I. Georges Bank Winter Flounder by Lisa Hendrickson

1.0 Background

The Georges Bank winter flounder stock was last assessed in November, 2001 at SAW/SARC 34 (NEFSC 2002a). The assessment was based on a biomass dynamics model (ASPIC) (Prager 1995) which incorporated catch (1964-2000) and biomass indices from the NEFSC autumn (1963-2000) and spring (1968-2001) bottom trawl surveys. Model results indicated a reasonable fit to the input data and that yield has been below surplus production since 1994. Relative estimates of mean biomass (B_t/B_{MSY}) declined sharply during 1977-1994, then increased to B_{MSY} in 2000. Relative fishing mortality rates (F_t/F_{MSY}) have been at or below F_{MSY} since 1994. During 2000, the stock was not overfished and overfishing was not occurring.

In 2002, the biological reference points adopted at SAW34 were re-examined and use of the absolute estimates of F_{MSY} and B_{MSY}, rather than survey-based equivalents, were recommended (NEFSC 2002b). In addition, medium term stochastic projections (Prager 1995) were generated for 2002-2008 using bootstrap distributions of stock biomass in 2001 generated from the SAW 34 ASPIC model and assuming $F_{2002}=F_{2001}$ and $F_{2003-2008}=F_{MSY}$. Projected biomass was maintained at B_{MSY} throughout the projected time series with high probability. Projected catch increased to 3,000 mt and was also maintained throughout the projected time series.

2.0 Assessment Results

Stock status was assessed from the results of an updated run of the SAW 34 ASPIC model. Data updates included the addition of NEFSC survey biomass indices from autumn of 2001 and spring of 2002, as well as total landings in 2001.

The sensitivity of catch rate underestimation, due to trawl warp length offsets, during NEFSC surveys conducted between the spring of 2000 and 2002 was also assessed.

2.1 The Fishery

Total commercial landings of Georges Bank winter flounder are predominately from the U.S., but prior to 1977 also included landings from Canadian and distant water fleets. Since 1994, the Canadian proportion of total landings has increased to 5-10%. Total landings peaked at 4,500 mt in 1972 then declined between 1984 and 1995 from 3,900 mt to 800 mt, respectively (Table I1 and Figure I1). Landings have been increasing since 1995 and reached 2,500 mt in 2001.

Discarding of winter flounder occurs in the multi-species otter trawl fishery and the scallop dredge fishery. However, existing data are insufficient to produce reliable estimates of the magnitude or size and age composition of these discards (NEFSC 2002a).

2.2 Research Survey Indices

Relative biomass (stratified mean kg per tow) and abundance (stratified mean number per tow) indices from the NEFSC spring (April 1968-2002) and autumn (October 1963-2001) bottom trawl surveys, as well the Canadian spring bottom trawl surveys (March 1987-2002) are presented in Table I2. Biomass indices from all three surveys are presented in Figure I2. Canadian survey indices were not included in the current assessment because not all winter flounder habitat on Georges Bank is sampled during that survey (NEFSC 2001). Despite considerable variability, both NEFSC series of biomass indices indicate a declining trend during the 1980s and an increasing trend since the early 1990s. The Canadian biomass indices also indicate an increasing trend since 1992. In 2001, biomass indices from all three surveys were above their time series averages.

2.3 Biological Reference Points

The biological reference points for Georges Bank winter flounder are the absolute estimates of F_{MSY} and B_{MSY} from the SAW 34 ASPIC model (NEFSC 2002b). A maximum sustainable yield of 3,020 mt was estimated to be produced by a biomass (B_{MSY}) of 9,355 mt at a F_{MSY} value of 0.32. Threshold F is defined as F_{MSY} (= 0.32) when biomass is greater than B_{MSY} (= 9,355 mt) then declines linearly to zero at 1/2 B_{MSY} (= 4,677 mt). The target fishing mortality rate is defined as 75% of F_{MSY} (= 0.24) when biomass is greater than 9,355 mt then declines linearly to zero at a threshold biomass of 4,677 mt.

2.4 ASPIC Model Results and Stock Status

Fishing mortality rates declined sharply during 1993 and 1999, from 0.71 to 0.14, (Table I3 and Figure I3) and were at or below F_{MSY} (= 0.32) during 1995-2001. Average total biomass has been increasing since 1994 and was slightly above B_{MSY} during 2001 (Figure I4). There was no retrospective pattern in the ASPIC-derived estimates of fishing mortality rates or total biomass (Figure I5). The 2001 fishing mortality rate estimate is 0.25 and the 2001 total biomass estimate is 9,805 mt. Therefore, in 2001 the stock was not overfished and overfishing was not occurring.

