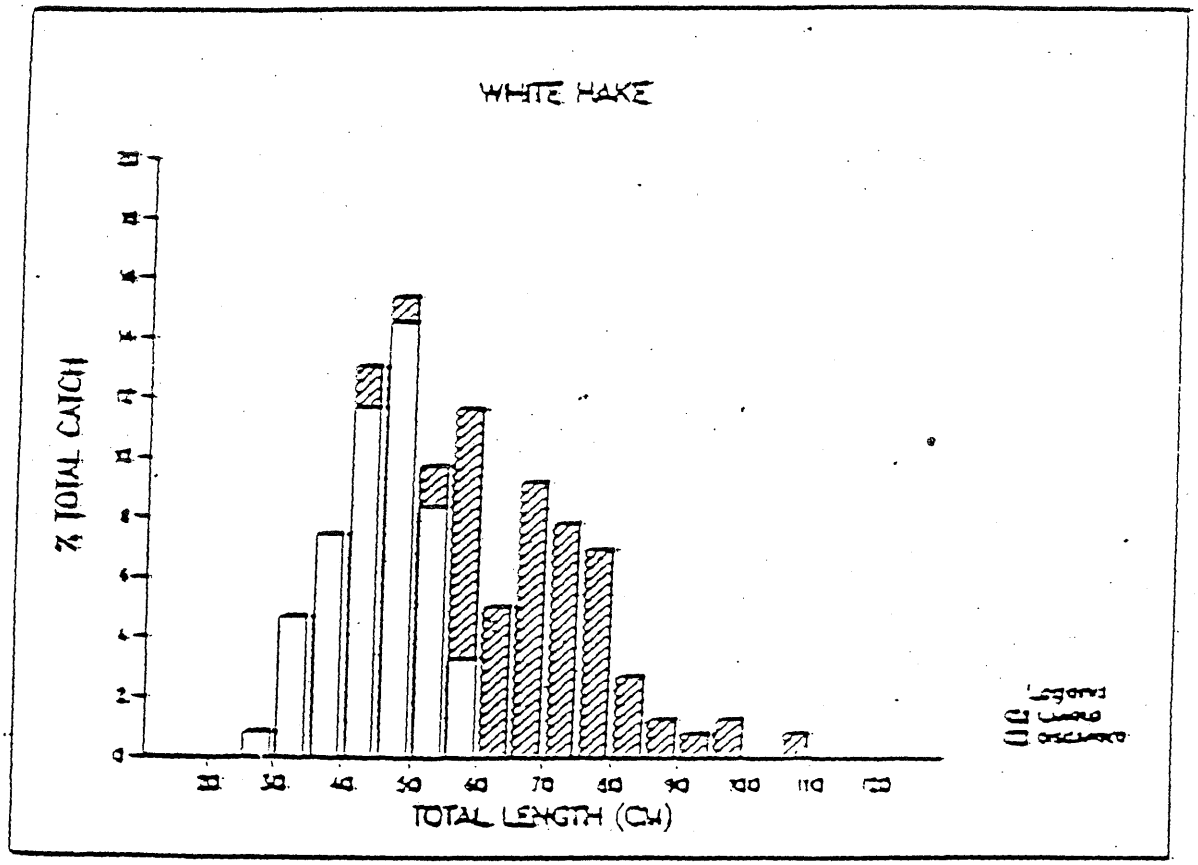


Figure 6.1 Length-frequency data for landings and discard of white hake obtained aboard F/V IRENE'S WAY, July 3-13, 1984.

7. SEA SCALLOP

Source Document: Serchuk, Fredric M., and Susan E. Wigley. 1986. Status of the Sea Scallop Resources off the Northeastern United States, 1986. NMFS, NEFC Woods Hole Lab. Ref. Doc. No. 86-08.

The current status of this stock is described in the source document. Harvestable stock abundance has been low in recent years, but a strong year class was generated in 1982. Scallops from this cohort, however, will not attain a 40-count size until late 1986 or early 1987. If this year class is not subjected to high fishing mortality in 1986, it will be capable of sustaining elevated fishery yields for at least 2-3 years. Failure to protect and husband this cohort before moderate gains in yield per recruit and spawning potential can be achieved in 1986 and 1987 will result in a significant loss in yield and a likely return to the depressed resource conditions characteristic of recent years.

Effort in the scallop fishery remains high and there is strong economic incentive to harvest the 1982 cohort due to its prevalence and abundance. Despite the fishing strike in New Bedford that curtailed scalloping activity during January 1986, the average catch rate by New Bedford vessels during January-April 1986 was about double that observed during January-April 1985. Compared with 1985, New Bedford scallop landings during the first four months of 1986 were up 20% even though 100 fewer vessel trips had been made. These observations, as well as informal reports from fishermen, suggest that the 1982 year class is already receiving considerable exploitation. Should this trend continue unabated, long-term yield from the growth potential of the 1982 cohort will be sacrificed.

Alternate assessment methods and foci of research were discussed, including length-based analytic assessments to estimate fishing mortalities and bioeconomic system modeling studies. The bioeconomic studies would use information on dynamics of growth, recruitment, harvesting costs, and revenue to examine fishing strategies which address the stated management goal of optimizing yield per recruit while stabilizing annual yields.

Biological tissues identified at the First Stock Assessment Workshop were also reviewed. Biological size-frequency samples provided by fishermen from scallop catches were still considered as potentially biased. Analyses of USA and Canadian scallop research vessel survey data (Serchuk and Wigley 1985) indicated that, despite sampling design differences, statistically comparable estimates of relative abundance, population size composition, and recruitment were obtained from the two surveys; in this sense, the surveys have been redundant. Evaluation of survey catchability differences on different substrate types, and assessment of fishing power coefficients in the commercial fishery are areas of needed research.

II. SPECIES REVIEW--WITCH FLOUNDER

8. WITCH FLOUNDER

Source Document: Burnett, Jay, and Stephen H. Clark. 1983. Status of Witch Flounder in the Gulf of Maine--1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-36.

The Fishery

Landings of witch flounder in NAFO Subarea 5 (Gulf of Maine and Georges Bank) during the last 10 years reached an historical high level in 1984, at 6,500 mt (preliminary), after steadily increasing from a low of 1,900 mt in 1976 (Table 8.1). Preliminary figures for 1985 indicate some decline from that peak, to 6,100 mt. This level still exceeds the previously observed peak of 5,900 mt in 1971, which was followed by a rapid drop in landings. There is little or no recreational component in this fishery. U.S. catches from the Grand Banks were 255.5 mt in 1985.

Catch and Effort

Catch and effort statistics are based on the otter trawl fishery. The directed fishery was defined as comprising trips where 40% or more of the landings consisted of witch flounder. Witch flounder are primarily landed as an intended component of a mixed species fishery or as by-catch, however (Table 8.2).

Catch rates for tonnage class 2 otter trawls in the directed fishery peaked in 1981 at 1.73 mt/day fished and have declined to historically low levels (0.97 mt/day fished) in 1985 (Table 8.2). Catch rates for tonnage class 3 otter trawlers peaked in 1980 at 2.66 mt/day fished and have declined to historically low levels (0.80 mt/day fished) in 1985. Although very little of the catch by tonnage class 4 can be categorized as directed (especially in early years) catch per effort in 1985 by that vessel class appears to have declined since 1980. These consistent declines in catch rates over the past 5-6 years indicate likely decline in stock abundance.

Research Survey Indices

No consistent trends are evident in NEFC spring offshore bottom trawl survey indices, although autumn survey data indicate a potential downward trend since 1977 (Table 8.3). Indices from Commonwealth of Massachusetts spring and fall inshore surveys appear to fluctuate without trend (1978-1985) (Table 8.4).

Summary

Witch flounder stock abundance in the Gulf of Maine - Georges Bank area appears to be declining, based on declining indices of commercial catch-per-unit effort and recent general downward trends in research survey abundance indices. Current historically high landing levels do not appear sustainable.

II. SPECIES REVIEW--WITCH FLOUNDER

Discussion

Since this fishery is mostly part of a mixed fishery it was suggested that it may be better to examine survey and catch data for correlations only in the statistical areas of major catch (513 and 516). Basically, catches for this species are up when it is abundant and this changes as other fisheries in the mix change their abundance levels to become dominant for a while. It was suggested that because of the nature of the multispecies fishery in this area the multispecies catch per effort problem needed to be reexamined.

During discussion of the important assessment issues (terms of reference) for witch flounder it was pointed out that:

- CPUE analyses have not addressed the question of mixed species effort.
- Some discard samples have been obtained from northern shrimp fisheries, although discard sampling has not been intensive.
- Preliminary estimates of Z have been developed (Burnett, 1986).
- No recruitment estimators have yet appeared from analyses of survey data.
- Ageing techniques using otoliths have been finalized, and validated as far as possible.
- Growth rates have been calculated for a variety of growth models including von Bertalanffy. Statistical variation in these parameters over time can now be evaluated.
- A study of distribution of ichthyoplankton, juveniles, and adults has been completed. Although the distribution of juveniles and adults relative to depth and temperature has been described, no linkage between location of observed spawning individuals and larval distribution has appeared.

Table 8.1 Nominal catch[1] of witch flounder (metric tons, live) from the Gulf of Maine to Cape Hatteras (NAFO Subareas 5 and 6), by country, 1983 - 1985.

	Subarea/Division													
	5Y[2]			5Z			6[3]			Totals				
Year	Canada	USA	Others[4]	Canada	USA	Others[4]	Canada	USA	Others[4]	Canada	USA	Others	Total SA5	Total SA5&6
1983	11	4,470	-	34	1,324	-	-	43	-	45	5,837	-	5,839	5,882
1984	10	4,584		5	1,863			86		15	6,532	-	6,447	6,532
1985	4	4,380		42	1,635			50		46	6,065	-	6,061	6,111

[1]As reported to ICNAF/NAFO for 1960-1982.

[2]NK landings for SA5 assigned to Div. 5Y.

[3]Statistics not available prior to 1963.

[4]Includes West Germany, East Germany, Poland, Spain, Japan, and the USSR.

Table 8.2 Nominal catch[1] (C), days fished (DF) and catch per day fished (C/DF) by vessel tonnage class for trips in which some witch flounder were landed, and trips for which 40% or more of the total catch consisted of witch flounder, 1983 - 1985.

	Tonnage Class								
	2			3			4		
Year	C	DF	C/DF	C	DF	C/DF	C	DF	C/DF
	All Trips								
1983	1,242	4,335	0.29	2,890	10,973	0.26	1,324	4,707	0.28
1984	1,315	4,477	0.29	3,346	13,343	0.25	1,434	4,934	0.29
1985	1,228	4,370	0.28	2,828	14,280	0.20	1,608	5,770	0.28
	40% trips								
1983	186	140	1.33	522	279	1.87	48	30	1.59
1984	241	212	1.14	720	612	1.18	176	98	1.80
1985	271	279	0.97	458	582	0.80	177	143	1.24

[1]Source: NEFC weighout and interview files. Nominal catch and catch per day fished given in metric tons.

Table 8.3 Stratified mean catch per tow in numbers and weight (kg) of witch flounder from NEFC offshore spring and fall bottom trawl surveys[1] in the Gulf of Maine and on Georges Bank, 1983 - 1985.

	Spring		Fall	
Year	Nos.	Wt.	Nos.	Wt.
1983	6.28	2.63	4.28	1.93
1984	3.13	1.84	4.36	2.40
1985	5.98	3.20	2.68	1.55

[1]Strata 22, 24, 26-30 and 33-40.

Table 8.4 Stratified mean catch per tow in numbers and weight (kg) of witch flounder from Massachusetts inshore[1] spring and fall bottom trawl surveys, 1983 - 1985.

	Spring		Fall	
Year	Nos.	Wt.	Nos.	Wt.
1983	0.00	0.00	3.79	2.68
1984	1.50	1.01	0.62	0.45
1985	1.12	0.82	0.82	0.57

[1]Regions 4 and 5 (strata 25-36)

9. AMERICAN PLAICE

Source Document: None available.

Trends in Landings

Landings of American plaice from the Gulf of Maine have dropped sharply in recent years, from historical peaks of around 11,000 mt from 1980-1982 to 4,700 mt in 1985 (Table 9.1). Historically, landings from the Gulf of Maine had been minor, averaging 800 mt between 1960-1974. In 1975, landings began a pattern of steady increase to 1980-1982 levels before their recent downturn.

Landings from the Georges Bank area have shown similar overall patterns but not as wide fluctuations over time as those from the Gulf of Maine. U.S. landings have dropped from historically high levels of around 4,000 mt in 1982-1983 to 2,300 mt in 1985. Before that, U.S. landings from 1960-1974 averaged 1,700 mt with higher levels between 1964-1970.

The American plaice fishery has been dominated by U.S. commercial catches. The Canadian commercial component has been minor and fairly stable over time, primarily prosecuted in the Georges Bank region. Commercial catch by other nations, primarily the U.S.S.R., occurred between 1965-1977. The otter trawl is the principal gear in the fishery. There is no significant recreational component to this offshore fishery. U.S. Grand Banks catches were 1,310 mt in 1985.

Size Compositions of Landings

American plaice are landed in six market categories: unclassified, jumbo, large, medium, small, and peewee. In 1985, fish in the "peewee" category ranged from 23-40 cm (total length); fish in the small and medium categories were generally between 35-40 or 50 cm; fish in the large and jumbo categories were over 40 cm. A 30 cm fish is approximately 4 years old (Sullivan 1982) and approximately 33% are mature at that length (Morse 1979).

The fraction of small fish in the landings from the Gulf of Maine appears to be increasing from 16-22% in 1975-1977 to 26-31% in 1978-1981. With the addition of peewee and medium categories in 1982, small/peewee fish contributed at least 22% of area landings, and up to maxima of 26-40% if all medium landings could be combined with the small/peewee category. In the Georges Bank region, the fraction of small/peewee fish has fluctuated at between 27-35% of the total area landings; combining all medium landings would increase that fraction to up to maxima of 40-48% in 1982-1984.

Commercial Catch Per Unit Effort Abundance Indices

In recent years, the fishery has tended toward increased vessel tonnage classes and increased effort in terms of both number of trips and days fished (Tables 9.2-9.4). In the Gulf of Maine, tonnage class 2 domination has been steadily eroded by increased landings by vessel class 3 and most recently, vessel class 4. On Georges Bank, a greater percentage of landings are being made by vessel class 4 relative to vessel class 3 (Table 9.2). Effort by

ton class 2 vessels in the Gulf of Maine reached record high levels in 1982; effort by ton class 3 and 4 vessels reached record high levels in 1985 (Table 9.3). Overall, total effort (catching any American plaice) has tripled since the early 1970's. On Georges Bank, effort by ton class 2 vessels peaked in 1981; effort (as days fished) by ton class 3 vessels continues to increase to record high levels in 1985; effort by ton class 4 vessels appears to be remaining at record high levels from 1984-1985 (Table 9.4).

The earlier trend toward a more directed fishery in the Gulf of Maine is reversing somewhat (Table 9.5). The percentage of landings derived from directed trips (trips in which 50% or more of the trip catch weight consisted of plaice) increased in the Gulf of Maine from the mid-1970's to 1981. At that point, nearly 70% of plaice landings came from directed trips. Since then, the fraction of landings obtained from directed trips has declined to 15% overall; less effort qualifies as "directed". On Georges Bank, between 20-30% of landings from 1964-1970 could be categorized as from directed trips. Most plaice were landed as "by-catch" from 1972-1980 although recently there seems to be more concentrated landings of plaice (Table 9.5).

Directed CPUE indices are at or near historically low levels for all vessel tonnage classes in the Gulf of Maine (Table 9.6). CPUE by ton class 2 and 3 vessels has declined from peaks in 1977 and 1979 of 2.46 and 3.22 mt/day fished, to 0.96 and 1.17 mt/day fished, respectively.

For Georges Bank, ton class 3 vessels provide the most consistent and sizeable effort over the analysis period. CPUE in that case was steady or slightly increasing from 1971 to 1982, when the index reached 2.29 mt/day fished. Since 1982 it has dropped to 0.68 mt/day fished in 1985 (Table 9.7).

Research Vessel Survey Indices

Trends in abundance based on NEFC offshore survey indices are consistent with those observed in the commercial CPUE time series. In the Gulf of Maine, abundance in the mid-1970's was low compared to the late 1960's and late 1970's-early 1980's. Recently, there has been a sizeable decline from peak indices of 11.0 kg/tow (autumn index) in 1978 and 1980 to 3.2 kg/tow in 1985, comparable to the low values of the mid-1970's (Table 9.8).

On Georges Bank, the declining trend from the early 1960's to the early 1970's and increasing trend from the mid-1970's to the early 1980's is present in both commercial and research index series. The autumn survey index reached a maximum in 1980 (3.2 kg/tow) and declined to the second lowest level observed by 1985 (0.7 kg/tow). The spring survey index peaked in 1982 (4.0 kg/tow) and has also rapidly declined to historically low levels in 1984-1985 (0.6-0.8 kg/tow) (Table 9.8).

Summary

Commercial catch-per-unit-effort indices and research survey abundance indices have declined from near record high levels in the early 1980's to near record low levels in 1985. Total landings have declined rapidly from peak levels. Stock abundance is currently in decline.

II. SPECIES REVIEW--AMERICAN PLAICE

Discussion

It was indicated that there may not be any reason to segregate Georges Bank from the Gulf of Maine for discussion of American plaice. Review of the important assessment issues (terms of reference) identified from the first Stock Assessment Workshop indicated that:

- Although definitive studies of stock structure (e.g., tagging programs, genetic studies) have not been undertaken, trends in abundance from the Gulf of Maine and Georges Bank appear identical over time.

- Shifts in catch by market category have been identified over the past ten years.

- Ageing data have not been incorporated in the most recent years, which, in turn, have prevented estimates of Z or complete evaluation of likely recruitment indices.

Table 9.1 Commercial nominal catch (metric tons) of American plaice from the Gulf of Maine Georges Bank-Southern New England, and the Mid-Atlantic, 1960-1985.

