

## **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 and was overexploited in 1999 (SSB was 1,900 mt and fully recruited F was 0.31; Cadrin and King 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 Cape Cod and northern Gulf of Maine yellowtail flounder should be assessed and managed as a single unit stock, and is concurrently preparing an assessment of the Cape Cod - Gulf of Maine yellowtail resource (Cadrin and King 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 Cadrin et al. (1999; Table E1; Figure E1). Landings from the Cape Cod stock increased from 1,100 mt in 1999 to 2,300 mt in 2000 and to 2,400 mt in 2001. Sampling intensity of landings in 2000 and 2001 improved from recent years. Although all classified market categories were sampled in each half-year period, the overall number of samples was low (Table E2).

#### 2.2 2000-2001 Discards

Estimates of discarded catch for 1998-1999 were revised from those derived from logbook information (Cadrin and King 2001) using observer data by fishery as described by Cadrin et al. (1999). Estimates of 2000-2001 discards were also based on observer data. Discard rates varied between 7% and 19% of total catch for 1998-2001. Discards at age were estimated from sea-sampled lengths and survey age-length keys. Total catch at age and mean weights at age are reported in Table E3.

#### 2.3 2000-2002 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). Three of the four survey series indicate a substantial increase in biomass during 1999 and 2000, but only the Massachusetts spring survey remained high in 2001 and that index sharply decreased in 2002 (Figure E2).

### **3.0 Assessment Results**

Results of an updated VPA calibration of Cape Cod yellowtail flounder (using the existing stock definition) are summarized in Table E5. This analysis updates the assessment reported in Cadrin and King (2001) by including 2000-2001 landings and discards, 2000 fall indices, all 2001 indices, and 2002 spring indices. The Working Group recommended a revised calibration configuration that includes all survey indices for older yellowtail to reduce the bias in estimates of age-5 abundance. Although parameter estimates in Cadrin et al. (1999) were not substantially

biased, the positive bias in age-5 abundance increased in the updated assessments. The 2002 updated assessment initially had a 17% bias, when indices of older ages were excluded, but the bias decreased to 4% when the indices of older ages were included. Therefore, the revised calibration is used as the basis for this assessment. Results indicate that  $F$  increased to nearly 2.0 in 2000 and 2001, and SSB increased to 1,900mt in 2001 (Figure E3). Retrospective analysis indicates a tendency toward greatly underestimate  $F$  in the most recent years (Figure E4). Bootstrap analysis indicates that abundance was estimated with moderate to low precision (CV=33-43%). Sensitivity to recent NEFSC survey observations was evaluated using sensitivity analyses (Figure E6). 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  $F_{40\%}$  (0.21 on fully-recruited ages) and average recruitment (7.89 million at age-1),  $MSY=1,700$  mt and  $SSB_{MSY}=8,400$  mt. Therefore, despite uncertainty in the assessment, the stock is clearly overfished (2001 SSB= 1,900 mt=23% $SSB_{MSY}$ ) and overfishing is occurring (2001  $F=2.0$ , =  $F > 9 \cdot F_{MSY}$ ).

Stochastic projections at 85% of status quo  $F$  in 2002 and  $F_{rebuild}=0.12$  for 2003-2009 indicate there is a 50% probability of rebuilding to  $SSB_{MSY}$  by 2009 (Table E6, Figure E5). However, retrospective patterns indicate that projections may be overly optimistic.

## 5.0 Sources of Uncertainty

- Retrospective patterns indicate that VPA estimates of biomass and  $F$  may be overly optimistic. Updated VPAs may indicate that 2002 biomass levels were substantially lower, and 1999  $F$  substantially greater than reported here. For example, previous assessments concluded that SSB rapidly increased in the late 1990s, but this updated assessment indicates much less rebuilding.
- Estimates of prorated landings and discard ratios are based on preliminary logbook data and are subject to change.
- The limited number of observer samples in small mesh and scallop dredge fisheries imposes considerable uncertainty in discard estimates.

## 6.0 GARM Discussion

The GARM noted that the high  $F$  seems inconsistent with level or increasing SSB and increasing survey indices. Discussion centered on how this could be possible, without the GARM reaching a consensus conclusion. The panel recommends that a cooperative tagging study be conducted to estimate  $F$  and evaluate the possibility of movement patterns out of the stock area that could be causing the estimates of  $F$  to be mis-representative.

It was suggested that the high  $F$  means that the tuning is actually only working on the oldest age group. The estimated catchabilities increase without reaching an asymptote with increasing age.

Ageing does not seem to be a problem with this stock, especially for the young ages in the catch. However, inadequate sampling of the catch could be causing a problem.

