Northeast Fisheries Science Center Reference Document 01-20

Assessment of 19 Northeast Groundfish Stocks through 2000

A Report
to the New England
Fishery Management Council's
Multi-Species Monitoring Committee

by

Northern Demersal
and Southern Demersal Working Groups,
Northeast Regional Stock Assessment Workshop

December 2001

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
Northeast Fisheries Science Center
Woods Hole, Massachusetts

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Northeast Fisheries Science Center Reference Documents

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Section 1. Introduction

The Northern Demersal Working Group and the Southern Demersal Working Group met on an intermittent basis during July and August, 2000, and in joint session on 30 and 31 August, 2000 to review assessments of 19 stocks of groundfish regulated by the Northeast Multi-species Fishery Management Plan.

This report was prepared for the NEFMC Multi-Species Monitoring Committee for use in developing management advice for the 2001 fishing year. This report represents a summary of the assessment results presented to the Joint Working Group at its 30-31 August, 2000 Final Review Meeting. The report consists of this introduction, followed by a concise section for each of the 19 stocks in the review. A concluding section contains overall comments by the Joint Working Group, an evaluation of the quality of the data and assessments, and recommendations for future improvement. This Working Group report contains information on current stock status, with no explicit references to management advice.

Terms of Reference

The agreed terms of reference for this assessment review cycle are as follows:

a) For stocks where sufficient data are available for 1999, determine 1999 fishing mortality, spawning stock biomass, and mean biomass, and stock size at the beginning of 2000.

b) For stocks where 1999 landings and indices of current biomass are available, use proxies to determine whether there has been a significant change in exploitation rate or stock biomass between 1998 and 1999.

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List of Stocks Reviewed

The letter associated with each of the stocks listed below corresponds to a section of this report following the introductory section. The 19 stocks comprised 4 categories, corresponding to the review status or assessment methodology used to determine stock status as follows:

1) Stocks reviewed by the Transboundary Resources Assessment Committee in April, 2000

A. Georges Bank Cod
B. Georges Bank Haddock
C. Georges Bank Yellowtail Flounder

2) Stocks for which a VPA was performed to estimate 1999 F

D. So. New England Yellowtail Flounder
E. Cape Cod Yellowtail Flounder
F. Gulf of Maine Cod

3) Stocks for which projection methodology was used to derive 1999 F

G. Witch Flounder
H. American Plaice
I. Georges Bank Winter Flounder
J. So. New England/Mid-Atlantic Winter Flounder
K. White Hake

4) Stocks for which index assessment methods were applied to evaluate 1999 exploitation ratios

L. Pollock
M. Redfish
N. Ocean Pout
O. Gulf of Maine/Georges Bank Windowpane
P. So. New England/Mid-Atlantic Windowpane
Q. Mid-Atlantic Yellowtail Flounder
R. Gulf of Maine Haddock
S. Atlantic Halibut

Section 2. Stock Assessments for 19 Northeast Groundfish Stocks

The following sub-sections A-S contain a summary of the detailed assessment working papers reviewed by the joint meeting of the SAW Northern Demersal and Southern Demersal Working Groups on 30 and 31 August, 2000.

A. Georges Bank Atlantic Cod by L. O'Brien

1.0 Background

This stock was last assessed and peer reviewed in April 2000 (O'Brien 2000, Transboundary Resources Assessment Committee 2000) and is summarized in this report. Fully recruited F (ages 4-8, u) was estimated to be 0.22 in 1999, the lowest in the time series (1978-1999). Spawning stock biomass was 34,800 mt in 1999 and continued the increasing trend from the record low estimate of 20,000 mt in 1994. Mean biomass was 43,000 mt in 1999 and has followed trends similar to SSB. Since 1992, recruiting year classes have all been below the long term average and the 1997 year class which entered the 1999 fishery as 2 year olds, is the lowest on record. The NEFSC spring and autumn bottom trawl survey indices continue to remain near record low values. Recruitment indices for age 2 fish from the 1994, 1995, 1996, and 1997 year classes are below the time series (1963-1999) average . The most recent above average year class occurred in 1993.

2.0 2000 Assessment

The Fishery

Total commercial landings of Georges Bank cod (Table A1, Figure A1) in 1999 (9,800 mt) increased 12% from 1998. USA landings increased 16% (8,100 mt) and Canadian landings declined 3% (1819 mt) in 1999 (Table A1). No discards estimates were derived for 1999. Recreational landings were estimated at 357 mt, a decline of about 31% from 1998.

The total number of commercial length samples in 1999 were less than in 1998. The number of quarterly samples were adequate for both scrod and market size categories, but poor for the large market category. The 'large' samples were pooled on a semi-annual basis. Spatial coverage was poor for eastern Georges Bank (SA 561, 562), as it has been for several years. As in the last assessment, length samples from western Georges Bank and combined US and Canadian age samples from eastern Georges Bank were applied to characterize the landings from eastern Georges Bank. Landings were dominated in numbers by age 3 fish in both the US and Canadian fisheries and in weight by age 3 fish in the USA fishery and age 4 fish in the Canadian fishery.

Input data and Analyses

The current assessment is an update of the 1999 assessment and employs the same VPA formulation (NDWG,NEFSC 2000). A slight variation from the previous assessment is that the number of surveys available as tuning indices in the terminal year decreases from three to two since the USA 2000 spring survey was not available when the assessment was conducted. Catch at age has been updated with total 1999 landings (USA and Canadian) and research survey indices have been estimated for the 1999 NEFSC spring and autumn bottom trawl surveys and the 2000 Canadian Department of Fisheries and Oceans (DFO) spring bottom trawl survey. A conditional non-parametric bootstrap procedure (Efron 1982) was used to evaluate the

precision of fishing mortality, spawning stock biomass, and mean biomass estimates. A retrospective analysis was performed for terminal year fishing mortality, spawning stock biomass, and age 1 recruitment.

3.0 Assessment Results

NEFSC spring and autumn survey abundance and biomass indices declined in 1999 to similar values observed in 1997, except for the autumn biomass index which has increased slightly since 1997. All indices, however, remain below the long term average (Table A2, Figure A2). The Canadian spring survey index of abundance increased in 1999 to similar values observed in 1996 (Figure A2). The recruitment indices for age 1 and 2 from the 1999 NEFSC autumn bottom trawl survey were well below average.

Fully recruited fishing mortality (age 4-8) was estimated at 0.22 in 1999 and the uncertainty of this estimate, as indicated by the retrospective analysis, is discussed below. The 1998 F estimate was 0.39, 39% higher than initially estimated in the 1999 assessment (NDWG, NEFSC 2000) (Figure A3). Biomass weighted fishing mortality declined from a time series high of 0.64 in 1993 to 0.23 in 1999 (Table A3, Figure A3). Spawning stock biomass in 1999 was estimated at 34,800 mt, a 10% increase from 1998 and a 74% increase from the record low in 1994 (Table A3, Figure A4). Mean biomass increased from a record low 31,000 mt in 1994 to 43,000 mt in 1999 (Table A3, Figure A4). Recruitment of the 1998 year class (5.3 million age 1 fish) is estimated to be similar to the 1994 year class (4.7 million age 1 fish) (Table A3, Figure A4). The survival ratio of recruit/SSB was above average for the 1995 and 1996 year classes and below average for the more recent year classes.

VPA Diagnostics

Stock size estimates for ages 1-8 were well estimated with CVs ranging from 0.21 to 0.47. The distribution of F estimates from the bootstrap analysis ranged from 0.16 to 0.40 with an 80% probability that F in 1999 was between 0.18 and 0.25. The distribution of SSB estimates from the bootstrap analysis ranged from 28,000 mt to 48,000 mt with an 80% probability that SSB in 1999 was between 31,000 mt and 39,000 mt. The distribution of the 1999 mean biomass estimates, derived from bootstrap analysis, ranged from 32,000 to 62,000 mt. There is a 80% probability that the mean biomass in 1999 was between 38,000 mt and 48,000 mt.

A retrospective pattern exists in this model formulation back to 1994 (Figure A5). The terminal year estimates of both recruits and fishing mortality are less than converged estimates since 1994 and 1995, respectively, and SSB estimates are greater than converged estimates since 1994. This may partially be due to the lack of Canadian indices in the calibration for 1993 and 1994. Other factors influencing the retrospective pattern may include mis-reporting of catch, immigration or emigration, an unrepresentative estimate of natural mortality, and mis-specification of the model.

The fishing mortality of 0.28 that was assumed for the projection analysis in 1999 (NDWG, 2000) was not within the 80% confidence interval (0.18 - 0.25) of the 1999 F derived from current VPA calibration.

4.0 SFA control rule

The SFA control rule for Georges Bank cod is based on B_{MSY} (108,000 mt) and states that when the stock biomass is between 1/4 and ½ B_{MSY} (27,000-54,000 mt), the threshold mortality rate is defined by a five year rebuilding time period, and if the stock is between ½ B_{MSY} and B_{MSY} the rebuilding time period is 10 years (Figure A6). In 1999, mean biomass was estimated at 43,000 mt, about 40% of the target B_{MSY} and F weighted by biomass was estimated at 0.23.

5. 0 Sources of Uncertainty

- Landings data for 1994-1999 are derived by proration and are provisional.
- There was inadequate commercial sampling in 1999 both temporally and spatially. The large market category was not well sampled by quarter, and samples from eastern GB were minimal.
- The retrospective analysis indicates a pattern in the estimates of F, SSB, and recruits in the VPA. The terminal year estimates of both fishing mortality and recruits are less than the converged estimates and SSB estimates are greater than the converged estimates.
- There are inadequate data to characterize both the recreational and discarded catch, particularly if these components increase. The SARC previously rejected using poorly sampled recreational catch since a recreational catch at age with a similar age structure to the commercial catch at age would only be a scaling factor.

6.0 References

Efron, B. 1982. The jackknife, the bootstrap and other resampling plans. Phila. Soc. Ind. and Appl. Math. 34: 92 p.

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Table A1. Commercial landings (metric tons, live) of Atlantic cod from Georges Bank and South (Division 5Z and Subarea 6), 1960 - 1999.

	Country						
Year	USA	Canada	USSR	Spain	Poland	Other	Total
1960	10834	19	-	-	-	-	10853
1961	14453	223	55	-	-	-	14731
1962	15637	2404	5302	-	143	-	23486
1963	14139	7832	5217	-	-	1	27189
1964	12325	7108	5428	18	48	238	25165
1965	11410	10598	14415	59	1851	-	38333
1966	11990	15601	16830	8375	269	69	53134
1967	13157	8232	511	14730	-	122	36752
1968	15279	9127	1459	14622	2611	38	43136
1969	16782	5997	646	13597	798	119	37939
1970	14899	2583	364	6874	784	148	25652
1971	16178	2979	1270	7460	256	36	28179
1972	13406	2545	1878	6704	271	255	25059
1973	16202	3220	2977	5980	430	114	28923
1974	18377	1374	476	6370	566	168	27331
1975	16017	1847	2403	4044	481	216	25008
1976	14906	2328	933	1633	90	36	19926
1977	21138	6173	54	2	-	-	27367
1978	26579	8778	-	-	-	-	35357
1979	32645	5978	-	-	-	-	38623
1980	40053	8063	-	-	-	-	48116
1981	33849	8499	-	-	-	-	42348
1982	39333	17824	-	-	-	-	57157
1983	36756	12130	-	-	-	-	48886
1984	32915	5763	-	-	-	-	38678
1985	26828	10443	-	-	-	-	37271
1986	17490	8411	-	-	-	-	25901
1987	19035	11845	-	-	-	-	30880
1988	26310	12932	-	-	-	-	39242
1989	25097	8001	-	-	-	-	33098
1990	28193	14310	-	-	-	-	42503
1991	24175	13455	-	-	-	-	37630
1992	16855	11712	-	-	-	-	28567
1993	14594	8519	-	-	-	-	23113
1994	9893*	5276	-	-	-	-	15169
1995	6759*	1100	-	-	-	-	7859
1996	7020*	1885	-	-	-	-	8905
1997	7537*	2898	-	-	-	-	10435
1998	6959*	1873	-	-	-	-	8832
1999	8061*	1819	-	-	-	-	9880

* Provisional data

Table A2. Standardized stratified mean catch per tow in numbers and weight (kg) for Atlantic cod in NEFSC offshore spring and autumn research vessel bottom trawl surveys on Georges Bank (Strata 13-25), 1963 - 2000. [a,b,c]

	Spring		Autumn	
Year	No/Tow	Wt/Tow	No/Tow	Wt/Tow
1963	-	-	4.37	17.8
1964	-	-	2.98	11.6
1965	-	-	4.25	11.7
1966	-	-	4.81	8.1
1967	-	-	10.38	13.6
1968	4.72	12.6	3.30	8.6
1969	4.64	17.8	2.20	8.0
1970	4.34	15.6	5.07	12.5
1971	3.39	14.2	3.19	9.9
1972	8.97	19.0	13.09	23.0
1973	18.68 [d]	39.7 [d]	12.28	30.8
1974	14.75	36.4	3.49	8.2
1975	6.89	26.0	6.41	14.1
1976	7.06	18.6	10.44	17.7
1977	6.30	15.4	5.45	12.5
1978	12.31	31.2	8.59	23.3
1979	5.16	16.9	5.95	16.5
1980	6.12	16.7	2.91	6.7
1981	10.44	26.1	9.04	19.0
1982	8.20 [e]	15.4 [e]	3.71	6.9
1983	7.70	24.0	3.64	6.5
1984	4.08	15.4	4.75	10.3
1985	6.94	21.5	2.43	3.5
1986	5.04	16.7	3.12	4.7
1987	3.26	10.3	2.33	4.4
1988	5.86	13.5	3.11	5.8
1989	4.80	10.8	4.78	4.6
1990	4.74	11.6	3.62 [f]	7.1 [f]
1991	4.39	9.0	0.96	1.4
1992	2.67	7.5	1.84	3.1
1993	2.48	7.3	2.15	2.2
1994	0.94	1.2	1.82	3.3
1995	3.29	8.4	3.62	5.6
1996	2.70	7.5	1.10	2.7
1997	2.32	5.2	0.87	1.9
1998	4.36	11.7	1.87	2.8
1999	2.15	4.7	1.02	3.0
2000	3.57	8.2		
Average	5.86	16.64	4.46	9.55

[a] During 1963-1984, BMV oval doors were used in spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NEFC 1991).

[b] Spring surveys during 1980-1982, 1989-1991 and 1994 and autumn surveys during 1977-1981, 1989-1991, and 1993 were accomplished with the *R/V Delaware II*; in all other years, the surveys were accomplished using the *R/V Albatross IV*. Adjustments have been made to the *R/V Delaware II* catch per tow data to standardize these to *R/V Albatross IV* equivalents. Conversion coefficients of 0.79 (numbers) and 0.67 (weight) were used in this standardization (NEFC 1991).

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

[d] Excludes unusually high catch of 1894 cod (2558 kg) at Station 230 (Strata tow 20-4).

[e] Excludes unusually high catch of 1032 cod (4096 kg) at Station 323 (Strata tow 16-7).

[f] Excludes unusually high catch of 111 cod (504 kg) at Station 205 (Strata tow 23-4).

Table A3. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), mean biomass (mt), spawning stock biomass (mt), and percent mature of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-1999.

Stock Numbers (Jan 1) in thousands

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	27711	23512	20109	41393	17471	9615	27391	8675	42754	16377	23456	15718	9252	17881	6880	9225	7706	4656	8803	10420	2842	6830	5329
2	4270	22686	19220	16383	33865	14004	7774	22352	6981	34863	13385	19195	12869	7568	14593	5569	7549	6308	3812	7206	8528	2327	5590
3	25527	3140	16774	12318	10514	19458	7588	5182	12486	4516	21781	9532	13827	6064	4817	8168	3625	5820	4810	2933	5432	6314	1647
4	7933	13889	1756	8460	6266	5148	8635	3115	2032	6085	2425	10574	5160	6758	2031	1980	2846	1587	3808	3121	1823	3373	3426
5	2877	4411	6965	986	4697	2608	1992	4052	1312	943	3063	1070	4898	2522	2564	723	612	679	673	2001	1758	1110	2122
6	1127	1604	2515	3614	594	2036	1181	871	1611	640	519	1153	576	1962	745	758	194	145	293	333	920	1146	727
7	1414	804	899	1085	1687	232	965	500	340	752	296	205	455	265	622	245	194	72	79	129	154	539	850
8	67	846	588	334	511	772	104	375	212	200	371	97	93	150	103	229	57	35	35	51	29	91	333
9	147	12	463	403	162	226	419	46	124	108	107	126	40	44	60	53	58	5	15	26	27	11	60
10+	55	148	27	191	187	145	293	208	76	68	99	45	89	43	18	28	9	2	1	2	18	17	19
1 +	71127	71053	69317	85167	75953	54244	56343	45375	67929	64552	65503	57714	47259	43258	32432	26979	22850	19308	22328	26222	21533	21757	20104

Fishing Mortality

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0	0	0	0	0.02	0.01	0	0.02	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0
2	0.11	0.1	0.24	0.24	0.35	0.41	0.21	0.38	0.24	0.27	0.14	0.13	0.55	0.25	0.38	0.23	0.06	0.07	0.06	0.08	0.1	0.15
3	0.41	0.38	0.48	0.48	0.51	0.61	0.69	0.74	0.52	0.42	0.52	0.41	0.52	0.89	0.69	0.85	0.63	0.22	0.23	0.28	0.28	0.41
4	0.39	0.49	0.38	0.39	0.68	0.75	0.56	0.66	0.57	0.49	0.62	0.57	0.52	0.77	0.83	0.97	1.23	0.66	0.44	0.37	0.3	0.26
5	0.38	0.36	0.46	0.31	0.64	0.59	0.63	0.72	0.52	0.4	0.78	0.42	0.72	1.02	1.02	1.12	1.24	0.64	0.5	0.58	0.23	0.22
6	0.14	0.38	0.64	0.56	0.74	0.55	0.66	0.74	0.56	0.57	0.73	0.73	0.58	0.95	0.91	1.16	0.79	0.41	0.62	0.57	0.34	0.1
7	0.31	0.11	0.79	0.55	0.58	0.6	0.74	0.66	0.33	0.51	0.92	0.59	0.91	0.75	0.8	1.27	1.52	0.51	0.24	1.28	0.33	0.28
8	1.49	0.4	0.18	0.52	0.62	0.41	0.63	0.91	0.47	0.43	0.88	0.68	0.56	0.72	0.46	1.17	2.3	0.65	0.1	0.43	0.75	0.22
9	0.36	0.44	0.51	0.44	0.66	0.67	0.6	0.71	0.54	0.49	0.73	0.58	0.63	0.87	0.94	1.09	1.27	0.64	0.46	0.47	0.28	0.22
10+	0.36	0.44	0.51	0.44	0.66	0.67	0.6	0.71	0.54	0.49	0.73	0.58	0.63	0.87	0.94	1.09	1.27	0.64	0.46	0.47	0.28	0.22
mn4-8,u	0.54	0.35	0.49	0.47	0.65	0.58	0.64	0.74	0.49	0.48	0.79	0.60	0.65	0.84	0.80	1.14	1.42	0.57	0.38	0.65	0.39	0.22
Fwb	0.31	0.29	0.39	0.32	0.47	0.52	0.41	0.53	0.29	0.33	0.42	0.35	0.53	0.55	0.57	0.64	0.5	0.26	0.25	0.26	0.22	0.23

Table A3 continued. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), mean biomass (mt), spawning stock biomass (mt), and percent mature of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-1999.

Mean biomass (mt)

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	17756	18930	15201	33078	11990	8411	26100	7072	35928	10767	16706	11525	6965	18026	7119	7289	6327	3823	7037	9008	1492	5137
2	4816	29255	22650	19782	36452	15601	10449	24026	8347	41188	17252	26461	14109	9907	17073	6946	9698	8127	5054	9900	10923	3079
3	47057	5118	29978	21113	20017	31667	12313	7020	21792	8390	36585	16164	24310	9394	7862	11373	5349	9937	9507	5419	9947	10500
4	20817	42243	4894	21840	16000	10999	21921	8106	5192	18433	5814	27821	12978	14801	4867	3884	5528	4082	9512	8386	5027	9319
5	9449	16495	28841	4033	17037	8352	6889	13464	5247	4126	10558	4304	15698	6951	6973	1999	1557	2522	2375	5708	6772	4427
6	5533	8742	11357	18264	2510	9170	5214	3621	8109	3448	2246	5023	2536	6869	2768	2640	916	800	1323	1398	4228	6364
7	8154	6341	4785	6532	10957	1273	5563	2718	2353	4828	1564	1165	2326	1267	2954	965	742	553	533	541	981	3141
8	275	6555	4453	2347	3458	5943	717	2321	1538	1487	2266	691	697	1034	741	1151	195	273	259	326	163	721
9	1326	107	2801	4217	1355	1693	3264	341	1107	894	774	1020	345	260	431	290	296	33	140	227	273	113
10+	553	1376	303	2611	2091	1408	3101	1839	751	735	986	533	880	407	202	206	79	23	5	19	209	191
Total	115735	135163	125263	133817	121867	94516	95531	70527	90365	94297	94751	94707	80844	68916	50990	36742	30687	30172	35744	40933	40013	42991

SSB at the start of the spawning season - males and females (mt)

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	912	1104	850	1962	1200	902	3122	773	8516	2226	3481	2482	638	1964	791	722	106	63	112	1002	126	622
2	1411	7540	6911	5784	16138	6347	4303	11650	5032	25333	8898	13723	6629	4245	9031	3577	3180	2713	1662	4620	5497	1192
3	33839	3730	22412	15924	15649	26066	10500	6879	18778	7106	32841	14541	22033	9069	7483	11494	5473	9005	8047	4662	8793	9526
4	20179	38255	4300	21375	15792	12655	21656	8076	4842	17024	6137	27191	12817	16519	5296	4619	6431	3965	9113	8318	4783	8801
5	8796	16541	30441	3962	17468	9636	7118	14908	5434	3936	12375	4200	18065	8434	8395	2538	1926	2644	2597	6554	6695	4279
6	4892	8127	12487	20325	2961	10514	5653	4252	8584	3704	2763	5937	2959	8694	3355	3310	1000	779	1541	1593	4152	6013
7	8094	5563	5914	7240	12174	1464	6221	3163	2355	5364	2024	1326	2844	1548	3501	1303	1041	572	575	734	991	3282
8	366	6672	5047	2693	4108	6842	815	2980	1702	1701	2932	811	769	1217	786	1518	313	291	321	389	209	756
9	1339	111	3841	4111	1557	2059	3958	420	1245	1030	965	1193	408	372	557	420	432	40	163	236	262	109
10+	657	1674	376	3178	2704	1825	3942	2407	941	907	1296	673	1127	554	281	296	117	30	6	24	242	217
Total	80485	89318	92581	86552	89751	78311	67288	55509	57430	68331	73713	72077	68289	52617	39476	29798	20019	20102	24138	28131	31750	34796

Percent Mature (females)

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	7	7	7	7	13	13	13	13	28	28	28	28	12	12	12	12	2	2	2	13	13	13
2	34	34	34	34	47	47	47	47	67	67	67	67	52	52	52	52	39	39	39	57	57	57
3	78	78	78	78	84	84	84	84	91	91	91	91	90	90	90	90	95	95	95	92	92	92
4	96	96	96	96	97	97	97	97	98	98	98	98	99	99	99	99	100	100	100	100	100	100
5-10+	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

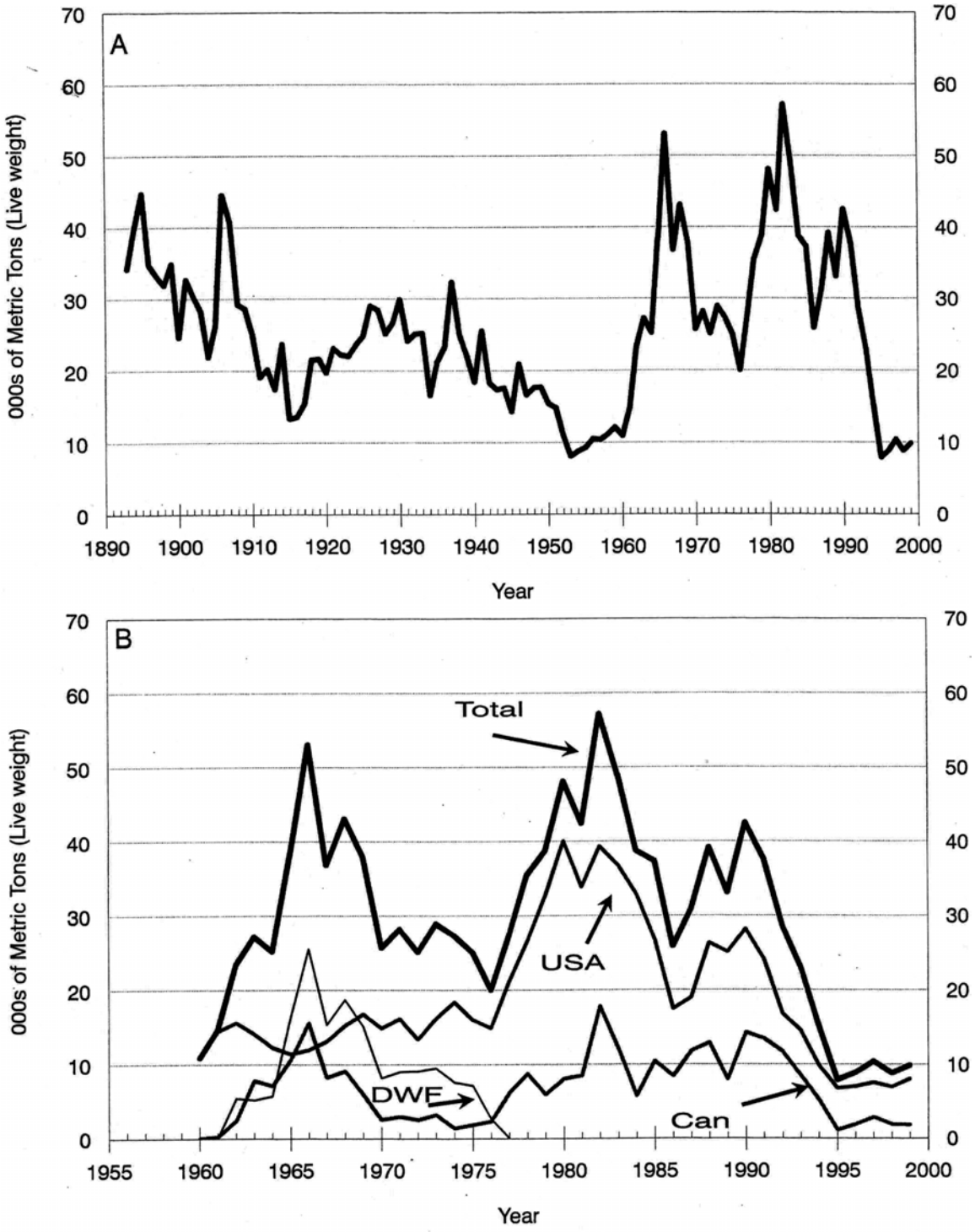

Figure A1. Total commercial landings of Georges Bank cod (Division 5Z and Subarea 6), 1893-1999 (Panel A) and total commercial landings of Georges Bank cod by country, 1960-1999 (Panel B).

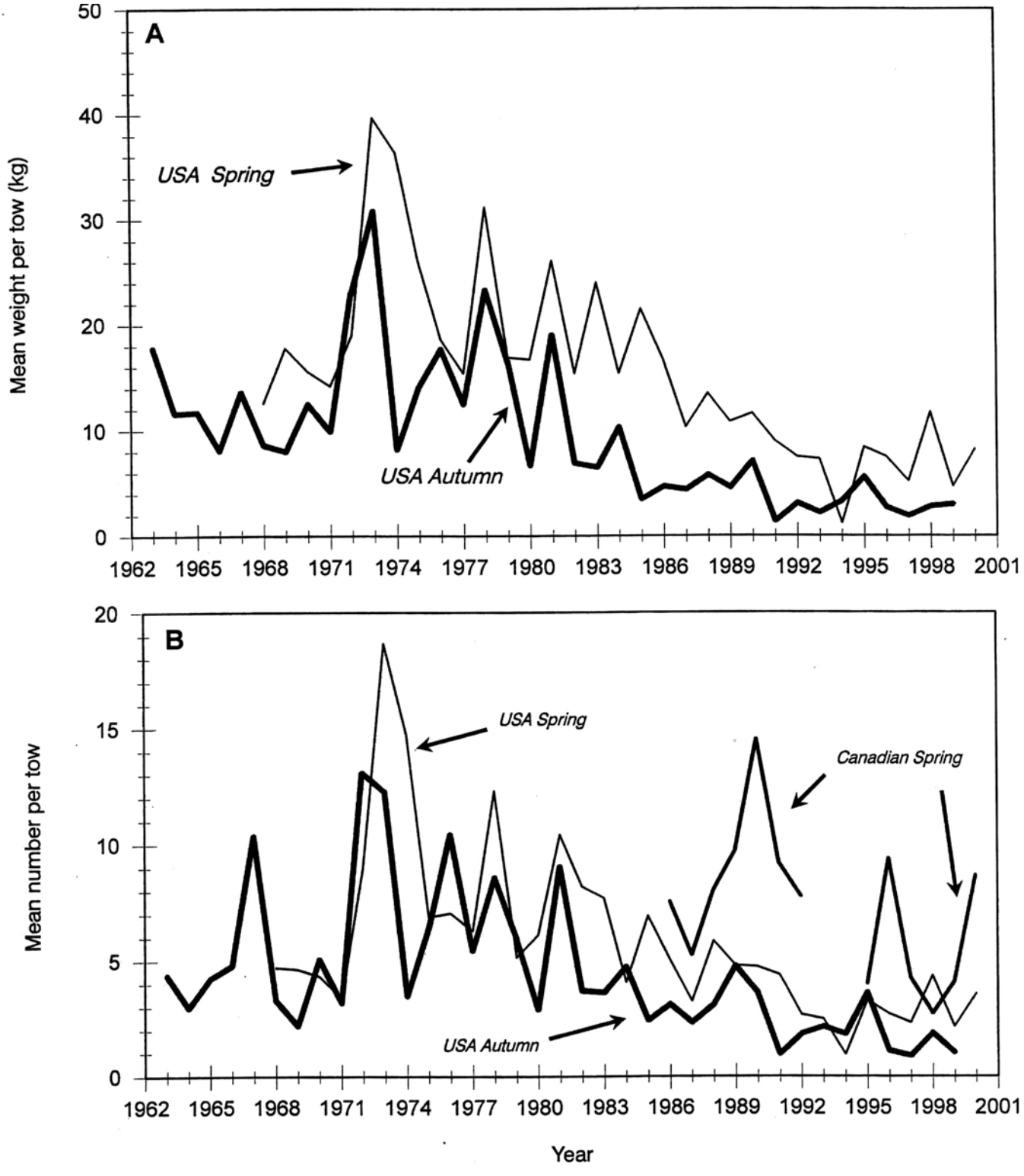

Figure A2. Standardized stratified mean weight (Panel A) and number (Panel B) per tow of Atlantic cod in NEFSC spring and autumn research vessel bottom trawl surveys, 1963 -1999, and Candian spring research vessel bottom trawl surveys, 1986-1992 and 1994-2000, on Georges Bank.

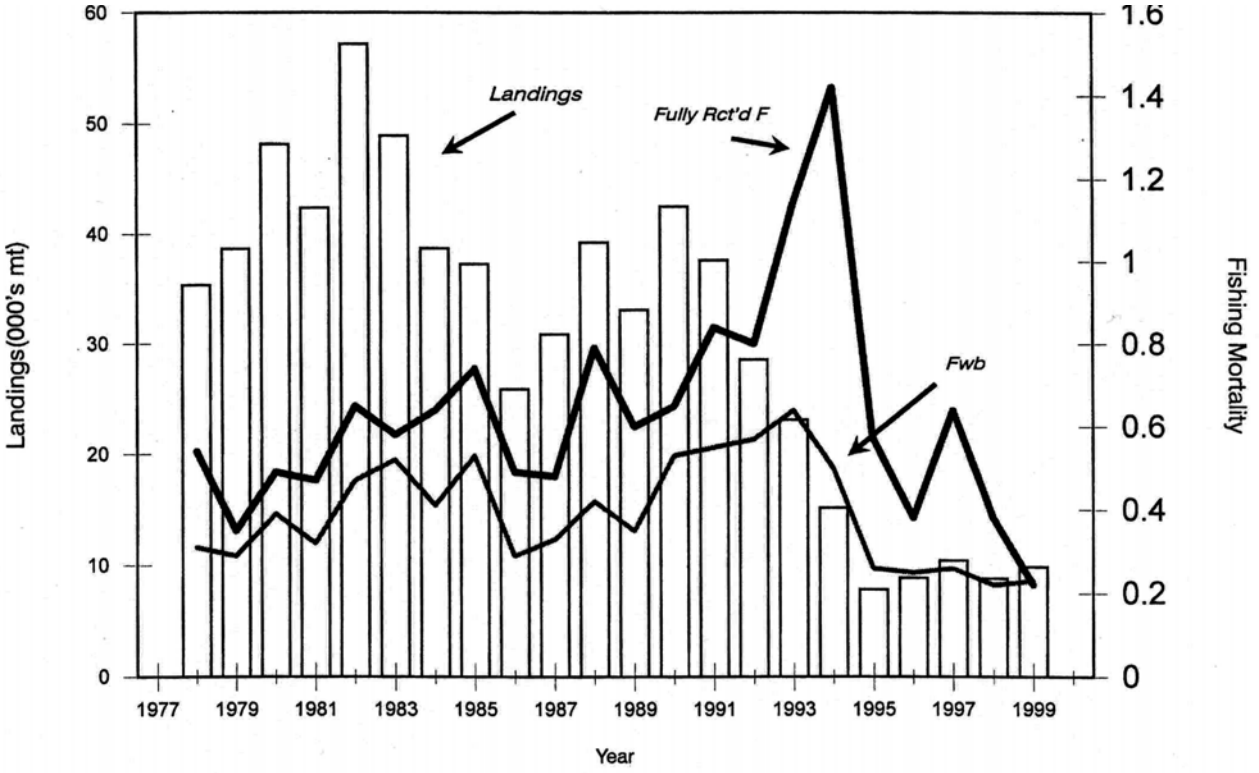

Figure A3. Trends in total commercial landings and fishing mortality for Georges Bank cod, 1978-1999.

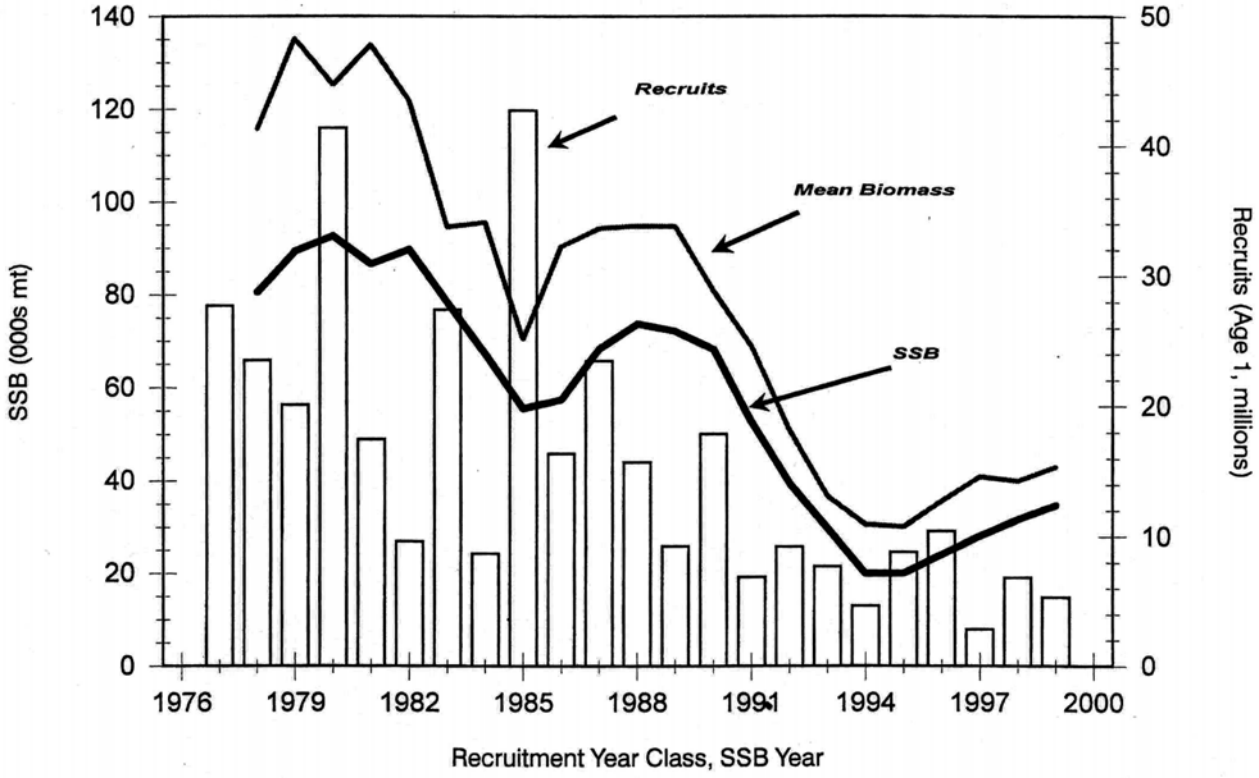

Figure A4. Trends in spawning stock biomass and recruitment for Georges Bank cod, 1978-1999.

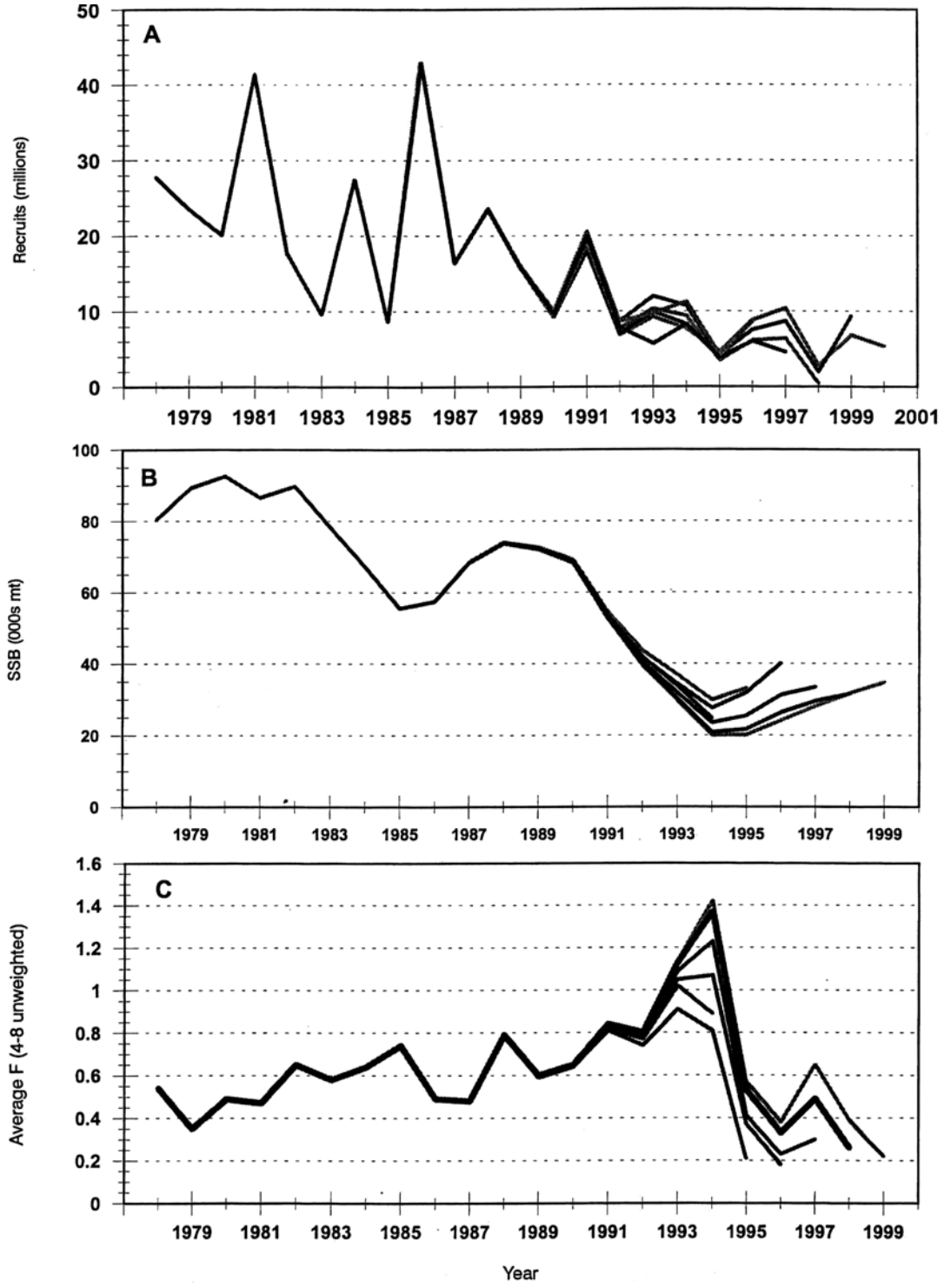

Figure A5 Retrospective analysis of Georges Bank cod recruits at age 1 (A), spawning stock biomass (B) and fishing mortality (C, average F, ages 4-8, unweighted) based on the final ADAPT VPA formulation, 1999-1994.

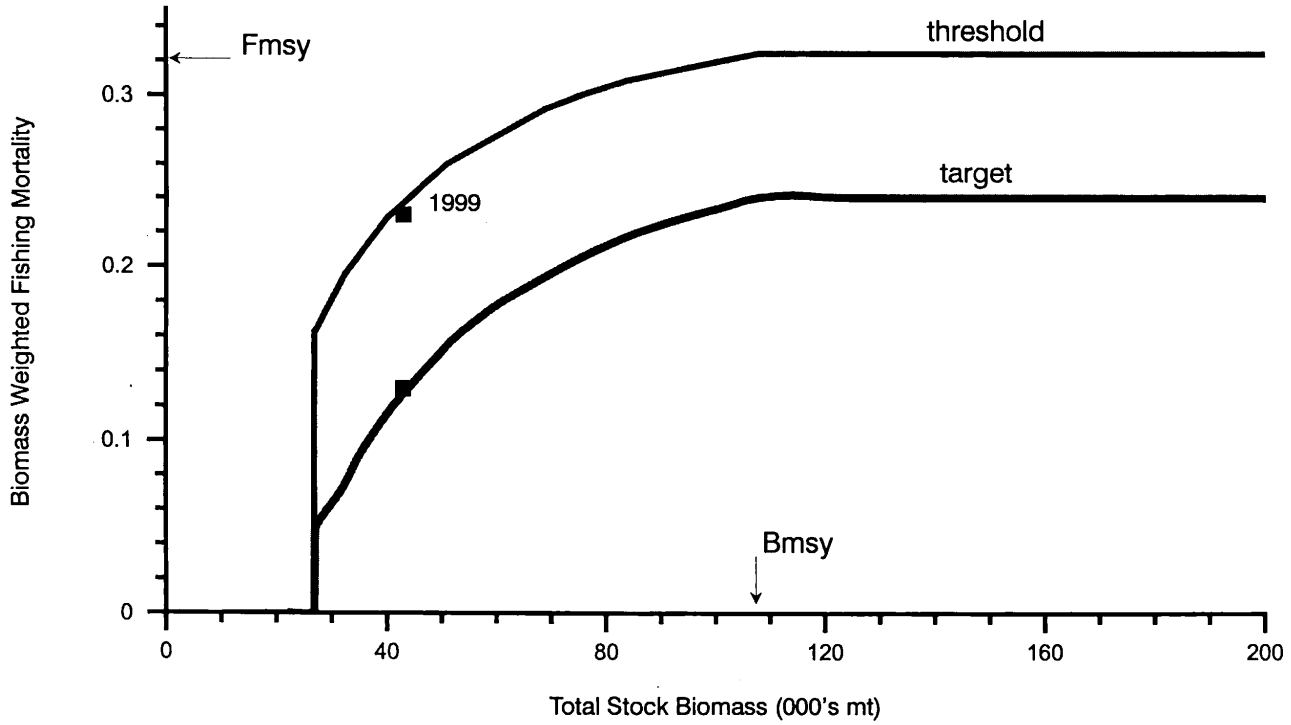

Figure A6. SFA control rule and recent stock status for Geroges Bank Atlantic cod.

B. Georges Bank Haddock by R.W. Brown

1.0 Background

The Georges Bank haddock stock was last assessed by the United States in 1999 and reviewed by the Northern Demersal Committee of the Northeast Fisheries Science Center's Stock Assessment Workshop (NDWG 2000). The current stock assessment was reviewed at the 3rd Transboundary Resource Assessment Committee in April 2000 (TRAC 2000. Brown 2000). In addition, a Canadian assessment through 1999 was completed in the April 2000 for the 5Zj&m portion of the stock. The 1999 U.S. assessment estimated fully recruited fishing mortality (ages 4-7) in 1999 to be 0.15 (13% exploitation rate), which was above the fishing mortality rate (F_{target} = 0.00) specified by the Sustainable Fisheries Act (SFA) harvest control rule (Brown 2000). Fishing mortality was estimated to have remained between 0.1 and 0.2 between 1995 and 1998. Spawning stock biomass (SSB) was estimated to have increased from 10,900 mt in 1993 to 38,100 mt in 1998. The age structure of the population was continuing to expand and the age 4+ biomass was estimated to be at its highest level since the early 1980s. Preliminary estimates of the 1998 year class indicated an estimated year class size of 61.9 million fish at age 1, the largest year class since 1978. However, there was considerable uncertainty about the size of this year class due to highly variable catches in research vessel surveys available at the time of this assessment.

2.0 2000 Assessment

1999 Fishery

U.S. trip limit regulations for haddock continued to be liberalized, and 1999 regulations were significantly in more liberal in comparison to the 1998 calendar year. The trip limit from January 1 to April 30, 1999 was 3,000 pounds/day up to a maximum of 30,000 pounds/trip, 2,000 pounds/day up to a maximum of 20,000 pounds/trip from May 1 to November 4, 1999, and 5,000 pounds/trip up to a maximum of 50,000 pounds/trip from November 5 to December 31, 1999. As a result of both increased haddock abundance and liberalization of trip limit regulations, U.S. commercial landings of Georges Bank haddock in 1999 were 2,775 mt, a 51% increase from 1998 and an 887% increase over 1996 landings (Table B1, Figure B1). U.S. landings included 2,420 mt of landings from western Georges Bank (statistical areas 521, 522, 525, 526) and 355 mt of landings from eastern Georges Bank (statistical areas 561 & 562). U.S. catch continues to be displaced inshore as a result of Days at Sea regulations and area closures.

U.S. landings at age on western Georges Bank and south were estimated separately by market category using U.S. port sampling data. Sampling was sufficient to characterize western Georges Bank landings, but poor temporal distribution of samples made it necessary to use different temporal pooling for each of the two market categories. For the large haddock, samples were applied separately for quarters 1 and 2 and pooled for quarters 3 and 4. For scrod haddock, samples were pooled for quarters 1 and 2, and estimated separately for quarters 3 and 4.

U.S. port samples were insufficient to characterize U.S. landings from eastern Georges Bank, but landings from this area comprise a relatively small portion of the U.S. and total landings in the assessment. Of the 2,775 mt of U.S. haddock landings from Georges Bank, 355 mt (12.8% of U.S. landings and 5.5% of total landings) occurred in eastern Georges Bank. U.S. landings from eastern Georges Bank were partitioned using U.S. length samples by market category from western Georges Bank and Canadian survey ages (quarter 1) and Canadian commercial ages (quarters 2, 3 & 4). Length samples and landings were pooled identically to the analysis for western Georges Bank.

Discard estimates have been added to the catch at age during the assessment when resource conditions and management actions have resulted in the generation of levels of regulatory discard significantly higher than chronic background levels. In 1974, 1977, 1978, and 1980, discarding increased sharply as three large year classes (1972, 1975, 1978) recruited to the fishery (Overholtz et al. 1983). The catch at age in each of these years was augmented by estimates of associated discard. More recently, the catch at age was also augmented with estimates of discards from 1994 to 1998 to account for discard mortality generated in response to trip limit regulations in the U.S. fishery. Low discard rates reported in the Sea Sample and Vessel Trip Report databases are consistent with liberalized haddock trip limits that were in effect during 1999. These discarding rates are less than the rates reported in the U.S. fishery during the 1994 to 1998 period, and appear to be representative of background discarding rates reported in the Sea Sampling database from 1989 to 1993. Based on these observations and the dearth of information available to characterize the size and age distribution of U.S. discards, estimates of U.S. discards were not included in the 1999 catch at age.

Canadian catch from the Georges Bank haddock stock consisted of 3,680 mt of landings (Table B1), approximately 94% of the allocated 1999 quota of 3,900 mt and 57% of the total haddock landings from the Georges Bank stock. Comparison of observer samples with port samples did not reveal any persistent patterns which would indicate that discarding or high grading was occurring. The size and age composition of the 1999 Canadian fishery was characterized by port and at sea samples from all principal gears and all seasons.

The combined catch at age was dominated by age 3 (1996 year class) haddock, although there were significant contributions by ages 4-6 (1995, 1994, and 1993 year classes). Although 25% of landings by weight from the stock were accounted for by the 1996 year class, age 5 and older fish still comprised 58% of total landings by weight.

Fishery Independent Information

Abundance (stratified mean number/tow) and biomass (stratified mean weight/tow) survey indices in the U.S. Spring survey in 1999 and 2000 remained above levels observed from 1986-1995 (Table B2; Figure B2). The 1999 U.S. Spring survey catch of age 1 haddock (1998 year class) was the highest level observed since 1979 (1978 year class), but the index in the 2000 U.S. Spring survey for this year class was reduced substantially. The abundance and biomass survey indices in the U.S. Autumn survey in 1999 were the highest observed since 1979 (Table B2;

Figure B2). The 1998 U.S. Autumn survey catch of age 0 haddock (1998 year class) was the highest level observed since 1985 (1985 year class), but the index for this year class at age 1 declined sharply in the 1999 survey. Aggregate abundance survey indices in the Canadian Spring survey in 2000 were the highest levels observed since the initiation of the survey in 1986, and three-fold higher than the 1999 index (Figure B2). The majority of this abundance was comprised of large catches of age 1 and 2 haddock (1999 and 1998 year classes, respectively). Each of these indices was 3 fold higher than the next index at age in the Canadian survey time series. A single large tow in the 2000 Canadian survey had a significant effect on the aggregate index value.

Input Data and Analysis

The present assessment represents a one-year update to the previous U.S. assessment (NDWG 2000). The VPA formulation used for the current assessment was identical to the one used in the 1999 U.S. assessment, except for the addition of the terminal year of catch at age (1999) and research survey data (U.S. Spring 1999, U.S. Autumn 1999, Canadian Spring 2000). Very minor revisions were made to 1997 catch at age to incorporate revisions to the estimate of 1997 Canadian catch at age.

Precision of the 2000 stock sizes and 1999 fishing mortality and SSB estimates was derived from 1000 bootstrap simulations of the 1999 VPA formulation. A retrospective analysis of terminal year estimates of stock size, fully recruited fishing mortality and SSB was carried out to 1995.

3.0 Assessment Results

The current assessment continues to consistently estimate the strength of incoming year classes, indicating that the 1992 (15.3 million at age 1), 1993 (12.4 million), and 1996 (19.5 million) were stronger than other year classes since 1988 (Table B3; Figure B3). Based on the consistent strength of age 0+ and 1 survey indices, the 1998 and 1999 year classes are estimated to be 48.8 and 35.2 million fish at age 1, respectively. If these estimates are reliable, the 1998 and 1999 year classes would be the third and fourth largest year class since 1964, although smaller than the 1975 (103.3 million at age 1) and 1978 (84.0 million) year classes (Table B3). There is considerable uncertainty about the relative size of these two year classes due to highly variable results from research vessel surveys conducted to date. The size of these year classes will remain uncertain until additional fishery dependent and independent information is collected and analyzed. The age distribution of the stock continues to show evidence of broadening.

SSB has continued to increase steadily since 1994 and was estimated to be 48,500 mt. Although SSB is threefold higher than was estimated in 1993, it remains less than 50% of the B_{MSY} level of 105,000 mt established by harvest control rules. Fully recruited fishing mortality (ages 4-7) in 1999 is estimated to be 0.16, a slight increase from the fishing mortality estimated for 1998 (Table B3; Figure B4).

VPA Diagnostics

The sums of squares and mean squared residuals from the VPA were within the range of accepted VPAs from the last four U.S. assessments of Georges Bank haddock. The coefficients of variation on estimated age 1-8 stock sizes (range 0.25 - 0.61) were slightly nearly identical to those observed in recent U.S. assessments. Other VPA diagnostics including the range of CV's on survey q estimates, the number of large standardized residuals and the maximum partial variance estimates are consistent with previous U.S. haddock assessments. There were no outstanding residual patterns detected during an analysis of standardized residuals. Residual patterns for the 1998 and 1999 year classes exhibit a general trend reflecting consistently higher Canadian survey indices which are contrasted by consistently lower U.S. Autumn survey indices.

Accounting for precision in the current assessment, there is a 80% probability that fully recruited F in 1999 was between 0.14 and 0.18, and that SSB in 1999 was between 43,800 and 54,500 mt. There was a 14.9% change that SSB in 1999 exceeded the limit threshold (53,000 mt) and a zero percent chance that SSB in 1999 had exceeded the target biomass threshold (68,000 mt).

Retrospective patterns for fishing mortality were similar to those observed in the 1999 assessment of this stock, indicating that terminal year estimates of fishing mortality and SSB are relatively well estimated in the terminal year of the assessment. The alternating pattern of slightly overestimated and slightly underestimated terminal year estimates indicates that there is not a retrospective pattern in the terminal year estimates of these parameters.

Terminal year estimates of age 1 recruitment were more variable with a significant tendency to overestimate age 1 recruitment in some years (1995 year class in 1996, 1998 year class in 1999). The retrospective analysis of age 1 stock sizes reinforces the need for additional survey information on incoming recruitment before firm estimates of year class strength can be made.

Harvest Control Rule

The SFA harvest control rule for Georges Bank haddock is based on MSY-based reference point proxies (Figure B5). When SSB is greater than 105,000 mt, the overfishing limit is $F_{0.1}$ (currently estimated to be 0.26), and the target F is 75% of the F_{MSY} proxy (0.20). The limit F decreases linearly from 0.26 at 105,000 mt of SSB to zero at 53,000 mt SSB, and the target F decreases linearly from 0.20 at 105,000 mt of SSB to zero at 68,000 mt of SSB.

4.0 Consistency of 1999 Projection Forecast with 2000 Assessment Results

Projections conducted during the 1999 assessment (NDWG 2000) were based on the 1999 assessment results, assumed that $F_{1999} = F_{1998} = 0.15$, and estimated that SSB would rise to 44,700 mt in 1999. The 2000 assessment estimated $F_{1999} = 0.16$ and SSB at 48,500 mt (Table B3). The fishing mortality assumption made during the 1999 assessment was reasonable (0.15 vs. realized F of 0.16) and the resulting SSB projection for 1999 (48,500 mt) is within the 80% confidence

interval (40,000 - 49,800 mt) of the 1999 assessment projection. The 2000 assessment resulted in improved SSB estimates for 1997-1999, based on relatively stronger contributions from the 1994 and 1996 year classes.

5.0 Sources of Uncertainty

a) Sampling of U.S. landings and discards was insufficient to accurately characterize the size and age distribution of the catch. There is a critical need for increased biological sampling for Georges Bank haddock.

b) There is considerable uncertainty regarding the size of the 1998 and 1999 year classes. Survey indices for these year classes are highly variable and there is conflicting information about the relative size of these year classes from U.S. and Canadian surveys.

6.0 Conclusions

The Georges Bank haddock stock remains in an overexploited condition based on the current low level of biomass in relation to management rebuilding thresholds and pre-collapse stock levels. The assessment indicates that fishing mortality has been reduced from pre-1994 levels, and F_{1999} (0.16 or 13% exploitation) indicates that fishing mortality has remained stable and at relatively low levels since 1994. The age structure of the population is continuing to expand and the age 4+ biomass is at its highest levels since 1982. Recruitment continues to improve and the 1998 and 1999 year classes are currently estimated to be the largest observed since 1978. There is considerable uncertainty about the absolute size of these year classes due to the influence of large tows that have a significant influence on available survey indices. Spawning stock biomass (SSB) in 1998 was estimated to be 48,500 mt, a 3-fold increase over levels estimated in 1993 but less than 50% of the B_{MSY} of 105,000 mt established by U.S. harvest control rules.

Observed increases in SSB of Georges Bank haddock have resulted from conservation of a series of relatively weak year classes. This was a necessary first step in the stock rebuilding process. Spawning stock has been rebuilt and age structure has been restored to the point where recruitment appears to be improving significantly. If incoming recruitment from the 1998 and 1999 year classes is conserved, growth and maturation of these year classes will result in significant increases in SSB. Based on historical stock recruitment relationships for this stock, as SSB increases, the probability of additional strong recruitment events will be significantly enhanced. Maintenance of low fishing mortality rates to promote continuous rebuilding of SSB is essential to achieving biomass rebuilding targets for this stock. Given the potential growth trajectories for this stock, maintenance of current low fishing mortality rates should still allow for significant increases in available landings to both the U.S. and Canadian fisheries over the next several years.

7.0 References

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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 Laboratory Reference Document No. 83-23.

TRAC (Transboundary Resource Assessment Committee) 2000. TRAC Advisory Report on Stock Status. A Report of the Third Meeting of the Transboundary Resources Assessment Committee (TRAC), Woods Hole, Massachusetts, April 26-28, 2000. NMFS, NEFSC Reference Document 00-08.

Table B1. Commercial landings (mt) of haddock from Georges Bank and south (NAFO Division 5Z and Subarea 6), 1960-1999.[1]

Year	U.S.	Canada	USSR	Spain	Other	Total
1960	40800	77	0	0	0	40877
1961	46384	266	0	0	0	46650
1962	49409	3461	1134	0	0	54004
1963	44150	8379	2317	0	0	54846
1964	46512	11625	5483	2	464	64086
1965	52823	14889	81882	10	758	150362
1966	52918	18292	48409	1111	544	121274
1967	34728	13040	2316	1355	30	51469
1968	25469	9323	1397	3014	1720	40923
1969	16456	3990	65	1201	540	22252
1970	8415	1978	103	782	22	11300
1971	7306	1630	374	1310	242	10862
1972	3869	609	137	1098	20	5733
1973	2777	1563	602	386	3	5331
1974	2396	462	109	764	559	4290
1975	3989	1358	8	61	4	5420
1976	2904	1361	4	46	9	4324
1977	7934	2909	0	0	0	10843
1978	12160	10179	0	0	0	22339
1979	14279	5182	0	0	0	19461
1980	17470	10017	0	0	0	27487
1981	19176	5658	0	0	0	24834
1982	12625	4872	0	0	0	17497
1983	8682	3208	0	0	0	11890
1984	8807	1463	0	0	0	10270
1985	4273	3484	0	0	0	7757
1986	3339	3415	0	0	0	6754
1987	2156	4703	0	0	0	6859
1988	2492	4046[2]	0	0	0	6538
1989	1430	3059	0	0	0	4489
1990	2001	3340	0	0	0	5341
1991	1395	5446	0	0	0	6841
1992	2005	4061	0	0	0	6066
1993	687	3727	0	0	0	4414
1994	218[3]	2411	0	0	0	2629
1995	218[3]	2064	0	0	0	2282
1996	313[3]	3643	0	0	0	3956
1997	888[3]	2622	0	0	0	3510
1998	1841[3]	3371	0	0	0	5212
1999	2775[3]	3680	0	0	0	6455

[1]All landings 1960-1979 are from Clark et al. (1982); U.S. landings 1980-1981 are from Overholtz et al. (1983); U.S. landings 1982-1993 are from NMFS, NEFC Detailed Weighout Files and Canvas data; Canadian landings 1980-1998 from Gavaris and Van Eeckhaute (1999); Canadian landings 1999 from S. Gavaris (Personal Communication).

[2]1895 tons were excluded because of suspected misreporting (Gavaris and Van Eeckhaute 1995).
[3]U.S. landings from 1994-1999 are prorated using Vessel Trip Report data and are considered provisional.

Table B2. Mean number and mean weight (kg) per tow of haddock caught in the U.S. spring and autumn bottom trawl surveys from 1963-1999.

	Spring Survey		Autumn Survey	
Year	Number/Tow	Weight (kg)/tow	Number/tow	Weight (kg)/tow
1963			145.01	79.77
1964			193.24	96.75
1965			101.69	72.78
1966			33.26	29.87
1967	*Spring survey initiated in 1968*		17.70	25.47
1968	13.84	20.55	7.51	15.40
1969	7.33	16.93	3.38	8.44
1970	6.00	17.12	7.70	13.50
1971	2.79	5.00	4.20	5.59
1972	6.38	7.37	11.35	8.47
1973	37.62	15.37	14.89	9.78
1974	19.01	17.70	4.05	3.99
1975	6.24	8.21	30.95	15.10
1976	83.19	15.72	71.07	35.76
1977	36.86	26.58	23.25	27.52
1978	19.41	31.27	25.29	18.06
1979	45.50	19.77	52.24	31.98
1980	60.06	53.92	30.54	21.98
1981	31.21	38.02	13.45	14.01
1982	8.60	13.11	4.96	7.34
1983	5.60	13.21	7.99	5.75
1984	6.24	7.45	5.38	4.48
1985	8.85	11.14	14.19	3.86
1986	5.85	5.86	6.81	5.10
1987	4.95	5.60	3.62	2.56
1988	3.38	3.43	5.35	5.57
1989	5.35	4.70	4.34	4.70
1990	7.68	7.57	2.92	2.62
1991	3.97	4.38	2.92	0.94
1992	1.18	1.41	6.06	3.17
1993	2.79	2.48	8.09	4.33
1994	4.99	3.63	3.58	2.93
1995	5.61	5.72	17.11	10.66
1996	23.40	25.73	4.47	4.11
1997	12.95	18.50	6.16	6.51
1998	7.28	6.12	11.07	5.75
1999	16.66	7.74	33.09	23.13

Table B3. Beginning year stock size (000s) of Georges Bank haddock estimated from VPA, 1963 - 1999.

	1963	1964	1965	1966	1967	1968	1969
1	190706	471885	33154	4137	12954	422	988
2	32266	153504	377207	18457	3284	9565	338
3	32743	22756	111260	194986	8920	2536	5122
4	45821	20096	14510	50830	68425	4687	1435
5	29031	27424	12131	7034	24273	37321	2099
6	9186	16351	14561	5959	3254	10519	17419
7	5595	5526	8144	5868	2535	1570	5446
8	2795	3309	2640	3255	2694	1177	682
9	4217	4251	3258	2201	2031	2163	1712
1+	352360	725101	576867	292727	128369	69961	35241

	1970	1971	1972	1973	1974	1975	1976
1	4661	369	8517	19418	10547	7661	103305
2	807	3774	301	6832	13582	8594	6098
3	267	518	1846	245	3716	7211	6100
4	2657	204	222	1104	198	2448	4217
5	770	1660	131	109	555	160	1665
6	1127	462	1097	78	41	391	127
7	8874	729	156	790	37	32	282
8	3035	5177	339	57	577	28	22
9	1875	3245	6311	1679	2702	622	623
1+	24071	16137	18919	30311	31954	27146	122441

	1977	1978	1979	1980	1981	1982	1983
1	13810	6073	83984	10137	7225	2480	3108
2	84449	11306	4971	68760	8292	5915	2029
3	4565	51420	8568	4046	28246	5212	3788
4	4497	3568	29074	5453	2999	13174	2789
5	2657	3066	2645	17317	3582	1703	7408
6	1168	1709	1997	1691	8700	2085	1041
7	104	633	931	1264	847	4796	1192
8	210	82	392	478	541	394	2914
9	594	390	187	251	319	406	275
1+	112054	78246	132750	109396	60751	36164	24545

	1984	1985	1986	1987	1988	1989	1990
1	17265	1761	14746	2103	16757	1087	2644
2	2544	14136	1442	12068	1722	13716	890
3	1468	1999	9396	1131	8075	1363	10087
4	2366	933	1139	5150	810	4454	1038
5	1659	1279	588	731	2757	542	2853
6	4039	999	630	350	488	1415	314
7	606	1966	612	360	220	265	835
8	808	284	1134	365	214	130	175
9	1628	550	254	461	351	208	166
1+	32384	23908	29941	22719	31393	23180	19002

Table B3 (Cont). Beginning year stock size (000s) of Georges Bank haddock estimated from VPA, 1963 - 1999.

	1991	1992	1993	1994	1995	1996	1997
1	2377	9306	15272	12448	10425	9908	19530
2	2163	1940	7613	12497	10190	8527	8107
3	719	1365	1365	5970	9989	8262	6933
4	6951	506	828	801	4155	7638	6249
5	694	3746	295	408	502	2988	5398
6	1551	476	1686	147	274	357	2027
7	168	899	289	784	58	196	230
8	523	72	443	202	505	40	141
9	243	247	210	198	160	58	356
1+	15388	18558	28001	33456	36258	37974	48971

	1998	1999	2000
1	11294	48760	35243
2	15963	9245	39921
3	6477	12890	7534
4	5415	4927	9592
5	4413	3980	3507
6	3906	2987	2808
7	1460	2722	1984
8	171	1061	1926
9	331	303	951
1+	49430	86877	103466

Table B3 (Cont). Spawning stock biomass (mt) of Georges Bank haddock estimated from the VPA, 1963-1999.

	1963	1964	1965	1966	1967	1968	1969
1	00	00	00	00	00	00	00
2	00	00	00	00	00	1675	61
3	24233	15655	65996	91773	4934	1433	3119
4	56101	23010	14892	48128	60273	4294	1636
5	38629	36355	15691	8788	26351	41983	2731
6	16464	25247	20964	8946	5063	15410	26018
7	10877	10439	13799	10289	4575	2780	10823
8	6533	7059	5446	6850	5610	2397	1526
9	11435	10811	8271	5784	5324	5124	5278
1+	164273	128575	145060	180559	112131	75096	51190

	1970	1971	1972	1973	1974	1975	1976
1	00	00	00	00	00	00	00
2	164	756	67	1594	3142	2253	1510
3	185	411	1652	273	4216	7623	6069
4	3442	266	304	1789	359	4459	6767
5	1303	3215	236	189	1248	342	3694
6	2067	873	2671	183	116	1039	316
7	17573	1590	354	2308	126	113	863
8	7609	12676	962	170	1956	105	87
9	6177	10450	20679	5770	10659	2455	2771
1+	38520	30237	26924	12276	21822	18389	22076

	1977	1978	1979	1980	1981	1982	1983
1	00	00	00	00	00	00	00
2	17995	2458	1134	12825	1686	1074	293
3	4151	45760	6800	3345	20420	4055	3145
4	7098	5675	44468	7305	3874	17421	3991
5	5546	6779	5353	30529	6242	3137	12974
6	2927	4333	5274	3784	18209	4569	2279
7	351	1847	2737	3438	2262	12571	3240
8	725	286	1233	1494	1781	1315	8354
9	2664	1797	799	827	1224	1445	1019
1+	41458	68935	67797	63547	55698	45586	35294

	1984	1985	1986	1987	1988	1989	1990
1	376	79	1114	137	1105	97	117
2	436	4746	491	4335	685	5044	339
3	1429	1787	8534	1097	6681	1395	9917
4	3212	1317	1593	7119	1112	6049	1507
5	2933	2274	1163	1340	4738	911	4770
6	8196	2162	1446	808	983	2853	638
7	1405	4897	1526	923	540	672	1994
8	2283	820	3256	1054	597	377	476
9	5141	1817	848	1710	1197	708	603
1+	25411	19900	19971	18523	17638	18106	20361

Table B3 (Cont). Spawning stock biomass (mt) of Georges Bank haddock estimated from the VPA, 1963 - 1999.

	1991	1992	1993	1994	1995	1996	1997
1	92	323	521	252	53	58	96
2	947	822	1704	3010	2160	1888	1759
3	698	1589	1209	5366	11204	8713	8350
4	9669	666	1230	1309	6979	11583	9641
5	1244	6115	480	882	1092	5885	10037
6	3201	985	3336	281	686	812	4543
7	367	2109	683	1940	158	560	601
8	1319	185	1132	570	1392	124	440
9	907	878	706	800	586	198	1196
1+	18445	13674	11001	14409	24311	29823	36663

	1998	1999
1	75	569
2	3457	2240
3	7181	14483
4	8875	7744
5	8013	7212
6	8241	6006
7	3713	6366
8	535	2885
9	1178	1018
1+	41270	48522

Table B3 (Cont). Estimated mean biomass (mt) for the Georges Bank haddock estimated from VPA, 1963 - 1999.

	1963	1964	1965	1966	1967	1968	1969
1	97717	211391	14554	2142	7375	223	465
2	23694	108938	190543	9574	2026	5762	235
3	30570	20524	79454	107563	6249	2031	4131
4	52683	22565	13938	45273	60547	4252	1805
5	37107	33322	14500	8336	23357	41005	2735
6	15484	23667	19034	8292	4737	16183	25212
7	10228	9378	12048	9296	4088	2471	10392
8	6577	6509	4809	6534	5219	2165	1497
9	10122	9407	6938	4896	4586	4345	4563
1+	284182	445700	355818	201907	118183	78438	51035

	1970	1971	1972	1973	1974	1975	1976
1	2983	224	4739	9796	6867	4247	46780
2	828	2777	280	5270	10666	7130	5242
3	286	458	2511	348	5529	9097	7308
4	4091	287	324	1700	414	4489	6720
5	1320	3249	248	167	1324	315	3728
6	2183	791	2731	181	136	980	356
7	17699	1487	300	2318	132	107	901
8	7654	12198	942	169	1948	96	85
9	5489	9174	18665	5098	9910	2252	2513
1+	42532	30643	30740	25047	36925	28713	73634

	1977	1978	1979	1980	1981	1982	1983
1	6634	2917	40343	5051	2554	494	930
2	71235	9281	4493	42806	5771	4630	1768
3	5826	58786	8824	4231	24504	5619	4140
4	8107	6291	45834	7702	4192	18830	3982
5	5864	6958	5353	27164	6363	3188	12276
6	2803	4087	5034	3442	17830	4408	2131
7	384	1695	2568	3068	2195	12237	3210
8	683	242	1162	1257	1652	1198	7491
9	2411	1633	711	717	1071	1275	898
1+	103947	91891	114321	95439	66131	51880	36824

	1984	1985	1986	1987	1988	1989	1990
1	5164	527	6013	820	6378	522	1533
2	2080	11489	1203	8249	1505	10509	778
3	1558	2125	9604	1375	8155	1765	12464
4	3234	1480	1683	7660	1120	6434	1519
5	2864	2256	1174	1353	4145	923	4522
6	7688	2149	1365	736	894	2826	596
7	1259	4627	1415	847	509	702	1871
8	2021	810	3087	1042	561	370	404
9	4444	1600	756	1498	1045	635	533
1+	30312	27062	26301	23578	24312	24687	24221

Table B3 (Cont). Estimated mean biomass (mt) for the Georges Bank haddock estimated from VPA, 1963 - 1999.

