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

1.0 Background

The southern New England yellowtail stock was at low biomass and relatively low F in 1999 (SSB was 5,400 mt and fully recruited F was 0.3; Cadrin 2001). This report updates catch and survey indices, and estimates 2001 fishing mortality and 2002 stock size. In August 2002, the Southern Demersal Working Group concluded that southern New England and Mid Atlantic yellowtail flounder should be assessed and managed as a single unit stock, and is concurrently preparing an assessment of the southern New England- Mid Atlantic yellowtail resource (Cadrin 2002). In September 2002, the Working Group reviewed input data, analyses and projections in this report.

2.0 2002 Assessment

2.1 2000-2001 Landings

U.S. landings were prorated as described in NEFSC (1998; Table D1; Figure D1). Landings from southern New England have steadily increased since 1999 (a 9% increase in 2000 and an 11% increase in 2001). Sampling in 2000 and 2001 improved from that in 1999 (Table D2). Although all classified market categories were sampled in each half-year period, the overall number of samples was low. Landings at length for 2001 and 2002 were estimated by half-year and market category. Landings at age for 1999 were revised by assuming the average age distribution for July to December in 1998, 2000 and 2001 for landings in the second half of 1999.

2.2 2000-2001 Discards

Discarded catch was estimated from logbook information on discard to kept ratios by half-year and gear (NEFSC 1998). Discards were 5% of landings by weight in 2000 and 2001. Discards at age were estimated from observer lengths and survey age-length keys, however length distribution of scallop dredge discards were only sampled in the second half of 2000. Those samples were used to characterize all 2000-2001 dredge discards. Total catch at age and mean weights at age are reported in Table D3.

2.3 2000-2002 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, 34, 35, 46), standardized according to net, vessel, and door changes (NEFSC 1998). All survey indices of total abundance and total biomass remained low in recent years (Figure D2).

3.0 Assessment Results

3.1 Age-Based Analysis

Results of an updated VPA calibration of southern New England yellowtail are summarized in Table D5. This update uses existing stock definitions, i.e., Southern New England yellowtail flounder is a single stock. This analysis updates the assessment reported by Cadrin (2000) by including 1999-2001 landings and discards, 1999-2000 scallop and fall indices, and 2000-2002 winter and spring indices. Note that a VPA was updated in 2000, but was rejected because of

inadequate sampling of catch at age in 1999 (see Cadrin 2000 for details). Results indicate that fishing mortality increased to 1.58 in 1999, and decreased to 0.54 and 0.46 in 2000 and 2001 (Figure D3). Spawning biomass increased from extremely low levels in the middle 1990s to 1,400 mt in 1999 and 2,000 mt in 2000, but slightly decreased to 1,900 mt in 2001. Retrospective analysis indicates a strong pattern of underestimating F, and overestimating SSB in recent years, but the estimates of 2000 F and SSB were much more consistent than those from 1994-1999 (Figure D4). Bootstrap analysis indicates that abundance was estimated with moderate precision (CV=38-47%). Sensitivity to recent NEFSC survey observations was evaluated by arbitrarily increasing recent NEFSC survey observations by 10%, 25%, and 100% (Figure D7). Results are summarized in Section 5.2 (Summary of Assessment Advice).

Proxies for MSY reference points were derived from yield and SSB per recruit analyses and the assumption of constant recruitment (NEFSC 2002). Assuming that F_{MSY} is approximately $F_{40\%}$ (0.27 on fully-recruited ages) and long-term average recruitment (40.7 million at age-1), MSY=9,000 mt and SSB_{MSY}=45,200 mt. Therefore, despite uncertainty in the assessment, the stock is clearly overfished (2001 SSB= 1,900mt, 4%SSB_{MSY}) and overfishing is occurring (2001 F=0.46, =1.7 · F_{MSY}).

Stochastic projections that assume a 15% reduction in F from 2001 to 2002 and recruitment similar to that experienced in the last decade suggest that the stock cannot rebuild to B_{MSY} by 2009 even if F in 2003-2010 is zero. If the same hindcast recruitment values used to derive the reference points (NEFSC 2002) are assumed for projections, therefore stock is expected to have approximately a 50% chance of rebuilding to SSB_{MSY} by 2009 with an F of 0.10 (Figure D5, Table D6). However, long-term recruitment levels are not likely in the short-term, because SSB is extremely low, and retrospective patterns indicate that projections may be overly optimistic.

3.2 Biomass-Based Analysis

Due to continued low intensity of sampling and resulting problems estimating catch at age, a surplus production analysis (ASPIC) was updated to provide alternative perspectives on stock status. Biomass and F estimates are generally similar to the VPA, but biomass estimates in recent years are substantially greater than those from VPA (Figure D6). Despite the more optimistic perspective from ASPIC, stock biomass in 2001 remains only 15% of the ASPIC estimate of B_{MSY}. Therefore, ASPIC results also suggest that the stock is overfished. Stochastic projections at status quo F in 2002 and F=0 for 2003-2009 indicate a 25% probability of rebuilding to the ASPIC estimate of B_{MSY} by 2009.

4.0 Sources of Uncertainty

- Estimates of recent catch at age may not be reliable due to poor sampling intensity. Therefore VPA and age-based projections 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 2001 biomass levels were lower, and 2001 F greater than reported here.

- 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.

5.0 GARM Discussion

The GARM noted that the Nantucket Lightship Closure does not appear to be helping recovery of this species. Abundance and size structure within the closed area does not appear to be significantly different from outside the area.

The question of what recruitment is appropriate for projections was raised. Using only the recent ten years of recruitment results in zero probability of rebuilding to SSB_{MSY} because these recruitment values are so low. Using the entire time series of recruitment for projections does allow for rebuilding with F greater than zero. The GARM suggested that an interim rebuilding target may be derived from short-term recruitment (average=2.4 million) and 40% maximum SSB per recruit. The expected biomass at $F_{40\%}$ and short term recruitment is 2,700mt SSB, and current SSB is approximately 70% of the proposed interim target.