2.5 Sensitivity Analyses

Autumn and spring survey biomass indices from 2000-2002 were increased by 10%, 25% and 100% and included in a sensitivity analysis using the updated ASPIC model configuration (Table I4). Relative total biomass and fishing mortality rate point estimates for 2001 and their respective 80% confidence intervals, generated from 1,000 bootstrap iterations, are shown for the nominal run and the three sets of increased survey indices (Figure I6). The ASPIC model produces new reference point estimates with each run, so a solid line is used in Figure I6 to indicate a ratio of the current F_{MSY} and B_{MSY} reference points in relation to those re-estimated for comparison of the sensitivity analysis results (dashed line). Relative fishing mortality rates decreased and relative total biomass increased with increases in the survey biomass indices. However, overlapping confidence intervals indicate there was no significant difference between the nominal run and the three runs that incorporated increased survey biomass indices.

3.0 Projections

Short-term (2002-2005) and long-term (2002-2010) stochastic projections (Figure I7) were performed under a scenario where F_{2002}=15% reduction in F_{2001} and fishing mortality rates for the following years were set at F_{MSY} (= 0.32). Biomass levels above B_{MSY} were projected for 2003-2005 and yields of about 3,000 mt (MSY) were projected for the same time period (Table I5).

4.0 Sources of Uncertainty

1. Exclusion of the discards from the U.S. otter trawl and scallop dredge fisheries results in an underestimation of fishery removals of the younger age classes (ages 0 to 3).

2. Current biomass levels estimated from the ASPIC model may not be reliable because recruitment is implicitly assumed to be a function of stock biomass.

3. U.S. landings are based on prorations of preliminary logbook data which are subject to change.

4. 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.

5.0 Literature Cited

Northeast Fisheries Science Center. 2002a. Report of the 34th Northeast Regional Stock Assessment Workshop (34th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. *Northeast Fish. Sci. Cent. Ref. Doc.* 02-06; 346 p.

Northeast Fisheries Science Center. 2002b. Final report of the working group on re-evaluation of biological reference points for New England groundfish. 231 p.

Prager, M.H. 1995. User's manual for ASPIC: a stock production model incorporating covariates. SEFSC Lab. Doc. MIA

Table I1. Landings (mt) of Georges Bank winter flounder, by statistical area and country, during 1964-2001.

	522-525 561-562	5Ze[2] (521-526 and 541-562)		5Z (521-562)		
YEAR	USA[1]	CANADA	USSR	CANADA	USSR	TOTAL
1964	1,371			146		1,517
1965	1,176			199	312	1,687
1966	1,877			164	156	2,197
1967	1,917			83	349	2,349
1968	1,570	57	372			1,999
1969	2,167	116	235			2,518
1970	2,615	61	40			2,716
1971	3,092	62	1,029			4,183
1972	2,805	8	1,699			4,512
1973	2,269	14	693			2,976
1974	2,124	12	82			2,218
1975	2,409	13	515			2,937
1976	1,877	15	1			1,893
1977	3,572	15	7			3,594
1978	3,185	65				3,250
1979	3,045	19				3,064
1980	3,931	44				3,975
1981	3,993	19				4,012
1982	2,961	19				2,980
1983	3,894	14				3,908
1984	3,927	4				3,931
1985	2,151	12				2,163
1986	1,762	25				1,787
1987	2,637	32				2,669
1988	2,804	55				2,859
1989	1,880	11				1,891
1990	1,898	55				1,953
1991	1,814	14				1,828
1992	1,822	27				1,849
1993	1,662	21				1,683
1994	907	65				972
1995	706	54				760
1996	1,265	71				1,336
1997	1,287	143				1,430
1998	1,243	93				1,336
1999	938	104				1,042
2000	1,677	161				1,838
2001	1,945	529				2,474

[1] USA landings prior to 1985 include those from Statistical Areas 551 and 552 and landings during 1994-2001 were prorated from Vessel Trip Reports based on gear, month and state.

[2] Includes landings from statistical areas 521 and 526; outside of the Georges Bank winter flounder stock area.