	1991	1992	1993	1994	1995	1996	1997
1	1250	4536	9120	5043	4052	4094	7358
2	2082	1922	7901	12238	8889	8457	7247
3	795	1761	1828	8228	13045	10792	10387
4	9420	692	1288	1413	7168	11861	9980
5	1262	5640	451	885	1080	5758	10202
6	3161	944	3095	262	656	734	4402
7	323	1912	644	1841	159	572	618
8	1203	171	994	611	1329	118	404
9	794	747	605	718	542	182	1105
1+	20290	18326	25925	31237	36919	42567	51703

	1998	1999
1	5230	29963
2	15579	9205
3	9061	17041
4	8632	7644
5	7746	7093
6	7905	5734
7	3723	6206
8	542	2648
9	1086	935
1+	59505	86470

Table B3 (Cont). Estimated fishing mortality (F) for the Georges Bank haddock estimated from VPA, 1963 - 1999.

	1963	1964	1965	1966	1967	1968	1969
1	0.02	0.02	0.39	0.03	0.10	0.02	0.00
2	0.15	0.12	0.46	0.53	0.06	0.42	0.04
3	0.29	0.25	0.58	0.85	0.44	0.37	0.46
4	0.31	0.30	0.52	0.54	0.41	0.60	0.42
5	0.37	0.43	0.51	0.57	0.64	0.56	0.42
6	0.31	0.50	0.71	0.65	0.53	0.46	0.47
7	0.33	0.54	0.72	0.58	0.57	0.63	0.38
8	0.34	0.42	0.61	0.56	0.47	0.55	0.45
9	0.34	0.42	0.61	0.56	0.47	0.55	0.45
4-7	0.33	0.44	0.62	0.59	0.53	0.56	0.43

	1970	1971	1972	1973	1974	1975	1976
1	0.01	0.00	0.02	0.16	0.00	0.03	0.00
2	0.24	0.52	0.01	0.41	0.43	0.14	0.09
3	0.07	0.65	0.31	0.01	0.22	0.34	0.10
4	0.27	0.24	0.52	0.49	0.01	0.19	0.26
5	0.31	0.21	0.31	0.77	0.15	0.03	0.15
6	0.24	0.89	0.13	0.55	0.06	0.13	0.00
7	0.34	0.57	0.81	0.11	0.06	0.15	0.09
8	0.32	0.38	0.24	0.35	0.11	0.17	0.22
9	0.32	0.38	0.24	0.35	0.11	0.17	0.22
4-7	0.29	0.48	0.44	0.48	0.07	0.12	0.13

	1977	1978	1979	1980	1981	1982	1983
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.30	0.08	0.01	0.69	0.26	0.25	0.12
3	0.05	0.37	0.25	0.10	0.56	0.43	0.27
4	0.18	0.10	0.32	0.22	0.37	0.38	0.32
5	0.24	0.23	0.25	0.49	0.34	0.29	0.41
6	0.41	0.41	0.26	0.49	0.40	0.36	0.34
7	0.04	0.28	0.47	0.65	0.57	0.30	0.19
8	0.23	0.21	0.32	0.44	0.39	0.35	0.36
9	0.23	0.21	0.32	0.44	0.39	0.35	0.36
4-7	0.22	0.25	0.32	0.46	0.42	0.33	0.31

	1984	1985	1986	1987	1988	1989	1990
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.04	0.21	0.04	0.20	0.03	0.11	0.01
3	0.25	0.36	0.40	0.13	0.39	0.07	0.17
4	0.41	0.26	0.24	0.42	0.20	0.25	0.20
5	0.31	0.51	0.32	0.20	0.47	0.35	0.41
6	0.52	0.29	0.36	0.26	0.41	0.33	0.42
7	0.56	0.35	0.32	0.32	0.32	0.21	0.27
8	0.45	0.36	0.30	0.39	0.40	0.27	0.34
9	0.45	0.36	0.30	0.39	0.40	0.27	0.34
4-7	0.45	0.35	0.31	0.30	0.35	0.28	0.33

Table B3 (Cont). Estimated fishing mortality (F) for the Georges Bank haddock estimated from VPA, 1963 - 1999.

	1991	1992	1993	1994	1995	1996	1997
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.26	0.15	0.04	0.02	0.01	0.01	0.02
3	0.15	0.30	0.33	0.16	0.07	0.08	0.05
4	0.42	0.34	0.51	0.27	0.13	0.15	0.15
5	0.18	0.60	0.49	0.20	0.14	0.19	0.12
6	0.35	0.30	0.57	0.73	0.14	0.24	0.13
7	0.65	0.51	0.16	0.24	0.17	0.13	0.10
8	0.39	0.54	0.50	0.27	0.13	0.16	0.14
9	0.39	0.54	0.50	0.27	0.13	0.16	0.14
4-7	0.40	0.44	0.43	0.36	0.14	0.18	0.12

	1998	1999
1	0.00	0.00
2	0.01	0.00
3	0.07	0.10
4	0.11	0.14
5	0.19	0.15
6	0.16	0.21
7	0.12	0.15
8	0.15	0.16
9	0.15	0.16
4-7	0.14	0.16

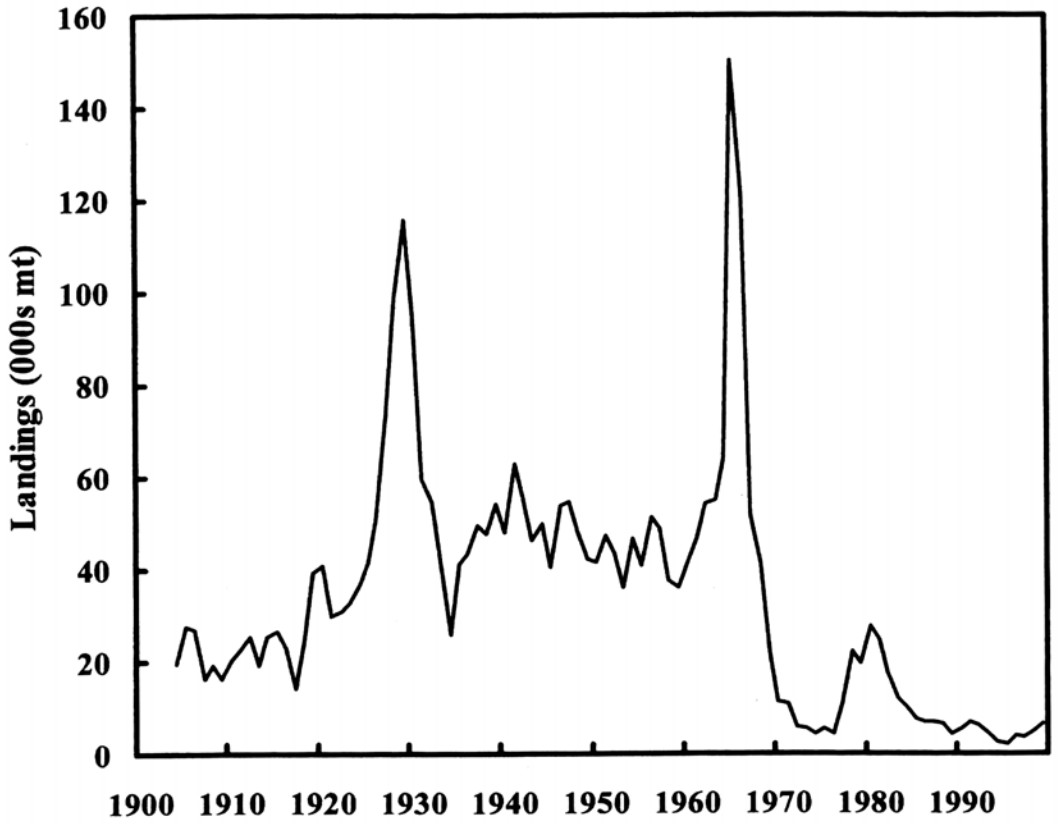

Figure B1. Total commercial landings (000s mt) of haddock from Georges Bank and south, 1904-1999.

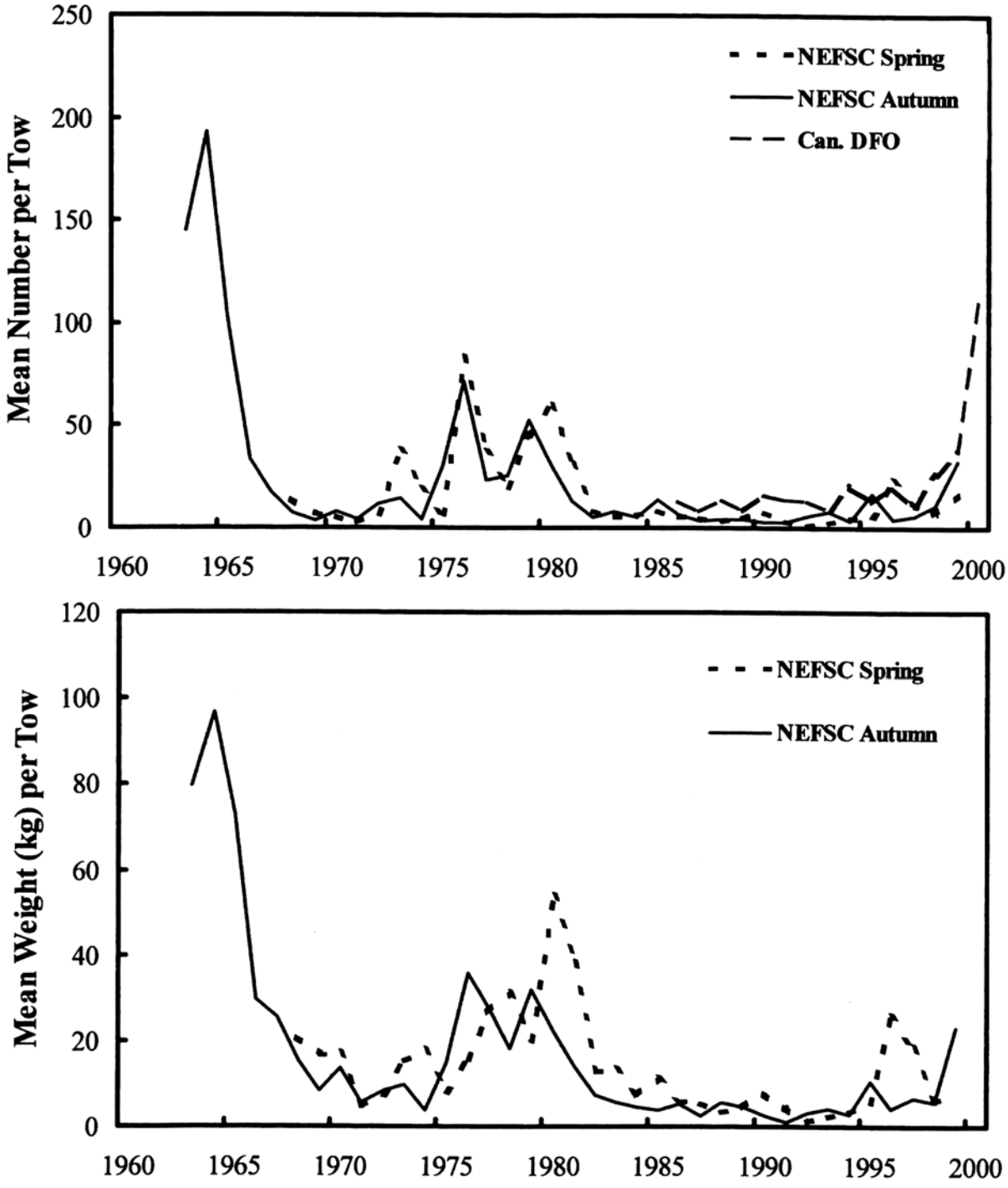

Figure B2. U.S. and Canadian research vessel survey abundance (stratified and standardized mean number/tow, Top Panel) and biomass (kg per tow, Bottom Panel) indices for Georges Bank haddock from 1963-1999. U.S. survey includes strata 01130-01250 and 01290-01300; Canadian survey indices include strata 5Z1-5Z8. Surveys have not been adjusted for catchabilities.

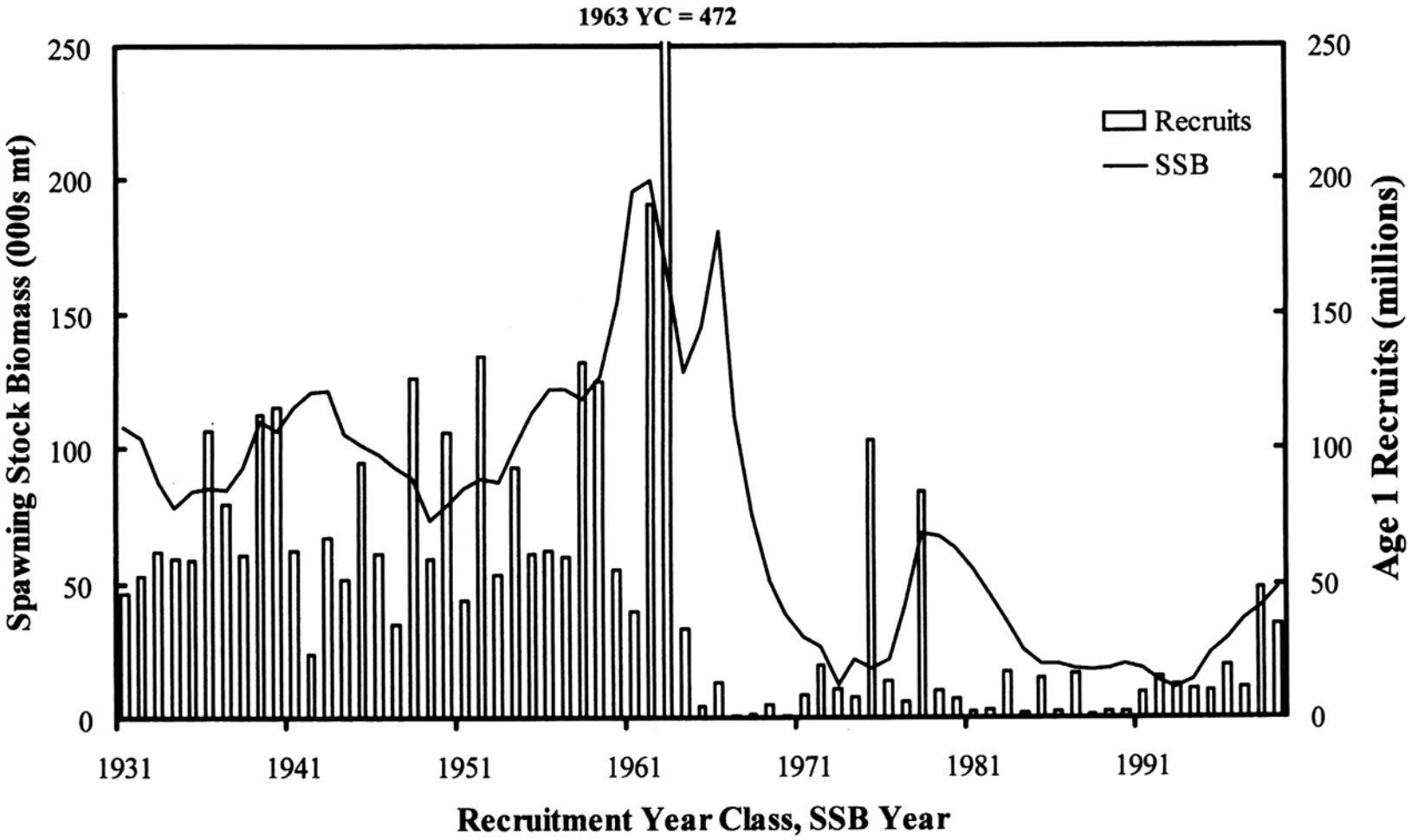

Figure B3. Trends in spawning stock biomass (line) and age 1 recruitment (bars) for Georges Bank haddock from 1931-1999.

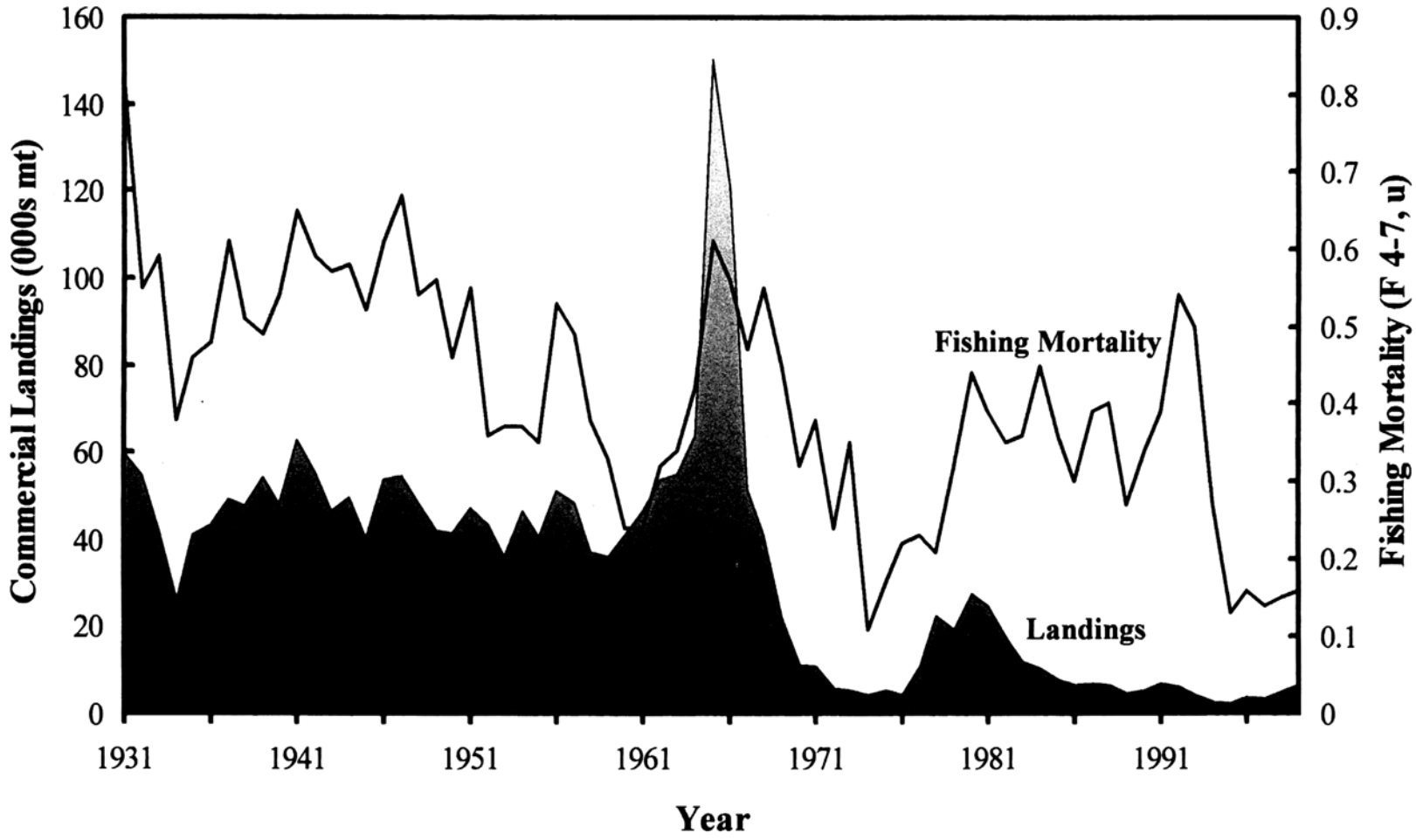

Figure B4. Trends in commercial landings (mt, live weight) and fully recruited fishing mortality (mean F, ages 4-7, unweighted) for Georges Bank haddock from 1931-1999.

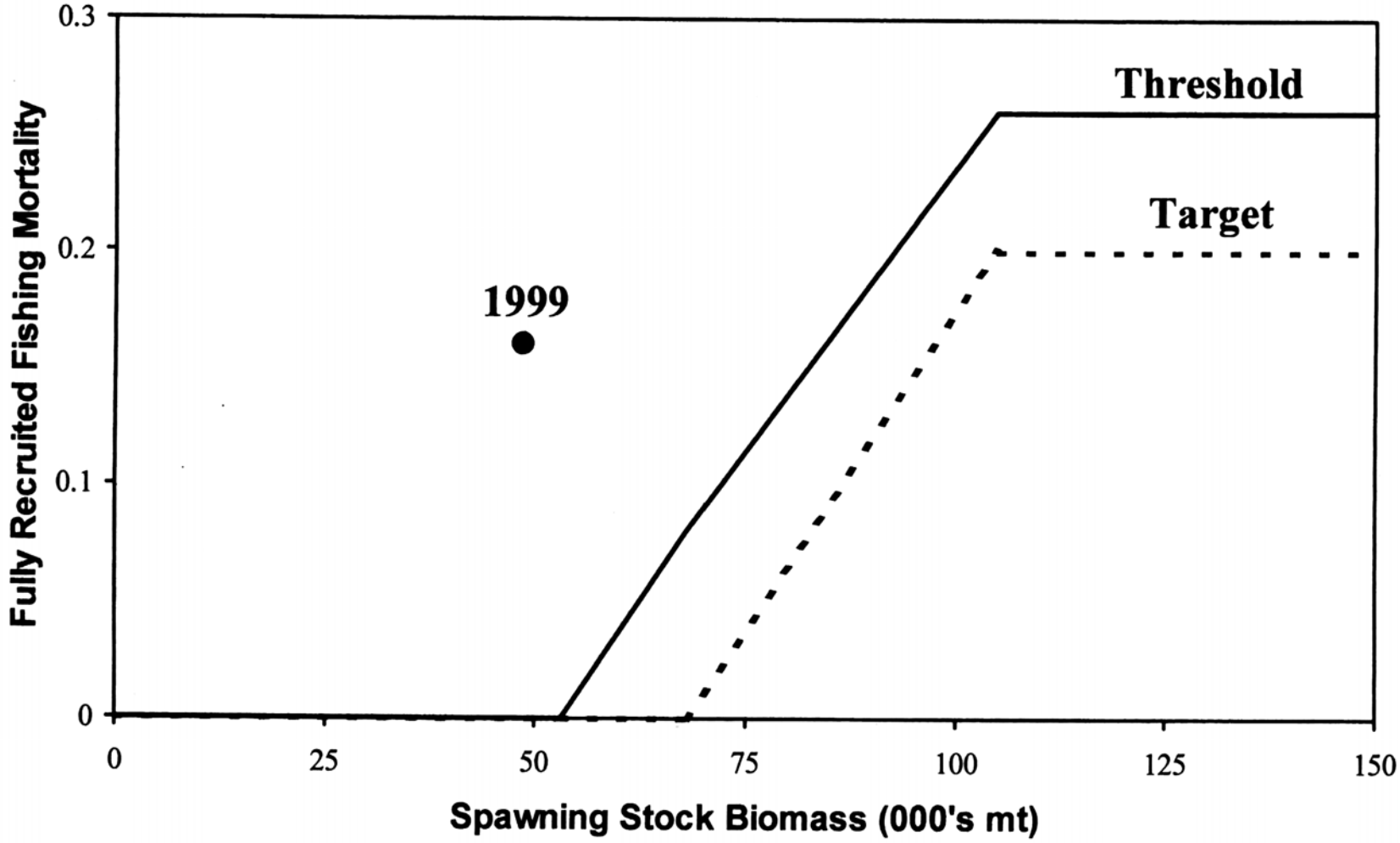

Figure B5. SFA harvest control rule for Georges Bank haddock based on proxies of MSY-based reference points and minimum biomass thresholds.

C. Georges Bank Yellowtail Flounder by S.X. Cadrin

1.0 Background

In 1998, the stock was at 75% of B_{MSY} with low F (fully recruited F was 0.21, Neilson et al. 1999). This report summarizes the 2000 Transboundary Resources Assessment Committee stock assessment (Cadrin et al, 2000; NEFSC 2000), which updated catch and survey indices, and estimated 1999 fishing mortality and 2000 stock size.

2.0 2000 Assessment

2.1 1999 Landings

U.S. landings were prorated as described in Cadrin et al. (1998; Table C1; Figure C1). Landings from Georges Bank yellowtail (including Canadian landings) increased 31% from 1998.

Sampling intensity of landings in 1999 was poor. There were samples of Georges Bank yellowtail flounder for the U.S. fishery in the third quarter of 1999, and no age samples were available from the Canadian fishery. Landings at length were estimated by half year and market category. Canadian landings at age were estimated from Canadian port sample lengths and NEFSC fall survey ages (Table C2a); U.S. landings at age and mean weights at age are reported in Table C2b.

2.2 1999 Discards

Discarded catch was estimated from logbook information on discard to kept ratios by half-year and gear (Cadrin et al. 1998), except for discards from the scallop exemption program, which was estimated from relatively intensive observer sampling. Discard ratios from the trawl fishery were 4% and 6% for the first and second half, respectively. Total discarded catch from the trawl fishery was estimated to be 89 mt. Total discarded yellowtail catch from the scallop dredge fishery was 395 mt, which was predominantly from the exemption program. Discards at age were estimated from sea sampled lengths and pooled commercial-survey age-length keys. Discards at age and recent mean weights at age are reported in Table C3.

2.3 1999-2000 Survey Indices

Survey abundance and biomass indices are reported in Table C4. Estimates are from valid tows on Georges Bank (offshore strata 13-21; scallop strata 54, 55, 58-72, 74), standardized according to net, vessel, and door changes (Cadrin et al. 1998). All survey indices of total abundance and total biomass increased for Georges Bank yellowtail in 1999 and 2000 (Figure C2).

3.0 Assessment Results

3.1 Age-Based Analysis

An updated VPA calibration for Georges Bank yellowtail is summarized in Table C5. Results indicate that F remained low (F_{4-5} = 0.13; F on biomass = 0.09), and biomass continued to rebuild in 1999 (33,500 mt of spawning biomass and 49,600 mt of mean total biomass; Figures C3 and C4). Retrospective analysis indicates a strong tendency for terminal year estimates of F to be less than converged estimates, and terminal year estimates of biomass to be greater than converged estimates (Figure C5). Bootstrap analysis indicates that abundance was estimated with moderate to high precision (CV=14-34%), there is an 80% probability that fully-recruited F in 1999 was 0.11-0.15, SSB in 1999 was 27,700-38,800 mt, and mean biomass in 1999 was 41,000-59,000 mt. However, bootstrap estimates of uncertainty do not account for retrospective error.

The value of F assumed for 1999 by the previous assessment (F_{4-5} = 0.20; Cadrin 2000) was substantially greater than that estimated by this updated analysis (F_{4-5} = 0.13). As a result, the projected SSB in 1999 (28,000 mt) and mean biomass in 1999 (43,400 mt) were substantially less than indicated by this analysis (SSB=33,500 mt and mean biomass=49,600 mt).

3.2 Biomass-Based Analysis

Due to continued poor sampling and resulting problems estimating catch at age, surplus production analysis (ASPIC) was updated to provide alternative perspectives on stock status. Results for the Georges Bank stock are similar to those from VPA; biomass increased to 99% of B_{MSY} in 1999 at low F (Figure C4). Estimates of MSY (16,600 mt) and B_{MSY} (54,000 mt) are greater than previous estimates (Cadrin 2000), but the estimate of F_{MSY} (0.31 on biomass) was similar.

4.0 Harvest Control Rule

The SFA control rule specifies a biomass threshold of 25% B_{MSY}, a maximum F threshold of F_{MSY}, and F on biomass (1+,wb) as the metric for fishing mortality . When biomass is less than B_{MSY}, threshold F is the maximum F that allows rebuilding to B_{MSY} in 5 years at the estimated intrinsic rate of increase. When biomass is below 1/4Bmsy, threshold F = 0. When biomass exceeds B_{MSY}, target F is the tenth percentile of the F_{MSY} estimate. When biomass is less than B_{MSY}, target F is based on rebuilding to B_{MSY} at the tenth percentile of the intrinsic rate of increase estimate (Figure C4). Current biomass is approaching B_{MSY} and current F is well below the control rule target (Figure C4).

5.0 Sources of Uncertainty

- Estimates of catch at age may not be reliable due to poor sampling intensity. Therefore VPA estimates may be misleading. Retrospective patterns may indicate inadequate sampling and mis-allocation of catch at age.
- Retrospective patterns indicate that VPA estimates of biomass and F may be overly optimistic. Updated VPAs may indicate that 1999 biomass levels are lower, and 1999 F was greater than reported here.
- Although a historical perspective from production models is valuable, current biomass levels may not be reliable, because recruitment is implicitly assumed to be a function of stock biomass. Statistical problems were also encountered in finding a stable solution for the production model.
- Estimates of prorated landings and discard ratios are based on preliminary logbook data and are subject to change.

6.0 Acknowledgments

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Table C1. Catch of Georges Bank yellowtail flounder (thousand mt).

Year	US landings	US discards	Canada	Foreign	Total Catch
1963	11.0	5.6	0.0	0.1	16.7
1964	14.9	4.9	0.0	0.0	19.8
1965	14.2	4.4	0.0	0.8	19.4
1966	11.3	2.1	0.0	0.3	13.7
1967	8.4	5.5	0.0	1.4	15.3
1968	12.8	3.6	0.0	1.8	18.2
1969	15.9	2.6	0.0	2.4	20.9
1970	15.5	5.5	0.0	0.3	21.3
1971	11.9	3.1	0.0	0.5	15.5
1972	14.2	1.2	0.0	2.2	17.6
1973	15.9	0.4	0.0	0.3	16.5
1974	14.6	1.0	0.0	1.0	16.6
1975	13.2	2.7	0.0	0.1	16.0
1976	11.3	3.0	0.0	0.0	14.4
1977	9.4	0.6	0.0	0.0	10.0
1978	4.5	1.7	0.0	0.0	6.2
1979	5.5	0.7	0.0	0.0	6.2
1980	6.5	0.4	0.0	0.0	6.9
1981	6.2	0.1	0.0	0.0	6.3
1982	10.6	1.4	0.0	0.0	12.0
1983	11.4	0.1	0.0	0.0	11.4
1984	5.8	0.0	0.0	0.0	5.8
1985	2.5	0.0	0.0	0.0	2.5
1986	3.0	0.0	0.0	0.0	3.1
1987	2.7	0.2	0.0	0.0	3.0
1988	1.9	0.3	0.0	0.0	2.1
1989	1.1	0.1	0.0	0.0	1.2
1990	2.8	0.8	0.0	0.0	3.6
1991	1.8	0.2	0.0	0.0	2.0
1992	2.9	1.9	0.0	0.0	4.7
1993	2.1	1.1	0.7	0.0	3.9
1994	1.6	0.1	2.1	0.0	3.9
1995	0.3	0.0	0.5	0.0	0.8
1996	0.8	0.0	0.5	0.0	1.3
1997	1.0	0.1	0.8	0.0	1.8
1998	1.8	0.1	1.2	0.0	3.1
1999	2.0	0.5	2.0	0.0	4.4
average	7.4	1.5	0.2	0.3	9.4

Table C2a. Canadian landings at age (thousands) of Georges Bank yellowtail Flounder (from Neilson et al. 1999).

	Age								
Year	1	2	3	4	5	6	7	8+	Total
1993	5	85	727	901	27	0	5	0	1750
1994	70	415	2890	1701	654	59	29	0	5818
1995	0	100	576	427	66	10	0	0	1179
1996	1	107	655	229	22	4	0	0	1018
1997	9	242	607	614	164	10	15	7	1668
1998	19	447	1086	642	254	29	6	0	2482
1999	12	1141	1295	776	349	76	19	0	3667
mean	17	190	1091	774	187	17	10	1	2287

Table C2b. U.S. landings at age (above) and mean weight at age (below) of Georges Bank yellowtail flounder.

Landings at age (thousands)	Age								
Year	1	2	3	4	5	6	7	8+	Total
1973	0	3837	13076	9274	3743	1259	278	81	31548
1974	180	6297	7818	7397	3544	852	452	173	26713
1975	427	16851	6943	3391	2084	671	313	164	30844
1976	43	19320	5085	1347	532	434	287	147	27195
1977	31	6616	9805	1721	394	221	129	124	19041
1978	0	2140	3970	1660	459	102	37	35	8403
1979	17	6804	3396	1242	550	141	79	52	12281
1980	0	2371	8696	1419	321	85	4	10	12906
1981	6	479	5267	4555	796	122	4	0	11229
1982	217	13132	7061	3245	1031	62	19	3	24770
1983	239	7667	16016	2316	625	109	10	8	26990
1984	244	1913	4266	4734	1592	257	47	17	13070
1985	371	3335	816	652	410	60	5	0	5649
1986	90	5733	978	347	161	52	16	8	7385
1987	15	1819	2730	761	132	39	32	41	5569
1988	0	1650	1181	624	165	15	20	3	3658
1989	0	1337	664	262	68	11	8	0	2350
1990	0	735	4582	738	105	17	3	0	6180
1991	0	27	867	2256	289	56	4	0	3499
1992	0	3183	1891	1176	502	20	7	0	6779
1993	0	375	1538	1392	287	65	4	1	3662
1994	0	129	2614	853	253	40	8	1	3897
1995	0	12	272	281	70	3	11	3	651
1996	0	161	751	482	144	5	5	1	1550
1997	0	205	616	875	175	16	30	12	1929
1998	0	422	1625	1156	366	53	14	0	3636
1999	0	1217	1645	666	277	54	4	0	3864
mean	70	3991	4228	2030	707	179	68	33	11305

Landed weight at age (kg)	Age							
Year	1	2	age-3	age-4	age-5	6	7	8+
1973	0.198	0.375	0.464	0.527	0.603	0.689	1.067	1.136
1974	0.200	0.378	0.500	0.609	0.680	0.725	0.906	1.249
1975	0.211	0.340	0.492	0.554	0.618	0.687	0.688	0.649
1976	0.185	0.339	0.545	0.636	0.741	0.814	0.852	0.866
1977	0.197	0.364	0.527	0.634	0.782	0.865	1.036	1.013
1978	0.182	0.337	0.513	0.684	0.793	0.899	0.930	0.948
1979	0.139	0.356	0.462	0.649	0.728	0.835	1.003	0.882
1980	0.138	0.354	0.495	0.656	0.813	1.054	1.256	1.214
1981	0.091	0.389	0.493	0.603	0.707	0.798	0.832	1.044
1982	0.213	0.313	0.487	0.650	0.748	1.052	1.024	1.311
1983	0.215	0.296	0.440	0.604	0.736	0.952	1.018	0.987
1984	0.208	0.240	0.378	0.500	0.642	0.738	0.944	1.047
1985	0.236	0.363	0.497	0.647	0.733	0.819	0.732	1.044
1986	0.234	0.343	0.540	0.664	0.823	0.864	0.956	1.140
1987	0.212	0.338	0.523	0.666	0.680	0.938	0.793	0.788
1988		0.351	0.557	0.688	0.855	1.054	0.873	1.385
1989		0.355	0.543	0.725	0.883	1.026	1.254	1.044
1990		0.337	0.419	0.588	0.699	0.807	1.230	1.044
1991		0.270	0.383	0.484	0.728	0.820	1.306	1.044
1992		0.341	0.381	0.528	0.648	1.203	1.125	1.044
1993		0.316	0.390	0.510	0.562	0.858	1.263	1.044
1994		0.300	0.355	0.473	0.629	0.787	0.896	1.166
1995		0.309	0.379	0.465	0.583	0.778	0.785	0.531
1996		0.321	0.417	0.569	0.726	0.926	1.031	1.209
1997		0.353	0.416	0.525	0.668	0.867	0.920	1.217
1998		0.360	0.468	0.540	0.664	0.819	0.879	1.042
1999	0.271	0.401	0.503	0.636	0.717	0.836	0.850	1.104
mean	0.196	0.338	0.465	0.593	0.711	0.871	0.980	1.044

Table C3. U.S. discards at age (above) and recent mean weights at age (below) of Georges Bank yellowtail flounder.

Discards at age (thousands)	Age								
Year	1	2	3	4	5	6	7	8+	Total
1973	347	1053	167	2	0	0	0	0	1569
1974	1963	2674	86	1	0	0	0	0	4724
1975	3945	8433	114	1	0	0	0	0	12493
1976	572	11692	61	0	0	0	0	0	12325
1977	299	1964	112	0	0	0	0	0	2375
1978	9659	965	64	0	0	0	0	0	10688
1979	216	2701	49	0	0	0	0	0	2966
1980	309	1201	125	0	0	0	0	0	1635
1981	49	250	84	1	0	0	0	0	384
1982	1846	4359	61	1	0	0	0	0	6267
1983	457	22	0	0	0	0	0	0	479
1984	184	4	0	0	0	0	0	0	188
1985	279	10	0	0	0	0	0	0	289
1986	68	38	0	0	0	0	0	0	106
1987	125	834	21	0	0	0	0	0	980
1988	483	717	10	0	0	0	0	0	1210
1989	185	179	4	0	0	0	0	0	368
1990	219	1196	1541	62	2	0	0	0	3020
1991	412	27	355	174	4	0	0	0	972
1992	2389	5176	636	93	8	0	0	0	8302
1993	5189	549	512	99	4	0	0	0	6353
1994	1	317	238	17	3	0	0	0	577
1995	14	45	47	7	0	0	0	0	114
1996	49	115	103	6	0	0	0	0	273
1997	7	148	35	13	1	0	0	0	205
1998	7	102	81	26	4	0	0	0	220
1999	9	930	270	56	25	6	2	0	1298
mean	1085	1693	177	21	2	0	0	0	3154

Discarded weight at age (kg)	Age							
Year	1	2	3	4	5	6	7	8+
1994	0.130	0.238	0.287	0.417	0.512	0.622	----	----
1995	0.155	0.233	0.283	0.357	0.496	0.593	----	0.531
1996	0.137	0.266	0.312	0.418	----	----	----	----
1997	0.162	0.250	0.315	0.442	0.544	0.671	0.792	0.895
1998	0.190	0.280	0.380	0.450	0.590	0.700	0.760	----
1999	0.227	0.332	0.414	0.606	0.759	0.889	0.910	1.104
mean	0.167	0.267	0.332	0.448	0.580	0.695	0.821	0.843

Table C4a. Survey indices of Georges Bank yellowtail abundance and biomass.

NEFSC Spring Survey	Age									
Year	1	2	3	4	5	6	7	8+	Total	kg/tow
1968	0.149	3.364	3.579	0.316	0.084	0.160	0.127	0.000	7.779	2.813
1969	1.015	9.406	11.119	3.096	1.423	0.454	0.188	0.057	26.758	11.170
1970	0.093	4.485	6.030	2.422	0.570	0.121	0.190	0.000	13.911	5.312
1971	0.791	3.335	4.620	3.754	0.759	0.227	0.050	0.029	13.564	4.607
1972	0.138	7.136	7.198	3.514	1.094	0.046	0.122	0.000	19.247	6.450
1973	1.931	3.266	2.368	1.063	0.410	0.173	0.023	0.020	9.254	2.938
1974	0.316	2.224	1.842	1.256	0.346	0.187	0.085	0.009	6.265	2.719
1975	0.420	2.939	0.860	0.298	0.208	0.068	0.000	0.013	4.806	1.676
1976	1.034	4.368	1.247	0.311	0.196	0.026	0.048	0.037	7.268	2.273
1977	0.000	0.671	1.125	0.384	0.074	0.013	0.000	0.000	2.267	0.999
1978	0.936	0.798	0.507	0.219	0.026	0.000	0.008	0.000	2.494	0.742
1979	0.279	1.933	0.385	0.328	0.059	0.046	0.041	0.000	3.072	1.227
1980	0.057	4.644	5.761	0.473	0.057	0.037	0.000	0.000	11.030	4.456
1981	0.012	1.027	1.779	0.721	0.205	0.061	0.000	0.026	3.830	1.960
1982	0.045	3.742	1.122	1.016	0.455	0.065	0.000	0.026	6.472	2.500
1983	0.000	1.865	2.728	0.531	0.123	0.092	0.061	0.092	5.492	2.642
1984	0.000	0.093	0.809	0.885	0.834	0.244	0.000	0.000	2.865	1.646
1985	0.110	2.198	0.262	0.282	0.148	0.000	0.000	0.000	3.000	0.988
1986	0.027	1.806	0.291	0.056	0.137	0.055	0.000	0.000	2.372	0.847
1987	0.000	0.128	0.112	0.133	0.053	0.055	0.000	0.000	0.480	0.329
1988	0.078	0.275	0.366	0.242	0.199	0.027	0.000	0.000	1.187	0.566
1989	0.047	0.424	0.740	0.290	0.061	0.022	0.022	0.000	1.605	0.729
1990	0.000	0.065	1.108	0.393	0.139	0.012	0.045	0.000	1.762	0.699
1991	0.435	0.000	0.254	0.675	0.274	0.020	0.000	0.000	1.659	0.631
1992	0.000	2.010	1.945	0.598	0.189	0.000	0.000	0.000	4.742	1.566
1993	0.046	0.290	0.500	0.317	0.027	0.000	0.000	0.000	1.180	0.482
1994	0.000	0.621	0.638	0.357	0.145	0.043	0.000	0.000	1.804	0.660
1995	0.040	1.180	4.810	1.490	0.640	0.010	0.000	0.000	8.170	2.579
1996	0.030	0.990	2.630	2.700	0.610	0.060	0.000	0.000	7.020	2.853
1997	0.019	1.169	3.733	4.081	0.703	0.134	0.000	0.000	9.837	4.359
1998	0.000	2.081	1.053	1.157	0.759	0.323	0.027	0.000	5.400	2.324
1999	0.050	4.746	10.820	2.720	1.623	0.426	0.329	0.024	20.738	9.307
mean	0.253	2.323	2.647	1.146	0.406	0.103	0.045	0.011	6.934	2.739

Table C4b. Survey indices of Georges Bank yellowtail abundance and biomass.

NEFSC Fall Survey	Age										
Year	0	1	2	3	4	5	6	7	8+	Total	kg/tow
1963	0.000	14.722	7.896	11.226	1.858	0.495	0.281	0.034	0.233	36.746	12.791
1964	0.000	1.721	9.723	7.370	5.998	2.690	0.383	0.095	0.028	28.007	13.625
1965	0.014	1.138	5.579	5.466	3.860	1.803	0.162	0.284	0.038	18.345	9.104
1966	1.177	8.772	4.776	2.070	0.837	0.092	0.051	0.000	0.000	17.775	3.989
1967	0.106	9.137	9.313	2.699	1.007	0.309	0.076	0.061	0.000	22.708	7.577
1968	0.000	11.782	11.946	5.758	0.766	0.944	0.059	0.000	0.000	31.254	10.535
1969	0.135	8.106	10.381	5.855	1.662	0.553	0.149	0.182	0.000	27.023	9.278
1970	1.048	4.610	5.133	3.144	1.952	0.451	0.063	0.017	0.000	16.417	4.978
1971	0.025	3.627	6.949	4.904	2.248	0.551	0.234	0.024	0.024	18.586	6.362
1972	0.785	2.424	6.525	4.824	2.095	0.672	0.279	0.000	0.000	17.604	6.328
1973	0.094	2.494	5.497	5.104	2.944	1.216	0.416	0.171	0.031	17.967	6.600
1974	1.030	4.623	2.854	1.524	1.060	0.460	0.249	0.131	0.000	11.931	3.734
1975	0.361	4.625	2.511	0.877	0.572	0.334	0.033	0.000	0.031	9.344	2.365
1976	0.000	0.336	1.929	0.475	0.117	0.122	0.033	0.000	0.067	3.079	1.533
1977	0.000	0.928	2.161	1.649	0.618	0.113	0.056	0.036	0.016	5.577	2.828
1978	0.037	4.729	1.272	0.773	0.406	0.139	0.011	0.000	0.024	7.391	2.383
1979	0.018	1.312	1.999	0.316	0.122	0.138	0.038	0.064	0.007	4.014	1.520
1980	0.078	0.761	5.086	6.050	0.678	0.217	0.162	0.006	0.033	13.071	6.722
1981	0.000	1.584	2.333	1.630	0.500	0.121	0.083	0.013	0.000	6.264	2.621
1982	0.000	2.424	2.185	1.590	0.423	0.089	0.000	0.000	0.000	6.711	2.271
1983	0.000	0.109	2.284	1.914	0.473	0.068	0.012	0.000	0.038	4.898	2.131
1984	0.012	0.661	0.400	0.306	2.428	0.090	0.029	0.000	0.018	3.944	0.593
1985	0.010	1.350	0.560	0.160	0.040	0.080	0.000	0.000	0.000	2.200	0.709
1986	0.000	0.280	1.110	0.350	0.070	0.000	0.000	0.000	0.000	1.810	0.820
1987	0.000	0.113	0.390	0.396	0.053	0.079	0.000	0.000	0.000	1.031	0.509
1988	0.011	0.019	0.213	0.102	0.031	0.000	0.000	0.000	0.000	0.376	0.171
1989	0.027	0.248	1.992	0.774	0.069	0.066	0.000	0.000	0.000	3.176	0.977
1990	0.147	0.000	0.326	1.517	0.280	0.014	0.000	0.000	0.000	2.284	0.725
1991	0.000	2.100	0.275	0.439	0.358	0.000	0.000	0.000	0.000	3.172	0.730
1992	0.000	0.151	0.396	0.712	0.162	0.144	0.027	0.000	0.000	1.592	0.576
1993	0.000	0.842	0.136	0.587	0.536	0.000	0.000	0.000	0.000	2.101	0.545
1994	0.010	1.200	0.220	0.980	0.710	0.260	0.030	0.030	0.000	3.440	0.897
1995	0.070	0.280	0.120	0.350	0.280	0.050	0.010	0.000	0.000	1.160	0.354
1996	0.000	0.140	0.350	1.870	0.450	0.070	0.000	0.000	0.000	2.880	1.303
1997	0.000	1.392	0.533	3.442	2.090	1.071	0.082	0.000	0.000	8.611	3.781
1998	0.050	1.900	4.817	4.202	1.190	0.298	0.055	0.019	0.000	12.531	4.347
1999	0.025	3.090	8.423	5.727	1.432	1.436	0.260	0.000	0.000	20.394	7.973
mean	0.142	2.803	3.475	2.625	1.091	0.412	0.090	0.032	0.016	10.687	3.900

Table C4c. Survey indices of Georges Bank yellowtail abundance and biomass.

Canadian Survey

	Age							
Year	1	2	3	4	5	6+	Total	kg/tow
1987	0.12	0.68	2.00	1.09	0.06	0.00	3.95	1.26
1988	0.00	0.66	1.89	0.80	0.59	0.01	3.96	1.24
1989	0.11	0.78	0.80	0.32	0.10	0.02	2.13	0.47
1990	0.00	1.27	4.62	1.12	0.43	0.01	7.45	1.58
1991	0.02	0.59	1.72	2.91	0.99	0.00	6.24	1.76
1992	0.22	10.04	4.52	1.21	0.16	0.00	16.14	2.48
1993	0.33	2.16	5.04	3.47	0.62	0.00	11.63	2.64
1994	0.00	6.03	3.33	3.08	0.75	0.33	13.51	2.75
1995	0.21	1.31	4.07	2.22	1.14	0.11	9.07	2.03
1996	0.45	5.54	8.44	7.49	1.37	0.16	23.45	5.30
1997	0.10	9.48	15.16	19.09	3.11	0.54	47.49	13.29
1998	0.92	3.10	3.81	5.15	2.44	0.59	16.01	4.29
1999	0.22	13.05	24.78	9.07	6.85	3.10	57.07	17.67
2000	0.06	8.43	43.32	7.20	6.73	3.48	69.22	19.95
mean	0.20	4.41	8.12	4.97	2.25	0.58	20.52	4.29

Scallop Survey

Year	age-1
1982	0.313
1983	0.140
1984	0.233
1985	0.549
1986	0.103
1987	0.047
1988	0.116
1989	0.195
1990	0.100
1991	2.117
1992	0.167
1993	1.129
1994	1.503
1995	0.609
1996	0.508
1997	1.062
1998	1.872
1999	1.038
mean	0.656

Table C5a. Estimates of Georges Bank yellowtail flounder abundance at age (thousands).

	1973	1974	1975	1976	1977	1978	1979
1	28290	50265	68516	22919	15760	50823	23375
2	23279	22848	39214	52140	18208	12605	32871
3	28937	14635	10589	9228	14628	7144	7510
4	16960	11709	4830	2284	2899	3003	2199
5	6729	5492	2893	885	651	816	957
6	2859	2240	1551	1417	768	304	465
1+	107055	107189	127593	88873	52914	74695	67376

	1980	1981	1982	1983	1984	1985	1986
1	22099	61066	21627	5818	8620	14594	6660
2	18927	17814	49947	15840	4134	6670	11361
3	18312	12264	13925	25067	6011	1650	2434
4	3032	7011	5199	4957	6031	1062	613
5	677	1198	1618	1319	1962	654	279
6	206	185	129	264	382	102	129
1+	63252	99538	92445	53266	27141	24732	21476

	1987	1988	1989	1990	1991	1992	1993
1	7023	19351	8532	11709	22098	16087	12549
2	5310	5623	15406	6818	9388	17720	11009
3	4079	1947	2462	11242	3835	7638	6944
4	1108	851	516	1411	3664	2034	3967
5	188	219	132	185	432	801	517
6	155	49	36	34	86	42	120
1+	17863	28039	27085	31400	39503	44321	35106

	1994	1995	1996	1997	1998	1999	2000
1	12696	19199	29801	37016	89609	43121	00
2	5574	10330	15706	24354	30291	73342	35285
3	8101	3785	8316	12512	19401	23922	57073
4	3173	1437	2289	5443	9106	13358	16682
5	1083	271	529	1226	3097	5805	9581
6	155	53	47	321	508	1439	5196
1+	30782	35074	56688	80872	152012	160986	123817

Table C5b. Estimates of Georges Bank yellowtail flounder fishing mortality at age, fully recruited F (F4,5) and biomass weighted F (Fwb).

	1973	1974	1975	1976	1977	1978	1979
1	0.01	0.05	0.07	0.03	0.02	0.24	0.01
2	0.26	0.57	1.25	1.07	0.74	0.32	0.39
3	0.70	0.91	1.33	0.96	1.38	0.98	0.71
4	0.93	1.20	1.50	1.05	1.07	0.94	0.98
5	0.95	1.25	1.59	1.09	1.10	0.97	1.01
6	0.95	1.25	1.59	1.09	1.10	0.97	1.01
F4,5	0.94	1.22	1.54	1.07	1.09	0.96	0.99
Fwb	0.61	0.74	0.91	0.92	0.93	0.52	0.44

	1980	1981	1982	1983	1984	1985	1986
1	0.02	0.00	0.11	0.14	0.06	0.05	0.03
2	0.23	0.05	0.49	0.77	0.72	0.81	0.82
3	0.76	0.66	0.83	1.22	1.53	0.79	0.59
4	0.73	1.27	1.17	0.73	2.02	1.14	0.98
5	0.74	1.33	1.22	0.74	2.27	1.18	1.01
6	0.74	1.33	1.22	0.74	2.27	1.18	1.01
F4,5	0.74	1.30	1.19	0.73	2.14	1.16	1.00
Fwb	0.48	0.36	0.62	0.96	1.38	0.62	0.68

	1987	1988	1989	1990	1991	1992	1993
1	0.02	0.03	0.02	0.02	0.02	0.18	0.61
2	0.80	0.63	0.12	0.38	0.01	0.74	0.11
3	1.37	1.13	0.36	0.92	0.43	0.46	0.58
4	1.42	1.66	0.82	0.98	1.32	1.17	1.10
5	1.50	1.79	0.84	1.01	1.39	1.22	1.14
6	1.50	1.79	0.84	1.01	1.39	1.22	1.14
F4,5	1.46	1.73	0.83	1.00	1.35	1.19	1.12
Fwb	0.94	0.54	0.18	0.62	0.31	0.61	0.50

	1994	1995	1996	1997	1998	1999
1	0.01	0.00	0.00	0.00	0.00	0.00
2	0.19	0.02	0.03	0.03	0.04	0.05
3	1.53	0.30	0.22	0.12	0.17	0.16
4	2.26	0.80	0.42	0.36	0.25	0.13
5	2.64	0.82	0.43	0.37	0.25	0.13
6	2.64	0.82	0.43	0.37	0.25	0.13
F4,5	2.45	0.81	0.43	0.37	0.25	0.13
Fwb	0.94	0.14	0.11	0.11	0.10	0.09

Table C5c. Estimates of Georges Bank yellowtail flounder mean biomass (mt).

	1973	1974	1975	1976	1977	1978	1979
1	2547	4451	5996	2047	1412	4120	2107
2	6462	5404	6404	8972	3985	3040	8088
3	8797	4405	2648	2963	3847	2140	2271
4	5360	3840	1288	828	1042	1224	838
5	2408	1973	832	368	284	381	404
6	1169	858	496	648	371	161	225
1+	26743	20930	17663	15826	10943	11066	13934

	1980	1981	1982	1983	1984	1985	1986
1	1988	5532	1858	493	760	1291	596
2	4883	5368	10718	3003	649	1526	2431
3	5791	4034	4211	5879	1079	520	910
4	1296	2218	1839	1952	1210	379	239
5	356	435	646	629	467	260	133
6	140	76	73	163	104	45	65
1+	14454	17662	19346	12119	4271	4021	4374

	1987	1988	1989	1990	1991	1992	1993
1	630	1730	764	1051	1983	1339	860
2	1036	1221	4520	1457	2189	3255	2607
3	1073	598	1024	2629	1020	2017	1767
4	365	265	234	475	902	575	1117
5	61	81	72	75	157	277	160
6	70	22	23	16	36	27	57
1+	3235	3918	6637	5702	6285	7489	6568

	1994	1995	1996	1997	1998	1999
1	1147	1739	2699	3354	8120	3907
2	1211	2415	4341	6731	7825	24066
3	1352	1092	2772	4909	6444	9842
4	556	421	891	2463	3754	7205
5	226	99	262	666	1627	3561
6	41	26	30	214	407	1030
1+	4532	5791	10995	18338	28178	49611

Table C5d. Estimates of Georges Bank yellowtail flounder spawning stock biomass (mt).

	1973	1974	1975	1976	1977	1978	1979
1	00	00	00	00	00	00	00
2	2796	2530	2984	4200	1870	1413	3767
3	8895	4500	2678	3026	3883	2185	2320
4	5531	3982	1319	861	1084	1275	873
5	2509	2042	848	383	296	397	421
6	1218	888	505	673	386	168	234
1+	20949	13942	8334	9143	7519	5438	7616

	1980	1981	1982	1983	1984	1985	1986
1	00	00	00	00	00	00	00
2	2260	2678	5454	1534	629	1480	2358
3	5918	4161	4347	6031	1103	543	947
4	1351	2295	1908	2035	1195	394	248
5	371	449	670	656	450	270	139
6	146	78	75	170	101	47	67
1+	10047	9660	12455	10426	3479	2733	3760

	1987	1988	1989	1990	1991	1992	1993
1	00	00	00	00	00	00	00
2	1004	1183	4297	1402	2067	1765	1385
3	1106	621	1058	2741	1057	2093	1581
4	375	269	244	495	931	597	1162
5	63	82	75	78	162	287	166
6	72	22	24	17	37	28	59
1+	2620	2177	5699	4732	4253	4768	4353

	1994	1995	1996	1997	1998	1999
1	00	00	00	00	00	00
2	646	1276	2296	3559	4140	12745
3	1189	969	2451	4317	5684	8675
4	536	439	923	2547	3865	7374
5	208	103	272	689	1675	3644
6	37	27	31	222	419	1054
1+	2618	2814	5973	11335	15783	33491

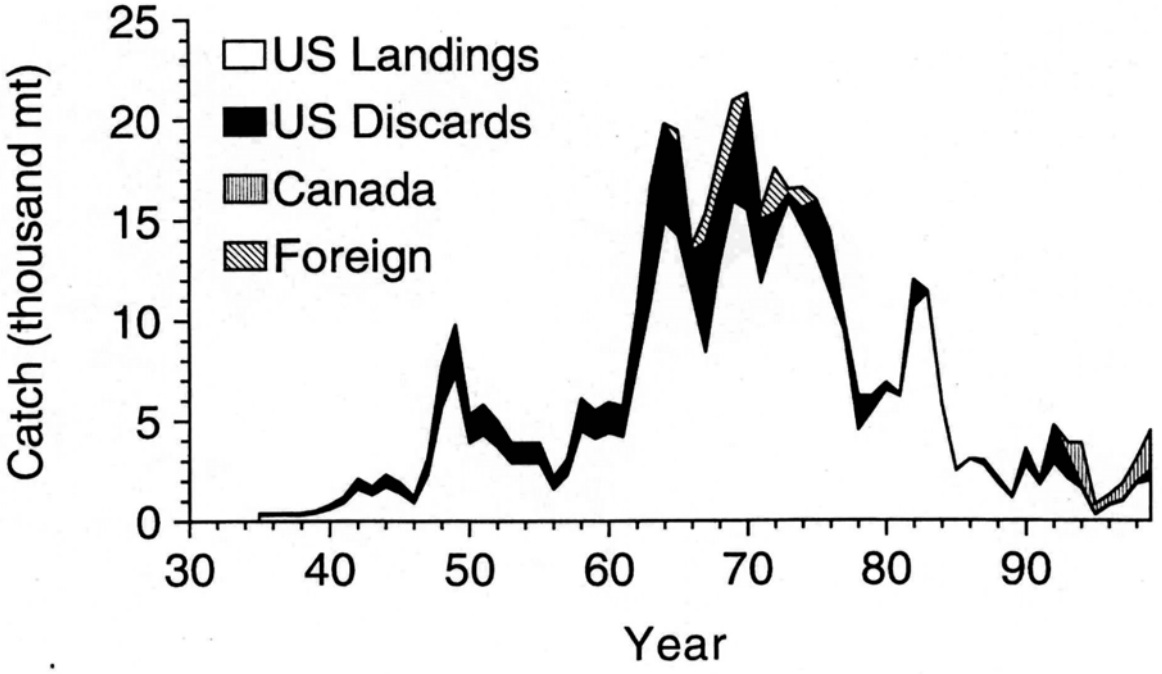

Figure C1. Total catch of Georges Bank yellowtail flounder.

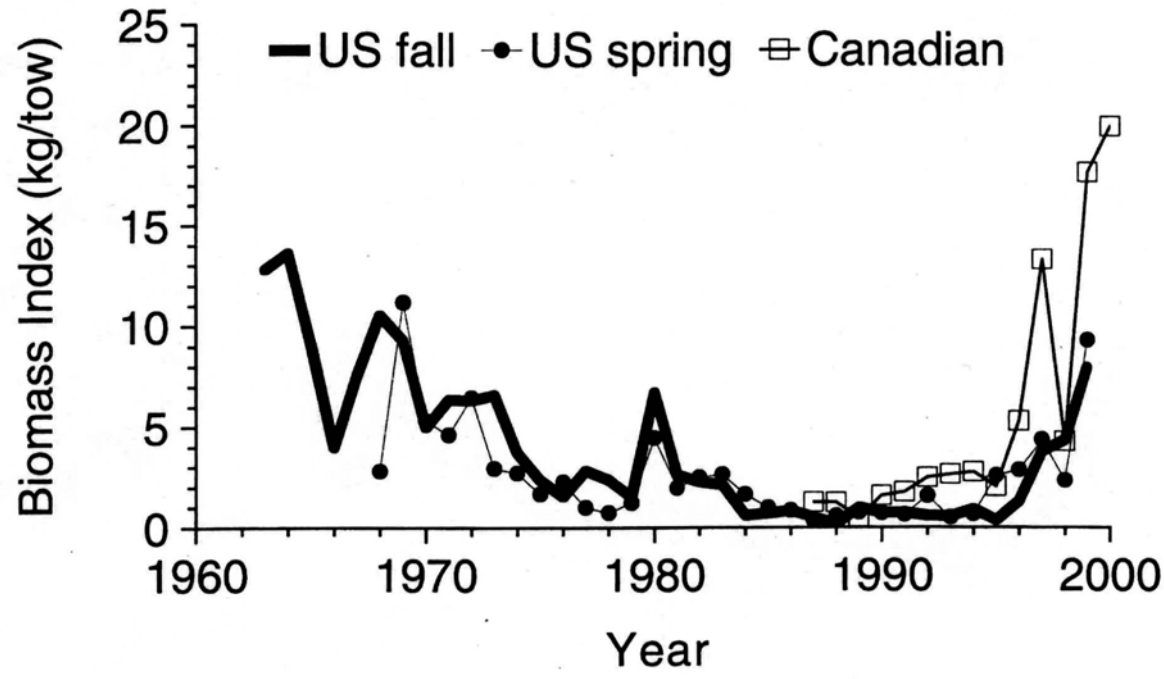

Figure C2. Survey indices of Georges Bank yellowtail flounder biomass.

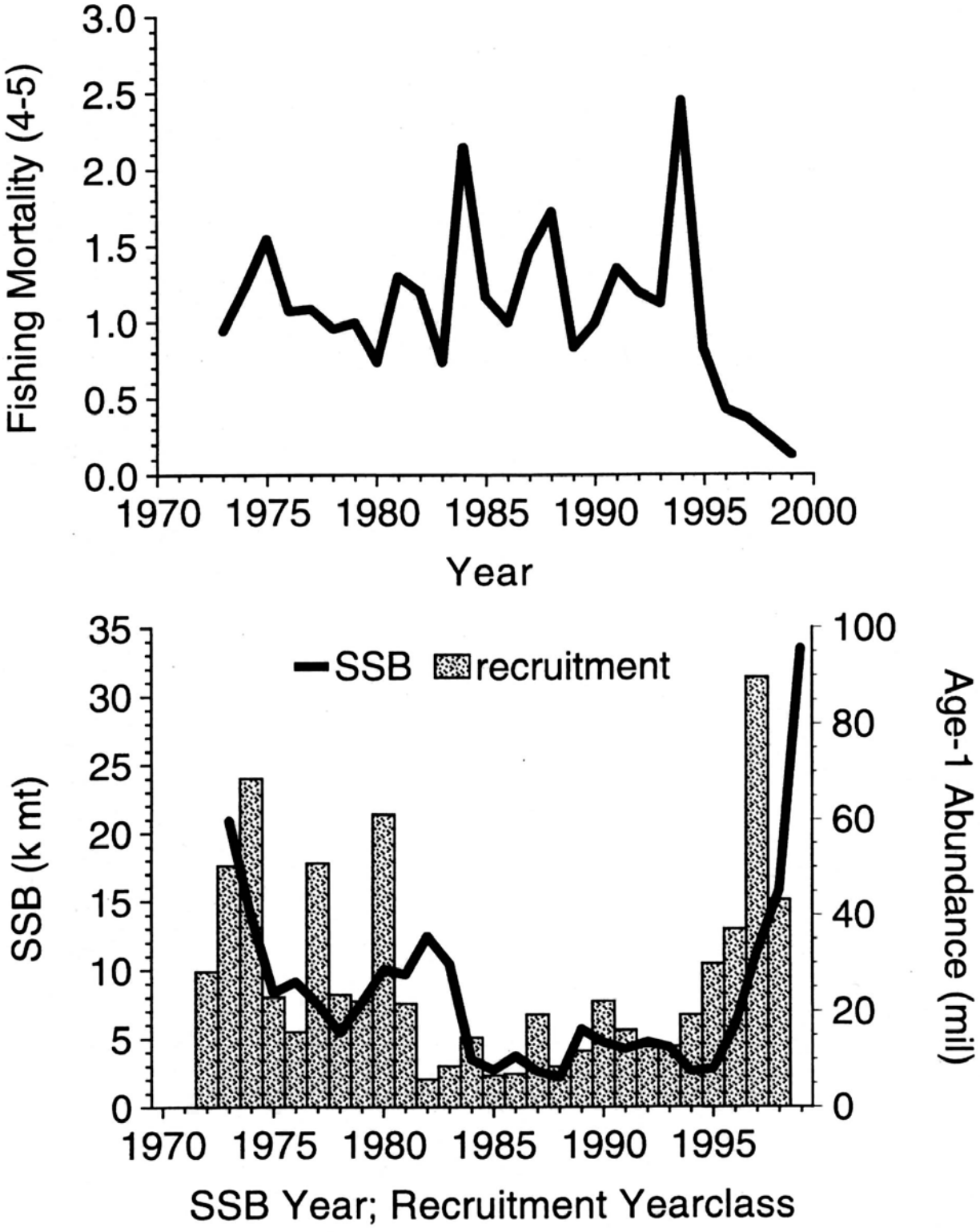

Figure C3. Summary of Georges Bank yellowtail VPA results.

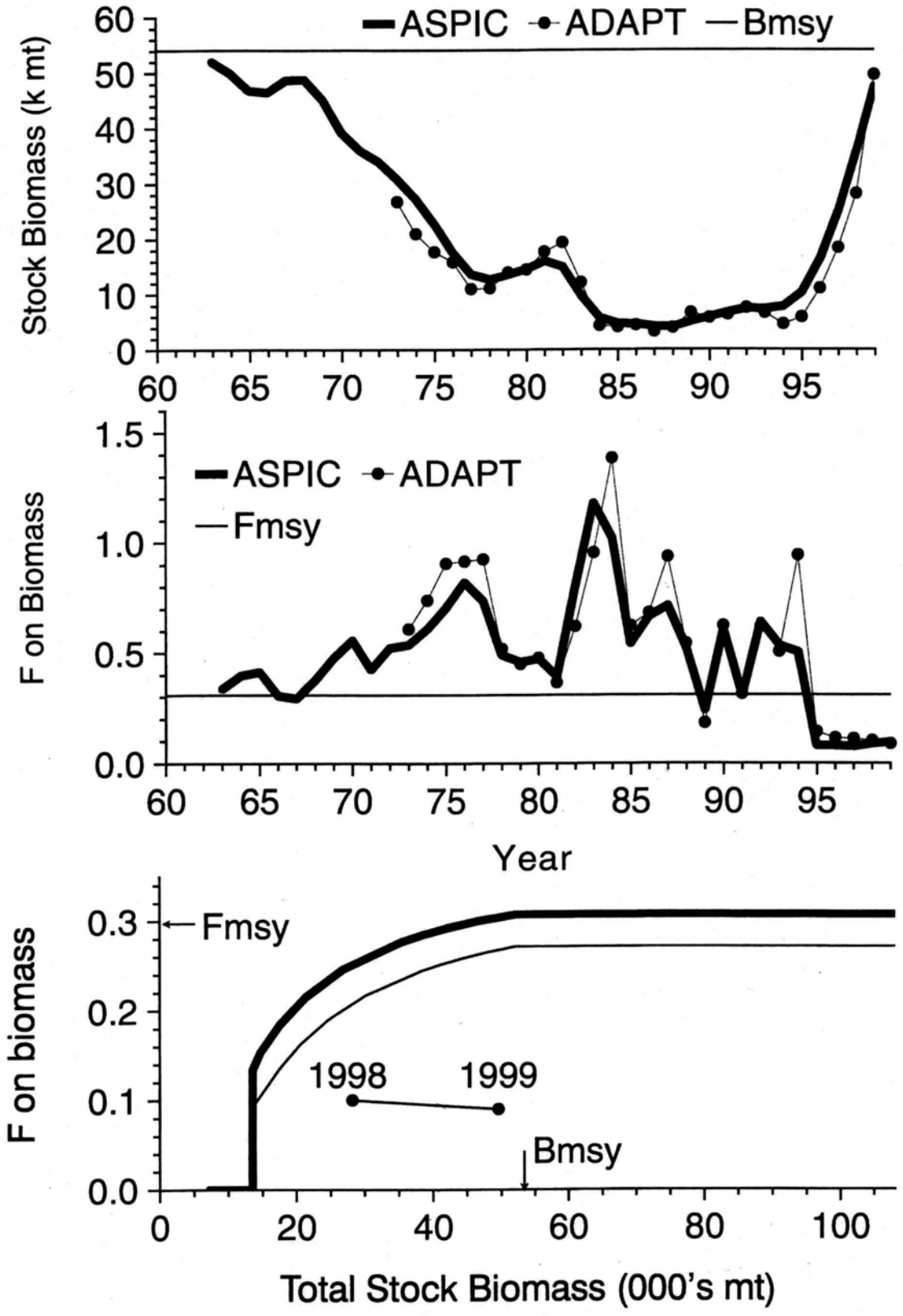

Figure C4. Status of the Georges Bank yellowtail flounder stock.

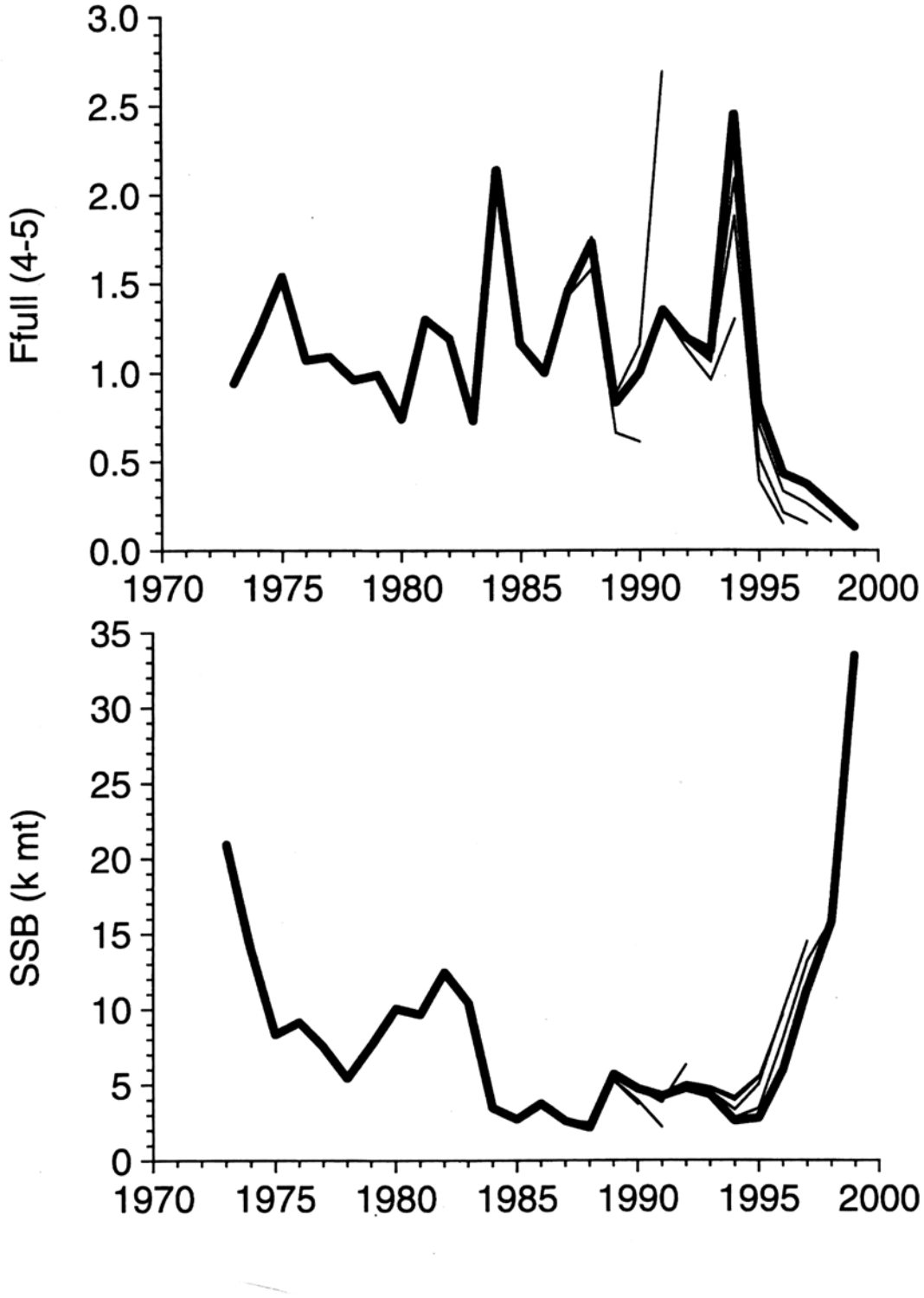

Figure C5. Retrospective analysis of the Georges Bank yellowtail flounder VPA.