It was suggested that a jackknife approach be used to quantify the uncertainty in the generation of the catch at age.

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.

Cadrin, S.X. 2001. Southern New England yellowtail flounder. In Assessment of 19 Northeast Groundfish Stocks through 2000. NEFSC Ref. Doc. 01-20: 54-66.

Cadrin, S.X. 2002. Stock Assessment of yellowtail flounder in the southern New England - Mid Atlantic area. SAW36 WPA6.

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

NEFSC (Northeast Fisheries Science Center). 2002. Final report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. 19 March, 2002.

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

	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	0.1			0.8
2000	0.7	0.0			0.8
2001	0.8	0.0			0.9

Table D2. Samples of southern New England yellowtail flounder (italics indicate observer lengths).

Number of Fish Sampled

year	half year	unclassified length	large lengths	small lengths	ages	# of observer trips
1993	1	0	347	625	189	11
	2	0	72	234	73	3
1994	1	0	102	133	52	4
	2	0	252	254	143	6
1995	1	0	234	240	121	6
	2	0	94	146	50	3
1996	1	0	0	0	0	0
	2	0	469	691	226	13
1997	1	0	813	803	317	18
	2	0	328	679	133	11
1998	1	49	283	596	202	8
	2	80	0	126	37	2
1999	1	*154*	272	408	333	9
	2	*0*	0	0	0	0
2000	1	*170*	304	103	621	11
	2	*178*	214	177	363	17
2001	1	*249*	191	263	710	9
	2	*263*	175	313	514	9

Table D3a. Catch at age (thousands) of southern New England yellowtail flounder.

	age 1	age 2	age 3	age 4	age 5	age 6	age 7+
1973	188	5056	8299	4673	1716	1517	312
1974	858	28334	4715	5098	2500	950	1217
1975	8840	3779	1497	983	1257	549	471
1976	214	6599	912	245	337	391	355
1977	5442	4771	3973	392	205	253	283
1978	8698	13311	1495	1025	165	34	72
1979	204	19225	8371	1033	428	96	24
1980	988	9998	6342	3619	472	117	31
1981	38	6745	6737	2449	884	128	14
1982	169	35130	13693	1744	404	78	7
1983	2526	18430	38615	3364	376	129	42
1984	510	5731	14843	6661	740	244	21
1985	2230	7015	1516	1312	774	135	31
1986	462	9680	2921	561	324	119	22
1987	1590	3404	2033	803	139	47	9
1988	5899	2050	508	407	101	17	6
1989	24	19215	3103	411	47	3	0
1990	192	2048	42185	2025	79	5	0
1991	445	1607	5050	9489	93	1	17
1992	477	1453	1982	2347	279	11	3
1993	13	423	376	426	124	40	0
1994	9	150	222	165	132	49	1
1995	7	248	163	210	30	4	3
1996	21	305	496	151	29	13	6
1997	1	56	351	150	15	2	3
1998	0	388	478	179	34	5	1
1999	3	72	1446	180	56	13	5
2000	31	456	834	336	12	2	2
2001	1	235	1161	300	84	18	9

Table D3b. Mean weight at age (kg) of southern New England yellowtail flounder catch.

	age 1	age 2	age 3	age 4	age 5	age 6	age 7+
1973	0.210	0.298	0.381	0.420	0.430	0.506	0.611
1974	0.203	0.308	0.359	0.429	0.477	0.476	0.518
1975	0.218	0.290	0.385	0.439	0.436	0.469	0.515
1976	0.228	0.303	0.427	0.528	0.533	0.568	0.603
1977	0.215	0.284	0.385	0.521	0.529	0.484	0.612
1978	0.234	0.296	0.402	0.543	0.710	0.791	0.677
1979	0.189	0.301	0.366	0.476	0.590	0.684	0.679
1980	0.206	0.281	0.384	0.499	0.690	0.891	1.182
1981	0.140	0.262	0.343	0.484	0.619	0.664	0.476
1982	0.226	0.263	0.354	0.502	0.661	0.821	0.956
1983	0.175	0.262	0.341	0.499	0.671	0.829	0.838
1984	0.182	0.239	0.298	0.388	0.497	0.652	0.724
1985	0.183	0.264	0.370	0.428	0.541	0.62	0.867
1986	0.186	0.285	0.335	0.470	0.598	0.617	0.804
1987	0.247	0.268	0.361	0.412	0.542	0.595	0.905
1988	0.270	0.293	0.398	0.501	0.664	0.936	0.937
1989	0.311	0.337	0.389	0.546	0.736	0.959	1.046
1990	0.301	0.327	0.378	0.461	0.800	0.884	0.781
1991	0.206	0.262	0.336	0.414	0.676	0.874	0.594
1992	0.167	0.316	0.367	0.430	0.597	0.779	1.409
1993	0.122	0.358	0.430	0.471	0.645	1.040	0.901
1994	0.108	0.320	0.349	0.416	0.556	0.717	0.949
1995	0.123	0.317	0.410	0.460	0.668	0.883	0.863
1996	0.147	0.374	0.409	0.466	0.585	0.665	0.804
1997	0.143	0.295	0.425	0.495	0.680	0.871	0.926
1998	0.130	0.284	0.399	0.528	0.694	0.790	0.707
1999	0.210	0.320	0.428	0.574	0.806	1.177	1.128
2000	0.020	0.367	0.493	0.587	0.774	0.860	0.904
2001	0.153	0.335	0.412	0.610	0.729	0.919	0.948

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

Mean Number per Tow at Age

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	2.016	1.680	0.672	0.168	0.000	0.000	0.000	4.537	1.444
2001	0.000	0.109	2.535	0.471	0.077	0.000	0.000	0.000	3.192	1.267
2002	0.292	1.750	0.680	0.583	0.097	0.000	0.000	0.000	3.402	0.939
mean	0.587	5.330	5.427	3.157	0.979	0.364	0.076	0.035	15.956	4.288