The short time series may not be sufficient to adequately estimate stock sizes. The time series is short due to extremely low sampling of catch prior to 1985 and because inshore strata were not sampled in the NEFSC surveys prior to 1979.

The possibility of contributions from the Georges Bank and/or Southern New England stocks of yellowtail flounder to the Cape Cod stock was discussed in terms of both adult movement and recruitment impacts. Given the relative sizes of the stocks, especially the Georges Bank and Cape Cod stocks, any transfer among stocks could overwhelm the signal from Cape Cod.

## **7.0 References**

Cadrin, S.X. and J. King 2001. Cape Cod yellowtail flounder. In Assessment of 19 Northeast Groundfish Stocks through 2000. NEFSC Ref. Doc. 01-20: 67-79.

Cadrin, S.X. and J. King 2002. Stock Assessment of yellowtail flounder in the Cape Cod - Gulf of Maine area. SAW36 WPA7.

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

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

	Landings (mt)	Discards (mt)	Percent Discard	Total Catch (mt)
1960	1,500	500	33	2,000
1961	1,800	600	33	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	259	22	1,428
1999	1,089	107	10	1,196
2000	2,279	163	7	2,443
2001	2,362	447	19	2,810

Table E2. Samples of Cape Cod yellowtail flounder.

Number of Fish Sampled

year	half year	trips	unclass. lengths	small lengths	large lengths	ages
1985	1	5	109	304	196	292
	2	12	0	825	543	357
1986	1	4	0	608	206	217
	2	6	0	321	172	240
1987	1	6	0	300	352	353
	2	5	0	284	269	207
1988	1	6	0	477	267	286
	2	5	0	291	364	252
1989	1	6	10	261	314	305
	2	4	97	262	173	200
1990	1	8	536	532	374	339
	2	6	636	429	276	137
1991	1	8	811	501	332	610
	2	7	109	531	242	277
1992	1	4	707	126	254	339
	2	7	136	262	457	268
1993	1	3	170	145	182	177
	2	3	273	244	74	114
1994	1	4	100	261	170	273
	2	3	0	106	144	149
1995	1	4	39	276	201	196
	2	6	998	392	275	157
1996	1	1	2560	0	87	196
	2	12	118	495	640	485
1997	1	7	343	388	483	556
	2	17	317	996	869	634
1998	1	7	4781	0	508	195
	2	6	165	0	600	165
1999	1	4	2501	278	60	49
	2	4	1024	268	116	57
2000	1	46	521	723	2775	903
	2	15	0	566	1057	395
2001	1	8	3502	251	570	192
	2	16	1950	393	774	436

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

	Total catch at age (thousands)					
	age 1	age 2	age 3	age 4	age 5	age 6+
1985	344	922	734	522	268	99
1986	79	3655	654	250	32	7
1987	14	1486	1954	268	100	46
1988	361	2130	1219	625	172	36
1989	114	2131	1385	233	31	8
1990	81	2738	8692	435	32	26
1991	460	1206	1464	1555	256	61
1992	1688	3881	1538	543	153	12
1993	138	349	857	602	91	46
1994	60	471	1301	699	240	113
1995	453	702	2382	858	154	83
1996	7	547	1425	892	298	18
1997	1	880	1437	819	182	14
1998	56	650	2101	518	151	44
1999	11	481	1321	668	109	48
2000	3	1024	2844	1228	153	38
2001	19	1644	3633	1083	155	39

	weight at age (kg)					
	age 1	age 2	age 3	age 4	age 5	age 6+
1985	0.13	0.28	0.36	0.49	0.60	0.79
1986	0.10	0.25	0.43	0.53	0.73	0.99
1987	0.06	0.24	0.40	0.55	0.65	0.91
1988	0.12	0.21	0.34	0.53	0.70	0.85
1989	0.13	0.27	0.39	0.65	0.92	1.31
1990	0.08	0.26	0.37	0.55	0.82	0.96
1991	0.12	0.23	0.34	0.53	0.73	1.02
1992	0.05	0.13	0.32	0.52	0.61	1.15
1993	0.09	0.16	0.36	0.43	0.74	1.00
1994	0.08	0.22	0.36	0.49	0.62	0.83
1995	0.07	0.22	0.33	0.42	0.61	0.80
1996	0.04	0.19	0.39	0.49	0.53	1.02
1997	0.03	0.31	0.38	0.46	0.57	0.81
1998	0.03	0.27	0.40	0.53	0.62	1.04
1999	0.03	0.33	0.42	0.56	0.57	0.91
2000	0.03	0.37	0.44	0.56	0.61	0.87
2001	0.03	0.32	0.41	0.58	0.74	1.05