D. Southern New England Yellowtail Flounder by S.X. Cadrin

1.0 Background

The southern New England yellowtail stock was at low biomass (less than 25% B_{MSY}) at relatively low F (fully recruited F was 0.2) in 1998 (Cadrin 2000). This report updates catch and survey indices and estimates 1999 fishing mortality and 2000 stock size.

2.0 2000 Assessment

2.1 1999 Landings

U.S. landings were prorated as described in NEFSC (1998; Table D1; Figure D1). Landings from southern New England increased 89% from 1998 to 1999.

Sampling intensity of landings in 1999 was poor (Table D2). The 1999 southern New England yellowtail fishery was not sampled from April to December, 1999, which accounts for 53% of the annual landings. Landings at length and age were estimated for the entire year by market category for an exploratory VPA.

2.2 1998 Discards

Estimates of total discards were attempted from logbook information on discard to kept ratios by half-year and gear (NEFSC 1998; Table D3). Discards at age were estimated from sea sampled lengths and pooled commercial-survey age-length keys for the exploratory VPA. However 1998 samples were used to characterize trawl discards, because no observations of 1999 trawl discards were available. Alternatively, discards were estimating by projecting the 1999 VPA abundance with observed landings and recent average discard ratios (methods described in Cadrin 2000).

2.3 1998-1999 Survey Indices

Survey abundance and biomass indices are reported in Table D4. Estimates are from valid tows in southern New England (offshore strata 5, 6, 9, 10; scallop strata 33-48), standardized according to net, vessel, and door changes (NEFSC 1998). All survey indices of total abundance and total biomass decreased in 2000 (Figure D2).

3.0 Assessment Results

3.1 Age-Based Analysis

An updated VPA calibration of southern New England yellowtail was attempted, but was rejected because of inadequate sampling of catch at age in 1999 (e.g., there were no samples after the first quarter). Estimating catch at age directly using only first quarter samples

underestimates weight at age and overestimates numbers at age. Retrospective analysis of the exploratory VPA indicated a strong tendency for terminal year estimates of F to be less than converged estimates, and terminal year estimates of biomass to be greater than converged estimates.

Alternatively, projections from the 1999 VPA (methods described in NEFSC 2000) were revised with the estimate of 1999 landings. Results from the revised projection indicate that F increased in 1999 (80% confidence of F_{3-6} = 0.23-0.39; F on biomass = 0.09-0.18), and there was approximately 75% probability of being greater than $F_{0.1}$ (0.27)(Table D5, Figure D3). The value of F assumed for 1999 by the previous assessment (F_{3-6} = 0.20; Cadrin 2000) was less than that estimated by this revised projection. The projected estimate of SSB increased (4,100-7,000 mt with 80% confidence), but there was negligible chance of being greater then the Amendment #7 rebuilding target of 10,000 mt. The projected estimate of mean biomass increased (4,700-9,600 mt with 80% confidence). These bootstrap confidence intervals do not include the substantial retrospective error in VPA estimates (Cadrin 2000).

3.2 Biomass-Based Analysis

Due to continued poor sampling and resulting problems estimating catch at age, surplus production analysis (ASPIC) was updated to provide alternative perspectives on stock status. The estimate of F_{MSY} (0.20) was similar to the 1998 SARC estimate (0.23), but the estimate of B_{MSY} (92,400 mt) was substantially greater than the 1998 SARC estimate (61,500 mt; NEFSC 1998). Estimates of biomass and F are generally similar to the VPA, but 1999 F (F on biomass = 0.04-0.12 with 80% confidence) is less than indicated by the VPA projection, and the estimate of 1999 biomass (5,100-19,400 mt with 80% confidence) is substantially greater than the VPA estimate (Figure D4).

4.0 Harvest Control Rule

The SFA control rule specifies a biomass threshold of 25% B_{MSY}, a maximum F threshold of F_{MSY}, and F on biomass (1+,wb) as the metric for fishing mortality . When biomass is less than B_{MSY}, threshold F is the maximum F that allows rebuilding to B_{MSY} in 5 years. When biomass is below 1/4Bmsy, threshold F = 0. When biomass exceeds B_{MSY}, target F is the tenth percentile of the F_{MSY} estimate. When biomass is less than B_{MSY}, target F is based on rebuilding to B_{MSY} at the tenth percentile of the intrinsic rate of increase estimate (Figure D4). Stochastic projections from the VPA indicate that there was less than 5% chance that mean biomass in 1999 was greater than the Amendment #9 biomass threshold (1/4 B_{MSY} = 15,800 mt, NEFSC 1998). The production model indicates less than 25% chance that 1999 biomass was greater than the Amendment #9 biomass threshold.

5.0 Sources of Uncertainty

- Estimates of catch at age are not reliable due to poor sampling intensity. Therefore VPA will not be possible until sampling improves.
- Although historical perspective from production models are valuable, current biomass levels may not be reliable, because recruitment is implicitly assumed to be a function of stock biomass.
- Inappropriate stock delineation may result in underestimated removals (e.g., from adjacent areas in the mid-Atlantic Bight).
- Estimates of prorated landings and discard ratios are based on preliminary logbook data and are subject to change.

6.0 References

Cadrin, S.X. 2000. Southern New England yellowtail flounder. In Assessment of 11 Northeast Groundfish Stocks through 1999. NEFSC Ref. Doc. 00-05: 65-82.

NEFSC (Northeast Fisheries Science Center). 1998. Southern New England yellowtail flounder. NEFSC Ref. Doc. 98-15: 328-350.

Table D1. Landings of southern New England yellowtail flounder (thousand mt).

year	US Landings	US discards	Industrial landings	Foreign landings	total catch
1960	7.8	3.2	0.5		11.5
1961	11.6	4.7	0.7		17.0
1962	13.1	5.3	0.2		18.6
1963	22.0	5.9	0.3	0.2	27.9
1964	19.0	10.0	0.5		29.0
1965	18.4	9.4	1.0	1.4	27.8
1966	14.9	8.7	2.7	0.7	23.6
1967	10.8	15.0	4.5	2.8	25.8
1968	14.3	13.7	3.9	3.5	28.0
1969	11.4	24.2	4.2	17.6	35.6
1970	13.1	9.3	2.1	2.5	22.4
1971	8.2	4.0	0.4	0.3	12.2
1972	8.2	5.0	0.3	3.0	13.2
1973	6.9	1.5	0.3	0.2	8.4
1974	6.4	8.7		0.1	15.1
1975	3.2	1.9			5.1
1976	1.6	1.6			3.2
1977	2.8	1.9			4.7
1978	2.3	5.0			7.3
1979	5.3	4.4			9.7
1980	6.0	1.7			7.7
1981	4.7	1.2			5.9
1982	10.3	5.0			15.3
1983	17.0	3.5			20.5
1984	7.9	1.1			9.0
1985	2.7	1.2			3.9
1986	3.3	1.1			4.4
1987	1.6	0.9			2.5
1988	0.9	1.8			2.7
1989	2.5	5.5			8.0
1990	8.0	9.7			17.7
1991	3.9	2.3			6.2
1992	1.4	1.1			2.5
1993	0.5	0.1			0.6
1994	0.2	0.1			0.3
1995	0.2	0.1			0.2
1996	0.3	0.1			0.4
1997	0.2	0.0			0.3
1998	0.4	0.1			0.5
1999	0.7	0.2			0.9
average	6.8	4.5	1.5	2.9	11.4

Table D2. Samples of the 1999 southern New England yellowtail fishery.

port samples

quarter	ages	unclassified lengths	large lengths	small lengths	trips
1	154	262	408	333	9
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
	154	262	408	333	9

sea samples

quarter	ages	kept lengths	trawl discard lengths	dredge discard lengths	trips
1	0	0	0	0	0
2	0	10	0	17	3
3	0	0	0	0	0
4	0	0	0	95	4
	0	10	0	112	7

quarter	**survey** ages
1	22
2	101
3	14
4	0
	137

total

quarter	ages	kept lengths	discard lengths	trips	landings (mt)
1	176	1003	0	9	322
2	101	10	17	3	164
3	14	0	0	0	118
4	0	0	95	4	83
	291	1013	112	16	687

Table D3. Estimates of southern New England yellowtail discards in 1999 from logbook data and observer data.

		logbook data			expansion	
half		kept	disc		landings	discards
year	gear	(mt)	(mt)	d/k	(mt)	(mt)
1	trawl	110.1	3.9	0.03	483	17
	dredge	0.2	5.7	29.91 *	3	79
2	trawl	24.0	0.6	0.02	200	5
	dredge	0.0	1.1	29.91 *	1	23
	total			0.18	687	124

* entire year

		observer data				expansion	
half		kept	disc			landings	discards
year	gear	(mt)	(mt)	d/k	trips	(mt)	(mt)
1	trawl				0	483	0
	dredge	0.000	0.021		33	3	0
2	trawl	0.012	0.004	0.31	2	200	62
	dredge	0.007	0.291	42.83	123	1	33
	total			0.14	158	687	94

Table D4a. Survey indices of southern New England yellowtail abundance and biomass.

NEFSC Spring Survey					Age					
Year	1	2	3	4	5	6	7	8+	Total	kg/tow
1968	1.662	31.719	31.913	19.002	0.886	0.168	0.067	0.000	85.416	18.624
1969	5.102	19.866	27.261	14.675	2.540	0.285	0.000	0.000	69.730	13.340
1970	1.486	10.669	19.964	14.136	4.066	1.096	0.235	0.096	51.749	11.721
1971	1.066	11.323	8.519	23.664	6.065	0.967	0.011	0.011	51.627	10.693
1972	0.492	21.844	14.735	4.596	8.813	1.360	0.257	0.000	52.098	10.728
1973	1.301	7.270	12.713	6.276	4.261	6.595	0.820	0.456	39.693	14.678
1974	0.742	2.972	2.326	2.530	1.647	0.593	0.964	0.193	11.967	5.040
1975	0.561	1.556	0.500	0.769	0.810	0.471	0.033	0.146	4.845	1.984
1976	0.026	3.259	0.528	0.250	0.302	0.250	0.157	0.051	4.823	2.452
1977	0.205	1.251	1.556	0.166	0.173	0.080	0.024	0.103	3.557	1.993
1978	2.963	9.783	2.027	0.715	0.187	0.036	0.047	0.138	15.897	5.146
1979	1.542	3.357	1.741	0.354	0.110	0.000	0.000	0.008	7.112	2.147
1980	0.370	4.303	3.278	2.711	0.291	0.116	0.006	0.039	11.115	5.949
1981	0.203	8.622	3.089	1.279	0.464	0.047	0.000	0.000	13.704	6.846
1982	0.333	14.049	7.459	1.860	0.605	0.186	0.020	0.000	24.512	6.001
1983	0.090	3.900	12.916	1.059	0.312	0.000	0.000	0.000	18.278	4.641
1984	0.000	0.500	1.648	2.612	0.665	0.223	0.000	0.000	5.649	1.625
1985	0.561	0.744	0.417	0.201	0.454	0.093	0.000	0.000	2.470	0.666
1986	0.037	4.083	1.492	0.308	0.073	0.036	0.000	0.000	6.029	1.605
1987	0.000	0.198	0.919	0.144	0.000	0.000	0.000	0.000	1.261	0.402
1988	0.327	0.692	0.177	0.245	0.127	0.000	0.000	0.000	1.568	0.399
1989	0.151	10.308	0.604	0.066	0.000	0.000	0.000	0.000	11.129	2.433
1990	0.091	0.368	18.994	3.794	0.031	0.000	0.000	0.000	23.278	7.828
1991	0.438	0.340	1.573	4.484	0.510	0.111	0.000	0.000	7.455	2.786
1992	0.081	0.269	0.275	1.196	0.112	0.000	0.000	0.000	1.933	0.653
1993	0.037	0.533	0.221	0.517	0.097	0.000	0.000	0.000	1.405	0.506
1994	0.031	0.494	0.040	0.019	0.045	0.015	0.000	0.000	0.643	0.219
1995	0.054	0.944	0.284	0.072	0.030	0.011	0.018	0.000	1.413	0.360
1996	0.000	0.528	2.442	0.314	0.063	0.000	0.000	0.000	3.347	1.054
1997	0.119	1.816	1.735	0.274	0.081	0.000	0.000	0.000	4.025	1.183
1998	0.154	3.696	0.433	0.231	0.077	0.000	0.000	0.000	4.590	0.973
1999	0.037	1.426	3.265	0.243	0.036	0.000	0.000	0.000	5.006	1.763
2000	0.000	1.772	2.449	0.198	0.116	0.000	0.000	0.000	4.535	1.444
mean	0.614	5.590	5.682	3.302	1.032	0.386	0.081	0.038	16.723	4.481

Table D4b. Survey indices of southern New England yellowtail abundance and biomass.

NEFSC Fall Survey					Age					
Year	1	2	3	4	5	6	7	8+	Total	kg/tow
1963	19.798	20.168	14.960	5.830	0.660	0.151	0.000	0.100	61.667	16.842
1964	22.529	31.952	5.861	8.701	3.983	1.108	0.000	0.000	74.133	19.03
1965	13.231	21.390	7.771	2.140	2.167	0.155	0.000	0.090	46.944	12.675
1966	43.305	13.066	2.375	1.247	0.231	0.000	0.000	0.000	60.224	9.431
1967	22.497	31.159	13.716	1.936	0.472	0.079	0.160	0.000	70.019	14.057
1968	11.285	13.352	22.860	1.443	0.115	0.000	0.000	0.000	49.055	10.062
1969	14.481	11.884	33.861	6.351	0.113	0.050	0.050	0.000	66.791	14.401
1970	5.157	6.736	19.936	12.961	3.067	0.520	0.089	0.000	48.466	10.965
1971	7.748	13.298	7.618	18.468	3.287	0.264	0.196	0.000	50.879	11.632
1972	5.135	20.125	24.054	22.993	14.991	2.050	0.054	0.000	89.402	20.114
1973	1.726	1.590	2.224	1.640	1.241	1.057	0.212	0.000	9.689	2.264
1974	1.216	2.047	0.676	2.776	1.166	0.489	0.238	0.093	8.701	2.141
1975	1.981	0.516	0.266	0.329	0.334	0.000	0.104	0.000	3.531	0.715
1976	3.632	7.331	0.877	0.088	0.139	0.361	0.423	0.189	13.041	2.962
1977	1.759	2.275	0.828	0.053	0.046	0.113	0.078	0.000	5.151	1.501
1978	3.247	7.599	0.450	0.392	0.043	0.009	0.079	0.032	11.851	3.057
1979	1.794	4.533	2.537	0.388	0.043	0.041	0.000	0.000	9.335	2.565
1980	1.463	4.506	1.202	0.426	0.000	0.000	0.000	0.000	7.597	1.957
1981	4.704	8.944	1.404	0.334	0.080	0.061	0.000	0.000	15.527	3.789
1982	2.610	29.372	8.673	1.025	0.409	0.000	0.000	0.000	42.088	8.126
1983	4.582	17.956	10.078	0.876	0.073	0.000	0.050	0.000	33.616	6.515
1984	0.719	2.217	2.400	0.659	0.000	0.000	0.000	0.000	5.994	1.365
1985	1.018	0.447	0.161	0.122	0.000	0.000	0.000	0.000	1.748	0.438
1986	0.826	1.685	0.365	0.088	0.000	0.000	0.000	0.000	2.963	0.883
1987	1.515	0.674	0.558	0.047	0.037	0.000	0.037	0.000	2.868	0.607
1988	1.261	0.388	0.173	0.195	0.048	0.000	0.000	0.000	2.065	0.496
1989	0.000	8.004	1.400	0.065	0.000	0.000	0.000	0.000	9.469	2.359
1990	0.000	0.097	2.395	0.270	0.000	0.000	0.000	0.000	2.763	0.974
1991	0.865	0.219	1.709	0.453	0.000	0.000	0.000	0.000	3.247	1.013
1992	0.261	0.062	0.180	0.337	0.012	0.000	0.000	0.000	0.852	0.229
1993	0.070	0.015	0.028	0.020	0.000	0.000	0.000	0.000	0.133	0.053
1994	0.754	0.553	0.198	0.192	0.085	0.011	0.000	0.000	1.793	0.374
1995	0.180	1.306	0.171	0.095	0.000	0.000	0.000	0.000	1.752	0.432
1996	0.653	0.290	0.258	0.025	0.000	0.000	0.000	0.000	1.226	0.266
1997	0.889	0.716	1.687	0.373	0.037	0.000	0.000	0.000	3.702	1.041
1998	1.384	2.141	0.188	0.076	0.000	0.036	0.000	0.000	3.824	0.899
1999	0.189	0.119	0.116	0.000	0.000	0.000	0.000	0.000	0.424	0.101
mean	5.526	7.804	5.249	2.525	0.889	0.177	0.048	0.014	22.231	5.036

Table D4c. Survey indices of southern New England yellowtail abundance and biomass.

NEFSC Winter Survey

	Age									
Year	1	2	3	4	5	6	7	8+	Total	kg/tow
1992	0.000	2.884	1.881	6.418	1.295	0.000	0.000	0.000	12.478	4.402
1993	1.349	3.853	0.711	1.841	0.306	0.000	0.000	0.000	8.060	1.968
1994	0.586	17.778	1.363	2.917	1.258	0.199	0.000	0.000	24.101	6.809
1995	0.368	7.615	4.474	1.317	0.493	0.123	0.036	0.000	14.426	4.059
1996	0.092	2.304	11.703	1.552	0.207	0.109	0.033	0.000	16.000	5.159
1997	0.301	3.976	9.141	2.625	0.508	0.000	0.000	0.000	16.551	5.831
1998	0.267	3.160	1.210	0.365	0.000	0.000	0.041	0.000	5.043	1.281
1999	0.550	10.699	14.210	0.528	0.176	0.000	0.000	0.000	26.163	8.874
1999	0.246	4.540	4.341	1.296	0.000	0.000	0.000	0.000	10.422	3.330
mean	0.418	6.312	5.448	2.095	0.471	0.048	0.012	0.000	14.805	4.635

Scallop Survey

Year	age-1
1982	0.584
1983	0.891
1984	0.205
1985	0.647
1986	0.282
1987	0.601
1988	1.343
1989	0.169
1990	0.026
1991	1.060
1992	0.411
1993	0.419
1994	1.265
1995	0.551
1996	0.608
1997	2.744
1998	1.227
1999	1.270
mean	0.795

Table D5. Projection of southern New England yellowtail flounder VPA with 1999 landings.

INPUT ASSUMPTIONS

Age	1	2	3	4	5	6	7+
Stock Wt.	0.130	0.318	0.398	0.473	0.636	0.785	0.850
Landed Wt.	0.254	0.326	0.398	0.475	0.639	0.783	0.830
Discard Wt.	0.13	0.28	0.4	0.53	0.69	0.79	0.71
Maturity	0.13	0.74	0.98	1.00	1.00	1.00	1.00
PR	0.01	0.12	0.53	1.00	1.00	1.00	1.00
% Discard	1.00	0.44	0.17	0.15	0.25	0.31	0.20

LANDINGS FOR F-BASED PROJECTIONS

YEAR	AVG LANDINGS (000 MT)	STD
1999	0.688	0.000

SPAWNING STOCK BIOMASS (THOUSAND MT)

YEAR	AVG SSB (000 MT)	STD
1999	5.496	1.123

PERCENTILES OF SPAWNING STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1999	3.348	3.939	4.134	4.695	5.414	6.140	7.045	7.520	8.637

ANNUAL PROBABILITY THAT SSB EXCEEDS THRESHOLD: 10.000 THOUSAND MT

YEAR	Pr(SSB > Threshold Value)
1999	0.000

MEAN BIOMASS (THOUSAND MT) FOR AGES:1 TO 7

YEAR	AVG MEAN B (000 MT)	STD
1999	7.117	3.043

PERCENTILES OF MEAN STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1999	3.586	4.357	4.736	5.436	6.449	7.603	9.637	12.616	17.786

ANNUAL PROBABILITY THAT MEAN BIOMASS EXCEEDS THRESHOLD: 61.500 THOUSAND MT

YEAR	Pr(MEAN B > Threshold Value)
1999	0.000

F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 7

YEAR	AVG F_WT_B	STD
1999	0.135	0.038

PERCENTILES OF F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 7

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1999	0.040	0.069	0.088	0.115	0.134	0.159	0.181	0.193	0.225

RECRUITMENT UNITS ARE:1000. FISH

BIRTH YEAR	AVG RECRUITMENT	STD
1999	28598.914	36179.477

PERCENTILES OF RECRUITMENT UNITS ARE:1000. FISH

BIRTH YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1999	1120.702	2422.346	3578.866	7311.790	15912.085	34470.023	68069.242	100635.180	184369.031

DISCARDS FOR F-BASED PROJECTIONS

YEAR	AVG DISCARDS (000 MT)	STD
1999	0.179	0.010

PERCENTILES OF DISCARDS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1999	0.160	0.165	0.167	0.172	0.178	0.183	0.190	0.197	0.208

REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS

YEAR	AVG F	STD
1999	0.314	0.066

PERCENTILES OF REALIZED F SERIES

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1999	0.186	0.215	0.234	0.269	0.300	0.364	0.393	0.423	0.505

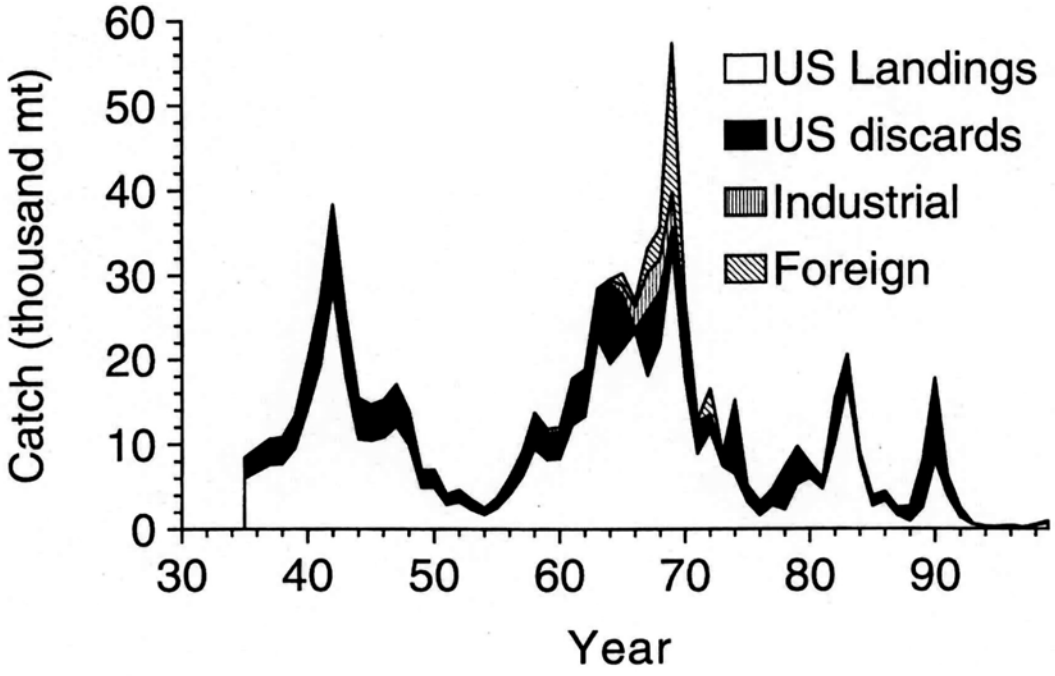

Figure D1. Total catch of southern New England yellowtail flounder.

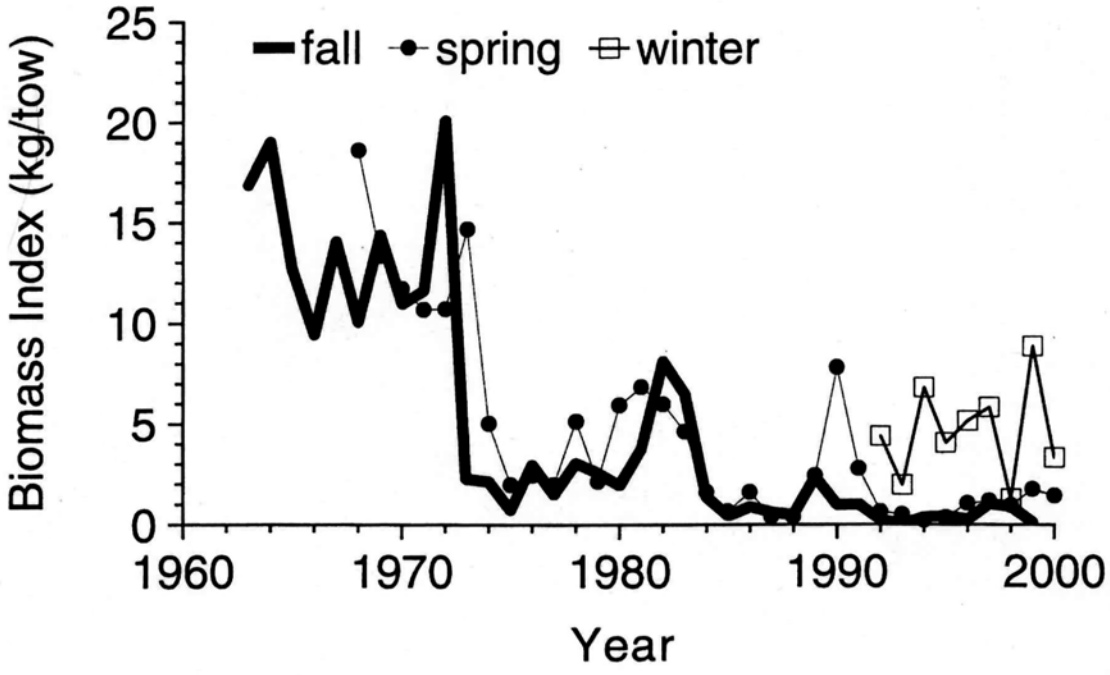

Figure D2. Survey indices of southern New England yellowtail flounder biomass.

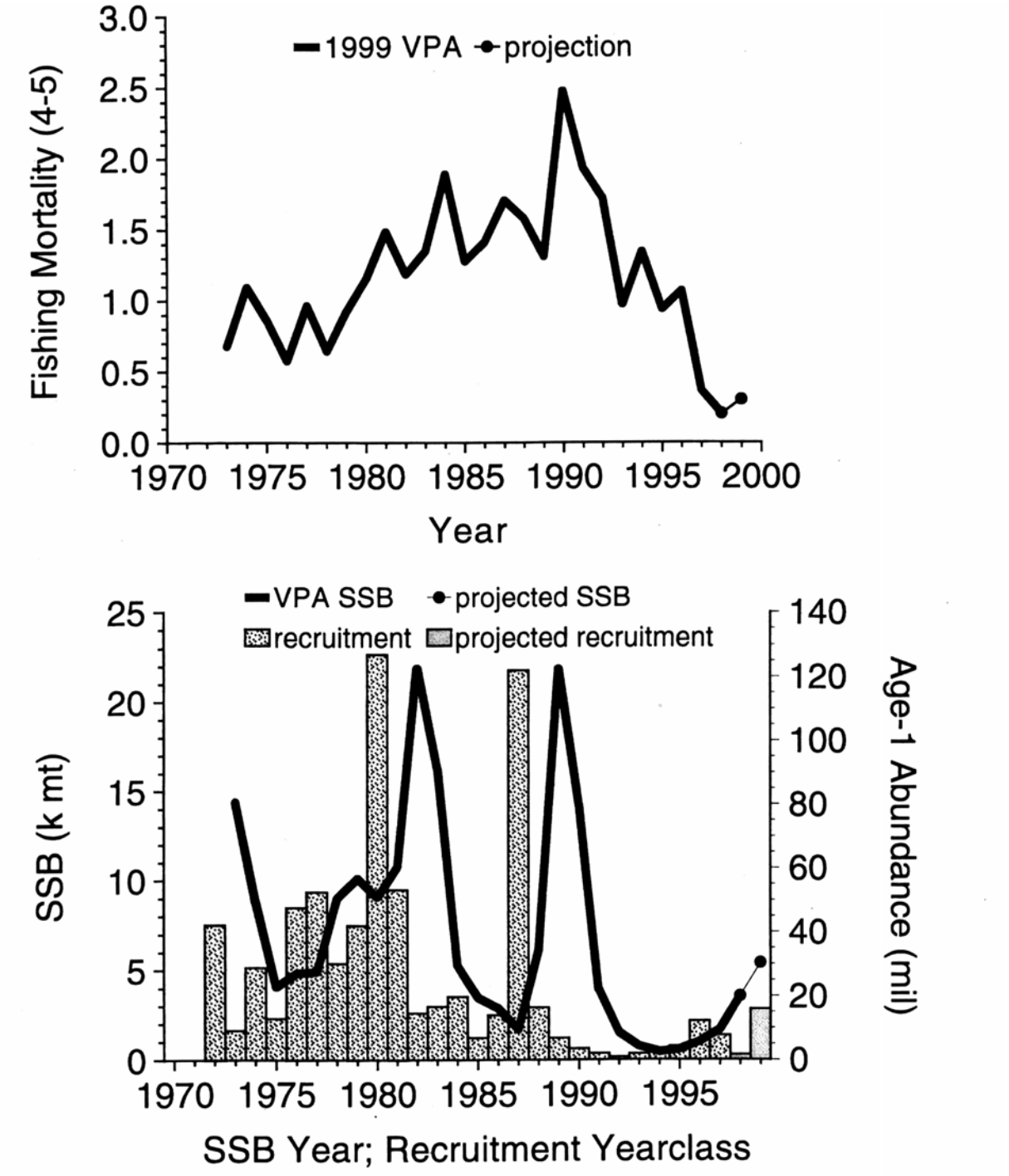

Figure D3. Summary of southern New England yellowtail VPA results from the 1999 assessment with revised projections.

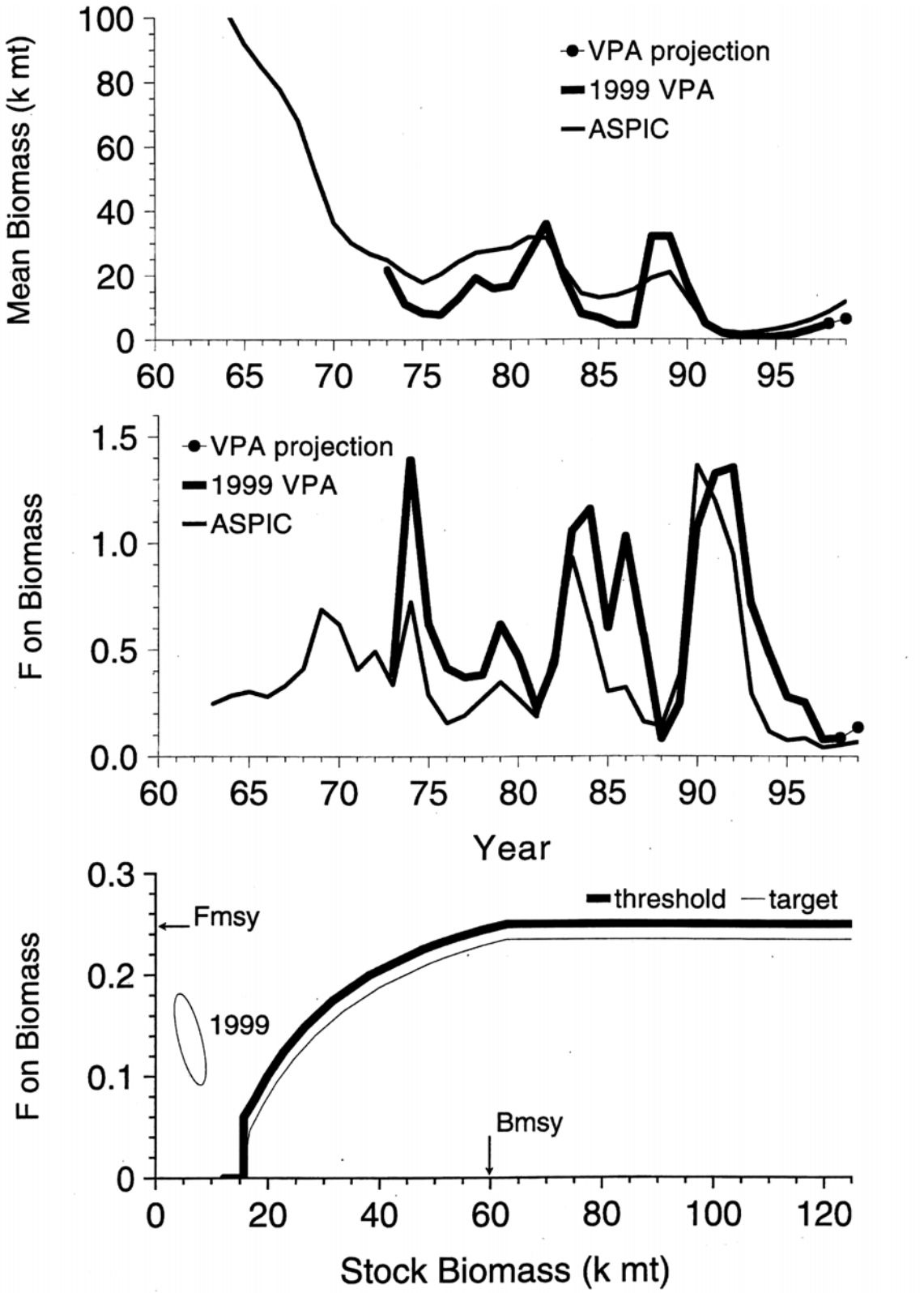

Figure D4. Mean biomass of southern New England yellowtail flounder (upper panel), F on biomass (middle panel), and stock status showing 80% confidence ellipse from projected VPA (lower panel).

E. Cape Cod Yellowtail Flounder by **S.X. Cadrin** and **J. King**

1.0 Background

The Cape Cod yellowtail flounder stock was at low biomass (50% of B_{MSY}) and was overexploited (fully recruited F was 0.41) in 1998 (Cadrin 2000). This report updates catch and survey indices and estimates 1999 fishing mortality and 2000 stock size.

2.0 2000 Assessment

2.1 1999 Landings

U.S. landings were prorated as described in Cadrin et al. (1999; Table E1; Figure E1). Landings from the Cape Cod stock decreased by 7% from 1998 to 1999.

Sampling intensity of landings in 1999 was poor. Only eight trips from the 1999 Cape Cod yellowtail fishery were sampled, and no samples were taken during the third quarter, when 16% of annual landings were taken. Landings at length were estimated by half year and market category. Landings at age and mean weights at age are reported in Table E2.

2.2 1999 Discards

Discarded catch was estimated from logbook information on discard to kept ratios by half-year and gear. However, discards of Cape Cod yellowtail are substantially less than those estimated in recent years, presumably because previous estimates were based on observer data by fishery (Cadrin et al. 1999). Therefore, the level of discards for Cape Cod yellowtail may be underestimated and should be considered preliminary. Discards at age were estimated from sea sampled lengths and pooled commercial-survey age-length keys. Discards at age and recent mean weights at age are reported in Table E3.

2.3 1999-2000 Survey Indices

Survey abundance and biomass indices are reported in Table E4. Estimates are from valid tows on the Cape Cod grounds (offshore strata 25, 26; inshore strata 56-66; Massachusetts strata 17-36) standardized according to net, vessel, and door changes (NEFSC 1998). Recent survey indices of Cape Cod yellowtail greatly increased (Figure E2).

3.0 Assessment Results

3.1 Age-Based Analysis

An updated VPA calibration of Cape Cod yellowtail is summarized in Table E5. This analysis updates the assessment reported in Cadrin (2000) by including 1999 landings and provisional

discards, 1999 fall indices, and 2000 NEFSC spring indices. Results indicate that F decreased (F_{4-5} = 0.59, F on biomass = 0.31) and biomass increased in 1999 (1,900 mt of spawning biomass and 3,900 mt of mean total biomass; Figures 3 and 4). Retrospective analysis indicated a strong tendency for terminal year estimates of F to be less than converged estimates since 1996, and terminal year estimates of biomass to be greater than converged estimates since 1994. Bootstrap analysis indicates that abundance was estimated with moderate precision (CV=29-41%), F_{4-5} was 0.43-0.90 with 80% confidence, SSB was 1,500-2,400 mt. Mean biomass had an 80% confidence interval of 3,100-4,700.

The value of F assumed for 1999 by the previous assessment (F_{4-5} = 0.41; Cadrin 2000) was substantially less than that estimated by this updated analysis (F_{4-5} = 0.59). The projected SSB in 1999 (1,900 mt) is similar to the estimate from this updated analysis, but the projected mean biomass in 1999 (3,600 mt) is less than indicated by this analysis (3,900 mt).

4.0 Harvest Control Rule

The SFA control rule specifies a biomass threshold of 50% B_{MSY}, a maximum F threshold of F_{MSY}, and F on biomass (1+,wb) as the metric for fishing mortality . When biomass is less than B_{MSY}, threshold F is the maximum F that allows rebuilding to B_{MSY} in 5 years. When biomass is below 1/4Bmsy, threshold F = 0. When biomass exceeds B_{MSY}, target F is the tenth percentile of the F_{MSY} estimate. When biomass is less than B_{MSY}, target F is based on rebuilding to B_{MSY} at the tenth percentile of the intrinsic rate of increase estimate (Figure E4). The estimate of mean biomass in 1999 was greater than the biomass threshold (1/2 B_{MSY} proxy = 3,050 mt) with greater than 90% probability, but F exceeded the rebuilding threshold.

5.0 Sources of Uncertainty

- Estimates of catch at age may not be reliable due to poor sampling intensity. Therefore VPA results may be misleading. Extreme estimates of mean weights (e.g. ages 2-3), odd exploitation patterns, and retrospective patterns may indicate inadequate sampling and mis-allocation of catch at age.
- Retrospective patterns since the mid 1990s indicate that VPA estimates of biomass and F may be overly optimistic. Updated VPAs may indicate that 1999 biomass levels are substantially lower, and 1999 F was substantially greater than reported here.
- Estimates of prorated landings and discard ratios are based on preliminary logbook data and are subject to change.
- The magnitude of discards in 1999 are probably underestimated.

6.0 References

Cadrin, S.X. 2000. Cape Cod yellowtail flounder. In Assessment of 11 Northeast Groundfish Stocks through 1999. NEFSC Ref. Doc. 00-05: 83-98.

Cadrin, S., J. King, and L. Suslowicz. 1999. Status of the Cape Cod yellowtail flounder stock for 1998. NEFSC Ref. Doc. 99-04.

Table E1. Landings of Cape Cod yellowtail flounder (mt).

	Landings (mt)	Discards (mt)	Percent Discard	Total (mt)
1960	1,500	500	32	2,000
1961	1,800	600	32	2,400
1962	1,900	600	32	2,500
1963	3,600	1,000	28	4,600
1964	1,851	600	32	2,451
1965	1,498	500	33	1,998
1966	1,808	300	17	2,108
1967	1,542	800	52	2,342
1968	1,569	600	38	2,169
1969	1,346	300	22	1,646
1970	1,185	400	34	1,585
1971	1,662	700	42	2,362
1972	1,364	300	22	1,664
1973	1,662	0	0	1,662
1974	2,054	200	10	2,254
1975	2,027	0	0	2,027
1976	3,587	100	3	3,687
1977	3,469	0	0	3,469
1978	3,683	400	11	4,083
1979	4,163	500	12	4,663
1980	5,106	600	12	5,706
1981	3,149	600	19	3,749
1982	3,150	400	13	3,550
1983	1,884	300	16	2,184
1984	1,121	20	2	1,141
1985	967	77	8	1,044
1986	1,041	305	29	1,346
1987	1,159	198	17	1,357
1988	1,085	283	26	1,368
1989	909	390	43	1,299
1990	2,984	1,141	38	4,125
1991	1,472	405	28	1,877
1992	828	637	77	1,465
1993	628	90	14	718
1994	978	192	20	1,170
1995	1,207	233	19	1,440
1996	1,064	182	17	1,246
1997	1,040	257	25	1,297
1998	1,169	75	6	1,244
1999	1,089	115	11	1,204
mean	1,882	373	22	2,255

Table E2. Landings at age (above) and mean weight at age (below) of Cape Cod yellowtail flounder.

Landings at age (thousands)	age								
	1	2	3	4	5	6	7	8+	sum
1985	5	738	700	522	268	89	3	7	2,332
1986	0	1,998	579	223	32	6	0	1	2,838
1987	0	609	1,786	268	100	29	12	5	2,808
1988	1	802	1,043	625	172	36	0	0	2,679
1989	0	726	989	231	31	3	2	2	1,986
1990	0	692	6,191	416	32	16	7	3	7,357
1991	0	311	903	1,455	249	33	27	1	2,978
1992	0	338	807	514	150	6	5	1	1,821
1993	0	25	684	573	90	24	15	7	1,418
1994	0	87	1,023	650	236	65	38	9	2,109
1995	0	233	1,730	808	152	78	5	0	3,006
1996	0	150	1,097	798	287	11	5	2	2,349
1997	0	481	1,086	702	160	13	0	1	2,443
1998	0	257	1,681	472	141	41	3	0	2,595
1999	0	328	1,134	646	106	43	1	0	2,258
mean	0	518	1,429	594	147	33	8	3	2,732

Landed weight at age (kg)	age							
	1	2	3	4	5	6	7	8+
1985	0.19	0.32	0.37	0.49	0.60	0.73	1.20	1.39
1986		0.32	0.46	0.57	0.73	0.90		1.40
1987		0.31	0.42	0.55	0.65	0.81	1.03	1.18
1988	0.11	0.31	0.37	0.53	0.70	0.85		
1989		0.38	0.45	0.65	0.92	1.41	1.24	1.24
1990		0.31	0.41	0.56	0.82	0.90	0.99	1.17
1991		0.35	0.39	0.54	0.74	0.99	1.06	1.01
1992		0.32	0.41	0.53	0.61	0.73	1.53	1.91
1993		0.31	0.38	0.43	0.74	0.95	1.01	1.17
1994		0.29	0.38	0.50	0.62	0.68	1.04	1.11
1995		0.35	0.36	0.43	0.61	0.78	1.11	
1996		0.32	0.42	0.50	0.53	0.91	1.19	1.18
1997		0.39	0.41	0.47	0.57	0.78	1.30	1.31
1998		0.33	0.41	0.55	0.63	1.00	1.62	
1999		0.36	0.45	0.56	0.58	0.88	1.62	
mean	0.15	0.33	0.41	0.52	0.67	0.89	1.23	1.28

Table E3. Discards at age (above) and mean weights at age (below) of Cape Cod yellowtail flounder.

Discards at age (thousands)				age			
	1	2	3	4	5	6	sum
1985	340	184	34	0	0	0	558
1986	79	1,657	75	26	0	0	1,837
1987	14	877	168	0	0	0	1,059
1988	360	1,328	177	0	0	0	1,864
1989	114	1,405	396	1	0	0	1,917
1990	81	2,047	2,501	19	0	0	4,648
1991	460	895	561	100	7	0	2,023
1992	1,688	3,543	731	29	3	0	5,994
1993	138	324	173	30	0	0	665
1994	60	383	279	49	4	1	776
1995	453	469	652	50	2	0	1,627
1996	7	397	327	94	11	0	837
1997	1	399	351	117	22	1	891
1998	8	39	171	29	6	0	253
1999	2	202	170	22	3	4	255
mean	254	943	451	38	4	0	1,680

Discarded weight at age (kg)				age		
	1	2	3	4	5	6
1985	0.13	0.15	0.15			
1986	0.10	0.17	0.19	0.18		
1987	0.06	0.19	0.19			
1988	0.12	0.15	0.20			
1989	0.13	0.21	0.25	0.36		
1990	0.08	0.24	0.27	0.33		
1991	0.12	0.19	0.27	0.37	0.54	
1992	0.05	0.11	0.22	0.31	0.36	
1993	0.09	0.15	0.27	0.33	0.63	
1994	0.08	0.20	0.29	0.32	0.38	0.34
1995	0.07	0.16	0.23	0.33	0.48	
1996	0.04	0.15	0.28	0.36	0.50	
1997	0.03	0.21	0.29	0.39	0.54	0.65
1998	0.03	0.26	0.35	0.44	0.56	0.59
1999	0.03	0.24	0.28	0.49	0.50	0.99
mean	0.08	0.19	0.25	0.35	0.50	0.64

Table E4a. Survey indices of Cape Cod yellowtail abundance and biomass.

MADMF Spring Survey					age					
year	1	2	3	4	5	6	7	8+	sum	kg/tow
1978	2.71	20.69	11.82	1.60	0.63	0.54	0.10	0.13	38.22	10.16
1979	2.63	22.58	13.85	3.68	0.86	0.00	0.17	0.00	43.77	11.38
1980	2.68	17.62	10.10	2.30	0.15	0.00	0.00	0.00	32.85	10.03
1981	5.61	58.83	9.00	2.26	1.59	0.27	0.00	0.00	77.56	16.35
1982	0.69	17.06	17.04	4.45	0.94	0.06	0.04	0.00	40.28	12.85
1983	3.13	8.50	11.51	4.28	0.04	0.17	0.03	0.00	27.66	9.00
1984	0.43	18.13	7.56	2.29	0.85	0.00	0.00	0.00	29.26	7.37
1985	1.97	8.27	7.15	1.52	0.59	0.39	0.05	0.05	19.99	5.21
1986	1.73	15.39	1.74	0.24	0.21	0.04	0.00	0.00	19.36	4.52
1987	2.53	4.95	5.31	0.97	0.27	0.11	0.08	0.00	14.22	3.67
1988	3.10	14.46	2.52	0.60	0.05	0.02	0.00	0.00	20.74	3.83
1989	0.67	22.26	3.18	1.08	0.06	0.00	0.00	0.00	27.25	4.73
1990	0.63	11.77	15.57	0.63	0.14	0.01	0.02	0.01	28.77	6.60
1991	0.06	5.34	3.31	2.15	0.48	0.12	0.05	0.00	11.50	3.32
1992	1.30	11.03	9.71	2.38	1.45	0.03	0.03	0.00	25.94	6.54
1993	0.63	7.99	6.31	1.94	0.23	0.06	0.20	0.03	17.38	4.60
1994	2.67	24.02	7.53	1.49	0.33	0.12	0.00	0.00	36.15	6.23
1995	7.51	14.64	24.96	2.88	1.20	0.02	0.02	0.00	51.22	10.38
1996	1.17	18.03	14.70	6.78	1.74	0.00	0.04	0.00	42.46	9.25
1997	0.52	16.94	12.22	4.04	0.54	0.00	0.00	0.00	34.26	7.55
1998	0.55	4.96	13.50	1.25	0.19	0.02	0.00	0.00	20.46	5.17
1999	0.10	6.34	10.90	1.28	0.08	0.00	0.00	0.00	18.70	5.08
2000*									69.11	20.37
mean	1.96	15.90	9.98	2.28	0.57	0.09	0.04	0.01	32.48	8.01

* preliminary

MADMF Fall Survey						age					
year	0	1	2	3	4	5	6	7	8+	sum	kg/tow
1978	0.04	7.13	7.74	1.45	0.11	0.00	0.01	0.00	0.00	16.48	2.80
1979	0.03	24.11	22.82	1.78	0.06	0.00	0.00	0.00	0.00	48.80	7.33
1980	0.03	26.54	12.38	2.70	0.35	0.00	0.00	0.00	0.00	42.00	5.90
1981	0.00	2.93	6.54	1.54	0.23	0.17	0.00	0.00	0.00	11.41	2.76
1982	0.00	9.58	3.36	5.54	0.30	0.08	0.00	0.00	0.00	18.86	4.20
1983	0.00	9.68	6.68	1.60	0.13	0.00	0.00	0.00	0.00	18.09	3.39
1984	0.04	1.91	3.00	0.86	0.39	0.10	0.02	0.00	0.04	6.37	1.18
1985	0.04	5.70	1.63	1.03	0.00	0.00	0.00	0.00	0.02	8.42	1.17
1986	0.01	2.60	4.95	0.20	0.03	0.01	0.00	0.00	0.00	7.80	1.36
1987	0.44	5.85	2.30	0.49	0.07	0.02	0.00	0.00	0.00	9.17	1.09
1988	0.00	8.96	11.24	2.27	0.15	0.00	0.00	0.00	0.00	22.62	3.71
1989	0.00	2.64	5.22	0.96	0.10	0.00	0.00	0.00	0.00	8.92	1.52
1990	0.00	5.20	11.93	4.84	0.01	0.00	0.00	0.00	0.00	21.98	4.16
1991	0.00	3.76	5.14	5.03	0.86	0.00	0.00	0.00	0.00	14.78	3.23
1992	0.20	7.18	3.62	2.08	0.47	0.20	0.00	0.00	0.00	13.75	2.00
1993	0.00	8.39	7.29	5.80	1.43	0.00	0.00	0.00	0.00	22.91	3.99
1994	0.00	2.36	11.79	1.79	0.15	0.00	0.00	0.00	0.00	16.09	3.27
1995	0.00	8.38	15.16	5.85	0.00	0.00	0.00	0.00	0.00	29.40	5.75
1996	0.01	1.87	3.94	2.18	0.17	0.00	0.00	0.00	0.00	8.17	1.56
1997	0.00	1.01	7.38	1.14	0.16	0.10	0.00	0.00	0.00	9.79	2.10
1998	0.00	7.05	6.74	2.25	0.00	0.00	0.00	0.00	0.00	16.05	2.68
1999	0.15	4.73	11.94	4.10	0.65	0.08	0.00	0.00	0.00	21.66	4.71
mean	0.04	7.29	7.71	2.46	0.26	0.03	0.00	0.00	0.00	17.79	3.12

Table E4b. Survey indices of Cape Cod yellowtail abundance and biomass.

NEFSC Spring Survey

	age									
year	1	2	3	4	5	6	7	8+	sum	kg/tow
1979	0.55	0.71	1.33	0.85	0.04	0.03	0.00	0.00	3.51	1.20
1980	0.00	7.14	4.08	1.43	0.29	0.00	0.00	0.00	12.94	4.89
1981	0.10	6.30	4.27	0.93	1.06	0.51	0.66	0.00	13.83	4.41
1982	0.08	2.79	7.23	3.71	1.00	0.57	0.63	0.16	16.17	7.16
1983	2.36	6.33	5.09	2.09	0.22	0.15	0.00	0.00	16.24	4.78
1984	0.09	2.39	1.42	0.92	0.60	0.05	0.07	0.16	5.70	1.99
1985	0.13	1.86	1.81	0.43	0.25	0.10	0.00	0.00	4.58	1.37
1986	0.03	3.55	0.30	0.08	0.20	0.00	0.00	0.00	4.16	0.81
1987	0.12	2.82	4.22	0.69	1.07	1.07	1.25	0.61	11.84	5.57
1988	1.75	7.47	1.53	1.00	0.39	0.15	0.07	0.00	12.34	1.96
1989	0.43	5.19	3.18	0.29	0.14	0.00	0.00	0.00	9.23	1.50
1990	0.00	4.52	10.94	0.29	0.00	0.20	0.00	0.00	15.94	3.42
1991	0.79	6.75	4.65	1.48	0.34	0.00	0.09	0.00	14.09	2.94
1992	0.30	1.84	2.89	0.80	0.03	0.00	0.00	0.00	5.87	1.31
1993	0.12	1.24	1.43	0.71	0.00	0.00	0.00	0.00	3.51	0.73
1994	0.66	4.62	1.91	0.74	0.27	0.16	0.00	0.00	8.35	1.40
1995	0.26	1.72	6.01	3.89	0.38	0.09	0.00	0.00	12.34	2.87
1996	0.02	0.70	0.97	0.52	0.00	0.00	0.00	0.00	2.20	0.49
1997	0.04	1.62	2.58	2.08	0.46	0.00	0.00	0.00	6.79	1.90
1998	0.00	1.40	4.12	1.50	0.34	0.00	0.00	0.00	7.36	1.81
1999	0.03	1.29	4.14	2.96	0.58	0.22	0.00	0.00	9.21	2.85
2000*	0.17	16.53	26.68	2.45	0.40	0.16	0.00	0.00	46.39	15.15
mean	0.37	4.04	4.58	1.36	0.37	0.16	0.13	0.04	11.03	3.21

* preliminary

NEFSC Fall Survey

	age									
year	1	2	3	4	5	6	7	8+	sum	kg/tow
1979	7.87	8.02	2.41	0.60	0.11	0.03	0.00	0.00	19.04	5.34
1980	20.70	17.63	8.00	3.04	0.67	0.00	0.07	0.00	50.11	13.52
1981	6.34	9.64	1.74	0.45	0.29	0.00	0.00	0.00	18.46	4.11
1982	1.13	5.39	5.18	0.63	0.70	0.06	0.00	0.00	13.09	4.32
1983	0.66	0.88	0.55	0.04	0.00	0.00	0.00	0.00	2.13	0.49
1984	0.64	2.25	1.04	1.31	0.93	0.30	0.15	0.15	6.77	2.79
1985	9.03	3.48	2.65	0.40	0.00	0.00	0.00	0.00	15.56	3.25
1986	2.15	5.85	0.49	0.00	0.00	0.00	0.00	0.00	8.49	1.55
1987	0.89	2.13	0.75	0.09	0.07	0.00	0.00	0.00	3.93	0.87
1988	5.05	7.39	0.73	0.14	0.00	0.00	0.00	0.00	13.30	1.79
1989	2.89	9.34	3.43	0.61	0.00	0.00	0.00	0.11	16.39	3.68
1990	5.75	9.75	4.57	0.07	0.02	0.00	0.00	0.00	20.16	3.72
1991	2.93	2.73	2.36	0.48	0.00	0.00	0.00	0.00	8.50	1.83
1992	3.95	4.34	3.02	1.25	0.30	0.22	0.00	0.00	13.07	2.98
1993	7.18	7.05	0.83	0.12	0.00	0.00	0.00	0.00	15.18	1.68
1994	3.92	11.70	4.20	1.15	0.35	0.00	0.00	0.00	21.32	4.20
1995	0.97	1.34	1.29	0.28	0.07	0.00	0.00	0.00	3.94	1.17
1996	1.70	4.39	7.20	1.89	0.21	0.00	0.00	0.00	15.39	4.00
1997	1.70	3.93	4.47	2.02	1.09	0.19	0.00	0.00	13.39	3.62
1998	1.60	4.59	1.93	1.40	0.39	0.00	0.00	0.00	9.92	2.53
1999	6.38	12.77	8.33	2.57	1.13	0.04	0.00	0.00	31.23	9.28
mean	4.45	6.41	3.10	0.88	0.30	0.04	0.01	0.01	15.21	3.65

Table E5a. Estimates of abundance at age of Cape Cod yellowtail flounder.

	1985	1986	1987	1988	1989	1990	1991
1	9891	4712	6755	21229	7697	6280	9144
2	2702	7787	3786	5518	17054	6199	5068
3	1443	1378	3068	1756	2590	12034	2598
4	657	517	536	744	334	868	1988
5	326	65	197	196	43	63	317
6	116	14	89	39	11	50	73
1+	15133	14473	14432	29482	27730	25494	19187

	1992	1993	1994	1995	1996	1997	1998
1	7159	7099	5579	5218	7263	5652	8114
2	7070	4334	5688	4514	3862	5940	4626
3	3058	2277	3232	4230	3060	2667	4067
4	802	1112	1089	1469	1308	1216	883
5	221	165	366	259	427	264	255
6	17	82	168	137	25	20	75
1+	18327	15070	16122	15827	15945	15758	18020

	1999	2000
1	7973	
2	6636	6526
3	3521	4954
4	1654	1703
5	270	750
6	120	177
1+	20174	

Table E5b. Estimates of fishing mortality at age of Cape Cod yellowtail flounder.

	1985	1986	1987	1988	1989	1990	1991
1	0.04	0.02	0.00	0.02	0.02	0.01	0.06
2	0.47	0.73	0.57	0.56	0.15	0.67	0.31
3	0.83	0.74	1.22	1.46	0.89	1.60	0.98
4	2.11	0.76	0.80	2.64	1.47	0.81	2.00
5	2.40	0.78	0.82	3.43	1.56	0.83	2.24
6	2.40	0.78	0.82	3.43	1.56	0.83	2.24
F4,5	2.25	0.77	0.81	3.03	1.52	0.82	2.12
Fwb	0.48	0.61	0.72	0.40	0.24	1.09	0.66

	1992	1993	1994	1995	1996	1997	1998
1	0.30	0.02	0.01	0.10	0.00	0.00	0.00
2	0.93	0.09	0.10	0.19	0.17	0.18	0.07
3	0.81	0.54	0.59	0.97	0.72	0.91	0.70
4	1.38	0.91	1.24	1.04	1.40	1.36	0.99
5	1.45	0.94	1.29	1.07	1.48	1.44	1.02
6	1.45	0.94	1.29	1.07	1.48	1.44	1.02
F4,5	1.42	0.92	1.26	1.05	1.44	1.40	1.00
Fwb	0.86	0.35	0.43	0.62	0.62	0.50	0.42

	1999
1	0.00
2	0.09
3	0.53
4	0.59
5	0.59
6	0.59
F4,5	0.59
Fwb	0.31

Table E5c. Estimates of mean biomass and spawning biomass of Cape Cod yellowtail flounder.

MEAN BIOMASS (using catch mean weights at age)

	1985	1986	1987	1988	1989	1990	1991
1	1144	423	367	2288	900	452	968
2	551	1267	634	813	3888	1077	915
3	325	383	656	291	614	2064	520
4	126	176	186	131	106	301	426
5	70	30	80	37	19	32	87
6	33	09	51	09	07	30	28
1+	2247	2288	1974	3569	5533	3956	2943

	1992	1993	1994	1995	1996	1997	1998
1	281	573	402	315	263	154	221
2	550	601	1083	823	613	1533	1296
3	616	580	805	822	779	613	1100
4	210	289	283	354	320	283	279
5	66	73	118	89	110	74	93
6	10	49	73	62	12	08	45
1+	1732	2165	2764	2465	2098	2665	3033

	1999
1	217
2	1841
3	1051
4	640
5	106
6	75
1+	3931

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1985	1986	1987	1988	1989	1990	1991
1	00	00	00	00	00	00	00
2	46	106	53	68	319	90	76
3	274	324	551	242	519	1703	438
4	123	183	194	121	108	314	422
5	66	32	84	30	19	34	84
6	31	09	53	07	07	31	27
1+	540	654	934	468	972	2172	1046

	1992	1993	1994	1995	1996	1997	1998
1	00	00	00	00	00	00	00
2	46	49	88	68	50	126	106
3	520	488	679	693	658	518	928
4	216	301	293	369	329	292	291
5	68	76	122	93	112	76	97
6	10	51	75	64	13	08	47
1+	859	966	1257	1287	1163	1020	1469

	1999
1	00
2	150
3	885
4	666
5	111
6	78
1+	1890

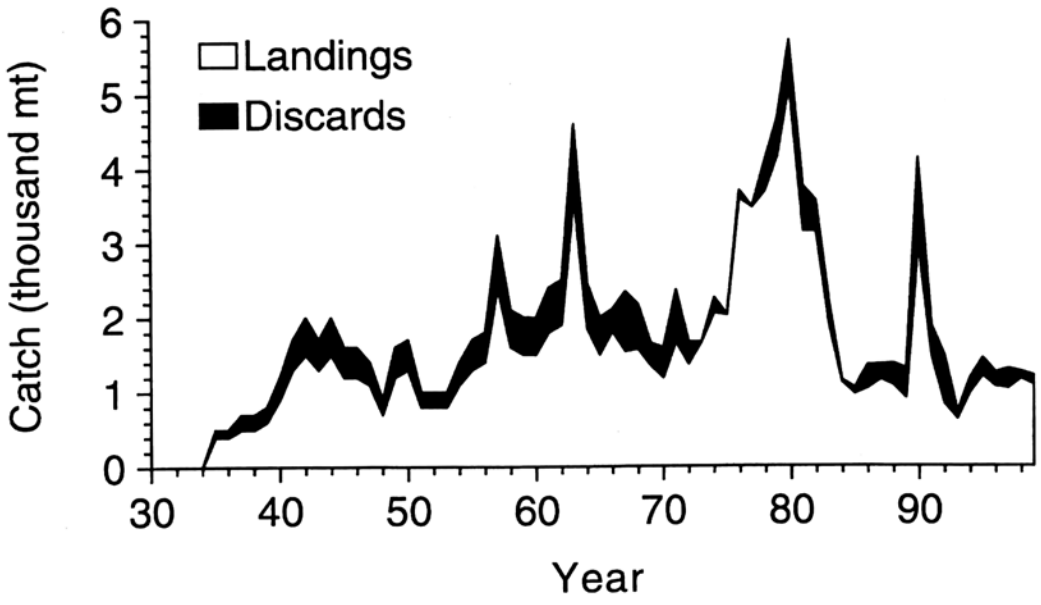

Figure E1. Total catch of Cape Cod yellowtail flounder.

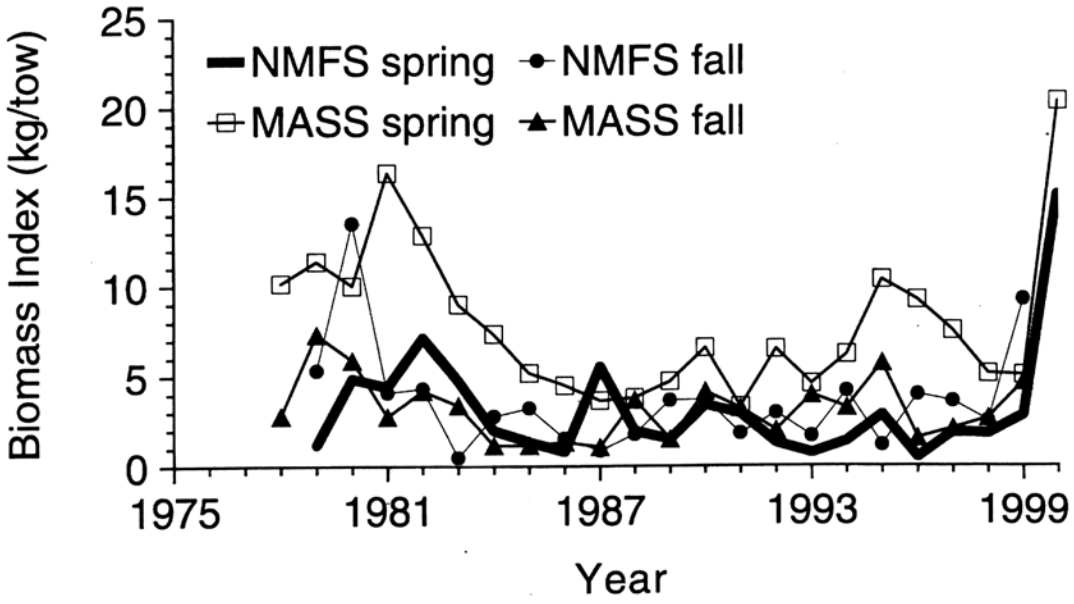

Figure E2. Survey indices of Cape Cod yellowtail flounder biomass.

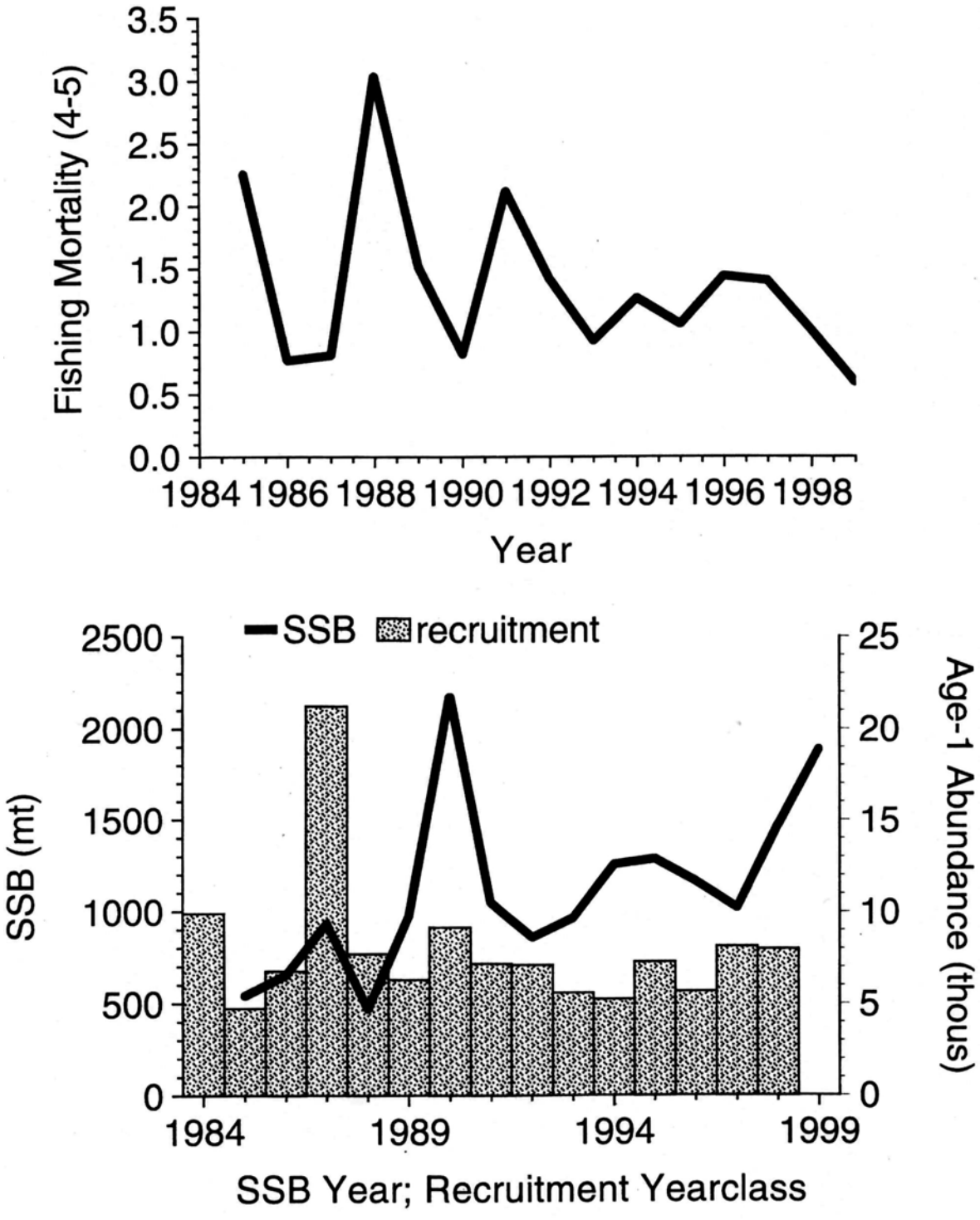

Figure E3. Summary of Cape Cod yellowtail VPA results.

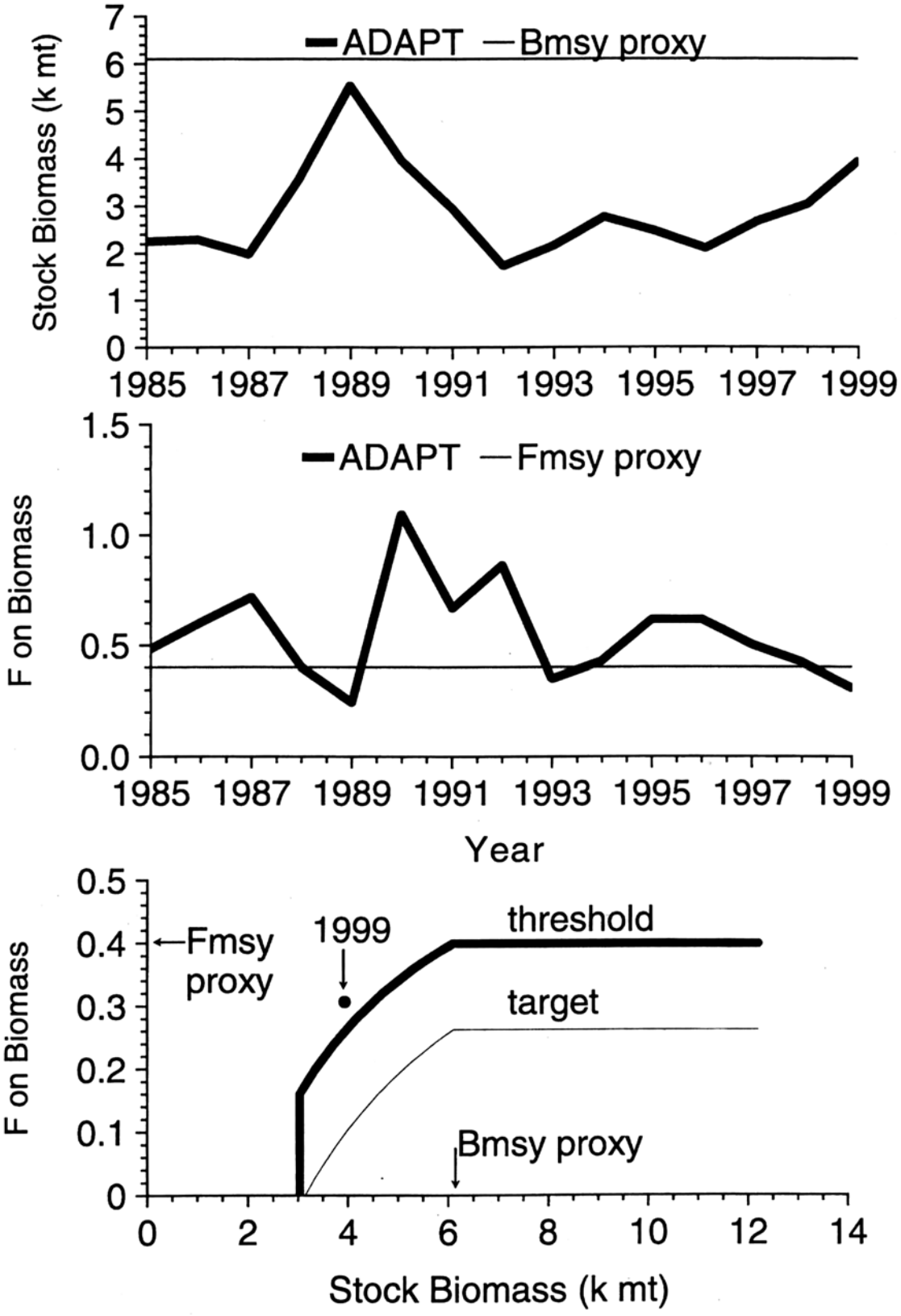

Figure E4. Status of the Cape Cod yellowtail flounder stock.