Year	Gulf of Maine			Georges Bank-Southern New England					Mid-Atlantic			GRAND TOTAL	
	USA	Canada	Total	USA	Canada	USSR	Other	Total	USA	Other	Total	USA	Total
1960	620	1	621	689	-	-	-	689	-	-	-	1,309	1,310
1961	692	-	692	830	-	-	-	830	-	-	-	1,522	1,522
1962	694	-	694	1,233	44	-	-	1,277	-	-	-	1,927	1,971
1963	693	-	693	1,489	125	-	-	1,614	-	-	-	2,182	2,307
1964	811	-	811	2,800	177	-	11	2,988	-	-	-	3,611	3,799
1965	967	-	967	2,376	180	112	-	2,668	-	-	-	3,343	3,635
1966	955	1	956	2,388	243	279	1	2,911	-	-	-	3,343	3,867
1967	1,066	1	1,067	2,166	208	1,018	10	3,402	4	-	4	3,236	4,473
1968	904	-	904	2,332	178	338	7	2,855	18	-	18	3,254	3,777
1969	1,059	1	1,060	2,243	77	412	17	2,749	-	-	-	3,302	3,809
1970	895	-	895	1,691	92	945	698	3,426	-	-	-	2,586	4,321
1971	648	4	652	1,522	39	340	502	2,403	-	2	2	2,170	3,057
1972	569	-	569	1,225	22	439	-	1,686	1	2	3	1,795	2,258
1973	687	-	687	915	38	447	-	1,400	1	-	1	1,603	2,088
1974	945	2	947	1,311	27	20	2	1,180	-	15	15	2,076	2,142
1975	1,507	-	1,507	916	25	148	-	1,089	4	34	38	2,427	2,634
1976	2,550	-	2,550	958	24	3	-	985	1	-	1	3,509	3,536
1977	5,647	-	5,647	1,414	35	128	-	1,577	7	27	34	7,068	7,258
1978	7,228	30	7,258	2,267	77	-	-	2,344	8	1	9	9,503	9,611
1979	8,835	-	8,835	2,516	23	6	1	2,546	4	64	68	11,355	11,449
1980	11,136	-	11,136	2,412	43	-	5	2,460	1	-	1	13,549	13,597
1981	10,324	1	10,325	2,511	15	-	-	2,526	46	1	47	12,881	12,898
1982	11,148	-	11,148	3,971	27	-	-	3,998	8	-	8	15,127	15,154
1983	9,137	7	9,144	4,018	30	-	-	4,048	5	-	5	13,160	13,197
1984	6,835[1]	2	6,837	3,293	6	-	-	3,299	7	-	7	10,135	10,143
1985	4,757	1	4,758	2,259	38	-	-	2,297	2	-	2	7,018	7,057

[1] Includes 14 mt from SNK.

Table 9.2 Percentage distribution of USA commercial otter trawl landings (metric tons, live) of American plaice, by vessel tonnage class[1], from the Gulf of Maine (Area 5Y) and Georges Bank (Area 5Ze), 1964-1984.

	Gulf of Maine (Area 5Y)				Georges Bank (Area 5Ze)			
Year	Class 2	Class 3	Class 4	Total	Class 2	Class 3	Class 4	Total
1964	70.0	28.8	1.2	100.0	11.2	80.4	8.4	100.0
1965	76.5	22.3	1.2	100.0	13.3	71.7	15.0	100.0
1966	73.1	25.7	1.2	100.0	9.8	71.3	18.9	100.0
1967	66.3	31.1	2.6	100.0	5.2	82.4	12.4	100.0
1968	64.8	33.0	2.2	100.0	2.6	84.7	12.7	100.0
1969	68.0	28.2	3.8	100.0	4.7	80.1	15.2	100.0
1970	70.6	25.4	4.0	100.0	1.5	83.1	15.4	100.0
1971	71.1	24.5	4.4	100.0	2.3	85.2	12.5	100.0
1972	67.2	29.4	3.4	100.0	1.6	88.9	9.5	100.0
1973	69.6	27.3	3.1	100.0	1.9	82.7	15.4	100.0
1974	73.2	23.9	2.9	100.0	3.7	80.3	16.0	100.0
1975	73.4	25.0	1.6	100.0	3.9	81.0	15.1	100.0
1976	70.2	28.2	1.6	100.0	5.4	79.1	15.5	100.0
1977	69.6	28.7	1.7	100.0	3.8	77.3	18.9	100.0
1978	65.6	30.9	3.5	100.0	4.3	83.0	12.7	100.0
1979	62.8	34.3	2.9	100.0	5.0	78.1	16.9	100.0
1980	62.2	33.5	4.3	100.0	4.1	68.6	27.2	100.0
1981	60.0	34.7	5.3	100.0	6.5	67.6	25.9	100.0
1982	57.9	34.1	8.0	100.0	5.0	70.4	24.6	100.0
1983	51.5	37.8	10.7	100.0	2.7	65.6	31.7	100.0
1984	46.5	41.7	11.8	100.0	4.6	64.4	31.0	100.0
1985	39.8	41.0	19.2	100.0	4.2	64.7	31.1	100.0

[1]Class 2: 5-50 GRT; Class 3: 51-150 GRT; Class 4: 151-500 GRT.

Table 9.3 USA commercial vessel trips, days fished[1], and average days fished per trip, by vessel tonnage class (Class 2: 5-50 GRT; Class 3: 51-150 GRT; Class 4: 151-500 GRT) for otter trawl trips landing American plaice from the Gulf of Maine (Area 5Y), 1964-1984. Data are also provided for otter trawl trips in which plaice comprised 50% or more of the total trip catch, by weight (directed trip).

	Vessel Tonnage Class											
	Class 2			Class 3			Class 4			Totals		
Year	Total Trips	Days Fished	Days Fished Per Trip	Total Trips	Days Fished	Days Fished Per Trip	Total Trips	Days Fished	Days Fished Per Trip	Total Trips	Days Fished	Days Fi Per T
					All Trips							
1964	2778	1844	0.66	1118	1233	1.15	70	142	2.03	3966	3269	0.3
1965	3416	2070	0.61	875	800	0.91	54	88	1.63	4345	2958	0.4
1966	2519	1802	0.69	860	767	0.89	32	70	2.19	3511	2639	0.7
1967	2258	1692	0.75	1010	1068	1.06	88	186	2.11	3366	2946	0.8
1968	1715	2148	1.25	1058	1115	1.05	90	172	1.91	2861	3435	1.2
1969	2120	2337	1.10	1256	1345	1.07	164	292	1.78	3540	3974	1.1
1970	2614	3668	1.40	1239	1455	1.13	184	350	1.90	4087	5473	1.3
1971	1971	2809	1.43	877	1201	1.37	157	319	2.03	3005	4329	1.4
1972	1769	2828	1.60	888	1239	1.45	89	183	2.06	2746	4300	1.5
1973	2216	2667	1.20	896	1177	1.31	118	205	1.74	3230	4049	1.2
1974	2678	3006	1.12	986	1214	1.23	151	276	1.83	3815	4496	1.1
1975	3740	3699	0.99	1056	1429	1.35	165	328	1.99	4961	5456	1.1
1976	2933	3491	1.19	1183	1658	1.40	194	453	2.34	4310	5602	1.3
1977	3066	3603	1.18	1462	1934	1.32	266	588	2.21	4794	6125	1.2
1978	3448	4407	1.28	1444	2308	1.60	435	810	1.86	5327	7525	1.4
1979	3763	4906	1.30	1548	2227	1.44	388	737	1.90	5699	7870	1.3
1980	3858	5487	1.42	1884	2952	1.56	367	855	2.33	6109	9274	1.5
1981	6711	4908	0.73	2531	2996	1.18	366	958	2.62	9608	8862	0.9
1982	6845	6172	0.90	2671	3976	1.49	423	1405	3.32	9939	11553	1.1
1983	6379	4965	0.78	2922	4354	1.49	414	1744	4.21	9715	11063	1.1
1984	6155	4932	0.80	3174	4774	1.50	395	1662	4.21	9724	11368	1.1
1985	5308	4410	0.83	3315	5672	1.71	643	2670	4.15	9266	[illegible]	[illegible]
					≥50% Trips							
1964	165	72	0.44	2	<1	-	0	0	-	167	72	0.4
1965	159	91	0.57	30	14	0.47	0	0	-	189	105	0.5
1966	148	75	0.51	19	11	0.58	0	0	-	167	86	0.5
1967	112	37	0.33	30	11	0.37	0	0	-	142	48	0.3
1968	59	26	0.44	32	12	0.38	0	0	-	91	38	0.4
1969	106	35	0.33	4	2	0.50	0	0	-	110	37	0.3
1970	31	9	0.29	0	0	-	0	0	-	31	9	0.2
1971	10	3	0.30	1	<1	-	0	0	-	11	3	0.2
1972	18	7	0.39	1	<1	-	0	0	-	19	7	0.3
1973	19	22	1.16	3	5	1.60	0	0	-	22	27	1.2
1974	72	99	1.38	3	3	1.00	0	0	-	75	102	1.3
1975	175	112	0.64	19	7	0.37	1	<1	-	195	119	0.61
1976	269	376	1.40	42	52	1.24	0	0	-	311	428	1.38
1977	564	586	1.04	117	145	1.24	0	0	-	681	731	1.07
1978	625	812	1.30	143	188	1.31	0	0	-	768	1000	1.30
1979	804	1447	1.80	221	345	1.55	2	1	0.50	1027	1791	1.7
1980	910	1508	1.66	272	408	1.50	13	10	0.77	1195	1926	1.61
1981	2060	1564	0.76	512	465	0.91	15	17	1.13	2587	2046	0.79
1982	1975	2112	1.07	411	551	1.34	7	11	1.57	2393	2674	1.12
1983	1408	1242	0.88	291	326	1.12	4	7	1.75	1703	1575	0.93
1984	1247	962	0.77	236	231	0.81	2	3	1.50	1535	1196	0.78
1985	817	562	0.69	103	106	1.03	3	6	2.00	923	674	0.73

[1]Days fished with trawl on bottom was derived by dividing hours fished with trawl on bottom by 24.0.

Table 9.4 USA commercial vessel trips, days fished[1], and average days fished per trip, by vessel tonnage class (Class 2: 5-50 GRT; Class 3: 51-150 GRT; Class 4: 151-500 GRT) for otter trawl trips landing American plaice from Georges Bank (Area 5Ze), 1964-1984. Data are also presented for otter trawl trips in which plaice comprised 50% or more of the total trip catch, by weight (directed trip).

	Vessel Tonnage Class											
	Class 2			Class 3			Class 4			Totals		
Year	Total Trips	Days Fished	Days Fished Per Trip	Total Trips	Days Fished	Days Fished Per Trip	Total Trips	Days Fished	Days Fished Per Trip	Total Trips	Days Fished	Days Fish Per Trip
					All Trips							
1964	247	395	1.60	1652	4736	2.87	303	1229	4.06	2202	6360	2.89
1965	235	532	2.26	1823	6289	3.45	465	2215	4.76	2523	9036	3.58
1966	248	436	1.76	1797	5902	3.28	591	2759	4.67	2636	9097	3.45
1967	179	220	1.23	1532	4952	3.25	457	1935	4.23	2168	7107	3.28
1968	156	143	0.96	1399	4526	3.24	424	1782	4.20	1979	6451	3.26
1969	89	122	1.37	1385	4417	3.19	334	1348	4.04	1808	5887	3.26
1970	91	82	0.90	1406	4329	3.08	304	1155	3.80	1801	5566	3.09
1971	193	208	1.08	1390	4622	3.33	231	858	3.71	1814	5688	3.14
1972	147	175	1.19	1428	5520	3.87	246	958	3.31	1821	6653	3.64
1973	94	120	1.28	1267	4511	3.56	258	855	3.31	1619	5486	3.39
1974	208	173	0.83	1190	4562	3.83	292	1035	3.54	1690	5770	3.41
1975	293	315	1.08	1888	6749	3.57	361	1287	3.57	2542	8351	3.29
1976	175	208	1.19	1151	4118	3.58	269	881	3.28	1595	5207	3.26
1977	234	224	0.96	1609	4920	3.06	273	771	2.82	2116	5915	2.80
1978	322	223	0.71	1973	5879	2.98	349	953	2.73	2644	7060	2.67
1979	269	338	1.26	2539	6230	2.47	609	1556	2.56	3417	8174	2.38
1980	316	429	1.36	2378	5833	2.45	708	1974	2.79	3402	8236	2.42
1981	490	519	1.06	2177	5880	2.70	712	2350	3.30	3379	8749	2.59
1982	516	455	0.88	2350	6580	2.80	782	3018	3.86	3648	10053	2.76
1983	336	268	0.80	2001	5989	2.99	805	3214	3.99	3142	9471	3.01
1984	347	285	0.82	2245	7850	3.50	790	3495	4.42	3382	11630	3.44
1985	276	380	1.38	2169	7933	3.66	777	3432	4.42	3222	11745	3.64
					≥50% Trips							
1964	14	47	3.36	58	166	2.86	0	0	-	72	213	2.96
1965	30	100	3.33	55	205	3.73	1	2	2.00	86	307	3.57
1966	14	59	4.21	68	239	3.51	1	1	1.00	83	299	3.60
1967	13	42	3.23	100	354	3.54	3	6	2.00	116	402	3.47
1968	2	5	2.50	80	230	3.50	1	2	2.00	83	237	3.46
1969	7	26	3.71	66	153	2.32	1	1	1.00	74	180	2.43
1970	0	0	-	78	144	1.89	7	15	2.14	84	159	1.89
1971	1	<1	-	42	71	1.69	7	6	0.86	50	77	1.54
1972	0	0	-	26	73	2.81	2	2	1.00	28	75	2.68
1973	0	0	-	14	34	2.43	3	3	1.00	17	37	2.18
1974	0	0	-	33	88	2.67	5	9	1.80	38	97	2.55
1975	7	14	2.00	49	117	2.39	5	16	3.20	61	147	2.41
1976	2	<1	-	21	50	2.38	2	5	2.50	25	55	2.20
1977	2	<1	-	26	59	2.27	5	7	1.40	33	66	2.00
1978	8	5	0.63	37	84	2.27	2	5	2.50	47	94	2.00
1979	33	9	0.27	54	96	1.68	5	8	1.60	92	113	1.23
1980	2	9	4.50	24	40	1.67	7	9	1.29	33	58	1.76
1981	26	21	0.81	62	125	2.02	2	5	2.50	90	151	1.68
1982	25	11	0.44	146	423	2.90	21	50	2.38	192	484	2.52
1983	4	1	0.25	132	445	3.37	19	51	2.68	155	497	3.21
1984	14	7	0.50	109	313	2.87	18	55	3.06	141	375	2.66
1985	7	6	0.86	45	152	3.38	20	46	2.29	72	204	2.83

[1]Days fished with trawl on bottom was derived by dividing hours fished with trawl on bottom by 24.0.

Table 9.5 Percentage, within vessel tonnage class[1], of vessel class American plaice landings (L)[2], vessel trips (T) and effort (DF)[3] of otter trawlers landing plaice from the Gulf of Maine (Area 5Y) and from Georges Bank (Area 5Ze) in which plaice comprised 50% or more of trip catch weight (directed trip).

	Vessel Tonnage Class											
	Class 2			Class 3			Class 4			Total		
Year	L	T	DF	L	T	DF	L	T	DF	L	T	DF
					Gulf of Maine (Area 5Y)							
1964	16.0	5.9	3.9	<0.1	0.2	<0.1	0.0	0.0	0.0	11.2	4.2	2.2
1965	14.3	4.7	4.4	12.3	3.4	1.3	0.0	0.0	0.0	14.1	4.3	3.5
1966	15.7	5.7	4.2	9.5	2.2	1.4	0.0	0.0	0.0	13.9	4.3	3.3
1967	13.0	4.9	2.2	9.7	3.0	1.0	0.0	0.0	0.0	11.7	4.2	1.6
1968	8.2	3.4	1.2	8.7	3.0	1.1	0.0	0.0	0.0	8.2	3.2	1.1
1969	12.9	5.0	1.5	1.0	0.3	0.1	0.0	0.0	0.0	9.0	3.1	0.9
1970	1.6	1.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.8	0.2
1971	0.7	0.5	0.1	<0.1	0.1	<0.1	0.0	0.0	0.0	0.5	0.4	0.1
1972	1.9	1.0	0.2	0.6	0.1	<0.1	0.0	0.0	0.0	1.3	0.7	0.2
1973	3.1	0.9	0.3	6.3	0.3	0.4	0.0	0.0	0.0	4.0	0.7	0.7
1974	16.7	2.7	3.3	0.9	0.3	0.2	0.0	0.0	0.0	12.3	2.0	2.3
1975	13.5	4.7	3.0	5.6	1.3	0.5	0.0	0.6	<0.1	11.4	3.9	2.2
1976	30.0	9.2	10.8	18.3	3.6	3.1	0.0	0.0	0.0	26.2	7.2	7.6
1977	42.3	18.4	16.3	23.2	8.0	7.5	0.0	0.0	0.0	37.6	14.2	11.9
1978	45.3	18.1	18.4	27.3	9.9	8.1	0.0	0.0	0.0	38.3	14.4	13.3
1979	60.9	21.4	29.5	41.5	14.3	15.4	0.4	0.5	0.1	52.5	18.0	22.3
1980	53.3	23.6	27.5	35.9	14.4	13.9	5.9	3.5	1.2	45.3	19.6	20.3
1981	60.4	30.7	31.9	40.0	20.2	15.5	9.5	4.1	1.3	69.5	26.9	23.1
1981	59.2	23.9	34.2	29.7	15.4	13.9	2.3	1.7	0.3	44.6	24.1	23.1
1983	48.9	22.1	25.0	19.3	10.0	7.3	1.5	1.0	0.4	32.7	17.5	14.2
1984	41.1	20.3	19.5	14.3	9.0	4.3	2.0	0.5	0.2	25.3	15.3	10.5
1985	30.5	15.4	12.7	6.9	3.1	1.9	1.4	0.5	0.2	15.3	10.0	5.3
					Georges Bank (Area 5Ze)							
1964	59.1	5.7	11.9	30.2	3.5	3.5	0.0	0.0	0.0	30.9	3.3	3.3
1965	69.7	12.8	13.8	27.9	3.0	3.3	1.1	0.2	0.1	29.4	3.4	3.4
1966	53.5	5.6	13.5	31.8	3.8	4.0	0.2	0.2	<0.1	23.0	3.1	3.3
1967	61.7	7.3	19.1	38.4	6.5	7.1	6.2	0.7	0.3	35.6	5.4	5.7
1968	23.3	1.3	3.5	37.4	5.7	6.2	1.9	0.2	0.1	32.3	4.2	4.4
1969	53.6	7.9	21.3	22.0	4.8	3.5	0.4	0.3	0.1	21.0	4.1	3.1
1970	0.0	0.0	0.0	23.2	5.4	3.3	12.6	2.3	1.3	21.2	4.7	2.9
1971	<0.1	0.5	<0.1	11.4	3.0	1.5	11.2	3.0	0.7	11.1	2.3	1.4
1972	0.0	0.0	0.0	8.5	1.8	1.3	0.9	0.8	0.2	7.7	1.5	1.1
1973	0.0	0.0	0.0	6.9	1.1	0.8	4.3	1.2	0.4	6.4	1.1	0.7
1974	0.0	0.0	0.0	15.9	2.3	1.9	6.0	1.7	0.9	13.3	2.2	1.7
1975	22.4	2.4	4.4	9.1	2.6	1.7	5.5	1.4	1.2	9.1	2.4	1.3
1976	3.9	1.1	<0.1	8.1	1.8	1.2	2.7	0.7	0.6	7.1	1.6	1.1
1977	5.7	0.9	<0.1	9.2	1.6	1.2	4.9	1.3	0.9	8.1	1.6	1.1
1978	9.8	2.5	2.2	8.3	1.9	1.4	2.5	0.6	0.5	7.7	1.8	1.3
1979	12.4	12.3	2.7	7.8	2.1	1.5	3.2	0.8	0.5	7.3	2.7	1.4
1980	7.3	0.6	2.1	4.8	1.0	0.7	5.2	1.0	0.5	5.0	1.0	0.7
1981	20.9	5.3	4.0	15.2	2.8	2.1	3.0	0.3	0.2	12.4	2.7	1.7
1982	17.8	4.8	2.4	36.1	6.2	6.4	11.5	2.7	1.7	29.2	5.3	4.3
1983	3.8	1.2	0.4	29.6	6.6	7.4	7.5	2.4	1.6	21.9	4.9	5.2
1984	7.5	4.0	2.5	16.5	4.9	4.0	9.3	2.3	1.6	13.3	4.2	3.2
1985	4.4	2.5	2.1	7.2	2.1	1.9	5.0	2.6	1.3	6.4	3.4	1.8

[1]Class 2: 5-50 GRT; Class 3: 51-150 GRT; Class 4: 151-500 GRT.