Table E4a. Survey indices of Cape Cod yellowtail abundance and biomass.  
 Mean Number per Tow at Age

<b>MADMF Spring Survey</b>				<b>Age</b>					<b>sum</b>	<b>kg/tow</b>
<b>year</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8+</b>		
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	0.83	21.92	33.29	11.28	1.30	0.52	0.00	0.00	69.14	20.37
2001	0.22	10.21	38.20	10.39	1.68	0.00	0.00	0.00	60.71	19.34
2002	0.36	1.29	13.84	5.34	0.26	0.17	0.00	0.00	21.27	7.43
mean	1.91	16.16	10.99	2.67	0.60	0.11	0.04	0.01	32.48	8.44

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

MADMF Fall Survey		Mean Number per Tow at Age									sum	kg/tow
year	0	1	2	3	4	5	6	7	8+			
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	
2000	0.00	1.36	8.25	3.53	0.22	0.10	0.00	0.03	0.00	13.48	3.46	
2001	0.00	0.57	8.06	4.23	0.14	0.00	0.00	0.00	0.00	13.00	3.55	
mean	0.04	6.65	7.88	2.63	0.26	0.04	0.00	0.00	0.00	17.50	3.20	



Table E4c. Survey indices of Cape Cod yellowtail abundance and biomass.

NEFSC Spring Survey		Mean Number per Tow at Age								sum	kg/tow
year	1	2	3	4	5	6	7	8+			
1979	0.36	0.47	0.88	0.56	0.03	0.02	0.00	0.00	2.32	0.76	
1980	0.00	4.76	2.72	0.95	0.19	0.00	0.00	0.00	8.62	3.11	
1981	0.07	4.31	2.92	0.64	0.73	0.35	0.45	0.00	9.46	2.93	
1982	0.05	1.86	4.82	2.47	0.67	0.38	0.42	0.11	10.78	4.57	
1983	2.01	5.39	4.33	1.78	0.19	0.13	0.00	0.00	13.82	4.09	
1984	0.06	1.72	1.02	0.66	0.43	0.04	0.05	0.12	4.10	1.37	
1985	0.13	1.85	1.80	0.43	0.25	0.10	0.00	0.00	4.56	1.39	
1986	0.03	2.99	0.26	0.07	0.17	0.00	0.00	0.00	3.51	0.68	
1987	0.11	2.41	3.61	0.59	0.91	0.92	1.07	0.52	10.13	4.75	
1988	1.48	6.31	1.30	0.85	0.33	0.12	0.06	0.00	10.43	1.68	
1989	0.32	3.83	2.35	0.21	0.10	0.00	0.00	0.00	6.82	1.11	
1990	0.00	3.66	8.87	0.23	0.00	0.16	0.00	0.00	12.93	2.78	
1991	0.66	5.64	3.89	1.23	0.29	0.00	0.08	0.00	11.79	2.51	
1992	0.25	1.50	2.34	0.65	0.03	0.00	0.00	0.00	4.77	1.06	
1993	0.10	1.01	1.17	0.58	0.00	0.00	0.00	0.00	2.87	0.59	
1994	0.54	3.81	1.57	0.61	0.22	0.13	0.00	0.00	6.88	1.15	
1995	0.22	1.41	4.94	3.19	0.31	0.07	0.00	0.00	10.14	2.35	
1996	0.02	0.57	0.79	0.42	0.00	0.00	0.00	0.00	1.81	0.40	
1997	0.03	1.33	2.12	1.71	0.38	0.00	0.00	0.00	5.56	1.56	
1998	0.00	1.14	3.35	1.22	0.28	0.00	0.00	0.00	5.99	1.47	
1999	0.03	1.07	3.44	2.45	0.48	0.18	0.00	0.00	7.65	2.34	
2000	0.48	5.56	21.74	7.49	1.21	1.45	0.00	0.00	37.93	12.39	
2001	0.00	1.92	6.50	1.11	0.34	0.00	0.00	0.00	9.87	3.15	
2002	0.02	2.66	8.15	3.60	0.28	0.04	0.00	0.04	14.80	4.58	
mean	0.29	2.80	3.95	1.41	0.33	0.17	0.09	0.03	9.06	2.61	

Table E4d. Survey indices of Cape Cod yellowtail abundance and biomass.