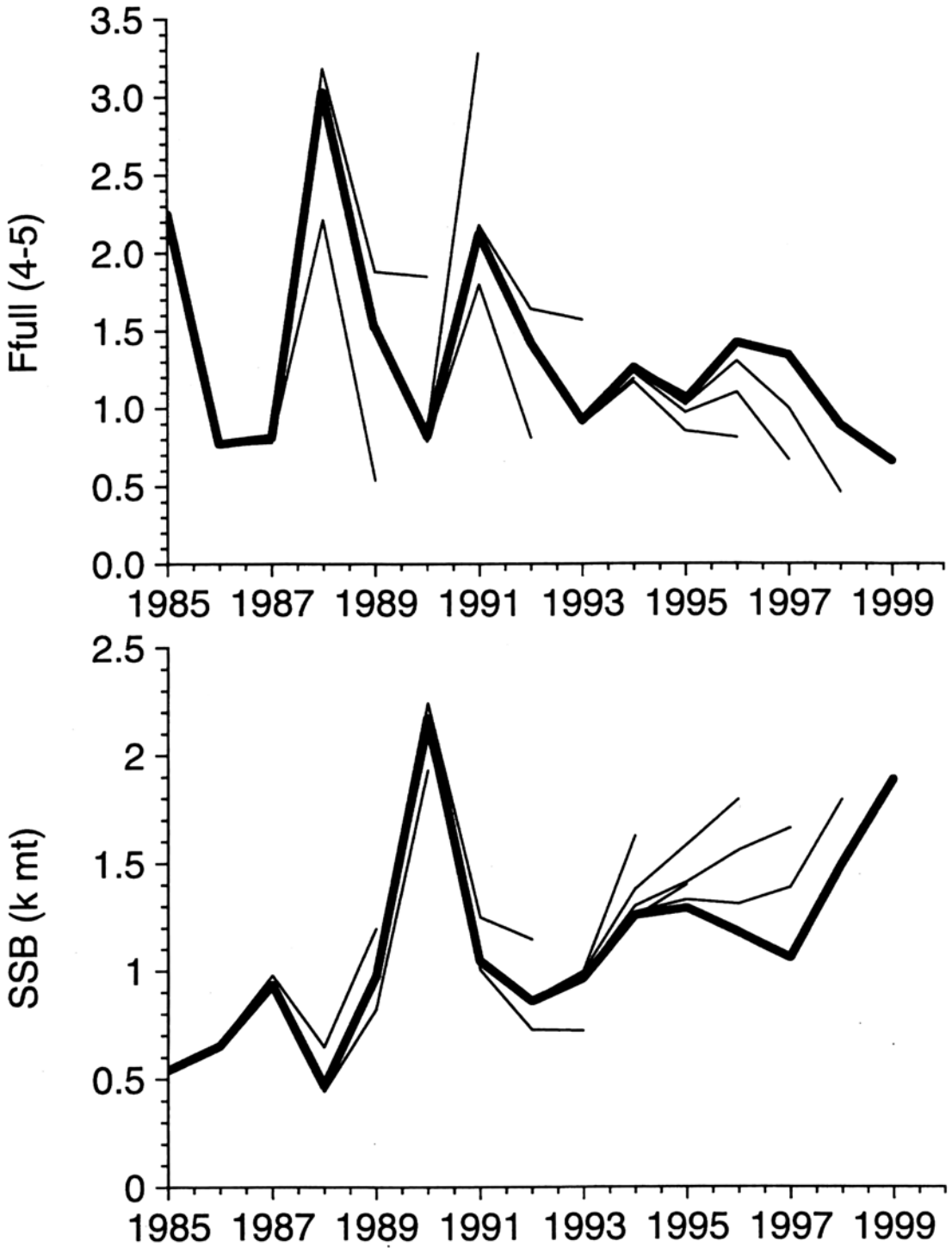

Figure E5. Retrospective analysis of the Cape Cod yellowtail flounder VPA.

F. Gulf of Maine Cod by R.K. Mayo

1.0 Background

The Gulf of Maine cod stock was last assessed in 1999 (Mayo MS 1999; Northern Demersal Working Group 2000) and the 1998 assessment was reviewed by the SARC at SAW 27 (Mayo et. al 1998; NEFSC 1998). In the 1999 assessment, fully recruited fishing mortality (ages 4+) in 1998 was estimated to be 0.64, and the 1997 F, which had been estimated at 0.75 in 1998 was estimated to be 0.85. Spawning stock biomass was estimated to have declined to 8,300 mt in 1998, a decline from a recent high of 14,200 mt in 1995 and a series high of 26,200 mt in 1989.

The strength of the most recent recruiting year classes was estimated to be very low. The 1994, 1995 and 1996 year classes continue to be estimated as the lowest in the VPA series dating back to 1982 (1980 year class). The recruit/SSB survival ratios for these most recent year classes were also estimated to be very low compared to previous year classes.

NEFSC spring and autumn research vessel bottom trawl survey indices for Gulf of Maine cod had declined to record low levels in the mid-1990s; indices from both surveys continue to fluctuate at relatively low levels. Recruitment indices for the 1994-1996 year classes derived from the NEFSC and Commonwealth of Massachusetts surveys were also among the lowest in the respective series, but the Mass. DMF survey indicated that the 1998 year class may be larger than the recent average.

2.0 The Fishery

Commercial landings of Gulf of Maine cod declined to 1,636 metric tons (mt) in 1999, a 61 % decline from 1998 (Table F1; Figure F1). Discard estimates have been derived on a gear-quarterly basis from 1989 through 1999; these results indicate a substantial increase in the overall discard /kept ratio in 1999 compared to previous years. The estimated recreational catch of Gulf of Maine cod (retained component only) remained the same in 1999 as in 1998 at approximately 822-824 mt.

The number of commercial port samples for this stock declined from 74 in 1997 to 46 in 1998 to 16 in 1999. Sampling was not well distributed among quarters and market categories in recent years, as only 1 biological sample was taken in the 3rd and 4th quarter of 1999, requiring substantial pooling over quarter. In 1999 samples from each market category were pooled on an annual basis. As has generally been the case, the landings at age in 1999 were dominated by age 3 and 4 cod.

The seasonal distribution of landings changed somewhat in 1999 compared to previous years. This may have been related to the imposition of very restrictive trip limits beginning in the latter part of the 3rd quarter of 1999. As a result, biological samples weighted toward the first half of the year may still be representative of the overall length and age composition of the landings,

although it is likely that annual numbers landed may have been overestimated. The following table illustrates the shift in the seasonal distribution of commercial landings between 1998 and 1999, and the corresponding trip limit regulations imposed during 1999.

Quarter	Landings % 1998	Landings % 1999	1999 Trip Limit Restrictions
1	26	34	400 lbs Jan-Mar
2	42	42	400 lbs Apr; 200 lbs May, Jun (part); 30 lbs Jun (part)
3	14	10	30 lbs Jul; 30 lbs Aug(part); 100 lbs Aug (part)-Sep
4	18	14	100 lbs Oct-Dec

3.0 Research Vessel Surveys

NEFSC research vessel bottom trawl survey abundance and biomass indices for Gulf of Maine cod remained relatively low through autumn 1999 and spring 2000 (Table F2; Figure F2). The autumn 1999 indices increased slightly from 1998, while the spring 2000 indices decreased slightly from the 1999, and remain no higher than indices observed in 1996 and 1997.

Recruitment indices for the 1994-1997 year classes derived from the NEFSC and Mass. DMF bottom trawl surveys are among the lowest in the respective series, although indices for the 1998 and 1999 year classes appears to be above the recent average (Figures F3a-b).

Autumn biomass indices were also partitioned into inshore (strata 26 and 27; area 1,734 square miles) and offshore (strata 28-30, 36-40; 16,158 square miles) Gulf of Maine regions. When expressed in this manner, stratified mean weight per tow indices may be seen to represent comparative biomass density rather than as indices of absolute biomass (Figure F4a). However, when appropriate weighting by area is applied to the respective inshore and offshore indices to allow comparison of absolute biomass between regions, the weighted indices provide a perspective on trends in absolute biomass (Figure F4 b). These results suggest that biomass has declined more precipitously in the offshore regions of the Gulf of Maine, while biomass in the inner region has declined at a lesser rate.

4.0 Assessment

Input Data and Analyses

The present assessment represents a one-year update to the previous assessment (Mayo MS 1999; NEFSC 2000). The same VPA formulation used in the previous assessment was employed in the present update, including the addition of current year (2000) spring survey data. Catch at age data for 1999, and NEFSC and Mass. DMF survey abundance indices (stratified mean number per tow at age) were updated through spring 2000. As in the most recent VPAs, commercial CPUE indices were included only through 1993.

Given the uncertainty in the amount of catch to include in the1999 catch at age (due to uncertainty in the magnitude of 1999 discards), no precision estimates of the 2000 stock sizes and 1999 fishing mortality and SSB estimates were derived. No retrospective analysis of terminal year estimates of stock sizes, fully recruited fishing mortality and SSB were carried out. However, the sensitivity of the VPA to terminal year catch assumptions was examined by performing the VPA under several discarding scenarios in 1999. The 1999 catch at age was adjusted upward by the ratio of landings plus discard to landings under various assumptions of discards ranging from 500 mt to 2,500 mt. Preliminary estimates of 1999 discards of Gulf of Maine cod range as high as 2,630 mt when the gear-quarter approach used in previous assessments is applied to 1999 Observer Program data

Assessment Results

Fully recruited fishing mortality (ages 4+) in 1999 is estimated to range from 0.29 (base run, assuming no discards) to 0.76 (assuming 2,500 mt discarded), while estimates of 1999 spawning stock biomass varied only slightly, ranging from 8,700 mt to 9,400 mt in 1999 (Table F12). Biomass-weighted fishing mortality (ages 1+) in 1999 is estimated to range from 0.10 (base run, assuming no discards) to 0.24 (assuming 2,500 mt discarded), while estimates of 1999 mean stock biomass (ages 1+) varied only slightly, ranging from 17,000 mt to 17,100 mt in 1999 (Table F12). However, almost one-half of the increase in age 1+ mean biomass between 1998 and 1999 can be attributed to the recruitment estimate for the 1998 year class at age 1 in 1999. Age 1 fish are not part of the exploitable biomass of Gulf of Maine cod; therefore the increase in age 1+ mean biomass overstates the apparent increase in the exploitable portion of the stock.

Regardless of the discard assumption employed in the analyses, recent recruiting year classes are estimated to be poor (Table F12). The 1993, 1994, 1995 and 1996 year classes are still estimated to be the lowest in the VPA series dating back to 1982.

VPA Diagnostics

No bootstrap runs or retrospective analyses were performed.

5.0 Forecasts

No forecasts of stock size and landings were performed.

6.0 Harvest Control Rule

According to the SFA control rule for Gulf of Maine cod, when the mean stock biomass is between 1/4 and ½ Bmsy (8,250-16,500 mt), a 5-year rebuilding period may be appropriate. The control rule and stock rebuilding harvest plan are based on the relation between mean biomass and biomass-weighted fishing mortality for ages 1+. Given that only ages 2 and older

are represented in the catch throughout the VPA series, a more appropriate control rule should be based on mean biomass and biomass-weighted F for ages 2+.

7.0 Conclusions

Given the uncertainty in the amount of discarding in 1999, it is not possible at this point to determine current fishing mortality. However, it may be considered that the fully recruited F and the biomass-weighted F derived from the base run (assuming no discards in 1999) may be considered as minimum estimates for these measures of 1999 fishing mortality. However, the maximum values for these measures of fishing mortality in 1999 is uncertain.

8.0 Sources of Uncertainty

- A substantial discarding event is likely to have occurred in 1999, but the magnitude is not precisely known. Until further information on effort is available, the degree of uncertainty in the current assessment cannot be determined.

- Poor biological sampling in 1998 and very poor sampling in 1999.

  Incomplete seasonal coverage and apparent incomplete sampling of larger cod may have resulted in an underestimate of the number of larger, relatively older cod in the 1998 and 1999 commercial landings. This would result in an overall lower mean weight, higher numbers landed and a greater dominance of younger fish in the estimated landings. The over-estimate of younger fish may have inflated the size of recruiting year classes in 1998 and 1997. No age 2 cod were detected in the biological samples in 1999, the first time ever.

- The proportion of unaccounted recreational catch in the 'total' catch used to model the dynamics of this stock has increased substantially in recent years.

  The landed component of the recreational catch represented 34% of the total commercial plus recreational landings in 1999, compared to 10-20% prior to 1999. This trend may affect current perceptions of fishing mortality unless all sources of fishing mortality are taken into account.

- Recent retrospective pattern inVPA.

  Fully recruited F has been under-estimated since 1995. Thus, short-term projections are likely to be optimistic if fishing mortality is actually higher in 1998 and 1999 than initially estimated.

9.0 References

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NEFSC. 1998. 27th Northeast Regional Stock Assessment Workshop (27th SAW). Stock Assessment Review Committee (SARC) Consensus Summary of Assessments. NMFS/NEFSC, Woods Hole Laboratory Ref. Doc. 98-15.

NDWG (Northern Demersal Working Group, Northeast Regional Stock Assessment Workshop). 2000. Assessment of 11 Northeast Groundfish Stocks through 1999: A Report to the New England Fishery Management Council's Multi-Species Monitoring Committee. NEFSC, Ref. Doc. 00/05.

Table F1. Commercial landings (metric tons, live) of Atlantic cod the Gulf of Maine (NAFO Division 5Y), 1960 - 1999.[1]

	Gulf of Maine				
Year	USA	Canada	USSR	Other	Total
1960	3448	129	-	-	3577
1961	3216	18	-	-	3234
1962	2989	83	-	-	3072
1963	2595	3	133	-	2731
1964	3226	25	-	-	3251
1965	3780	148	-	-	3928
1966	4008	384	-	-	4392
1967	5676	297	-	-	5973
1968	6360	61	-	-	6421
1969	8157	59	-	268	8484
1970	7812	26	-	423	8261
1971	7380	119	-	163	7662
1972	6776	53	11	77	6917
1973	6069	68	-	9	6146
1974	7639	120	-	5	7764
1975	8903	86	-	26	9015
1976	10172	16	-	-	10188
1977	12426	-	-	-	12426
1978	12426	-	-	-	12426
1979	11680	-	-	-	11680
1980	13528	-	-	-	13528
1981	12534	-	-	-	12534
1982	13582	-	-	-	13582
1983	13981	-	-	-	13981
1984	10806	-	-	-	10806
1985	10693	-	-	-	10693
1986	9664	-	-	-	9664
1987	7527	-	-	-	7527
1988	7958	-	-	-	7958
1989	10397	-	-	-	10397
1990	15154	-	-	-	15154
1991	17781	-	-	-	17781
1992	10891	-	-	-	10891
1993	8287	-	-	-	8287
1994*	7877	-	-	-	7877
1995*	6798	-	-	-	6798
1996*	7194	-	-	-	7194
1997*	5421	-	-	-	5421
1998*	4156	-	-	-	4156
1999*	1636	-	-	-	1636

* Provisional

[1] USA 1960-1993 landings from NMFS, NEFSC Detailed Weighout Files and Canvass data.

[2] USA 1994-1999 landings estimated by prorating NMFS, NEFSC Detailed Weighout data by Vessel Trip Reports.

Table F2. Standardized stratified mean catch per tow in numbers and weight (kg) for Atlantic cod from NEFSC offshore spring and autumn research vessel bottom trawl surveys in the Gulf of Maine (Strata 26-30 and 36-40), 1963 - 2000 [a,b]

	Gulf of Maine [c]			
	Spring		Autumn	
Year	No/Tow	Wt/Tow	No/Tow	Wt/Tow
1963	-	-	5.92	17.9
1964	-	-	4.00	22.8
1965	-	-	4.49	12.0
1966	-	-	3.78	12.9
1967	-	-	2.56	9.2
1968	5.44	17.9	4.39	19.4
1969	3.25	13.2	2.76	15.4
1970	2.21	11.1	4.90	16.4
1971	1.43	7.0	4.37	16.5
1972	2.06	8.0	9.31	13.0
1973	7.54	18.8	4.46	8.7
1974	2.91	7.4	4.33	9.0
1975	2.51	6.0	6.15	8.6
1976	2.78	7.6	2.15	6.7
1977	3.88	8.5	3.08	10.2
1978	2.06	7.7	5.75	12.9
1979	4.27	9.5	3.49	17.5
1980	2.15	6.2	7.04	14.2
1981	4.86	10.8	2.42	8.1
1982	3.75	8.6	7.77	16.1
1983	3.91	10.5	4.22	8.8
1984	3.40	5.8	2.42	8.8
1985	2.52	7.7	2.92	8.5
1986	1.96	3.6	1.95	5.1
1987	1.68	3.0	2.98	3.4
1988	3.13	3.3	5.90	6.6
1989	2.26	2.5	4.65	4.6
1990	2.36	3.1	2.99	4.9
1991	2.39	2.9	1.25	2.8
1992	2.41	8.7	1.43	2.4
1993	2.50	5.9	1.23	1.0
1994	1.27	2.4	2.14	2.7
1995	1.91	2.4	2.01	3.7
1996	2.46	5.4	1.32	2.4
1997	2.19	5.6	0.87	1.9
1998	1.71	4.2	0.84	1.5
1999	2.30	5.1	1.81	3.5
2000	3.08	3.2		

[a] During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portugeuse polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NEFSC 1991).

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

[c] In the Gulf of Maine, spring surveys during 1980-1982, 1989-1991 and 1994, and autumn surveys during 1977-1978, 1980, 1989-1991 and 1993 were accomplished with the R/V DELAWARE II; in all other years, the surveys were accomplished using the R/V ALBATROSS IV. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBTATROSS IV equivalents. Conversion coefficients 0.79 (number) and 0.67 (weight) were used in this standardization (NEFSC 1991).

Table F3. VPA results for Gulf of Maine cod under various assumption of 1999 discarding ranging from 0 tons (landings only base run) to 2,500 tons.

Fisheries Assessment Toolbox GoM Cod 1999 Base Run Run Number 1 8/23/2000 9:17:20 AM
FACT Version 1.3.6
GoM Cod 1999 (No Discards)
Input Parameters and Options Selected

RESULTS

Approximate Statistics Assuming Linearity Near Solution
Sum of Squares: 131.946102581412
Mean Square Residuals: 0.45499

	PAR. EST.	STD. ERR.	T-STATISTIC C.V.
N 2	5.79E+03	2.02E+03	2.87E+00 0.35
N 3	2.62E+03	6.91E+02	3.79E+00 0.26
N 4	1.41E+03	3.39E+02	4.14E+00 0.24
N 5	4.49E+02	1.33E+02	3.38E+00 0.30
N 6	2.84E+02	9.48E+01	3.00E+00 0.33

STOCK NUMBERS (Jan 1) in thousands - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_base.2

	1996	1997	1998	1999	2000
1	2101	2981	3902	7066	00
2	2371	1720	2441	3195	5785
3	1721	1882	1360	1913	2615
4	3635	881	1145	761	1405
5	531	1404	327	447	449
6	89	121	396	119	284
7	19	14	20	157	169
1+	10467	9002	9592	13658	10709

FISHING MORTALITY - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_base.2

	1996	1997	1998	1999
1	0.00	0.00	0.00	0.00
2	0.03	0.03	0.04	0.00
3	0.47	0.30	0.38	0.11
4	0.75	0.79	0.74	0.33
5	1.28	1.06	0.81	0.25
6	0.82	0.98	0.77	0.29
7	0.82	0.98	0.77	0.29

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1996	1997	1998	1999
1+	12222	9420	8053	8656

MEAN BIOMASS (using catch mean weights at age)

	1996	1997	1998	1999
1+	15096	13057	12377	16947
2+	13382	10624	9194	11184

Biomass Weighted F

	1996	1997	1998	1999
1+	0.48	0.42	0.34	0.10
2+	0.54	0.52	0.46	0.15

Table F3 (cont.). VPA results for Gulf of Maine cod under various assumption of 1999 discarding ranging from 0 tons (landings only base run) to 2,500 tons.

Fisheries Assessment Toolbox GoM Cod 1999 Disc500 Run Run Number 1 8/23/2000 9:44:33 AM
FACT Version 1.3.6
GoM Cod 1999 Discards = 500 mt
Input Parameters and Options Selected

RESULTS

Approximate Statistics Assuming Linearity Near Solution
Sum of Squares: 132.038584642968
Mean Square Residuals: 0.45531

	PAR. EST.	STD. ERR.	T-STATISTIC C.V.
N 2	5.80E+03	2.03E+03	2.86E+00 0.35
N 3	2.62E+03	6.93E+02	3.79E+00 0.26
N 4	1.39E+03	3.42E+02	4.06E+00 0.25
N 5	4.17E+02	1.31E+02	3.17E+00 0.32
N 6	2.67E+02	9.30E+01	2.87E+00 0.35

STOCK NUMBERS (Jan 1) in thousands - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.2

	1996	1997	1998	1999	2000
1	2147	3039	3914	7088	00
2	2389	1758	2488	3204	5803
3	1725	1897	1391	1952	2623
4	3641	884	1157	786	1388
5	531	1409	330	457	417
6	89	121	400	121	267
7	19	14	20	161	157
1+	10542	9122	9702	13770	10656

FISHING MORTALITY - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.2

	1996	1997	1998	1999
1	0.00	0.00	0.00	0.00
2	0.03	0.03	0.04	0.00
3	0.47	0.29	0.37	0.14
4	0.75	0.79	0.73	0.44
5	1.28	1.06	0.80	0.34
6	0.82	0.97	0.76	0.39
7	0.82	0.97	0.76	0.39

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1996	1997	1998	1999
1+	12254	9490	8182	8743

MEAN BIOMASS (using catch mean weights at age)

	1996	1997	1998	1999
1+	15187	13222	12565	16908
2+	13435	10743	9372	11126

Biomass Weighted F

	1996	1997	1998	1999
1+	0.48	0.42	0.33	0.13
2+	0.54	0.52	0.44	0.20

Table F3 (cont.). VPA results for Gulf of Maine cod under various assumption of 1999 discarding ranging from 0 tons (landings only base run) to 2,500 tons.

Fisheries Assessment Toolbox GoM Cod 1999 Disc1000 Run Run Number 2 8/23/2000 9:32:53 AM
FACT Version 1.3.6
GoM Cod 1999 Discards = 1000 mt
Input Parameters and Options Selected

RESULTS

Approximate Statistics Assuming Linearity Near Solution
Sum of Squares: 132.133151684434
Mean Square Residuals: 0.45563

	PAR. EST.	STD. ERR.	T-STATISTIC C.V.
N 2	5.82E+03	2.03E+03	2.86E+00 0.35
N 3	2.63E+03	6.96E+02	3.79E+00 0.26
N 4	1.37E+03	3.45E+02	3.98E+00 0.25
N 5	3.87E+02	1.29E+02	2.99E+00 0.33
N 6	2.52E+02	9.11E+01	2.76E+00 0.36

STOCK NUMBERS (Jan 1) in thousands - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.3

	1996	1997	1998	1999	2000
1	2199	3102	3928	7113	00
2	2409	1800	2539	3216	5824
3	1736	1913	1426	1994	2633
4	3650	893	1170	815	1373
5	532	1415	338	468	387
6	89	122	406	127	252
7	19	14	21	166	148
1+	10634	9259	9827	13898	10616

FISHING MORTALITY - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.3

	1996	1997	1998	1999
1	0.00	0.00	0.00	0.00
2	0.03	0.03	0.04	0.00
3	0.46	0.29	0.36	0.17
4	0.75	0.77	0.72	0.54
5	1.27	1.05	0.78	0.42
6	0.82	0.96	0.75	0.48
7	0.82	0.96	0.75	0.48

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1996	1997	1998	1999
1+	12307	9587	8345	8865

MEAN BIOMASS (using catch mean weights at age)

	1996	1997	1998	1999
1+	15306	13425	12794	16911
2+	13512	10895	9590	11109

Biomass Weighted F

	1996	1997	1998	1999
1+	0.48	0.41	0.33	0.16
2+	0.54	0.50	0.44	0.24

Table F3 (cont.). VPA results for Gulf of Maine cod under various assumption of 1999 discarding ranging from 0 tons (landings only base run) to 2,500 tons.

Fisheries Assessment Toolbox GoM Cod 1999 Disc1500 Run Run Number 3 8/23/2000 9:39:40 AM
FACT Version 1.3.6
GoM Cod 1999 Discards = 1500 mt
Input Parameters and Options Selected

RESULTS

Approximate Statistics Assuming Linearity Near Solution
Sum of Squares: 132.35171912039
Mean Square Residuals: 0.45639

	PAR. EST.	STD. ERR.	T-STATISTIC C.V.
N 2	5.85E+03	2.04E+03	2.86E+00 0.35
N 3	2.64E+03	6.99E+02	3.78E+00 0.26
N 4	1.36E+03	3.48E+02	3.90E+00 0.26
N 5	3.63E+02	1.28E+02	2.84E+00 0.35
N 6	2.38E+02	8.93E+01	2.66E+00 0.38

STOCK NUMBERS (Jan 1) in thousands - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.2

	1996	1997	1998	1999	2000
1	2263	3166	3943	7141	00
2	2434	1853	2592	3228	5846
3	1743	1934	1469	2037	2643
4	3658	899	1187	850	1359
5	533	1423	342	482	363
6	89	123	412	131	238
7	20	14	21	172	139
1+	10741	9411	9966	14040	10588

FISHING MORTALITY - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.2

	1996	1997	1998	1999
1	0.00	0.00	0.00	0.00
2	0.03	0.03	0.04	0.00
3	0.46	0.29	0.35	0.20
4	0.74	0.77	0.70	0.65
5	1.27	1.04	0.76	0.51
6	0.82	0.95	0.73	0.58
7	0.82	0.95	0.73	0.58

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1996	1997	1998	1999
1+	12355	9687	8523	9003

MEAN BIOMASS (using catch mean weights at age)

	1996	1997	1998	1999
1+	15436	13646	13043	16933
2+	13590	11064	9827	11108

Biomass Weighted F

	1996	1997	1998	1999
1+	0.47	0.41	0.32	0.19
2+	0.53	0.51	0.42	0.29

Table F3 (cont.). VPA results for Gulf of Maine cod under various assumption of 1999 discarding ranging from 0 tons (landings only base run) to 2,500 tons.

Fisheries Assessment Toolbox GoM Cod 1999 Disc2000 Run Run Number 4 8/23/2000 9:47:12 AM
FACT Version 1.3.6
GoM Cod 1999 Discards = 2000 mt
Input Parameters and Options Selected

RESULTS

Approximate Statistics Assuming Linearity Near Solution
Sum of Squares: 132.633682240907
Mean Square Residuals: 0.45736

	PAR. EST.	STD. ERR.	T-STATISTIC C.V.
N 2	5.87E+03	2.05E+03	2.86E+00 0.35
N 3	2.65E+03	7.02E+02	3.78E+00 0.26
N 4	1.35E+03	3.52E+02	3.83E+00 0.26
N 5	3.42E+02	1.26E+02	2.71E+00 0.37
N 6	2.26E+02	8.77E+01	2.58E+00 0.39

STOCK NUMBERS (Jan 1) in thousands - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.2

	1996	1997	1998	1999	2000
1	2336	3234	3959	7171	00
2	2463	1913	2648	3242	5871
3	1752	1957	1518	2083	2654
4	3668	906	1206	890	1347
5	534	1431	348	497	342
6	89	123	419	136	226
7	20	14	21	178	131
1+	10862	9578	10119	14196	10572

FISHING MORTALITY - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.2

	1996	1997	1998	1999
1	0.00	0.00	0.00	0.00
2	0.03	0.03	0.04	0.00
3	0.46	0.28	0.33	0.24
4	0.74	0.76	0.69	0.76
5	1.27	1.03	0.74	0.59
6	0.81	0.94	0.71	0.67
7	0.81	0.94	0.71	0.67

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1996	1997	1998	1999
1+	12410	9802	8724	9169

MEAN BIOMASS (using catch mean weights at age)

	1996	1997	1998	1999
1+	15584	13894	13321	16988
2+	13678	11256	10091	11139

Biomass Weighted F

	1996	1997	1998	1999
1+	0.47	0.40	0.32	0.22
2+	0.54	0.49	0.42	0.34

Table F3 (cont.). VPA results for Gulf of Maine cod under various assumption of 1999 discarding ranging from 0 tons (landings only base run) to 2,500 tons.

Fisheries Assessment Toolbox GoM Cod 1999 Disc2500 Run Run Number 5 8/23/2000 9:51:27 AM
FACT Version 1.3.6
GoM Cod 1999 Discards = 2500 mt
Input Parameters and Options Selected

RESULTS

Approximate Statistics Assuming Linearity Near Solution
Sum of Squares: 132.976882676815
Mean Square Residuals: 0.45854

	PAR. EST.	STD. ERR.	T-STATISTIC C.V.
N 2	5.90E+03	2.07E+03	2.86E+00 0.35
N 3	2.67E+03	7.06E+02	3.77E+00 0.26
N 4	1.34E+03	3.56E+02	3.76E+00 0.27
N 5	3.25E+02	1.25E+02	2.60E+00 0.38
N 6	2.15E+02	8.61E+01	2.50E+00 0.40

STOCK NUMBERS (Jan 1) in thousands - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.2

	1996	1997	1998	1999	2000
1	2416	3304	3977	7203	00
2	2495	1978	2705	3256	5897
3	1761	1984	1571	2130	2666
4	3680	914	1228	934	1336
5	535	1440	354	515	325
6	90	124	427	141	215
7	20	14	22	186	125
1+	10997	9759	10284	14364	10565

FISHING MORTALITY - D:\ASSESS\GMCOD\gmcod2000\gmcod2000_disc.2

	1996	1997	1998	1999
1	0.00	0.00	0.00	0.00
2	0.03	0.03	0.04	0.00
3	0.46	0.28	0.32	0.27
4	0.74	0.75	0.67	0.85
5	1.26	1.02	0.72	0.67
6	0.81	0.93	0.69	0.76
7	0.81	0.93	0.69	0.76

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1996	1997	1998	1999
1+	12475	9933	8947	9356

MEAN BIOMASS (using catch mean weights at age)

	1996	1997	1998	1999
1+	15752	14166	13626	17068
2+	13782	11471	10382	11192

Biomass Weighted F

	1996	1997	1998	1999
1+	0.46	0.39	0.31	0.24
2+	0.53	0.48	0.41	0.37

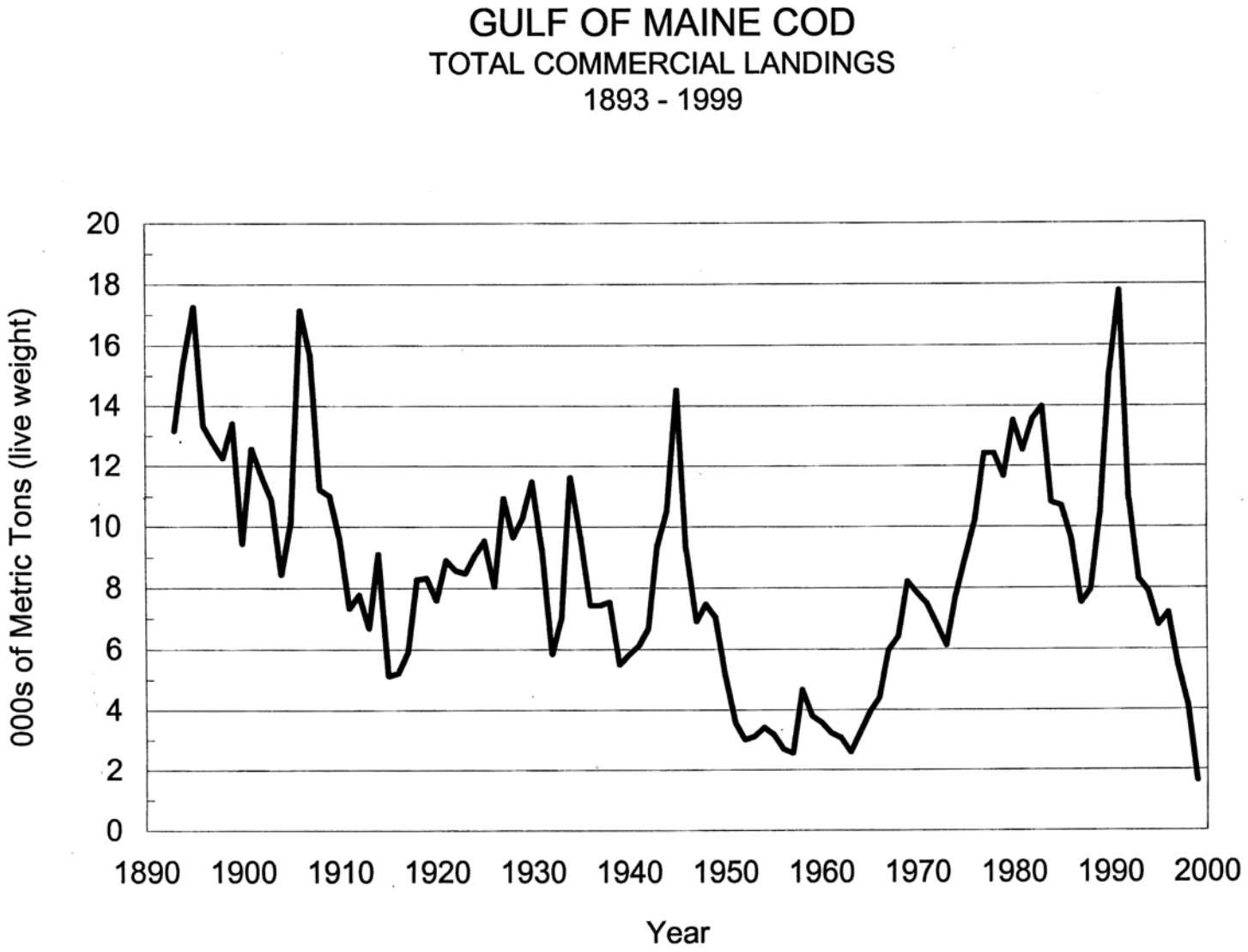


Figure F1. Total commercial landings of Gulf of Maine cod (NAFO Div. 5Y), 1893-1999.

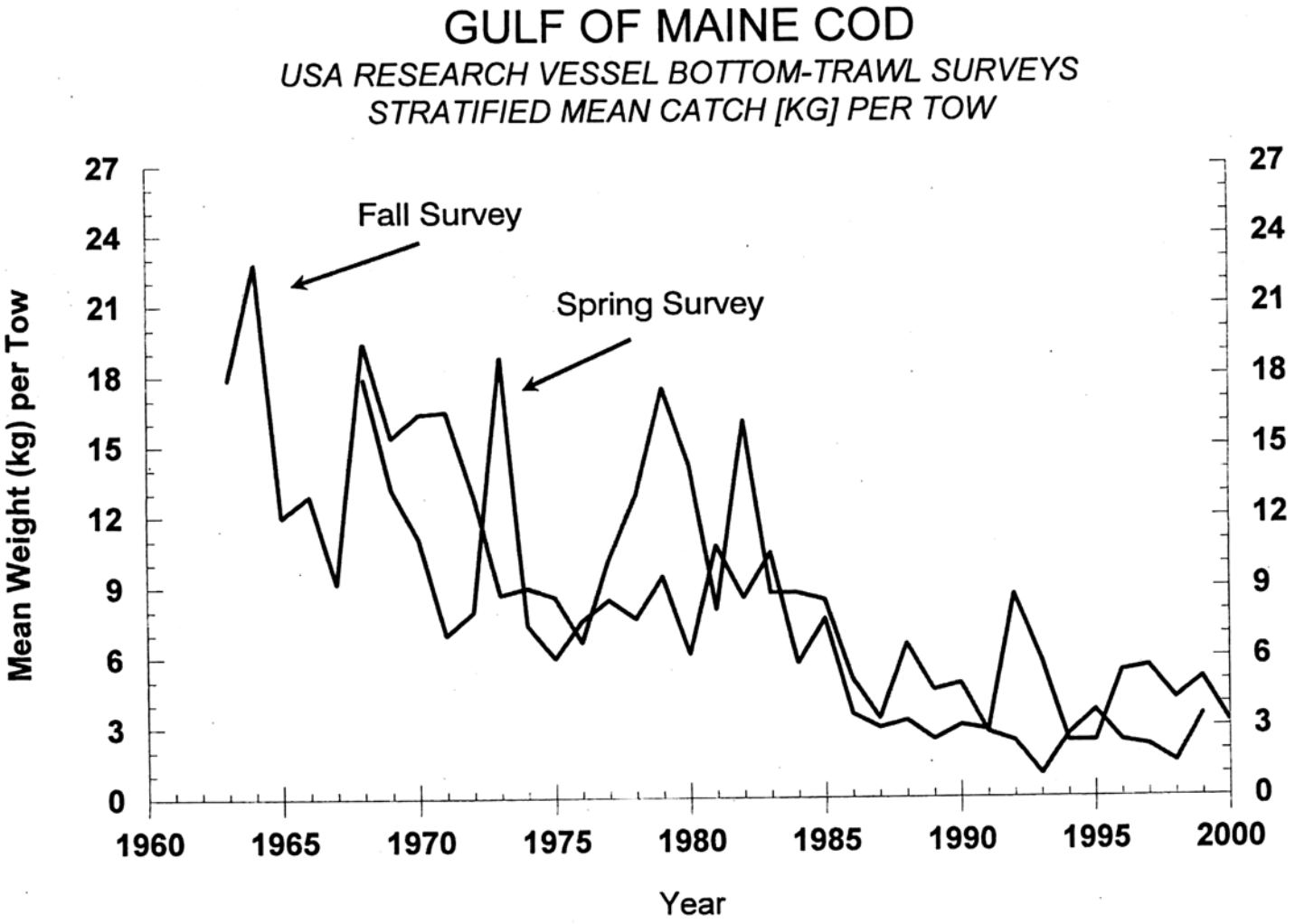
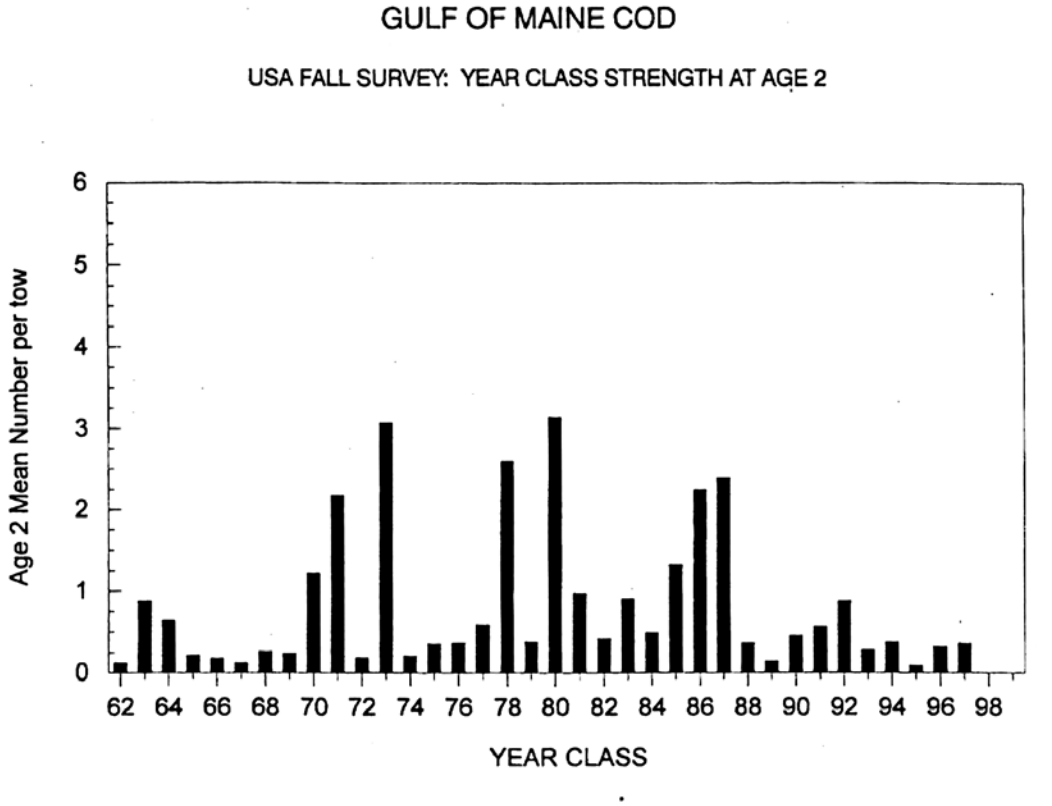


Figure F2 Standardized stratified mean catch (kg) per tow of Atlantic cod in NEFSC spring and autumn research vessel bottom trawl surveys in the Gulf of Maine, 1963-2000.



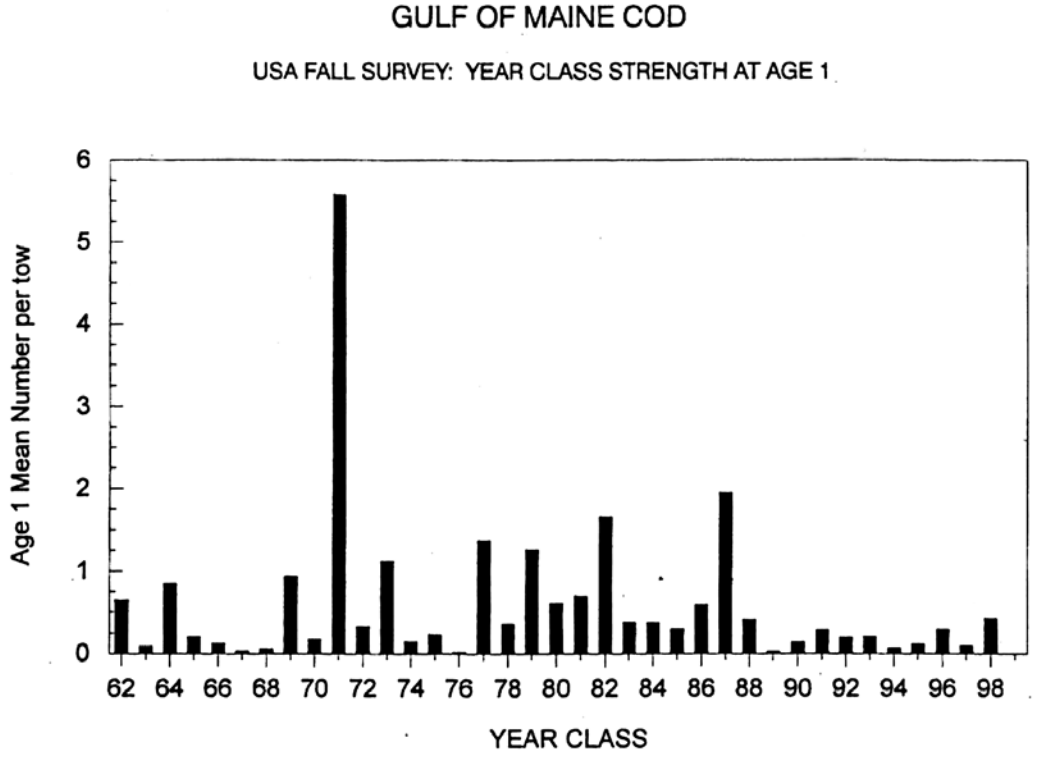
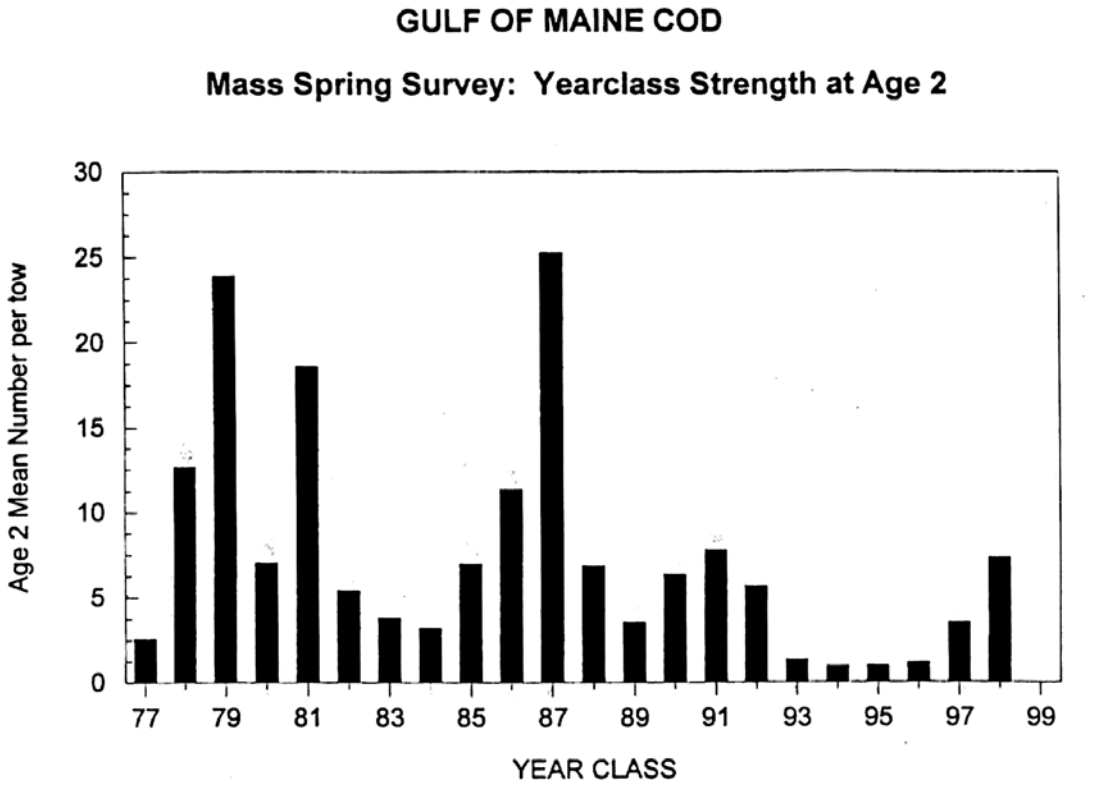


Figure F3a. Recruitment indices from NEFSC autumn surveys.



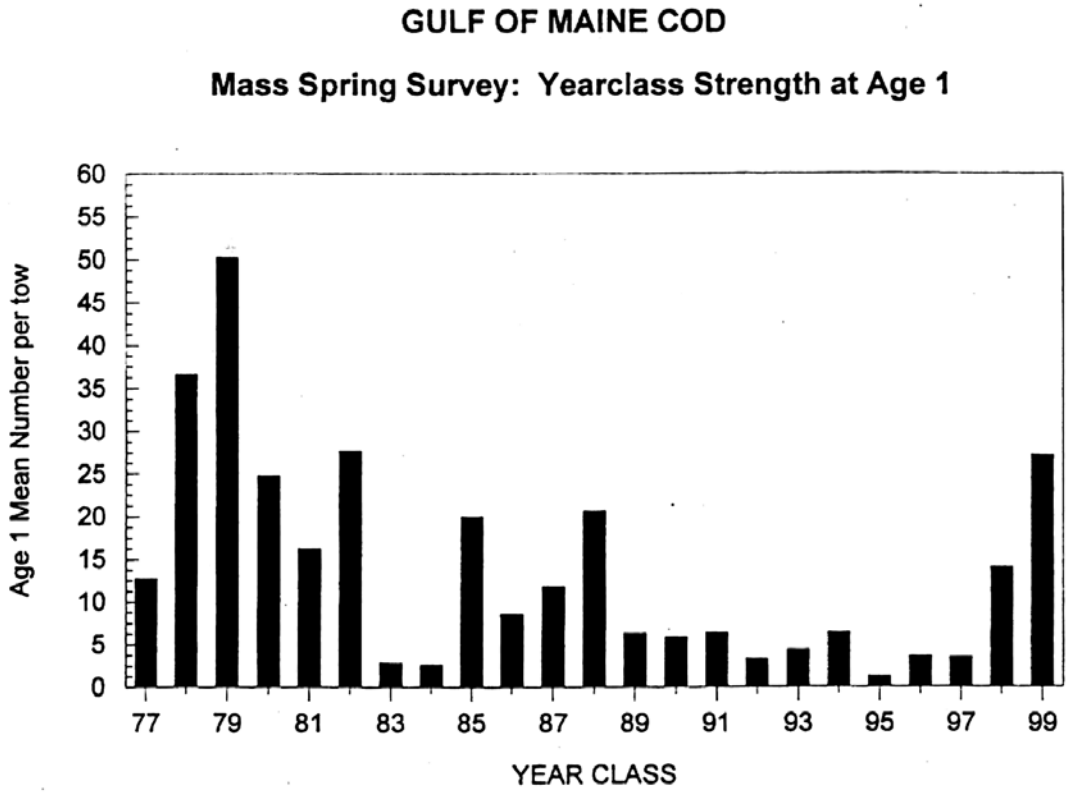


Figure F3b. Recruitment indices from Comm. of Mass. DMF spring surveys.

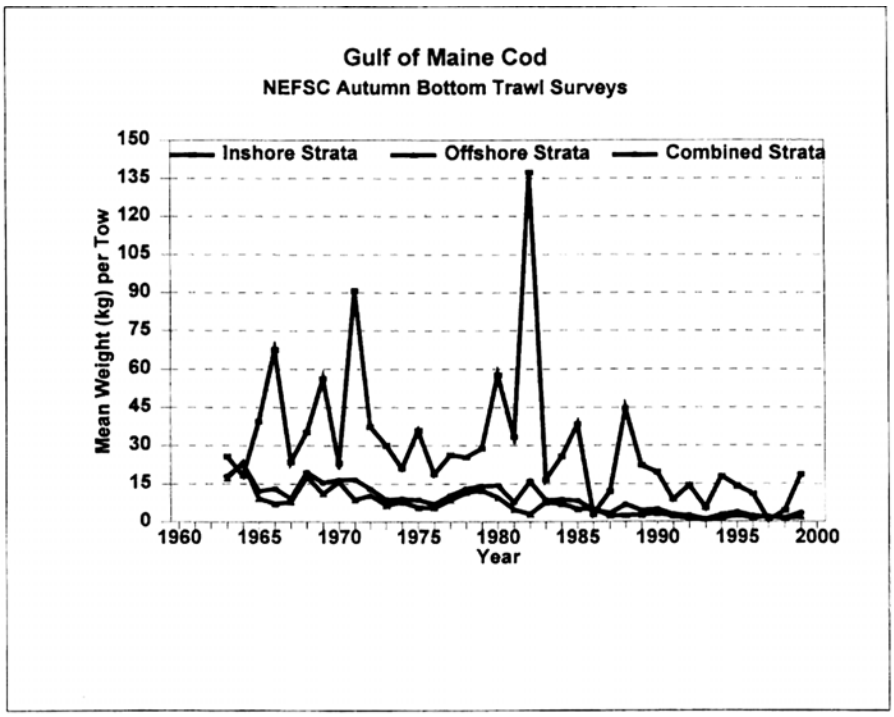


Figure F4a. Stratified mean weight per tow indices for Gulf of Maine cod by Inshore (strata 26 and 27), Offshore (strata 28-30 and 36-40), and Combined (Strata 26-30 and 36-40) regions, providing comparative indices of relative stock biomass density between inshore and off shore regions.

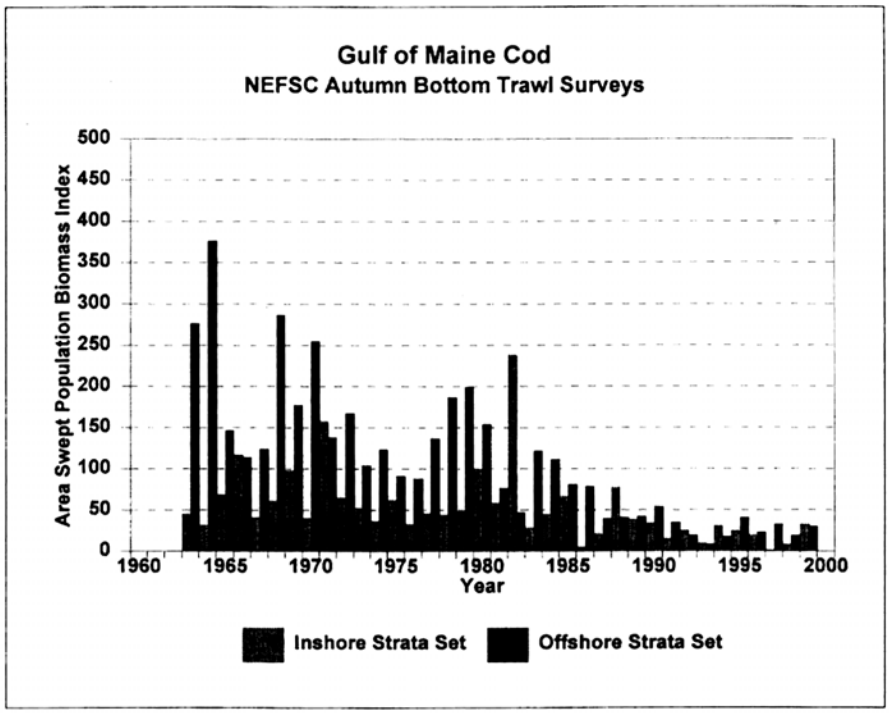


Figure F4b. Stratified mean weight per tow indices for Gulf of Maine cod by Inshore (strata 26 and 27), Offshore (strata 28-30 and 36-40), and Combined (Strata 26-30 and 36-40) regions weighted by the area of each region providing comparative indices of relative stock biomass between regions.

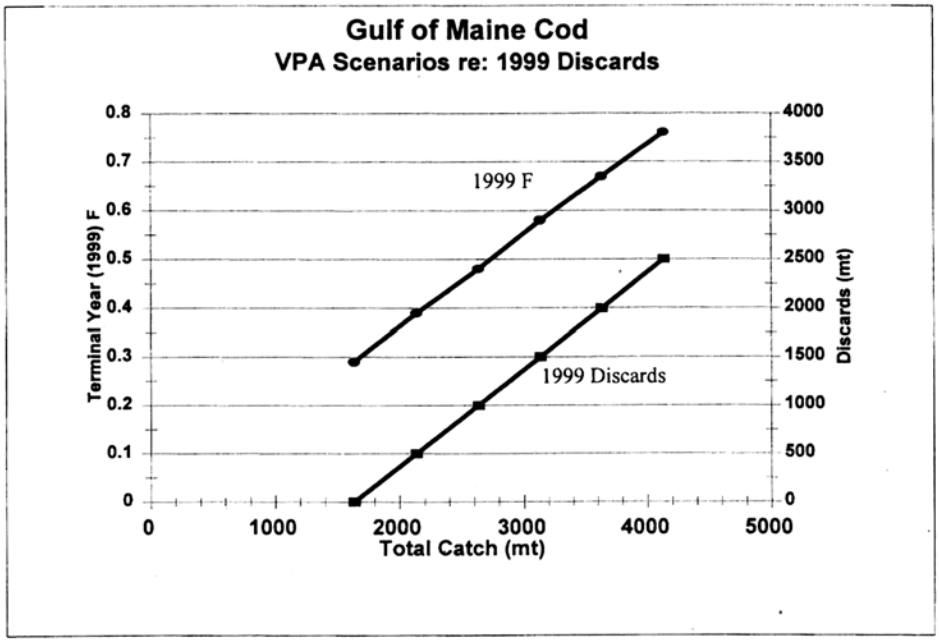


Figure F5 Effect of increased 1999 discarding on estimates of fully recruited terminal F for Gulf of Maine cod.

G. Witch Flounder by S. E. Wigley

1.0 Background

Witch flounder, *Glyptocephalus cynoglossus*, are assessed as a unit stock from the Gulf of Maine southward. An analytical assessment was conducted on this species in 1999 (Wigley et al. 1999) and reviewed at SAW 29 (NEFSC 1999). At that time, average fishing mortality (ages 7-9, unweighted) increased from 0.21 in 1982 to 0.59 in 1985, declined to 0.24 in 1990, increased to 0.86 in 1996, then declined to 0.37 (F on 3+ biomass was 0.13) in 1998. Mean 3+ biomass declined steadily from 27,930 mt in 1982 to 7,742 mt in 1994, then sharply increased to 18,934 mt by 1998. Spawning stock biomass declined from 18,000 tons in 1982 to about 4,000 tons in 1993 and then increased sharply to 8,600 mt in 1998. However, spawning stock biomass was at a low level relative to the long-term survey biomass indices. Since 1982, recruitment at age 3 has ranged from approximately 3 million fish (1984 year class) to 38 million fish (1996 year class) with a mean of 14 million fish. Recent recruitment had been above average, and the 1995 and 1996 year classes were estimated to be among the highest in the time series.

Assuming 1999 catches will equal 1998 catches, the 1999 fully recruited fishing mortality rate was estimated to be 0.20, and the target fishing mortality (F on biomass) prescribed by the control rule for the 1999 stock size was 0.096, which was approximately equivalent to 0.19 on fully recruited ages assuming the current age structure of the population (NEFSC 1999). The estimated mean 3+ biomass in 1999 was projected to be 26,048 mt (above the overfishing threshold and near Bmsy) and the F on 3+ biomass was estimated to be 0.096 (slightly lower that the overfishing threshold and near F target). Based in the 1999 estimates, the stock was considered to be near target biomass and fishing mortality levels (NEFSC 1999).

2.0 The Fishery

Historically, significant proportions of the U.S. nominal catch have been taken both on Georges Bank and in the Gulf of Maine; but in recent years most of the U.S. catch has come from the Gulf of Maine area. Canadian landings from both areas have been minor (never more than 68 mt annually). Distant-water fleet catches averaged 2,700 mt in 1971-1972, but subsequently declined sharply and have been negligible since 1976. Total landings peaked at more than 6,000 mt in 1971, declined to an annual average of 2,800 mt during 1973-1981, and then increased sharply to 6,700 mt in 1984. Landings then declined steadily to only 1,500 mt in 1990, the lowest value since 1964. Landings for 1991-1998 averaged 2,200 mt annually. Total landings in 1999 were 2,123 mt (Table G1, Figure G1), 15% higher than the estimated landings used in the 1999 assessment. Based upon the 1998 percentage of discard/landings (18%), discard weight in 1999 was estimated to be 382 mt.

3.0 Research Vessel Survey Indices

The NEFSC autumn bottom trawl survey biomass index declined from an average of 3.6 kg per tow in 1966-1970 to 0.9 kg per tow in 1976 following heavy exploitation by distant-water fleets. The index increased in 1977-78 but then declined to 0.2 kg per tow in 1992, the lowest level on record. Since 1993, the survey biomass index has remained at low levels, averaging 0.7 kg per tow. The 1999 biomass index was 0.9 kg per tow (Table G2, Figure G1). The maximum age of witch flounder observed in the 1999 research vessel surveys was age 10, the lowest maximum age in the 20 year time series, indicating the age structure of the population remains truncated. The low number of older fish may adversely impact the stock's reproductive potential output.

4.0 Assessment Results

Results of the projection analysis indicate that the 1999 fully recruited F was 0.23 (0.18 - 0.30 with 80% confidence) and that F on 3+ biomass was 0.109. The 1999 assumed fully recruited F (0.2) from the previous assessment was slightly lower, but falls within the confidence band of the current analysis. The 1999 mean 3+ biomass was 25,509 mt (19,235 - 34,631 mt with 80% confidence), slightly lower than the estimate from the previous assessment (26,048 mt), but within the confidence band of the current analysis (Table G3, Figure G2). The index assessment presented above reveals that landings and survey trends have remained stable indicating that no substantial change in stock status has occurred since the last analytical assessment.

5.0 Harvest Control Rule

The harvest control rule for witch flounder states that when the stock biomass exceeds B_{msy}, the overfishing threshold is F_{msy}, and target F is the lower 80^{th} percentile (or 10^{th} percentile) of F_{msy}. When stock biomass is less than B_{msy}, the overfishing threshold is based on maximum F that would allow rebuilding to B_{msy} in five years. When biomass is less than the biomass threshold, F = 0. The biomass threshold is defined by the minimum stock size that is projected to rebuild to B_{msy} in 5 years at F=0. The harvest control rule was updated during the 1999 analytical assessment with revised estimates of F_{msy} (0.106), B_{msy} (25,000 mt), biomass threshold (13,200 mt) and the tenth percentile of F_{msy} (0.090). MSY is estimated as 2,684 mt (Figure G2).

6.0 Sources of Uncertainty

- VPA results indicate the mean biomass 3+ trend has increased in recent years and is near Bmsy, however, the survey biomass indices have remained low. This inconsistency may be due to the variability in age at full recruitment to the survey sampling gear, and/or Bmsy may not be well estimated.

- The sources of uncertainty associated with the 1999 assessment identified by the SARC/SAW 29 are still unsolved, and are listed in NDWG 2000.

7.0 References

Burnett, J. and S.H. Clark. 1983. Status of witch flounder in the Gulf of Maine - 1983. NMFS/NEFC, Woods Hole Laboratory Ref. Doc. No. 83-36, 31 p.

Lange, A.M.T. and F.E. Lux. 1978. Review of the other flounder stocks (winter flounder, American plaice, witch flounder, and windowpane flounder) off the northeast United States. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 78-44, 53 pp.

NDWG [Northern Demersal Working Group, Northeast Regional Stock Assessment Workshop]. 2000. Assessment of 1 Northeast groundfish stocks through 1999: Report to the New England Fishery Management Council's Multispecies Monitoring Committee. Northeast Fish. Sci. Cent. Ref. Doc. 00-05; 175 p.

NEFSC [Northeast Fisheries Science Center]. 1999. Report of the 29th Northeast Regional Stock Assessment Workshop (29th SAW), Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 99-14, 347 p.

Wigley, S.E., J. K.T. Brodziak, and S.X. Cadrin. 1999. Assessment of the witch flounder stock in Subareas 5 and 6 for 1999. Northeast Fish. Sci. Cent. Ref. Doc. 99-16, 153 p.

Table G1. Witch flounder landings, discards and catch (metric tons, live) from Subareas 5 and 6, by country, 1960-1999 [1960-1963 reported to ICNAF/NAFO (Burnett and Clark, 1983)].

	Landings					Total USA Catch
Year	Canada	USA [2]	Other[1]	Total	Discards	(used in VPA)
1960	-	1255	-	1255		
1961	2	1022	-	1024		
1962	1	976	-	977		
1963	27	1226	121	1374		
1964	37	1381	-	1418		
1965	22	2140	502	2664		
1966	68	2935	311	3314		
1967	63	3370	249	3682		
1968	56	2807	191	3054		
1969	-	2542	1310	3852		
1970	19	3112	130	3261		
1971	35	3220	2860	6115		
1972	13	2934	2568	5515		
1973	10	2523	629	3162		
1974	9	1839	292	2140		
1975	13	2127	217	2357		
1976	5	1871	6	1882		
1977	11	2469	13	2493		
1978	18	3501	6	3525		
1979	17	2878	-	2895		
1980	18	3128	1	3147		
1981	7	3442	-	3449		
1982	9	4906	-	4915	48	4953
1983	45	6000	-	6045	162	6162
1984	15	6660	-	6675	100	6760
1985	46	6130	-	6176	61	6191
1986	67	4610	-	4677	25	4635
1987	23	3450	-	3473	47	3497
1988	45	3262	-	3307	60	3322
1989	13	2074	-	2087	133	2207
1990	12	1478	-	1490	184	1662
1991	7	1798	-	1805	95	1893
1992	7	2246	-	2253	171	2417
1993	10	2605	-	2615	376	2981
1994	34	2670	-	2704	422	3092
1995	11	2212	-	2223	265	2477
1996	10	2088	-	2098	454	2542
1997	7	1775	-	1782	393	2168
1998	*	1849	-	1849	334	2184
1999	*	2123	-	2123	*382*[3]	*2505*[3]

[1] Includes West Germany, East Germany, Poland, Spain, Japan, & the former USSR.
[2] excluding landings from Grand Banks (subarea 3).
* 1998 and 1999 Canadian landings not available.
[3] 1999 USA discards estimated by applying the 1998 percentage of discards/landings (18%).

Table G2. Stratified mean number, weight (kg) and length (cm) per tow of witch flounder in NEFSC offshore spring and autumn bottom trawl surveys in Gulf of Maine-Georges Bank region (strata 22-30,36-40), 1963-1999.

	SPRING			AUTUMN		
YEAR	Number per tow	Weight per tow	Length per tow	Number per tow	Weight per tow	Length per tow
1963	-	-	-	5.52	3.46	39.7
1964	-	-	-	2.89	2.00	44.2
1965	-	-	-	3.94	2.27	40.6
1966	-	-	-	7.80	4.56	41.2
1967	-	-	-	3.01	2.02	43.6
1968	4.76	3.34	42.5	4.82	3.49	44.8
1969	3.74	2.53	45.3	5.81	4.40	43.9
1970	6.39	4.49	44.7	4.89	3.71	45.0
1971	2.74	2.06	46.5	4.32	2.95	42.1
1972	5.35	4.01	45.8	3.24	2.42	43.9
1973	8.20	6.21	44.8	3.18	2.05	43.6
1974	6.23	3.62	39.3	2.34	1.54	40.9
1975	3.72	2.75	43.9	1.66	1.03	39.8
1976	5.50	3.70	42.3	1.34	0.94	41.9
1977	4.20	1.96	37.2	5.06	3.38	42.0
1978	3.87	2.56	41.7	4.04	2.94	42.9
1979	3.01	1.77	38.3	1.94	1.62	45.2
1980	8.46	3.89	36.0	2.62	2.04	43.6
1981	8.40	4.18	38.1	3.66	2.19	40.4
1982	3.64	1.87	37.2	0.99	0.83	44.7
1983	6.41	2.74	36.3	4.72	2.12	36.7
1984	3.00	1.66	39.9	4.37	2.34	39.7
1985	5.18	2.75	40.3	2.76	1.59	42.0
1986	2.07	1.35	44.1	1.59	1.09	43.3
1987	1.01	0.65	43.4	0.48	0.37	44.0
1988	1.43	0.85	42.3	1.38	0.57	35.2
1989	1.95	0.74	35.8	0.89	0.38	31.3
1990	0.63	0.24	35.2	2.00	0.40	24.8
1991	1.68	0.57	31.5	2.08	0.54	29.3
1992	1.26	0.50	34.8	0.94	0.24	29.5
1993	1.47	0.36	30.3	5.15	0.54	17.0
1994	3.13	0.53	27.4	2.21	0.42	24.9
1995	1.88	0.47	30.7	4.47	0.62	25.7
1996	1.36	0.28	30.5	5.38	1.02	29.7
1997	2.22	0.43	31.0	5.10	0.77	24.9
1998	4.27	0.77	29.0	3.70	0.47	24.2
1999	3.15	0.48	28.1	5.92	0.88	26.3
2000	3.45	0.52	27.3			

Note: During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. No significant differences in catchability were found for witch flounder, therefore no adjustments have been made (Byrne and Forrester, MS 1991). No significant differences were found between research vessels, and no adjustment have been made (Byrne and Forrester, MS 1991). Spring surveys during 1973-1981 were accomplished with a 41 Yankee trawl; in all other years, a 36 Yankee trawl was used. No adjustments have been made.

Table G3. Input data and results of 1999 projection for witch flounder.

```
Input:
July2000 Witch fld
      1999
        11
       100
     12345
         0
         1
         1
         0
         0
         0
         0
         1
         0
         0
         0
         1
         0
         1
         1
         9 1 9
    0.150000
    0.056     0.140   0.247   0.357   0.484   0.615   0.764   0.908   1.319
    0.094     0.199   0.299   0.419   0.549   0.677   0.846   0.973   1.319
    0.030     0.078   0.149   0.189   0.235   0.235   0.235   0.235   0.235
    0.00      0.08    0.45    0.85    1.00    1.00    1.00    1.00    1.00
    0.16670
         3
        16
      15434000  17862000   15866000  7326000   4876000  2950000   9502000
    6359000  6871000    8949000 15279000  10906000 13869000  27833000
   26142000 20549000
       1000
boot54n.txt
     1000.000
 18124000 25000000 0.09
   0.013  0.073   0.233  0.473  1.00  1.00  1.00  1.00  1.00
   1.00  0.89   0.62  0.12  0     0      0     0     0
   1 0 0 0 0 0 0 0 0 0 0
   2505000 0 0 0 0 0 0 0 0 0 0
   0 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11

Results:

 MIXTURE OF F AND QUOTA BASED CATCHES
 YEAR   F       QUOTA (THOUSAND MT)
 1999            2.505

 SPAWNING STOCK BIOMASS (THOUSAND MT)
 YEAR    AVG SSB (000 MT)    STD
 1999        14.725         2.639
```

Table G3 (Continued)

```
 PERCENTILES OF SPAWNING STOCK BIOMASS (000 MT)
 YEAR       1%         5%         10%        25%        50%        75%        90%        95%        99%
 1999      9.477     10.678     11.498     12.903     14.599     16.214     18.192     19.338     21.828

ANNUAL PROBABILITY THAT SSB EXCEEDS THRESHOLD:    18.124 THOUSAND MT
 YEAR    Pr(SSB > Threshold Value)
 1999            0.109

 MEAN BIOMASS (THOUSAND MT) FOR AGES: 3 TO 9
 YEAR   AVG MEAN B (000 MT)      STD
 1999        26.539             6.820

 PERCENTILES OF MEAN STOCK BIOMASS (000 MT)
 YEAR       1%         5%         10%        25%        50%        75%        90%        95%        99%
 1999     14.783     17.531     19.235     22.092     25.509     29.601     34.631     39.870     48.923

ANNUAL PROBABILITY THAT MEAN BIOMASS EXCEEDS THRESHOLD:    25.000 THOUSAND MT
 YEAR    Pr(MEAN B > Threshold Value)
 1999            0.540

 F WEIGHTED BY MEAN BIOMASS FOR AGES: 3 TO 9
 YEAR  AVG F_WT_B        STD
 1999    0.112          0.026

 PERCENTILES OF F WEIGHTED BY MEAN BIOMASS FOR AGES: 3 TO 9
 YEAR   1%     5%     10%    25%    50%    75%    90%   95%     99%
 1999  0.061  0.072  0.082  0.094  0.109  0.126  0.144  0.158  0.183

ANNUAL PROBABILITY THAT F WEIGHTED BY MEAN BIOMASS EXCEEDS THRESHOLD: 0.090
 YEAR    Pr(F_WT_B > Threshold Value)
 1999            0.814

 RECRUITMENT UNITS ARE:1000. FISH
 BIRTH       AVG
 YEAR     RECRUITMENT      STD
 1999     13157.602      7098.799

 PERCENTILES OF RECRUITMENT UNITS ARE:1000. FISH
 BIRTH
 YEAR      1%         5%         10%        25%        50%        75%        90%        95%        99%
 1999   2950.000   2950.000   4876.000   7326.000  13869.000  15866.000  26142.000  27833.000  27833.000

 LANDINGS FOR F-BASED PROJECTIONS
 YEAR    AVG LANDINGS (000 MT)   STD
 1999         2.505             0.000

 PERCENTILES OF LANDINGS (000 MT)
 YEAR      1%         5%         10%        25%        50%        75%        90%        95%        99%
 1999      2.505      2.505      2.505      2.505      2.505      2.505      2.505      2.505      2.505

 DISCARDS FOR F-BASED PROJECTIONS
 YEAR  AVG DISCARDS (000 MT)    STD
 1999      0.135               0.039

 PERCENTILES OF DISCARDS (000 MT)
 YEAR      1%         5%         10%        25%        50%        75%        90%        95%        99%
 1999      0.069      0.080      0.090      0.107      0.129      0.158      0.185      0.206      0.248

 REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS
 YEAR    AVG F     STD
 1999    0.237    0.050

 PERCENTILES OF REALIZED F SERIES
 YEAR    1%     5%     10%    25%    50%    75%    90%  95%     99%
 1999  0.143  0.166  0.178  0.202  0.229  0.267  0.300  0.327  0.379
```

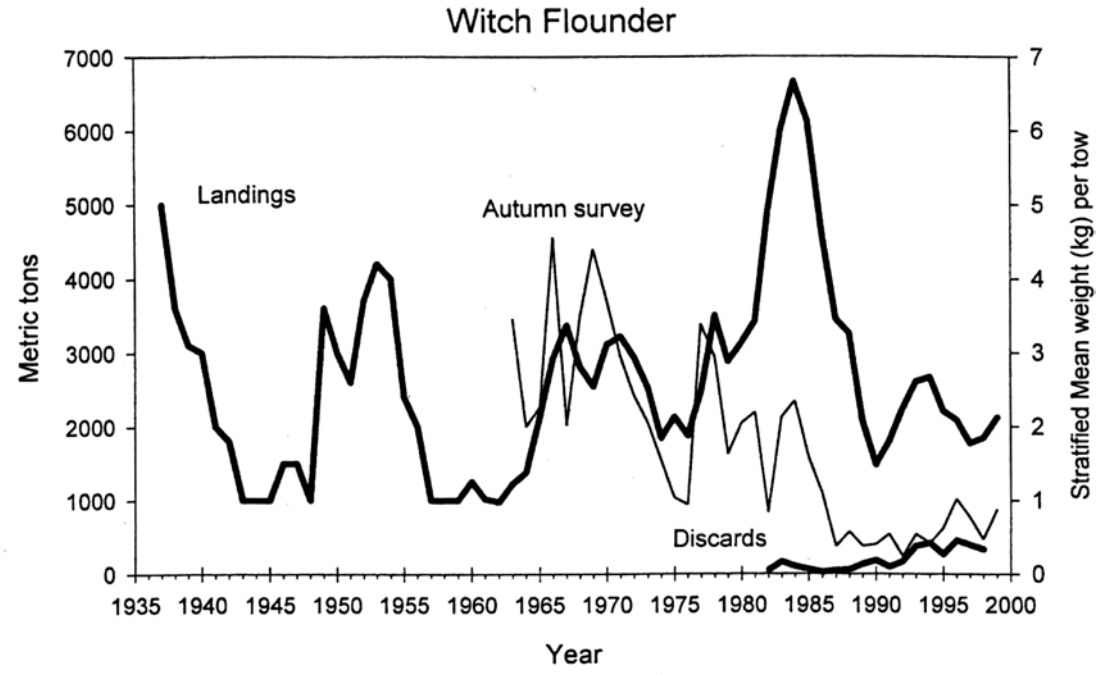


Figure G1. Trends in total landings and NEFSC autumn survey biomass indices for witch flounder (Note: USA landings from the Grand Banks have been excluded; landings prior to 1960 are provisional landings taken from Lange and Lux (1978).