[2]Metric tons, live weight.

[3]Effort is expressed as days fished with trawl on the bottom and derived from hours fished with trawl on bottom divided by 24.0.

Table 9.6 USA commercial landings (L)[1], days fished (DF)[2], and landings per day fished (L/DF), by vessel tonnage class (Class 2:5-50 GRT; Class 3:51-150 GRT; Class 4:151-500 GRT), of American plaice for otter trawl trips catching plaice from the Gulf of Maine (Area 5Y), 1964-1984. Data are also provided for otter trawl trips in which plaice comprised 50% or more of the total trip catch, by weight (directed trip).

	Vessel Tonnage Class											
	Class 2			Class 3			Class 4			Total		
Year	L	DF	L/DF	L	DF	L/DF	L	DF	L/DF	L	DF	L/DF[3]
					All Trips							
1964	538	1844	0.30	221	1283	0.17	9	142	0.06	768	3269	0.25
1965	698	2070	0.34	203	300	0.25	11	88	0.13	912	2958	0.32
1966	656	1802	0.36	231	767	0.30	11	70	0.16	898	2639	0.34
1967	682	1692	0.40	320	1068	0.30	27	186	0.15	1029	2946	0.36
1968	562	2148	0.26	236	1115	0.26	19	172	0.11	867	3435	0.26
1969	708	2337	0.30	294	1345	0.22	40	292	0.14	1042	3974	0.27
1970	617	3668	0.17	222	1455	0.15	35	350	0.10	874	5473	0.16
1971	452	2809	0.16	156	1201	0.13	28	319	0.09	636	4329	0.13
1972	372	2828	0.13	163	1239	0.13	19	183	0.10	554	4300	0.13
1973	452	2667	0.17	177	1177	0.15	20	205	0.10	649	4049	0.16
1974	651	3006	0.22	213	1214	0.18	26	276	0.09	890	4496	0.21
1975	1048	3699	0.28	356	1429	0.25	23	328	0.07	1427	5456	0.27
1976	1670	3491	0.48	671	1658	0.40	38	453	0.08	2379	5602	0.45
1977	3639	3603	1.01	1497	1934	0.77	90	588	0.15	5226	6125	0.93
1978	4410	4407	1.00	2076	2308	0.90	238	810	0.29	6724	7525	0.94
1979	4859	4906	0.99	2655	2227	1.19	227	737	0.31	7741	7870	1.04
1980	5859	5487	1.07	3151	2932	1.07	408	855	0.48	9418	9274	1.04
1981	6118	4908	1.25	3540	2996	1.18	535	958	0.56	10193	8862	1.19
1982	6316	6172	1.02	3722	3976	0.94	871	1405	0.62	10909	11553	0.96
1983	4368	4965	0.88	3200	4354	0.73	904	1744	0.52	8472	11063	0.78
1984	2951	4932	0.60	2547	4774	0.53	753	1662	0.45	6351	11368	0.56
1985	1765	4410	0.40	1814	5672	0.32	851	2570	0.32	4430	12752	0.35
					≥50% Trips							
1964	86	72	1.19	<1	<1	-	0	0	-	86	72	1.19
1965	103	91	1.13	26	14	1.86	0	0	-	129	105	1.23
1966	103	75	1.37	22	11	2.00	0	0	-	125	86	1.48
1967	89	37	2.41	31	11	2.82	0	0	-	120	48	2.52
1968	46	26	1.77	25	12	2.08	0	0	-	71	38	1.88
1969	91	35	2.60	3	2	1.50	0	0	-	94	37	2.56
1970	10	9	1.11	0	0	-	0	0	-	10	9	1.11
1971	3	3	1.00	<1	<1	-	0	0	-	3	3	1.00
1972	7	7	1.00	1	<1	-	0	0	-	7	7	1.00
1973	14	22	0.64	12	5	2.40	0	0	-	26	27	1.45
1974	109	99	1.10	2	3	0.67	0	0	-	111	102	1.09
1975	142	112	1.27	20	7	2.86	0	<1	-	162	119	1.47
1976	501	376	1.33	123	52	2.37	0	0	-	624	428	1.54
1977	1541	586	2.63	422	145	2.91	0	0	-	1963	731	2.69
1978	1997	812	2.46	577	188	3.07	0	0	-	2574	1000	2.60
1979	2958	1447	2.04	1103	343	3.22	1	1	1.00	4062	1791	2.36
1980	3154	1508	2.09	1132	408	2.77	24	10	2.40	4310	1926	2.27
1981	3693	1564	2.36	1416	465	3.05	51	17	3.00	7086	2046	2.56
1982	3737	2112	1.77	1106	551	2.01	24	11	2.18	4867	2674	1.33
1983	2136	1242	1.72	618	326	1.90	14	7	2.00	2768	1575	1.76
1984	1213	962	1.26	378	231	1.64	15	3	5.00	1606	1196	1.38
1985	539	562	0.96	125	106	1.17	12	6	1.37	676	674	1.01

[1] Metric tons, live weight.

[2] Days fished with trawl on bottom was derived by dividing hours fished with trawl on bottom by 24.0.

[3] Total landings per day fished was derived by weighting individual tonnage class landings rates by the percentage of total landings represented in each vessel class and summing the weighted landings rates over the three vessel class categories.

Table 9.7 USA commercial landings (L)[1], days fished (DF)[2], and landings per day fished (L/DF), by vessel tonnage class (Class 2:5-50 GRT, Class 3:51-150 GRT; Class 4:151-500 GRT), of American plaice for otter trawl trips catching plaice from Georges Bank (Area 5Ze), 1964-1984. Data are also provided for otter trawl trips in which plaice comprised 50% or more of the total trip catch, by weight (directed trip).

	Vessel Tonnage Class											
	Class 2			Class 3			Class 4			Total		
Year	L	DF	L/DF	L	DF	L/DF	L	DF	L/DF	L	DF	L/
					All Trips							
1964	198	395	0.50	1420	4736	0.30	149	1229	0.12	1767	6360	0.
1965	317	532	0.60	1704	6239	0.27	356	2215	0.16	2377	9036	0.
1966	217	436	0.50	1586	5902	0.27	421	2759	0.15	2224	9097	0.
1967	107	220	0.49	1707	4952	0.34	257	1935	0.13	2071	7107	0.
1968	43	143	0.30	1426	4526	0.32	214	1782	0.12	1683	6451	0.
1969	81	122	0.66	1388	4417	0.31	264	1348	0.20	1733	5887	0.
1970	25	82	0.30	1334	4329	0.31	247	1155	0.21	1606	5566	0.
1971	35	208	0.17	1236	4622	0.23	138	858	0.22	1509	5688	0.
1972	20	175	0.11	1089	5520	0.20	116	938	0.12	1225	6673	0.
1973	17	120	0.14	754	4511	0.17	141	855	0.16	912	5486	0.
1974	39	173	0.23	841	4562	0.18	167	1035	0.16	1047	5770	0.
1975	98	315	0.31	2027	6749	0.30	379	1237	0.29	2504	8351	0.
1976	51	208	0.25	750	4118	0.18	147	881	0.17	948	5207	0.
1977	54	224	0.24	1081	4920	0.22	264	771	0.34	1399	5915	0.
1978	92	223	0.40	1797	5879	0.31	276	953	0.29	2165	7060	0.
1979	121	338	0.36	1899	6230	0.30	412	1556	0.26	2432	8174	0.
1980	96	429	0.22	1598	5833	0.27	634	1974	0.32	2328	8236	0.
1981	158	519	0.30	1648	5880	0.28	632	2350	0.27	2438	8749	0.
1982	191	455	0.42	2684	6580	0.41	938	3013	0.31	3813	10053	0.
1983	105	268	0.39	2538	5989	0.42	1228	3214	0.38	3871	9471	0.
1984	147	285	0.52	2077	7850	0.26	1001	3495	0.29	3225	11630	0.
1985	94	280	0.33	1446	7933	0.18	696	3432	0.20	2236	11645	0.
					≥50% Trips							
1964	117	47	2.49	429	166	2.58	0	0	-	546	213	2.
1965	221	100	2.21	475	205	2.32	4	2	2.00	700	307	2.
1966	116	59	1.97	505	239	2.11	1	1	1.00	622	299	2.
1967	66	42	1.57	655	354	1.85	16	6	2.67	737	402	1.
1968	10	5	2.00	533	280	1.90	4	2	2.00	547	287	1.
1969	45	26	1.73	318	153	2.08	1	1	1.00	364	180	2.
1970	0	0	-	310	144	2.15	31	15	2.07	341	159	2.
1971	<1	<1	-	147	71	2.07	21	6	3.50	168	77	2.
1972	0	0	-	93	73	1.27	1	2	0.50	94	75	1.
1973	0	0	-	52	34	1.53	6	3	2.00	58	37	1.
1974	0	0	-	134	88	1.52	10	9	1.11	144	97	1.
1975	22	14	1.57	184	117	1.57	21	16	1.31	227	147	1.
1976	2	<1	-	61	50	1.22	4	5	0.80	67	55	1.
1977	2	<1	-	99	59	1.68	13	7	1.86	114	66	1.
1978	9	5	1.80	150	84	1.79	7	5	1.40	166	94	1.
1979	15	9	1.67	149	96	1.55	13	8	1.63	177	113	1.
1980	7	9	0.78	76	40	1.90	33	9	3.67	116	58	2.
1981	33	21	1.57	250	125	2.00	19	5	3.80	302	151	2.
1982	34	11	3.09	970	423	2.29	108	50	2.16	1112	484	2.
1983	4	1	4.00	751	445	1.69	92	51	1.80	847	497	1.
1984	11	7	1.57	342	313	1.09	93	55	1.69	446	375	1.
1985	4	6	0.68	104	152	0.68	35	46	0.76	143	204	0.

[1]Metric tons, live weight.

[2]Days fished with trawl on bottom was derived by dividing hours fished with trawl on bottom by 24.0.

[3]Total landings per day fished was derived by weighting individual tonnage class landings rates by the percentage of total landings represented in each vessel class and summing the weighted landings rates over the three vessel class categories.

Table 9.8 Stratified mean catch per tow in numbers and weight (kgs) for American plaice from USA offshore spring and autumn bottom trawl surveys on Georges Bank (Strata 13-25), in the Gulf of Maine (Strata 26-30 and 36-40), and for the combined Gulf of Maine-Georges Bank area, 1963-1985.

	Georges Bank				Gulf of Maine				Combined Gulf of Maine-Georges Bank			
	Spring[1]		Autumn		Spring[1]		Autumn		Spring[1]		Autumn	
Year	Nos.	Wt.	Nos.	Wt.	Nos.	Wt.	Nos.	Wt.	Nos.	Wt.	Nos.	Wt.
1963	-	-	10.00	5.49	-	-	17.74	6.19	-	-	14.17	5.87
1964	-	-	5.55	1.99	-	-	10.53	3.63	-	-	8.23	2.87
1965	-	-	4.73	1.23	-	-	18.12	5.98	-	-	11.95	3.79
1966	-	-	11.15	3.27	-	-	23.44	6.29	-	-	17.77	4.90
1967	-	-	5.04	1.73	-	-	16.19	3.50	-	-	11.05	2.68
1968	5.91	1.61	6.03	1.29	16.14	4.96	10.82	4.28	11.42	3.42	8.61	2.90
1969	7.04	2.20	2.84	1.11	9.90	3.90	11.51	3.48	8.58	2.68	7.51	2.39
1970	4.01	1.44	4.93	1.50	6.65	2.11	7.77	2.44	5.43	1.80	6.46	2.01
1971	3.08	1.13	3.03	0.90	4.42	1.37	11.26	2.86	3.80	1.26	7.47	1.96
1972	3.24	1.24	3.28	0.87	5.17	1.36	11.00	2.21	4.28	1.30	7.44	1.59
1973	2.10	0.79	3.73	0.88	11.56	2.77	8.29	2.84	7.20	1.86	6.19	1.94
1974	4.89	1.30	1.37	0.35	11.28	2.47	11.62	2.32	8.33	1.93	6.90	1.41
1975	2.70	1.04	3.96	1.23	8.52	2.32	11.68	3.45	5.84	1.73	8.12	2.43
1976	3.26	0.99	2.80	1.03	19.20	5.40	16.13	4.67	11.85	3.37	9.99	2.99
1977	4.35	1.36	5.73	2.39	23.35	8.35	21.79	7.42	14.59	5.13	14.39	5.10
1978	5.32	1.60	5.72	1.80	15.14	5.72	29.33	11.00	10.61	3.82	18.45	6.76
1979	2.75	1.05	3.93	1.27	16.98	7.12	16.80	7.84	10.42	4.32	10.87	4.81
1980	9.71	1.39	8.87	3.16	32.75	11.35	24.63	11.07	22.13	6.76	17.37	7.42
1981	11.27	3.04	5.62	2.14	33.72	13.57	20.73	9.99	23.37	8.72	13.76	6.37
1982	11.46	4.04	6.56	2.00	16.45	6.76	6.27	3.29	14.15	5.51	6.41	2.70
1983	4.42	1.94	3.73	1.58	27.42	7.31	15.94	5.28	16.82	4.83	10.31	3.57
1984	1.72	0.65	1.88	0.76	5.84	2.10	11.55	2.93	3.94	1.43	7.09	1.93
1985	1.98	0.83	2.38	0.70	7.54	2.83	11.03	3.18	4.98	1.91	7.04	2.04

[1]Spring surveys, 1973-1981, were accomplished with a "41 Yankee" trawl; spring surveys in other years were accomplished with a "36 Yankee" trawl. No adjustments have been made to the catch per tow data for these gear differences.

II. SPECIES REVIEW--MACKEREL

10. MACKEREL

Source Document: Overholtz, W., and B. L. Parry. 1986. Update of the Status of the Northwest Atlantic Mackerel Stock for 1985. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 85-13, 15 p.

The current status of mackerel is described in the source document. The population has been increasing steadily, and several strong year classes have recruited in recent years. Present catches are small compared to those occurring from 1969-1976, and fishing mortality estimated from VPA is low.

Discussion

The recreational fishery statistical surveys that have been conducted since 1979 need to be explored for length frequency data in order to avoid the need to apportion the age composition of either the U.S. or foreign commercial catch to the recreational catch. The issue of one versus two stocks is still open and although the Canadians are performing stock identification work, many felt that tagging studies would help clarify the issue. There have been Canadian tagged Atlantic mackerel caught in the Mid-Atlantic. The possible usefulness of biological tags (parasites) was also mentioned and research being conducted by NMFS at its Oxford laboratory will be addressed next year.

With the extensive rebuilding of the stocks since fishing has been restricted (it was noted that the very high 400,000 mt catches during the early 1970's may have been underreported), theoretically several density dependent factors may become important in the future. In addition to the possibility of parasite loads increasing, there potentially could be density dependent growth, mortality, and maturity changes. The imprecision of VPA analysis at very low fishing levels led to discussion of using Atlantic mackerel stocks for an experimental fishery. Although at this time the effort levels needed to significantly impact upon the stocks are not known. An ad hoc working group was formed to develop a concept paper for our next workshop. That group was charged to determine the benefits and costs of an expanded experimental fishery upon review of the European/ICES studies and with emphasis also on the problem of river herring by-catch. There was no commitment of support for the effort beyond the scientific merit and the working group's efforts were not unanimously supported.

Work is beginning on the interactions of Atlantic mackerel with sand lance, herring, and marine mammals. No conclusive results are yet available although there does seem to be some indications of predators switching more to mackerel. Fifteen to 20% of the recently analyzed diets of cod and spiny dogfish contain mackerel.

The Atlantic mackerel, squid, and butterfish FMP Amendment #2 change from fishing year to calendar year was approved in 1986 and thus all quota setting requirements were moved forward 90 days. Thus data in the source document, with addition of the spring 1986 survey indices and VPA, will provide the basis for 1987 quota setting.

11. BUTTERFISH

Source Document: Waring, G. T., and E. D. Anderson. 1983. Status of the Northwestern Atlantic Butterfish Stock--1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No.83-41, 39 p.

Commercial Fishery

The total international catch of butterfish declined 58% from 12,254 mt in 1984 to 5,139 mt in 1985 (Table 11.1). The international catch peaked in 1973 at 19,500 mt, most of which was taken by distant-water fleets (DWF) in conjunction with their squid fisheries. The DWF catch declined from 429 mt in 1984 to 400 mt in 1985, representing the fourth consecutive yearly decline in DWF catches. The USA catch declined from a record high level of 11,325 mt in 1984 to 4,739 mt in 1985. The decline primarily reflected a reduced export market for "super small" butterfish, and decreased availability of larger butterfish.

Discard rates of small butterfish continued to be relatively high (30-80% by weight of the landed catch) as new freezer-trawlers and some otter trawlers equipped with size-sorting machines continue to fish in areas of high abundance of small butterfish. These machines select marketable fish and discard sub-marketable fish at sea, thus allowing vessels to make a profitable trip.

Butterfish are managed under the provisions of the Fishery Management Plan (FMP) for the Atlantic Mackerel, Squid, and Butterfish Fisheries, developed by the Mid-Atlantic Fishery Management Council (MAFMC). The FMP currently allows an annual butterfish catch (USA and foreign combined) of up to 16,000 mt, which is equivalent to the maximum sustainable yield (MSY) for this species. The allowable domestic harvest is less than or equal to 16,000 mt, minus the DWF by-catch total allowable level of foreign fishery (TALFF). The TALFF equals 6% of the allocated portion of the *Loligo* TALFF and 1% of the allocated portions of the *Illex*, mackerel, silver hake, and red hake TALFF's.

Survey Abundance Indices

The catch index (all ages) from the NEFFC 1985 autumn bottom trawl survey (15.2 kg) increased 33% from 1984, and equalled the record high 1980 value (Table 11.2). Likewise, the recruitment index (number per tow at age 0) (286.3) and the age 1+ index (100.4) from the 1985 autumn survey increased 6.7% and 7.5%, respectively, above 1984 values (Table 11.2). Additionally, the age 1+ index is a record high value for the 18-year (1968-1985) time series. Age 1, 2, 3, and 4 fish accounted for 85%, 12%, and 1%, respectively, of this index. The indices of relative abundance by age (Table 11.3) have shown increases among nearly all age groups recently.