NEFSC Fall Survey		Mean Number per Tow at Age									
year	1	2	3	4	5	6	7	8+	sum	kg/tow	
1979	5.73	5.84	1.75	0.44	0.08	0.02	0.00	0.00	13.86	3.88	
1980	14.13	12.04	5.46	2.08	0.46	0.00	0.05	0.00	34.21	8.95	
1981	4.20	6.38	1.15	0.30	0.19	0.00	0.00	0.00	12.22	2.60	
1982	0.77	3.67	3.53	0.43	0.48	0.04	0.00	0.00	8.92	2.84	
1983	0.59	0.79	0.50	0.04	0.00	0.00	0.00	0.00	1.92	0.46	
1984	0.43	1.50	0.69	0.87	0.62	0.20	0.10	0.10	4.51	1.77	
1985	6.60	2.54	1.94	0.29	0.00	0.00	0.00	0.00	11.37	2.52	
1986	1.73	4.71	0.40	0.00	0.00	0.00	0.00	0.00	6.83	1.25	
1987	0.73	1.75	0.61	0.07	0.06	0.00	0.00	0.00	3.23	0.72	
1988	4.13	6.04	0.60	0.11	0.00	0.00	0.00	0.00	10.88	1.49	
1989	2.32	7.47	2.75	0.49	0.00	0.00	0.00	0.09	13.12	2.95	
1990	4.67	7.93	3.72	0.06	0.01	0.00	0.00	0.00	16.38	3.05	
1991	2.39	2.23	1.93	0.40	0.00	0.00	0.00	0.00	6.95	1.49	
1992	3.32	3.65	2.54	1.05	0.25	0.19	0.00	0.00	10.99	2.49	
1993	5.86	5.75	0.68	0.10	0.00	0.00	0.00	0.00	12.39	1.38	
1994	3.23	9.64	3.47	0.95	0.29	0.00	0.00	0.00	17.57	3.46	
1995	0.79	1.09	1.05	0.23	0.05	0.00	0.00	0.00	3.21	0.93	
1996	1.41	3.64	5.96	1.57	0.18	0.00	0.00	0.00	12.75	3.31	
1997	1.39	3.23	3.67	1.66	0.90	0.15	0.00	0.00	11.00	2.96	
1998	1.58	4.51	1.90	1.38	0.39	0.00	0.00	0.00	9.76	2.27	
1999	5.27	10.55	6.88	2.12	0.94	0.04	0.00	0.00	25.80	7.64	
2000	1.30	8.81	5.87	0.34	0.00	0.00	0.00	0.00	16.33	4.53	
2001	0.29	4.93	2.92	0.12	0.03	0.03	0.00	0.00	8.31	2.47	
mean	3.17	5.16	2.61	0.66	0.21	0.03	0.01	0.01	11.85	2.84	

Table E5a. Stock numbers of Cape Cod yellowtail flounder from VPA.

STOCK NUMBERS (Jan 1) in thousands -							
	1985	1986	1987	1988	1989	1990	1991
1	9891	4712	6755	21229	7697	6279	9142
2	2702	7787	3786	5518	17054	6199	5067
3	1443	1378	3068	1756	2590	12034	2597
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	25492	19184
	1992	1993	1994	1995	1996	1997	1998
1	7149	7076	5495	4997	6435	5972	7932
2	7068	4326	5668	4445	3681	5262	4889
3	3057	2275	3226	4215	3004	2519	3512
4	802	1112	1088	1464	1295	1170	762
5	221	165	365	258	422	253	217
6	17	82	168	136	25	19	62
1+	18315	15036	16011	15514	14862	15195	17373
	1999	2000	2001	2002			
1	11269	7444	1645	00			
2	6444	9216	6092	1329			
3	3414	4841	6619	3500			
4	974	1600	1390	2132			
5	155	193	199	158			
6	67	46	48	28			
1+	22323	23341	15993	7148			

Table E5b. Fishing mortality estimates for Cape Cod yellowtail flounder from VPA.

FISHING MORTALITY -							
	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
4,5	2.25	0.77	0.81	3.03	1.52	0.82	2.12
	1992	1993	1994	1995	1996	1997	1998
1	0.30	0.02	0.01	0.11	0.00	0.00	0.01
2	0.93	0.09	0.10	0.19	0.18	0.20	0.16
3	0.81	0.54	0.59	0.98	0.74	1.00	1.08
4	1.38	0.91	1.24	1.04	1.43	1.49	1.39
5	1.45	0.94	1.29	1.08	1.51	1.58	1.47
6	1.45	0.94	1.29	1.08	1.51	1.58	1.47
4,5	1.42	0.93	1.27	1.06	1.47	1.53	1.43
	1999	2000	2001				
1	0.00	0.00	0.01				
2	0.09	0.13	0.35				
3	0.56	1.05	0.93				
4	1.42	1.89	1.97				
5	1.50	2.08	1.97				
6	1.50	2.08	1.97				
4,5	1.46	1.98	1.97				

Table E5c. Spawning stock biomass estimates for Cape Cod yellowtail flounder from VPA.