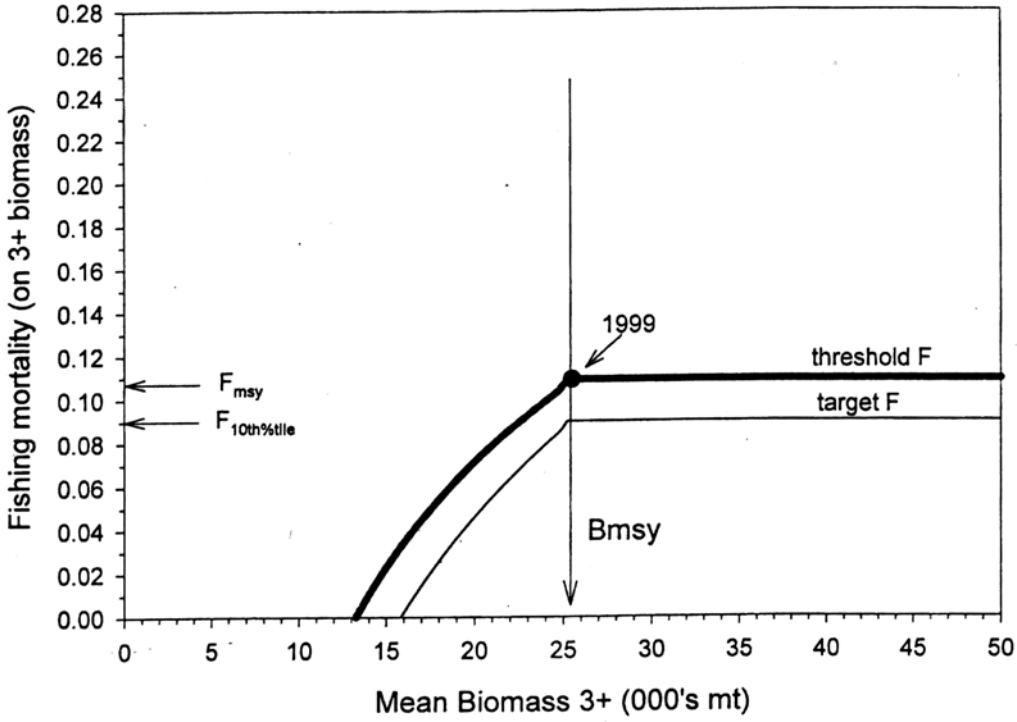


Figure G2. Harvest control rule for witch flounder.

H. Gulf of Maine-Georges Bank American Plaice by L. O'Brien

1.0 Background

This stock was last assessed in 1998 (O'Brien *et al.* 1999) and reviewed by the 28th Northeast Regional SAW (NEFSC 1999). Fully recruited F (ages 5-8, u) in 1997 was estimated to be 0.47, a decrease of 10% from 1996. Spawning stock biomass was 13,500 mt in 1997, an increase of 11% from 1996. Recruitment since 1993 has been near record low and the 1996 year class (age 1 fish) was estimated to be the lowest in the time series (1980-1997) with a less than average recruit/SSB survival ratio.

The NEFSC spring and autumn bottom trawl survey indices indicated a decline in abundance and biomass each year from spring of 1995 to the spring of 1998. Similarly, the MADMF abundance indices declined each year during 1994 -1998. Recruitment indices were below average for the 1994-1996 year classes.

2.0 2000 Assessment Update

The Fishery

Total commercial landings of Gulf of Maine-Georges Bank American plaice in 1999 were 3,257 mt, a 12 % decline from 1998 and a 19% decline from 1997 (Table H1, Figure H1). Discards were not estimated. Canadian fisheries landed 123 mt in 1999, about 4% of the total landings.

Research Survey Indices

The NEFSC indices of abundance and biomass indicate an increase in the spring 2000 indices and in the autumn 1998 and 1999 indices (Table H2, Figure H2 and H3). Recruitment indices of age 1 fish from NEFSC autumn surveys indicate that both the 1997 and 1998 year classes are above average and similar in size to the 1992 year class (Table H3, Figure H4). The same year classes are just below the time series average in the Massachusetts autumn survey (Table H4).

Mortality and Stock Size

Landings have been gradually declining since 1992 and fishing mortality declined during 1995 to 1997. A projection analysis based on 1998 and 1999 landings and an empirical resampling model predicted that fishing mortality declined from 1997 to 1999 (Table H5, Figure H5). Spawning stock biomass was predicted to remain relatively stable during 1998 and 1999 and similar to the 1997 estimate (13,500 mt) (Figure H6).

Comparison of these results to the projection analyses conducted in 1999 (Northern Demersal Working Group 2000) indicate very similar results. Fishing mortality in 1999 had previously been assumed to be 0.32, equivalent to the 1998 F. The assumed 1999 F was only slightly higher

than the projected 1999 F = 0.27 and within the projected 80% confidence limits. The 1999 SSB had previously been predicted to be about 13,755 mt compared to the current projection of 13,837 mt and was within the projected 80% confidence limits.

3.0 SFA Control Rule

The SFA control rule for Gulf of Maine-Georges Bank American plaice is based on SSB_{MSY} which is currently estimated at 24,200 mt (Figure H7). The rule states that $F_{0.1}$ will be the maximum fishing mortality threshold when the stock is above SSB_{MSY} then decrease linearly to zero at 1/4 SSB_{MSY} (6,050 mt). The target F will be 60% of $F_{0.1}$ when the stock is above SSB_{MSY} and would decrease linearly to zero at ½ of SSB_{MSY} (12,100 mt). F in 1999 was projected to be 0.27 and SSB in 1999 was projected to be 13,837 mt.

4.0 Sources of Uncertainty

- No estimation of discards for the 1998 and 1999 fishery.
- Assessment is based on projection analysis of landings instead of a calibrated VPA.

From the previous update (Northern Demersal Working Group 2000) :

- VPA estimates of 1998 calibrated age 1 stock size were not available. The derived estimates may be optimistic.
- Projections of SSB are likely to be optimistic if recruits are overestimated.

5.0 References

O'Brien, L., R.K. Mayo, and C. Esteves. 1999. Assessment of American plaice in the Gulf of Maine-Georges Bank Region for 1998. *Northeast Fish. Sci. Cent. Ref. Doc*. 99-09, 96 p.

NDWG (Northern Demersal Working Group, Northeast Regional Stock Assessment Workshop). 2000. Assessment of 11 Northeast groundfish stocks through 1999: a report to the New England Fishery Management Council's Multi-Species Monitoring Committee. *Northeast Fish. Sci. Cent. Ref. Doc*. 00-05, 175 p.

NEFSC. 1999. Report of the 28th Northeast Regional Stock Assessment Workshop (28th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. *Northeast Fish. Sci. Cent. Ref. Doc*. 99-08, 304 p.

Table H1. Commerical landings (metric tons, live weight) of American plaice from the Gulf of Maine, Georges Bank, Southern New England and the Mid-Atlantic, 1960-1999.

Year	Gulf of Maine			Georges Bank					Southern New England				Mid - Atlantic			Grand Total		
	USA	Can	Total	USA	Can	USSR	Other	Total	USA	USSR	Other	Total	USA	Other	Total	USA	Other	Total
1960	620	1	621	689	-	-	-	689	-	-	-	0	-	-	0	1309	1	1310
1961	692	-	692	830	-	-	-	830	-	-	-	0	-	-	0	1522	0	1522
1962	694	-	694	1233	44	-	-	1277	-	-	-	0	-	-	0	1927	44	1971
1963	693	-	693	1489	127	24	-	1640	-	-	-	0	-	-	0	2182	151	2333
1964	811	-	811	2800	177	-	11	2988	-	-	-	0	-	-	0	3611	188	3799
1965	967	-	967	2376	180	112	-	2668	-	-	-	0	-	-	0	3343	292	3635
1966	955	2	957	2388	242	279	1	2910	-	-	-	0	-	-	0	3343	524	3867
1967	1066	6	1072	2166	203	1018	10	3397	-	-	-	0	4	-	4	3236	1237	4473
1968	904	5	909	1695	173	193	5	2066	637	145	-	782	18	2	20	3254	523	3777
1969	1059	7	1066	1738	71	63	17	1889	505	349	-	854	130	-	130	3432	507	3939
1970	895	-	895	1603	92	927	658	3280	88	18	40	146	8	-	8	2594	1735	4329
1971	648	5	653	1511	38	228	296	2071	11	112	206	329	6	2	8	2176	887	3063
1972	569	-	569	1222	22	358	-	1602	3	71	-	74	-	-	0	1794	451	2245
1973	687	-	687	910	38	289	-	1237	5	158	-	163	-	-	0	1602	485	2087
1974	945	2	947	1039	27	16	2	1084	92	4	-	96	-	-	0	2076	51	2127
1975	1507	-	1507	913	25	148	-	1086	3	-	-	3	-	-	0	2423	173	2596
1976	2550	-	2550	948	24	3	-	975	10	-	-	10	1	-	1	3509	27	3536
1977	5647	-	5647	1408	35	50	-	1493	6	78	-	84	7	-	7	7068	163	7231
1978	7287	30	7317	2193	77	-	-	2270	15	-	-	15	8	-	8	9503	107	9610
1979	8835	-	8835	2478	23	-	-	2501	13	-	7	20	4	-	4	11330	30	11360
1980	11139	-	11139	2399	43	-	5	2447	10	-	-	10	1	-	1	13549	48	13597
1981	10327	1	10328	2482	15	-	2	2499	26	-	2	28	46	-	46	12881	20	12901
1982	11147	-	11147	3935	27	-	1	3963	35	-	2	37	9	-	9	15126	30	15156
1983	9142	7	9149	3955	30	-	-	3985	40	-	-	40	4	-	4	13141	37	13178
1984	6833	2	6835	3277	6	-	-	3283	17	-	-	17	7	-	7	10134	8	10142
1985	4766	1	4767	2249	40	-	-	2289	12	-	-	12	2	-	2	7029	41	7070
1986	3319	-	3319	1146	34	-	-	1180	4	-	-	4	3	-	3	4472	34	4506
1987	2766	-	2766	1032	48	-	-	1080	2	-	-	2	1	-	1	3801	48	3849
1988	2271	-	2271	1097	108	-	-	1205	13	-	-	13	1	-	1	3382	108	3490
1989	1646	-	1646	703	68	-	-	771	1	-	-	1	3	-	3	2353	68	2421
1990	1802	-	1802	639	52	-	-	690	2	-	-	2	2	-	2	2445	52	2497
1991	2936	-	2936	1310	26	-	-	1310	15	-	-	15	0	-	0	4261	26	4287
1992	4564	-	4566	1838	3	-	-	1838	10	-	-	10	4	-	4	6416	3	6419
1993	3865	-	3865	1838	-	-	-	1838	11	-	-	11	4	-	4	5718	-	5718
1994	***3357***	-	3431	***1683***	30	-	-	1562	***22***	-	-	22	***4***	-	4	5066	30	5096
1995	***3105***	-	3126	***1505***	2	-	-	1486	***15***	-	-	15	***20***	-	20	4645	2	4647
1996	***2912***	-	2922	***1430***	2	-	-	1423	***40***	-	-	40	***15***	-	15	4396	2	4398
1997	***2312***	-	2396	***1576***	65	-	-	1560	***23***	-	-	23	***26***	-	26	3937	65	4002
1998	***2234***	-	2234	***1385***	20	-	-	1405	***23***			23	***20***		20	3663	20	3683
1999	***1718***	-	1718	***1384***	123	-	-	1507	***11***			11	***21***		21	3134	123	3257

** 1994-1999 data are provisional and spatially distributed based on proportions of landings recorded by area in the VTR database

Table H2. Standardized stratified mean number and mean weight per tow (kg)of American plaice in NEFSC spring and autumn bottom trawl surveys in the Gulf of Maine - Georges Bank area, 1963-1999.

	SPRING		AUTUMN	
	Number	Weight	Number	Weight
1963	–	–	14.17	5.87
1964	–	–	8.20	2.84
1965	–	–	11.95	3.80
1966	–	–	17.78	4.90
1967	–	–	11.05	2.69
1968	11.36	3.40	8.61	2.91
1969	8.59	2.68	7.51	2.36
1970	5.43	1.81	6.46	2.01
1971	3.80	1.26	7.47	1.96
1972	4.28	1.32	7.44	1.60
1973	7.18	1.85	6.19	1.94
1974	8.34	1.94	6.89	1.42
1975	5.78	1.72	8.12	2.43
1976	11.85	3.37	9.98	2.99
1977	14.57	5.11	11.80	3.52
1978	10.61	3.82	15.13	4.66
1979	9.23	3.62	9.96	4.00
1980	18.34	4.78	4.24	5.12
1981	18.75	5.88	13.04	5.62
1982	11.61	3.80	5.88	2.49
1983	16.94	4.60	9.34	3.45
1984	4.10	1.42	7.12	2.02
1985	4.94	1.88	6.95	2.00
1986	3.09	0.92	5.61	1.56
1987	3.50	0.81	4.38	1.09
1988	3.58	0.84	9.69	1.46
1989	4.81	0.75	9.21	1.17
1990	5.09	0.75	15.46	2.90
1991	5.91	1.05	7.71	1.56
1992	4.11	1.36	6.31	1.78
1993	5.29	1.39	11.89	2.39
1994	4.89	0.85	18.07	2.67
1995	9.43	1.94	11.84	2.58
1996	7.83	1.69	7.58	2.23
1997	7.62	1.62	6.27	1.94
1998	4.52	1.11	9.29	2.22
1999	4.18	1.20	11.03	2.57
2000	9.96	2.30		
Average	7.86	2.21	9.72	2.72

Table H3. Standardized stratified mean number per tow by age and mean weight per tow (kg) of American plaice in NEFSC spring and autumn bottom trawl surveys in the Gulf of Maine - Georges Bank[1] area, 1980-2000.

	AGE GROUP																
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	#/tow	kg/tow
Spring																	
1980	0.00	0.45	3.69	4.55	3.05	2.93	1.61	1.14	0.26	0.31	0.23	0.04	0.04	0.03	0.01	18.34	4.78
1981	0.00	0.13	3.43	4.21	3.46	2.61	1.69	1.41	0.77	0.40	0.32	0.07	0.09	0.07	0.09	18.75	5.88
1982	0.00	0.03	1.05	1.79	3.17	2.13	1.33	0.92	0.50	0.35	0.19	0.07	0.02	0.05	0.01	11.61	3.80
1983	0.00	0.20	3.68	3.33	4.48	2.64	1.18	0.58	0.32	0.15	0.15	0.11	0.05	0.02	0.04	16.94	4.60
1984	0.00	0.02	0.35	0.56	0.90	1.29	0.58	0.22	0.10	0.01	0.02	0.01	0.01	0.00	0.04	4.10	1.42
1985	0.00	0.03	0.32	0.98	0.86	0.73	0.86	0.46	0.42	0.12	0.07	0.04	0.02	0.02	0.02	4.94	1.88
1986	0.00	0.01	0.46	0.34	1.01	0.59	0.29	0.21	0.10	0.04	0.04	0.00	0.00	0.00	0.00	3.09	0.92
1987	0.00	0.09	0.61	0.99	0.69	0.51	0.25	0.17	0.07	0.03	0.03	0.03	0.01	0.00	0.00	3.50	0.81
1988	0.00	0.20	0.99	0.84	0.76	0.31	0.23	0.12	0.01	0.09	0.01	0.01	0.00	0.00	0.00	3.58	0.84
1989	0.00	0.05	1.59	1.27	0.86	0.49	0.29	0.16	0.03	0.07	0.01	0.01	0.00	0.00	0.00	4.81	0.75
1990	0.00	0.00	0.57	2.65	1.02	0.54	0.17	0.06	0.04	0.05	0.00	0.00	0.00	0.00	0.00	5.09	0.75
1991	0.00	0.03	0.71	1.63	2.33	0.92	0.15	0.07	0.04	0.02	0.00	0.02	0.00	0.00	0.01	5.91	1.05
1992	0.00	0.06	0.34	1.15	0.88	1.07	0.43	0.11	0.04	0.02	0.01	0.00	0.01	0.00	0.00	4.11	1.36
1993	0.00	0.33	0.84	1.16	1.58	0.61	0.45	0.17	0.08	0.02	0.01	0.02	0.03	0.00	0.00	5.29	1.39
1994	0.00	0.03	1.43	1.14	1.12	0.75	0.23	0.10	0.03	0.01	0.00	0.01	0.01	0.01	0.01	4.89	0.85
1995	0.00	0.03	1.97	3.21	2.30	1.11	0.44	0.22	0.03	0.04	0.03	0.01	0.02	0.01	0.01	9.43	1.94
1996	0.00	0.02	0.47	1.94	3.30	1.31	0.53	0.20	0.05	0.02	0.00	0.00	0.00	0.00	0.00	7.83	1.69
1997	0.00	0.01	0.85	1.66	2.52	2.05	0.39	0.09	0.01	0.00	0.01	0.00	0.02	0.00	0.00	7.62	1.62
1998	0.00	0.06	0.19	1.02	1.12	1.22	0.68	0.16	0.06	0.01	0.01	0.003	0.01	0.00	0.00	4.52	1.11
1999	0.00	0.08	0.41	0.52	1.13	0.79	0.64	0.41	0.17	0.02	0.02	0.00	0.00	0.00	0.00	4.18	1.20
2000	0.00	0.03	1.91	2.48	2.22	1.60	0.86	0.60	0.15	0.07	0.02	0.003	0.01	0.00	0.00	9.96	2.30

Table H3 (continued). Standardized stratified mean number per tow by age and mean weight per tow (kg) of American plaice in NEFSC spring and autumn bottom trawl surveys in the Gulf of Maine - Georges Bank[1] area, 1980-2000.

	AGE GROUP																
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	#/tow	kg/tow
Autumn																	
1980	0.00	1.58	2.23	2.72	2.84	1.53	1.02	0.93	0.57	0.30	0.19	0.11	0.04	0.09	0.09	14.24	5.12
1981	0.003	0.44	2.64	2.16	2.48	2.16	1.44	0.59	0.53	0.06	0.16	0.15	0.02	0.02	0.16	13.04	5.62
1982	0.00	0.20	0.91	1.65	1.27	0.57	0.48	0.30	0.17	0.19	0.08	0.03	0.00	0.00	0.02	5.88	2.49
1983	0.06	0.50	1.01	2.02	2.92	1.36	0.68	0.34	0.17	0.10	0.03	0.05	0.06	0.01	0.03	9.34	3.45
1984	0.02	0.22	2.24	1.56	1.21	1.07	0.51	0.12	0.10	0.00	0.03	0.01	0.02	0.00	0.01	7.12	2.02
1985	0.02	0.91	0.83	2.64	1.05	0.79	0.41	0.19	0.05	0.03	0.02	0.00	0.00	0.01	0.00	6.95	2.00
1986	0.10	0.51	1.46	0.87	1.43	0.47	0.42	0.16	0.11	0.04	0.01	0.02	0.01	0.00	0.00	5.61	1.56
1987	0.01	0.53	1.27	0.99	0.43	0.69	0.25	0.10	0.04	0.04	0.01	0.02	0.00	0.00	0.00	4.38	1.09
1988	0.00	2.84	2.97	2.39	0.78	0.47	0.10	0.07	0.00	0.03	0.00	0.02	0.00	0.00	0.00	9.69	1.46
1989	0.05	0.48	4.45	2.86	0.98	0.19	0.10	0.02	0.02	0.02	0.02	0.00	0.01	0.02	0.00	9.21	1.17
1990	0.01	1.71	2.26	7.49	2.89	0.59	0.25	0.12	0.07	0.02	0.02	0.01	0.01	0.01	0.01	15.46	2.90
1991	0.01	0.47	2.47	2.02	1.59	0.73	0.29	0.04	0.06	0.00	0.01	0.00	0.00	0.00	0.01	7.71	1.56
1992	0.02	0.65	1.23	1.85	1.28	0.78	0.30	0.07	0.05	0.03	0.02	0.00	0.02	0.00	0.00	6.31	1.78
1993	0.01	1.70	2.34	3.47	2.28	1.05	0.80	0.11	0.04	0.04	0.04	0.00	0.00	0.00	0.00	11.89	2.39
1994	0.04	3.83	7.53	2.81	1.71	1.30	0.40	0.25	0.13	0.01	0.03	0.02	0.00	0.00	0.00	18.07	2.67
1995	0.01	0.50	3.80	3.82	2.50	0.90	0.22	0.04	0.03	0.00	0.00	0.00	0.02	0.00	0.00	11.84	2.58
1996	0.01	0.54	0.81	2.00	2.74	0.93	0.39	0.07	0.04	0.03	0.00	0.00	0.02	0.00	0.02	7.58	2.23
1997	0.01	0.36	1.06	1.55	1.86	1.04	0.32	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.02	6.27	1.94
1998	0.01	1.73	0.60	1.88	2.01	1.78	1.08	0.12	0.05	0.01	0.01	0.00	0.01	0.00	0.00	9.29	2.22
1999	0.02	2.00	2.20	2.05	2.13	1.60	0.81	0.20	0.03	0.00	0.00	0.00	0.00	0.00	0.00	11.03	2.57

[1] Offshore strata 13-30, 36-40

Table H4. Stratified mean number per tow by age of American plaice in Massachusetts State spring and autumn bottom trawl surveys in Massachusetts Bay and Cape Cod Bay (Regions 4+5), 1982-2000.

						Age							
Year	0	1	2	3	4	5	6	7	8	9	10	11	# / tow
Spring													
1982	0.00	7.18	49.25	33.35	17.14	5.00	2.42	1.12	0.26	0.15	0.03	0.07	115.97
1983	0.00	1.93	18.76	22.42	21.46	10.22	2.37	0.73	0.20	0.19	0.06	0.10	78.44
1984	0.00	2.15	27.44	21.32	10.57	4.64	1.21	0.18	0.09	0.01	0.03	0.07	67.71
1985	0.00	21.56	17.16	24.22	9.50	3.77	2.24	0.65	0.76	0.12	0.04	0.03	80.05
1986	0.00	27.06	110.27	26.91	14.43	2.84	0.61	0.05	0.08	0.06	0.00	0.16	182.47
1987	0.00	34.36	17.26	15.79	3.90	1.76	0.51	0.10	0.02	0.00	0.00	0.00	73.70
1988	0.00	81.47	63.57	17.85	8.72	1.54	0.47	0.09	0.00	0.00	0.00	0.00	173.71
1989	0.00	8.07	127.26	44.97	11.99	3.03	1.31	0.20	0.03	0.03	0.00	0.05	196.94
1990	0.00	7.73	25.37	56.71	16.48	3.43	0.53	0.11	0.10	0.13	0.00	0.00	110.59
1991	0.00	2.10	19.98	34.77	18.98	3.24	0.18	0.07	0.01	0.00	0.00	0.00	79.33
1992	0.00	8.20	11.06	33.98	14.99	7.42	1.11	0.45	0.00	0.00	0.00	0.00	77.21
1993	0.00	11.60	18.98	16.08	9.16	3.45	0.81	0.04	0.02	0.00	0.00	0.00	60.14
1994	0.00	11.60	52.57	22.12	7.13	3.88	1.03	0.31	0.00	0.00	0.00	0.00	98.64
1995	0.00	0.54	34.65	49.64	10.32	3.16	0.62	0.17	0.03	0.05	0.02	0.00	99.20
1996	0.00	2.29	4.14	14.92	31.39	6.33	1.01	0.77	0.01	0.00	0.00	0.00	60.86
1997	0.00	1.55	7.96	13.95	17.24	12.21	2.41	0.21	0.00	0.00	0.00	0.00	55.52
1998	0.00	2.83	4.33	11.45	7.53	8.93	3.95	0.49	0.00	0.03	0.00	0.00	39.54
1999	0.00	1.35	11.65	11.65	15.11	7.57	3.96	1.62	0.35	0.01	0.00	0.00	53.27
2000													
Autumn													
1982	0.17	13.24	15.46	10.22	5.11	1.14	0.56	0.14	0.05	0.05	0.01	0.08	46.23
1983	1.29	52.17	18.98	10.02	8.30	1.39	0.32	0.15	0.05	0.06	0.00	0.01	92.74
1984	0.11	3.14	13.24	4.27	1.83	0.77	0.24	0.04	0.05	0.00	0.00	0.00	23.69
1985	0.00	60.97	9.45	14.21	1.56	0.14	0.03	0.02	0.00	0.00	0.00	0.00	86.38
1986	0.23	41.27	40.08	12.07	5.30	0.39	0.13	0.01	0.00	0.00	0.00	0.00	99.48
1987	0.24	46.36	14.60	3.00	0.52	0.23	0.07	0.01	0.04	0.00	0.00	0.00	65.07
1988	0.00	85.63	41.28	13.98	1.34	0.45	0.08	0.00	0.00	0.00	0.00	0.00	142.76
1989	0.03	57.56	122.25	31.03	2.33	0.13	0.01	0.01	0.00	0.00	0.00	0.00	213.35
1990	0.08	31.99	14.20	20.12	3.93	0.21	0.03	0.00	0.00	0.00	0.00	0.00	70.56
1991	0.04	24.07	90.36	40.05	11.51	1.17	0.14	0.00	0.00	0.00	0.00	0.00	167.34
1992	0.00	46.33	12.99	29.79	11.04	1.38	0.00	0.00	0.12	0.00	0.00	0.00	101.66
1993	0.00	76.21	36.80	17.59	6.85	1.71	0.69	0.00	0.00	0.00	0.00	0.00	139.84
1994	0.00	36.71	79.31	10.76	2.91	1.56	0.23	0.14	0.00	0.00	0.00	0.00	131.62
1995	0.00	11.84	44.22	24.93	4.21	0.91	0.08	0.00	0.00	0.00	0.00	0.00	86.19
1996	0.09	16.25	19.25	27.55	13.96	1.39	0.28	0.00	0.08	0.00	0.00	0.00	78.86
1997	0.00	13.61	28.08	17.91	10.29	1.46	0.19	0.01	0.00	0.00	0.00	0.00	71.55
1998	0.16	34.56	6.12	13.80	7.10	3.76	0.62	0.01	0.00	0.00	0.00	0.00	66.13
1999	0.00	29.23	32.57	20.61	10.58	2.85	1.20	0.04	0.00	0.00	0.00	0.00	97.08
2000													

Table H5. Input parameters and results of stochastic projection analysis using an empirical resampling model for Gulf of Maine-Georges Bank American plaice for 1998-1999.

INPUT

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Catch	Stock	Discards
1	0.0200	1.000	0.0000	0.0160	0.0100	0.0160
2	0.0500	1.000	0.0400	0.0520	0.0290	0.0470
3	0.0800	1.000	0.2400	0.1600	0.0920	0.1260
4	0.4200	1.000	0.7200	0.3050	0.2210	0.2060
5	1.0000	1.000	0.9500	0.4490	0.3660	0.2580
6	1.0000	1.000	1.0000	0.6320	0.5340	0.2930
7	1.0000	1.000	1.0000	0.8660	0.7420	0.3280
8	1.0000	1.000	1.0000	1.1070	0.9800	0.3020
9	1.0000	1.000	1.0000	1.5640	1.5640	0.3430

RESULTS

Projection analysis based on 1998 and 1999 landings of Gulf of Maine-Georges Bank American plaice.

```
 PROJECTION RUN: GM-GB AP 1998:ap_9899_base.in
 INPUT FILE: ap_9899_base.in
 OUTPUT FILE: ap_9899_base3.out
 RECRUITMENT MODEL: 3
 NUMBER OF SIMULATIONS: 100

 QUOTA-BASED PROJECTIONS
 TIME-VARYING QUOTA
 YEAR    QUOTA (000 MT)
 1998      3.683
 1999      3.257

 SPAWNING STOCK BIOMASS (THOUSAND MT)
 YEAR    AVG SSB (000 MT)    STD
 1998        14.519         1.736
 1999        13.984         2.064

 PERCENTILES OF SPAWNING STOCK BIOMASS (000 MT)
 YEAR       1%        5%        10%       25%       50%       75%       90%       95%       99%
 1998     10.712    11.855    12.321    13.318    14.424    15.634    16.807    17.409    19.022
 1999      9.361    10.801    11.334    12.564    13.837    15.334    16.650    17.298    19.133

ANNUAL PROBABILITY THAT SSB EXCEEDS THRESHOLD:    24.200 THOUSAND MT
 YEAR    Pr(SSB > Threshold Value)
 1998            0.000
 1999            0.000

 MEAN BIOMASS (THOUSAND MT) FOR AGES:1 TO 9
 YEAR   AVG MEAN B (000 MT)      STD
 1998        18.088             2.069
 1999        17.819             2.450
```

Table H5 Continued.

PERCENTILES OF MEAN STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	13.341	14.921	15.430	16.667	17.970	19.470	20.763	21.521	23.170
1999	12.382	14.053	14.713	16.119	17.720	19.469	20.886	21.959	24.093

ANNUAL PROBABILITY THAT MEAN BIOMASS EXCEEDS THRESHOLD: 0.000 THOUSAND MT

YEAR	Pr(MEAN B > Threshold Value)
1998	1.000
1999	1.000

F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 9

YEAR	AVG F_WT_B	STD
1998	0.270	0.033
1999	0.222	0.034

PERCENTILES OF F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 9

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.203	0.222	0.230	0.246	0.269	0.290	0.313	0.326	0.363
1999	0.158	0.175	0.183	0.198	0.219	0.241	0.267	0.280	0.321

ANNUAL PROBABILITY THAT F WEIGHTED BY MEAN BIOMASS EXCEEDS THRESHOLD: 0.000

YEAR	Pr(F_WT_B > Threshold Value)
1998	1.000
1999	1.000

RECRUITMENT UNITS ARE:1000. FISH

BIRTH YEAR	AVG RECRUITMENT	STD
1998	28330.191	14160.592
1999	28231.297	14137.658

PERCENTILES OF RECRUITMENT UNITS ARE:1000. FISH

BIRTH YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	7870.000	7870.000	12305.000	6667.000	26390.000	36417.000	52580.000	56601.000	56601.000
1999	7870.000	7870.000	12305.000	16667.000	26390.000	36417.000	52580.000	56601.000	56601.000

DISCARDS FOR F-BASED PROJECTIONS

YEAR	AVG DISCARDS (000 MT)	STD
1998	0.645	0.059
1999	0.350	0.043

PERCENTILES OF DISCARDS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.516	0.554	0.568	0.602	0.644	0.685	0.721	0.744	0.783
1999	0.263	0.284	0.298	0.321	0.348	0.376	0.406	0.427	0.460

REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS

YEAR	AVG F	STD
1998	0.327	0.046
1999	0.278	0.049

PERCENTILES OF REALIZED F SERIES

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.234	0.260	0.271	0.295	0.324	0.356	0.386	0.407	0.453
1999	0.186	0.211	0.221	0.244	0.273	0.306	0.343	0.364	0.425

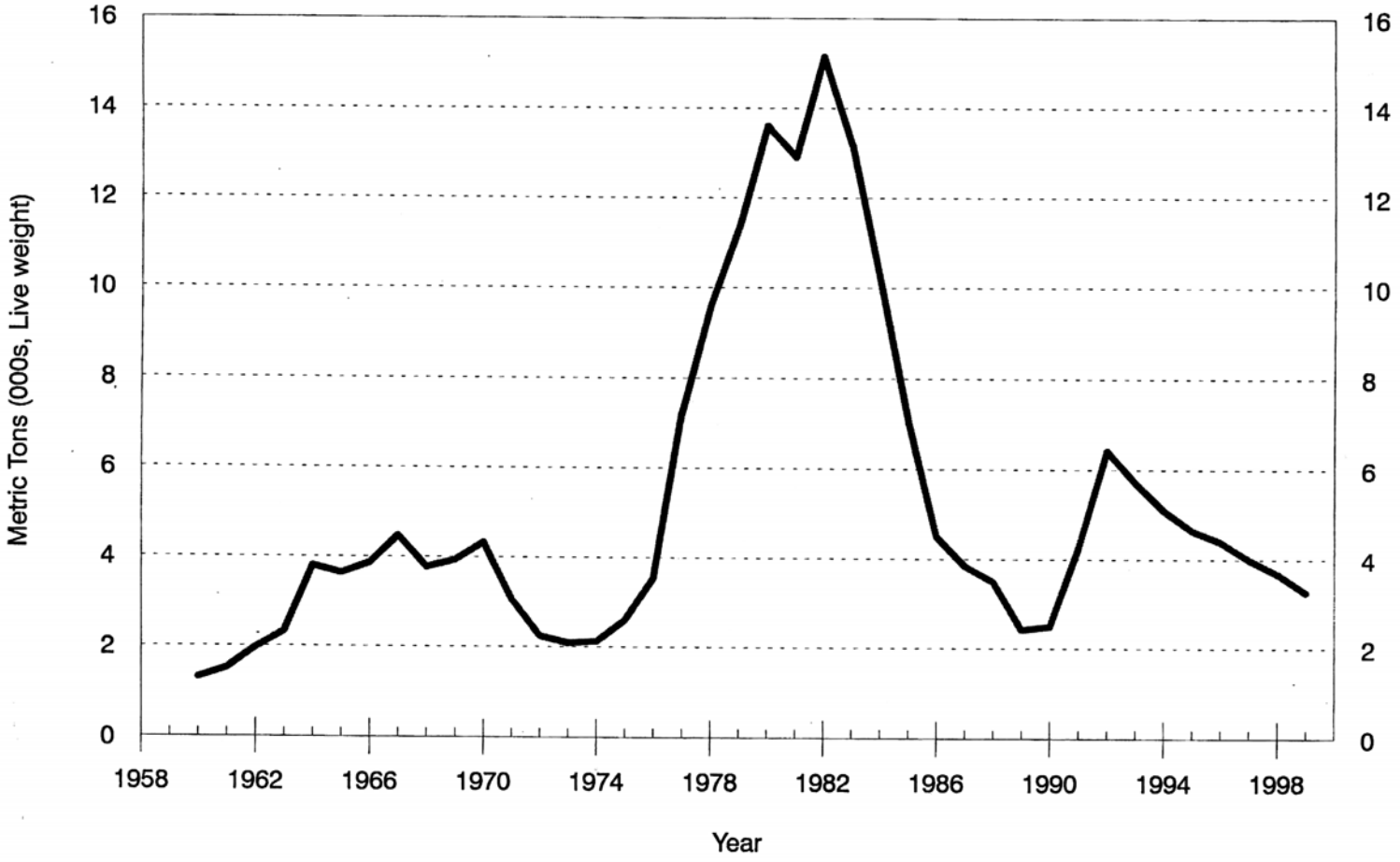


Figure H1. Total commercial landings of Gulf of Maine-Georges Bank American plaice (Division 5Zand 6), 1960-1999.

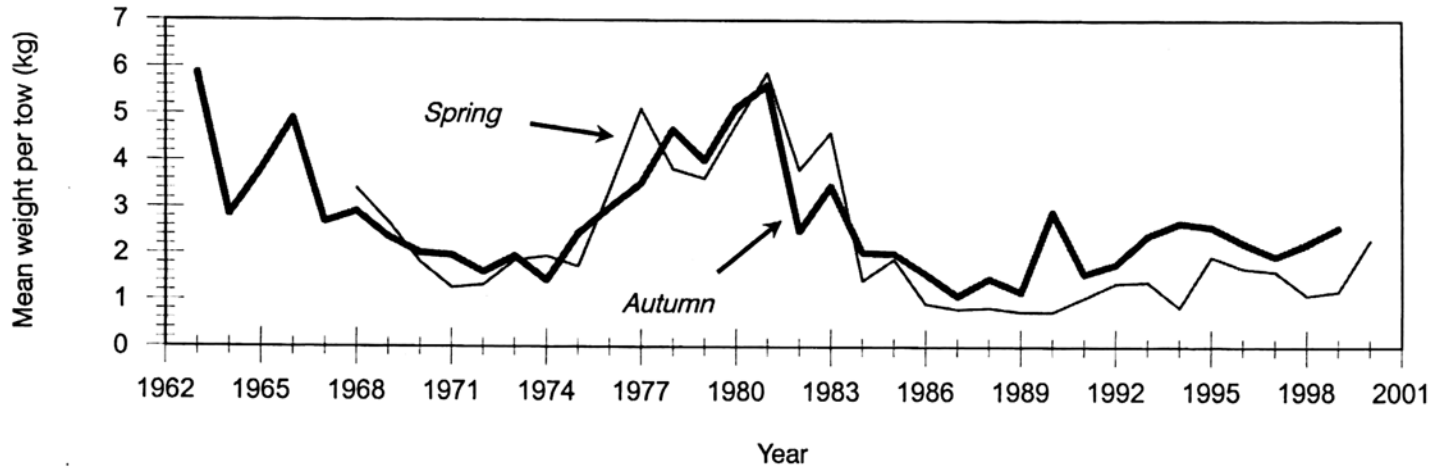


Figure H2. Standardized stratified mean weight per tow (kg) of American plaice in NEFSC spring and autumn research vessel bottom trawl surveys in the Gulf of Maine-Georges Bank region, 1963-2000.

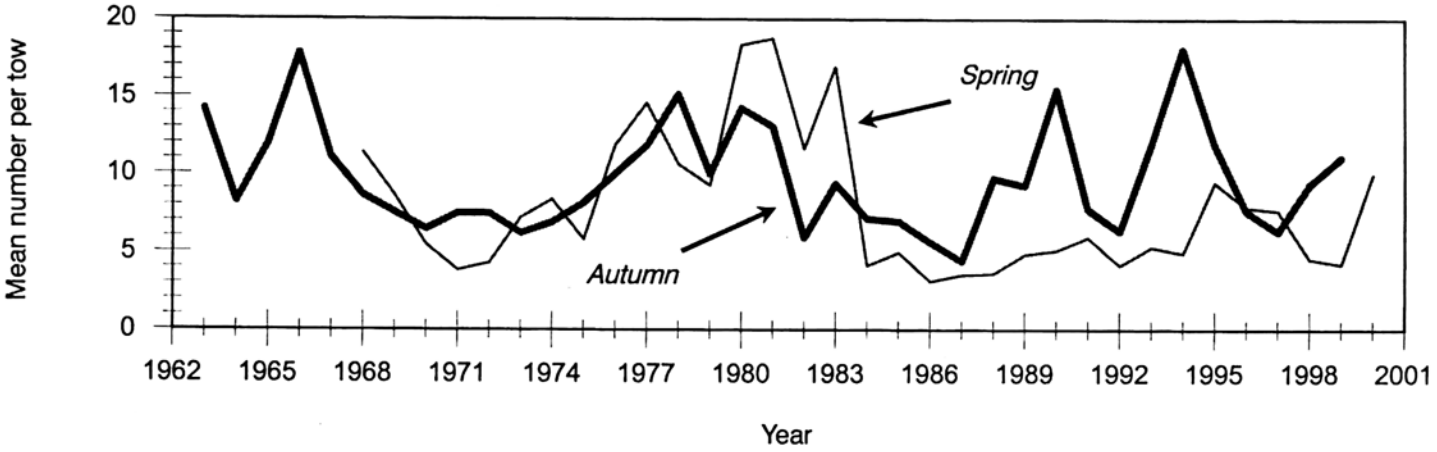


Figure H3. Standardized stratified mean number per tow of American plaice in NEFSC spring and autumn research vessel bottom trawl surveys in the Gulf of Maine-Georges Bank region, 1963 -2000.

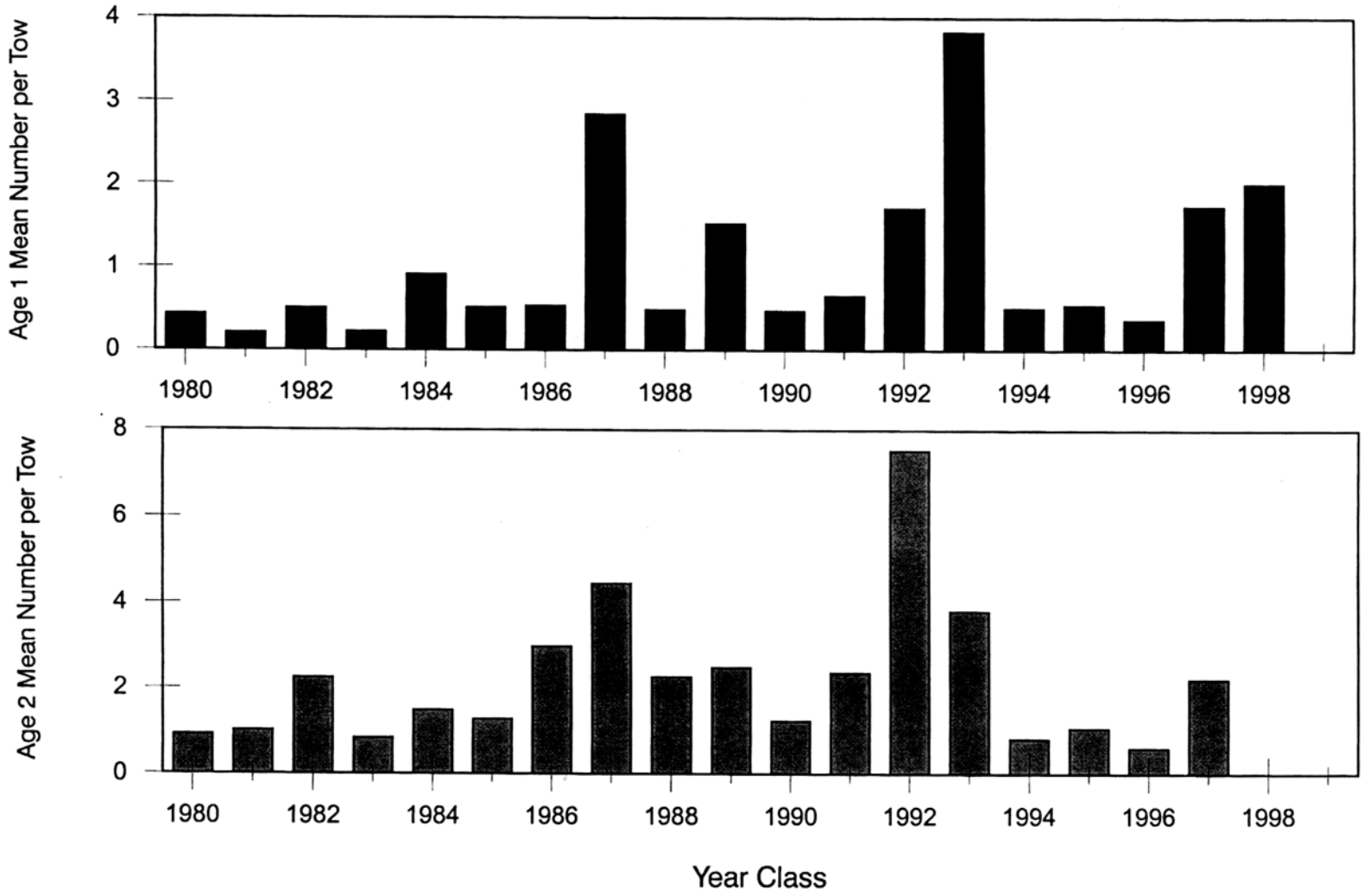


Figure H4. Relative year class strengths of age 1 and age 2 Gulf of Maine-Georges Bank American plaice based on standardized catch(number) per tow from NEFSC autumn reserach vessel bottom trawl surveys, 1980-1999.

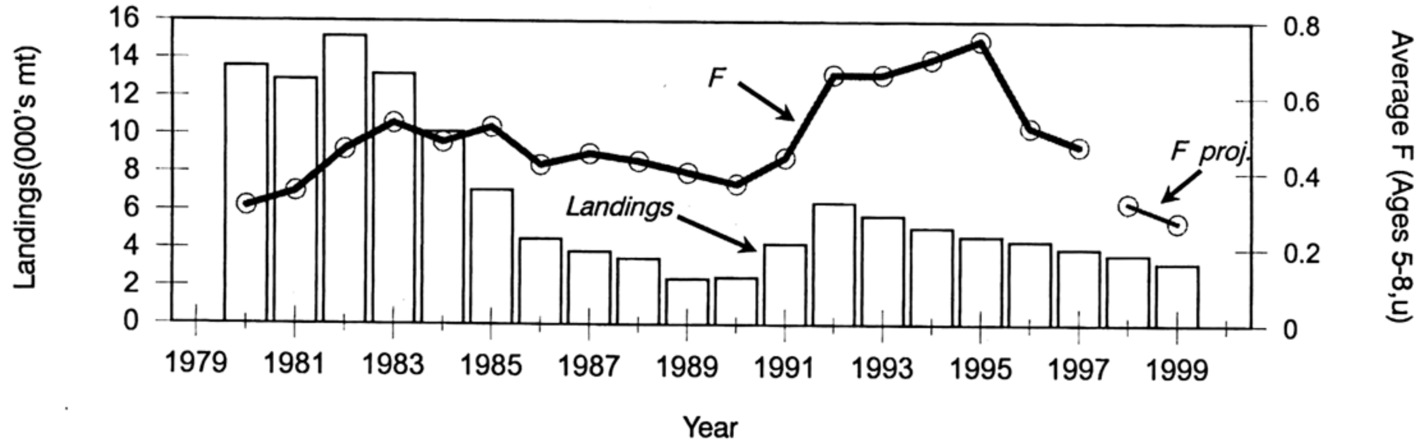


Figure H5. Trends in total commercial landings and fishing mortality for Gulf of Maine-Georges Bank American plaice, 1980 - 1999.

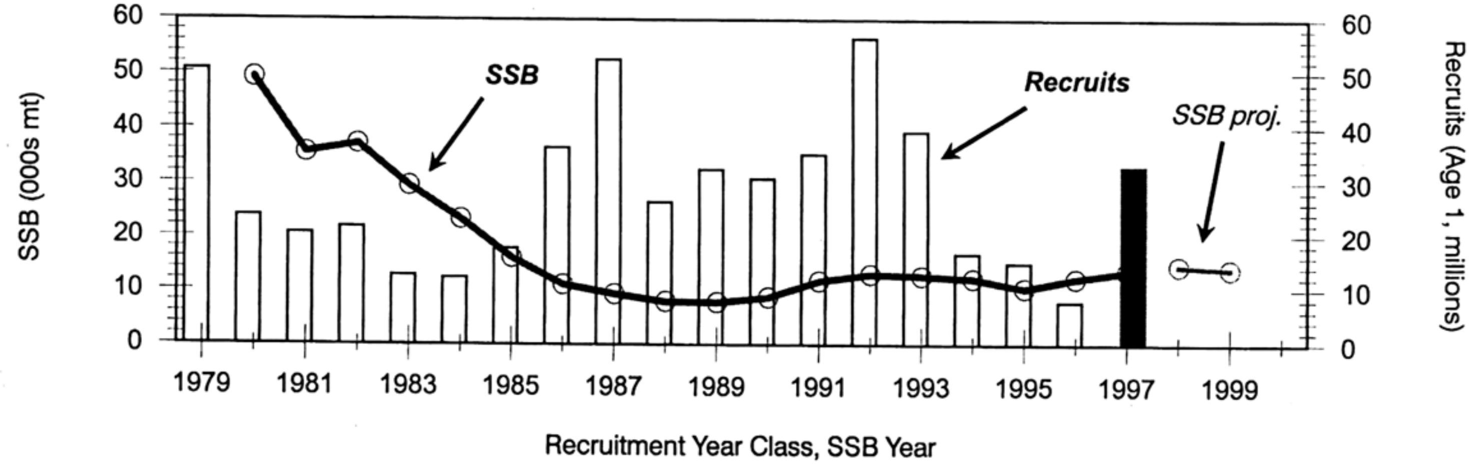


Figure H6. Trends in spawning stock biomass and recruitment for Gulf of Maine-Georges Bank American plaice, 1980-1999.

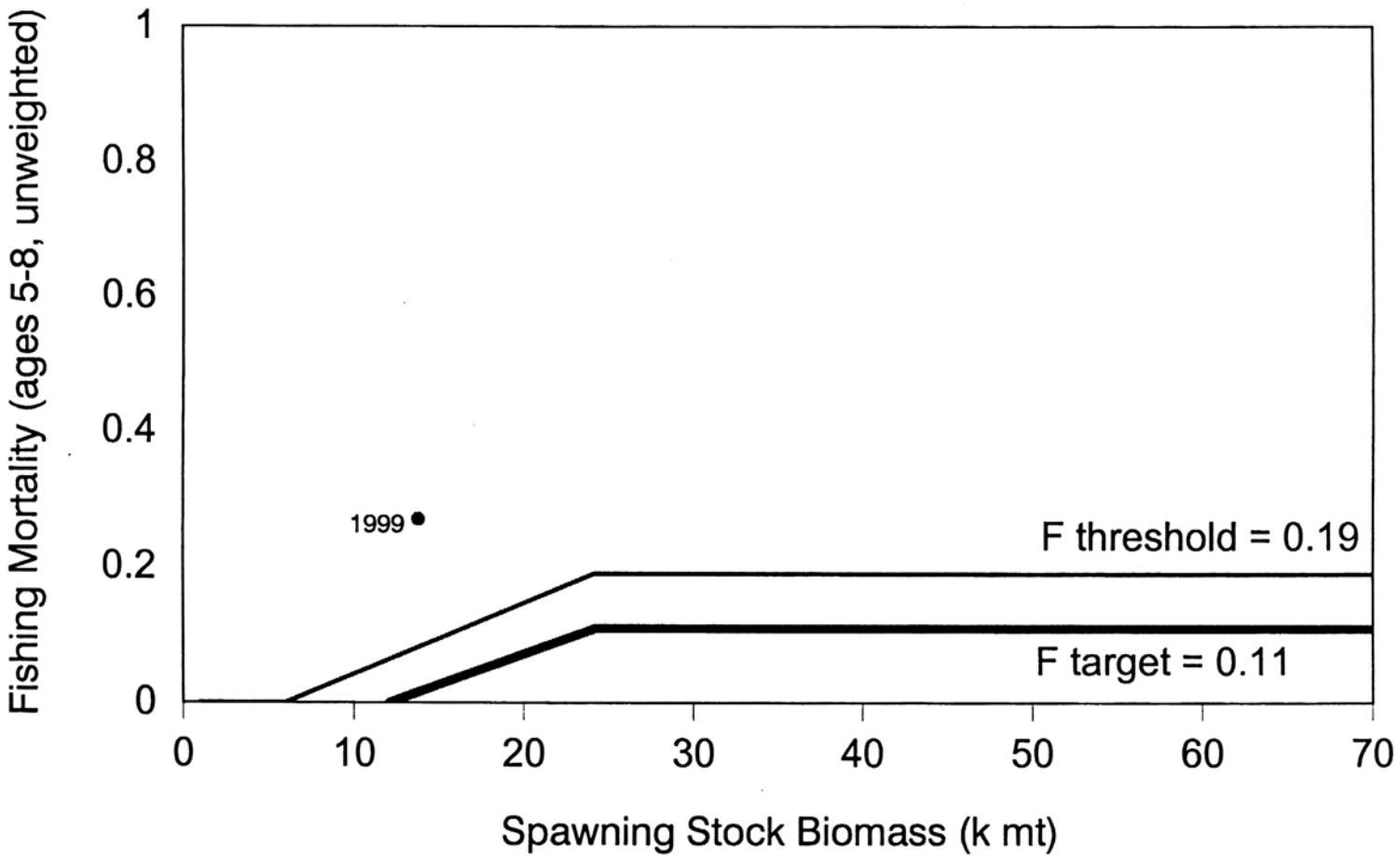


Figure H7. Control rule and projected 1999 stock status for Gulf of Maine-Georges Bank American plaice.

I. Georges Bank Winter Flounder by **Lisa Hendrickson**

1.0 Background

The Georges Bank winter flounder stock was last assessed in 1998 at SAW/SARC 28 (NEFSC 1999). The 1998 VPA assessment incorporated a catch at age from 1982 - 1997 and research survey indices from the U.S. autumn (1963-1997) and spring (1968-1998) surveys, as well as the Canadian spring (1987-1998) surveys. Fully-recruited F (ages 4-6) in 1997 was estimated to be 0.41 and spawning stock biomass was estimated to be 3,500 mt.

In 1999, medium term stochastic projections were generated (NDWG 2000) by deriving a 1998 fishing mortality rate (= 0.42) based on annual landings, then assuming a 1999 fishing mortality rate equal to 1998. Medium term projections were performed by applying the harvest control rule to determine the corresponding level of fishing mortality for 2000 - 2008.

2.0 2000 Assessment Update

The Fishery

Total commercial landings (U.S. and Canadian) of Georges Bank winter flounder have declined since 1997 (1,430 mt) to 1,328 mt in 1998 and 1,019 mt in 1999 (Table I1; Figure I1). Since the late 1960's, U.S. landings have been the predominant component of the total commercial landings. Canadian landings have averaged 0.1% to 2.7% of the total landings since 1970.

Canadian landings in 1997 (143 mt) reached their highest levels since 1966, but have since declined during 1998 and 1999, to 91 mt and 76 mt, respectively. U.S. landings have also declined since 1997. Landings for 1998 and 1999 were estimated, based on prorations, at 1,237 mt and 943 mt, respectively. Discarding of winter flounder occurs at low levels in both the otter trawl and scallop dredge fisheries. However, lack of reliable information to estimate either the magnitude or characterize the size and age distribution of discards precluded discard estimation.

Research Survey Indices

Stratified mean weight (kg) per tow and mean number per tow from the NEFSC spring (April 1968-1999) and autumn (October 1963-1999) bottom trawl surveys, as well as the Canadian spring (1987-1999) bottom trawl surveys, are presented in Table I2. NEFSC autumn survey biomass indices are also shown in relation to the landings for this stock in Figure I1. While landings declined during 1998 and 1999, autumn survey biomass indices increased slightly, reaching their 1996 level in 1999 (1.756 kg/tow).

3.0 Harvest Control Rule

The MSY-based control rule for Georges Bank winter flounder adopted in Amendment 9 was derived from survey-based proxies of biomass and exploitation. The parameters of this control rule were revised during SAW/SARC 28 due to revised estimates of landings and a revision to the strata set used to develop survey indices for the NEFSC spring and autumn surveys. The revised control rule defined maximum sustainable yield as 2,700 mt, and survey equivalents of MSY-based reference points. The F_{MSY} proxy is defined as catch / NEFSC autumn survey biomass index and the B_{MSY} proxy is defined as an autumn survey biomass index value. Threshold F is defined as an F_{MSY} proxy (= 1.125) when the NEFSC autumn survey biomass index is greater than 2.73 kg/tow and declines linearly to zero at 1/2 the B_{MSY} proxy (= 1.37 kg/tow). The target exploitation rate was defined as 75% of the F_{MSY} proxy (=0.84) when the NEFSC autumn survey biomass index is greater than 2.73 kg/tow and declines linearly to zero at 1.37 kg/tow (Figure I2).

Exploitation indices (catch/NEFSC autumn survey biomass index) during 1964-1999 are presented, in Table I3 and Figure I3, in relation to the harvest control rule F_{MSY} proxy (= 1.125). The 1997-1999 mean exploitation index equals 0.787 and the 1997-1999 mean NEFSC autumn survey biomass index equals 1.618 (Figure I2).

The availability of an analytical assessment for this stock provides an opportunity to update the harvest control rule. A revised control rule which incorporated estimates of mean biomass and F weighted by biomass would eliminate the necessity of translating between mean biomass and autumn survey units.

4.0 Forecasts

No stochastic projections were performed for 2000-2001. However, the 1999 U.S. and Canadian landings were used to recalculate the realized F_{1999} (= 0.34). The projected F_{1999} (=0.41) from the analysis conducted in 1999 (NDWG 2000) was assumed to equal the F_{1998}. This projected value for F_{1999} is within the 80th percentile of the recalculated F_{1999} value (= 0.34) (Tables I4 and I5).

5.0 Sources of Uncertainty

- Sampling of U.S. commercial landings may be inadequate to characterize the size and age composition, particularly in the years since 1992. This leads to uncertainty in the age composition of landings in the catch at age matrix.

- The exclusion of U.S. otter trawl and scallop dredge discards most likely results in an underestimation of fishery removals from the younger age classes (ages 0 to 3). Indications from both the sea sample and vessel trip record databases suggests that scallop dredge discards may have increased since the implementation of groundfish retention restrictions resulting in an underestimation of fishery removals of both younger and older age classes.

- There is some uncertainty about the accuracy of reported Canadian landings because of the non-targeted nature of the Canadian fishery and the tendency to report landings of some flatfish species, including winter flounder, as unclassified flounders.

- The Canadian fishery has no formal sampling program to estimate the size and age composition of Canadian landings. This assessment assumed that the size and age composition of Canadian landings was identical to the overall size and age composition in the U.S. fishery. This assumption is sensitive to the possibility that selectivity patterns may be different between the fisheries in each country.

6.0 References

NEFSC [Northeast Fisheries Science Center]. 1999. Report of the 28th Northeast Regional Stock Assessment Workshop (28th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. *Northeast Fish. Sci. Cent. Ref. Doc.* 99-08; 304 p.

NDWG [Northern Demersal Working Group], Northeast Regional Stock Assessment Workshop. 2000. Assessment of 11 Northeast groundfish stocks through 1999: a report to the New England Fishery Management Council's Multi-Species Monitoring Committee. *Northeast Fish. Sci. Cent. Ref. Doc.* 00-05; 175 p.

Table 11. Landings (mt) of Georges Bank winter flounder from 1962-1999 by statistical area and country.

	522-525	5Z (521-543)				5ZE (521-526, 541-543)				
	USA	USA	Canada	USSR	Total	USA	Canada	USSR	Total	Assessment
1962		6996	26		7022					
1963		6911	120	19	7050					
1964	1371	12656	146		12802					1517
1965	1176	10479	199	312	10990					1687
1966	1877	13807	164	156	14127					2197
1967	1917	10815	83	349	11247					2349
1968	1570		57			4346	59	372	4777	1999
1969	2167		116			6380		235	6615	2518
1970	2615		61			7020	64	40	7124	2716
1971	3092		62			14000	65	1029	15094	4183
1972	2805		8			10266	8	1699	11973	4512
1973	2269		14			4387	14	693	5094	2976
1974	2124		12			4508	12	82	4602	2218
1975	2409		13			4833	13	515	5361	2937
1976	1877		15			3732	11	1	3744	1893
1977	3572		15			5954	15	7	5976	3594
1978	3185		65			6378	65		6443	3250
1979	3045		19			6293	19		6312	3064
1980	3931		44			9941	44		9985	3975
1981	3993		19			9711	19		9730	4012
1982	2961		19			7347	19		7366	2980
1983	3894		14			8014	14		8028	3908
1984	3927		4			7574	4		7578	3931
1985	2151		12			4758	11		4769	2163
1986	1762		25							1787
1987	2637		32							2669
1988	2804		55							2859
1989	1880		11							1891
1990	1898		55							1953
1991	1814		14							1828
1992	1822		27							1849
1993	1662		21							1683
1994	907		65							972
1995	706		54							760
1996	1265		71							1336
1997	1287		143							1430
1998	1237		91							1328
1999	943		76							1019

Table 12. Standardized, stratified abundance (numbers) and biomass (weight) indices for Georges Bank winter flounder from the U.S. NEFSC Spring and Autumn, and Canadian Spring research vessel bottom trawl surveys. U.S. offshore survey strata 13-22; Canadian survey strata (5Z1-5Z8). Canadian biomass indices were estimated using the stratified mean number at length and the U.S. survey length-weight regression coefficients. Door standardization coefficients of 1.46 (numbers) and 1.39 (weight) applied to U.S. survey indices before 1985 to account for differences in catchability between survey doors.

	U.S. Spring Survey		**U.S. Autumn Survey**		**Canada Spring Survey**	
	Number/tow	kg/tow	Number/tow	kg/tow	Number/tow	kg/tow
1963			1.200	1.815		
1964			1.298	1.822		
1965			2.152	2.050		
1966			5.163	5.655		
1967	*Spring Survey initiated in 1968*		1.791	2.074		
1968	2.700	3.114	1.308	1.072		
1969	3.136	4.290	2.370	2.385		
1970	1.864	2.294	5.620	6.490		
1971	1.838	2.168	1.324	1.259		
1972	4.946	5.321	1.261	1.580		
1973	2.946	3.507	1.218	1.195		
1974	6.049	5.782	1.193	1.464		
1975	1.955	1.407	3.790	2.061		
1976	4.672	3.012	5.987	3.925		
1977	3.792	1.580	4.862	3.992		
1978	7.068	5.055	4.056	3.100		
1979	1.736	2.206	5.065	3.829		
1980	3.221	2.801	1.661	1.865		
1981	3.727	3.749	3.831	2.434		
1982	2.295	1.523	5.301	2.692		
1983	8.405	7.111	2.726	2.363		
1984	5.529	5.604	3.933	2.445		
1985	3.837	2.650	1.979	1.119		
1986	2.003	1.214	3.575	2.178	*Canadian Survey initiated in 1987*	
1987	2.803	1.247	0.762	0.889	3.73	2.83
1988	2.925	1.648	4.084	1.273	2.70	1.65
1989	1.299	0.757	1.560	1.051	3.48	1.88
1990	2.803	1.573	0.498	0.346	3.29	1.74
1991	2.403	1.319	0.268	0.136	1.43	0.97
1992	1.416	0.898	0.677	0.384	2.25	1.39
1993	1.018	0.570	1.166	0.663	2.78	1.45
1994	1.292	0.578	0.870	0.578	2.45	0.98
1995	2.613	1.489	2.357	1.337	3.10	1.17
1996	2.314	1.504	1.539	1.756	2.20	1.12
1997	1.610	1.192	1.744	1.534	2.80	1.77
1998	0.762	0.722	1.784	1.565	1.42	1.08
1999	3.830	3.479	1.539	1.756	0.98	0.74
2000	4.420	3.693				

Table 13. Exploitation indices (catch/NEFSC autumn survey biomass index) for Georges Bank winter flounder during 1964-1999.

Year	Exploitation Index
1964	0.833
1965	0.823
1966	0.389
1967	1.133
1968	1.865
1969	1.056
1970	0.418
1971	3.322
1972	2.856
1973	2.490
1974	1.515
1975	1.425
1976	0.482
1977	0.900
1978	1.048
1979	0.800
1980	2.131
1981	1.648
1982	1.107
1983	1.654
1984	1.608
1985	1.933
1986	0.820
1987	3.002
1988	2.246
1989	1.799
1990	5.645
1991	13.441
1992	4.815
1993	2.538
1994	1.682
1995	0.568
1996	0.761
1997	0.932
1998	0.849
1999	0.580

Table I4. Input file for stochastic projection program used to recalculate realized F_{1999} (= 0.34).

```
GB Winter Flounder
     1998
        3
      100
  4577161
        0
        1
        0
        0
        0
        0
        0
        1
        0
        0
        0
        0
        0
        1
        1
        7  1  7
   0.200000
   0.168000    0.300000    0.474000    0.670000    0.917000    1.195000    1.73400
   0.221000    0.387000    0.573000    0.788000    1.055000    1.137200    1.73500
   0.000000    0.620000    0.920000    1.000000    1.000000    1.000000    1.00000
   0.200000
        3
       16
   4627000 2725000 6089000 5963000 8027000 5307000 9002000 5243000
   3327000 4523000 2441000 2906000 4813000 6944000 2987000  946000
     1000
bootN.dat
       1000.000
   0.000    11400000.000   0.33
   0.0000   0.540000    0.860000    1.000000    1.000000    1.000000    1.000000
   1 1 0
   1328000 1019000 0
   0.0  0.0  0.420
```

Table I5. Output file from stochastic projection program used to recalculate realized F_{1999} (= 0.34).

```
PROJECTION RUN: GB Winter Flounder
 INPUT FILE: gbwf2.inp
 OUTPUT FILE: gbwf2.out
 RECRUITMENT MODEL: 3
 NUMBER OF SIMULATIONS: 100

 MIXTURE OF F AND QUOTA BASED CATCHES
 YEAR   F       QUOTA (THOUSAND MT)
 1998              1.328
 1999              1.019
 2000  0.420

 SPAWNING STOCK BIOMASS (THOUSAND MT)
 YEAR    AVG SSB (000 MT)    STD
 1998         3.292         0.597
 1999         3.203         0.689
 2000         3.574         0.752

 PERCENTILES OF SPAWNING STOCK BIOMASS (000 MT)
 YEAR       1%         5%         10%        25%        50%        75%        90%        95%        99%
 1998      1.996      2.354      2.568      2.861      3.281      3.670      4.042      4.320      4.805
 1999      1.747      2.113      2.379      2.717      3.184      3.635      4.063      4.405      4.960
 2000      1.951      2.391      2.643      3.064      3.545      4.050      4.534      4.849      5.519

ANNUAL PROBABILITY THAT SSB EXCEEDS THRESHOLD:     0.000 THOUSAND MT
 YEAR    Pr(SSB > Threshold Value)
 1998            1.000
 1999            1.000
 2000            1.000

 MEAN BIOMASS (THOUSAND MT) FOR AGES:1 TO 7
 YEAR   AVG MEAN B (000 MT)      STD
 1998         4.202             0.692
 1999         4.560             0.853
 2000         4.942             0.917

 PERCENTILES OF MEAN STOCK BIOMASS (000 MT)
 YEAR       1%         5%         10%        25%        50%        75%        90%        95%        99%
 1998      2.704      3.109      3.382      3.719      4.179      4.631      5.064      5.393      5.962
 1999      2.723      3.221      3.501      3.982      4.528      5.106      5.648      6.003      6.731
 2000      2.932      3.480      3.785      4.306      4.913      5.550      6.133      6.487      7.202

ANNUAL PROBABILITY THAT MEAN BIOMASS EXCEEDS THRESHOLD:    11.400 THOUSAND MT
 YEAR    Pr(MEAN B > Threshold Value)
 1998            0.000
 1999            0.000
 2000            0.000

 F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 7
 YEAR  AVG F_WT_B        STD
 1998    0.325          0.056
 1999    0.232          0.046
 2000    0.280          0.030

 PERCENTILES OF F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 7
 YEAR   1%     5%     10%    25%    50%    75%    90%    95%    99%
 1998  0.221  0.245  0.262  0.287  0.318  0.357  0.393  0.426  0.489
 1999  0.151  0.170  0.180  0.200  0.225  0.256  0.291  0.316  0.374
 2000  0.209  0.230  0.241  0.259  0.280  0.301  0.318  0.329  0.349

ANNUAL PROBABILITY THAT F WEIGHTED BY MEAN BIOMASS EXCEEDS THRESHOLD: 0.330
 YEAR    Pr(F_WT_B > Threshold Value)
 1998            0.404
 1999            0.034
 2000            0.046

  RECRUITMENT UNITS ARE:1000. FISH
 BIRTH       AVG
 YEAR     RECRUITMENT      STD
 1998      4738.131      2088.952
 1999      4748.381      2091.011
 2000      4726.709      2087.938

 PERCENTILES OF RECRUITMENT UNITS ARE:1000. FISH
 BIRTH
 YEAR      1%         5%         10%        25%        50%        75%        90%        95%        99%
 1998    946.000    946.000   2441.000   2906.000   4627.000   5963.000   8027.000   9002.000   9002.000
 1999    946.000    946.000   2441.000   2987.000   4627.000   6089.000   8027.000   9002.000   9002.000
 2000    946.000    946.000   2441.000   2906.000   4627.000   5963.000   8027.000   9002.000   9002.000
```

Table I5. (Cont.)

LANDINGS FOR F-BASED PROJECTIONS

YEAR	AVG LANDINGS (000 MT)	STD
1998	1.328	0.000
1999	1.019	0.000
2000	1.380	0.281

PERCENTILES OF LANDINGS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	1.328	1.328	1.328	1.328	1.328	1.328	1.328	1.328	1.328
1999	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019
2000	0.766	0.937	1.030	1.189	1.370	1.559	1.738	1.857	2.095

REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS

YEAR	AVG F	STD
1998	0.442	0.097
1999	0.352	0.091
2000	0.420	0.000

PERCENTILES OF REALIZED F SERIES

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.276	0.315	0.336	0.375	0.424	0.494	0.561	0.621	0.749
1999	0.206	0.235	0.257	0.290	0.335	0.396	0.460	0.516	0.641
2000	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420

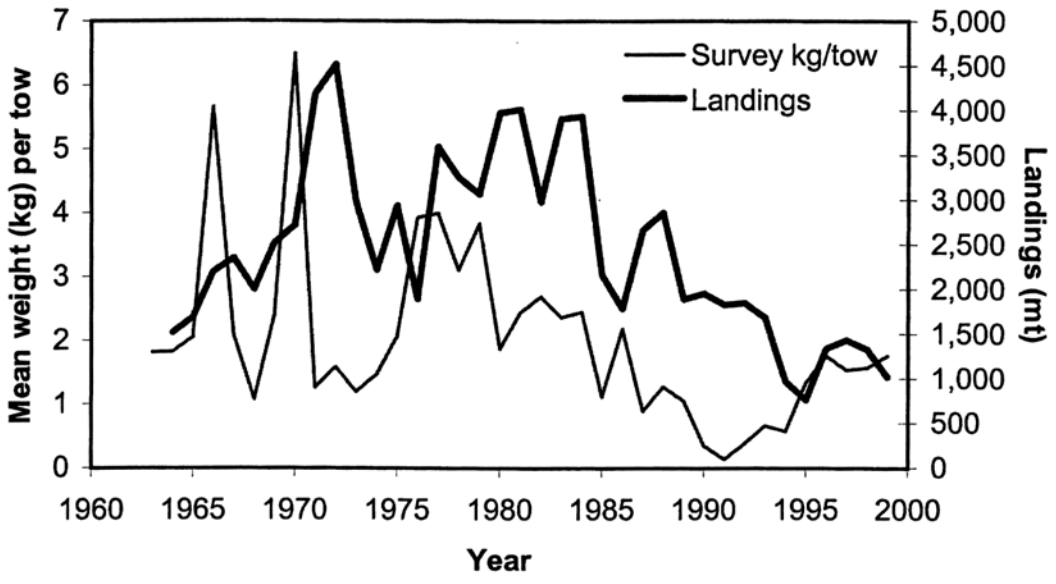


Figure I1. Total commercial landings (U.S. and Canadian) of Georges Bank winter flounder, 1964-1999, and NEFSC autumn bottom trawl survey stratified mean weight (kg) per tow in 1963-1999.