Table I2. 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 (5Z1-5Z4). Trawl door standardization coefficients of 1.46 (numbers) and 1.39 (weight) were applied to indices from U.S. survey indices conducted prior to 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			1.20	1.82		
1964			1.30	1.82		
1965			2.15	2.05		
1966			5.16	5.66		
1967	*Spring Survey initiated in 1968*		1.79	2.07		
1968	2.70	3.11	1.31	1.07		
1969	3.14	4.29	2.37	2.39		
1970	1.86	2.29	5.62	6.49		
1971	1.84	2.17	1.32	1.26		
1972	4.95	5.32	1.26	1.58		
1973	2.95	3.51	1.22	1.20		
1974	6.05	5.78	1.19	1.46		
1975	1.96	1.41	3.79	2.06		
1976	4.67	3.01	5.99	3.93		
1977	3.79	1.58	4.86	3.99		
1978	7.07	5.06	4.06	3.10		
1979	1.74	2.21	5.07	3.83		
1980	3.22	2.80	1.66	1.87		
1981	3.73	3.75	3.83	2.43		
1982	2.30	1.52	5.30	2.69		
1983	8.41	7.11	2.73	2.36		
1984	5.53	5.60	3.93	2.45		
1985	3.84	2.65	1.98	1.12		
1986	2.00	1.21	3.58	2.18	*Iinitiated in 1987*	
1987	2.80	1.25	0.76	0.89	1.24	1.74
1988	2.93	1.65	4.08	1.27	4.31	2.75
1989	1.30	0.76	1.56	1.05	4.05	1.95
1990	2.80	1.57	0.50	0.35	4.93	2.64
1991	2.40	1.32	0.27	0.14	1.98	1.38
1992	1.42	0.90	0.68	0.38	0.51	0.59
1993	1.02	0.57	1.17	0.66	3.53	1.76
1994	1.29	0.58	0.87	0.58	5.10	2.01
1995	2.61	1.49	2.36	1.34	5.63	1.96
1996	2.31	1.50	1.54	1.76	4.12	2.30
1997	1.61	1.19	1.74	1.53	4.58	3.09
1998	0.76	0.72	1.78	1.57	1.14	1.21
1999	3.83	3.48	1.54	1.76	1.25	1.89
2000	4.42	3.69	2.16	2.66	1.48	2.22
2001	1.29	1.22	2.45	2.51	2.28	2.54
2002	5.05	5.16			3.17	3.85

Table I3. Fishing mortality rates and average total biomass (mt) estimates for Georges Bank winter flounder during 1964-2001.

Year	Fishing Mortality	Total Biomass (mt)
1964	0.26	5,752
1965	0.25	6,883
1966	0.28	7,850
1967	0.27	8,569
1968	0.21	9,420
1969	0.25	10,160
1970	0.26	10,510
1971	0.42	9,978
1972	0.52	8,622
1973	0.38	7,933
1974	0.27	8,340
1975	0.34	8,765
1976	0.20	9,393
1977	0.37	9,630
1978	0.35	9,243
1979	0.34	9,120
1980	0.46	8,589
1981	0.53	7,567
1982	0.43	7,007
1983	0.62	6,327
1984	0.80	4,945
1985	0.51	4,232
1986	0.40	4,454
1987	0.60	4,446
1988	0.76	3,771
1989	0.57	3,313
1990	0.62	3,154
1991	0.62	2,949
1992	0.69	2,688
1993	0.71	2,365
1994	0.40	2,420
1995	0.25	3,089
1996	0.34	3,927
1997	0.30	4,730
1998	0.23	5,823
1999	0.14	7,407
2000	0.21	8,950
2001	0.25	9,805

Table I4. Summary of results from a sensitivity analysis of increases in survey biomass indices using an ASPIC biomass dynamics model for the assessment of Georges Bank winter flounder.

Input Data	U.S. autumn survey, 1964-2001 U.S. spring survey, 1968-2002 Total landings, 1964-2001 (Nominal run)	Nominal run with 10% increase in 2000-2002 survey indices	Nominal run with 25% increase in 2000-2002 survey indices	Nominal run with 100% increase in 2000-2002 survey indices
Total Objective Function	1.959	1.954	1.956	2.055
B coverage	0.923	0.938	0.945	1.130
B nearness	1.000	1.000	1.000	1.000
R^2 in CPUE				
U.S. Autumn Survey	0.34	0.35	0.36	0.41
U.S. Spring Survey	0.23	0.24	0.25	0.29
B1 Ratio	0.57	0.56	0.54	0.47
r	0.66	0.69	0.72	0.86
F_{msy}	0.33	0.35	0.36	0.43
B_{msy} (mt)	9,119	8,742	8,429	7,193
MSY (mt)	3,028	3,036	3,047	3,097
B_{2002}/B_{MSY}	1.10	1.16	1.22	1.38
F_{2001}/F_{MSY}	0.76	0.72	0.68	0.58

Table I5. Short-term stochastic projections of yield (mt) and total biomass (mt), during 2002-2005, for Georges Bank winter flounder assuming F2002=15% reduction in F2001 and F2003-2005 = FMSY.