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

	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	66	48	110	91
3	520	488	677	689	641	471	667
4	216	301	293	366	322	267	208
5	68	76	122	92	110	69	67
6	10	51	75	64	12	07	32
1+	859	965	1254	1278	1132	924	1065
	1999	2000	2001				
1	00	00	00				
2	151	238	124				
3	847	1026	1371				
4	278	376	326				
5	44	46	59				
6	30	16	21				
1+	1349	1700	1901				

Table E6. Short term projections of Cape Cod yellowtail flounder.

Input Assumptions	age 1	age 2	age 3	age 4	age 5	age 6+
stock weight (kg)	0.04	0.28	0.39	0.51	0.61	0.92
landed weight (kg)	0.15	0.35	0.41	0.52	0.61	0.92
discard weight (kg)	0.15	0.22	0.30	0.41	0.53	0.75
maturity	0.00	0.08	0.81	1.00	1.00	1.00
partial recruitment	0.01	0.11	0.55	1.00	1.00	1.00
proportion discarded	1.00	0.52	0.20	0.07	0.05	0.04

Results

Year	F	Landings (mt)	Discards (mt)	SSB (mt)
2002	1.67	1651	224	1368
2003	0.12	117	17	1179
2004	0.12	217	31	2463

Figure E1. Total catch of Cape Cod yellowtail flounder.

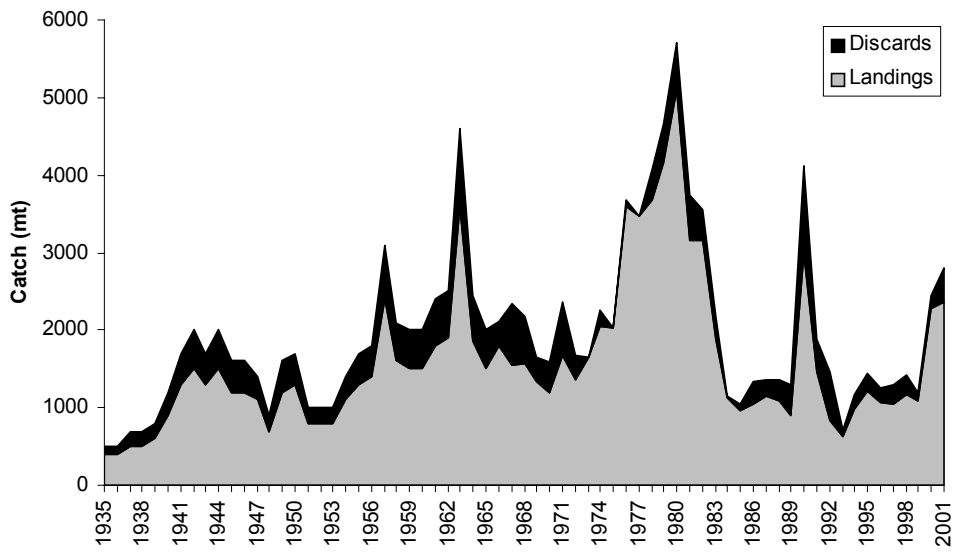


Figure E2. Survey indices of Cape Cod yellowtail flounder biomass.