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

Mean Number per Tow at Age

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
2000	0.223	1.675	0.670	0.335	0.000	0.000	0.112	0.000	3.015	0.988
2001	0.607	0.946	0.207	0.110	0.000	0.000	0.000	0.000	1.870	0.630
mean	5.264	7.471	5.002	2.407	0.843	0.168	0.048	0.013	21.216	4.819

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

NEFSC Winter Survey

Mean Number per Tow at Age

Year	Age 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
2000	0.246	4.540	4.341	1.296	0.000	0.000	0.000	0.000	10.422	3.330
2001	0.026	1.963	14.025	2.848	0.370	0.160	0.027	0.000	19.418	7.944
2002	0.057	4.477	4.024	3.627	0.227	0.057	0.000	0.000	12.467	4.077
mean	0.349	5.750	6.098	2.303	0.440	0.059	0.013	0.000	15.012	4.885

Scallop Survey

Mean Number per Tow at Age

Year	age-1	all
1982	0.406	8.129
1983	0.736	2.435
1984	0.193	0.612
1985	0.783	1.214
1986	0.020	0.581
1987	0.243	0.564
1988	6.133	6.613
1989	0.578	6.468
1990	0.077	0.647
1991	0.680	0.933
1992	0.456	0.653
1993	0.468	0.479
1994	1.020	1.664
1995	0.319	1.828
1996	0.213	1.570
1997	1.383	1.737
1998	1.121	2.383
1999	0.752	1.160
2000	0.360	1.855
2001	0.282	0.451
2002	0.088	0.605
average	0.760	1.939

Table D5a. Stock numbers from VPA for southern New England yellowtail flounder.

STOCK NUMBERS (Jan 1) in thousands -

	1973	1974	1975	1976	1977	1978	1979
1	42144	9234	28866	12910	47571	52422	30090
2	15230	34335	6784	15635	10376	34024	35049
3	19877	7894	2473	2135	6829	4179	15812
4	10100	8765	2197	670	922	1997	2068
5	3810	4041	2563	909	327	400	707
6	3446	1567	1046	961	439	82	179
7	700	1968	883	863	483	172	44
1+	95307	67803	44812	34082	66949	93276	83950

	1980	1981	1982	1983	1984	1985	1986
1	41943	126925	53147	14583	16730	19837	6969
2	24451	33446	103883	43360	9654	13236	14223
3	11300	10973	21280	53266	18824	2719	4489
4	5371	3513	2888	5033	8670	1982	854
5	759	1123	661	786	1077	1071	435
6	192	194	120	175	303	212	177
7	50	21	11	55	25	48	32
1+	84066	176195	181989	117259	55284	39104	27179

	1987	1988	1989	1990	1991	1992	1993
1	13987	121992	16399	6852	3535	1969	850
2	5287	10013	94541	13405	5436	2491	1180
3	2886	1249	6343	60017	9122	2997	725
4	1032	524	563	2385	10967	2899	660
5	192	119	60	89	121	393	250
6	63	31	06	07	01	15	69
7	12	11	00	00	22	04	00
1+	23459	133937	117911	82754	29203	10767	3735

	1994	1995	1996	1997	1998	1999	2000
1	1606	1509	1425	4145	3108	4887	2319
2	684	1306	1229	1148	3393	2545	3998
3	584	425	845	730	889	2427	2018
4	253	277	200	243	280	295	678
5	155	58	37	27	63	68	79
6	92	07	20	04	09	21	05
7	02	05	09	06	02	08	05
1+	3376	3588	3766	6303	7744	10250	9102

	2001	2002
1	2542	00
2	1871	2080
3	2861	1319
4	898	1292
5	251	464
6	54	130
7	27	42
1+	8503	5326

Table D5b. Fishing mortality estimates from VPA for southern New England yellowtail flounder.

FISHING MORTALITY -

	1973	1974	1975	1976	1977	1978	1979
1	0.00	0.11	0.41	0.02	0.14	0.20	0.01
2	0.46	2.43	0.96	0.63	0.71	0.57	0.93
3	0.62	1.08	1.11	0.64	1.03	0.50	0.88
4	0.72	1.03	0.68	0.52	0.63	0.84	0.80
5	0.69	1.15	0.78	0.53	1.18	0.61	1.11
6	0.67	1.11	0.87	0.60	1.01	0.61	0.90
7	0.67	1.11	0.87	0.60	1.01	0.61	0.90
4,6	0.69	1.10	0.78	0.55	0.94	0.69	0.94

	1980	1981	1982	1983	1984	1985	1986
1	0.03	0.00	0.00	0.21	0.03	0.13	0.08
2	0.60	0.25	0.47	0.63	1.07	0.88	1.39
3	0.97	1.13	1.24	1.62	2.05	0.96	1.27
4	1.36	1.47	1.10	1.34	1.89	1.32	1.29
5	1.16	2.04	1.13	0.75	1.43	1.60	1.73
6	1.12	1.30	1.27	1.68	2.19	1.22	1.36
7	1.12	1.30	1.27	1.68	2.19	1.22	1.36
4,6	1.22	1.61	1.17	1.26	1.84	1.38	1.46

	1987	1988	1989	1990	1991	1992	1993
1	0.13	0.05	0.00	0.03	0.15	0.31	0.02
2	1.24	0.26	0.25	0.18	0.40	1.03	0.50
3	1.51	0.60	0.78	1.50	0.95	1.31	0.85
4	1.96	1.96	1.64	2.78	3.13	2.25	1.25
5	1.62	2.82	1.97	3.99	1.91	1.53	0.80
6	1.73	0.93	0.85	1.63	1.73	1.79	1.01
7	1.73	0.93	0.85	1.63	1.73	1.79	1.01
4,6	1.77	1.90	1.49	2.80	2.26	1.86	1.02

	1994	1995	1996	1997	1998	1999	2000
1	0.01	0.01	0.02	0.00	0.00	0.00	0.01
2	0.28	0.24	0.32	0.06	0.14	0.03	0.13
3	0.55	0.55	1.05	0.76	0.90	1.07	0.61
4	1.27	1.82	1.79	1.14	1.22	1.12	0.79
5	2.84	0.85	2.06	0.94	0.90	2.48	0.18
6	0.89	0.91	1.22	0.86	1.00	1.14	0.65
7	0.89	0.91	1.22	0.86	1.00	1.14	0.65
4,6	1.67	1.19	1.69	0.98	1.04	1.58	0.54

	2001
1	0.00
2	0.15
3	0.60
4	0.46
5	0.46
6	0.46
7	0.46
4,6	0.46

Table D5c. Spawning stock biomass estimates from VPA for southern New England yellowtail flounder.