Year	Yield (mt)	Total Biomass (mt)
2002	2,250	10,250
2003	3,433	11,020
2004	3,323	10,590
2005	3,253	10,310

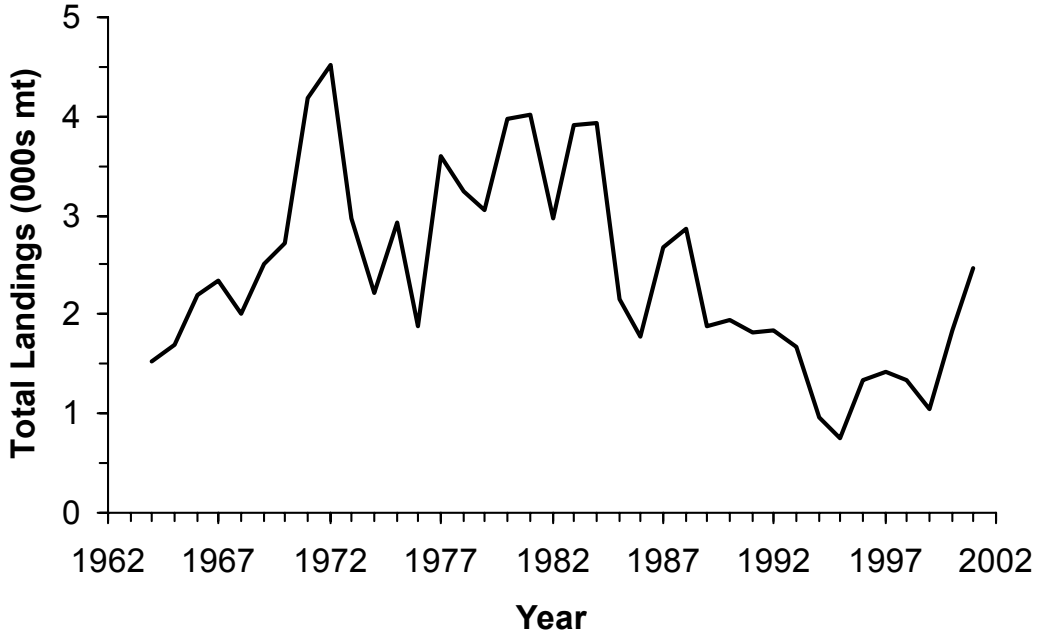

Figure I1. Total commercial landings of Georges Bank winter flounder during 1964-2001.