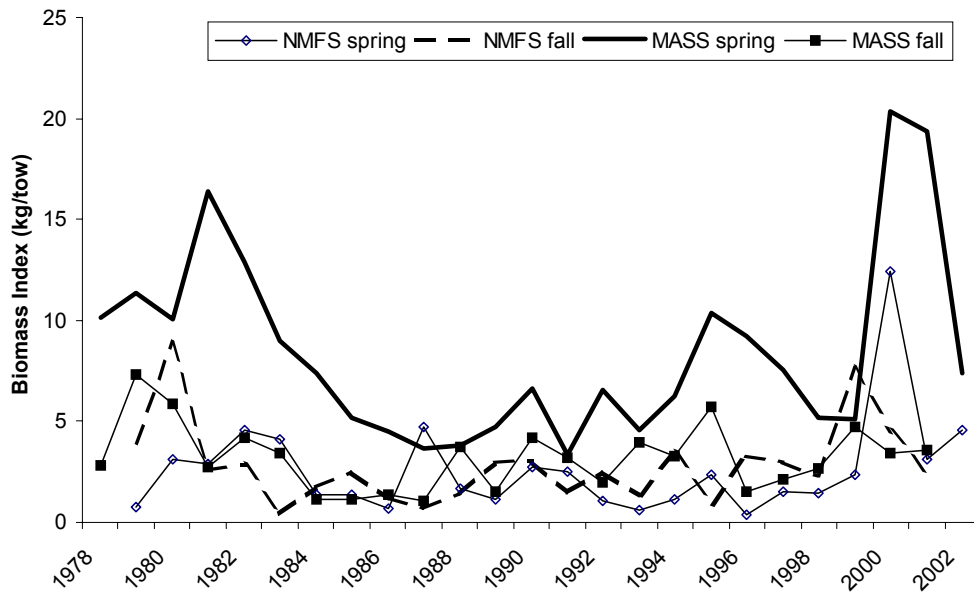


Figure E3. Cape Cod yellowtail flounder VPA results.

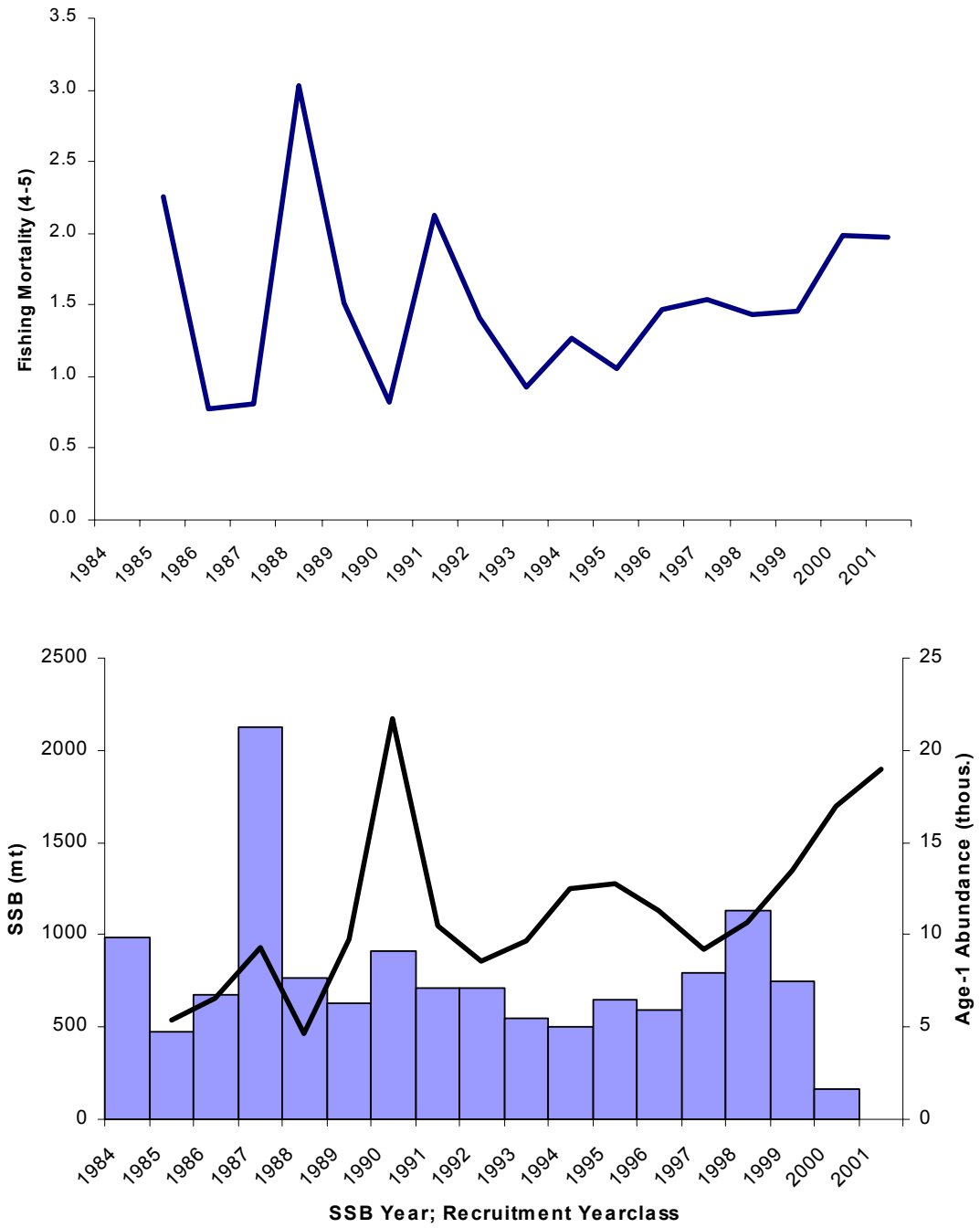




Figure E4. Retrospective analysis of the Cape Cod yellowtail flounder VPA.