Size composition and abundance data for butterfish inhabiting five geographic sub-regions of the northeast coast were assessed from NEFC inshore and offshore bottom trawl survey data (Waring 1986). The five sub-regions were: (1) offshore, south of Hudson Canyon, (2) inshore, south of Delaware Bay, (3) inshore, north of Delaware Bay and offshore of Long Island,

(4) Southern New England, and (5) Georges Bank. These relatively distinct sub-regions were identified based on consistency of patterns in size composition and abundance of butterfish over time.

Significant differences in the size composition of butterfish were apparent between the five geographic areas examined. Average sizes of butterfish in the SNE area (currently accounting for the predominance of landings) are generally intermediate between subareas to the south and west (occupied by smaller butterfish) and areas to the north and east (inhabited by larger fish). However, average butterfish abundance (numbers and weight per standardized survey tow) has been greatest off SNE since 1980. This spatial distribution by size groups confirms earlier work by Anderson and Waring (1981).

Summary

The 1985 autumn survey values represent the sixth year in the past seven years that abundance indices were greater than values observed during 1973-1976 when total butterfish catches were high (11,200-19,500 mt). This suggests that sufficient fish are available to support a catch up to the maximum (16,000 mt) currently allowed by the FMP. However, the length composition of all age 0 and 61% of the age 1 butterfish taken in the autumn 1985 survey were below marketable size. Therefore, discard rates during 1986 will probably continue to be high under current fishing practices. Since butterfish have a short life span (about 4 years) and a relatively high natural mortality rate (M=0.8), delaying the age of first harvest from age 0 to an older age does not lead to higher yields, as would be the case for longer-lived species with lower natural mortality rates. One benefit from delaying capture would be that a larger fish would probably command a higher price per pound to the fishermen. However, if fishing mortality were reduced on age 0 and undersize age 1 fish, stock biomass, on average would increase by at least 25%. An increased stock will improve spawning potential, hopefully ensure a higher probability of producing good recruitment, and provide a buffer to help support the fishery in the event of poor recruitment.

Discussion

The low abundance index for 1982 was addressed and probably is attributable to the fish not being available or vulnerable to the gear at the specific time of the survey. Whether the fish were in deeper waters or there was simply a magnified day/night difference in 1982 is presently unknown. Since the 1982 year class appeared quite strong in 1983 as 1-year-olds, it was agreed that full credibility could not be given to the 1982 age 0 index.

The possibility of yield levels increasing is a very difficult question because the U.S. boats appear to be targeting on small fish. There are, however, indications that we may be beginning to stockpile biomass in the older age groups (Table 11.3). There was a consensus that between 1969 and 1976 when foreign nationals were fishing heavily in the EEZ, the stocks were

overfished and there were few age 2 and 3 fish. However, the large coefficients of variation may preclude detection of differences. It was recommended for the next workshop that Z be calculated from the annual age composition.

Preliminary results of the mesh selectivity study on butterfish requested by the Mid-Atlantic Council were presented. Since this analysis is expected to be completed in the next couple of months, no summary of the literature survey and presently available data will be presented here.

In summary, the stock appears in good shape. The lack of large fish off Southern New England/Long Island appears to be more because of the preponderance of small fish (from the past several excellent year classes) simply overwhelming the numbers of larger fish. Ideally, there appear to be new opportunities, if vessels can be encouraged to fish in areas of large fish concentrations (Waring 1986).

Table 11.1 Nominal catch (mt) of butterfish from Northwest Atlantic Fisheries Organization (NAFO) Subareas 5 and 6, 1983-1985.

YEAR	USA	FOREIGN	NOMINAL CATCH	ADJUSTED NOMINAL CATCH [1]
1983	4,905	630	5,535	6,816
1984	11,825	429	12,254	16,854
1985 [2]	4,739	400	5,139	7,509

[1] Adjusted to account for non-reported discards.

[2] Provisional

Table 11.2 Indices of Relative Abundance (stratified mean catch per tow) for Butterfish by Age Group Derived from NEFC Autumn Bottom Trawl Survey Data, 1983 - 1985.

Year	AGE 0	AGE 1 AND OLDER	TOTAL	WEIGHT (kg)
1983	358.8	92.4	451.2	12.8
1984	268.6	93.4	362.0	11.4
1985	286.3	100.4	386.7	15.2

*Strata 1-12, 61-76, 13, 14, 16, 19, 20, 23, 25 (offshore);

1-46 (inshore).

Table 11.3 Indices of Relative Abundance (Stratified mean number per tow at age) for Butterfish Derived from NEFC Autumn Bottom Trawl Survey Data, 1968-1985.

Year	Age 0	1	2	3	4	Total
1968	41.28	50.59	1.64	0.10	0.	93.61
1969	39.48	18.82	2.12	0.16	0.	60.58
1970	26.43	11.24	0.86	0.10	0.	38.60
1971	208.85	8.76	0.70	0.24	0.	218.55
1972	73.20	8.34	0.31	0.05	0.	81.90
1973	119.10	27.73	1.50	0.07	0.	148.40
1974	82.13	15.96	1.74	0.37	0.	100.20
1975	26.34	17.54	1.71	0.15	0.	45.74
1976	110.63	26.50	2.12	0.33	0.	139.58
1977	47.73	32.78	6.22	0.24	0.	86.97
1978	134.96	7.96	10.18	1.05	0.	154.15
1979	231.51	73.01	4.85	0.18	0.	309.55
1980	233.19	80.42	18.82	0.73	0.04	333.20
1981	234.55	47.14	12.88	0.29	0.01	294.87
1982	80.31	26.12	4.73	0.14	0.14	111.44
1983	358.77	78.49	10.70	3.25	0.07	451.28
1984	268.60	79.55	11.07	2.79	0.	362.01
1985	286.26	85.69	12.40	2.27	0.09	386.71

II. SPECIES REVIEW--LONG-FINNED SQUID

12. LONG-FINNED SQUID

Source Document: Lange, A. M. T. 1984. An Assessment of the Long-Finned Squid Resource off the Northeastern United States-Autumn 1984. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-37, 24 p.

The Fishery

The USA *Loligo* fishery was prosecuted about equally in Subareas 5 and 6 during 1985, with about 4,901 mt reported from Subarea 5 (primarily south of Cape Cod), and about 5,253 mt (including 1,082 mt from joint ventures) from Subarea 6. The total domestic harvest was 10,155 mt during 1985, down 12% from the 1984 landings, but still almost five times the 1968-82 average (Table 12.1). Joint ventures with Japan, Italy, and Spain, while taking about 54% of their total allocation, accounted for about 11% of the USA *Loligo* harvest during 1985, compared to about 7% during 1984. Domestic landings were distributed throughout the year in 1985, with peaks during May and August in Statistical Areas (SA) 537-538 and during July in SA 611-616. The fishery has been dominated by ton class 3 otter trawl vessels (51-150 GRT) since 1978. Most of the directed catch (defined as the catch from those trips for which squid accounted for over 75% of the total) prior to 1984 was attributed to the inshore fishery in Vineyard and Nantucket Sounds (SA 538). In 1984, the directed catch in SA 537 (offshore, Southern New England) increased to account for 42% of the SA 537-539 total compared to less than 5% in previous years. This offshore fishery accounted for 89% of the fishery during 1985.

The distant-water-fleet (DWF) catch during 1985 was 6,549 mt (Table 12.1), with Italy and Spain accounting for 57% and 41%, respectively. Total catch (USA and DWF) during 1985 was about 26% less than that taken in 1984, and about 31% below the average seen since the foreign directed fishery began (1970-1983).

Commercial Length Frequencies

Length frequency data from the 1985 USA fishery in SA 537-539 indicate presence of several age classes throughout most of the year (Figure 12.1). Significant numbers of large individuals ($\geq$25 cm, probably about 20-24 months) were present from January through May, and again in September and November. Similar size distributions were evident in the samples taken from the SA 611-636 (Mid-Atlantic) fishery (Figure 12.2). Two major differences were: the high proportion of small ($\leq$10 cm) squid taken in April; and the much higher proportion of spring 1985 squid taken in Areas 6B and 6C during August and September. This may reflect earlier arrival of small squid from the previous autumn's cohorts as the water temperature in the southern areas increases first; and earlier spawning and subsequent movement of young out of coastal waters in the more southern area.

Two catch (metric tons) per unit effort (days fished) indices from the USA directed fishery, defined as those trips where over 75% of the catch was *Loligo*, are given in Figure 3 for 1976-1985. The first index (TC 3) is based on all ton class 3 otter trawl trips in Areas 538-539, and reflects

the relative availability of Loligo to the directed fishery which began there in about 1976. CPUE was greatest in 1983, and lowest in 1978, while the 1985 index was comparable to that seen during 1979-1982, but well below the 1983 and 1984 levels. The second CPUE index is based on all "directed" trips in Subareas 5 and 6, for all ton classes. This index is probably more appropriate at present since it accommodates recent movements of the directedfishery into more offshore areas. This total CPUE index does not indicate a strong continued steep decline in 1985.

Research Vessel Surveys

Figure 12.4 shows the seasonal distribution of long-finned squid in the NEFC survey areas based on catches during the 1985 spring and autumn research surveys. At the time of the spring survey long-finned squid are moving onto the shelf, initially in the more southern areas, and are found primarily in the deeper offshore strata. During summer the stock moves onto the shelf and into coastal waters to spawn. By the time of the NEFC autumn survey immature adults and young of the current year class are moving offshore and are found throughout the shelf, including small amounts in the Gulf of Maine.

Minimum biomass and abundance estimates based on areal expansion of stratified mean weights and numbers per tow are provided in Table 12.2. These estimates assume 100% catchability of Loligo during daytime, while nighttime tows are adjusted upward to account for off-bottom movements during that time. The 1985 estimates were the third highest of the time series.

The 1985 NEFC autumn bottom trawl survey abundance index (stratified mean number per tow) for the Mid-Atlantic through Georges Bank strata was the second highest of the series (1967-1985), 58% above the 1967-1984 mean (Table 12.3). The pre-recruit (≤8 cm dorsal mantle length individuals) index was the third highest since 1967, 35% above the 1967-1984 mean.

The commercial CPUE indices during 1976-1984 followed the same patterns as the research survey indices for the same year (Figure 12.5). However, during 1985 CPUE continued to drop from the 1983 high, while the survey index showed a significant increase. As mentioned previously, the total index probably better reflects the current fishery and showed only a slight decline in 1985. For Loligo, USA CPUE is primarily a measure of the spawning portion of the stock during the spring and summer, while the survey index is comprised predominantly of pre-recruits, progeny of those spawners. The consistency of these two measures suggest a relationship between spawners and recruits.

Prospects for 1986

Total abundance during the autumn 1985 survey, based on daytime tows was 3.2 billion. Pre-recruits accounted for 70.3% of the total (2.2 billion). If 55% of the pre-recruits are from the spring cohort, and catchability is 45%, 2.7 billion [2.2 X (0.55 x 0.45)] recruits are estimated from that cohort. As described in Lange (1984) the autumn cohort is assumed to contribute additional recruits equivalent to about 18% of those from the spring cohort (0.5 billion). Total recruitment from the 1985 year class is therefore estimated to be 3.2 billion.

II. SPECIES REVIEW--LONG-FINNED SQUID

Table 4 contains estimates of yield of Loligo from the 1985 year class, assuming 3.2 billion recruits, for an offshore/inshore and an inshore fishery and a range of fishing mortality rates. The nature of the current fishery probably falls somewhere between these two models. Lange et al. (1984), assuming a moderate stock-recruitment relationship, found the highest equilibrium yield associated with an F of 0.70. Yield from the 1985 year class at an F level of 0.70 is expected to range between 54,000 and 61,000 mt. The average F during 1978-1981 was estimated as 0.41. Yield from the 1985 year class at an F level of 0.40 is expected to range between 38,000 and 42,000 mt.

Conclusion

High apparent abundance of both adults and pre-recruits during the autumn 1985 NEFC research vessel survey suggest that current abundance of Loligo is more than adequate to provide catches, during 1986, at the optimum yield level established in the Fishery Management Plan.

Discussion

Previous studies (Sissenwine and Bowman 1978) showed day/night difference in catchability of Loligo. More than two and a half times more biomass was caught during daytime tows, but 19 times more individuals were caught during the day than at night. This suggests a significantly higher proportion of small individuals moving off the bottom during the night. There is the potential for a stronger stock recruitment relationship than previously believed. However, the relationship appears confounded because the NEFC autumn survey index may be an inconsistent measure of recruitment to the foreign fishery in the winter.

The high current abundance of Loligo is more than adequate for the optimum yield levels identified in the FMP. There was discussion of the potential benefits of not harvesting all the young when first available. Apparently several port agents during 1986 have noticed really large Loligo. These larger/older individuals are probably 3-year-olds. Mention was made of the preliminary stock discrimination study conducted by Dr. Carl Berg of the Marine Biological Laboratory (Woods Hole). This study showed no separate stocks along the N.E. coast. The working group felt that discussion of this topic should resume as more information becomes available.

Table 12.1 Annual long-finned squid catches (in metric tons) from the Northwest Atlantic (Cape Hatteras to Gulf of Maine) by the USA and the distant-water-fleet (DWF), 1983-85.

Year	USA	DWF	Total
1983	15,943	11,720	27,663
1984	11,592	11,031	22,623
1985	10,155	6,549	16,704

Table 12.2 *Loligo pealei* minimum biomass (metric tons) and abundance (in millions) estimates[1] for the Mid-Atlantic to Gulf of Maine, 1983-85.

Year	Biomass	Abundance
1983	62,363	4,460
1984	66,122	4,670
1985	55,612	4,865

[1]From areal expansion of stratified mean weights (kg) and numbers per tow assuming 100% catchability during daytime. Nighttime catch data were expanded to account for diel differences in catch (Sissenwine and Bowman 1978).

Table 12.3 Total and pre-recruit (≤8 cm) stratified mean numbers per tow[1] of *Loligo pealei* from the NEFC autumn bottom trawl surveys (Mid-Atlantic to Georges Bank), 1983-85.

Year	All sizes	Pre-recruits
1983	373.4	251.1
1984	299.8	152.2
1985	442.2	310.8

[1]Stratified mean number per tow of all sizes and of individuals ≤8 cm mantle length.

Table 12.4 Estimated yield (in metric tons) of long-finned squid associated with various levels of fishing mortality and the 1985 recruitment level of 3.2 billion individuals for the offshore/inshore and inshore fisheries.

F	Offshore/Inshore	Inshore
.27	27,200	29,760
.41	37,760	41,920
.55	46,720	52,160
.70	54,000	60,800
.93	58,560	65,920
1.20	61,760	73,280

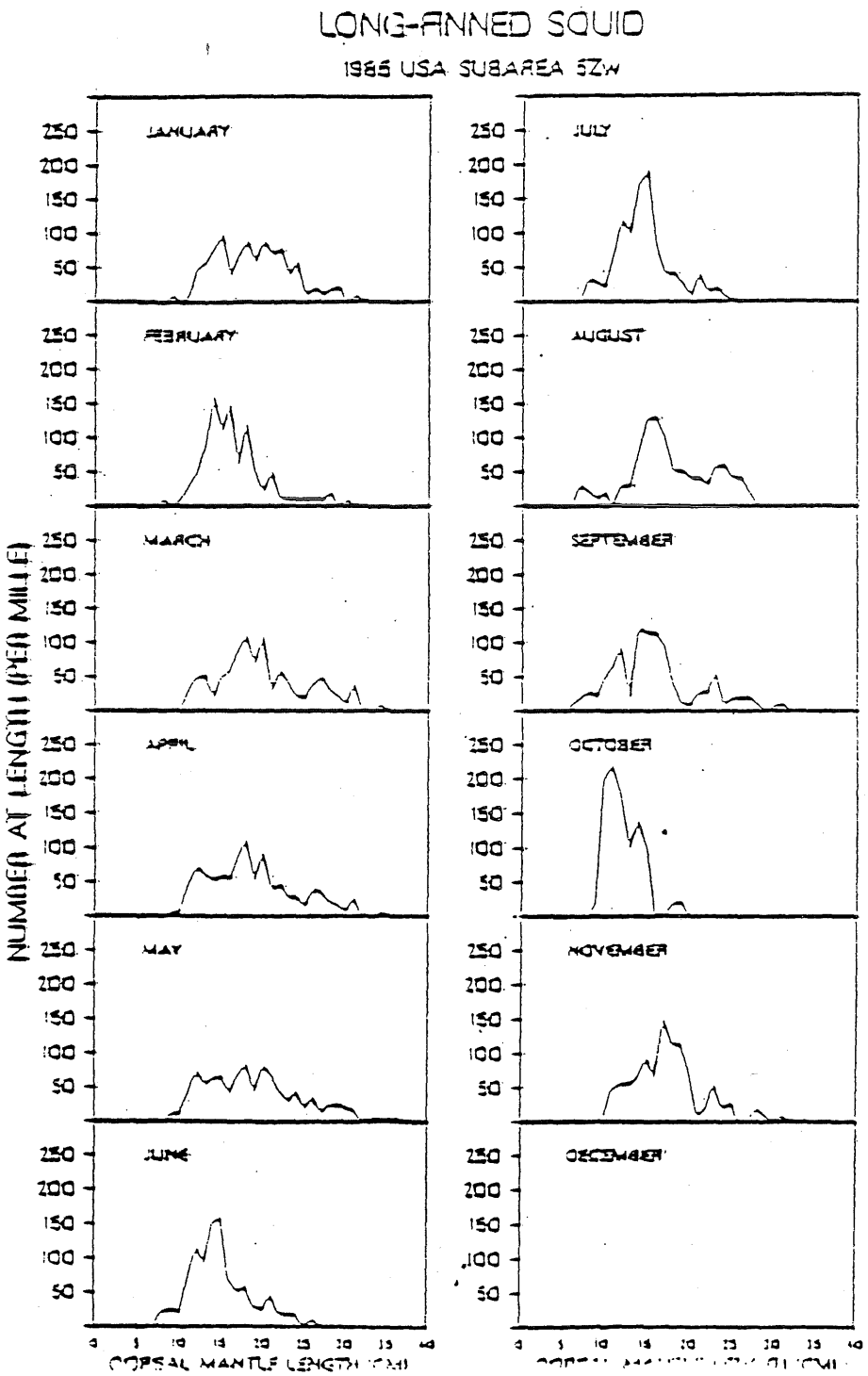


Figure 12.1 Length frequency distributions of long-finned squid. (Loligo pealei) from the 1985 USA fishery.
a. Statistical Areas 537-539 (NAFO Division 5ZW).