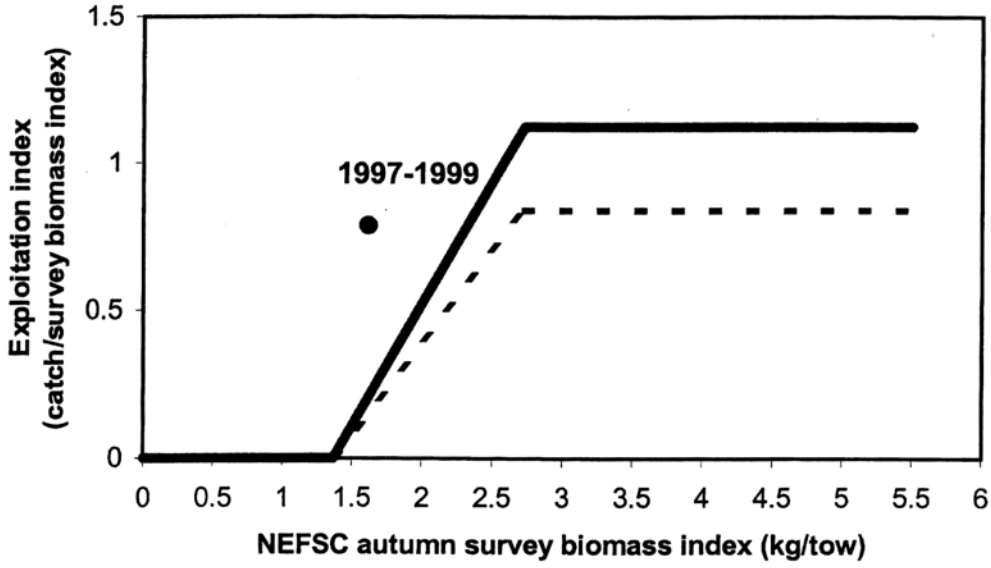


Figure I2. Harvest control rule for Georges Bank winter flounder based on survey equivalents of MSY-based reference points and 1997-1999 mean exploitation index.

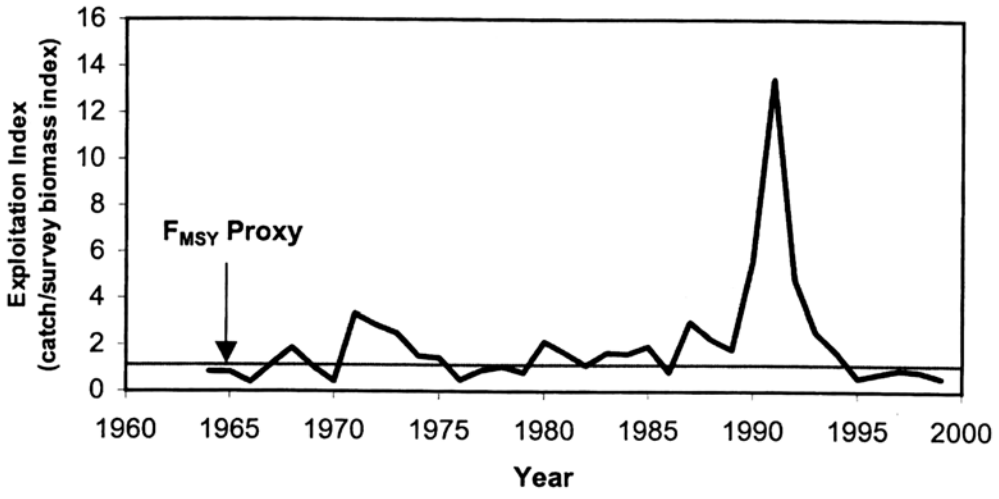


Figure I3. Trends in Georges Bank winter flounder exploitation indices (catch/autumn survey biomass index), during 1964-1999, in relation to the harvest control rule F_{MSY} proxy (= 1.125).

J. Southern New England/Mid-Atlantic Winter Flounder by P. Nitschke

1.0 Background

The Southern New England/Mid-Atlantic stock complex of winter flounder was last assessed by SAW 28 in December 1998, with catches through 1997 (NEFSC 1999). The assessment is for the entire stock complex, which includes several inshore spawning aggregations that individually may not demonstrate the same trend in abundance as the complex. Fully recruited (ages 4-6) fishing mortality in 1997 was estimated at 0.31, corresponding to a biomass weighted F = 0.24 (given current age structure). Mean stock biomass in 1997 was estimated to be 17,900 mt. Forecasts made in 1999 (Northern Demersal Working Group 2000) indicate that fully recruited F (age 4-6) in 1998 was 0.33, corresponding to a biomass weighted F (ages 1 and older) of 0.19. In the SAW 28 assessment, B_{MSY} was estimated to be 27,810 mt, MSY was estimated to be 10,200 mt, F_{MSY} was estimated to be biomass weighted F = 0.37, and the FMP Amendment 9 ten year rebuilding target biomass weighted fishing mortality was estimated to be $F_{target10} = 0.24$.

2.0 2000 Assessment Update

The Fishery

Commercial and recreational catch was updated through 1999 (Table J1). Commercial discards were assumed to be 7% of the landings, as in SAW 28 projections, and were calculated to be 242 mt for 1999. Recreational landings were taken from the MRFSS, and estimated to be 322 mt in 1999. Recreational discards were taken from the MRFSS, and estimated to be 12 mt in 1999. Total landings were estimated to be 3,779 mt, total discards were estimated to be 254 mt, and total catch was estimated to be 4,033 mt in 1999. Total catch has remained relatively stable and low since 1993 (4,041 mt) in comparison to a high of 15,657 mt in 1981 (Figure J1).

Research Survey Indices

NEFSC spring and autumn survey indices were updated though spring 2000 (Table J2; Figure J1). NEFSC survey indices show an increase in stock biomass since 1993. The NEFSC spring 1999 (1.245 kg/tow) and 2000 (1.123 kg/tow) survey biomass index are among the highest since 1985 (1.983 kg/tow). The NEFSC autumn 1999 survey biomass index (1.549 kg/tow) has decreased since 1997 (2.583 kg/tow) but remain among the highest since 1983 (2.691 kg/tow). The MDMF 1999 spring survey biomass index (4.44 kg/tow) has decreased from 1998 (7.99 kg/tow; Figure J2).

Assessment Results

Projections based on 1998 and 1999 total catch indicate that fully recruited F (age 4-6) declined slightly from 0.33 to 0.29, respectively (Table J3). The assumed 1999 F=0.33 used in the 1999 projection (Northern Demersal Working Group 2000) is slightly higher but does fall within the

updated 1999 F=0.29 80% confident interval (0.23 - 0.36). The updated 1999 stock biomass (25,300 mt) is therefore slightly higher than the estimated biomass from the 1999 projection (25,000 mt). Fishing mortality in 1999 likely remained at status quo given that total landings have remained stable and that survey indices have not changed greatly from 1998.

3.0 Harvest Control Rule

The target fishing mortality to be used when stock biomass is greater than B_{MSY} (27,800 mt) was estimated as the 10th percentile of F_{MSY} (Figure J3). $F_{THRESHOLD} = F_{MSY} = 0.37$ on biomass when biomass = B_{MSY}. When total stock biomass is between $\frac{1}{2}B_{MSY}$ (13,900 mt) and B_{MSY}, a 10-year rebuilding strategy applies. When total stock biomass is between $B_{THRESHOLD} = \frac{1}{4}B_{MSY}$ (7,000 mt) and $\frac{1}{2}B_{MSY}$, a 5-year rebuilding strategy applies. When biomass is below $\frac{1}{4}B_{MSY}$, $F_{THRESHOLD} = 0$.

4.0 References

NEFSC. 1999. 28th Northeast Regional Stock Assessment Workshop (28th SAW). Stock Assessment Review Committee (SARC) Consensus Summary of Assessment. NMFS/NEFSC, Woods Hole Laboratory Ref. Doc. 99-08.

NDWG (Northern Demersal Working Group, Northeast Regional Stock Assessment Workshop). 2000. Assessment of 11 Northeast groundfish stocks through 1999: a report to the New England Fishery Management Council's Multi-Species Monitoring Committee. *Northeast Fish. Sci. Cent. Ref. Doc.* 00-05, 153 p.

Table J1. Total winter flounder recreational and commercial catch for the Southern New England/Mid-Atlantic stock complex in weight (mt) and numbers (000s).

Year	Commercial Landings		Commercial Discards		Recreational Landings		Recreational Discards		Total Catch		% Discards/Total	
	mt	000s	mt	000s	mt	000s	mt	000s	mt	000s	mt	000s
1981	11,176	20,705	1,343	5,123	3,050	8,089	88	437	15,657	34,354	9.1	16.2
1982	9,438	19,016	1,149	4,271	2,457	8,392	66	341	13,110	32,020	9.3	14.4
1983	8,659	16,312	1,311	5,251	2,524	8,365	125	399	12,619	30,327	11.4	18.6
1984	8,882	17,116	986	3,936	5,772	12,756	148	745	15,788	34,553	7.2	13.5
1985	7,052	14,211	1,534	4,531	5,198	13,297	230	714	14,014	32,753	12.6	16.0
1986	4,929	9,460	1,273	4,902	2,940	6,994	66	356	9,208	21,712	14.5	24.2
1987	5,172	10,524	950	3,545	3,141	6,899	61	347	9,324	21,315	10.8	18.3
1988	4,312	8,377	904	3,728	3,423	7,359	69	416	8,708	19,880	11.2	20.8
1989	3,670	7,888	1,404	5,761	1,802	3,684	49	335	6,925	17,668	21.0	34.5
1990	4,232	7,202	673	2,567	1,063	2,485	31	201	5,999	12,455	11.7	22.2
1991	4,823	9,063	784	2,701	1,214	2,794	51	230	6,872	14,788	12.2	19.8
1992	3,816	6,759	511	1,811	393	802	15	83	4,735	9,455	11.1	20.0
1993	3,010	5,336	457	1,580	543	1,180	31	155	4,041	8,251	12.1	21.0
1994	2,159	1,948	304	344	598	1,210	34	93	3,095	3,595	10.9	12.2
1995	2,634	2,321	121	107	661	1,390	23	69	3,439	3,887	4.2	4.5
1996	2,781	2,372	173	149	689	1,555	64	168	3,707	4,244	6.4	7.5
1997	3,426	5,834	267	1,200	618	1,204	26	85	4,337	8,323	6.8	15.4
1998	3,213		231		564		16		4,024		6.1	
1999	3,457		242		322		12		4,033		6.3	

Table J2. Winter flounder NEFSC and MDMF survey index stratified mean number and mean weight (kg) per tow for the Southern New England- Mid-Atlantic stock complex, strata set (offshore 1-12, 25, 69-76 ; inshore 1-29, 45-56; MDMF 11-21).

	NEFSC Spring		NEFSC Fall		MDMF Spring	
YEAR	Number	Weight	Number	Weight	Number	Weight
1963			8.554	3.283		
1964			13.673	4.894		
1965			15.537	4.435		
1966			9.843	3.275		
1967			9.109	2.745		
1968	2.444	0.734	8.106	2.191		
1969	5.640	3.414	6.842	1.939		
1970	2.729	1.326	5.110	2.376		
1971	2.035	0.756	3.862	1.232		
1972	1.866	0.656	7.687	3.054		
1973	7.459	2.013	2.691	0.776		
1974	3.362	1.043	2.032	0.821		
1975	1.136	0.354	2.358	0.742		
1976	3.085	0.805	2.375	1.251		
1977	4.186	1.190	4.722	1.735		
1978	6.696	1.758	3.743	1.430	51.50	18.12
1979	2.965	1.069	10.058	2.606	53.61	18.17
1980	15.250	3.551	9.975	3.216	38.92	15.18
1981	18.234	4.762	9.899	3.109	46.05	15.77
1982	6.986	1.918	4.927	1.683	40.23	14.82
1983	6.262	2.469	8.757	2.691	56.39	19.45
1984	5.524	2.072	2.681	0.887	36.64	14.68
1985	5.360	1.983	2.727	0.991	38.36	11.60
1986	2.266	0.766	1.538	0.487	36.51	10.42
1987	1.763	0.568	1.167	0.419	37.84	9.57
1988	2.126	0.730	1.246	0.530	27.57	6.46
1989	2.485	0.582	1.435	0.341	24.42	7.96
1990	1.992	0.472	1.979	0.546	25.75	5.38
1991	2.473	0.692	1.950	0.708	10.57	2.91
1992	1.579	0.435	2.963	0.829	28.69	7.99
1993	0.961	0.219	1.382	0.392	46.92	8.16
1994	1.510	0.329	4.134	1.482	48.43	12.59
1995	2.097	0.592	2.253	0.626	33.35	7.26
1996	1.517	0.428	3.186	1.063	30.18	9.78
1997	1.436	0.399	7.893	2.583	39.31	10.02
1998	2.774	0.845	6.597	2.232	34.63	7.99
1999	4.171	1.245	3.596	1.549	25.11	4.44
2000	3.172	1.123				

NOTE: NEFSC 1968-1972 spring index does not include inshore strata ; NEFSC 1963-1971 fall index does not include inshore strata. All NEFSC indices calculated with trawl door conversion factors where appropriate.

Table J3. Projection of 1998 VPA (NESFC 1999) with observed 1998 and 1999 catch.

INPUT ASSUMPTIONS

Age	1	2	3	4	5	6	7+
Stock Wt.	0.134	0.388	0.508	0.612	0.754	0.941	1.135
Landed Wt.	0.204	0.427	0.520	0.615	0.755	0.941	1.135
Discard Wt.	0.134	0.277	0.350	0.445	0.617	0.000	0.000
Maturity	0.000	0.000	0.530	0.950	1.000	1.000	1.000
PR	0.020	0.250	0.610	1.000	1.000	1.000	1.000
Discard	1.000	0.350	0.150	0.010	0.010	0.000	0.000

QUOTA BASED CATCHES

YEAR	F	QUOTA (THOUSAND MT)
1998		3.777
1999		3.779

SPAWNING STOCK BIOMASS (THOUSAND MT)

YEAR	AVG SSB (000 MT)	STD
1998	11.849	1.671
1999	13.857	2.312

PERCENTILES OF SPAWNING STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	8.178	9.261	9.958	10.587	11.799	12.797	13.831	14.851	16.100
1999	8.633	10.315	10.999	12.200	13.844	15.355	16.631	17.919	19.829

ANNUAL PROBABILITY THAT SSB EXCEEDS THRESHOLD: 10.000 THOUSAND MT

YEAR	Pr(SSB > Threshold Value)
1998	0.885
1999	0.955

MEAN BIOMASS (THOUSAND MT) FOR AGES:1 TO 7

YEAR	AVG MEAN B (000 MT)	STD
1998	22.553	3.092
1999	25.803	4.580

PERCENTILES OF MEAN STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	16.541	17.693	18.680	20.180	22.318	24.432	26.393	28.524	29.854
1999	16.918	19.028	20.226	22.442	25.346	28.802	31.989	33.904	37.935

ANNUAL PROBABILITY THAT MEAN BIOMASS EXCEEDS THRESHOLD: 27.810 THOUSAND MT

YEAR	Pr(MEAN B > Threshold Value)
1998	0.060
1999	0.314

F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 7

YEAR	AVG F_WT_B	STD
1998	0.187	0.025
1999	0.165	0.029

PERCENTILES OF F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 7

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.137	0.146	0.157	0.169	0.184	0.204	0.220	0.234	0.245
1999	0.109	0.122	0.129	0.143	0.162	0.183	0.202	0.216	0.242

ANNUAL PROBABILITY THAT F WEIGHTED BY MEAN BIOMASS EXCEEDS THRESHOLD: 0.240

YEAR	Pr(F_WT_B > Threshold Value)
1998	0.030
1999	0.011

RECRUITMENT UNITS ARE:1000. FISH

BIRTH YEAR	AVG RECRUITMENT	STD
1998	27447.426	15121.907
1999	27612.614	15283.267

PERCENTILES OF RECRUITMENT UNITS ARE:1000. FISH

BIRTH YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	8834.000	8834.000	12020.000	16837.000	23487.000	34619.000	56505.000	62859.000	62859.000
1999	8834.000	8834.000	12020.000	16837.000	23288.000	34619.000	56505.000	62859.000	62859.000

TABLE J3. Continued.

LANDINGS FOR F-BASED PROJECTIONS

YEAR	AVG LANDINGS (000 MT)	STD
1998	3.777	0.000
1999	3.779	0.000

PERCENTILES OF LANDINGS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	3.777	3.777	3.777	3.777	3.777	3.777	3.777	3.777	3.777
1999	3.779	3.779	3.779	3.779	3.779	3.779	3.779	3.779	3.779

DISCARDS FOR F-BASED PROJECTIONS

YEAR	AVG DISCARDS (000 MT)	STD
1998	0.243	0.034
1999	0.226	0.041

PERCENTILES OF DISCARDS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.162	0.187	0.201	0.220	0.246	0.267	0.286	0.295	0.314
1999	0.144	0.165	0.176	0.196	0.223	0.252	0.281	0.298	0.343

REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS

YEAR	AVG F	STD
1998	0.334	0.048
1999	0.294	0.051

PERCENTILES OF REALIZED F SERIES

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.234	0.257	0.275	0.303	0.328	0.365	0.396	0.423	0.440
1999	0.194	0.220	0.234	0.260	0.289	0.326	0.364	0.391	0.440

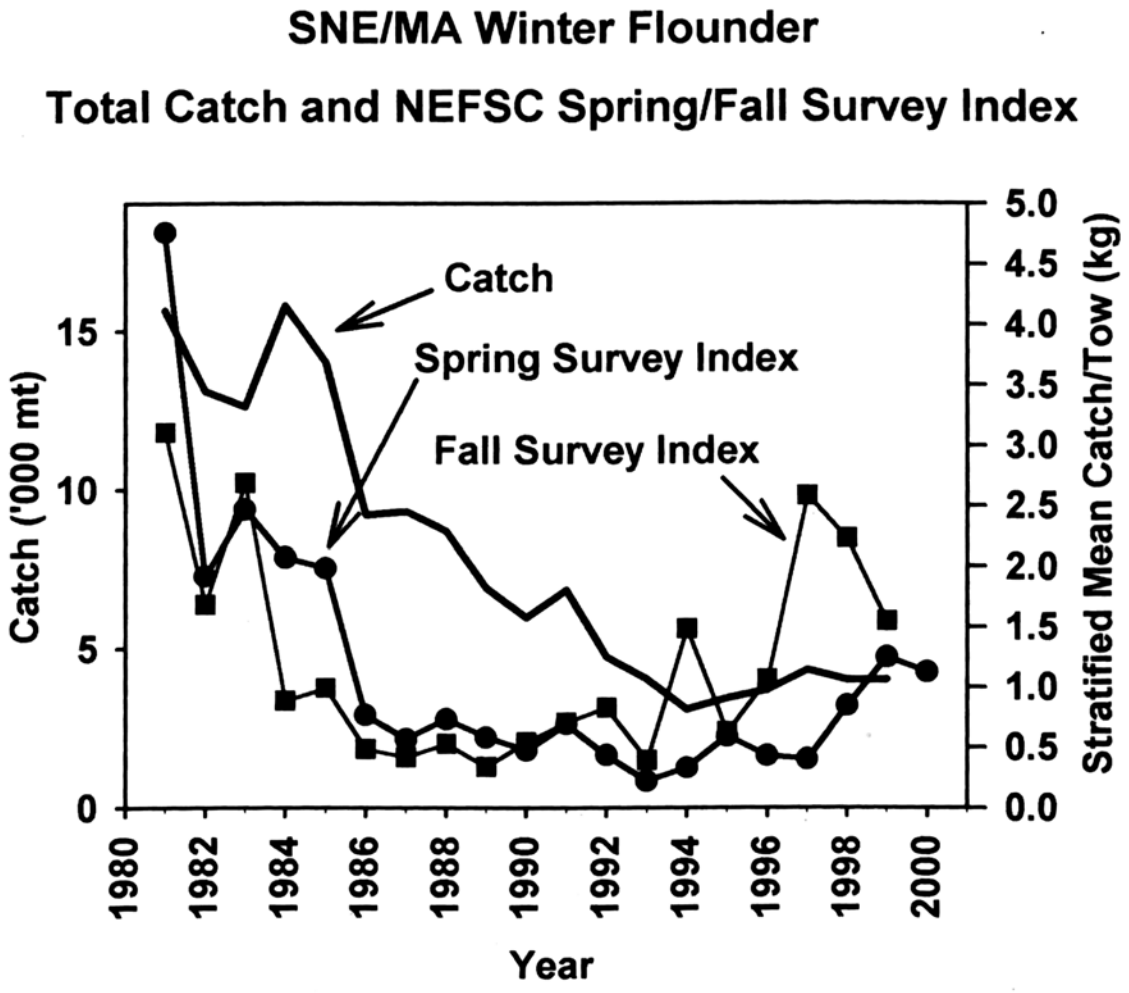


Figure J1. Total catch (landings and discards, thousands of metric tons) and the standardized spring and fall survey index for SNE/MA winter flounder.

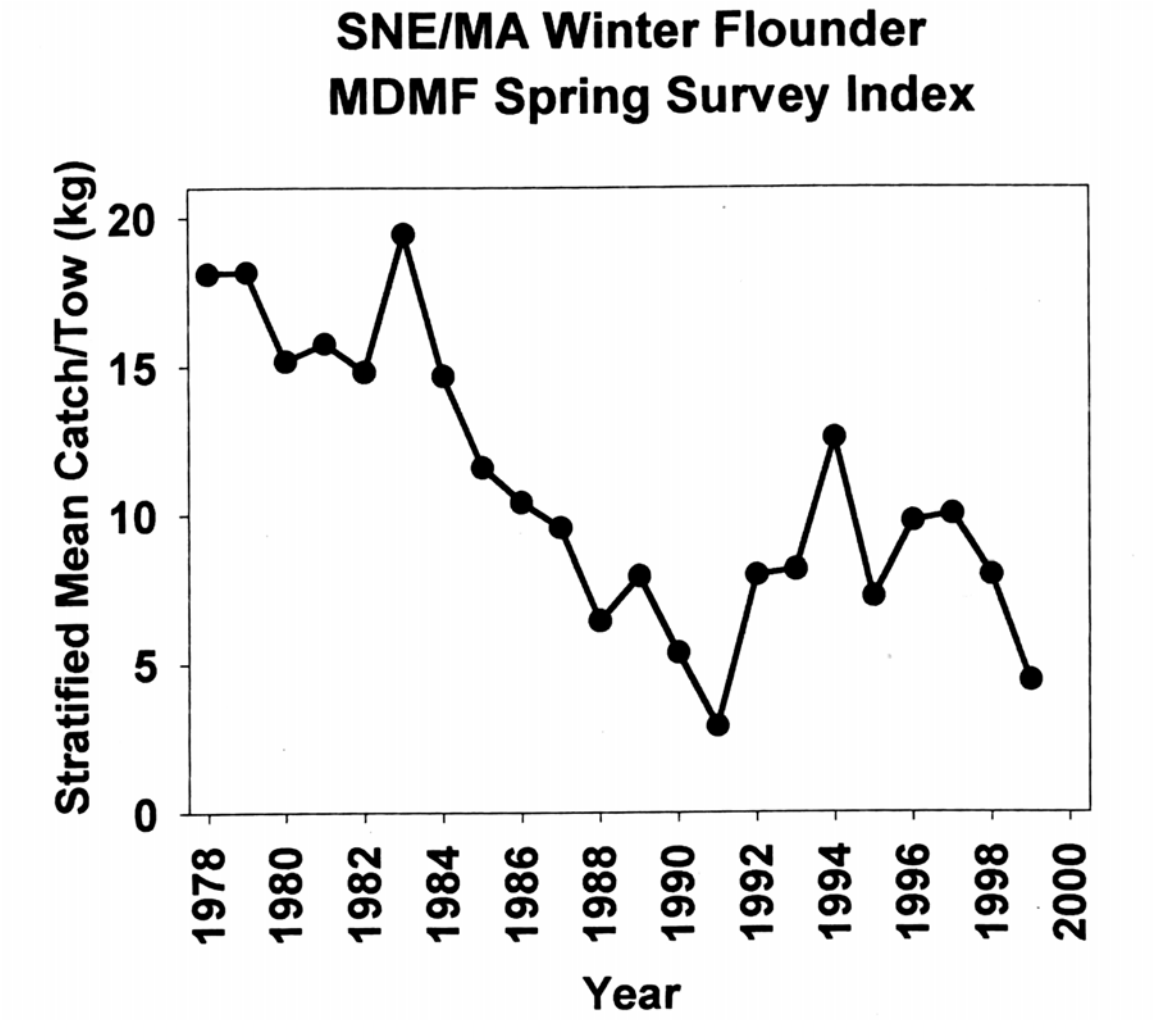


Figure J2. The MDMF spring biomass survey index for SNE/MA winter flounder.

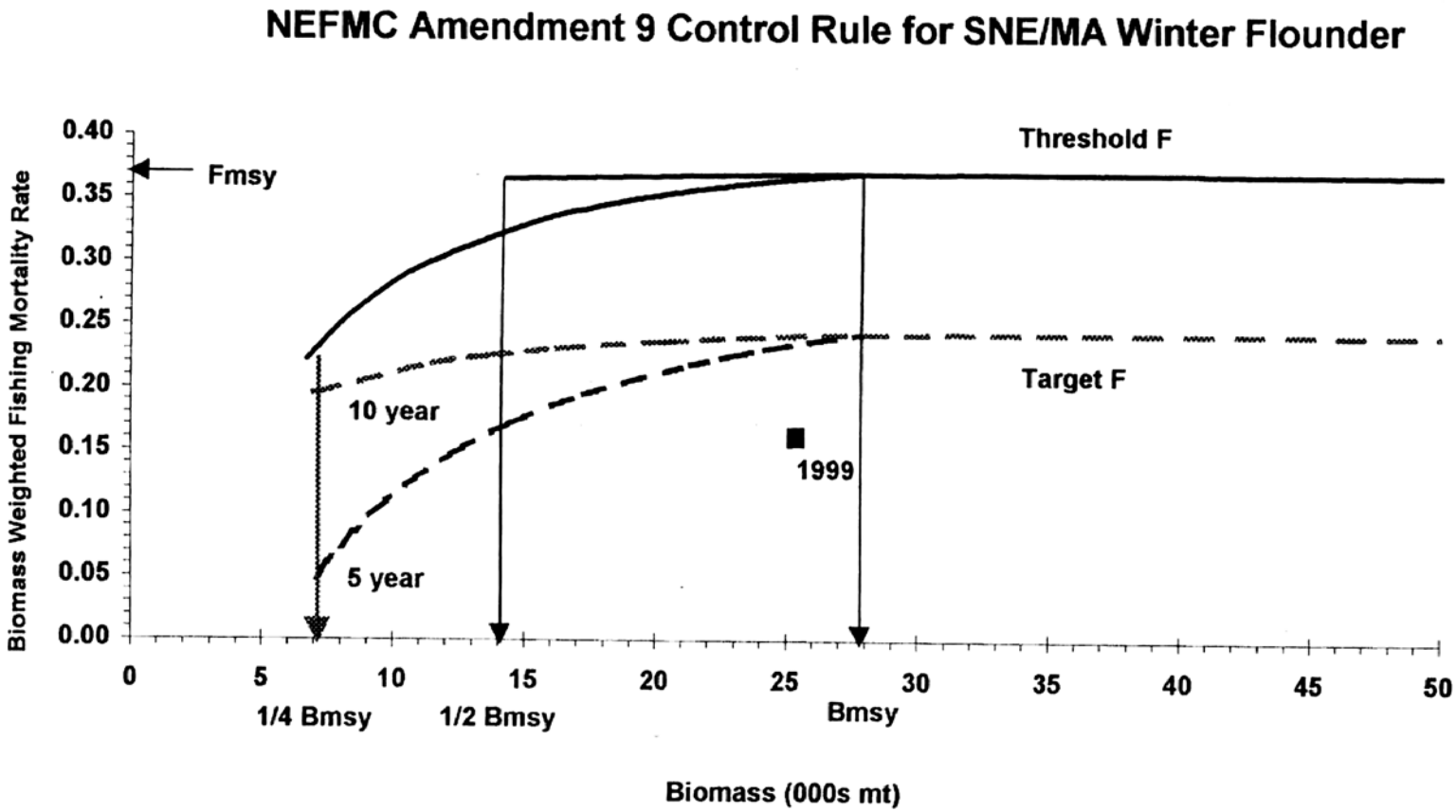


Figure J3. NEFMC FMP Amendment 9 control rule for SNE/MA winter flounder for rebuilding to BMSY, with current 1998-1999 projection estimates of biomass weighted F and mean stock biomass using the total catch in 1998 and 1999.

K. Georges Bank/Gulf of Maine White Hake by K.A. Sosebee

1.0 Background

A VPA was last conducted for this stock in 1998 and reviewed at SAW 28 (NEFSC 1999). In 1999, projections were done to estimate mean biomass in 2000. Reported landings in 1998 were used to derive fishing mortality in 1998. Fully recruited fishing mortality (ages 4-8) in 1998 was estimated to be 1.09, a decrease from 1.15 in 1997. Spawning stock biomass was estimated to have declined to 2,700 mt in 1998, a decline from a recent high of 9,600 mt in 1992. NEFSC spring and autumn research vessel bottom trawl survey indices had declined to near record low levels in 1998 and 1999.

2.0 2000 Assessment

Fishery

United States commercial landings of white hake increased to 2,624 metric tons (mt) in 1999, an 11% increase from 1998 (Table K1; Figure K1). Canadian landings declined to 175 mt (23% decline). No discard estimates were derived for 1999.

Input Data and Analyses

The present assessment represents a one-year update to the previous assessment (Northern Demersal Working Group 2000). Forecast software was used to estimate fishing mortality and biomass in 1999. Survivors from 1000 bootstrapped VPA outcomes from the 1997 assessment (NEFSC 1999) were used to start the projections. Reported landings were used to generate fishing mortality in 1998 and 1999. Survey data from the fall of 1998 and 1999 and the spring of 1999 and 2000 was aged using seasonal pooled age-length keys from 1982-1999. The age estimates for fall age-1 and spring age-2 were then used to derive an estimate of recruitment for the 1997 and 1998 year classes using RCT3 . The estimate and the standard error were used to generate 1000 recruitment estimates for age 1 in the projections for 1997. The estimate for 1998 was used in the first year of the projection.

3.0 Assessment Results

NEFSC research vessel bottom trawl survey abundance and biomass indices for white hake remained relatively low through autumn 1999 and spring 2000 (Table K2, Figure K2). The autumn 1999 indices declined slightly from the 1998 levels, while the spring 2000 indices increased from the 1998 levels because of an apparently strong 1998 year class (Figure K3). Recruitment of the 1997 year class was estimated to be 1.9 million fish, the second lowest value in the time series while the 1998 year class is estimated to be 9.0 million fish, the third highest value (Figure K5).

Fully recruited fishing mortality (ages 4-8) in 1999 is now estimated to be 0.90 (Figure K4), a slight decline from 1.09 in 1998, as reported in the previous assessment. Spawning stock biomass is estimated at 3,297 mt in 1999, an increase from 2,717 mt in 1998 (Figure K5). The most recent high level of SSB (9,563 mt) occurred in 1992. Mean biomass increased to 6,887 in 1999 due to both the 1996 and 1998 year classes (Figure K5). Biomass weighted fishing mortality (ages 1+) has declined from 0.8 in 1996 to 0.40 in 1999 (Figure K4). Accounting for precision in the current assessment, there is a 90% probability that fully recruited F in 1999 was greater than 0.6, SSB in 1999 was less than 4,500 mt, and mean biomass was less than 9,000 mt.

4.0 Consistency of 1999 Projection Forecast with 2000 Assessment Results

Projections conducted during the 1999 assessment were performed assuming that F1999= F1998 =1.09 and estimated that mean biomass would be 5498 mt in 1999. The 2000 assessment using actual landings estimated an F of 0.9 with 80% probability that F was between 0.6 and 1.7 which includes the former value of 1.09. With a lower value of fishing mortality and a higher level of recruitment in 1999, the mean biomass from the new projection was 6,887 mt as compared to 5,498 mt. With 80% confidence limits of 3847 and 8964, the values are still similar.

5.0 Control rule.

According to the SARC 28 overfishing control rule, when mean biomass is at B_{msy} (22,300 mt) or greater, the target fishing mortality is 0.12 and the threshold is 0.24 (Figure K6). When biomass is between 6,900 mt and 22,300 the fishing mortality rate should allow recovery to B_{msy} in 5years. At biomass levels below 6,900 mt, fishing mortality should be as close to zero as possible.

6.0 Sources of Uncertainty

- 1999 fishing mortality may be uncertain if landings are not complete and if the PR has changed.
- 1997 and 1998 year classes based on pooled age-length keys.
- The control rule is based on a rescaled estimate of F_{msy}. The scaling may not show the actual rate of recovery.

From SARC 28:

- Discards are not incorporated into the VPA catch at age.
- Red hake may be mis-identified as white hake and vice versa.
- Missing ages in the survey age/length keys were interpolated.
- White hake may move seasonally into and out of the defined stock area.

7.0 References

NEFSC. 1999. 28th Northeast Regional Stock Assessment Workshop (28th SAW). Stock Assessment Review Committee (SARC) Consensus Summary of Assessments. NMFS/NEFSC, Woods Hole Laboratory Ref. Doc. 99-08.

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Table K1. Total Landings (mt,live) of white hake by country from the Gulf of Maine to Cape Hatteras (NAFO Subareas 5 and 6), 1964-1999.

	Canada	USA	Other	Grand Total
1964	29	3016	0	3045
1965	0	2617	0	2617
1966	0	1563	0	1563
1967	16	1126	0	1142
1968	85	1210	0	1295
1969	34	1343	6	1383
1970	46	1807	280	2133
1971	100	2583	214	2897
1972	40	2946	159	3145
1973	117	3279	5	3401
1974	232	3773	0	4005
1975	146	3672	0	3818
1976	195	4104	0	4299
1977	170	4976	338	5484
1978	155	4869	29	5053
1979	251	4044	4	4299
1980	305	4746	2	5053
1981	454	5969	0	6423
1982	764	6179	2	6945
1983	810	6408	0	7218
1984	1013	6757	0	7770
1985	953	7353	0	8306
1986	956	6109	0	7065
1987	555	5818	0	6373
1988	534	4783	0	5317
1989	583	4548	0	5131
1990	547	4927	0	5474
1991	552	5607	0	6159
1992	1138	8444	0	9582
1993	1681	7466	0	9147
1994	955	4737	0	5692
1995	481	4333	0	4814
1996	372	3287	0	3659
1997	290	2225	0	2515
1998	228	2364	0	2592
1999	175	2624	0	2799

Table K2 Stratified mean catch per tow in numbers and weight (kg) for white hake from NEFSC offshore spring and autumn research vessel bottom trawl surveys (strata 21-30,33-40), 1963-2000.

	Spring			Autumn		
Year	No/Tow	Wt/Tow	Length	No/Tow	Wt/Tow	Length
1963				5.00	6.31	46.2
1964				1.77	4.14	56.3
1965				4.39	6.86	50.4
1966				6.79	7.67	45.1
1967				3.92	3.64	42.6
1968	1.60	1.74	44.1	4.24	4.54	44.9
1969	3.76	5.09	46.3	9.24	13.09	46.8
1970	5.84	11.86	52.9	8.05	12.82	51.3
1971	3.31	5.14	51.3	10.38	12.10	43.6
1972	10.18	12.66	47.3	12.52	13.10	45.2
1973	9.24	12.22	49.9	9.05	13.46	51.7
1974	8.08	13.99	55.0	5.35	11.00	54.5
1975	9.32	11.22	44.7	5.28	7.23	48.5
1976	9.98	17.01	52.7	6.04	10.56	54.7
1977	6.13	11.01	55.5	9.78	13.74	47.8
1978	3.22	6.14	51.8	7.87	12.54	50.2
1979	5.26	4.97	43.0	5.62	10.31	53.1
1980	10.38	13.96	49.7	10.86	16.66	48.8
1981	17.09	19.92	45.9	8.70	12.16	49.9
1982	6.06	8.91	51.0	1.96	2.11	46.7
1983	3.23	3.12	43.7	8.22	10.79	48.8
1984	2.75	4.17	51.4	5.32	8.23	51.9
1985	4.33	5.38	48.5	9.37	9.74	42.9
1986	8.24	5.61	40.0	14.42	11.56	41.9
1987	7.15	6.44	45.3	7.59	9.62	49.2
1988	4.52	3.69	41.9	8.12	9.88	46.1
1989	3.65	3.22	43.0	11.76	9.23	40.5
1990	11.11	18.37	53.3	13.09	10.58	41.5
1991	8.42	6.14	41.6	13.22	12.20	44.6
1992	7.59	7.11	45.1	10.16	11.24	47.7
1993	7.93	6.84	45.1	11.35	11.66	45.2
1994	4.59	3.17	40.1	8.44	7.02	42.3
1995	4.38	4.02	44.1	9.54	8.20	40.8
1996	2.87	3.07	45.9	4.52	6.35	51.2
1997	1.88	0.89	38.4	4.69	4.55	41.5
1998	2.25	1.09	37.7	4.41	4.27	44.5
1999	3.32	2.97	44.6	5.68	3.44	36.3
2000	5.19	3.33	40.4			

Table K3. Input data for projections.

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Catch	Stock
1	0.0000	1.0000	0.0400	0.199	0.124
2	0.0399	1.0000	0.2600	0.544	0.340
3	0.5191	1.0000	0.7000	1.066	0.756
4	1.0000	1.0000	0.8900	1.910	1.437
5	1.0000	1.0000	0.9800	3.069	2.416
6	1.0000	1.0000	0.9800	4.393	3.681
7	1.0000	1.0000	1.0000	6.040	5.175
8	1.0000	1.0000	1.0000	7.886	6.910
9+	1.0000	1.0000	1.0000	13.200	13.200

Table K4. PROJECTION RUN: white hake projection

INPUT FILE: whake993.in
OUTPUT FILE: whakenew.out
RECRUITMENT MODEL: 9
NUMBER OF SIMULATIONS: 100

MIXTURE OF F AND QUOTA BASED CATCHES

YEAR	F	QUOTA (THOUSAND MT)
1998		2.592
1999		2.799

SPAWNING STOCK BIOMASS (THOUSAND MT)

YEAR	AVG SSB (000 MT)	STD
1998	2.756	0.556
1999	3.335	1.276

PERCENTILES OF SPAWNING STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	1.234	1.868	2.051	2.403	2.717	3.091	3.456	3.738	4.070
1999	0.608	1.517	2.001	2.382	3.307	3.988	4.526	5.039	7.078

ANNUAL PROBABILITY THAT SSB EXCEEDS THRESHOLD: 10.000 THOUSAND MT

YEAR	Pr(SSB > Threshold Value)
1998	0.000
1999	0.000

MEAN BIOMASS (THOUSAND MT) FOR AGES:1 TO 9

YEAR	AVG MEAN B (000 MT)	STD
1998	5.573	1.411
1999	7.001	2.195

PERCENTILES OF MEAN STOCK BIOMASS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	2.723	3.673	3.987	4.551	5.471	6.228	6.803	7.444	9.623
1999	2.722	3.847	4.672	5.517	6.887	7.895	8.964	9.900	13.016

ANNUAL PROBABILITY THAT MEAN BIOMASS EXCEEDS THRESHOLD: 22.300 THOUSAND MT

YEAR	Pr(MEAN B > Threshold Value)
1998	0.000
1999	0.000

F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 9

YEAR	AVG F_WT_B	STD
1998	0.492	0.119
1999	0.438	0.141

PERCENTILES OF F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 9

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.199	0.312	0.374	0.414	0.470	0.569	0.630	0.691	0.875
1999	0.151	0.248	0.309	0.354	0.402	0.495	0.587	0.664	0.991

ANNUAL PROBABILITY THAT F WEIGHTED BY MEAN BIOMASS EXCEEDS THRESHOLD: 0.240

YEAR	Pr(F_WT_B > Threshold Value)
1998	0.990
1999	0.970

RECRUITMENT UNITS ARE:1000. FISH

BIRTH YEAR	AVG RECRUITMENT	STD
1998	9046.000	0.000
1999	2857.256	1666.965

PERCENTILES OF RECRUITMENT UNITS ARE:1000. FISH

BIRTH YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	9046.000	9046.000	9046.000	9046.000	9046.000	9046.000	9046.000	9046.000	9046.000
1999	1471.000	1471.000	1471.000	1911.000	1911.000	5692.000	5692.000	5692.000	5692.000

LANDINGS FOR F-BASED PROJECTIONS

YEAR	AVG LANDINGS (000 MT)	STD
1998	2.592	0.000
1999	2.799	0.000

PERCENTILES OF LANDINGS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	2.592	2.592	2.592	2.592	2.592	2.592	2.592	2.592	2.592
1999	2.799	2.799	2.799	2.799	2.799	2.799	2.799	2.799	2.799

REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS

YEAR	AVG F	STD
1998	1.145	0.333
1999	1.153	0.901

PERCENTILES OF REALIZED F SERIES

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.703	0.737	0.791	0.931	1.093	1.237	1.507	1.710	2.059
1999	0.282	0.510	0.605	0.712	0.901	1.310	1.663	2.104	5.441

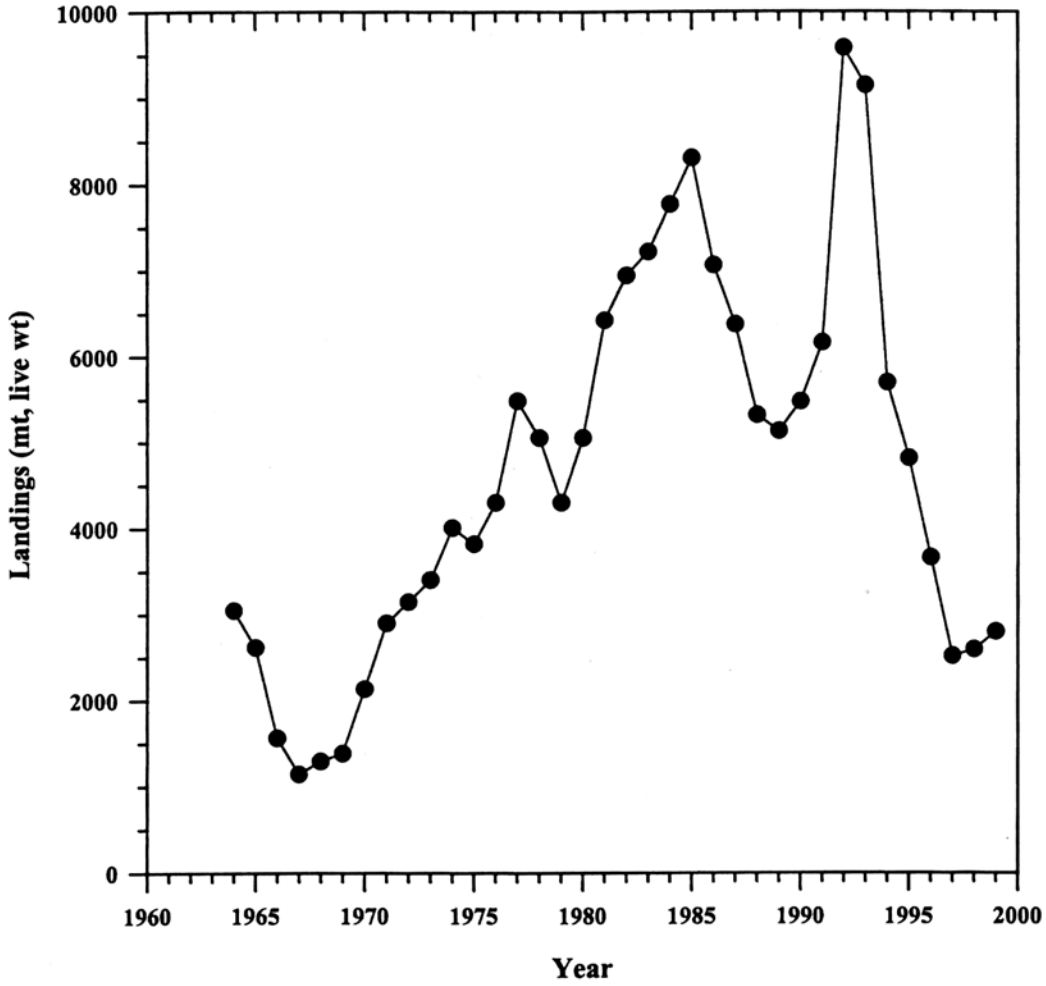

Figure K1. Total landings of white hake from the Gulf of Maine to Mid-Atlantic region, 1964-1999.

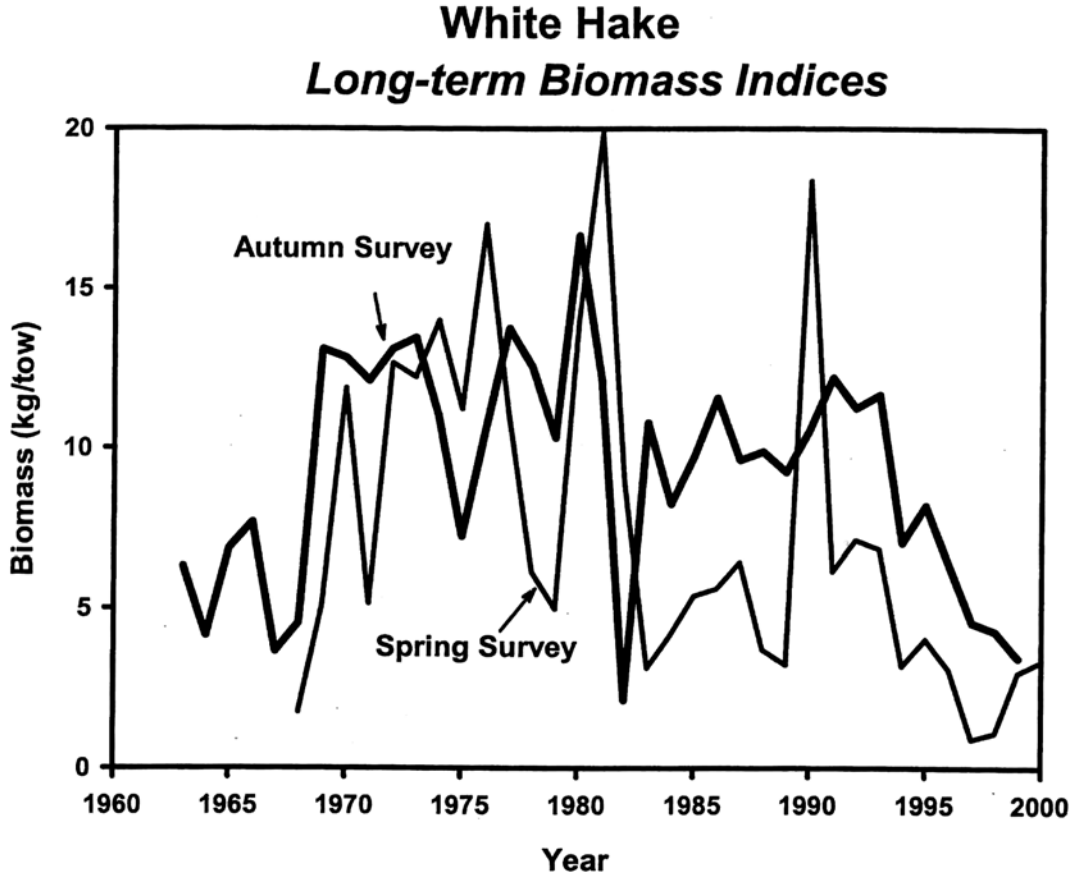

Figure K2. Spring and autumn bottom trawl indices from 1963-2000 for Gulf of Maine-Northern Georges Bank White Hake.

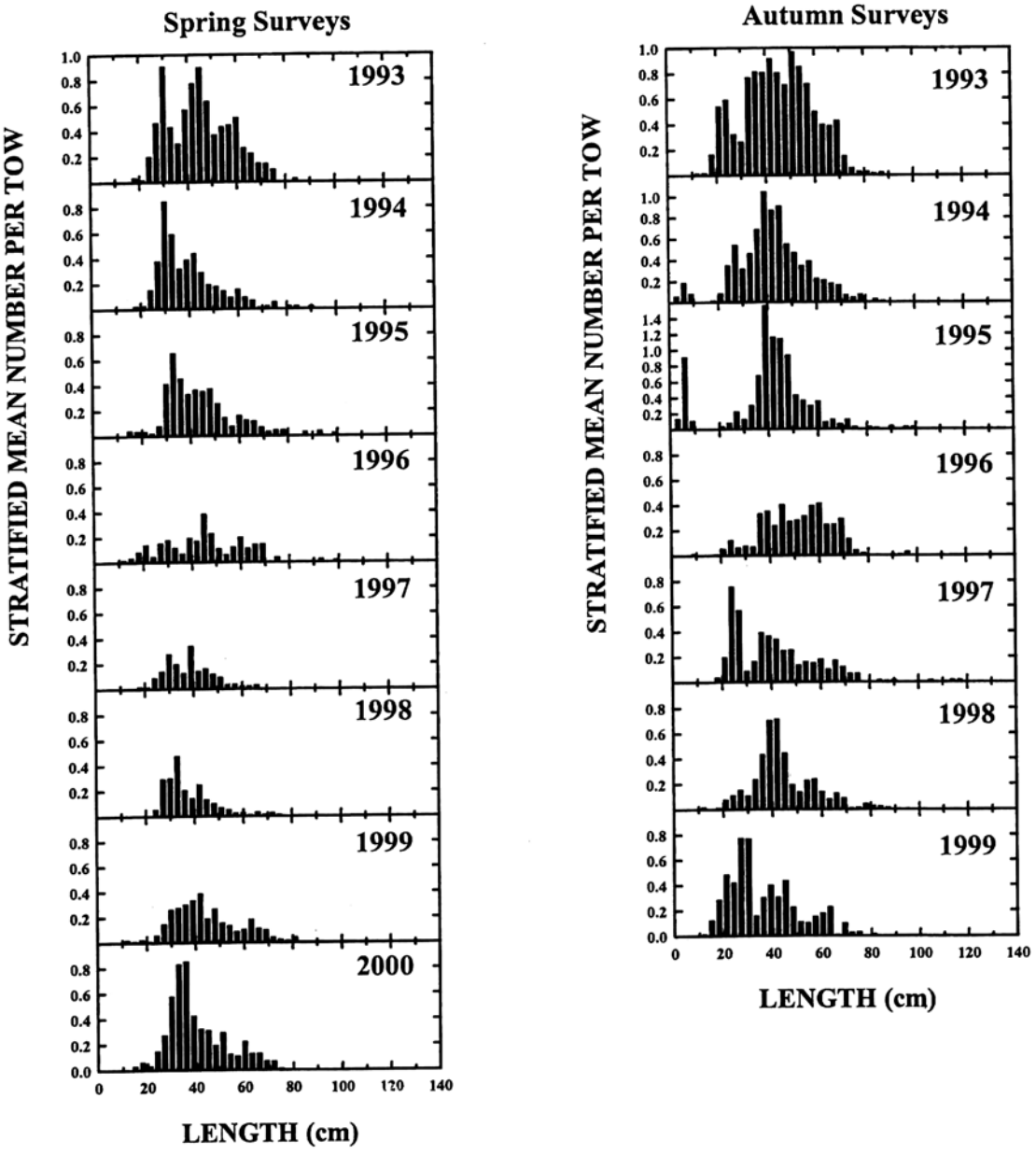

Figure K3. Length composition of white hake from the NEFSC bottom trawl surveys in the Gulf of Maine to northern Georges Bank region, 1993-2000.

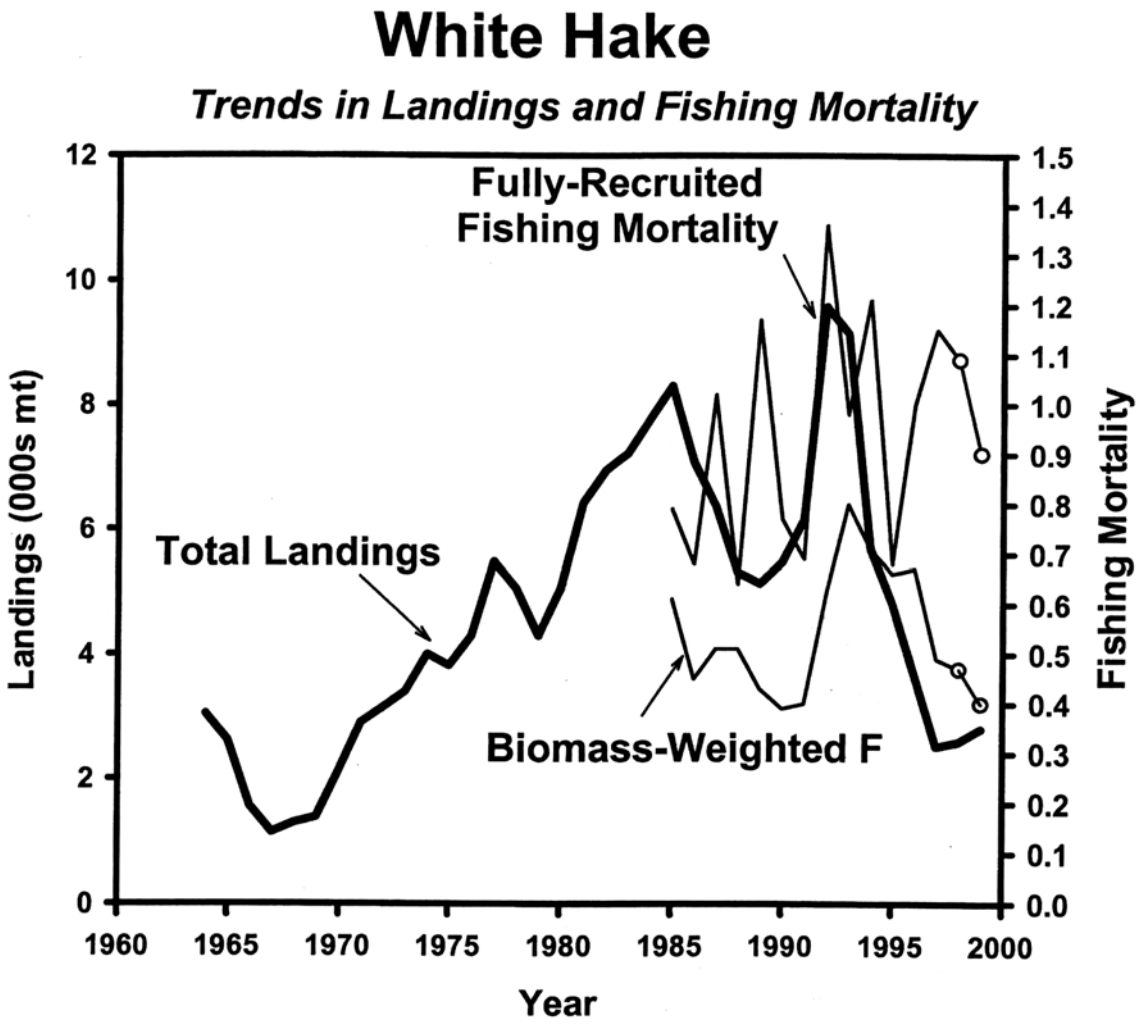

Figure K4. Total commercial landings and fishing mortality from the VPA calibration (solid thick lines) and the projection (open circle).

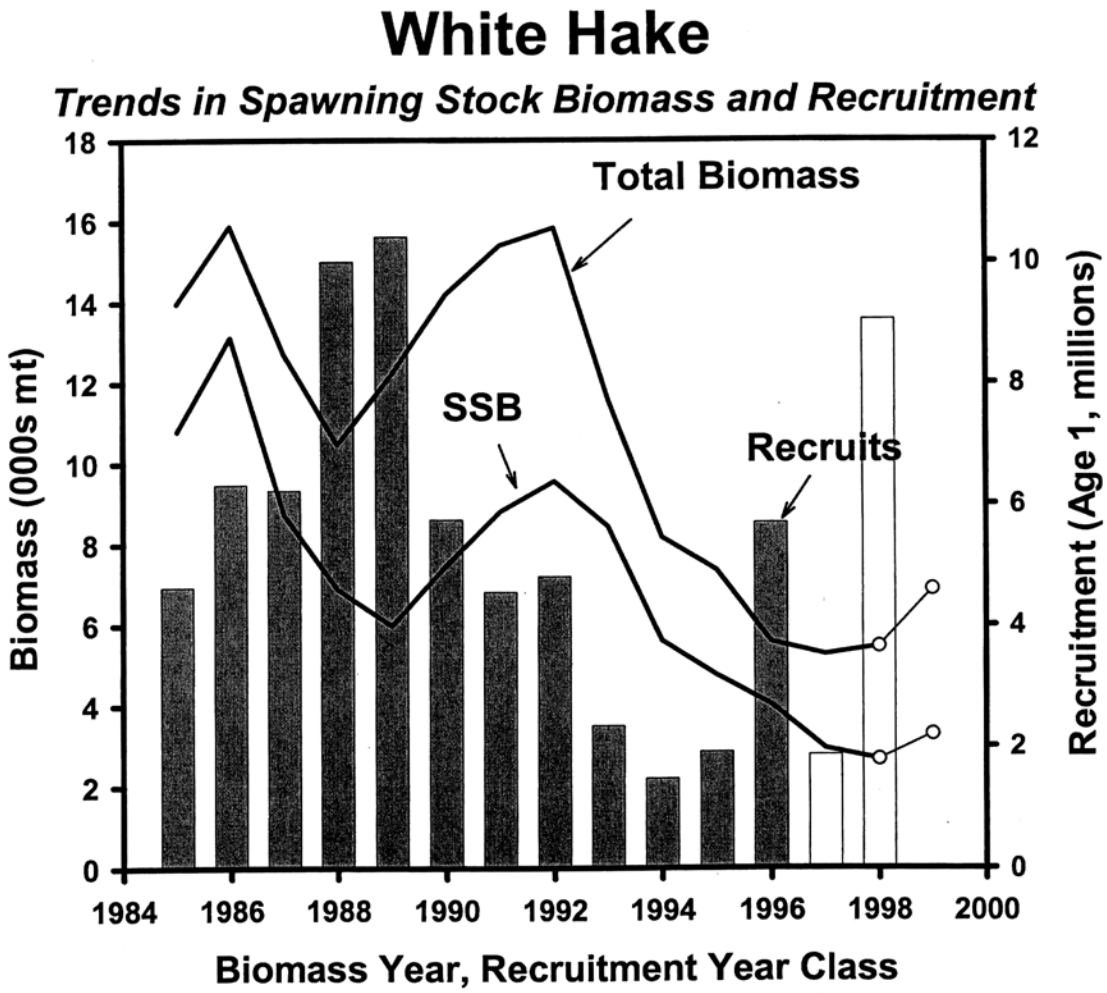

Figure K5. Total (mean) biomass, spawning stock biomass and recruitment from the VPA calibration (solid thick lines) and the projection (dotted line).

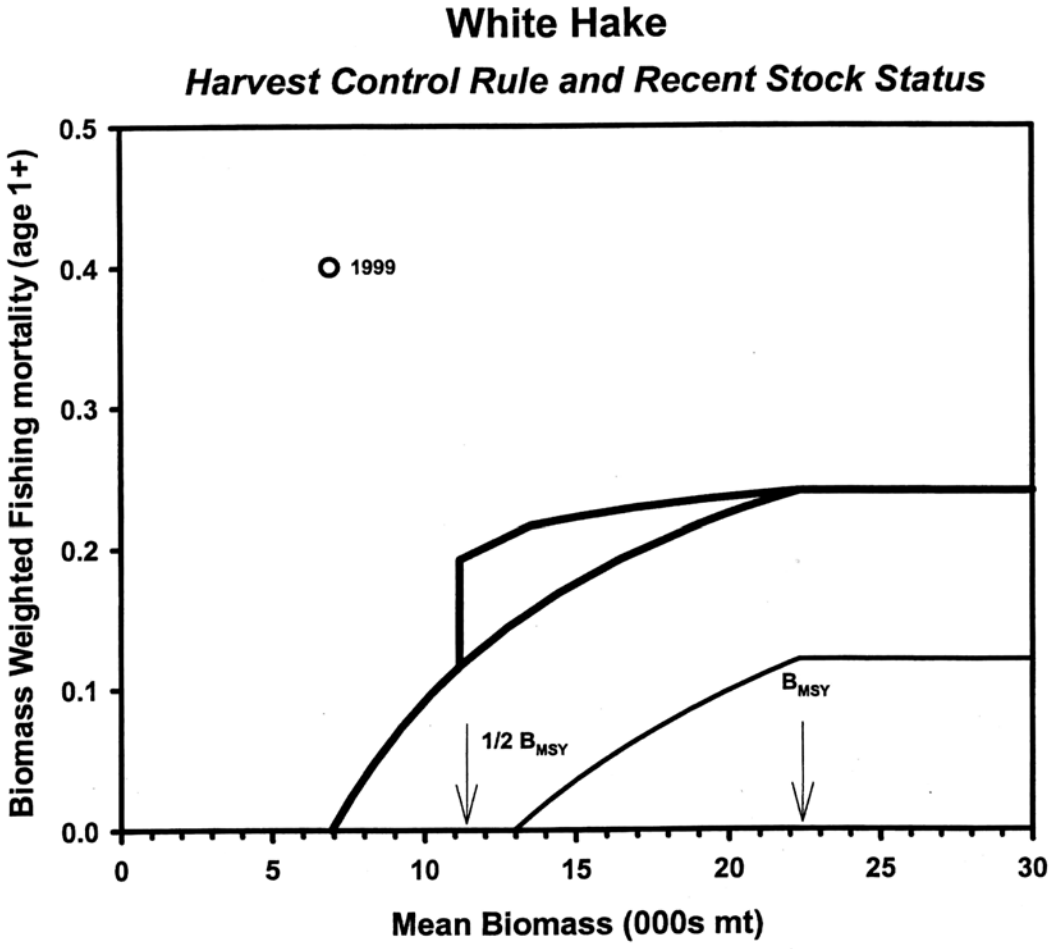

Figure K6. Harvest control rule for white hake.

L. Scotian Shelf/Georges Bank/Gulf of Maine Pollock by R.K. Mayo

1.0 Background

Pollock, *Pollachius virens* (L.) Are assessed as a unit stock from the eastern Scotian Shelf (NAFO Division 4V) to Georges Bank and the Gulf of Maine (Subarea 5). This stock was last assessed over its range *via* VPA at SAW 16 in 1993 (Mayo and Figuerido 1993, NEFSC 1993a, 1993b). At that time, spawning stock biomass had been declining since the mid-1980s, and was expected to reach its long-term average (144,000 mt). Fishing mortality was estimated to be 0.72 in 1992, above F20% (0.65) and well above Fmed (0.47). The stock was then considered to be fully exploited and at a medium biomass level.

The state of this stock was most recently evaluated in 1998 via index assessment (Mayo 1998). At that time, it was noted that biomass indices for the Gulf of Maine-Georges Bank portion of the stock, derived from NEFSC autumn bottom trawl surveys, had increased during the mid-1970s, declined sharply during the 1980s, and have remained relatively low since 1989. Indices derived from Canadian bottom trawl surveys, conducted on the Scotian Shelf, increased during the 1980s, but declined sharply during the early 1990s. The stock was then considered to be fully exploited, but at a low biomass level.

An assessment of this stock over the major portion of its range (NAFO Divisions 4VWX and Subdivision 5Zc) has been conducted by Canada since 1989. The most recent assessment was conducted in 1999 (Neilson et al. 1999), and it was noted that age 5+ population biomass reached a maximum in 1985 and then declined steadily to a minimum in 1995. Biomass has increased since 1995 due to recruitment from the 1992 year class. Recent recruitment has been declining, and it was concluded that most indicators of stock status suggest that the resource remains depleted.

2.0 The Fishery

Nominal commercial catches from the Scotian Shelf, Gulf of Maine, and Georges Bank region increased from an annual average of 38,200 mt during 1972-76 to 68,800 mt in 1986 (Table L1, Figure L1). Canadian landings increased steadily from 24,700 mt in 1977 to an annual average of 43,900 mt during 1985-87, while U.S. landings increased from an average of 9,700 mt during 1973-77 to more than 19,000 mt annually from 1985-1987, peaking at 24,500 mt in 1986. Landings by distant-water fleets declined from an annual average of 9,800 mt during 1970-73 to less than 1,100 mt per year during 1981-88. Distant-water fleet landings increased to 3,300 mt in 1991, but have since declined to negligible levels. Over time, most of the distant water fleet catch has been taken by the USSR/Russian fleet on the Scotian Shelf (Table L1).

Since 1984, the USA fishery has been restricted to areas of the Gulf of Maine and Georges Bank west of the line delimiting the USA and Canadian fishery zones. The Canadian fishery occurs primarily on the Scotian Shelf some additional landings from Georges Bank east of the line delimiting the USA and Canadian fishery zones. This fishery has shifted westward over time,

and the contribution to the total catch from larger, mobile gear vessels has steadily diminished since 1981.

By 1996, USA and Canadian landings had declined to 2,963 mt and 9,145 mt, respectively, the lowest landings by either country in over 3 decades. Landings by distant water fleets fishing on the Scotian Shelf remained almost negligible. Since 1996, USA and Canadian landings have increased slightly but remain low relative to past levels.

3.0 Research Survey Indices

Indices of relative biomass (ln re-transformed), derived from NEFSC autumn research vessel bottom trawl surveys have varied considerably since 1963 (Table L2, Figure L1). Indices generally fluctuated between 2 and 5 kg per tow throughout most of the 1960s and 1970s, peaking at over 5-7 kg per tow during the mid-to-late 1970s, reflecting recruitment of several moderate-to strong year classes from the early 1970s. Strong year classes were also produced in 1979 and 1980, after which recruitment began to diminish during the 1980s.

Biomass indices declined rapidly during the early 1980s, and continued to decline steadily through the early 1990s, remaining below 1 kg per tow and reaching a minimum in 1994. Since 1994, biomass indices from the Gulf of Maine-Georges Bank region have generally increased, reaching 1.5 kg per tow in 1999 (Table L2, Figure L1). On the Scotian Shelf, Canadian biomass indices, derived from commercial fishery catch rates, declined rapidly after 1985, following the recruitment of the 1979 year class. After increasing slightly from 1994 to 1996, catch rate indices have continued to decline.

4.0 Assessment Results

As evident from recent trends in landings and NEFSC autumn biomass indices, exploitation ratios, derived from landings/NEFSC autumn biomass index, peaked in the mid-to-late 1980s after which they have steadily declined (Table L3, Figure L2). Despite this, measures of stock biomass in the Gulf of Maine-Georges Bank region and on the Scotian Shelf remain extremely low relative to past levels.

5.0 Harvest Control Rule

The Harvest Control Rule proposed for this stock by the Overfishing Definition Review Panel is based upon Yield and SSB per Recruit analyses combined with an estimate of average recruitment. According to this control rule, a target F should be set at 75% of the Fmsy proxy (0.49 = 0.75xF20%) when spawning stock biomass is greater than 102,000 mt and would decrease linearly to zero at 51,000 mt (½ of the SSBmsy proxy).

The index assessment presented above provides no basis with which to evaluate the present state of the stock relative to this control rule.

6.0 Sources of Uncertainty

- Survey indices for pollock exhibit considerable inter-annual variability

- Movement of pollock among the NAFO Divisions comprising the stock unit is likely to vary over time, contributing to the year effects noted in the surveys

7.0 References

Mayo, R.K. and B.F. Figuerido. 1993. Assessment of Pollock, *Pollachius virens* (L.), in Divisions 4VWX and Subareas 5 and 6, 1993. NMFS, Northeast Fisheries Science Center Reference Document 93-13, 108 p.

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Neilson, J., P. Perley and C. Nelson. 1999. The 1999 Assessment of Pollock (*Pollachius virens*) in NAFO Divisions 4VWX and Subdivision 5Zc. DFO Can. Stock Assess. Sec. Res. Doc. 99/160.

Table L1. Pollock landings (metric tons, live) from Divisions 4VWX and Subareas 5 and 6 by country, 1960-1999.

Year	Canada	USA	FRG	GDR	Japan	Spain	USSR	Cuba	Others	Total DWF	Total
1960	29470	10132	0	0	0	783	0	0	1	784	40386
1961	26323	10265	0	0	0	982	0	0	1	983	37571
1962	31721	7391	0	0	0	0	0	0	0	0	39112
1963	28999	6650	126	0	0	0	793	0	28	947	36596
1964	30007	6006	208	0	0	0	4603	0	429	5240	41253
1965	27316	5303	71	0	0	1361	2667	0	11	4110	36729
1966	18271	3791	0	0	0	2384	9865	0	12	12261	34323
1967	17567	3312	0	0	0	1779	644	0	15	2438	23317
1968	18062	3276	0	0	0	1128	372	0	7	1507	22845
1969	15968	3943	1188	2195	0	1515	227	0	7	5132	25043
1970	10753	3976	3233	4710	40	532	527	0	0	9042	23771
1971	11757	4890	633	6849	15	912	2216	0	3	10628	27275
1972	18022	5729	475	4816	8	616	3495	0	58	9468	33219
1973	26990	6303	1124	948	1570	3113	3092	0	36	9883	43176
1974	24975	8726	149	2	40	1500	2301	0	62	4054	37755
1975	26548	9318	236	95	0	708	2004	0	124	3167	39033
1976	23568	10863	994	24	0	303	1466	0	390	3177	37608
1977	24654	13056	368	0	1	2	182	0	53	606	38316
1978	26801	17714	0	0	110	0	502	141	39	792	45307
1979	29967	15541	7	0	19	0	1025	50	23	1124	46632
1980	35986	18280	0	0	81	0	950	32	99	1162	55428
1981	40270	18171	0	0	15	0	358	0	90	463	58904
1982	38029	14357	0	0	3	0	297	84	44	428	52814
1983	32749	13967	0	0	6	0	226	261	22	515	47231
1984	33465	17903	0	1	1	0	97	123	46	268	51636
1985	43300	19457	0	0	17	0	336	66	77	496	63253
1986	42845	24542	0	0	51	0	564	387	81	1083	68470
1987	45407	20353	0	0	82	0	314	343	28	767	66527
1988	41690	14960	0	0	1	0	1054	225	0	1280	57930
1989	41093	10553	0	0	1	0	1782	99	478	2360	54006
1990	36178	9645	0	0	0	0	1040	261	3	1304	47127
1991	37931	7950	0	0	38	0	1117	459	167	1781	47662
1992	32002	7183	0	0	72	0	1006	1015	9	2102	41287
1993	20253	5629	0	0	0	0	176	644	0	820	26702
1994	15240	3768	0	0	0	0	0	10	0	10	19018
1995	9781	3358	0	0	0	0	0	58	0	58	13197
1996	9145	2963	0	0	0	0	6	129	0	135	12243
1997	11927	4267	0	0	0	0	0	64	0	64	16258
1998	14371	5583	0	0	0	0	1	9	0	10	19964
1999	7737	4594	0	0	0	0	0	6	0	6	12337

1996-1999 Canadian Data Preliminary
1994-1999 USA Data Preliminary
1999 DWF Data Preliminary

Table L2. Stratified mean catch per tow in numbers and weight (kg) for Scotian Shelf, Gulf of Maine, and Georges Bank pollock in **NEFSC offshore spring[1], summer[2], and autumn[1] bottom trawl surveys**, 1963-2000.