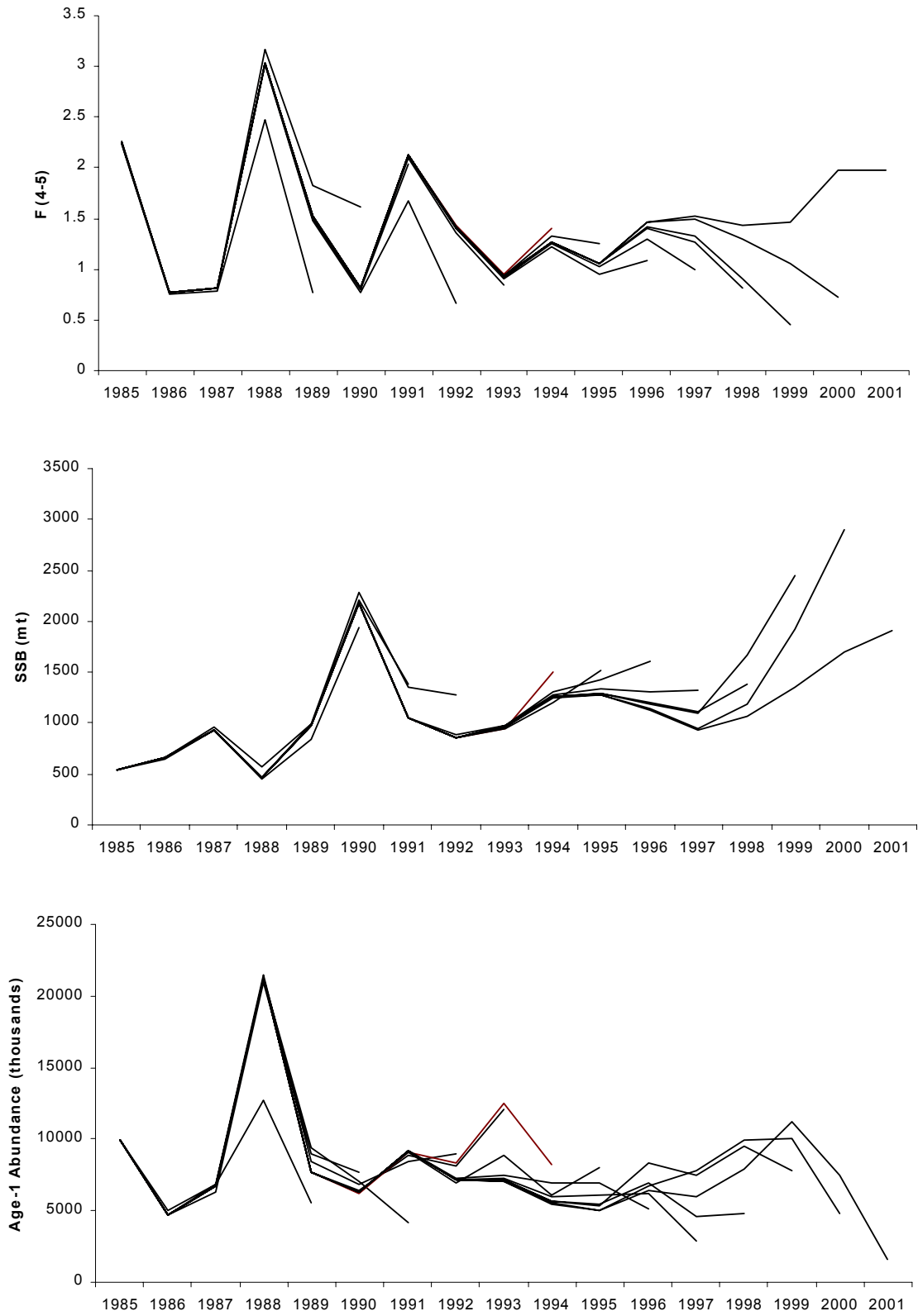


Figure E5. Stochastic projection of Cape Cod yellowtail flounder for  $F_{REBUILD}=0.12$ .