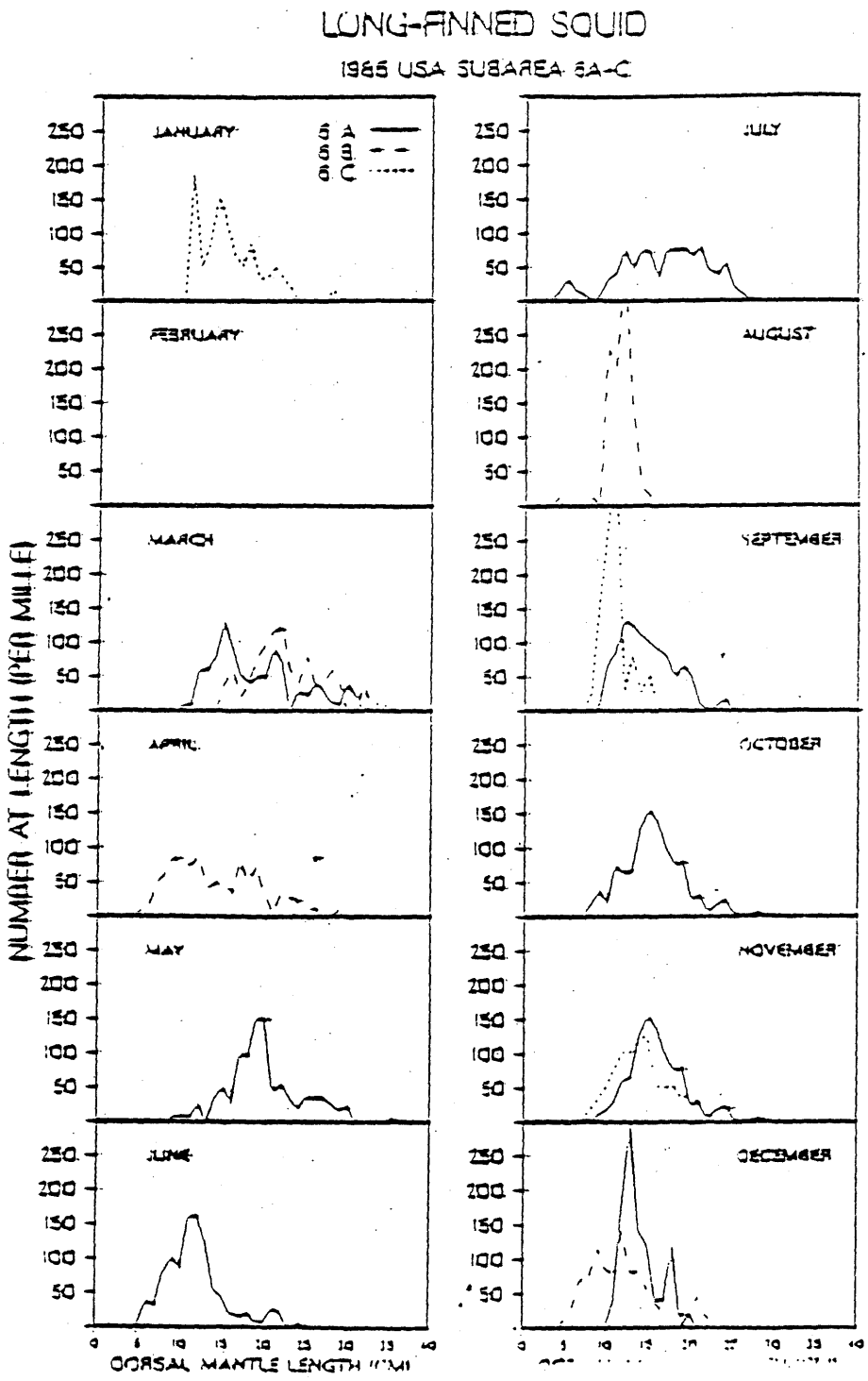


Figure 12.2 Statistical areas 611-636 (NAFO Divisions 6A - 6C).

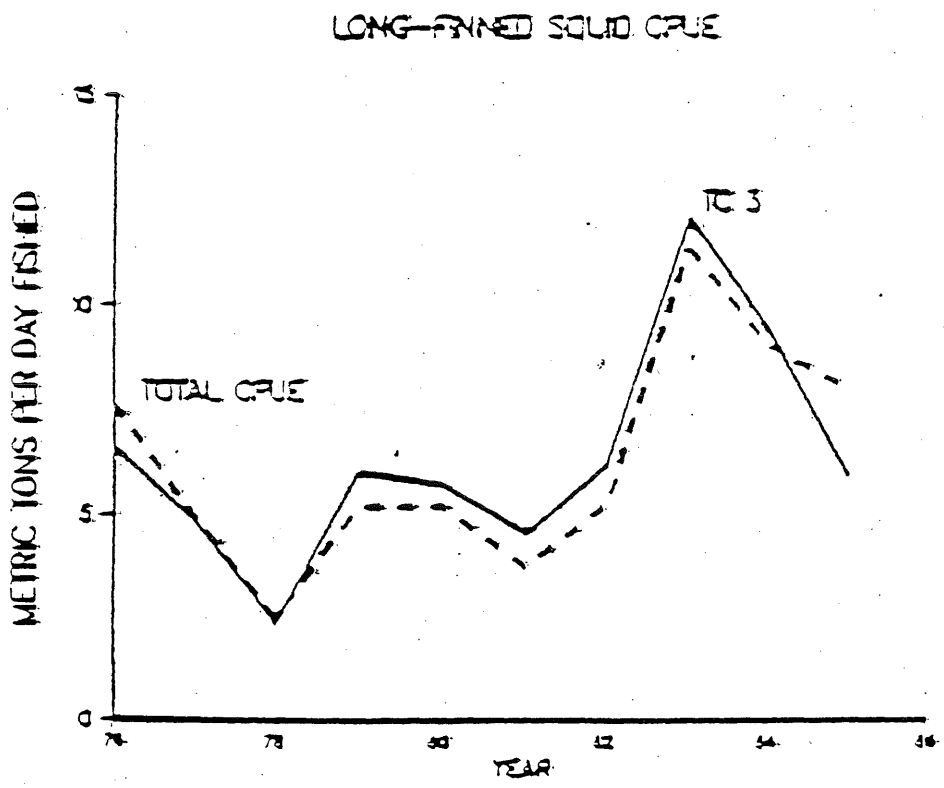
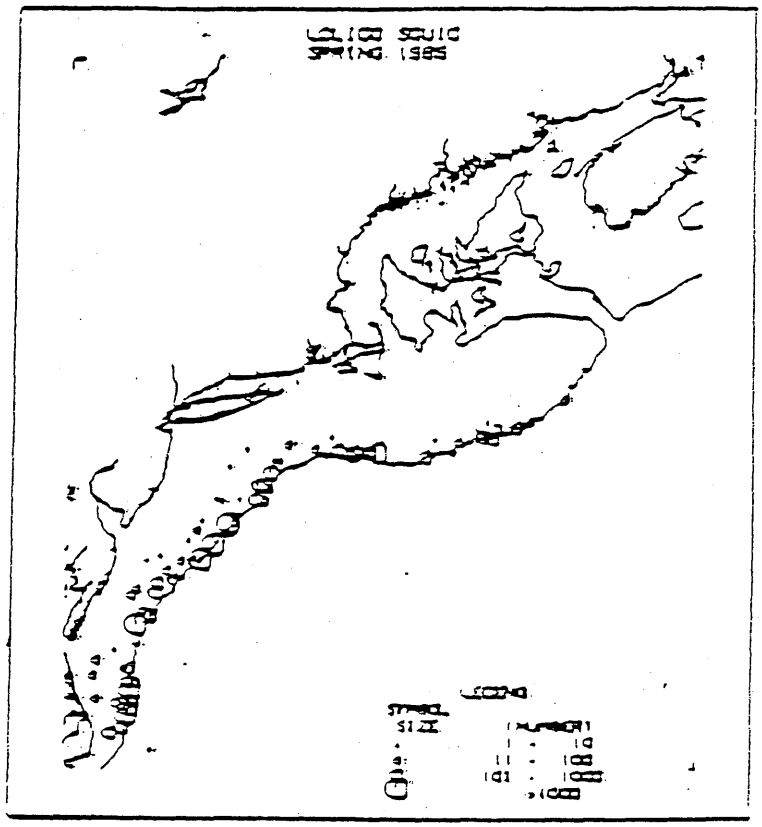


Figure 12.3. Catch (metric tons) per unit effort (days fished) of long-finned squid in the USA directed fishery (trips where squid accounted for over 75% of the total catch), 1978-85.



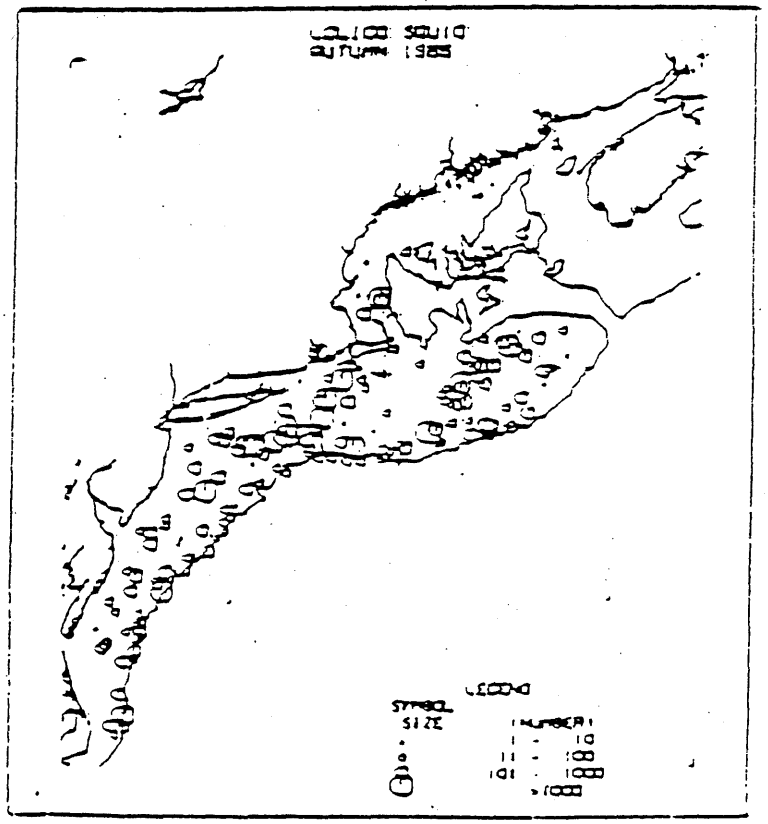


Figure 12.4 Distribution of long-finned squid during the spring

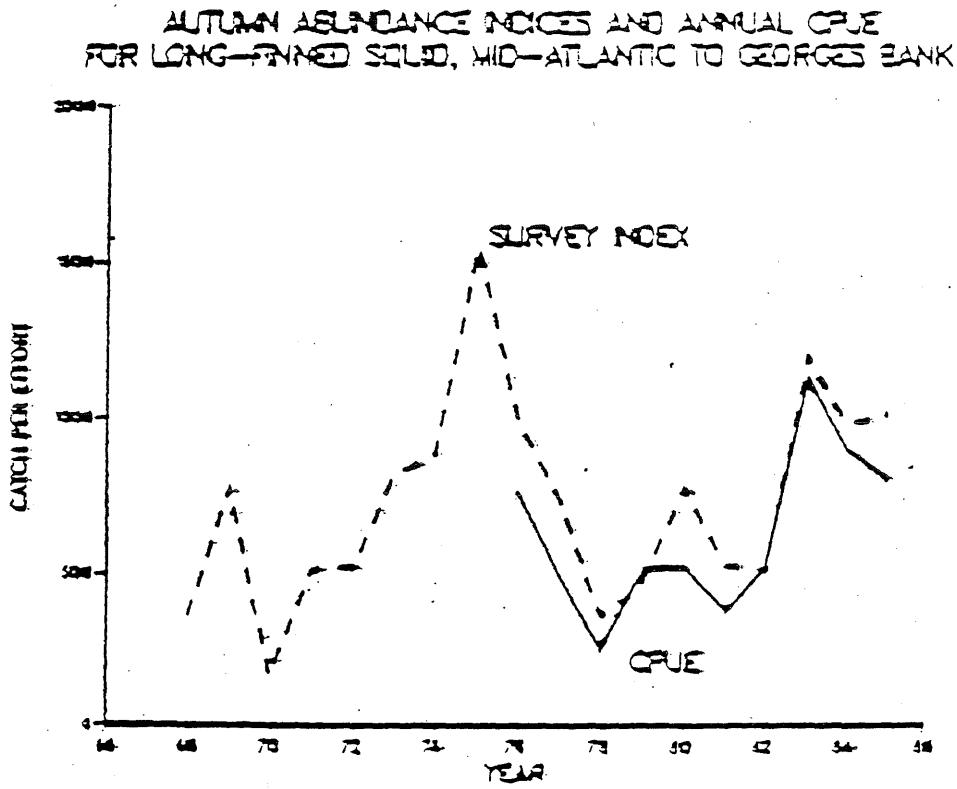


Figure 12.5 Stratified mean number per tow of long-finned squid from the NEFC autumn bottom trawl survey, and commercial CPUE in the directed squid fishery.

II. SPECIES REVIEW--SHORT-FINNED SQUID

13. SHORT-FINNED SQUID

Source Document: Lange, A. M. T. 1984. Status of the Short-finned Squid (*Illex illecebrosus*) off the Northeastern USA, November 1984. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-38, 20 p.

The Fishery

The USA *Illex* fishery was conducted entirely in Subarea 6, during 1985, with less than 2 mt reported from Subarea 5. This reflects the increased importance of the directed fishery in the Mid-Atlantic area and is a sharp contrast to the historical by-catch fishery which occurred primarily in the Gulf of Maine area prior to the early 1980's. The total domestic harvest was 4,997 mt during 1985, down 48% from the 1984 landings but still over five times the 1968-82 average (Table 13.1). Joint ventures with Spain, Italy, and Japan, while taking about 57% of their total allocation, accounted for about half the USA *Illex* harvest during 1985, compared to about 65% during 1984. About 80% of the domestic landings were made during June-August in the areas south of Delaware Bay. The fishery had been dominated by ton class 3 and 4 otter trawl vessels (51-150 GRT and 151-500 GRT) since 1982, but during 1985 half the domestic harvest was attributed to ton class 6 vessels (>900 GRT).

The distant-water-fleet (DWF) catch during 1985 was 1,053 mt (Table 13.1), with 94% of the total attributed to the Spanish fishery. By-catches in the winter *Loligo* fisheries of Italy and Japan accounted for most of the remaining 6%. Total catch (USA and DWF) during 1985 was about 44% less than that taken since 1983, and about 69% below the average seen since the foreign directed fishery began (1972-1982). It is difficult to determine how availability of *Illex* affected the DWF harvest since restrictive quotas may have prevented participation in the fishery.

Length frequency data from the 1985 USA fishery in Subarea 6 indicate presence of a single age class, taken at an average size of 14 cm during April and increasing in average size to about 19 cm by October (Figure 13.1). Average size of individuals taken by the DWF in the *Loligo* fishery was about 15 cm during January, from window 4, and about 12 cm during February and March from windows 2, 3, and 4 (Figure 13.2). January and March samples appear to represent single age classes, with smaller individuals appearing in March. February DWF samples contain modes at about 10 and 14 cm with smaller individuals from the more inshore (window 3) area. Presence of the second, smaller mode suggests significant spring (vs. winter) spawning may have occurred during 1984.

Catch (metric tons) per unit effort (day fished) indices from the USA directed fishery, defined as those trips where over 50% of the catch was *Illex*, are given in Figure 13.3 for 1982-85. This index is based on all otter trawl trips in Areas 622-636, and reflects the relative availability of *Illex* to the directed fishery which began in 1982. CPUE was greatest in 1984, and lowest in 1983, while the 1985 index was comparable to 1982 at about 61% of the 1984 level.

II. SPECIES REVIEW--SHORT-FINNED SQUID

Research Vessel Surveys

Figure 13.4 shows the seasonal distribution of short-finned squid in the NEFC survey area based on catches during the 1985 spring and autumn research surveys. At the time of the spring survey short-finned squid are found only in the deeper strata, along the edge of the continental shelf. During summer the stock moves onto the shelf and into the Gulf of Maine where it is still found at the time of the autumn survey. The 1985 NEFC autumn bottom trawl survey abundance index (stratified mean number per tow) for the Mid-Atlantic through Georges Bank strata was the lowest since 1973, and 14% below that seen during the previous period of low abundance (1968-1974 mean). The pre-recruit (<10 cm dorsal mantle length individuals) index was the second lowest since 1973 (Figure 13.5), 64% below the 1968-1974 mean.

Catch-per-tow index trends from each of the three major strata sets (Southern New England and Mid-Atlantic, Georges Bank, and the Gulf of Maine; Figure 13.6) reflect similar patterns. In most years, the abundance index was greatest on Georges Bank, next in the Southern New England - Mid-Atlantic area, and lowest in the Gulf of Maine.

Conclusion

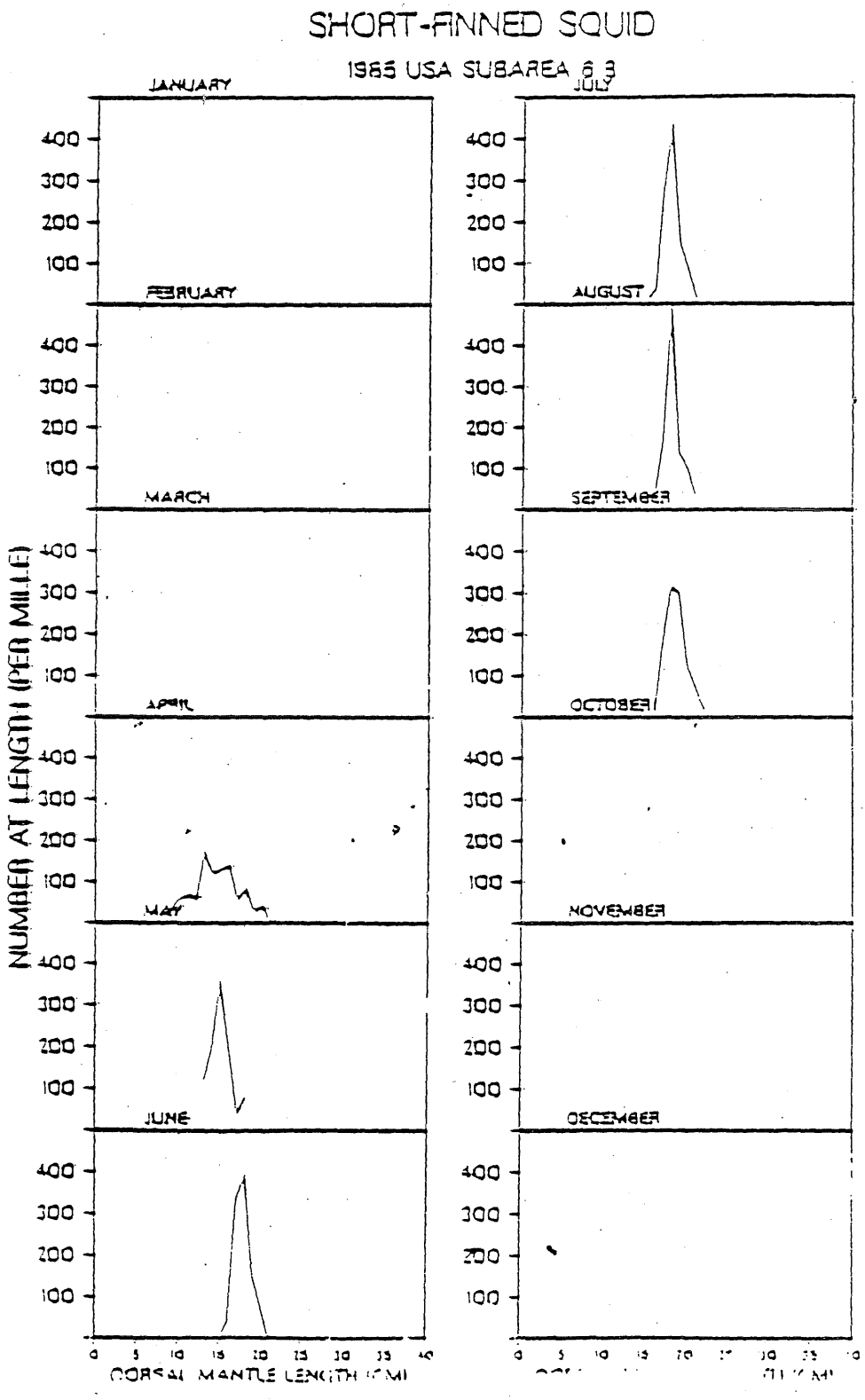
Low availability to the fishery in 1985 and especially continued low apparent abundance of both adults and pre-recruits during the autumn 1985 NEFC research vessel survey suggest that current abundance of Illex may not be adequate to provide catches during 1986 at the optimum yield level established in the Fishery Management Plan. However, since harvest of Illex is dependent upon availability in the areas of the fishery, and the fishery occurs in only a portion of the species' range, it is not likely that catch levels as seen in recent years will adversely affect the stock.