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

	1973	1974	1975	1976	1977	1978	1979
1	1056	214	634	349	1156	1348	678
2	2554	2615	899	2482	1493	5415	4871
3	5276	1630	542	630	1544	1228	3617
4	2896	2253	668	262	339	703	648
5	1131	1098	743	358	97	203	242
6	1215	432	315	392	128	46	77
7	298	591	292	373	178	83	19
1+	14427	8832	4091	4846	4936	9028	10152

	1980	1981	1982	1983	1984	1985	1986
1	1022	2125	1435	279	359	411	150
2	3641	5371	15306	5938	1007	1648	1543
3	2613	2115	4048	8354	2152	608	799
4	1396	847	843	1321	1407	451	215
5	297	273	251	355	272	273	116
6	98	69	53	66	73	73	57
7	34	05	05	21	07	23	13
1+	9102	10806	21941	16334	5276	3487	2894

	1987	1988	1989	1990	1991	1992	1993
1	391	3850	610	243	82	35	12
2	575	1795	19510	2763	822	348	233
3	501	349	1609	10949	1863	574	197
4	173	107	142	317	1134	449	170
5	49	22	18	12	34	114	106
6	17	18	04	03	01	05	43
7	05	06	00	00	06	02	00
1+	1710	6148	21892	14288	3941	1526	762

	1994	1995	1996	1997	1998	1999	2000
1	21	22	25	71	48	123	06
2	133	256	274	225	620	547	944
3	146	125	202	204	220	598	696
4	57	55	41	69	82	98	263
5	24	25	08	12	28	18	52
6	42	04	08	02	04	14	03
7	01	03	04	03	01	05	03
1+	424	490	561	586	1003	1403	1967

	2001
1	47
2	401
3	829
4	416
5	139
6	38
7	19
1+	1888

Table D6. Short-term projections of southern New England yellowtail flounder.

Input Assumptions	age 1	age 2	age 3	age 4	age 5	age 6	age 7+
stock weight (kg)	0.129	0.327	0.416	0.517	0.685	0.852	0.887
landed weight (kg)	0.129	0.341	0.419	0.521	0.674	0.858	0.891
discard weight (kg)	0.037	0.309	0.375	0.511	0.667	0.840	0.891
maturity	0.130	0.740	0.980	1.000	1.000	1.000	1.000
partial recruitment	0.010	0.130	0.580	1.000	1.000	1.000	1.000
proportion discarded	1.000	0.330	0.180	0.180	0.180	0.180	0.180

Results

Year	F	Landings (mt)	Discards (mt)	SSB (mt)
2002	0.39	405	92	1931
2003	0.10*	131	30	2647
2004	0.10*	214	54	5482