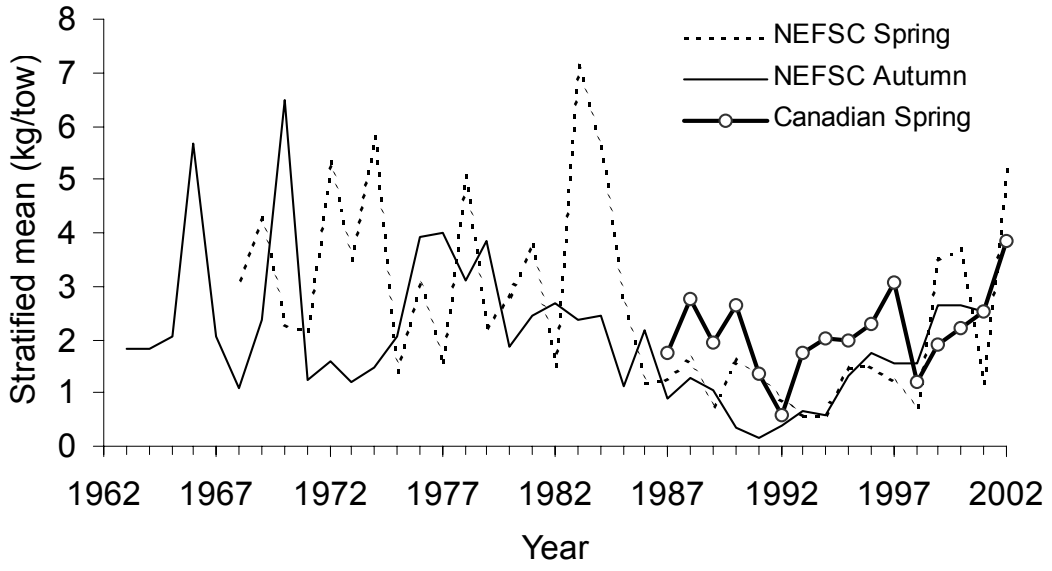

Figure I2. Relative biomass indices (stratified mean kg per tow) of Georges Bank winter flounder from NEFSC spring (1968-2002) and autumn (1963-2001) bottom trawl surveys and the Canadian spring (1987-2002) bottom trawl survey.

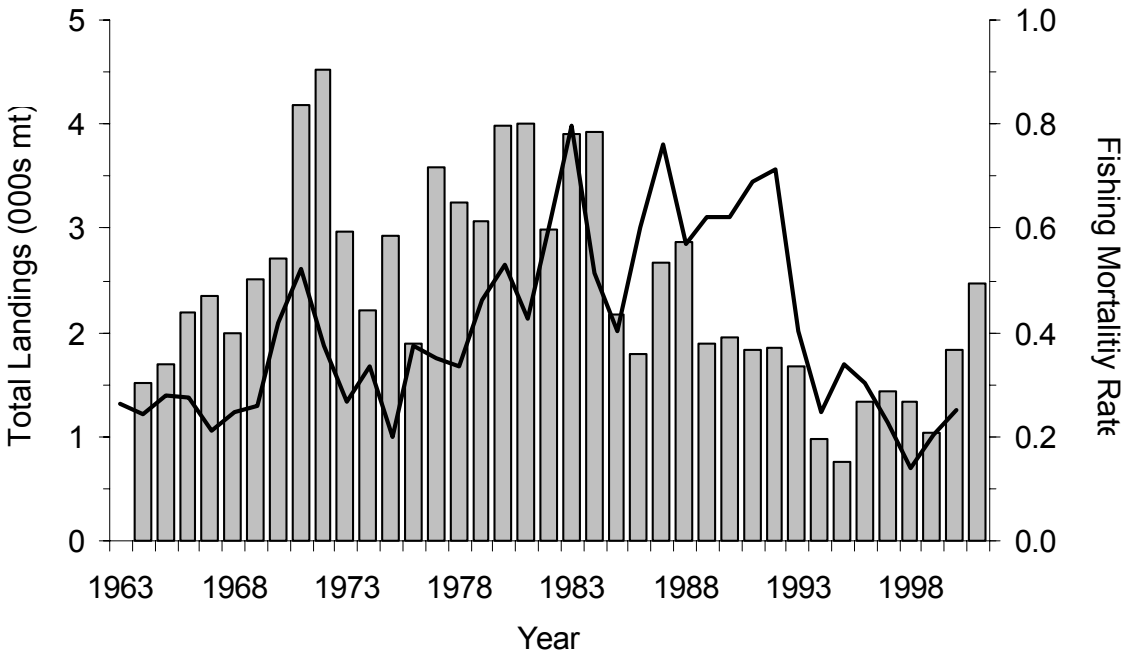

Figure I3. Trends in total landings and fishing mortality rates for Georges Bank winter flounder during 1964-2001.