Discussion

The discussion focused mainly on the availability of Illex and the uncertainty of management when the proportion of the stock that is vulnerable to the survey gear and U.S. fishermen is unknown. The NEFC is beginning exploration of Illex catchability and association with oceanographic features such as warm core rings. Since fishing associated mortalities have not been extensive during the 1980's, it is unlikely that the F's account for the recent low survey indices. The Canadians have observed the same phenomenon, however, during the 1980's. Some work is proceeding with the feeding and distribution of marine mammals, squid, and other finfish, but those results are not yet available. Realizing that the NEFC autumn bottom trawl survey is a better indicator of Illex availability than of abundance within the EEZ, and the lack of much critical life history information, the consensus of the group was that there was not enough information to change the long-term potential catch which was previously estimated at 30,000 mt. The working group discussed at length and without conclusion the efficacy of management strategies based on long-term sustainable catches for migratory stocks exhibiting substantial changes in resource availability and recruitment, and the analytical basis for such calculations.

Table 13.1 Annual short-finned squid landings (in metric tons) from the Northwest Atlantic (Cape Hatteras to Gulf of Maine) by the USA and the distant-water fleet (DWF), 1983-85.

Year	USA	DWF	Total
1983	9,944	1,776	11,720
1984	9,547	676	10,223
1985	4,997	1,053	6,050
1968-82 Mean	911	13,758	14,669



Fibure 13.1 Length frequency distributions of short-finned squid, (Illex illecebrosus) from the 1985 USA fishery.

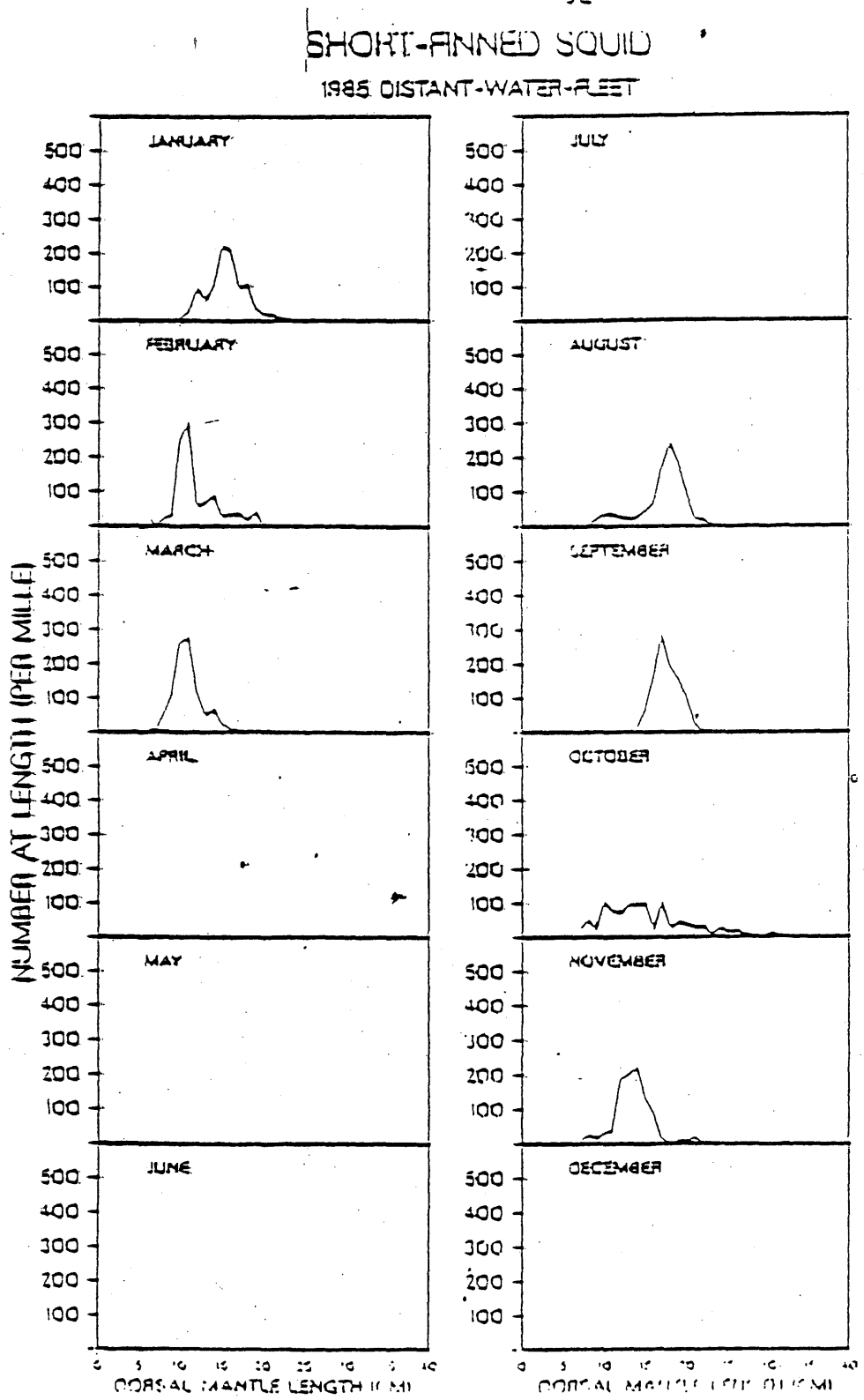


Figure 13.2 Length frequency distributions of short-finned squid from the 1985 distant-water-fleet fishery.

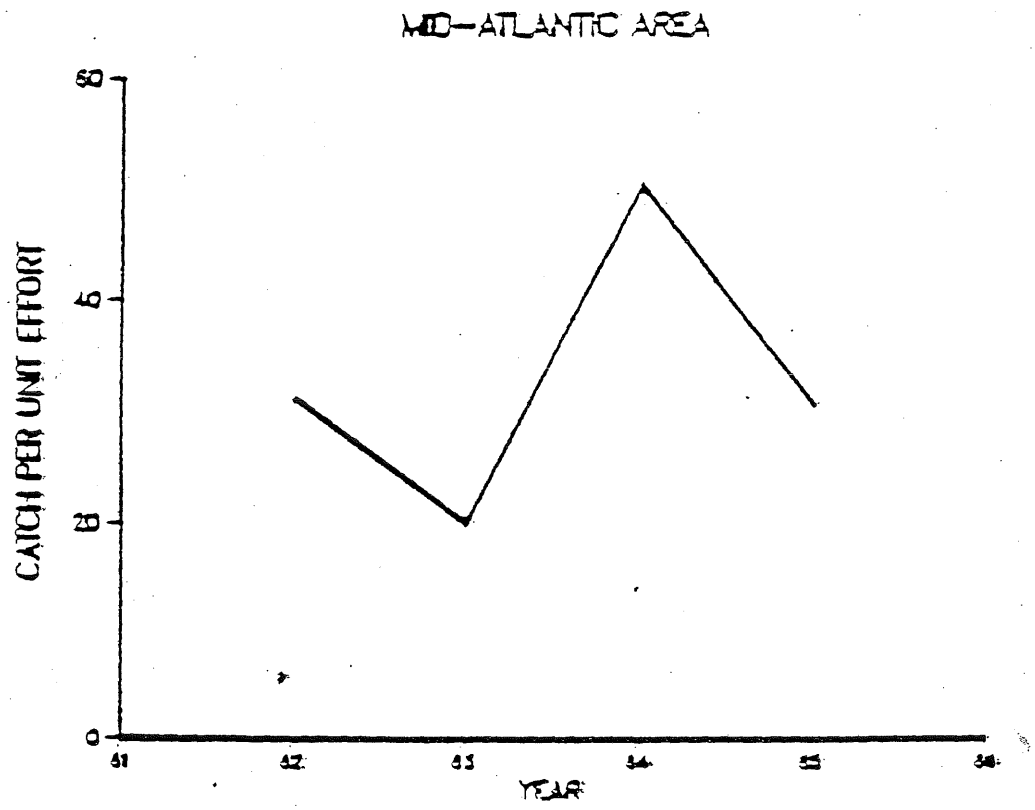
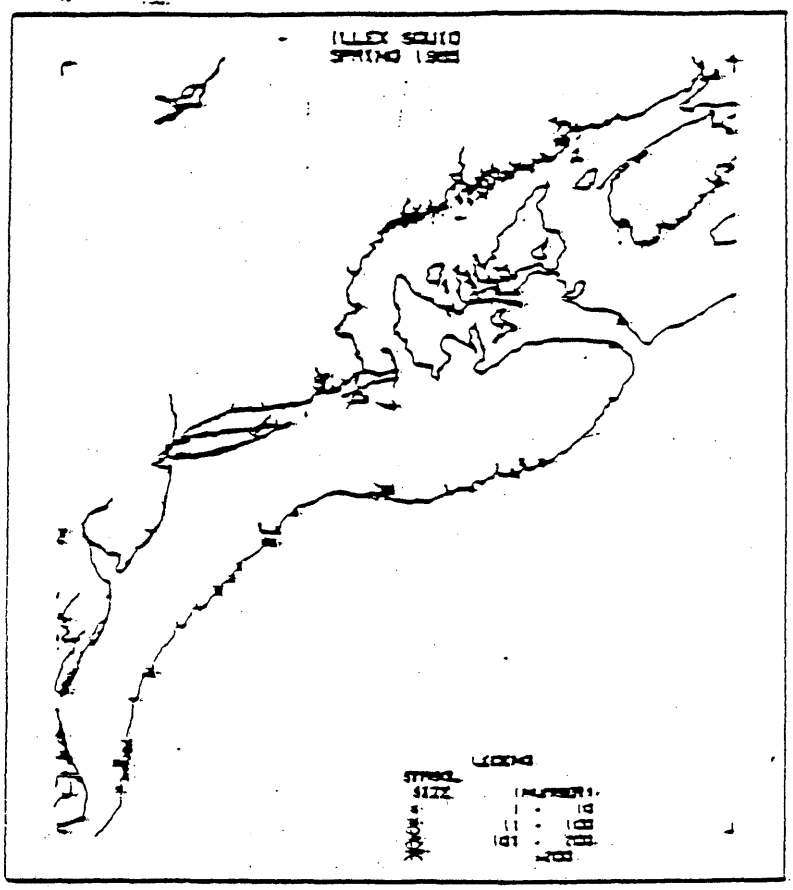
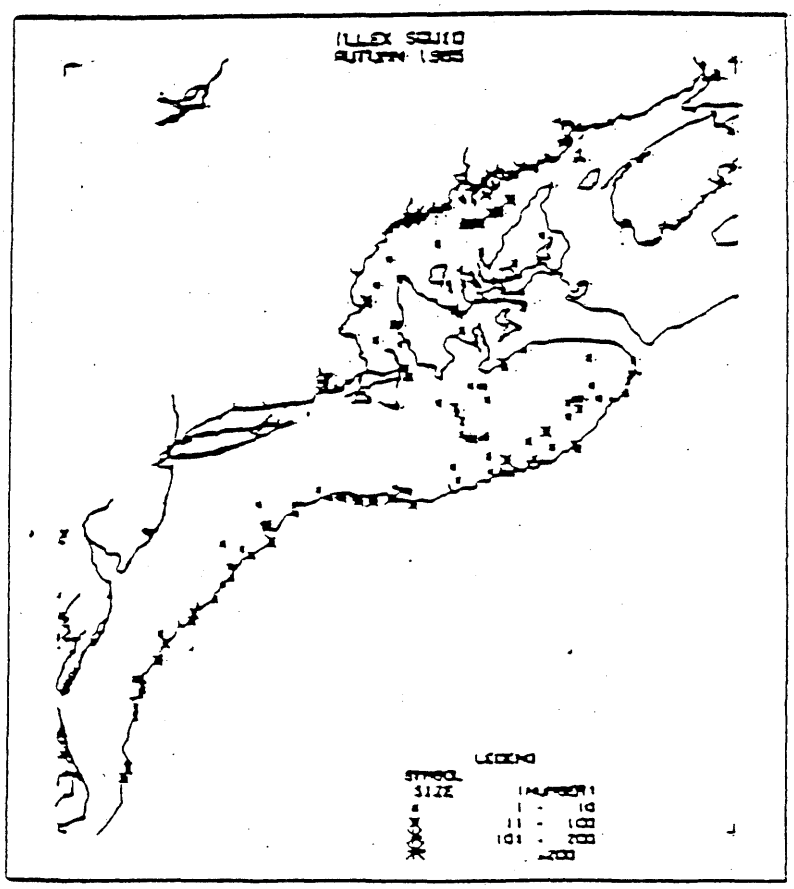


Figure 13.3 Catch (metric tons) per unit effort (days fished) of short-finned squid in the USA directed fishery (trips where squid accounted for over 50% of the total catch), 1982-85.


ILLEX SQUID
SPRING 1985
LEGEND
SYMBOL SIZE
NUMBER


ILLEX SQUID
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LEGEND
SYMBOL SIZE
NUMBER

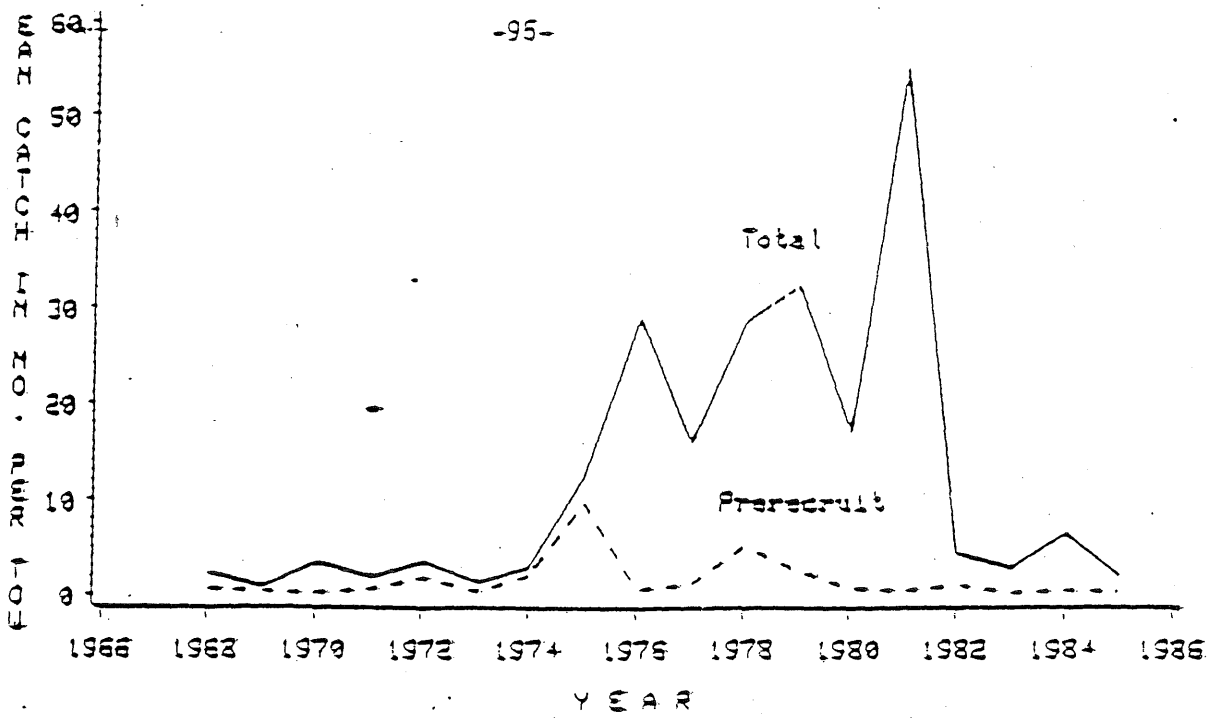

Figure 13.5 Stratified mean number per tow, of short-finned squid, from the NEFC autumn bottom trawl survey, including total and pre-recruit (≤10 cm) indices, 1968-85.