	Spring[3]				Summer				Autumn			
	Weight		Numbers		Weight		Numbers		Weight		Numbers	
Year	Linear	Retrans-formed	Linear	Retrans-formed	Linear	Retrans-formed	Linear	Retrans-formed	Linear	Retrans-formed	Linear	Retrans-formed
1963	-	-	-	-	10.28	3.45	2.31	1.07	5.79	4.96	1.46	1.32
1964	-	-	-	-	5.27	2.32	2.06	0.96	4.35	2.42	1.63	1.04
1965	-	-	-	-	2.56	1.05	1.72	0.63	2.75	2.12	0.83	0.77
1966	-	-	-	-	-	-	-	-	2.35	1.61	0.97	0.58
1967	-	-	-	-	-	-	-	-	1.80	1.16	0.52	0.44
1968	4.50	2.90	1.10	0.93	-	-	-	-	3.17	2.30	0.69	0.62
1969	2.66	2.53	1.12	0.99	1.75	1.19	0.70	0.47	6.59	3.01	1.31	0.85
1970	4.91	3.53	1.67	1.47	-	-	-	-	2.59	2.00	0.64	0.62
1971	4.39	3.30	1.18	1.05	-	-	-	-	3.96	1.90	1.09	0.69
1972	5.67	4.07	4.43	2.62	-	-	-	-	4.37	3.13	1.41	1.16
1973	4.82	3.77	4.00	1.61	-	-	-	-	4.71	4.04	1.64	1.25
1974	4.10	4.43	1.39	1.24	-	-	-	-	3.18	1.52	0.90	0.56
1975	5.90	5.37	1.67	1.32	-	-	-	-	2.04	1.50	0.70	0.50
1976	6.84	7.02	1.59	1.48	-	-	-	-	16.66	7.32	3.69	1.70
1977	3.38	3.04	1.61	1.23	9.98	8.35	2.07	1.67	8.78	5.26	2.14	1.25
1978	6.56	3.71	2.48	1.06	4.05	3.80	1.29	0.92	5.83	3.56	0.98	0.67
1979	4.75	4.07	1.06	0.97	17.57	4.14	2.96	1.19	5.81	4.67	1.28	0.91
1980	4.40	3.92	1.52	1.17	9.83	6.61	12.21	2.25	4.63	3.32	0.83	0.68
1981	6.17	5.42	1.95	1.40	-	-	-	-	7.75	1.56	5.24	0.63
1982	6.62	3.68	3.98	2.02	-	-	-	-	3.14	1.63	1.40	0.78
1983	1.83	1.20	0.90	0.69	-	-	-	-	3.03	1.41	0.98	0.61
1984	2.87	2.06	1.00	0.84	-	-	-	-	1.10	0.70	0.43	0.38
1985	26.81	7.85	13.70	3.05	-	-	-	-	2.43	1.97	1.12	0.77
1986	7.69	4.10	1.84	1.25	-	-	-	-	1.83	1.20	0.88	0.58
1987	13.17	2.50	6.94	1.14	-	-	-	-	2.01	1.20	0.60	0.51
1988	1.98	1.36	0.89	0.74	-	-	-	-	12.83	1.75	3.71	0.86
1989	5.17	2.18	1.98	1.02	-	-	-	-	1.20	0.61	1.86	0.76
1990	1.79	1.14	0.75	0.55	-	-	-	-	2.11	1.05	0.83	0.60
1991	5.14	2.96	2.32	1.44	-	-	-	-	1.04	0.64	0.72	0.54
1992	3.35	2.17	1.79	1.24	-	-	-	-	1.69	0.92	1.05	0.65
1993	1.63	1.29	1.64	1.16	-	-	-	-	0.76	0.56	1.03	0.56
1994	1.17	0.94	0.59	0.54	-	-	-	-	0.72	0.41	0.50	0.37
1995	3.89	1.48	3.46	0.89	-	-	-	-	1.38	0.67	0.93	0.54
1996	1.07	0.75	0.65	0.51	-	-	-	-	1.10	0.70	1.02	0.69
1997	4.51	2.01	3.33	1.78	-	-	-	-	1.49	0.98	1.74	0.90
1998	2.69	1.65	2.64	1.56	-	-	-	-	1.29	0.76	2.07	0.74
1999	1.07	0.86	2.16	1.02	-	-	-	-	3.07	1.52	2.40	1.40
2000	1.35	0.98	1.49	0.98	-	-	-	-				

[1] Strata 13-40 (See Figure 3).
[2] Strata 21-28 and 37-40 (See Figure 3).
[3] The "36 Yankee" trawl was used from 1968-1972, and 1982-1999; the "41 Yankee" trawl was used from 1973-1981. No gear conversion factors are available to adjust for differences in fishing power.

Table L3. Total commercial landings (mt), NEFSC autumn survey biomass index (kg/tow,Ln, retransformed), and calculated exploitation ratio for pollock in NAFO Divisions 4VWX and Subara 5.

Year	Total Landings (mt)	NEFSC Autumn Survey Biomass Index (kg/tow)	Exploitation Ratio
1963	36596	4.960	0.074
1964	41253	2.420	0.170
1965	36729	2.120	0.173
1966	34323	1.610	0.213
1967	23317	1.160	0.201
1968	22845	2.300	0.099
1969	25043	3.010	0.083
1970	23771	2.000	0.119
1971	27275	1.900	0.144
1972	33219	3.130	0.106
1973	43176	4.040	0.107
1974	37755	1.520	0.248
1975	39033	1.500	0.260
1976	37608	7.320	0.051
1977	38316	5.260	0.073
1978	45307	3.560	0.127
1979	46632	4.670	0.100
1980	55428	3.320	0.167
1981	58904	1.560	0.378
1982	52814	1.629	0.324
1983	47231	1.414	0.334
1984	51636	0.700	0.738
1985	63253	1.967	0.322
1986	68470	1.205	0.568
1987	66527	1.202	0.553
1988	57930	1.753	0.330
1989	54006	0.608	0.888
1990	47127	1.054	0.447
1991	47662	0.640	0.745
1992	41287	0.920	0.449
1993	26702	0.496	0.538
1994	19018	0.409	0.465
1995	13197	0.667	0.198
1996	12243	0.704	0.174
1997	16258	0.984	0.165
1998	19964	0.758	0.263
1999	12337	1.522	0.081

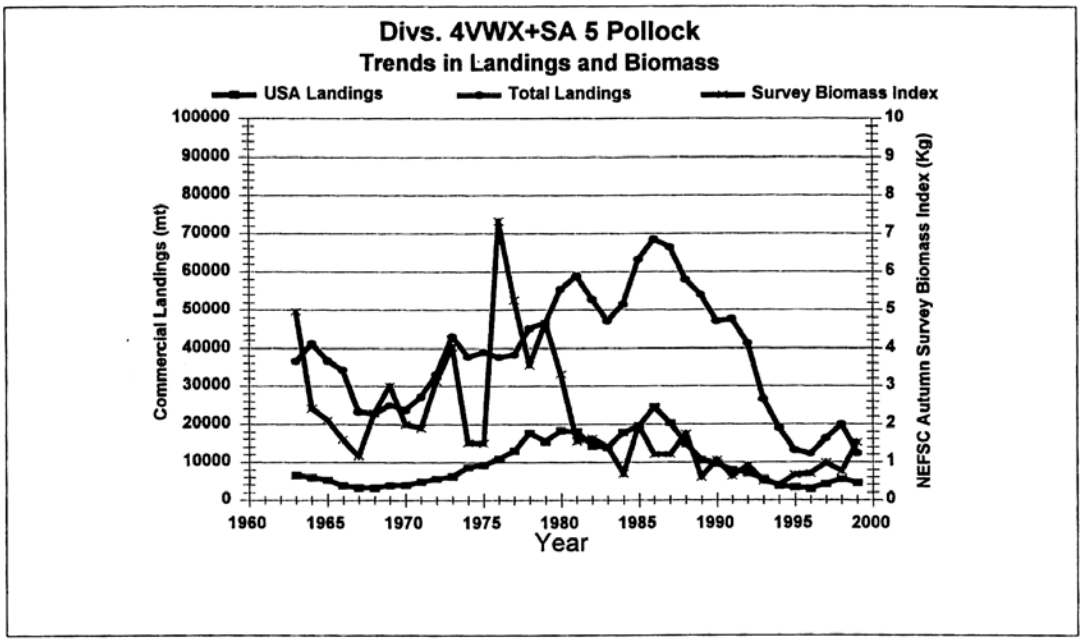

Figure L1. Total and USA commercial landings of pollock from NAFO Divs. 4VWX and Subarea 5, and NEFSC autumn biomass index (kg/tow, re-transformed).

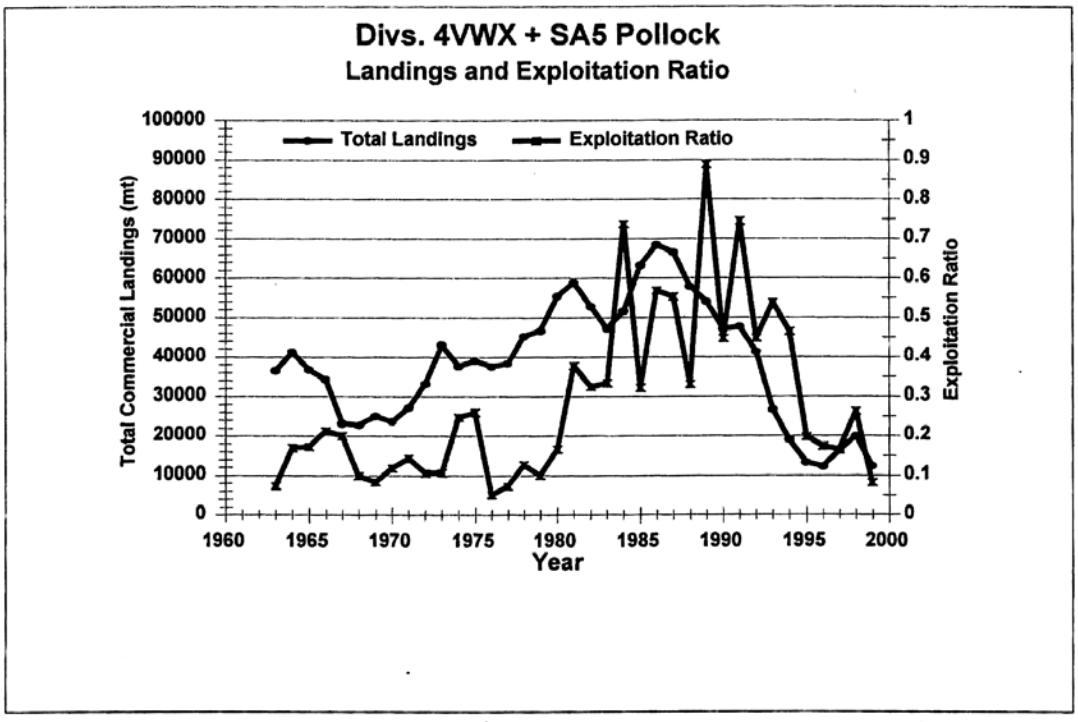

Figure L2. Total commercial landings of pollock from NAFO Divs. 4VWX and Subarea 5, and exploitation ratio derived from NEFSC autumn biomass index (kg/tow, re-transformed).

M. Gulf of Maine-Georges Bank Redfish by R.K. Mayo

1.0 Background

Redfish, *Sebastes fasciatus* Storer, are assessed as a unit stock in the Gulf of Maine and Georges Bank region (NAFO Subarea 5). This stock was last assessed *via* survey index at SAW 15 in 1992 (Mayo 1993, NEFSC 1993a, 1993b). At that time, the NEFSC autumn survey biomass index had been gradually increasing at a very slight rate since the mid-1980s, but the index remained well below levels seen in the 1960s and early 1970s. Since landings had also declined to record lows, it was concluded that the exploitation rate was probably quite low, but that the stock remained at a very low level. Recruitment was also found to be extremely poor in recent years and that the population was composed of very few contributing year classes.

The state of this stock was most recently evaluated in 2000 via index assessment (Mayo 2000). At this time, it was noted that biomass indices for Gulf of Maine-Georges Bank redfish, derived from NEFSC autumn bottom trawl surveys, had increased substantially beginning in 1996 and had reached levels approximately equal to those evident in the 1960s. Despite this extremely sharp increase, landings had not increased from the very low levels noted in the early 1990s. The gradual increase in the survey biomass index between 1990 and 1993 was consistent with incremental annual increases in the NEFSC survey abundance index (mean number per tow) observed during the early 1990s, and reflect accumulated recruitment and growth of one or more above-average year classes produced in the mid-1980s. However, the large increase in the survey biomass index in 1996 was supported almost exclusively by fish in the 18-23 cm range at a corresponding age of approximately 5-6 years. It was concluded, therefore, that production of these redfish is likely to have occurred during 1990 and 1991, with reproduction augmented by early-maturing spawners from the mid-1980s year classes. Thus, stock biomass appears to have increased during the mid-1990s through the combined effects of growth and survival of fish from a period of relatively successful reproduction in the early1990s. Further increases in biomass since 1996 have been supported by a wide range of sizes of fish in the population.

2.0 The Fishery

During the early development phase of the Gulf of Maine redfish fishery, USA landings increased rapidly to a peak level of about 56,000 mt in 1942 followed by a steep decline through the early 1950s (Table M1). Nominal catches then declined at a more gradual rate to less than 10,000 mt during the 1960s. During the 1970s, USA landings increased again, peaking at 16,000 mt in 1971 and again at 15,000 mt in 1979. During the1970s, additional catches by Canadian and distant water fleets increased the total redfish catch to a maximum of about 17,000 to 20,000 mt per year from 1970 through 1973; catches of redfish by these fleets declined to negligible levels after1976.

Landings of redfish declined steadily throughout the1980s, remaining below 1,000 mt per year since1989, and at less than 500 mt per year since 1994. Total redfish landings in 1999 were 353 mt compared to 320 mt in 1998.

3.0 Research Survey Indices

Indices of relative biomass, derived from NEFSC autumn research vessel bottom trawl surveys, although variable, exhibited a rather steady decline between 1963 and 1982 (Table M2, Figure M1). On average, the biomass index appears to have declined by about 90% over a 20 year period. During this time, only 2 year classes of any significance were produced, 1971 and 1978. Between 1983 and 1993, the biomass index approximately doubled, reflecting the relatively low rate of removals by the fishery and the very slow growth rate of the species. No substantial year classes were detected by the research vessel surveys in the inshore survey strata traditionally used to monitor recruitment until autumn 1995 when a substantial number of fish in the 15-19 cm range were noted, suggesting the possibility of above average reproduction in 1990 and/or 1991. This was followed by a very large increase in the index in the offshore strata in the autumn of 1996, followed by a large decrease in autumn 1997. The autumn biomass index rose sharply in 1996 and has fluctuated between 20 and 30 kg per tow since then, a magnitude comparable to the period between 1963 and the mid-1970s.

During the earlier periods, however, redfish were generally first detected in the inshore strata at relatively small sizes (~ 10 cm or less, age 1 or 2), only to appear in the offshore strata after about 5 or six years (Mayo, 1993). During the 1990s recruitment event, the year class was not detected until fish were close to 20 cm, or about ages 4 or 5, and the numbers appeared to be present in both inshore and offshore strata. In addition, the autumn biomass index increased 4-5 fold between the early 1990s and the mid-1990s, a rate that is inconsistent with the dynamics of this species. The spring index, however, suggests only a very modest change in biomass since the mid-1990s.

Given the continued extremely low landings of redfish relative to the recent increase in the autumn survey biomass index, the exploitation ratio is now extremely low compared to the 1960s and 1970s (Table M3; Figure M2). However, in contrast to this earlier period, where a substantial proportion of the stock persisted in the 30-40 cm range (Mayo, 1993), during the 1990s, almost all of the redfish are less than 25 cm, and almost none are greater than 30 cm. This suggests that, given the present demographics of the stock, only a small fraction of the biomass would be considered exploitable.

4.0 Harvest Control Rule

The Harvest Control Rule proposed for this stock by the Overfishing Definition Review Panel is derived from an estimate of Bmsy (121, 000) based on the ratio of an MSY estimate (14,000 mt) derived from a Generalized Production Model (Mayo 1980) to a proxy estimate of Fmsy (F20% = 0.116; Mayo, 1993). Annual biomass estimates which relate to Bmsy were then derived by expanding NEFSC autumn bottom trawl survey biomass indices to total biomass using swept area calculations.

Given that these two approaches are inconsistent, it would seem prudent that the basis for evaluating the current status of redfish relative to the biomass reference points and the harvest

control rule should be re-examined. Thus, the index assessment presented above provides no basis with which to evaluate the present state of the stock relative to this control rule.

5.0 Sources of Uncertainty

- The sharp increase in the survey biomass index in 1996 is inconsistent with the life history characteristics of this species.
- Given the pelagic diurnal movement and general distribution of redfish, swept area estimates of stock biomass derived from bottom trawl survey data will tend to under-estimate absolute stock size.

6.0 References

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NEFSC 1993a. Report of the 15th Northeast Regional Stock Assessment Workshop (15th SAW). Stock Assessment Review Committee (SARC) Consensus Summary of Assessments. NMFS, Northeast Fisheries Science Center Reference Document 93-06, 108 p.

NEFSC 1993b. Report of the 15th Northeast Regional Stock Assessment Workshop (15th SAW). The Plenary. NMFS, Northeast Fisheries Science Center Reference Document 93-07, 66 p.

Table M1. Nominal catches (metric tons), nominal and standardized catch per unit effort, and calculated standard USA and total effort (days fished) for the Gulf of Maine-Georges Bank redfish fishery.

	Nominal Catch (metric tons)			USA Catch per Unit Effort (Tons per Day Fished)		Calculated Standard Effort (Days Fished)	
Year	USA	Others	Total	Actual	Standard	USA	Total
1934	519		519				
1935	7549		7549				
1936	23162		23162				
1937	14823		14823				
1938	20640		20640				
1939	25406		25406				
1940	26762		26762				
1941	50796		50796				
1942	55892		55892	6.9	6.9	8100	8100
1943	48348		48348	6.7	6.7	7216	7216
1944	50439		50439	5.4	5.4	9341	9341
1945	37912		37912	4.5	4.5	8425	8425
1946	42423		42423	4.7	4.7	9026	9026
1947	40160		40160	4.9	4.9	8196	8196
1948	43631		43631	5.4	5.4	8080	8080
1949	30743		30743	3.3	3.3	9316	9316
1950	34307		34307	4.1	4.1	8368	8368
1951	30077		30077	4.1	4.1	7336	7336
1952	21377		21377	3.5	3.4	6287	6287
1953	16791		16791	3.8	3.6	4664	4664
1954	12988		12988	3.4	3.1	4190	4190
1955	13914		13914	4.5	4.0	3479	3479
1956	14388		14388	4.4	3.8	3786	3786
1957	18490		18490	4.3	3.6	5136	5136
1958	16043	4	16047	4.4	3.6	4456	4458
1959	15521		15521	4.3	3.5	4435	4435
1960	11373	2	11375	3.8	3.0	3791	3792
1961	14040	61	14101	4.6	3.5	4011	4029
1962	12541	1593	14134	5.4	4.0	3135	3534
1963	8871	1175	10046	4.1	3.0	2957	3349
1964	7812	501	8313	4.3	2.9	2694	2867
1965	6986	1071	8057	7.0	4.4	1588	1831
1966	7204	1365	8569	11.7	6.4	1126	1339
1967	10442	422	10864	12.4	5.6	1865	1940
1968	6578	199	6777	14.7	6.1	1078	1111
1969	12041	414	12455	11.4	4.9	2457	2542
1970	15534	1207	16741	9.0	4.0	3884	4185
1971	16267	3767	20034	7.0	3.2	5083	6261
1972	13157	5938	19095	5.7	2.9	4537	6584
1973	11954	5406	17360	5.3	2.9	4122	5986
1974	8677	1794	10471	5.0	2.6	3337	4027
1975	9075	1497	10572	4.0	2.2	4125	4805
1976	10131	565	10696	4.6	2.3	4405	4650
1977	13012	211	13223	4.9	2.5	5205	5289
1978	13991	92	14083	4.8	2.4	5830	5868
1979	14722	33	14755	3.6	1.9	7748	7766
1980	10085	98	10183	3.2	1.6	6303	6364
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	71	4793	1.9	1.1	4293	4357
1985	4164	118	4282	1.4	0.9	4627	4758
1986	2790	139	2929	1.0	0.6	4650	4882
1987	1859	35	1894	1.1	0.7	2656	2706
1988	1076	101	1177	0.9	0.5	2152	2354
1989	628	9	637	1.1	0.6	1047	1062
1990	588	13	601				
1991	525		525				
1992	849		849				
1993	800		800				
1994*	440		440				
1995*	440		440				
1996*	322		322				
1997*	251		251				
1998*	320		320				
1999*	353		353				

Table M2. NEFSC autumn bottom trawl survey stratified mean catch per tow indices, average weights (kg), and average lengths (cm) of redfish in the Gulf of Maine-Georges Bank region, 1963-1999.

	Inshore				Offshore				Combined	
	Stratified Mean Catch per Tow		Avg. Weight	Avg. Length	Stratified Mean Catch per Tow		Avg. Weight	Avg. Length	Stratified Mean Catch per Tow	
	No.	Kg	Kg	Cm	No.	Kg	Kg	Cm	No.	Kg
1963	86.3	7.6	0.088	17.4	87.5	27.0	0.309	26.4	87.3	24.1
1964	81.3	13.5	0.166	20.2	122.3	61.8	0.505	30.8	116.3	54.6
1965	189.5	22.3	0.118	17.7	33.9	11.5	0.339	25.3	57.0	13.1
1966	172.8	17.0	0.098	16.2	77.8	31.2	0.401	27.4	91.9	29.1
1967	62.9	5.3	0.084	17.7	107.1	27.6	0.258	23.6	100.5	24.3
1968	41.1	4.7	0.114	18.3	161.3	46.6	0.289	25.1	143.4	40.4
1969	105.9	16.0	0.151	20.7	65.2	24.8	0.380	27.4	71.2	23.5
1970	18.2	2.8	0.154	20.3	107.2	38.2	0.356	26.3	94.0	32.9
1971	20.7	4.7	0.227	21.8	52.8	26.7	0.506	29.7	48.0	23.4
1972	36.4	6.6	0.181	20.8	58.9	27.8	0.472	29.2	55.6	24.6
1973	26.2	2.1	0.080	15.6	41.4	19.7	0.476	29.7	39.2	17.0
1974	44.4	4.7	0.106	18.0	49.0	27.6	0.563	30.1	48.3	24.2
1975	45.7	6.0	0.131	19.6	79.9	45.9	0.574	30.6	74.8	39.9
1976	11.6	2.5	0.216	22.6	31.9	17.5	0.549	30.2	28.9	15.3
1977	54.6	12.3	0.225	23.4	37.9	18.1	0.478	28.5	40.4	17.3
1978	20.4	5.5	0.270	24.6	49.5	23.4	0.473	29.0	45.2	20.7
1979	6.2	2.1	0.339	26.5	32.8	18.4	0.561	30.5	28.9	16.0
1980	20.6	6.2	0.301	24.6	20.6	13.8	0.670	31.8	20.6	12.6
1981	6.8	1.9	0.279	24.9	22.7	14.0	0.617	31.8	20.4	12.2
1982	28.2	4.6	0.163	21.2	5.6	3.2	0.571	31.5	9.0	3.4
1983	30.2	8.7	0.288	24.8	6.5	3.3	0.508	29.1	10.0	4.1
1984	7.7	3.2	0.416	27.9	7.8	4.1	0.526	29.0	7.8	3.9
1985	7.2	2.1	0.292	24.8	14.0	6.3	0.450	28.0	13.0	5.7
1986	67.6	15.3	0.226	23.3	18.8	6.7	0.356	26.1	26.1	8.0
1987	26.5	4.8	0.181	21.9	11.5	5.6	0.487	29.2	13.7	5.5
1988	18.5	5.1	0.276	21.9	11.4	6.5	0.570	29.1	12.4	6.3
1989	14.0	2.9	0.207	22.6	21.3	7.5	0.352	25.9	20.3	6.8
1990	57.6	14.5	0.252	23.8	31.7	11.7	0.369	26.7	35.5	12.2
1991	7.2	1.1	0.153	20.4	21.1	9.6	0.455	28.5	19.1	8.4
1992	7.8	1.2	0.147	20.0	24.9	9.3	0.374	27.3	22.4	8.1
1993	53.7	7.4	0.137	20.0	32.5	11.9	0.366	26.3	35.6	11.2
1994	31.5	5.4	0.171	21.7	19.0	6.0	0.317	25.0	20.9	5.9
1995	109.7	11.1	0.102	18.5	19.9	3.5	0.177	21.3	33.2	4.7
1996	53.8	9.1	0.169	21.5	189.9	34.4	0.181	21.9	169.6	30.6
1997	105.6	15.7	0.149	20.3	57.9	19.5	0.337	26.0	65.0	18.9
1998	48.7	10.7	0.219	20.4	128.9	35.4	0.275	23.6	117.0	31.7
1999	164.2	35.1	0.214	23.2	68.2	20.7	0.304	25.6	82.5	22.9

Table M3. Commercial landings (mt), NEFSC autumn survey biomass index (kg/tow), And index of exploitation for Gulf of Maine redfish.

Year	Commercial Landings (mt)	NEFSC Autumn Biomass Index (kg/tow)	Exploitation Ratio
1963	10046	24.1	0.4168
1964	8313	54.6	0.1523
1965	8057	13.1	0.6150
1966	8569	29.1	0.2945
1967	10864	24.3	0.4471
1968	6777	40.4	0.1677
1969	12455	23.5	0.5300
1970	16741	32.9	0.5088
1971	20034	23.4	0.8562
1972	19095	24.6	0.7762
1973	17360	17.0	1.0212
1974	10471	24.2	0.4327
1975	10572	39.9	0.2650
1976	10696	15.3	0.6991
1977	13223	17.3	0.7643
1978	14083	20.7	0.6803
1979	14755	16.0	0.9222
1980	10183	12.6	0.8082
1981	7915	12.2	0.6488
1982	6903	3.4	2.0303
1983	5328	4.1	1.2995
1984	4793	3.9	1.2290
1985	4282	5.7	0.7512
1986	2929	8.0	0.3661
1987	1894	5.5	0.3444
1988	1177	6.3	0.1868
1989	637	6.8	0.0937
1990	601	12.2	0.0493
1991	525	8.4	0.0625
1992	849	8.1	0.1049
1993	800	11.2	0.0714
1994	440	5.9	0.0741
1995	440	4.7	0.0946
1996	322	30.6	0.0105
1997	251	18.9	0.0133
1998	320	31.7	0.0101
1999	353	22.9	0.0154

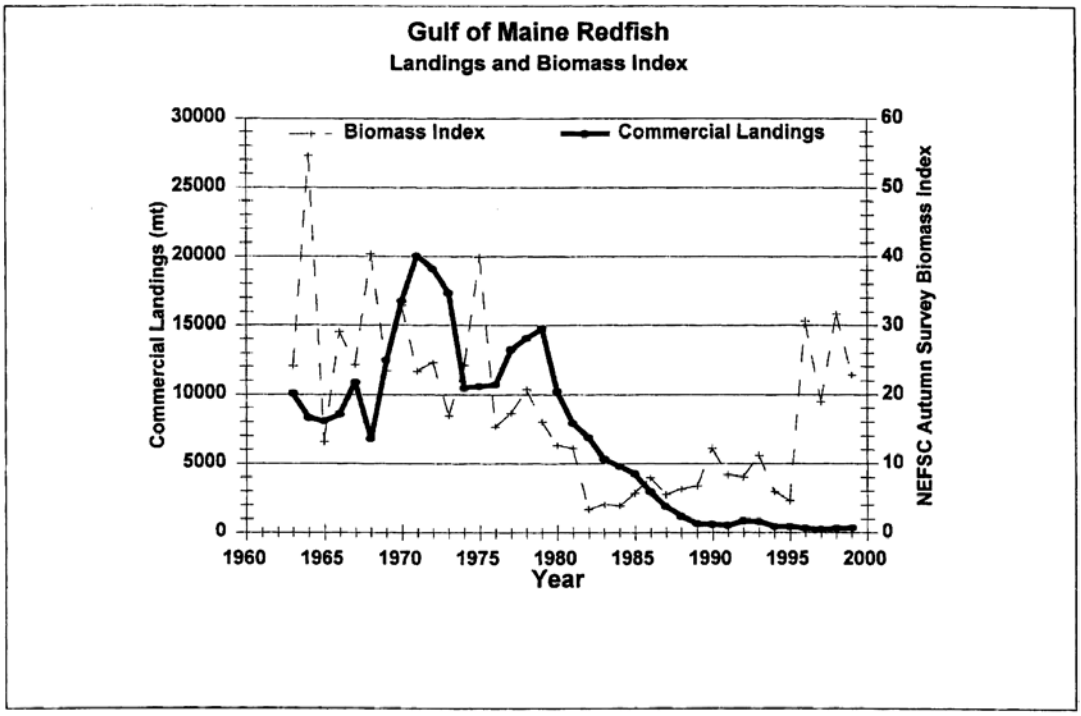


Figure M1. **Commercial landings and biomass index derived from NEFSC autumn survey biomass indices for Gulf of Maine redfish.**

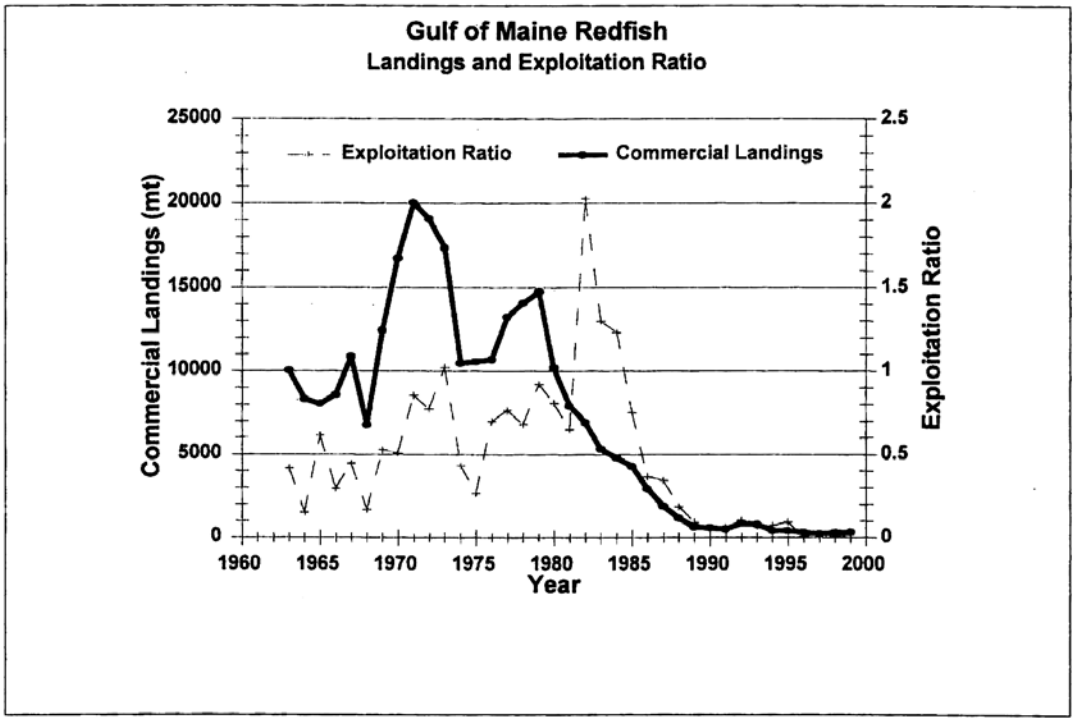


Figure M2. **Commercial landings and exploitation ratio derived from NEFSC autumn survey biomass indices for Gulf of Maine redfish.**

N. Ocean Pout by S.E. Wigley

1.0 Background

Ocean pout, *Macrozoarces americanus*, are assessed as a unit stock from Cape Cod Bay south to Delaware. An index assessment for this species was last reviewed at SAW 11 in 1990 (NEFSC 1990). The most recent update of stock status determined the ocean pout population was overfished and overfishing was occurring in 1999 (Wigley 2000). Ocean pout are included in the New England Fishery Management Council' s Multispecies Fishery Management Plan under the "nonregulated multispecies" category.

2.0 The Fishery

From 1964 to 1974, an industrial fishery developed for ocean pout, and nominal catches by the U.S. fleet averaged 4,700 mt. Distant-water fleets began harvesting ocean pout in large quantities in 1966, and total nominal catches peaked at 27,000 mt in 1969. Foreign catches declined substantially afterward, and none have been reported since 1974 (Table N1, Figure N1). United States landings declined to an average of 600 mt annually during 1975 to 1983. Catches increased in 1984 and 1985 to 1,300 mt and 1,500 mt respectively, due to the development of a small directed fishery in Cape Cod Bay supplying the fresh fillet market. Landings have declined more or less continually since 1987, in spite of continued market demand. In recent years, landings from the southern New England/Mid-Atlantic area have continued to dominate the catch, reversing landing patterns observed in 1986-1987, when the Cape Cod Bay fishery was dominant. The shift in landings is attributed to the changes in management (gear/mesh) regulations. Total landings in 1999 were only 18 mt, a near record low in the time series (Table N1, Figure N1).

3.0 Research Survey Indices

Commercial landings and the NEFSC spring research vessel survey biomass index followed similar trends during 1968 to 1975 (encompassing peak levels of foreign fishing and the domestic industrial fishery); both declined from very high values in 1968-1969 to lows of 300 mt and 1.3 kg per tow, respectively, in 1975. Between 1975 and 1985, survey indices increased to record high levels, peaking in 1981 and 1985. Since 1985, survey catch per tow indices have generally declined, and are presently less than the long-term survey average (3.9 kg per tow); the 2000 spring survey index was 2.0 kg per tow (Table N2, Figure N1). While the NEFSC winter survey and the Massachusetts Division of Marine Fisheries inshore research vessel surveys both confirm the declining trend observed in the NEFSC spring survey, length frequency data from all three surveys do not reveal a truncation in the size range.

Exploitation ratios have declined sharply from a peak in 1973 to low levels in the early 1980s then increased slightly in the late-1980s, after which they declined to record low levels (Table N3, Figure N2).

4.0 Assessment Results

The index assessment presented above reveals that landings, survey and exploitation ratios trends have remained stable indicating that no substantial change in stock status has occurred since the last assessment.

5.0 Harvest Control Rule

The Overfishing Definition Review Panel (Applegate et al. 1998) proposed a harvest control rule for ocean pout based upon research vessel survey biomass trends and the exploitation history. MSY was chosen to be 1,500 mt and the B-msy proxy was determined as the median survey index from 1980-1991 (4.9 kg/tow). Given these proxies, the threshold F-msy is 0.31 (1.5/4.9). The minimum biomass threshold is ½ of the B-msy proxy (2.4 kg/tow). The control rule states that a target F should be set at 60% of the F-msy proxy (F-msy = 0.19) when the spring survey index is greater than 4.9 kg/tow, and would decrease linearly to zero at 2.4 kg/tow.

To evaluate stock conditions, a three year average of NEFSC spring survey indices and an exploitation ratio (1999 catch/ average of 1997,1998,1999 spring survey biomass indices) are used as proxies for biomass and fishing mortality, respectively. In 1999, the three year average survey index (1.97 kg/tow) indicates that biomass is below the minimum biomass threshold (2.4 kg/tow) and the exploitation ratio (0.009) indicates F is well below the F threshold (Figure N3).

6.0 Sources of Uncertainty

- Due to the lack of commercial length samples (one sample of 17 fish since 1996), the size composition of the commercial landings could not be characterized.

- Discards have not been estimated, only landings were used to derive exploitation ratios instead of total catch. Therefore, exploitation ratios may be underestimated.

7.0 References

Applegate, A., S.X. Cadrin, J. Hoenig, C. Moore, S. Murawski, and E. Pikitch. 1998. Evaluation of existing overfishing definitions and recommendations for new overfishing definitions to comply with the Sustainable Fisheries Act. New England Fishery Management Council Report.

NEFSC [Northeast Fisheries Science Center]. 1990. Report of the Eleventh Stock Assessment Workshop (11th SAW), Fall 1990. Woods Hole, MA: NOAA/NMFS/NEFC. NEFC Ref. Doc.90-09.

Wigley, S.E. 2000. Ocean Pout. In: Clark, S.H. (Ed.) Status of the Fishery Resources off the Northeastern United States. NOAA Tech. Mem. NMFS-NE-115. Electronic document. http://www.nefsc.nmfs.gov/sos/spsyn/og/pout.html

Table N1. Commercial landings (mt, live) of ocean pout from the Gulf of Maine-Mid-Atlantic region (NAFO Subarea 5 and 6), 1962-1999.

	USA				
Year	5	6	Total	Other	Total
1962	0	0	0	0	0
1963	20	0	20	0	20
1964	2123	0	2123	0	2123
1965	877	0	877	0	877
1966	7149	0	7149	6231	13380
1967	7090	0	7090	271	7361
1968	8373	364	8737	4324	13061
1969	5571	966	6537	20435	26972
1970	5851	426	6277	895	7172
1971	2678	1448	4126	1784	5910
1972	1927	358	2285	1066	3351
1973	2810	285	3095	2275	5370
1974	2790	459	3249	483	3732
1975	209	65	274	3	277
1976	341	337	678	0	678
1977	809	250	1059	0	1059
1978	715	320	1035	0	1035
1979	658	14	672	0	672
1980	339	11	350	0	350
1981	234	17	251	0	251
1982	317	4	321	0	321
1983	408	0	408	0	408
1984	1324	0	1324	0	1324
1985	1450	54	1504	0	1504
1986	801	1	802	0	802
1987	2111	74	2185	0	2185
1988	1765	46	1811	0	1811
1989	1308	6	1314	0	1314
1990	1299	13	1312	0	1312
1991	1361	63	1424	0	1424
1992	406	68	474	0	474
1993	217	15	232	0	232
1994*	137	59	196	0	196
1995*	51	14	65	0	65
1996*	22	29	51	0	51
1997*	8	25	33	0	33
1998*	8	9	17	0	17
1999*	8	10	18	0	18

* 1994-1999 spatial patterns are based upon Vessel Trip Report data.

Table N2. Stratified mean catch per tow in weight and numbers, mean length and individual average fish weight of ocean pout in NEFSC spring surveys, in the Gulf of Maine-Mid-Atlantic region (strata 1-26,73-76), 1968-2000.

Year	Mean weight (kg) per tow	Mean number per tow	Mean Length (cm)	Individual ave weight (kg)
1968	5.366	6.766	51.1	0.793
1969	6.154	8.629	49.3	0.713
1970	5.180	6.133	51.9	0.845
1971	2.183	3.135	50.2	0.696
1972	4.453	5.090	51.6	0.875
1973	3.373	4.591	48.8	0.735
1974	1.479	2.310	47.0	0.640
1975	1.293	1.358	53.4	0.952
1976	1.400	2.440	46.5	0.574
1977	3.605	6.366	44.8	0.566
1978	3.371	11.831	31.6	0.285
1979	1.493	5.197	34.7	0.287
1980	5.729	11.837	42.6	0.484
1981	7.605	14.131	42.7	0.538
1982	4.743	8.690	44.0	0.546
1983	4.236	5.076	50.5	0.835
1984	5.540	7.275	50.0	0.762
1985	6.494	9.011	48.7	0.721
1986	6.345	6.995	53.0	0.907
1987	2.705	3.076	51.7	0.879
1988	3.244	5.405	45.0	0.600
1989	2.792	5.323	44.0	0.525
1990	5.074	6.369	50.3	0.797
1991	3.783	5.596	49.7	0.676
1992	2.257	2.639	52.9	0.855
1993	3.084	3.546	53.4	0.870
1994	2.309	2.639	54.3	0.875
1995	1.916	2.525	50.5	0.759
1996	2.058	3.127	47.6	0.658
1997	1.632	2.069	52.4	0.789
1998	1.733	2.957	46.1	0.586
1999	2.561	3.340	50.2	0.767
2000	2.016	3.113	48.2	0.648

Table N3. Exploitation ratios (annual landings / three year average of spring survey biomass indices) for ocean pout, 1970-1999.

Year	Exploitation Ratio
1970	1.2884
1971	1.0897
1972	0.8508
1973	1.6096
1974	1.2032
1975	0.1352
1976	0.4875
1977	0.5044
1978	0.3707
1979	0.2380
1980	0.0991
1981	0.0508
1982	0.0533
1983	0.0738
1984	0.2736
1985	0.2773
1986	0.1309
1987	0.4217
1988	0.4419
1989	0.4482
1990	0.3543
1991	0.3667
1992	0.1280
1993	0.0763
1994	0.0770
1995	0.0268
1996	0.0244
1997	0.0180
1998	0.0097
1999	0.0086

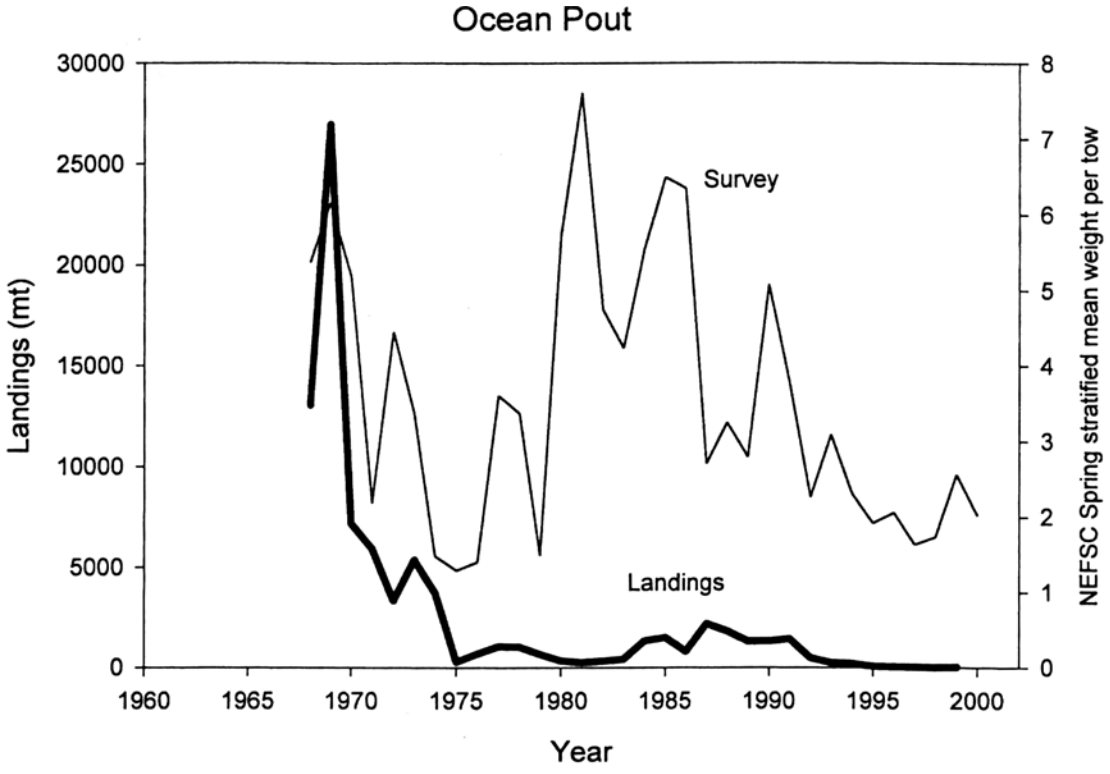


Figure N1. Trends in landings and NEFSC spring survey biomass indices for ocean pout.

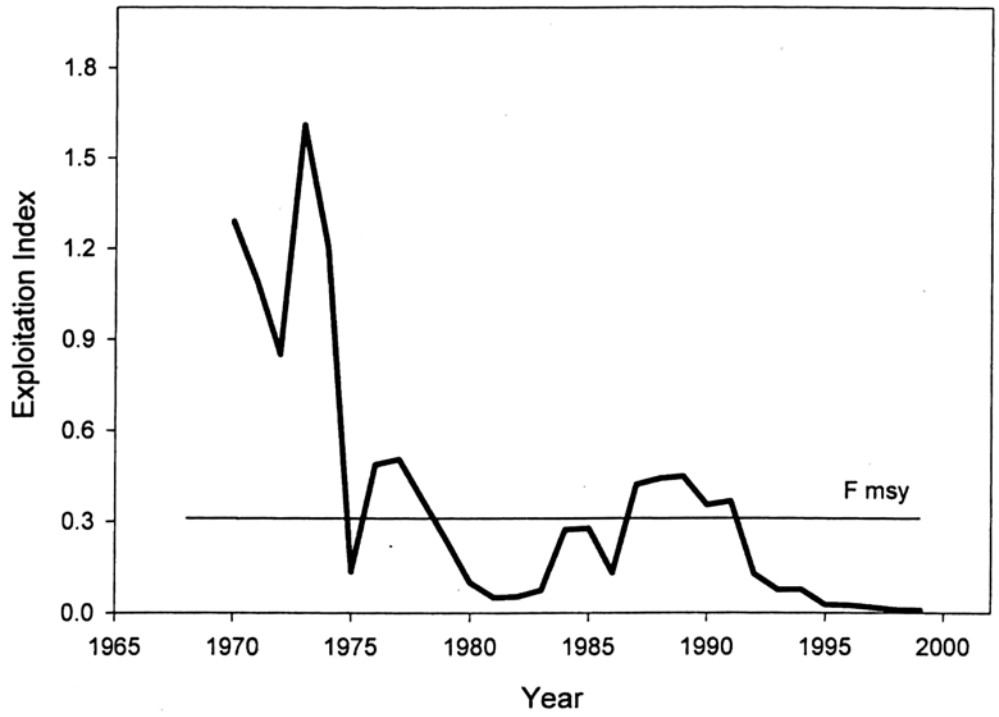


Figure N2. Exploitation index (landings/ three year average of spring biomass index) for ocean pout.

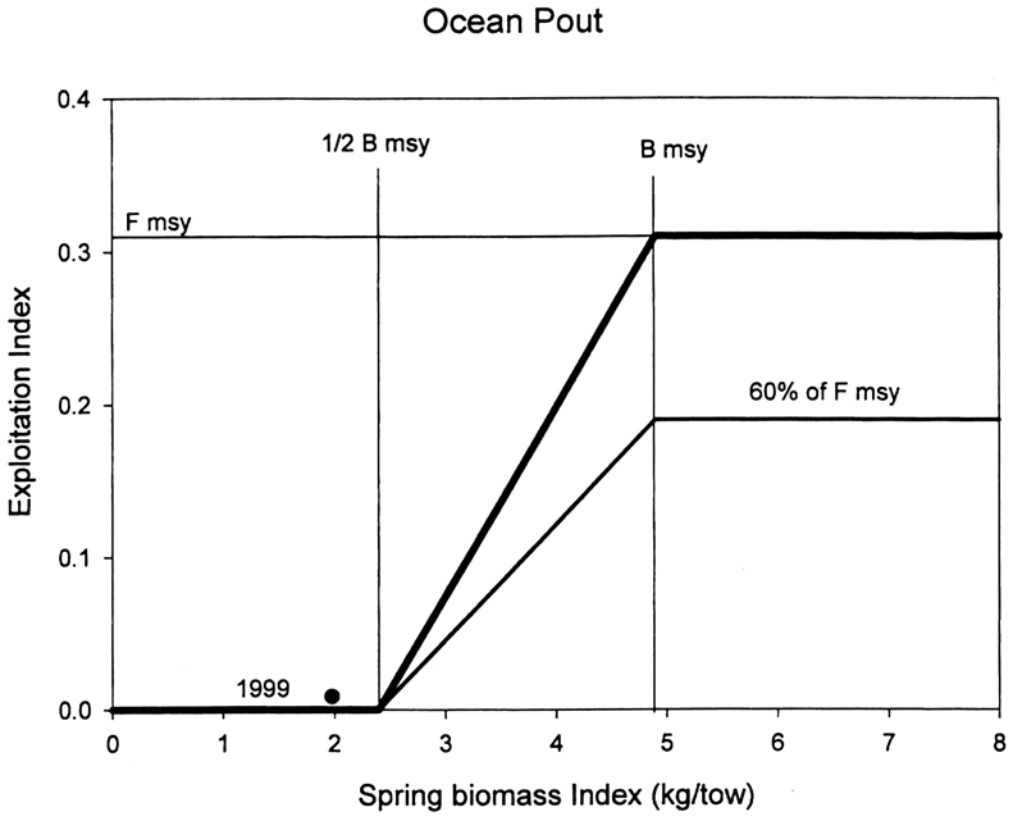


Figure N3. Harvest control rule for ocean pout.

O. Gulf of Maine -Georges Bank Windowpane Flounder by Lisa Hendrickson

1.0 Background

No stock structure information is available. Therefore, a provisional arrangement has been adopted that recognizes two stock areas based on apparent differences in growth, sexual maturity, and abundance trends between windowpane flounder from Georges Bank and from Southern New England. The proportions of total landings contributed by the Gulf of Maine and Mid-Atlantic areas are low (less than 7%), so data from these areas are combined with those from Georges Bank and Southern New England, respectively.

The northern windowpane flounder stock, which includes the Gulf of Maine and Georges Bank regions, has never been assessed through the SAW/SARC process. The following assessment is an update of the information contained in the Status of the Fishery Resources off the Northeastern United States, 2000 (Hendrickson 2000).

2.0 2000 Assessment Update

The Fishery

Since 1975, when landings of this species were first recorded, the majority of the total landings have been harvested from the Gulf of Maine-Georges Bank stock. Following a 1991 record high of 2,900 mt, landings declined to 300 mt in 1994. Landings have also been declining since 1996 and reached a record low of 46 mt in 1999 (Table O1; Figure O1). High landings during the early 1990s probably reflect an expansion of the fishery to offshore areas, as well as the targeting of windowpane flounder as an alternative to depleted groundfish stocks.

Research Survey Indices

Stratified mean weight (kg) per tow and mean number per tow of windowpane flounder from the NEFSC autumn (October 1963-1999) bottom trawl surveys are presented in Table 2 for the Gulf of Maine-Georges Bank stock. These biomass indices are also shown in relation to the stock landings in Figure 1. Survey biomass indices are highly variable, but in general, show an increasing trend since 1991. The large increase in the 1998 survey index is primarily attributable to a large catch of windowpane at one station.

3.0 Harvest Control Rule

The MSY-based control rule for GOM-GB windowpane flounder adopted in Amendment 9 was derived from survey-based proxies of biomass and exploitation. The control rule defines a maximum sustainable yield for the stock of 1,000 mt. The threshold F is defined as an FMSY proxy (FMSY = 1.11) when the NEFSC autumn survey index is greater than 0.94 kg/tow (minimum biomass threshold equal to a BMSY proxy) and declines linearly to zero at 50% of

the BMSY proxy (= 0.47 kg/tow). The target exploitation index is defined as 60% of the F MSY proxy (= 0.67) when the autumn survey index is greater than 0.94 kg/tow and declines linearly to zero at 0.47 kg/tow (Figure O2).

Exploitation indices (catch/NEFSC autumn survey biomass index) during 1975-1999 are presented, in Table O3 and Figure O3, in relation to the harvest control rule FMSY proxy (=1.11). The 1997-1999 autumn survey mean biomass index equals 0.94 kg/tow and the 1997-1999 mean exploitation index (catch/NEFSC autumn survey biomass index) equals 0.42.

4.0 Sources of Uncertainty

- Stock structure is uncertain.

- Discarding is not quantified and may a significant fraction of the catch given recent roundfish retention restrictions.

- Vessel trip reports have been used to prorate the landings since 1995, and a fraction of the landings from Southern New England may have been reported as Georges Bank landings or vice versa.

5.0 References

Hendrickson, L. C. 2000. Windowpane Flounder. In: Clark, S.H. (ed.) Status of the Fishery Resources off the Northeastern United States. NOAA Tech. Mem. NMFS-NE-115. NEFSC web page http://www.nefsc.nmfs.gov/sos/spsyn/fldrs/window.html/

Table O1. Landings (mt) of Gulf of Maine-Georges Bank windowpane flounder from 1975-1999. Includes Statistical Areas beginning with 51 and 52 except 526, 530-539 and 541.

Year	Landings (mt)
1975	1300
1976	1516
1977	1099
1978	923
1979	856
1980	408
1981	413
1982	411
1983	460
1984	743
1985	2141
1986	1842
1987	1396
1988	1377
1989	1577
1990	1078
1991	2862
1992	1519
1993	1212
1994	300
*1995	700
1996	700
1997	418
1998	396
1999	46

* Landings during 1995-1999 were prorated based on Vessel Trip Reports.

Table O2. Standardized, stratified biomass (mean kg/tow) indices for Gulf of Maine-Georges Bank windowpane flounder from the NEFSC autumn research vessel bottom trawl surveys during 1963-1999. Survey strata included were offshore strata 13-29 and 37- 40.

Year	Survey Biomass
1963	0.24
1964	0.10
1965	0.17
1966	0.48
1967	0.52
1968	0.26
1969	0.64
1970	0.19
1971	0.16
1972	0.57
1973	1.53
1974	0.82
1975	0.39
1976	1.17
1977	1.56
1978	1.15
1979	0.73
1980	0.63
1981	0.79
1982	0.49
1983	0.55
1984	2.14
1985	0.94
1986	1.11
1987	0.65
1988	0.65
1989	0.41
1990	1.13
1991	0.17
1992	0.38
1993	0.62
1994	0.31
1995	0.80
1996	0.50
1997	0.43
1998	1.66
1999	0.73

Table O3. Exploitation indices (catch/NEFSC autumn survey biomass index) for Gulf of Maine-Georges Bank windowpane flounder during 1975-1999.

Year	Exploitation Index
1975	3.38
1976	1.30
1977	0.71
1978	0.80
1979	1.18
1980	0.65
1981	0.52
1982	0.83
1983	0.84
1984	0.35
1985	2.29
1986	1.67
1987	2.16
1988	2.12
1989	3.81
1990	0.96
1991	16.74
1992	4.01
1993	1.96
1994	0.97
1995	0.87
1996	1.40
1997	0.96
1998	0.24
1999	0.06

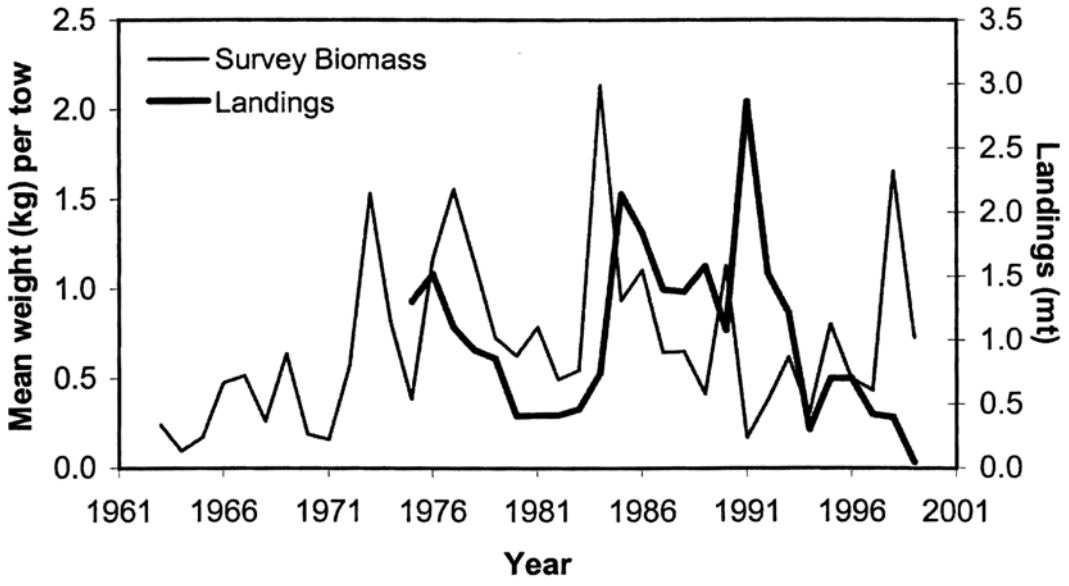


Figure O1. Commercial landings of GOM-GB windowpane flounder, during 1975-1999, and NEFSC autumn bottom trawl survey stratified mean weight (kg) per tow in 1963-1999.

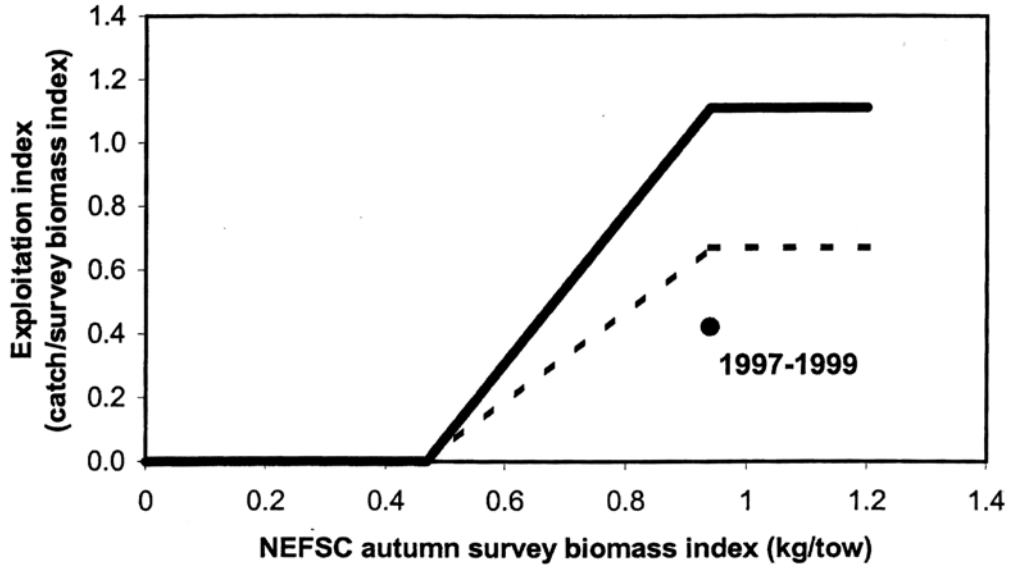


Figure O2. Harvest control rule for GOM-GB windowpane flounder based on survey equivalents of MSY-based reference points and the 1997-1999 mean exploitation index.

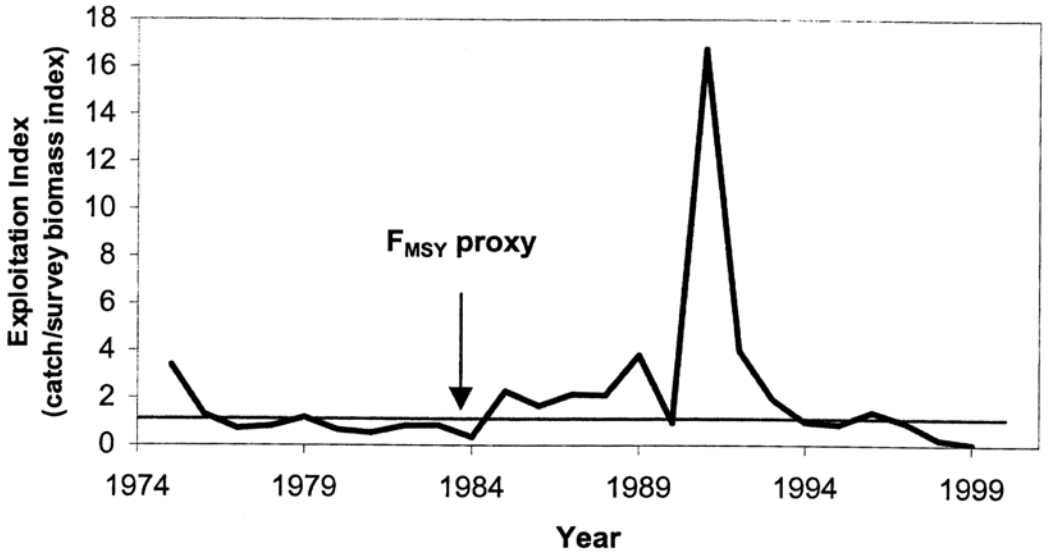


Figure O3. Trends in GOM-GB windowpane flounder exploitation indices (catch/autumn survey biomass index), during 1975-1999, in relation to the harvest control rule F_{MSY} proxy (= 1.11).

P. Southern New England/Mid-Atlantic Windowpane Flounder by Lisa Hendrickson

1.0 Background

No stock structure information is available. Therefore, a provisional arrangement has been adopted that recognizes two stock areas based on apparent differences in growth, sexual maturity, and abundance trends in fish from Georges Bank and from Southern New England. The proportions of total landings contributed by the Gulf of Maine and Mid-Atlantic areas are low (less than 7%), so data from these areas are combined with those from Georges Bank and Southern New England, respectively.

The southern windowpane flounder stock, which includes the southern New England and Mid-Atlantic Bight regions, has never been assessed through the SAW/SARC process. The following assessment is an update of the information contained in the Status of the Fishery Resources off the Northeastern United States, 2000 (Hendrickson 2000).

2.0 2000 Assessment Update

The Fishery

Commercial landings from this stock exceeded those from the Gulf of Maine-Georges Bank stock during 1980-1984, and reached a record high of 2,100 mt in 1985 (Table P1; Figure P1). Landings declined rapidly between 1988 and 1995, from 2,100 mt to a record low of 100 mt in 1995. Landings in 1998 and 1999 were 123 mt and 116 mt, respectively.

Research Survey Indices

Stratified mean weight (kg) per tow and mean number per tow of SNE-MAB windowpane flounder from the NEFSC autumn (October 1963-1999) bottom trawl surveys are presented in Table P2. NEFSC autumn survey biomass indices are also shown in relation to the landings for this stock in Figure P1. Both landings and survey biomass indices appear to have stabilized since 1995 at the lowest level on record.

3.0 Harvest Control Rule

The MSY-based control rule for SNE-MAB windowpane flounder adopted in Amendment 9 was derived from survey-based proxies of biomass and exploitation. The control rule defines a maximum sustainable yield for the stock of 900 mt. The threshold F is defined as an FMSY proxy (= 2.24) when the NEFSC autumn survey index is greater than 0.41 kg/tow (minimum biomass threshold equal to a BMSY proxy) and declines linearly to zero at 25% of the BMSY proxy (=0.10 kg/tow). The target exploitation index is defined as the 80th percentile of the FMSY bootstrap estimates (=1.60) (Figure P2).

Exploitation indices (catch/NEFSC autumn survey biomass index) during 1975-1999 are presented, in Table P3 and Figure P3, in relation to the harvest control rule FMSY proxy (=2.24). The1997-1999 mean exploitation index equals 0.84 and the mean of the 1997-1999 autumn mean weight per tow index equals 0.14 (Figure P2).

4.0 Sources of Uncertainty

- Stock structure is uncertain.

- Discarding is not quantified and may a significant fraction of the catch given recent groundfish retention restrictions.

- Vessel trip reports have been used to prorate the landings, since 1995, and a fraction of the landings from Southern New England may have been reported as Georges Bank landings or vice versa.

5.0 References

Hendrickson, L. C. 2000. Windowpane Flounder. In: Clark, S.H. (ed.) Status of the Fishery Resources off the Northeastern United States. NOAA Tech. Mem. NMFS-NE-115. NEFSC web page http://www.nefsc.nmfs.gov/sos/spsyn/fldrs/window.html/

Table P1. Landings (mt) of Southern New England – Mid-Atlantic Bight windowpane flounder from 1975-1999. Includes Statistical Areas beginning with 6, 526, 530-539 and 541.

Year	Landings (mt)
1975	681
1976	568
1977	647
1978	898
1979	633
1980	532
1981	883
1982	651
1983	798
1984	1088
1985	2065
1986	1381
1987	887
1988	1172
1989	1121
1990	890
1991	817
1992	584
1993	469
1994	200
*1995	100
1996	200
1999	7107
1998	123
1999	116

* Landings during 1995-1999 were prorated based on Vessel Trip Reports.

Table P2. Standardized, stratified mean weight (kg) per tow for Southern New England-Mid-Atlantic Bight windowpane flounder from the NEFSC autumn research vessel bottom trawl surveys during 1963-1999. Survey strata included were offshore strata 1-12 and 61- 76.

Year	Weight per tow (kg)
1963	1.99
1964	0.87
1965	0.78
1966	1.11
1967	0.81
1968	0.90
1969	0.37
1970	0.31
1971	0.40
1972	0.57
1973	0.58
1974	0.26
1975	0.14
1976	0.36
1977	0.54
1978	0.54
1979	0.76
1980	0.26
1981	0.52
1982	0.87
1983	0.37
1984	0.25
1985	0.62
1986	0.56
1987	0.44
1988	0.42
1989	0.09
1990	0.18
1991	0.41
1992	0.18
1993	0.03
1994	0.23
1995	0.20
1996	0.26
1997	0.13
1998	0.18
1999	0.12

Table P3. Exploitation indices (catch/NEFSC autumn survey biomass index) for Southern New England – Mid-Atlantic Bight windowpane flounder during 1975-1999.

Year	Exploitation Index
1975	4.76
1976	1.58
1977	1.21
1978	1.67
1979	0.83
1980	2.08
1981	1.70
1982	0.75
1983	2.17
1984	4.40
1985	3.34
1986	2.45
1987	2.02
1988	2.76
1989	12.18
1990	4.92
1991	2.02
1992	3.24
1993	15.14
1994	0.89
1995	0.50
1996	0.76
1997	0.84
1998	0.68
1999	1.00

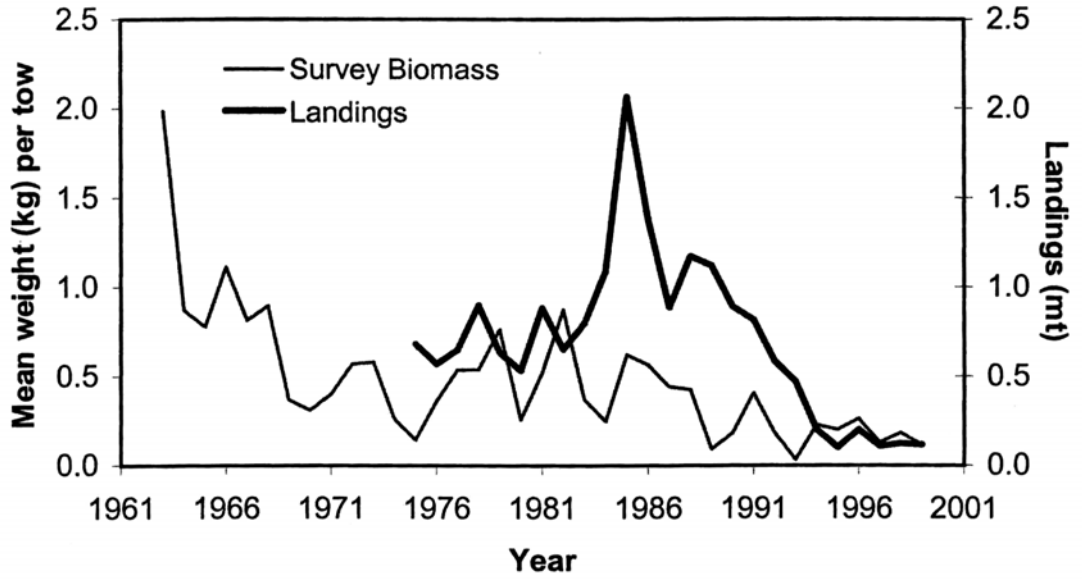


Figure P1. Commercial landings of SNE-MAB windowpane flounder, during 1975-1999, and NEFSC autumn bottom trawl survey stratified mean weight (kg) per tow in 1963-1999.

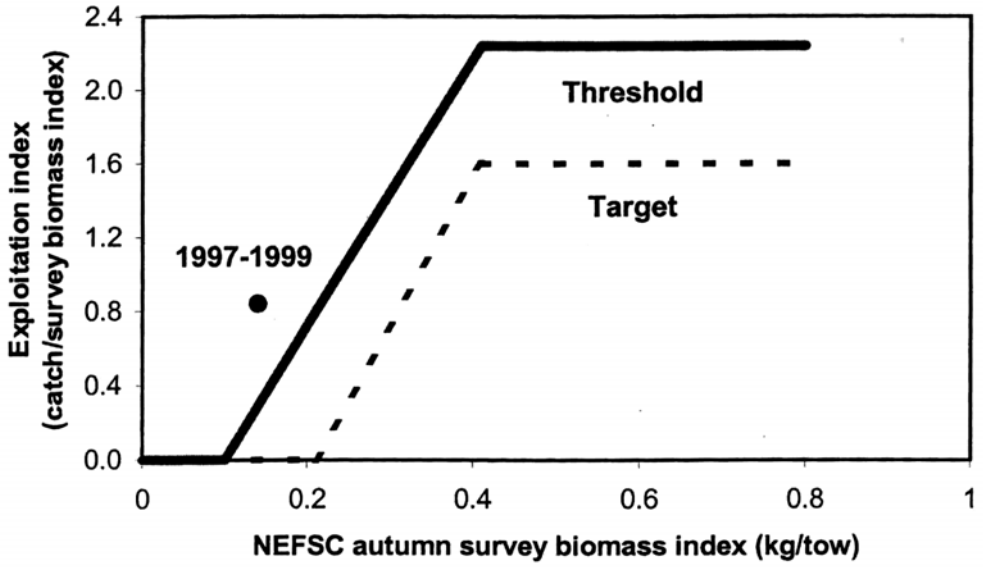


Figure P2. Harvest control rule for SNE-MAB windowpane flounder based on survey equivalents of MSY-based reference points and the 1997-1999 mean exploitation index.

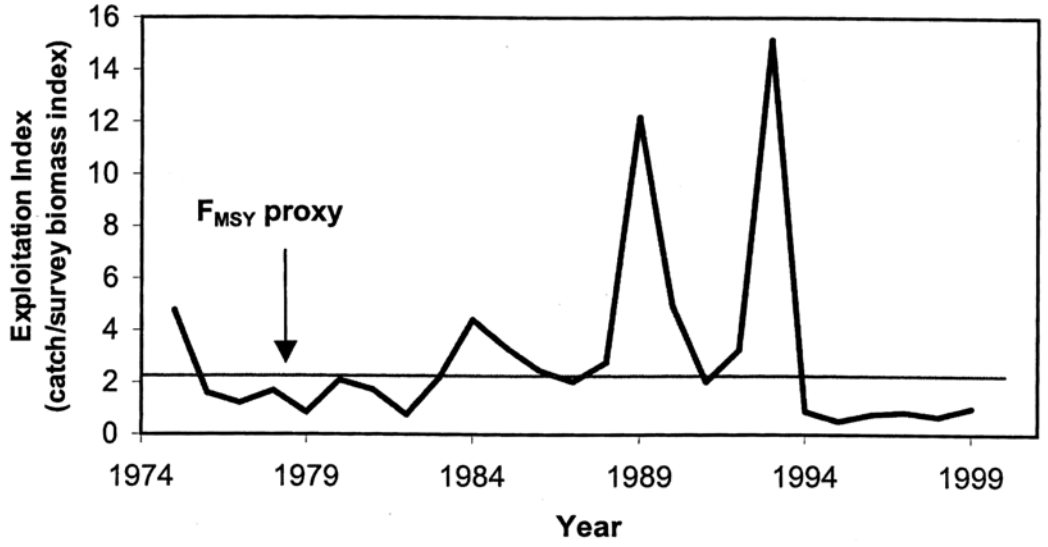


Figure P3. Trends in SNE-MAB windowpane flounder exploitation indices (catch/autumn survey biomass index), during 1975-1999, in relation to the harvest control rule F_{MSY} proxy (= 2.24).