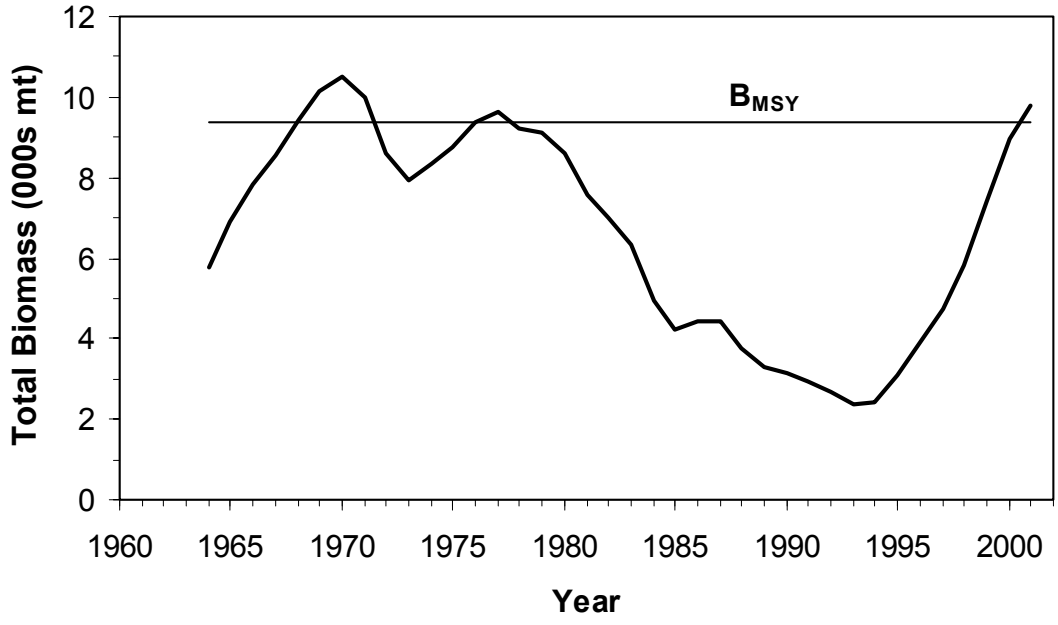

Figure I4. Trends in Georges Bank winter flounder total biomass, estimated from an ASPIC biomass dynamics model, during 1964-2001 in relation to B_{MSY} (9,355 mt).