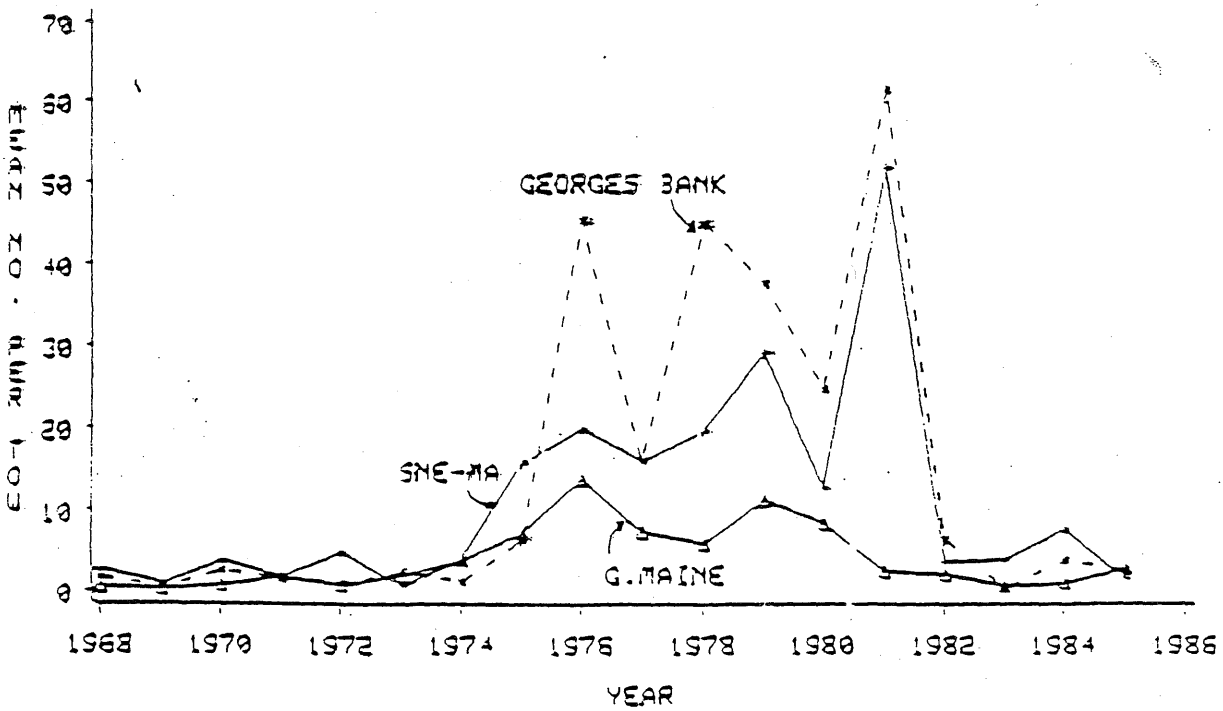

Figure 13.6 Stratified mean number per tow of short-finned squid from the NEFC atuumn bottom trawl survey, by area (Southern New England - Mid-Atlantic, Georges Bank and Gulf of Maine), 1968-85.

III. TRAWL SURVEY REVIEW

The workshop participants reviewed three aspects of stock assessment using trawl surveys. Two of the reviews were planned in advance, namely the description of several of the trawl surveys conducted in the region and a NEFC study on precision and accuracy of trawl survey indices of abundance. The third review, comparing indices across several species, arose as a working group created during the review of the status of some of the species.

1. DESCRIPTION OF EXISTING TRAWL SURVEY RESEARCH PROGRAMS

The status of current NEFC and state research vessel survey programs were described to the working group by meeting participants involved with those programs. Descriptions included the time series, areas covered, seasonality, and uses of the particular survey's data.

NEFC multispecies bottom trawl surveys have been conducted between Hudson Canyon and the Gulf of Maine during autumn since 1963. In the autumn of 1967 this survey was extended to Cape Hatteras and the Bay of Fundy, between 15 and 200 fathoms depth. The spring series covering the same areas began in 1968. In 1972, the Sandy Hook Laboratory began an inshore survey (inside 15 fms) which is now incorporated into the standard offshore survey.

This survey has been conducted using stratified random sample survey design and has been conducted with standardized survey (Yankee #36 trawl) gear. Major factors altering the standard design were: use of a Yankee #41 trawl during spring surveys between 1973-1982, and change of otter doors beginning in spring 1985. Analyses of comparability of the different trawls was conducted in the past and evaluation of the change in doors is ongoing.

NEFC now has equipment (SCANMAR Acoustic Link) which will continually monitor gear performance (headrope height, wingspread and bottom temperature) and plans to begin use of and establishment of standards for this equipment during the autumn 1986 survey. This gear may be made available to states to evaluate performance of their survey gear.

The group raised the question of the continuation of the NEFC survey time series in the face of increasing budgetary constraints. Options discussed were eliminating one of the seasonal surveys, reducing the total area covered by the survey, and reducing the sample size in the areas covered. The current evaluation of the survey time series is addressing these options.

The Massachusetts inshore survey has been conducted since 1978 between the Merrimack River and Buzzards Bay. This survey was designed in conjunction with NEFC, and has been conducted using a standard trawl (whiting trawl) in a stratified random design. The data have been integrated into the NEFC data base and are incorporated in the assessments of some of the stocks.

The Rhode Island trawl survey began in 1979 covering Narragansett Bay and Block Island Sound using a stratified random survey design. The survey was originally designed to be comparable with the NEFC survey and to have about 100 stations per survey. Problems with rough bottom in Block Island Sound

lead to a change to a number of fixed stations in that area. This survey uses a 42-foot research vessel and a 3/4 scale Yankee net. The data are used primarily for recruitment indices for winter flounder, Loligo squid, and scup, but are not fully integrated into the NEFC data base.

The Connecticut survey in Long Island Sound began in 1979 with NMFS funding, primarily as a scup assessment project. This survey has been conducted on a bimonthly basis, covering 40 stratified random stations each month during March-December since 1982. It is currently funded under Wallop-Breaux monies. Connecticut also conducts shore and boat based recreational surveys. It was noted that stations in the western part of the Sound are set in a fixed rather than random design due to gear conflictsin that area. The survey is useful for winter flounder, scup, and summer flounder. Progress reports are available for 1983 and 1984.

Delaware has been conducting surveys in Delaware Bay since 1972. Surveys in Chesapeake Bay have been conducted by VIMS since 1955 using a systematic sampling design during the winter at the mouths of the major rivers. Maryland samples four major striped bass spawning areas using beach seine surveys. All Maryland and Virginia survey data are being put up on the Chesapeake Bay Computer Center system and will be available for future analyses.

Discussions of the surveys centered around the reasons for conducting particular surveys (i.e., whether they were designed for a purpose or done because it was the thing to do), and what level of coordination and/or compatibility existed or was appropriate. It was recommended that a working group be formed to address these issues. Further discussions were deferred to the agenda item labeled "Description of Stock Assessment Research Programs."

2. EVALUATING PRECISION AND ACCURACY OF TRAWL SURVEYS

NEFC is currently conducting analytical and experimental analyses of bottom trawl survey methodology and results. The scope, objectives, and some preliminary results of this effort were described by NEFC personnel. The current program of trawl survey evaluation has five important objectives:

(1) Document current use of survey data base and information flow.

(2) Document current levels of precision attained for survey relative abundance indices.

(3) Explore methods of increasing precision of estimators (e.g., through alternative stratification schemes, time-series smoothing, etc.).

(4) Explore the implications of potential losses in sea time for the precision and accuracy of trawl survey results.

(5) Complete analyses of vessel/gear comparisons.

III. TRAWL SURVEY REVIEW: PRECISION

Bottom trawl surveys have been conducted annually, beginning in 1963. Autumn bottom trawl surveys were initially conducted between Nova Scotia and Hudson Canyon and later extended to Cape Hatteras (1967). In 1968 the spring bottom trawl survey series was begun. Survey gear for the spring surveys was changed in 1973 to a larger, higher-opening net to increase the reliability of abundance indices for pelagic species. In 1982, the spring survey gear reverted to the smaller (Yankee #36) trawl used in autumn surveys. In 1985 both spring and autumn surveys incorporated newer-model otter trawl doors than were used on previous surveys.

Data from NEFC bottom trawl surveys are used for a wide variety of assessment-related activities, and serve to address a multitude of problems not directly related to stock assessment issues. Survey data are a significant source of knowledge on abundance, growth rates, age/size composition, maturity, mortality rates, and recruitment rates.

Current NEFC survey evaluation studies involve 20 selected species (total of 41 stocks). The objective of the analysis is to estimate levels of precision for individual species/stocks and for the total complex and to explore alternative analytical methods to improve precision of abundance estimators.

The level of precision of a relative abundance index can be expressed by the coefficient of variation (CV: standard deviation divided by the mean). Preliminary analyses of CV's for various groupings of species indicate an overall modal CV of about 20% for autumn surveys and 30% for spring surveys. CV's for pelagic species were higher (50%) reflecting the greater inherent variability in trawl survey indices for these stocks.

Analyses for improving the precision of survey indices are currently ongoing at NEFC. Some alternative methods being evaluated include: (1) post-stratification of survey stations from the current stratified random survey design, (2) application of the delta-distribution to account for the high proportion of zero catches in surveys, and (3) the use of time-series models to utilize the entire time-series of observations, rather than single point estimates. Other analyses include the effects of diurnal variability on the indices, and the evaluation of variations in catchability for individual species among areas.

Experimental studies currently ongoing or being analyzed are evaluating differences in abundance indices between the two NOAA research vessels (Delaware II, Albatross IV), the two survey nets employed (Yankee #36, #41) and the two types of otter doors used.

The workshop participants commented in detail on aspects of current NEFC survey analyses, particularly in relation to implications for trawl survey programs in other areas, and in relation to defining the "optimality" of surveys. Reports of the NEFC survey evaluation will be circulated to interested working group members.

III. TRAWL SURVEY REVIEW: COMPARISON

3. COMPARISONS OF 1984-1985 ABUNDANCE INDICES

It was noted in species overviews conducted on New England resources that, in general, NEFC bottom trawl survey indices were generally higher in 1985 than in 1984. Such increases are normally explained by increased recruitment to the stocks (e.g., Georges Bank haddock), but could not be so explained for many of the New England resources wherein fishery dependent data and indices indicated stable or declining resource trends. The workshop participants noted the apparent inconsistencies in 1985 trawl survey indices for several stocks and indicated that an examination of 1984-1985 changes in the indices over a broad range of species/stocks would be helpful in resolving the apparent inconsistencies in changes in trawl survey indices for 1985. Accordingly, a working group was asked to conduct a cursory examination of 1984-1985 trawl survey abundance indices over a range of species/stocks.

The working group drew upon data and analyses currently being generated by NEFC investigators studying aspects of precision and efficiency of the trawl survey time series. A total of 38 stocks representing 18 species (Table 2) were analyzed for differences in catch per tow indices (in numbers and weights) between the 1984 and 1985 surveys.

Results of analyses on changes in abundance indices between 1984 and 1985 are summarized in Table 3. Data are presented for spring and autumn surveys individually; analyses were conducted on both number per tow and weight per tow indices. It is apparent that for a disproportional number of the stocks, abundance indices for both spring and autumn surveys increased between 1984-1985. Average percentage increases in abundance indices were relatively high, with substantial variability among stocks. Since a substantial number of stocks exhibiting decreased abundance indices were flounder stocks (i.e., yellowtail, winter, and summer flounders), a second analysis was conducted on the 25 non-flounder species/stocks listed in Table 2. Analyses of these 25 stocks indicated an increase in the proportion of indices increasing between 1984-1985 for indices in numbers per tow and weight per tow, and in both the spring and autumn surveys (Table 4).

Although these analyses cannot be considered definitive in terms of indicating potential biases in the 1985 survey, they are indicative of areas that need to be addressed by further directed research. One potential explanation for the increase in 1985 survey indices was the change to different otter trawl doors between years. Directed research on comparisons between door types to assess the impact of this operational change on survey abundance indices is currently ongoing at NEFC. These analyses should allow for a more definitive interpretation of changes in indices among years, and may allow for estimating appropriate standardization coefficients so as to relate subsequent indices to the pre-1985 trawl survey time series.

Table 2 Species/stocks included in analyses of changes in NEFC spring and autumn bottom trawl abundance indices, 1984-1985.

Species	Stocks
American lobster	Gulf of Maine Georges Bank Southern New England Mid-Atlantic Bight
Winter Flounder	Gulf of Maine Georges Bank Great South Channel Southern New England Mid-Atlantic Bight
Summer Flounder	Georges Bank Southern New England Mid-Atlantic Bight
Atlantic Cod	Gulf of Maine Georges Bank Southern New England Mid-Atlantic Bight
Haddock	Gulf of Maine Georges Bank
Pollock	Gulf of Maine Georges Bank
Silver Hake	Gulf of Maine-Georges Bank Georges Bank-Mid-Atlantic Bight
Red Hake	Gulf of Maine-Georges Bank Georges Bank-Mid-Atlantic Bight
White Hake	Gulf of Maine-Georges Bank
Yellowtail Flounder	Gulf of Maine Georges Bank Cape Cod Southern New England Mid-Atlantic Bight
Atlantic Herring	Gulf of Maine Georges Bank Southern New England Mid-Atlantic Bight
Atlantic Mackerel	Northwest Atlantic
Butterfish	Georges Bank Mid-Atlantic Bight
Scup	Southern New England Mid-Atlantic Bight
Bluefish	Southern New England Mid-Atlantic Bight
Black Sea Bass	Southern New England Mid-Atlantic Bight
Illex	Georges Bank-Mid-Atlantic Bight
Loligo	Georges Bank-Mid-Atlantic Bight

Table 3. Comparisons of 1984 and 1985 abundance indices for NEFC bottom trawl surveys for 38 species/stocks (Table 2).

		Stocks Exhibiting Increases[1]		Percentage Change in Indices[2]	
Index	Season	Number	Percent	Mean	SD
Number Per Tow	Spring	30/38	79	252	559
	Autumn	26/38	68	103	188
Weight Per Tow	Spring	28/38	74	193	368
	Autumn	22/38	58	44	39

[1]Number and percentage of those stocks given in Table 2 that exhibit increases in catch per tow indices, 1984-1985.

[2]Mean and standard deviation of the percentage change across the 38 species/stocks listed in Table 2.

Table 4. Comparisons of 1984 and 1985 abundance indices for NEFC bottom trawl surveys for the 25 non-flounder species/stocks in Table 2.

		Stocks Exhibiting Increases[1]		Percentage Change in Indices[2]	
Index	Season	Number	Percent	Mean	SD
Number Per Tow	Spring	22/25	88	348	664
	Autumn	19/25	76	151	212
Weight Per Tow	Spring	22/25	88	262	429
	Autumn	18/25	72	74	164

[1]Number and percentage of those non-flounder stocks given in Table 2 that exhibit increases in catch per tow indices, 1984-1985.

[2]Mean and standard deviation of the percentage change across the 25 non-flounder stocks listed in Table 2.

IV. STOCK ASSESSMENT RESEARCH AND MANAGEMENT NEEDS

The topics identified in the draft agenda pertaining to stock assessment research needs, to biological and management terms of reference, and to plans for subsequent workshops were discussed in one session. Several individuals representing specific organizations joined the workshop for these discussions (Appendix).

1. DESCRIPTION OF RESEARCH PROGRAMS FOR 1986 and 1987

The stock assessment program at NEFC was presented briefly using flow diagrams. Current plans within the Population Dynamics Branch assign priority levels for individual species, and create working groups to study projects that cut across species lines.

Stock assessment activities for individual species were divided into four categories: (1) research and management needs will be met, (2) research and management needs will be pursued but not met, (3) stocks will be monitored, and (4) stocks will be monitored only enough for annual status updating.

In addition to the specific assessment activities identified under each of the three Investigations in the Population Dynamics Branch, several generic problems were described. Approaches to these problems will be developed within three "working groups": biological interactions, fisheries interactions, and assessment methods development. Each of the three Investigation Chiefs has responsibility for one of these groups. Participation in these groups will vary, and priorities will change as problems are solved and as mangement needs evolve.

Several aspects of the priorities outlined by NEFC personnel were discussed. Some inconsistencies with the priorities of the several management agencies were noted, especially for some of the coastal species. Participants also noted that studies related to the recruitment problem were not evident, nor were studies related to calibration of fisheries effort. The recruitment issue is the main issue being addressed by the Fisheries Ecology Division. It was agreed that effort studies should receive high priority. Another point raised was the importance of studying the Grand Banks fisheries; it was noted that some effort has been devoted to this task already.

Representatives of the Mid-Atlantic Council stated that priority for squid, mackerel, butterfish, ocean quahog, and surf clams should be maintained at a level to provide data for Council purposes. River herring by-catch is also an important issue that needs to be addressed. Amendment #7 of the Squid, Mackerel, and Butterfish Fishery Management Plan will generate questions as to appropriateness of MSY estimates for Mid-Atlantic, Georges Bank, and Nantucket surf clams, and all quahogs. It was suggested that the prospects of recruitment failure should be examined. Catastrophe theory may be appropriate in looking at changes in catchability of commercial gear and recruitment variations. CPUE should be compared to stock abundance to see if there is a correlation.

IV. STOCK ASSESSMENT NEEDS: PROGRAMS

A bluefish management plan will be developed cooperatively between ASMFC, the Mid-Atlantic Council and NMFS. An S&S Committee was established to expedite completion of a plan. A subcommittee will look into the availability of data and methodologies required for the assessment, with the possiblity of presenting a report at the proposed stock assessment workshop in the fall. ASMFC foresees a 2-year schedule for completion of the plan.

It appears that the schedule for summer flounder assessment does not fall within the plan for two workshops per year. Summer flounder assessment will be discussed again at the fall workshop to keep up with management demands. A high level of communication needs to be maintained between management council staffs and NEFC over the summer so that no "surprises" are presented next fall.

Two parts of the assessments should be done: (1) routine information to provide to Councils, (2) development of new techniques to address generic problems. What is the appropriate division of effort between these two points? The purpose of the Population Dynamics Branch working groups described earlier is to address some of the generic problems, while still providing the routine information.

The New England Fishery Management Council (NEMFC) is looking at generic issues in the development of their multispecies management plan. They agreed with the list of species priorities as stated by NEFC. It is not clear why species in category 2, "research and management needs will be pursued but not met," are classified as having intermediate priority. Perhaps species in this list could be used to monitor effectiveness of the NEFMC management program. Species in this group should be treated collectively, rather than individually (which means witch flounder and plaice should have higher priority). The Council's Technical Monitoring Group will be setting specific terms of reference for species. The Council would like to see analyses of species in Category 2 in terms of the fisheries operations systems (e.g., multispecies effort and biological interactions). The Council spends a lot of time doing this type of work, so it welcomes NEFC's intentions to do some and offers to work closely on these types of projects (especially operational problems).

A suggestion was made that future workshops might emphasize "approaches" to stock assessments such as (1) stock-recruitment (S/R) relationships, (2) environmental impacts on the S/R relationship, (3) diagnosis of recruitment failure, or (4) measuring density dependent mortality. This approach would reverse the emphasis on the stock assessment procedure. In light of mixed species fisheries and other problems common to more than one species, this alternate approach may be more realistic. A contrary argument is that the workshop needs to produce assessments first and foremost, and that emphasizing approaches might dilute that focus.

Two parts of the assessments should be emphasized: (1) routine information to provide to users, and (2) development of new techniques to address generic problems. The appropriate division of effort between these two problems was discussed.

IV. STOCK ASSESSMENT NEEDS: PROGRAMS

The NEMFC operates within a time frame that is difficult for NEFC to meet. The Council does not want their information requests to disrupt the NEFC system so that function is compromised. Is it appropriate for NEFC to establish an ad hoc reactionary team? This would allow other NEFC staff to carry on with the structured program.

ASMFC responded to the New England Council's comments by stating that the operation of a state program is not like that of the Fishery Management Councils. Workshops should be used to develop a list of questions as well as recommendations to states for straightening out problem areas. It was noted that NEFC's bottom-line problem is not having enough people to address all information requests.