* assumes long-term recruitment pattern

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

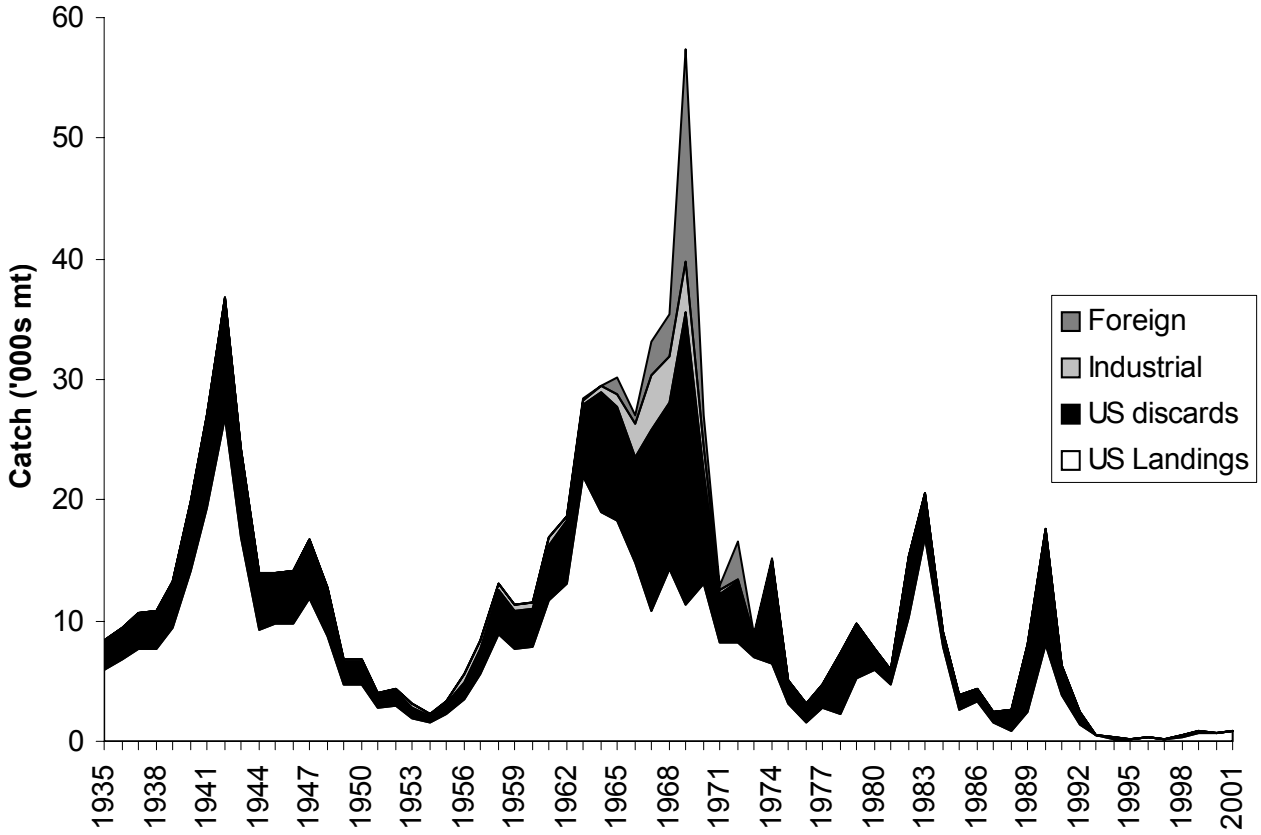

Figure D2. Survey indices of southern New England yellowtail flounder biomass.

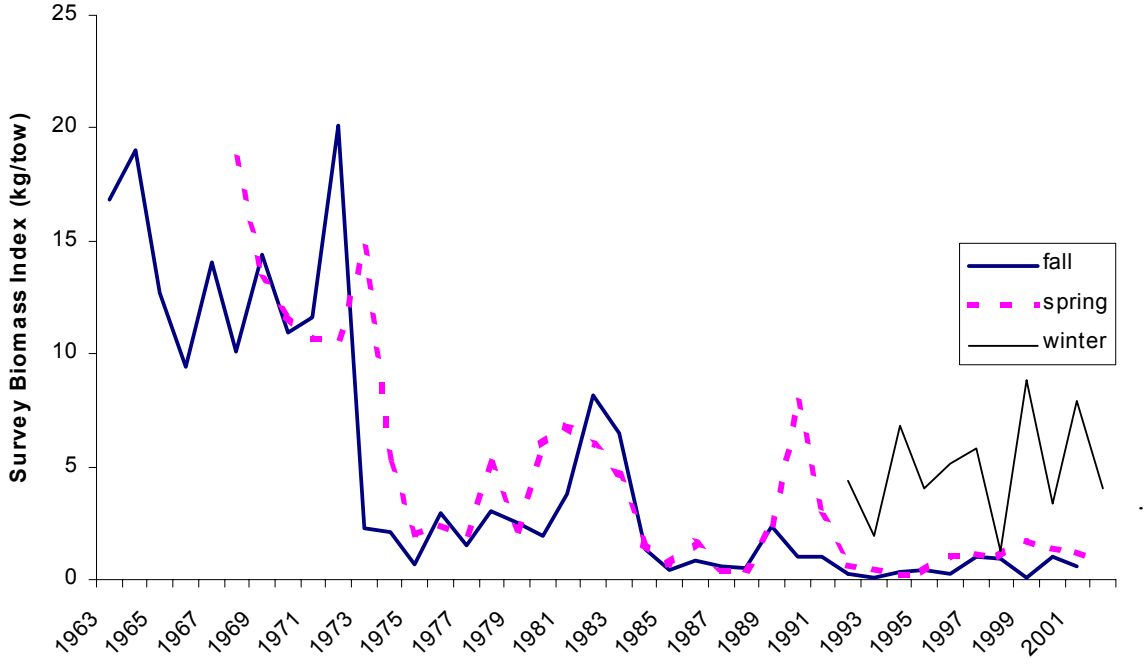

Figure D3a. Estimates of fishing mortality, recruitment and spawning stock biomass for southern New England yellowtail flounder from VPA.