Q. Mid-Atlantic Yellowtail Flounder by S.X. Cadrin

1.0 Background

The stock has been at relatively low abundance in recent years (Overholtz and Cadrin 1999, Cadrin 2000). This report updates catch through 1999 and survey indices through 2000.

2.0 2000 Assessment

2.1 1999 Landings

Historical landings were revised according to weighout records. Recent landings (1994-1999) were prorated as described in the Georges Bank assessment (Cadrin et al. 1998; Table Q1; Figure Q1). Landings from Mid-Atlantic yellowtail increased by 118% from 1998 to 1999.

2.3 1999-2000 Survey Indices

Survey abundance and biomass indices are reported in Table Q1. Estimates are from valid tows in the Mid-Atlantic area (offshore strata 1, 2, 69, 70, 73, 74), standardized according to net, vessel, and door changes (Cadrin et al. 1998). All survey indices of total biomass slightly decreased in 2000 (Figure Q2).

3.0 Assessment Results

The average fall biomass index for the last three years (1997-1999 average=0.26 kg/tow) is 2% of the B_{MSY} proxy (1963-1972 median=11.69 kg/tow) and well below the biomass threshold ($B_{MSY}/2$=5.85 kg/tow; Figure Q3). The average exploitation index (landings/fall survey biomass index) for the last three years (2.01) is 724% of the F_{MSY} proxy (0.28), derived as the MSY proxy (1964-1969 average annual landings, 3300 mt) divided by the B_{MSY} proxy.

4.0 Harvest Control Rule

The SFA control rule specifies a biomass threshold of 50% B_{MSY}, a maximum F threshold of F_{MSY}, and exploitation index (landings/fall survey biomass index) as the metric for fishing mortality . When biomass is less than B_{MSY}, threshold F decreases linearly to zero at 1/4 B_{MSY}. When biomass is below 1/4Bmsy, threshold F = 0. Target F is 60% of F_{MSY} when biomass exceeds B_{MSY}, and decreases linearly to zero at 1/4 B_{MSY}.

The amendment #9 B_{MSY} proxy is based on 1963-1972 survey indices. However, strata 69-74 were not sampled until 1967. Therefore the 1963-1972 series is inconsistent. A revised B_{MSY} proxy based on the 1967-1972 median biomass index would be slightly greater (12.91 kg/tow).

5.0 Sources of Uncertainty

- Estimates of prorated landings and discard ratios are based on preliminary logbook data and are subject to change.
- The Mid-Atlantic yellowtail resource may not be self-sustaining and may be an extension of the southern New England stock.

6.0 References

Cadrin, S.X. 2000.Yellowtail flounder. In Status of the Fishery Resources off the Northeastern United States, S.H. Clark, editor. NOAA Tech. Mem. NMFS-NE-115 updated online (2000 January <http://www.nefsc.nmfs.gov/sos/spsyn/fldrs/yellotail/>).

Cadrin, S.X., W.J. Overholtz, J.D. Neilson, S. Gavaris, and S. Wigley. 1998. Stock assessment of Georges Bank yellowtail flounder for 1997. NEFSC Ref. Doc. 98-06.

Overholtz, W. and S. Cadrin. 1998. Yellowtail flounder. In Status of the Fishery Resources off the Northeastern United States for 1998, S.H. Clark, editor. NOAA Tech. Mem. NMFS-NE-115: 70-74.

Table Q1. Survey indices, landings and exploitation indices of Mid-Atlantic yellowtail flounder.

	NEFSC fall		NEFSC spring		NEFSC winter		Landings	Exploitation
Year	#/tow	kg/tow	#/tow	kg/tow	#/tow	kg/tow	(k mt)	Index
1963	35.17*	11.45*						
1964	20.01*	6.22*					1.80	0.29*
1965	59.84*	7.45*					2.10	0.28*
1966	58.89*	11.33*					2.40	0.21*
1967	67.81	11.93					5.30	0.44
1968	99.21	17.26	106.06	21.78			3.30	0.19
1969	55.33	12.61	83.69	17.67			4.60	0.36
1970	55.16	13.20	58.05	14.41			4.20	0.32
1971	32.91	4.84	44.54	10.10			7.90	1.63
1972	105.21	26.82	46.71	12.69			8.90	0.33
1973	10.05	2.40	39.16	11.76			5.10	2.13
1974	0.80	0.24	16.33	5.62			1.90	7.85
1975	1.06	0.21	2.20	0.90			0.70	3.41
1976	0.46	0.08	5.22	1.22			0.30	3.80
1977	1.75	0.23	8.91	2.26			0.60	2.58
1978	1.45	0.29	12.12	2.59			0.40	1.39
1979	1.27	0.26	2.94	0.77			0.50	1.95
1980	0.97	0.19	14.53	4.60			0.30	1.55
1981	22.81	3.04	34.13	8.16			0.70	0.23
1982	12.47	2.18	29.23	6.71			0.43	0.20
1983	2.31	0.47	16.56	4.27			0.59	1.26
1984	2.05	0.23	4.13	1.22			1.04	4.48
1985	1.71	0.19	5.06	1.37			0.15	0.79
1986	0.97	0.21	2.51	0.56			0.25	1.18
1987	0.15	0.01	0.65	0.23			0.17	11.52
1988	3.93	0.23	0.93	0.33			0.09	0.42
1989	7.16	1.16	10.18	1.65			0.40	0.34
1990	4.23	0.81	9.94	2.62			0.24	0.29
1991	0.37	0.13	6.90	2.08			0.21	1.67
1992	0.00	0.00	2.29	0.83	12.86	4.96	0.24	
1993	0.58	0.09	0.45	0.19	4.19	1.87	0.17	1.90
1994	2.26	0.23	0.09	0.06	3.45	1.42	0.24	1.02
1995	0.08	0.03	1.30	0.28	13.50	2.73	0.02	0.71
1996	0.25	0.06	1.40	0.46	5.84	1.74	0.15	2.77
1997	0.83	0.21	1.14	0.43	12.26	4.52	0.54	2.59
1998	0.30	0.09	2.71	0.68	14.06	3.61	0.22	2.50
1999	2.03	0.50	1.39	0.59	1.75	3.74	0.47	0.95
2000			1.42	0.57	7.76	2.53		
Mean	18.16	3.70	17.36	4.23	8.41	3.01	1.57	1.82
97-99 Mean		0.26						2.01
Bmsy proxy		11.69	(1963-72 median)					
					MSY	proxy		3.25 (1964-69 average)
Bmsy proxy						Fmsy	proxy	0.28 (MSY/Bmsy)

* not all strata sampled.

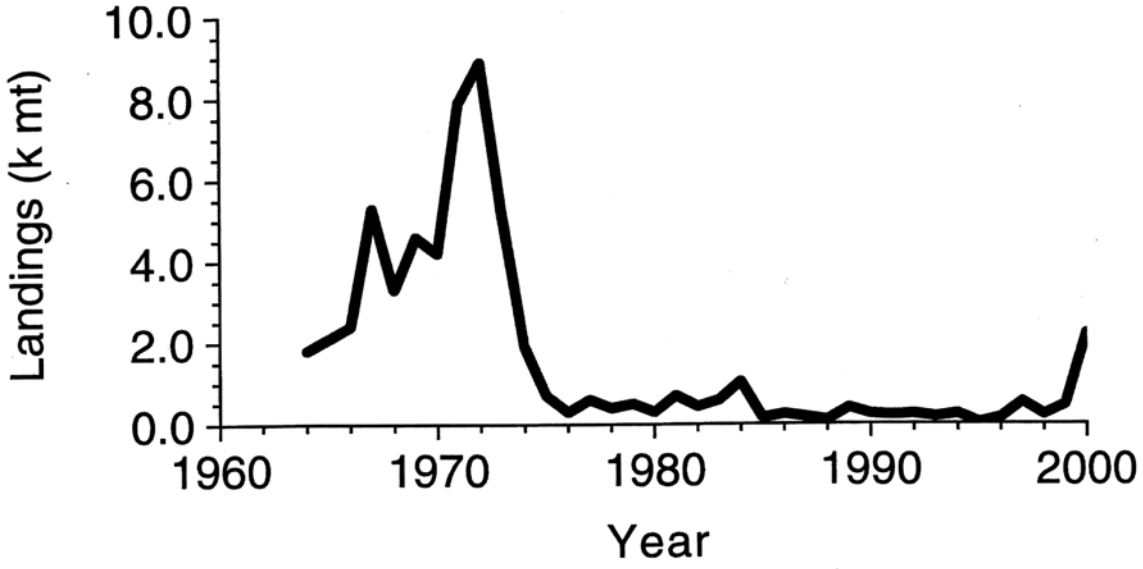


Figure Q1. Landings of Mid-Atlantic yellowtail flounder.

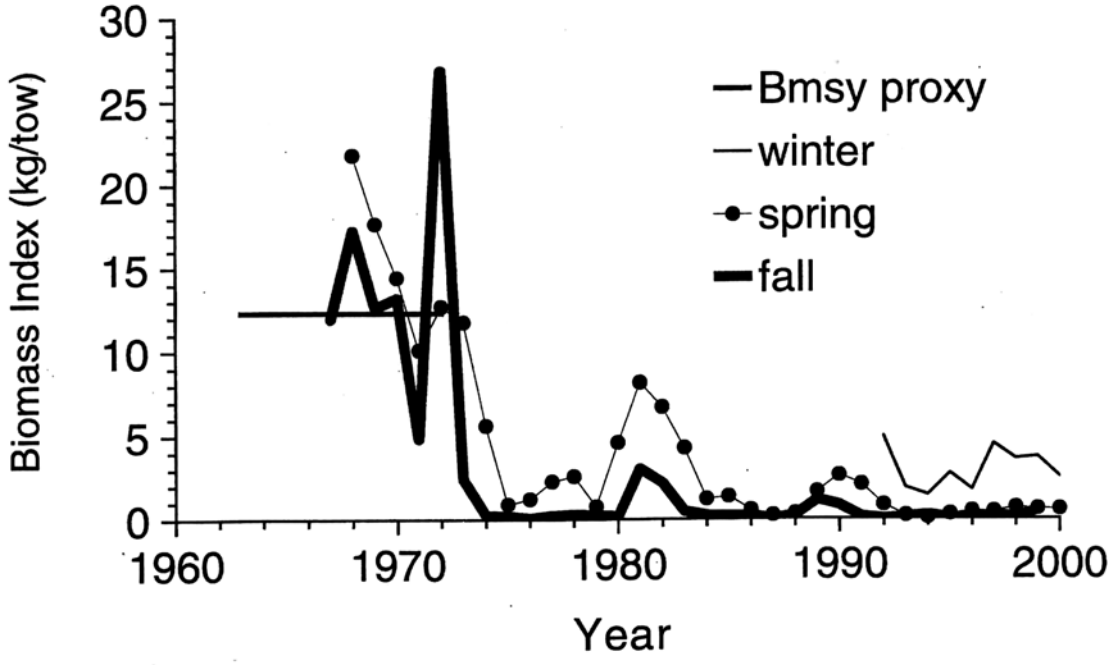


Figure Q2. Survey indices of Mid Atlantic yellowtail flounder biomass.

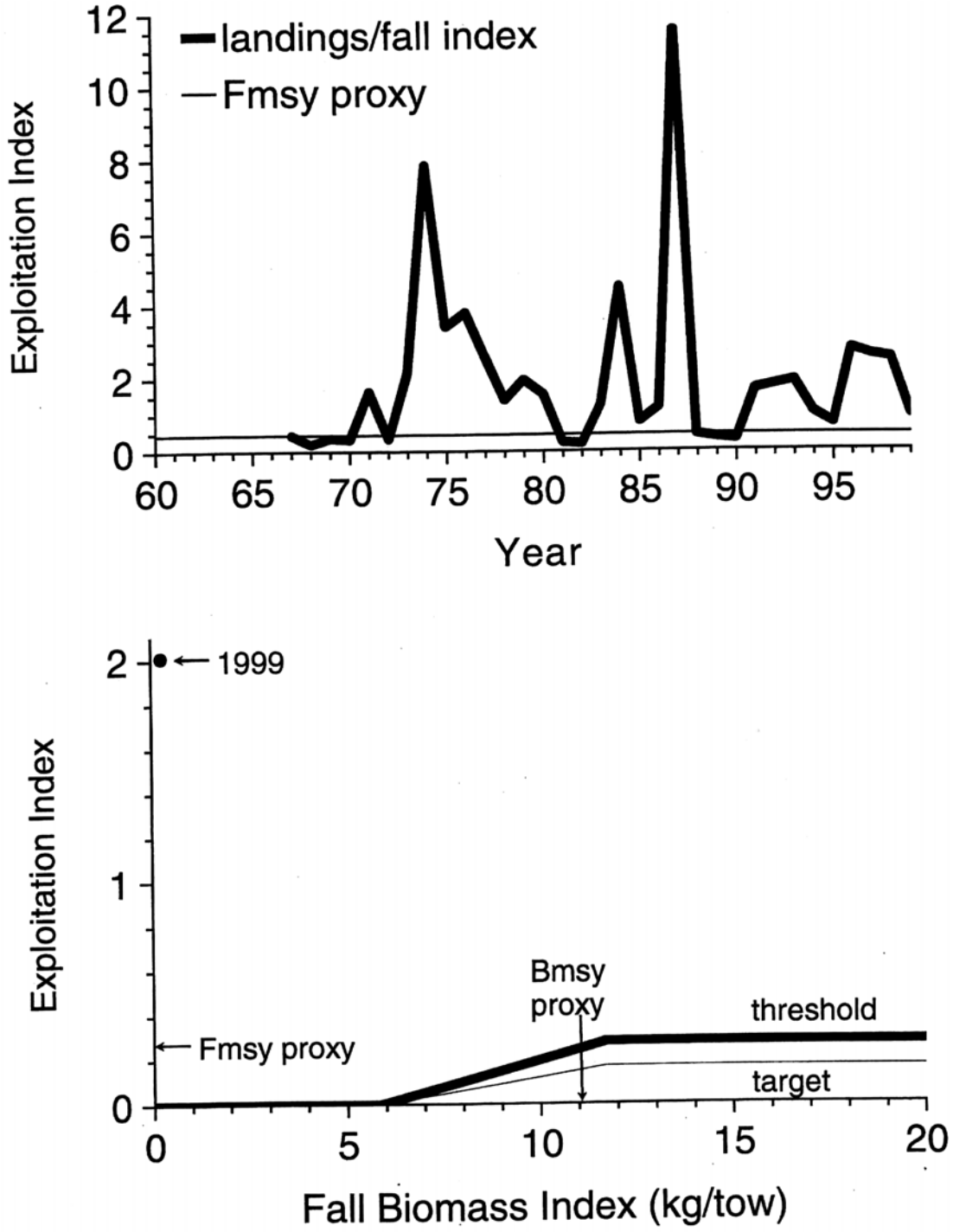


Figure Q3. Status of the Mid Atlantic yellowtail flounder stock.

R. Gulf of Maine Haddock by R.W. Brown

1.0 Background

The Gulf of Maine haddock stock was last assessed at SAW/SARC 2 in 1986 (NMFS-NEFSC 1986). At the time of the 1986 assessment, landings had declined from 7,600 mt in 1983 to 3,000 mt in 1985. Although no formal analysis of fishing mortality was attempted, fishing mortality was assumed to be relatively high. The fishery in the mid 1980s was being supported by spill over of large year classes from Georges Bank, and research vessel surveys indicated that recruitment in the Gulf of Maine was extremely poor. The Gulf of Maine haddock stock was not updated during the 1999 assessment process for groundfish stocks (NDWG 2000).

Although the last formal SAW/SARC assessment was in 1986, the Status of Stocks section for this stock has been updated on numerous occasions. In the most recent update (Brown 2000), both landings and research survey indices had declined sharply between the mid 1980s and the mid 1990s. Some increases in both landings and survey indices were observed in the late 1990s; however, the stock was determined to be in an overfished condition and that overfishing has been occurring with reference to the Amendment 9 MSY-based harvest control rule.

2.0 Fishery Catches and Research Survey Indices

Historical Landings

Following recruitment of the 1975 and 1978 year classes, landings of haddock in the Gulf of Maine exceeded 6,000 mt from 1980 to 1984. Landings declined steadily from 1982 and the mid 1990s, and reached a historic low of 112 mt in 1994. Landings have increased steadily since 1994 reaching 1,000 mt in 1998.

1999 Fishery

U.S. trip limit regulations for haddock continued to be liberalized in 1999, and regulations in 1999 were significantly in more liberal in 1999 compared to the 1998 calendar year. The trip limit from January 1 to April 1999 was 3,000 pounds/day up to a maximum of 30,000 pounds/trip, 2,000 pounds/day up to a maximum of 20,000 pounds/trip from May 1 to November 4, 1999, and 5,000 pounds/trip up to a maximum of 50,000 pounds/trip from November 5 to December 31, 1999. However, landings of Gulf of Maine haddock declined from 1,018 mt in 1998 to 668 mt in 1999 (Table 1, Figure 1). Management measures designed to reduce mortality on Gulf of Maine cod may have reduced access to the Gulf of Maine haddock resource in 1999.

Fishery Independent Information

Abundance (stratified mean number/tow) and biomass (stratified mean weight/tow) survey indices are available for the U.S. Spring (1968 to 2000) and Autumn (1963 to 1999) surveys. Spring survey biomass and abundance indices declined from high levels in the late 1970s to record low levels by 1990 (Table R2; Figure R2). The spring surveys in 1987, 1989, 1990 and 1991 approached the level where the survey had difficulty detecting the presence of haddock in

Gulf of Maine strata. Survey indices in the 1990s have remained at chronic low levels, with the exception of 1997, 1999, and 2000 surveys (Table R2; Figure R2). The 1999 and 2000 abundance indices were the highest observed since 1981, and the biomass index in 2000 was the highest observed since 1985. Most of the tows indicating larger abundance occurred in areas bordering the Georges Bank stock boundary, rather than in areas where the stock was traditionally concentrated.

U.S. autumn survey abundance and biomass indices declined from very high levels in the mid - 1960s to low levels in the early 1970s. The indices increased during the late 1970's and early 1980s in response to recruitment of the 1975 and 1978 year classes, and subsequently declined steady to historic low levels in 1991. The autumn surveys in 1990 and 1991 approached the level where the survey had difficulty detecting the presence of haddock in Gulf of Maine strata. Abundance and biomass indices increased moderately in the mid 1990s and sharply beginning in 1996. The 1999 autumn survey abundance index (6.73 haddock/tow) and biomass index (4.91 kg/tow) were the highest observed since 1980 and 1985, respectively. However, these indices are less than 50% of levels observed during the mid 1960s.

Trends in exploitation indices (3 year moving average of catch (000s mt) divided by the U.S. autumn survey biomass index [kg/tow]) indicate that relative exploitation was relatively low during the 1960s, rose sharply during the early 1980s and again during the early 1990s (Figure R3). The exploitation index dropped sharply beginning in 1994 and has remained at moderate levels since.

Survey indices at age for both the U.S. spring and autumn surveys indicate the presence of strong year classes through the assessment period. Both surveys exhibit large abundance indices for the 1963, 1975, and 1978 year classes (Figures R4 and R5). Survey indices during the 1980s indicate very low levels of recruitment. During the 1990s, survey indices at age reflect an increase in recruitment and some broadening of age structure. Survey indices corresponding to the 1998 year class are the largest observed since the early 1980s.

3.0 Harvest Control Rule Evaluation

The MSY-based harvest control rule for Gulf of Maine haddock is outlined as follows:

> *A maximum sustainable yield of 2,700 mt can be produced when relative stock biomass is 8.25 kg/tow (B_{MSY} proxy) and the relative exploitation index (catch/autumn biomass index) is 0.29 (f_{MSY} proxy). The maximum fishing mortality rate should be less than f_{MSY} when stock biomass exceeds B_{MSY}, and less than the fishing mortality that would allow rebuilding in five years when biomass is below B_{MSY}. Since the intrinsic rate of population growth (r=0.20) is less than other stocks where a 10 year rebuilding schedule was recommended, it is recommended that the minimum biomass threshold should be the biomass that can be rebuilt to B_{MSY} in five years with no fishing (F = 0.00). This biomass level is slightly greater than ½ B_{MSY} (average autumn survey biomass index of 4.38 kg /tow).*

The harvest control is shown graphically in Figure R6. Based on 1997 to 1999 autumn survey results, the current biomass proxy (3.41 kg/tow) is less than $B_{threshold}$ (4.38 kg/tow), and the F proxy (0.247) is greater than 1999 F_{Target} proxy of 0.00.

4.0 Conclusions

In recent years, exploitation indices have declined from previously high levels, and there has been a moderate increase in landings that appears to be associated with higher levels of abundance. U.S. spring and autumn survey indices provide evidence of increases in abundance and biomass within the stock area. Survey abundance at age indices provide evidence for broadening of the size and age structure of the population. Recent survey indices for younger ages provide evidence of significantly improved recruitment, especially indices corresponding to the 1998 year class. Despite indications of increased abundance and recruitment, biomass remains well below B_{MSY}.

5.0 Sources of Uncertainty

- There is insufficient length and age sampling of U.S. commercial landings to reliably estimate catch at age for this stock.

- The magnitude of discarding due to bycatch and in response to U.S. management regulations is uncertain.

6.0 References

Brown, R. 2000. Haddock. Status of Fishery Resources off the Northeastern United States for 1999. Electronic Publication: http://www.nefsc.nmfs.gov/sos/spsyn/pg/haddock/

NDWG (Northern Demersal Working Group, Northeast Regional Stock Assessment Workshop). 2000. Assessment of 11 northeast groundfishstocks through 1999. Report of the SAW Northern Demersal Working Group. A Report to the NEFMC Multi-Species Monitoring Committee. NMFS, NEFSC Reference Document 00-5.

NMFS-NEFSC. 1986. Report of the Second NEFC Stock Assessment Workshop (Second SAW). NMFS, NEFSC, Woods Hole Laboratory Reference Document 86-09.

Table R1. Commercial landings (mt, live weight) of haddock from the Gulf of Maine (NAFO Division 5Y; U.S. statistical areas 511-515) from 1960-1999.

Year	United States	Canada	USSR	Other	Total
1960	4541	383	--	--	4924
1961	5297	112	--	--	5409
1962	5003	107	--	--	5110
1963	4742	3	44	--	4789
1964	5383	70	--	--	5453
1965	4204	159	--	--	4363
1966	4579	1125	--	--	5704
1967	4907	589	--	--	5496
1968	3437	120	--	--	3557
1969	2423	59	--	231	2713
1970	1457	38	--	67	1562
1971	1194	85	--	27	1306
1972	909	23	4	--	936
1973	509	49	--	--	558
1974	622	198	--	9	829
1975	1180	79	--	4	1263
1976	1865	91	--	--	1956
1977	3296	26	--	--	3322
1978	4538	641	--	--	5179
1979	4622	257	--	--	4879
1980	7270	203	--	--	7473
1981	5726	513	--	--	6239
1982	5645	1278	--	--	6923
1983	5594	2003	--	--	7597
1984	2793	1245	--	--	4038
1985	2234	781	--	--	3025
1986	1443	225	--	--	1668
1987	829	--	--	--	829
1988	436	--	--	--	436
1989	264	--	--	--	264
1990	433	--	--	--	433
1991	431	--	--	--	431
1992	312	--	--	--	312
1993	193	--	--	--	193
1994 [1]	112	--	--	--	112
1995 [1]	192	--	--	--	192
1996 [1]	257	--	--	--	257
1997 [1]	616	--	--	--	616
1998 [1]	1018	--	--	--	1018
1999 [1]	668	--	--	--	668

[1] U.S. landings from 1994-1999 are provisional.

Table R2. Stratified and standardized mean number and mean weight (kg) per tow of haddock caught in the U.S. spring and autumn bottom trawl surveys from 1963-1999. An exploitation index has been calculated based on a 3 year moving average of landings (000s mt) / autumn survey biomass index (kg/tow).

	Spring Survey		Autumn Survey		Exploitation Index
Year	Number/Tow	Weight (kg)/tow	Number/tow	Weight (kg)/tow	(catch/Autumn survey biomss)
1963			69.54	50.69	
1964			14.17	18.82	0.168
1965			17.43	17.64	0.308
1966			11.65	13.85	0.322
1967	*Spring survey initiated in 1968*		12.186	16.85	0.319
1968	6.00	7.88	7.64	15.48	0.260
1969	3.78	7.37	5.45	12.85	0.218
1970	0.90	1.72	2.91	7.35	0.195
1971	0.87	2.52	2.87	8.13	0.202
1972	0.86	0.86	1.98	3.03	0.141
1973	1.20	1.57	4.16	8.58	0.155
1974	1.43	1.05	2.68	3.34	0.129
1975	2.77	3.48	5.53	8.61	0.202
1976	8.32	6.35	6.03	8.04	0.257
1977	6.79	6.72	8.29	8.75	0.277
1978	1.35	1.43	9.16	20.93	0.308
1979	3.33	4.63	5.52	13.72	0.394
1980	2.69	3.38	7.15	9.83	0.565
1981	4.40	4.48	3.86	9.34	0.884
1982	2.04	2.55	2.62	4.16	1.109
1983	3.67	3.56	2.59	5.21	1.398
1984	1.09	1.14	1.69	3.89	0.961
1985	1.77	1.88	4.07	6.14	0.764
1986	0.70	1.28	0.62	1.39	0.542
1987	0.09	0.06	1.03	2.64	0.532
1988	0.18	0.30	0.33	1.47	0.322
1989	0.08	0.12	0.28	0.63	0.446
1990	0.02	0.00	0.14	0.43	0.954
1991	0.07	0.06	0.14	0.12	1.829
1992	0.19	0.27	0.21	0.09	1.370
1993	0.45	0.20	0.86	0.47	0.791
1994	0.40	0.25	0.32	0.21	0.278
1995	0.80	0.35	0.97	1.09	0.115
1996	0.30	0.33	2.40	3.54	0.151
1997	1.93	1.22	2.68	2.42	0.213
1998	0.19	0.11	3.13	2.91	0.224
1999	4.26	1.10	6.73	4.91	
2000	3.61	1.81	*To be conducted in October 2000*		

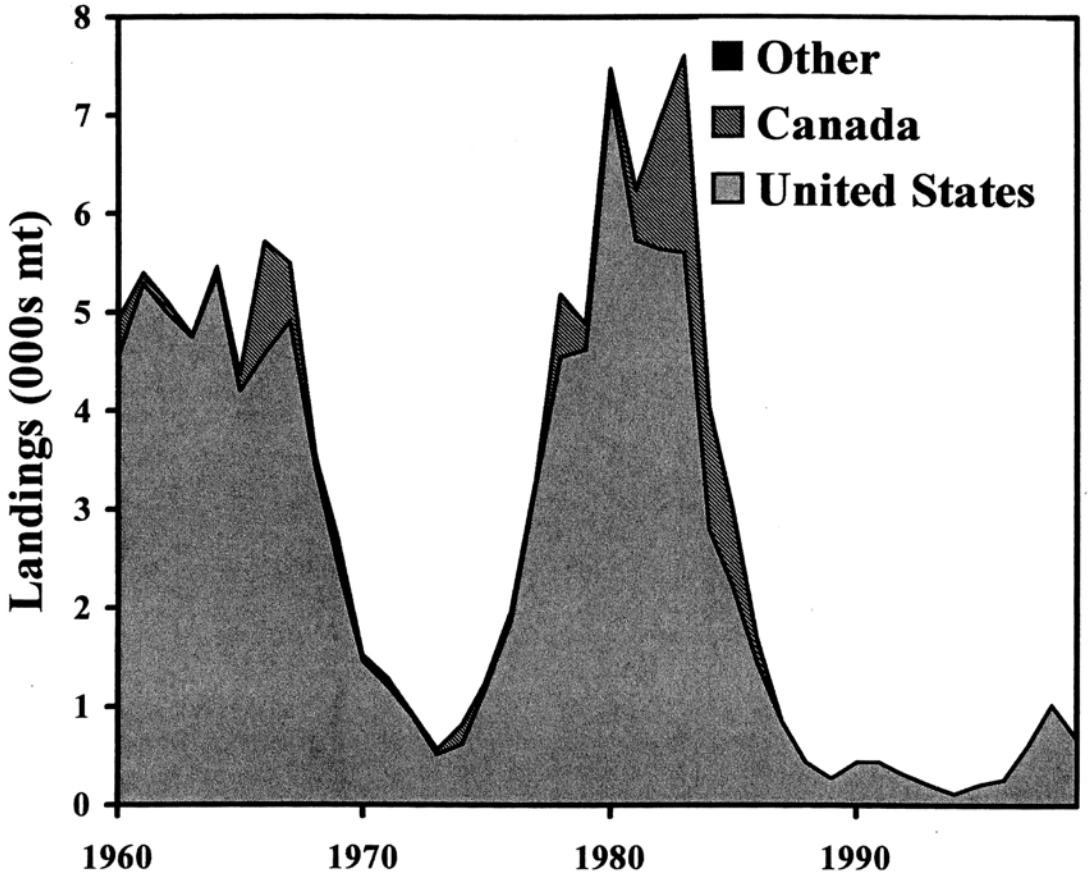


Figure R1. Landings (live weight, mt) of Gulf of Maine haddock from 1960 – 1999.

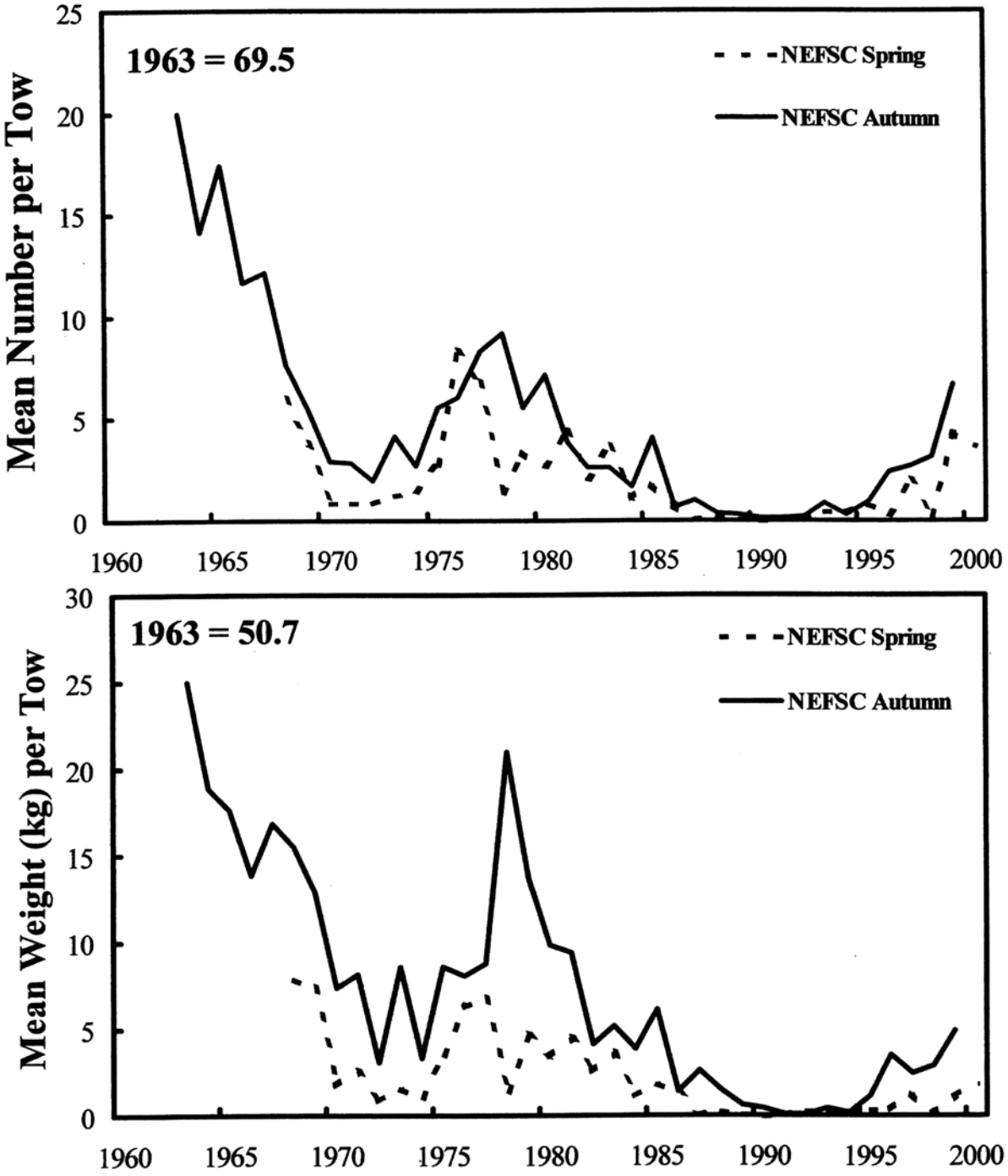


Figure R2. Northeast Fisheries Science Center research standardized and stratified survey abundance (mean number mean number per tow; top panel) and biomass (kg per tow, bottom panel) indices for Gulf of Maine haddock from 1963-1999. U.S. survey includes strata 01260-01280 and 01360-01400.

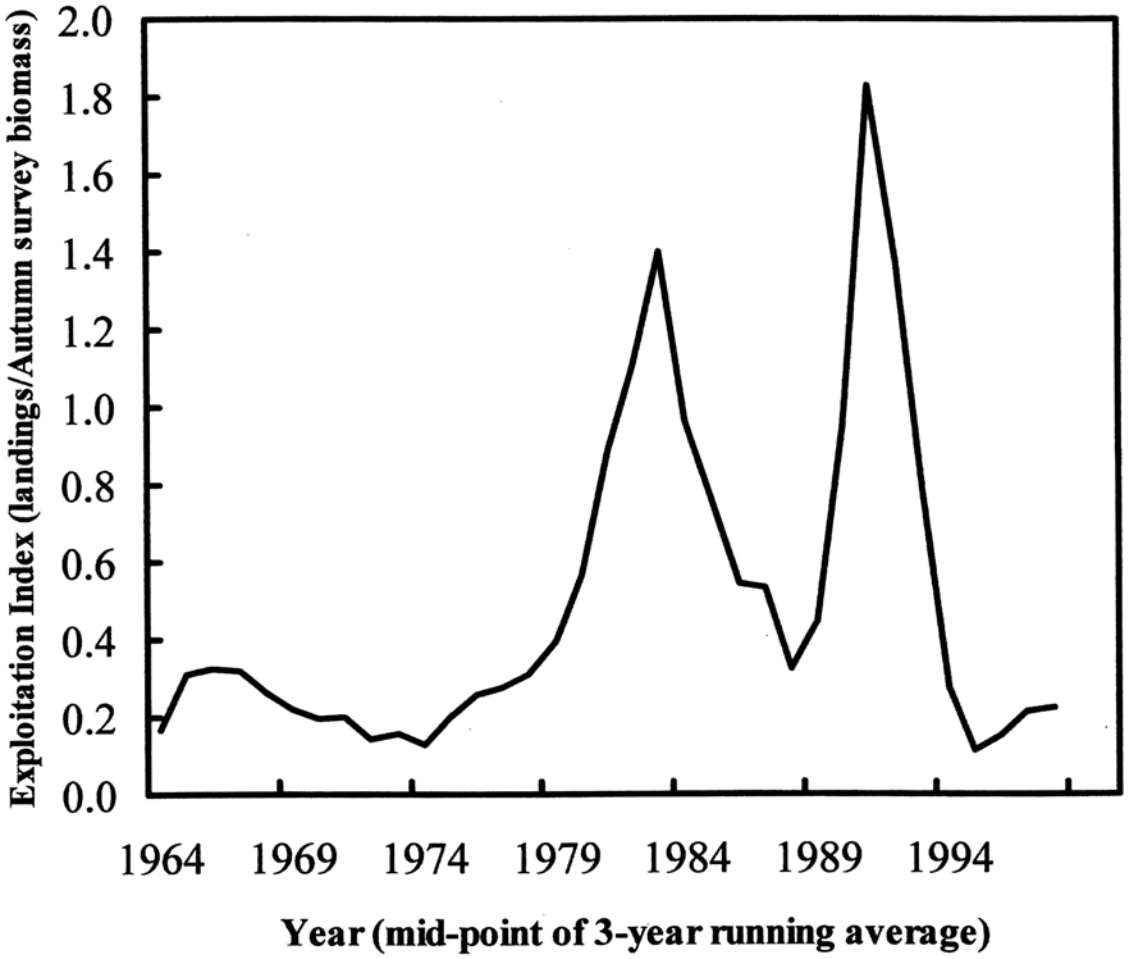


Figure R3. Exploitation index (landings [000s mt] / autumn survey biomass index [kg/tow]) for Gulf of Maine haddock.

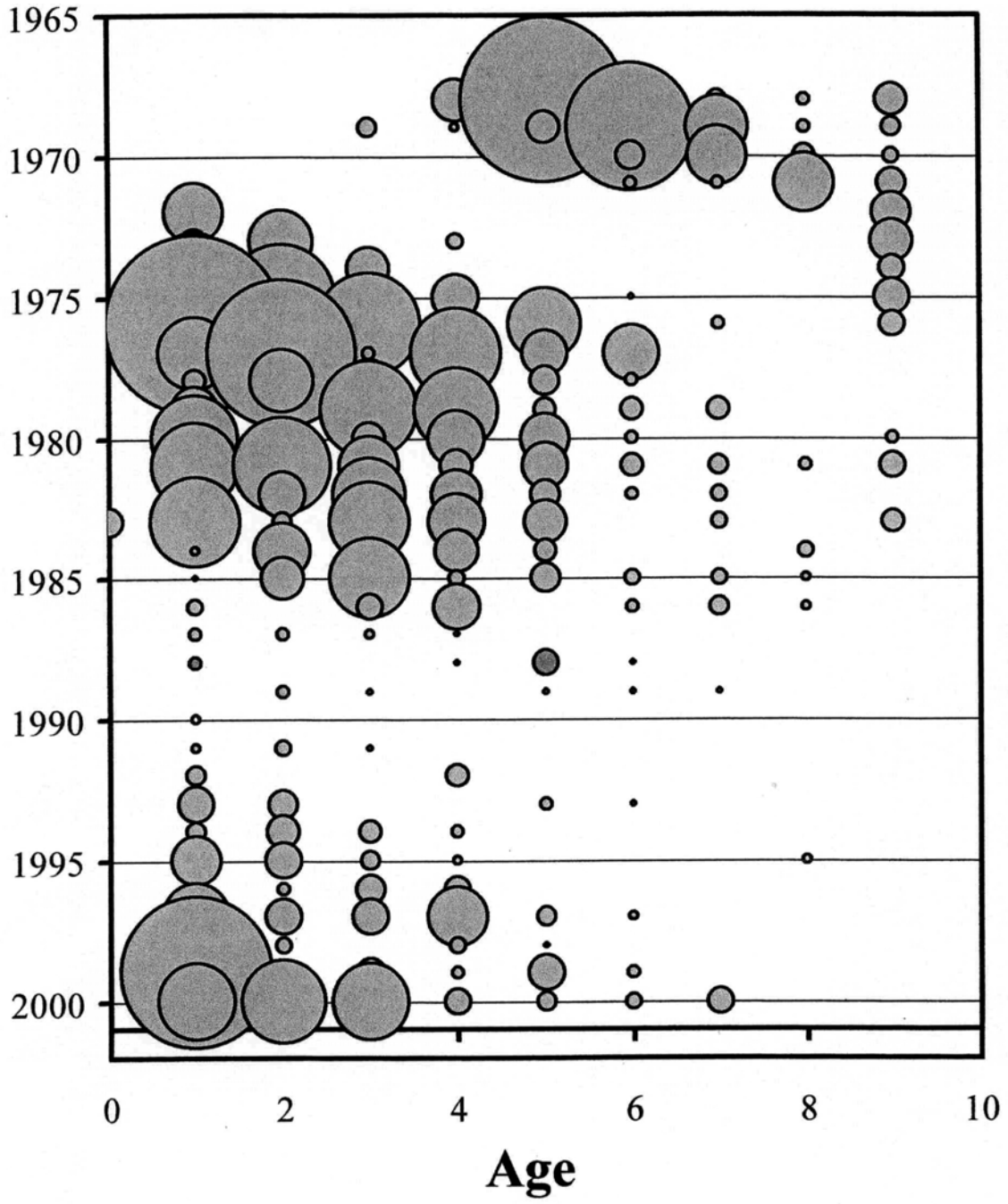


Figure R4. Abundance at age indices (standardized, stratified mean number per tow) from the Northeast Fisheries Science Center Spring research survey abundance, 1968-1999. The size of the bubbles indicates the relative magnitude of each index.

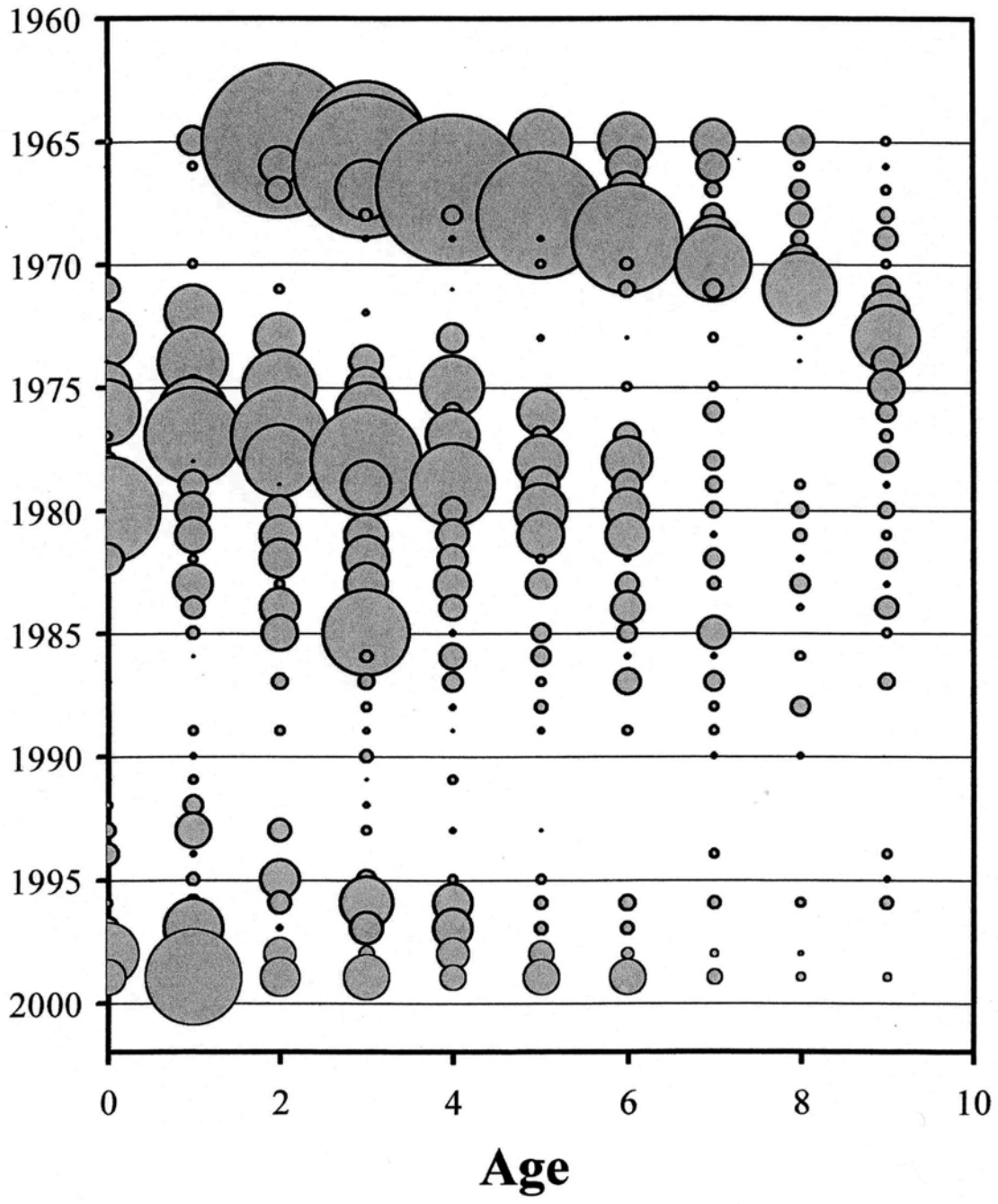


Figure R5. Abundance at age indices (standardized, stratified mean number per tow) from the Northeast Fisheries Science Center Autumn research survey abundance, 1968-1999. The size of the bubbles indicates the relative magnitude of each index.

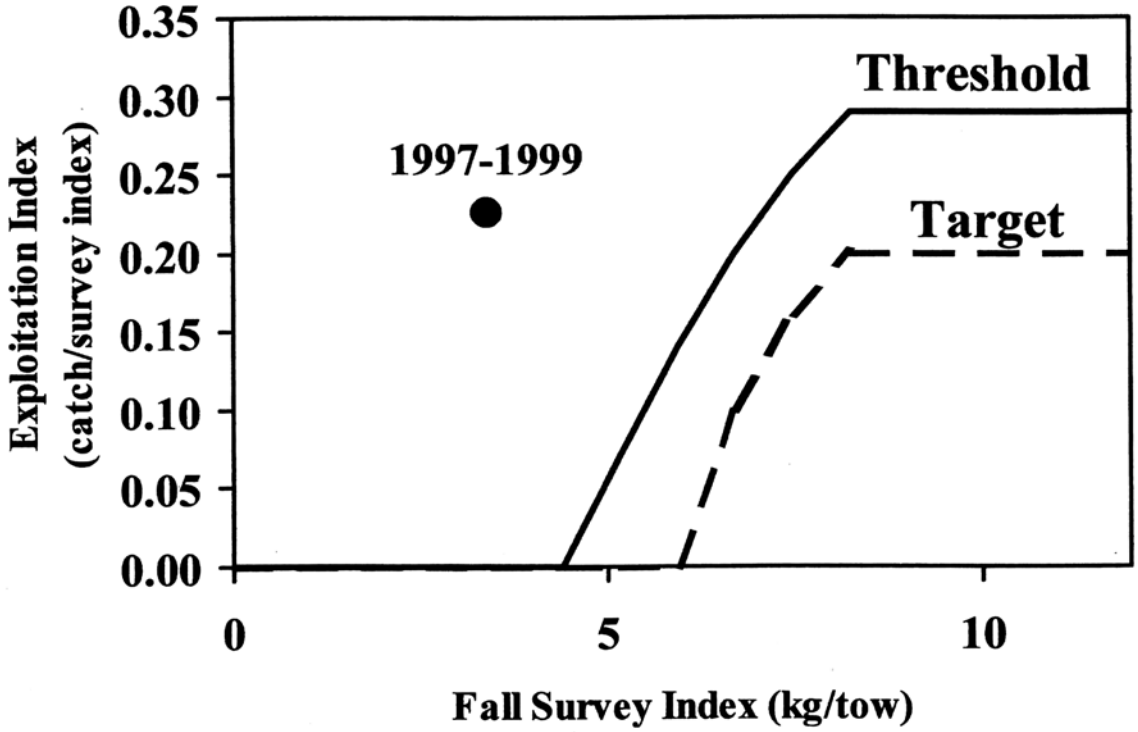


Figure R6. SFA harvest control rule for Gulf of Maine haddock based on proxies of MSY-based reference points and minimum biomass thresholds.

S. Atlantic Halibut by **Jon Brodziak**

1.0 Background

The Atlantic halibut (*Hippoglossus hippoglossus*) is distributed from Labrador to southern New England in the northwest Atlantic (Bigelow and Schroeder 1953). The Atlantic halibut stock within Gulf of Maine and Georges Bank waters (NAFO Subarea 5) has been exploited since the 1830s. This resource is currently depleted and is not expected to rebuild in the near future (NEFMC 1998). This working paper updates fishery and survey information to evaluate stock status.

2.0 Fishery

Records of Atlantic halibut landings from the Gulf of Maine and Georges Bank begin in 1893 (Table S1). Substantial landings occurred prior to this, however, as the halibut fishery declined in the late 1800s (Hennemuth and Rockwell 1987). Landings have decreased since the 1890s as components of the resource have been sequentially depleted. Annual landings averaged 662 mt during 1893-1940 and declined to an average of 144 mt during 1941-1976. Since 1977, landings have averaged 95 $mt \cdot yr^{-1}$. Reported landings in 1999 were 20 mt. Of these, 12 mt were landed by domestic fishermen (60%) with the remainder landed by Canadian fishermen (Division 5Zc).

3.0 Survey Indices

The Northeast Fisheries Science Center spring and autumn bottom trawl surveys provide measures of the relative abundance of Atlantic halibut within the Gulf of Maine and Georges Bank (Offshore survey strata 13-30 and 36-40, Table S2). Both indices have high inter-annual variability since relatively few halibut are captured during these surveys; in some years, no halibut are caught. The survey indices suggest that relative abundance increased during the 1970s to early 1980s and subsequently declined in the 1990s. It is unknown whether abundance trends in the Gulf of Maine and Georges Bank have been influenced by changes in the seasonal distribution and availability of Atlantic halibut, however.

4.0 Status Update

Based on updated spring and autumn survey data, Atlantic halibut biomass within the Gulf of Maine and Georges Bank remains very low. Swept-area biomass indices in spring 2000 and autumn 1999 were both less than 100 mt (Figure S1). Thus, even if survey catchability was as low as 25%, current stock biomass, as indexed by the 5-year moving average of swept-area biomass, would be below the biomass threshold of 2,700 mt (Figure S2). Although no estimates of fishing mortality are available, exploitation rate indices (annual landings/5-year moving average of survey index) suggest that exploitation rates have probably been stable since the 1970s, and may have declined during the 1990s (Figure S3). Thus, the Atlantic halibut stock in the Gulf of Maine and Georges Bank remains depleted and exploitation rates do not appear to have increased since the 1970s.

5.0 Harvest Control Rule

In the 1998 report on overfishing definitions and its Supplement (NEFMC 1998), the overfishing review panel recommended proxies for the stock biomass (B_{MSY}) and fishing mortality rate (F_{MSY}) that would produce the largest long-term potential yield. Based on yield-per-recruit and biomass-per-recruit calculations, the panel concluded that B_{MSY} was roughly 5,400 mt and that F_{MSY} was about 0.06 per year with an associated long-term potential yield of 300 mt per year. Accordingly, the panel recommended that the biomass threshold ($B_{THRESHOLD}$) be set to ½ of B_{MSY} so that $B_{THRESHOLD}$=2,700 mt and that the target fishing mortality rate (F_{TARGET}) be set to 60% of F_{MSY} so that F_{TARGET}=0.04 per year. The panel also recommended that an appropriate harvest control rule would be to keep fishing mortality as close to zero as practicable until the Gulf of Maine and Georges Bank stock was rebuilt. To evaluate the harvest control rule, the review panel compared swept-area biomass estimates from the NEFSC spring and autumn surveys with the threshold. The panel concluded that the stock was depleted because, on average, the swept-area biomass index was far below $B_{THRESHOLD,}$ given an implicit assumption that survey catchability was probably on the order of 25-50%.

6.0 Sources of Uncertainty

Fishery-dependent information on the size and age composition of Atlantic halibut landings is very limited. The magnitude of discards and unreported landings is uncertain. Fishery-dependent data needs to be collected to accurately quantify the impacts of harvests.

Life history information is limited for this species. In particular, research on growth is needed for age-structured population assessment.

Stock structure of Atlantic halibut within the Gulf of Maine and Georges Bank is uncertain. Wise and Jensen (1959) documented movements of tagged Atlantic halibut between Georges Bank and Browns Bank, but it is difficult to draw any definite conclusions about movement rates from their study.

The current harvest control rule, as proposed by the review panel, should be expressed in terms of relative biomass indices (weight in kg per tow) so that uncertainties about survey catchability do not affect the interpretation of biomass status.

The portion of the Atlantic halibut population within Gulf of Maine and Georges Bank waters is a transboundary stock. Conservation measures for both USA and Canadian fisheries may be needed to rebuild this stock.

7.0 References

Bigelow, H.B, and Schroeder, W.C. 1953. Fishes of the Gulf of Maine. Fishery Bulletin of the Fish and Wildlife Service, No. 74, 577 pp.

Hennemuth, R.C., and Rockwell, S. 1987. History of fisheries conservation and management. *In* Georges Bank. *Edited by* R. Backus, R. Price, and D. Bourne. MIT Press, Cambridge, MA. pp. 431-446.

New England Fishery Management Council [NEFMC]. 1998. Evaluation of existing overfishing definitions and recommendations for new overfishing definitions to comply with the Sustainable Fisheries Act. NEFMC, 50 Water Street, Mill 2 Newburyport, MA 01950.

Wise, J.P., and Jensen, A.C. 1959. Movement of tagged halibut off New England. Trans. Amer. Fish. Soc. 88:357-358.

Table S1. Reported landings of Atlantic halibut from the Gulf of Maine and Georges Bank, 1893- 1999.

Year	USA	Canada	Other	Total	Year	USA	Canada	Other	Total
1893	634	0	0	634	1947	196	0	0	196
1894	843	0	0	843	1948	156	0	0	156
1895	4200	0	0	4200	1949	157	0	0	157
1896	4908	0	0	4908	1950	116	0	0	116
1897	733	0	0	733	1951	154	0	0	154
1898	564	0	0	564	1952	123	0	0	123
1899	407	0	0	407	1953	104	0	0	104
1900	311	0	0	311	1954	125	0	0	125
1901	287	0	0	287	1955	74	0	0	74
1902	367	0	0	367	1956	62	0	0	62
1903	502	0	0	502	1957	80	0	0	80
1904	332	0	0	332	1958	73	0	0	73
1905	580	0	0	580	1959	59	0	0	59
1906	542	0	0	542	1960	63	0	0	63
1907	447	0	0	447	1961	79	5	0	84
1908	891	0	0	891	1962	86	35	25	146
1909	193	0	0	193	1963	94	88	1	183
1910	329	0	0	329	1964	115	120	1	236
1911	389	0	0	389	1965	128	153	18	299
1912	460	0	0	460	1966	110	110	62	282
1913	402	0	0	402	1967	102	386	26	514
1914	329	0	0	329	1968	74	193	3	270
1915	336	0	0	336	1969	63	96	9	168
1916	478	0	0	478	1970	52	67	19	138
1917	293	0	0	293	1971	81	38	0	119
1918	375	0	0	375	1972	63	37	8	108
1919	496	0	0	496	1973	51	38	0	89
1920	896	0	0	896	1974	46	29	1	76
1921	689	0	0	689	1975	70	36	0	106
1922	694	0	0	694	1976	58	33	0	91
1923	508	0	0	508	1977	50	31	0	81
1924	616	0	0	616	1978	84	50	0	134
1925	843	0	0	125	1979	125	29	0	154
1926	944	0	0	944	1980	80	88	0	168
1927	831	0	0	831	1981	80	118	0	198
1928	781	0	0	781	1982	85	116	0	201
1929	570	0	0	570	1983	72	131	0	203
1930	716	0	0	716	1984	75	62	0	137
1931	511	0	0	511	1985	61	57	0	118
1932	443	0	0	443	1986	44	32	0	76
1933	279	0	0	279	1987	27	23	0	50
1934	192	0	0	192	1988	47	81	0	128
1935	292	0	0	292	1989	13	65	0	78

Table S1 (continued.)

1936	374	0	0	374	1990	16	58	0	74
1937	187	0	0	187	1991	30	58	0	88
1938	146	0	0	146	1992	22	47	0	69
1939	124	0	0	124	1993	15	50	0	65
1940	497	0	0	497	1994	22	24	0	46
1941	145	0	0	145	1995	11	8	0	19
1942	250	0	0	250	1996	13	12	0	25
1943	76	0	0	76	1997	14	14	0	28
1944	77	0	0	77	1998	8	9	0	17
1945	55	0	0	55	1999	12	8	0	20
1946	124	0	0	124					

Table S2. Stratified mean weight (kg) per tow of Atlantic Halibut from NEFSC spring[1] and autumn surveys (offshore strata 13-30, 36-40) and exploitation rate indices calculated as annual landings divided by the 5-year moving average of swept area biomass indices.

Year	Spring Survey Index	Autumn Survey Index	Spring Exploitation Index	Autumn Exploitation Index
1963		0.085		
1964		0.067		
1965		0.032		
1966		0.004		
1967		0.009		3.93
1968	0.129	0.000		3.63
1969	0.236	0.494		0.47
1970	0.105	0.000		0.41
1971	0.033	0.091		0.30
1972	0.005	0.018	0.32	0.27
1973	0.113	0.131	0.27	0.18
1974	0.112	0.014	0.31	0.45
1975	0.000	0.095	0.61	0.46
1976	0.644	0.378	0.16	0.22
1977	0.142	0.059	0.12	0.18
1978	0.163	0.294	0.19	0.24
1979	0.357	0.040	0.18	0.27
1980	0.563	0.010	0.14	0.32
1981	0.066	0.321	0.23	0.41
1982	0.082	0.115	0.25	0.39
1983	0.611	0.000	0.18	0.63
1984	0.022	0.124	0.15	0.36
1985	0.063	0.106	0.21	0.27
1986	0.000	0.313	0.15	0.17
1987	0.287	0.033	0.08	0.13
1988	0.023	0.004	0.49	0.33
1989	0.000	0.066	0.32	0.23
1990	0.064	0.060	0.30	0.23
1991	0.062	0.243	0.30	0.33
1992	0.037	0.201	0.56	0.18
1993	0.006	0.046	0.58	0.16
1994	0.017	0.000	0.37	0.13
1995	0.005	0.066	0.23	0.05
1996	0.013	0.053	0.48	0.10
1997	0.063	0.174	0.41	0.12
1998	0.017	0.103	0.22	0.06
1999	0.239	0.015	0.09	0.07
2000	0.000			

1. Spring surveys during 1973-1981 were conducted using a modified 'Yankee 41' trawl; in all other years spring surveys were conducted using a 'Yankee 36' trawl. No adjustment have been made to survey catches for these differences.

Figure S1. Trends in swept-area biomass indices (mt) of Atlantic halibut from NEFSC spring and autumn bottom trawl surveys.

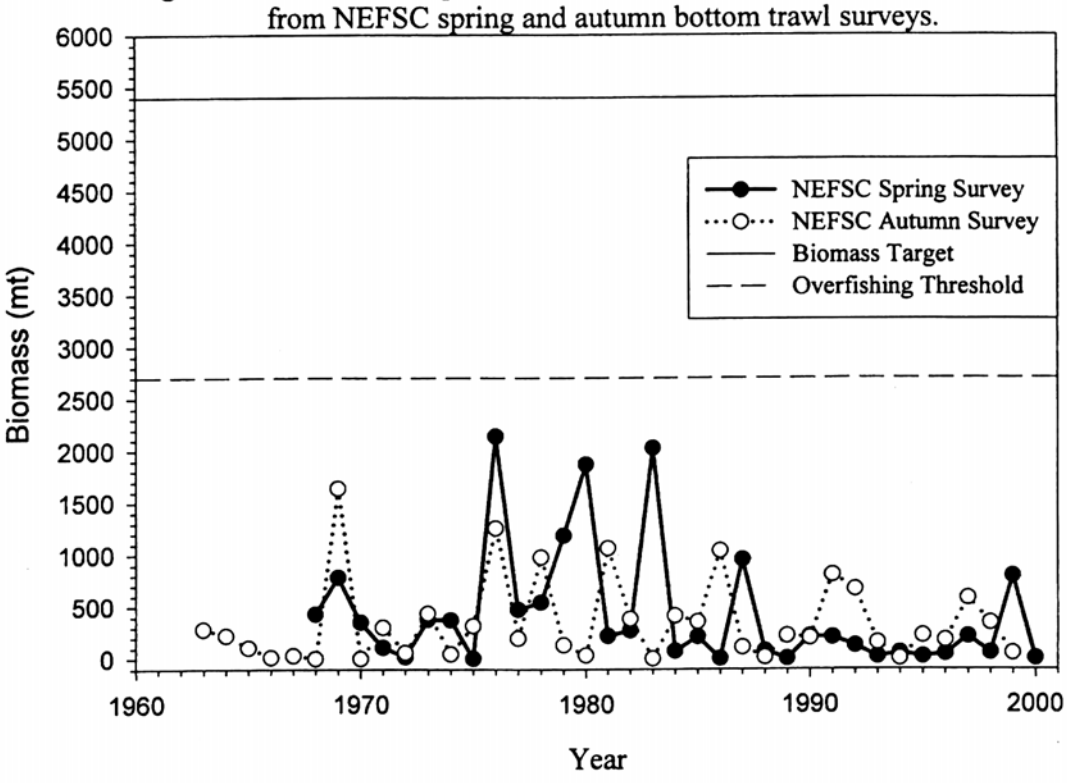


Figure S2. Trends in Atlantic halibut landings from the Gulf of Maine and Georges Bank in comparison to 5-year moving averages of spring and autumn survey indices, 1967-2000.

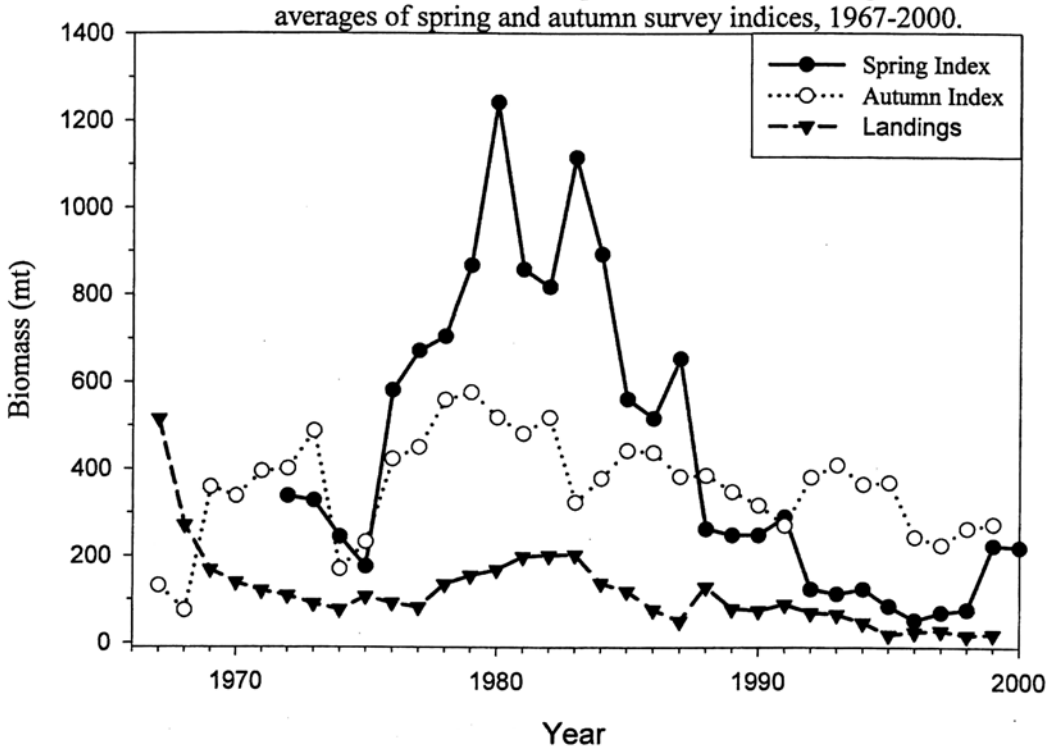
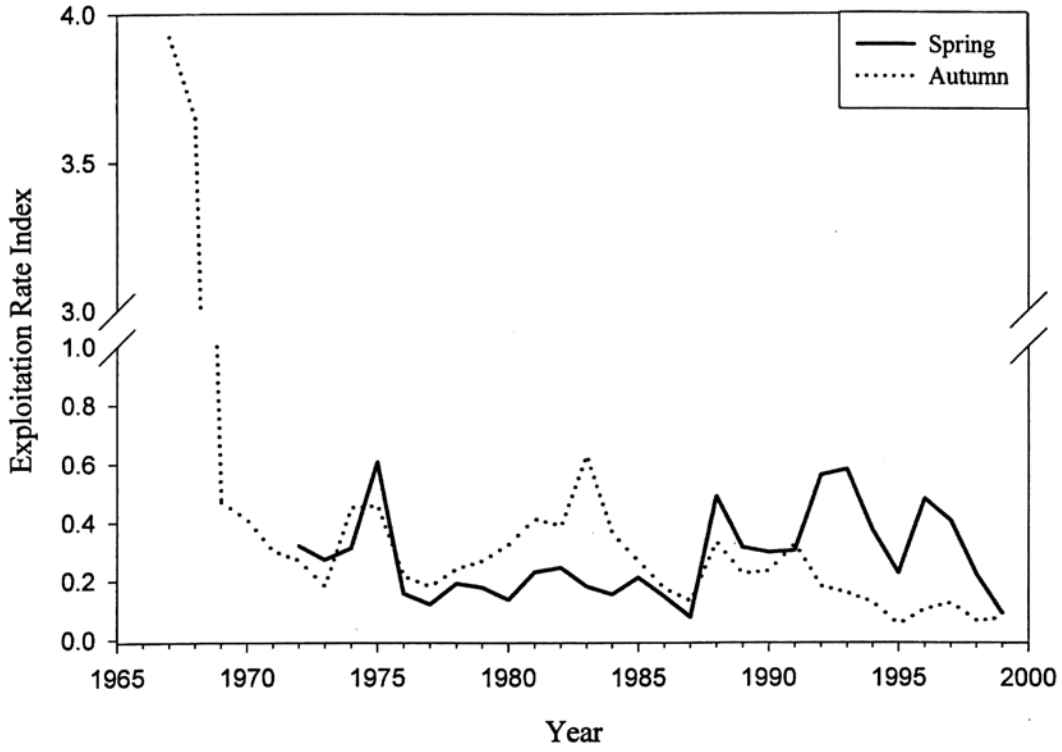


Figure S3. Trends in exploitation rate indices for Atlantic halibut from the Gulf of Maine and Georges Bank based on 5-year moving averages of NEFSC spring and autumn survey indices, 1967-1999



Section 3. Working Group Comments and Recommendations

The Joint Working Group noted that the quality of the data used for assessment purposes continues to deteriorate. The most serious concerns are:

- Continued reliance on provisional landings estimates by stock which are derived by prorating total landings to stock based primarily on unaudited VTR data.
- Continued deterioration of biological sampling of commercial landings in the ports.
- Continued poor spatial and seasonal coverage of most major gear sectors in the NEFSC Sea Sampling program and the effect on discard estimation accuracy.

The Joint Working Group developed the following generic and stock-specific recommendations:

1) Generic Recommendations

The most over-riding concern of the Joint Working Group was the continued deterioration of biological sampling of the commercial landings in the ports in 1999. Poor sampling intensity and seasonal coverage in 1999 required an unprecedented degree of pooling of samples across calendar quarters for many stocks, including Georges Bank cod, Georges Bank haddock, Georges Bank yellowtail flounder, Gulf of Maine cod, Southern New England yellowtail flounder and Cape Cod yellowtail flounder. Other stocks, including American plaice, witch flounder, Georges Bank winter flounder and Southern New England/Mid-Atlantic winter flounder, would have been included in the above list had VPAs been attempted this year.

This is an undesirable outcome and may have biased the estimation of catch numbers at age for use in VPA. In the case of Southern New England yellowtail flounder, poor sampling was the primary factor leading to the rejection of the VPA by the Working Group. In other cases, poor biological sampling contributed substantially to the uncertainty of the assessment results.

Therefore, the Working Group *recommends that biological sampling criteria including overall sampling levels and seasonal coverage as specified in annual requests be strictly met.*

Regulatory discarding has become an increasingly important component of fishing mortality for several stocks. Accurate estimates of discards depends on the availability of independent observations of kept and discarded components of the catch, obtained primarily from at-sea observer data. However, observer coverage in the groundfish fisheries is sparse, except for the sink gillnet gear sector, due to protected species priorities. Therefore, it has been necessary to rely on Vessel Trip Reports filed by individual vessel operators to estimate discard rates. It is unknown whether these reports are completed in a comprehensive and accurate manner.

Therefore, the Working Group *recommends that sea sampling coverage of major gear sectors involved in the Northeast groundfish fisheries be increased to a level which will allow estimation of discard rates for major gear types with sufficient seasonal and spatial resolution. The Working Group suggests that a minimum of 5 sea sample trips be completed within each 2-digit area per quarter for each major gear type (e.g., large mesh otter trawl, small mesh otter trawl, gill net, dredge, etc.).*

The Working Group noted a number of inconsistencies in the specification of the Harvest Control Rules across stocks. For example, for index level assessments, where mortality and biomass proxies are derived from research vessel survey biomass indices, approaches used to determine recent conditions vary among stocks (e.g., 3-year averages of exploitation ratio or biomass index). In other cases, reference points are based on absolute biomass and F, while the assessment of current stock conditions is derived from survey indices raised by swept area calculations, or Bmsy and Fmsy incorporate ages which are not part of the exploitable stock.

Therefore, the Working Group *recommends that the Harvest Control Rules be re-examined with a goal of achieving a more consistent derivation of reference points and specification of the Control Rule among stocks which are assessed in a similar manner.*

2) Stock-specific Recommendations

a) Recommendations for Georges Bank cod, as listed in 2000 TRAC Proceedings.

- Determine the effects of the following on NMFS survey indices:
  1) exclusion of survey data from areas south of Georges Bank and
  2) removal of unusually large catches

- Examine the appropriateness of assuming a flat-topped partial recruitment pattern for recent years.

- Review maturity ogives for 5Z and 5Zjm cod and reconcile differences if possible.

b) Recommendations for Georges Bank haddock, as outlined in 2000 TRAC Proceedings:

- Examine options for transformations of survey data to reduce the influence of large tows.

- Explore the use of inverse weighted by the variance of tuning indices relative to VPA formulations.

- Study the reproductive biology and factors affecting changes in maturation schedules.

- Develop consistent methods for inclusion of discards in the construction of the catch-at-age matrix.

c) Recommendations for Georges Bank Yellowtail flounder

- USA catches should be characterized by age/length keys dis-aggregated by sex if feasible
- The TAWG and the TRAC should further evaluate biological reference points with particular reference to MSY, including other methods of estimating MSY
- Other biological attributes of the stock should be included in future assessments to help characterize stock status

d) Recommendations for Gulf of Maine cod

- Examine sea sampling and other available data to determine the size composition of 1999 discards,
- Examine spatial aspects of 1999 discard rates with respect to perceived differences in density of cod between inshore and offshore regions of the Gulf of Maine,
- Examine VTR data to evaluate the level of fishing effort applied to Gulf of Maine cod in 1998 and 1999, and
- Examine the VTR data for the presence of outliers with respect to discard rates.

e) Recommendations for witch flounder:

- Examine inconsistency between VPA biomass and survey biomass trends in recent years.

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