A comment was made that two broad groups of people are evidently needed: (1) a group to answer short-term information requests, and (2) a group to work on approaches, techniques, etc. to solve long-term needs. The New England Council's response was that nested within Council requests are long-term generic problems.

NEFC's current approach is to pull people together as a request comes in, rather than to establish a permanent group of people who respond to immediate requests. Long-term questions such as recruitment and the role of the environment in controlling production are addressed by the Fishery Ecology Division (FED) as well as the Conservation and Utilization Division (CUD). The two divisions take different approaches. For example, experimental fishing would be appropriate for CUD, but questions related to long-term recruitment issues are more appropriate for FED.

Immediate needs of the Northeast Regional Office (NER) mirror some of those of the Councils. NER agrees with NEFC's species priorities. Some of the items to be addressed by the Population Dynamics Branch's working groups reflect pressing issues of NER. Another important issue is the "behavior" of fishermen when they cannot catch their target species. Also, determining which factors affect the overall abundance of the species is of major importance.

NER management needs were identified in catagories of routine and time critical. Previous discussion assured NER that routine needs would be taken care of in the planned working group activity. NER emphasized that time-critical needs, e.g., the effects of management measures that need to be evaluated on a real time basis, must also be part of the process.

Another NER comment is that working group activity is a <u>participatory</u> process. Some concessions on daily activities will have to be made (i.e., find the time). On duplicative activities (NEFC, NER, COUNCILS), working groups may be the appropriate way to save time and effort.

ASMFC is interested in participating with NEFC, but would like to know what NEFC is going to do. For certain species it is advantageous to meet at a particular time of year because of regulation and data availability questions.

IV. STOCK ASSESSMENT NEEDS: PROGRAMS

It was suggested that the scientific merits of experimental fishing on large, but lightly exploited stocks should be explored, and that the feasibility of this approach should be evaluated. This topic was discussed specifically for mackerel, and the working group suggested under that topic will expand its horizons to include this topic. Perhaps several species should be examined (e.g., silver hake, mackerel). The group should concentrate on the scientific merits rather than spend time second-guessing how the Councils may react. The InterAmerican Tropical Tuna Commission has been managing the yellowfin tuna for several years using this approach. The planning of this type of program should be such that the experiment can be realistic-
ally carried out over the long term, would involve several organizations, and must assess the data requirements. A report will be presented at the next assessment meeting.

The need to study the vulnerability of stocks to collapse at low abundance levels due to changes in catchability was restated. This should be examined for several species, and the general feeling is that such a hypothesis can be tested with existing data and data collection techniques. The methodology will require estimates of population abundance that are independent of VPA's. A question was raised as to how one would address the normally high variability in stock abundance. The study on variability in the trawl survey might eventually be expanded to address the catchability question. A suggestion was made to make a small subset of data available.

Returning to the earlier suggestion of a survey coordination committee, concern was raised about the amount of time that such a committee would take. A comment was that it may be one of the most important tasks NEFC can assume. There is a need to coordinate data bases and techniques among all the agencies involved. Perhaps those people responsible for the funding sources (of which there are relatively few) can take the lead in coordination. There is a danger of over-coordination (i.e., setting up one survey to try to answer too many questions). The analytical problems may override the coordination problems, but there has to be a constant reminder to have consistent surveys. The initial question to be resolved relates to sampling theory, and its associated technical and operational problems. It is critical that we know that the surveys we are conducting are done in an optimal way. We should begin by evaluating where we are now, along the lines of the NEFC precision and accuracy study described above, but also including where we can go from operations and research perspectives as well as the reasons for the surveys in the first place.

It was proposed that a working paper be developed to address where we should be going in trawl surveys, including the theoretical basis and operations and technical limitations. The paper should be prepared by the fall meeting for discussion. The paper might also be submitted to ICES because one of ICES' theme sessions this year is trawl surveys.

2. SPECIES PRIORITIES FOR SUBSEQUENT WORKSHOPS

The workshop participants reviewed the need for future stock assessment workshops in light of the progress made in this meeting, and in light of the recommendations made by the participants of the First Stock Assessment Workshop in July 1985. The species reviewed in the second workshop were the ones recommended last July, with the addition of mackerel. This addition was made because of changes in the calendar of assessment information needs of the Mid-Atlantic Council.

The participants felt that the level of treatment of the stocks of the 13 species treated in the present workshop was too uniform, and that the current management and scientific needs were sufficiently different to justify substantially different levels of treatment. Although all of the species need to be addressed in order to meet management information needs, species with low fishing interest or with few anticipated changes (on an annual basis) could be treated rather more simply than was done.

The First Stock Assessment Workshop recommended three workshops annually. One workshop was suggested to address the assessment of species of primary interest to the ASMFC. The other two workshops were to assess species of primary interest to the Mid-Atlantic and New England Fishery Management Councils. The participants noted that the present workshop would have benefited from greater involvement of state fishery biologists, that the species suggested for an ASMFC workshop would have attracted greater participation of state biologists, and that a separate workshop for ASMFC species might be desirable but was premature at present because of limitations in stock assessment expertise.

The workshop participants also noted that many of the species of interest to the Regional Management Councils that were suggested for review in a fall workshop were not of high priority. For example, the need for assessment information for red crab, wolffish, tilefish, skates, and spiny dogfish was low.

The possibility of combining the proposed fall workshops for ASMFC species and for other Regional Management Council species was explored. The workshop participants noted that from a scientific perspective assessments of all species were not required each year. That is, some species, such as surf clams and quahogs, were sufficiently stable so that any single new assessment was unlikely to be sufficiently different to markedly change either management directions or reasonable levels of catch. Thus, depending on current conditions, individual species might not be reassessed in any given year.

In light of these comments it was proposed that the assessment of red crab, skates, wolffish, cusk, tilefish, and spiny dogfish suggested for a fall workshop might be postponed until specific needs were identified.

IV. STOCK ASSESSMENT NEEDS: WORKSHOPS

Of the species identified on pages 5 and 6 of the report of the First NEFC Stock Assessment Workshop as being of primary interest to the ASMFC, the participants identified summer flounder, bluefish, shrimp, and weakfish as being of highest priority. If the lower priority species of interest to the Regional Management Councils were not assessed in a fall workshop, then there would be room on the agenda for these species.

These considerations lead the workshop participants to recommend that the following species be assessed at a fall workshop similar to the present one: lobster (inshore and offshore), winter flounder, surf clams, ocean quahogs, cod, summer flounder, bluefish, shrimp, and weakfish.

The participants noted that a fall workshop would need to be held in September to meet the needs of the Mid-Atlantic Fisheries Management Council for quota-managed species, and to precede the traditional timing of the annual ASMFC meeting. However, a difference was noted between providing specific advice for quota-managed species, and providing completed and reviewed stock assessments. The former might involve preliminary results, as has been the case for surf clam and quahog survey data, while the latter usually involves reviewed analyses as at the present workshop. Thus the timing of workshops to review assessments might be unhooked from the process of providing management advice.

The participants noted that planning for the species to be assessed in a fall workshop should be initiated in June, and that additional input on the priority of the species not addressed at the present workshop might be obtained from the directors of the state fishery research agencies.

V. LITERATURE CITED

The following documents were referred to in the text of this report. The source documents for each species in section II are not listed here.

Almeida, F. P. 1985. An analysis of the stock structure of silver hake, Merluccius bilinearis, off the northeast coast of the United States. MS Thesis. Oregon State University, Corvallis, Oregon, 141 p.

Burnett, J. 1986. MS. The population biology of the witch flounder (Glyptocephalus cynoglossus L.) in the Gulf of Maine Region. M.S. University of Massachusetts, Amherst.

Collie, J. S., and M. P. Sissenwine. 1983. Estimating population size from relative abundance data measured with error. Can. J. Fish. Aquat. Sci. 40:1871-1879.

Morse, W. W. 1979. An analysis of maturity observations of 12 groundfish species collected from Cape Hatteras, North Carolina to Nova Scotia in 1977. NMFS, NEFC Sandy Hook Laboratory Ref. No. 79-32.

O'Brien, L., and R. K. Mayo. MS 1984. Sources of Variation in Catch Per Unit Effort of Yellowtail Flounder on Georges Bank, Southern New England, and Cape Cod Grounds. Nat. Mar. Fish. Serv., Northeast Fish. Center, Woods Hole Laboratory Ref. Doc. No. 84-33, 41 p.

Serchuk, F. M., and S. E. Wigley. 1985. Evaluation of USA and Canadian research vessel surveys and survey design in assessing abundance size composition and recruitment of sea scallops on Georges Bank. NAFO SCR DOC. 85/88:20 p.

Sissenwine, M. P., and E. Bowman. 1978. An analysis of some factors affecting the catchability of fish by bottom trawls. Res. Bull. ICNAF (13):81-7.

Sullivan, L. F. 1982. American plaice, Hippoglossoides platessoides, in the Gulf of Maine. M.S. Thesis, Biological Oceanography, University of Rhode Island, 95 pp.

Waiwood, K. G., and J. D. Neilson. 1985. The 1985 assessment of 5Ze haddock. CAFSAC Research Document 85/95, 49 p.

Waring, G. T., and E. D. Anderson. 1981. Status of the Northwestern Atlantic butterfish stock, August 1981. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 81-27, 25 p.

Waring, G. T.; and E. D. Anderson. 1981. Status of the Northwestern Atlantic butterfish stock-1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-41, 39 p.

VI. APPENDICES

1. REFERENCE DOCUMENTS

The following documents were available to the workshop for background information. Several of these were identified as providing the most current assessment information for particular species, and are listed in the Species Reviews as the Source Document.

2nd SAW Reference List for Documents

1. Rapporteur's summary of First NEFC Stock Assessmen Workshop, July 1985. Sponsored by Conservation and Utilization Division NEFC, NMFS, Vaughn C. Anthony (Division Chief) and Steven A. Murawski (Rapporteur).

2. Almeida, F. P., 1984. Computer Programs for Fish Stock Assessment, 2nd Edition. Woods Hole Lab. Ref. Doc. 84-18. Partial Copy.

3. Anderson, E. D. 1984. Status of the Northwest Atlantic Mackerel Stock - 1984. Woods Hole Lab. Ref. Doc. 85-03, 46 pp.

4. Overholtz, W. J., S. H. Clark, and D. Y. White. 1983. A Review of the Status of the Georges Bank and Gulf of Maine Haddock Stocks for 1983. Woods Hole Lab. Ref. Doc. 83-23, 31 pp.

5. Waring, G. T. 1986. An Analysis of Spatial Difference in Size Composition and Abundance of Butterfish, Peprilus triacanthus, off the Northeast United States. Woods Hole Lab. Ref. Doc. 86-04, 23 pp.

6. Waring, G. T., and E. D. Anderson. 1983. Status of the Northwestern Atlantic Butterfish Stock - 1983. Woods Hole Lab. Ref. Doc. 83-41, 39 pp.

7. Lange, A. M. T. 1984. An Assessment of the Long-finned Squid Resource off the Northeastern United States - Autumn 1984. Woods Hole Lab. Ref. Doc. 84-37, 24 pp.

8. Lange, A. M. T. 1984. Status of the Short-finned Squid (Illex illecebrosus) off the Northeastern USA November 1984. Woods Hole Lab. Ref. Doc. 84-38, 20 pp.

9. Mayo, R. K., U. B. Dozier, and S. H. Clark. 1983. An Assessment of the Redfish (Sebastes fasciatus) Stock in the Gulf of Maine - Georges Bank Region. Woods Hole Lab. Ref. Doc. 83-22, 55 pp.

10. Clark, S. H., M. M. McBride, and B. Wells. 1984. Yellowtail Flounder Assessment Update - 1984. Woods Hole Lab. Ref. Doc. 84-39, 30 pp.

11. Burnett, J., S. H. Clark, and L. O'Brien. 1984. A Preliminary Assessment of White Hake in the Gulf of Maine - Georges Bank Area - 1984. Woods Hole Lab. Ref. Doc. 84-31,33 pp.

VI. APPENDICES: REFERENCE DOCUMENTS

12. Burnett, J., and S. H. Clark. 1983. Status of Witch Flounder in the Gulf of Maine - 1983. Woods Hole Lab. Ref. Doc.83-36, 31 pp.

13. Almeida, F. P., and E. D. Anderson. 1981. Status of the Silver Hake Resource off the Northeast Coast of the United States - 1981. Woods Hole Lab. Ref. Doc. 81-36, 67 pp.

14. Almeida, F. P., and E. D. Anderson. 1981. Status of the Red Hake Resources off the Northeast Coast of the United States - 1981. Woods Hole Lab. Ref. Doc. 81-37, 48 pp.

15. Report on the Status of the Atlantic Sea Scallop Fishery, 1986. Annual Report submitted by the Regional Director, Northeast Region, NMFS, to the New England and Mid-Atlantic Fishery Management Councils. Prepared by Northeast Region in cooperation with the Northeast Fisheries Center, January 1986, 19 pp.

16. Serchuk, F. M., and S. E. Wigley. 1985. Evaluation of USA and Canadian Research Vessel Surveys and Survey Design in Assessing Abundance, Size Composition and Recruitment of Sea Scallops on Georges Bank. NAFO SCR. DOC. 85/88, 24 pp.

17. Serchuk, F. M., and S. E. Wigley. 1984. Results of the 1984 USA Sea Scallop Research Vessel Survey: Status of Sea Scallop Resources in the Georges Bank, Mid-Atlantic, and Gulf of Maine regions and Abundance and Distribution of Iceland Scallops off the Southeastern Coast of Cape Cod. Woods Hole Lab. Ref. Doc. 84-34, 74 pp.

18. Status of the Fishery Resources off the Northeastern United States for 1985. U.S. Department of Commerce, NOAA, NMFS, NEFC, Woods Hole, Massachusetts, August 1985, NOAA Technical Memorandum NMFS-F/NEC-42.

2. DRAFT AGENDA

MONDAY, MAY 5

1300	WELCOME AND INTRODUCTIONS (DOC. 1, DOC. 2, DOC 18)	T. SMITH
1330	WELCOME BY NEFC CENTER DIRECTOR	PETERSON/ ANTHONY
1400	NEW ENGLAND FISHERIES RESOURCES	SERCHUK
	1. HADDOCK (WP 3, 4, DOC 4)	OVERHOLTZ
	2. REDFISH (WP 8, DOC 9)	MAYO
	3. RED HAKE (WP 15, DOC 14)	ALMEIDA
	4. SILVER HAKE (WP 14, DOC 13)	ALMEIDA

TUESDAY, MAY 6

0900	NEW ENGLAND -- CONTINUED	SERCHUK
	5. YELLOWTAIL FLO. (WP 12, DOC 12)	MCBRIDE
	6. WHITE HAKE (WP 10, DOC 11)	MAYO
	7. SEA SCALLOPS (WP 11, DOCs 15, 16, 17)	SERCHUK
	8. WITCH FLOUNDER (WP 12, DOC 12)	GABRIEL
	9. AMERICAN PLAICE (WP 13)	GABRIEL
1330	EVALUATING PRECISION AND ACCURACY OF TRAWL SURVEYS	FOGARTY
1500	WORKING GROUPS MEET	
1930	WORKING GROUPS MEET IF NEEDED	

WEDNESDAY, MAY 7

0900	MID-ATLANTIC RESOURCES	MURAWSKI
	10. MACKEREL (WP 1, DOC 3)	OVERHOLTZ
	11. BUTTERFISH (WP 5, DOC 5, 6)	WARING
	12. LOLIGO (WP 6, DOC 7)	LANGE
	13. ILLEX (WP 7, DOC 8)	LANGE
1330	WORKING GROUPS MEET	
1600	REVIEW OF WORKING GROUP AND RAPPORTEUR PROGRESS	T. SMITH
1730	WORKING GROUPS MEET IF NEEDED	

VI. APPENDICES: DRAFT AGENDA

THURSDAY, MAY 8

0900	DESCRIPTION OF EXISTING TRAWL SURVEY RESEARCH PROGRAMS	T. SMITH
1000	DESCRIPTION OF STOCK ASSESSMENT RESEARCH PROGRAMS FOR 1986 and 1987: STATES COUNCILS NEFC ACADEMIC	
1045	IDENTIFICATION OF ASSESSMENT RESEARCH NEEDS	
1115	IDENTIFICATION OF MANAGEMENT ASSESSMENT NEEDS	
	LUNCH	
1330	DEVELOPMENT OF COOPERATIVE STATE, FEDERAL, AND ACADEMIC ASSESSMENT RESEARCH PROGRAMS TO MEET IDENTIFIED NEEDS	
1530	WORKING GROUPS MEET	
1730	INFORMAL RECEPTION IN MEETING ROOM	

FRIDAY, MAY 9

0900	REVIEW OF MEETING REPORT	T. SMITH
1100	DISCUSSION OF 3rd SAW	

3. WORKING GROUPS

Several working groups were established during the workshop. Some were designed to meet specific needs for analysis during the reviews of the status of specific stocks; these completed their work during the workshop. Others were established to address more general problems, and are expected to provide some report of their work at subsequent workshops.

WORKING GROUP 1: Correlation of survey abundance indices between years.

This group prepared the analysis of survey data described in Section III. 3 of this report.

WORKING GROUP 2: Alternate projection of haddock stock size.

This group completed calculations of Georges Bank haddock stock size if fishing mortality on the 1985 year class were twice the average when that year class recruits to the fishery at age two. The results were incorporated into the species review.

WORKING GROUP 3: Revised VPA's for silver hake.

This group attempted to resolve some unreasonably high estimates of fishing mortality from the VPA for silver hake. These estimates were thought to be due to not pooling enough of the older age classes, but that change did not completely resolve the problem. Alternate VPA tuning procedures using survey indices were also explored, without complete success. The assessment of silver hake was not finalized because of this problem, as reflected in the species review.

WORKING GROUP 4: Pre-1973 recruitment indices for silver hake from length frequency data from trawl surveys.

The data were tabulated but the resulting indices were highly variable. No formal report was made.

WORKING GROUP 5: Scientific value of experimentally manipulating fishing mortality on mackerel or other lightly exploited species.

This group was established to develop a working paper on the scientific value of such experiments, as described in this report under the species review of mackerel and in discussion of priorities for subsequent workshops (Section III.2). A concept paper is expected at the fall workshop. Bill Overholtz and Steve Murawski will act as co-chairs, and other participants include Tim Smith and Brian Rothschild.

VI. APPENDICES: WORKING GROUPS

WORKING GROUP 6: Trawl survey design.

This group was established to develop a working paper on the theoretical basis and operational and technical limitations of trawl surveys. Brian Rothschild and Mike Fogarty will act as co-chairs, and participants include Tom Hoff, Mike Pennington, Steve Clark, Vic Crecco, and Sukwoo Chang.

WORKING GROUP 7: Analysis of changes in catchability with changes in stock abundance.

The possiblity of detecting changes in catchability by comparing survey indices and virtual population analysis, population size estimates will be explored by analysis of suitable data sets from NEFC. Vic Crecco will take a lead, and NEFC staff will provide some data; other participants were not identified.