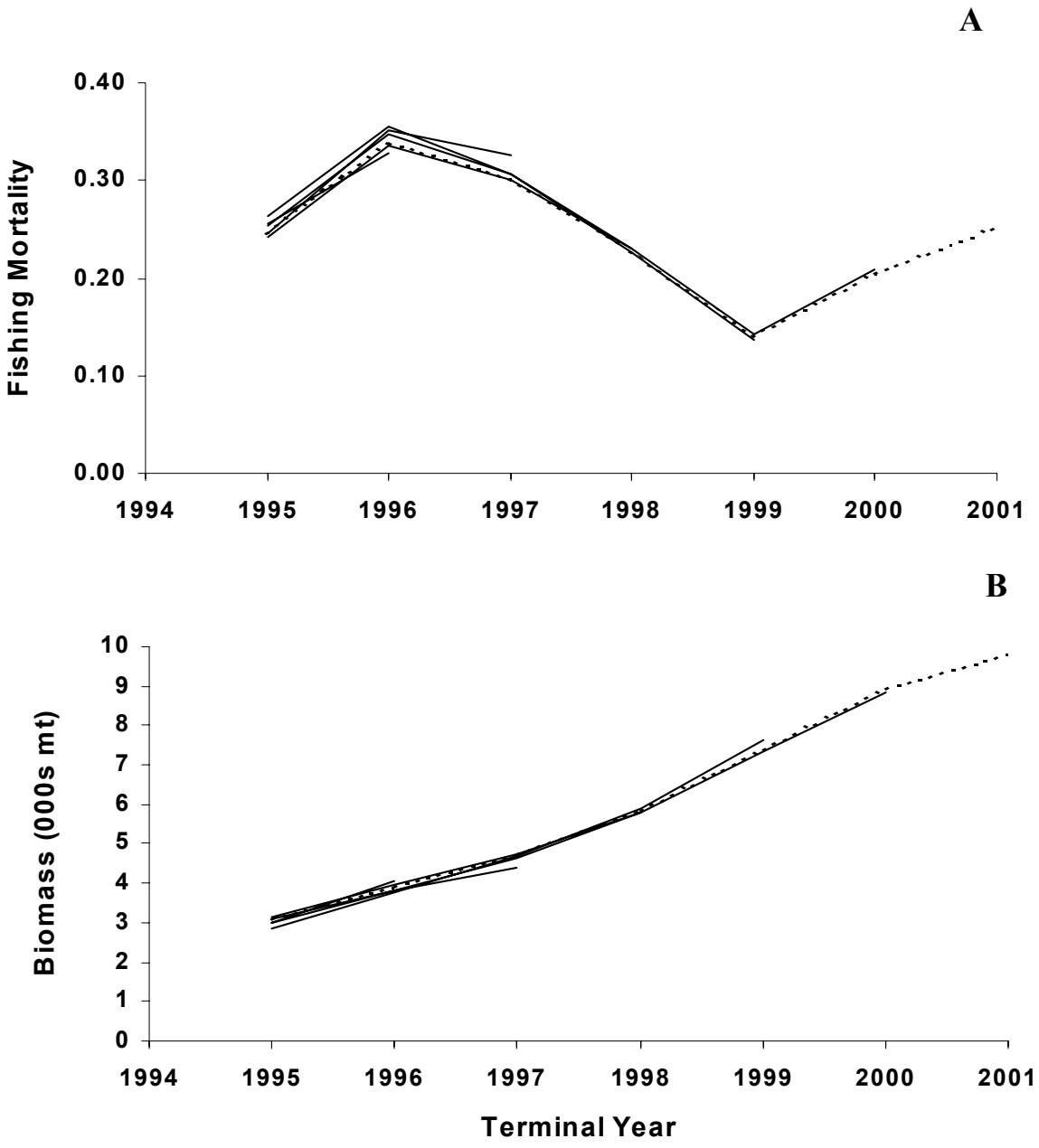

Figure I5. Retrospective analysis of ASPIC-derived estimates of (A) fishing mortality rates and (B) total biomass for Georges Bank winter flounder during 1995-2001.

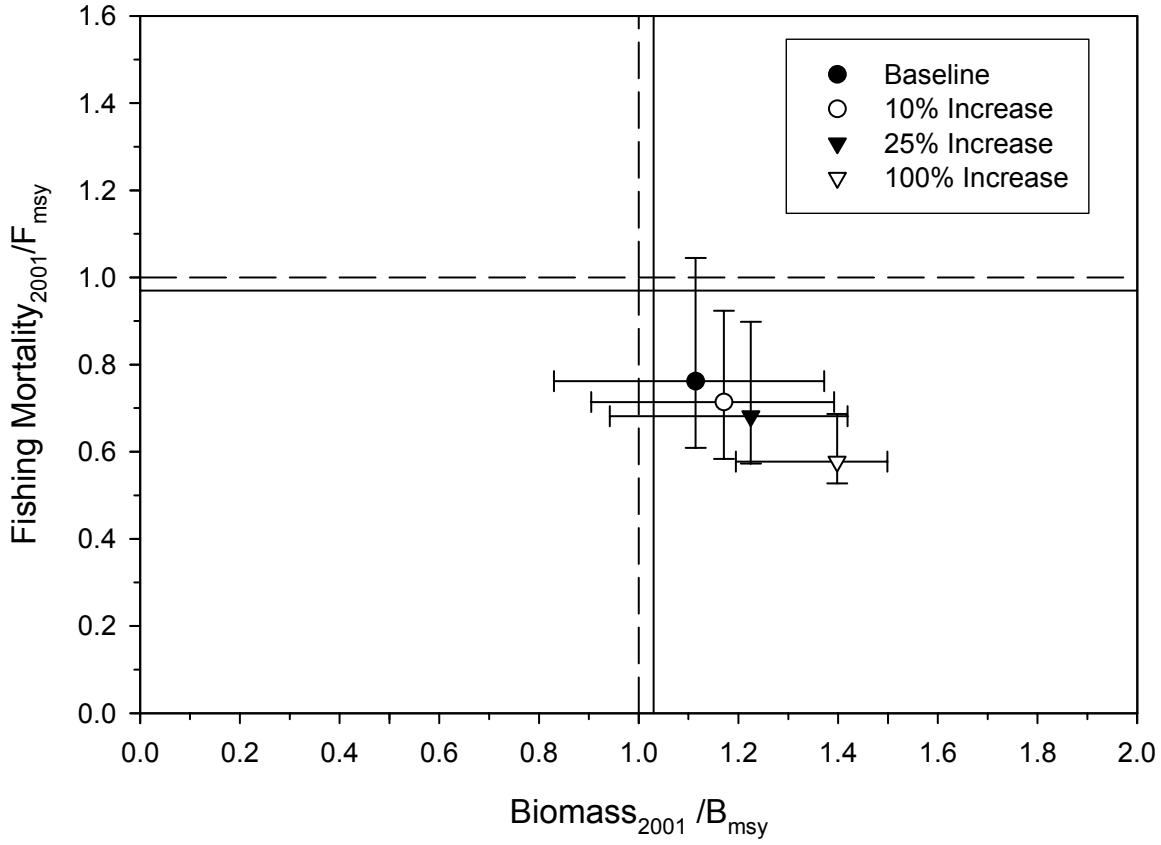

Figure I6. Point estimates and 80% confidence intervals of relative total biomass and fishing mortality rates during 2001 generated from a bootstrapped nominal run of an ASPIC biomass dynamics model and three sensitivity runs, including increased NEFSC survey biomass indices during spring 2000-2002, for the Georges Bank winter flounder stock. Solid lines represent ratios of the current B_{MSY} and F_{MSY} reference points in relation to those re-estimated from the sensitivity analysis (dashed line).