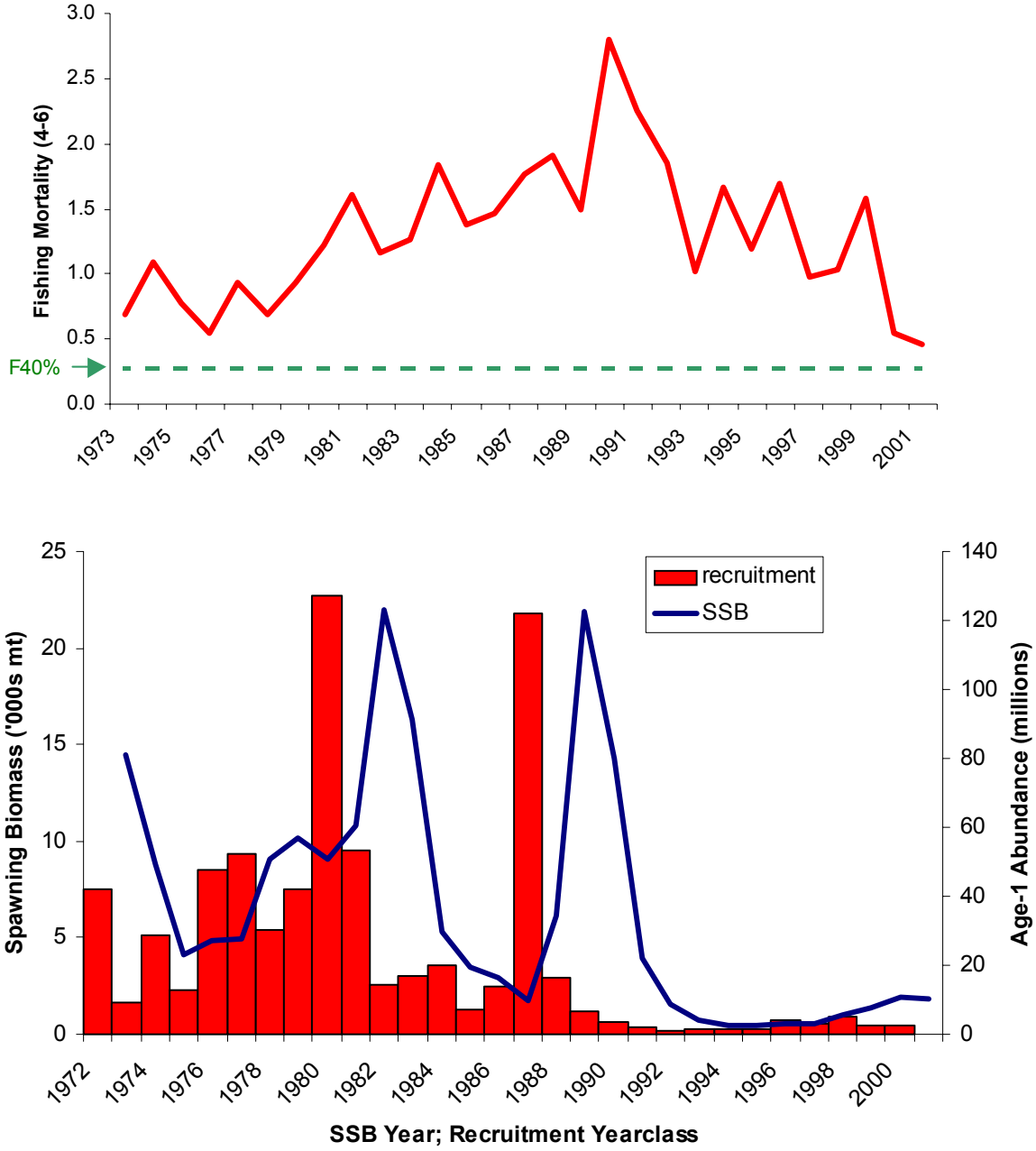

Figure D3b. Abundance at age of southern New England yellowtail flounder.

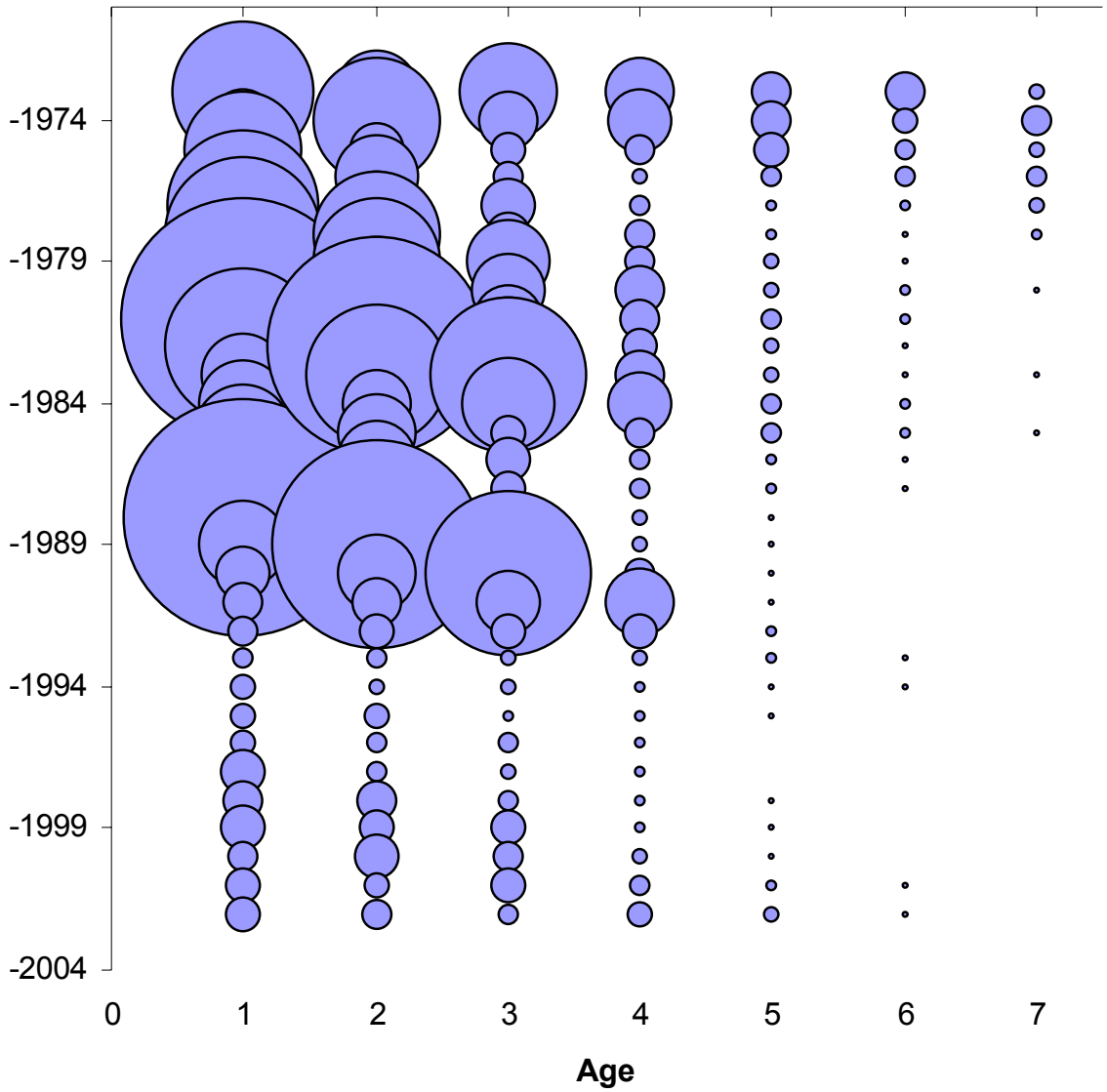

Figure D4. Retrospective analysis of the southern New England yellowtail flounder VPA.