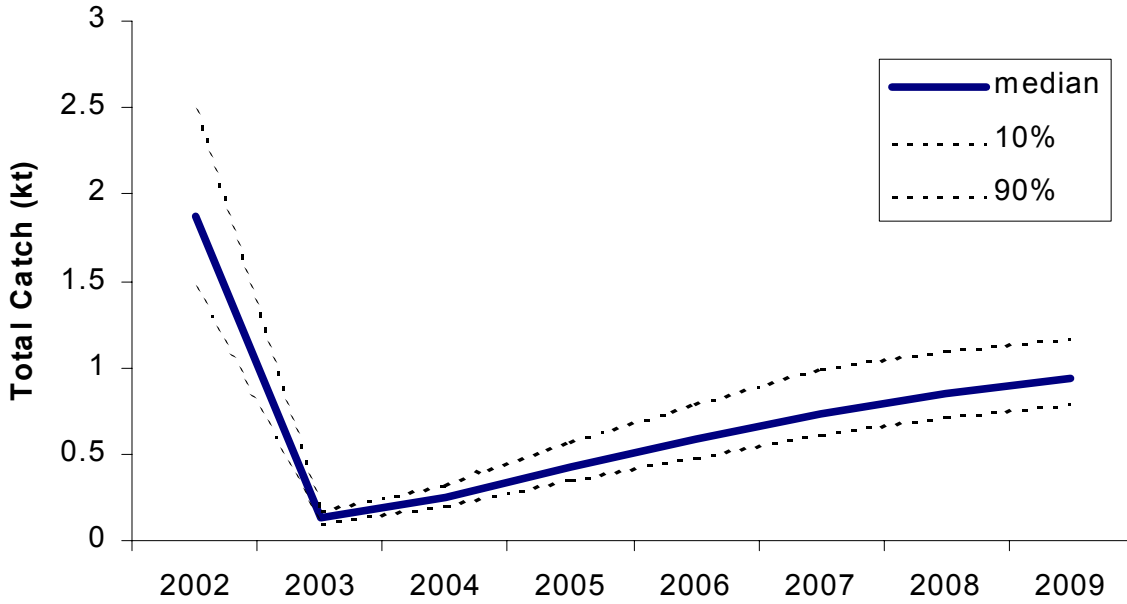
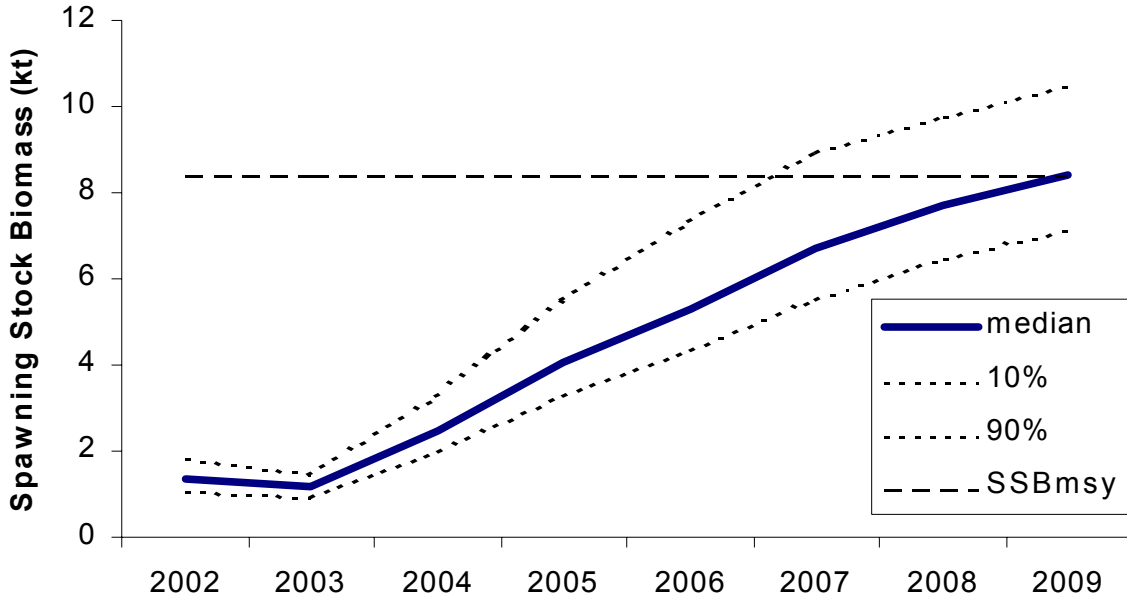


Figure E6. Sensitivity of results to excluding NEFSC survey indices and increasing NEFSC indices since 2000 by 10%, 25% and 100% (with 80% confidence intervals). Results accepted by the working group (“WG Run”) are shown for comparison.