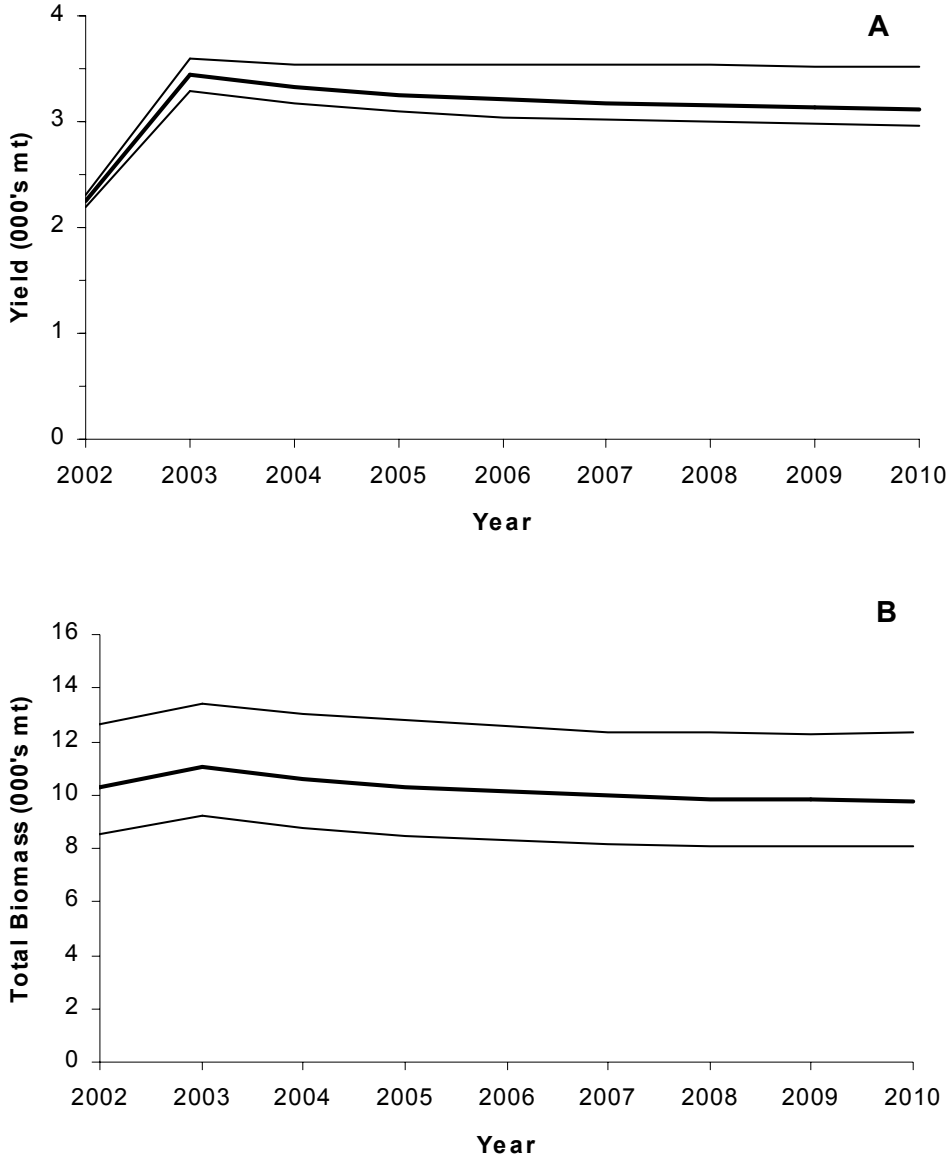

Figure I7. Median and 80% confidence intervals of projected (A) yield (mt) and (B) total biomass (mt) of Georges Bank winter flounder under F_{MSY} fishing mortality rates (F=0.32) during 2003-2010 and assuming F_{2002}=15% reduction in F_{2001}.