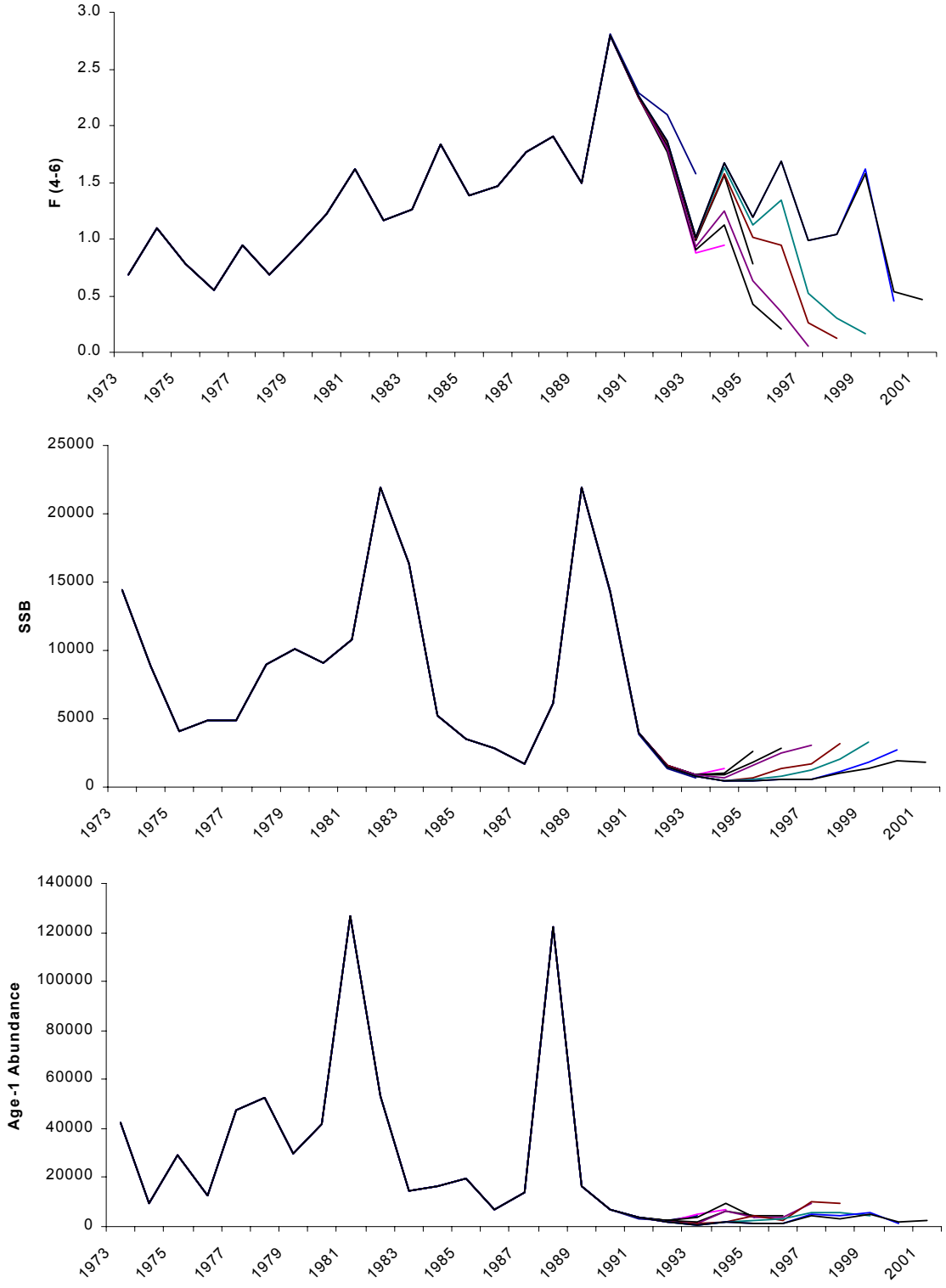

Figure D5. Stochastic projection of spawning biomass and total catch under two scenarios of recruitment and a constant F of $F_{rebuild} = 0.10$

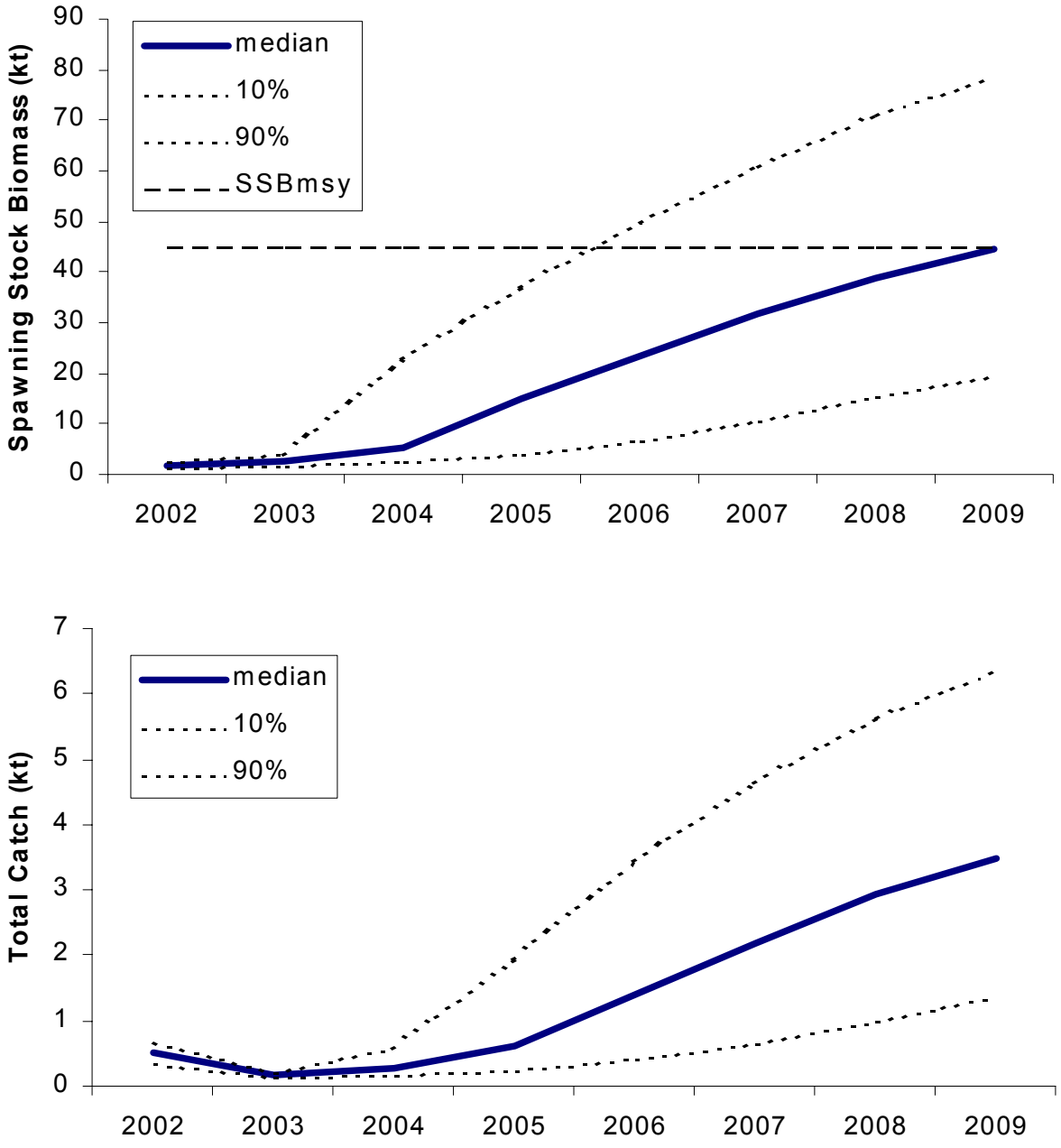

Figure D6. Mean biomass of southern New England yellowtail flounder and fishing mortality on biomass.

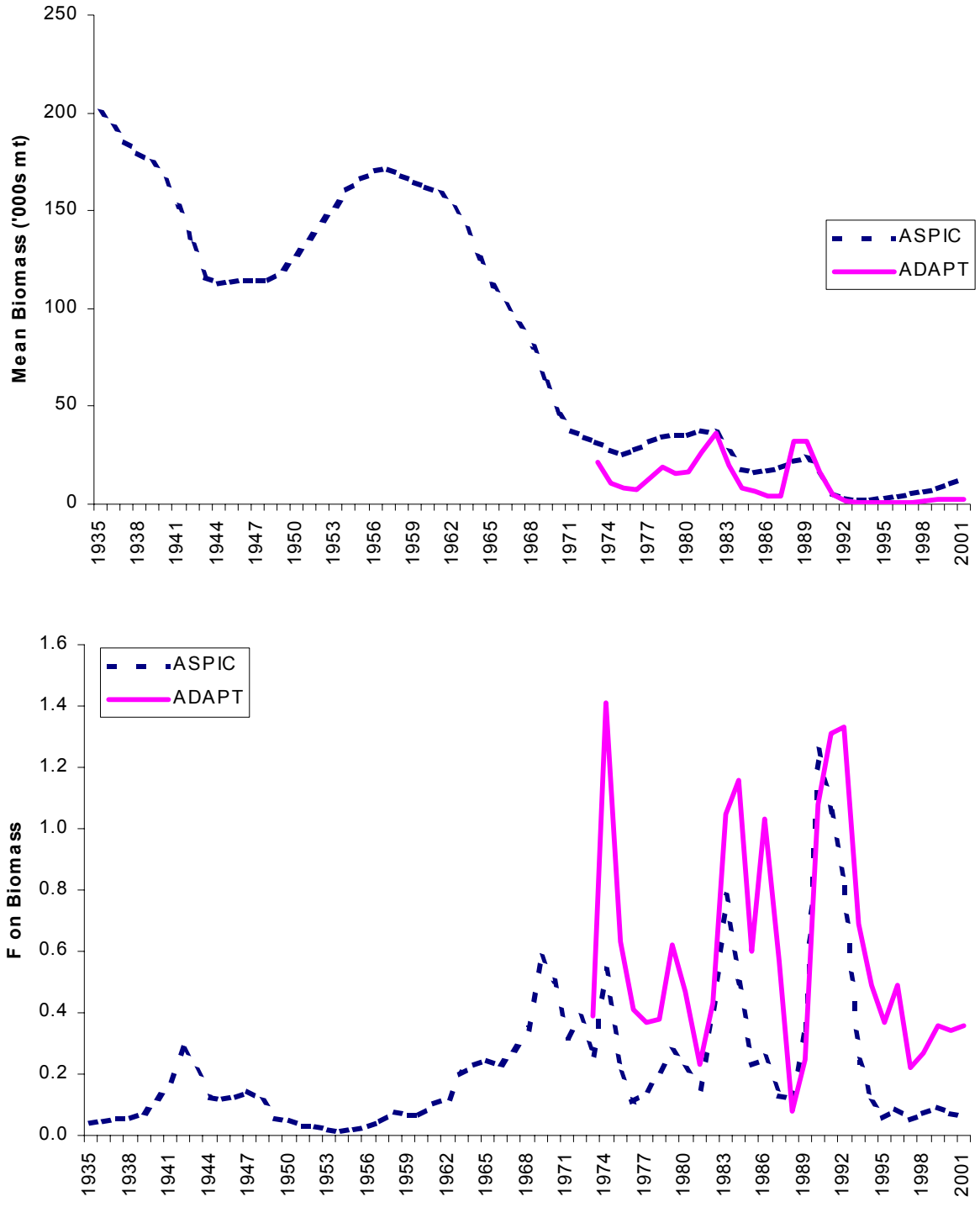

Figure D7. Sensitivity of results to increasing NEFSC indices since 2000 by 10%, 25% and 100% (with 80% confidence intervals). Results accepted by the working group ("WG Run") are shown for comparison.