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

This assessment was completed cooperatively with John Neilson, Stratis Gavaris and Peter Perley, Canada Dept. Fisheries and Oceans, St. Andrews, New Brunswick. Technical review was provided by the Transboundary Assessment Working Group and the Transboundary Resources Assessment Committee.

7.0 References

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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).

Year	Age								
	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

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

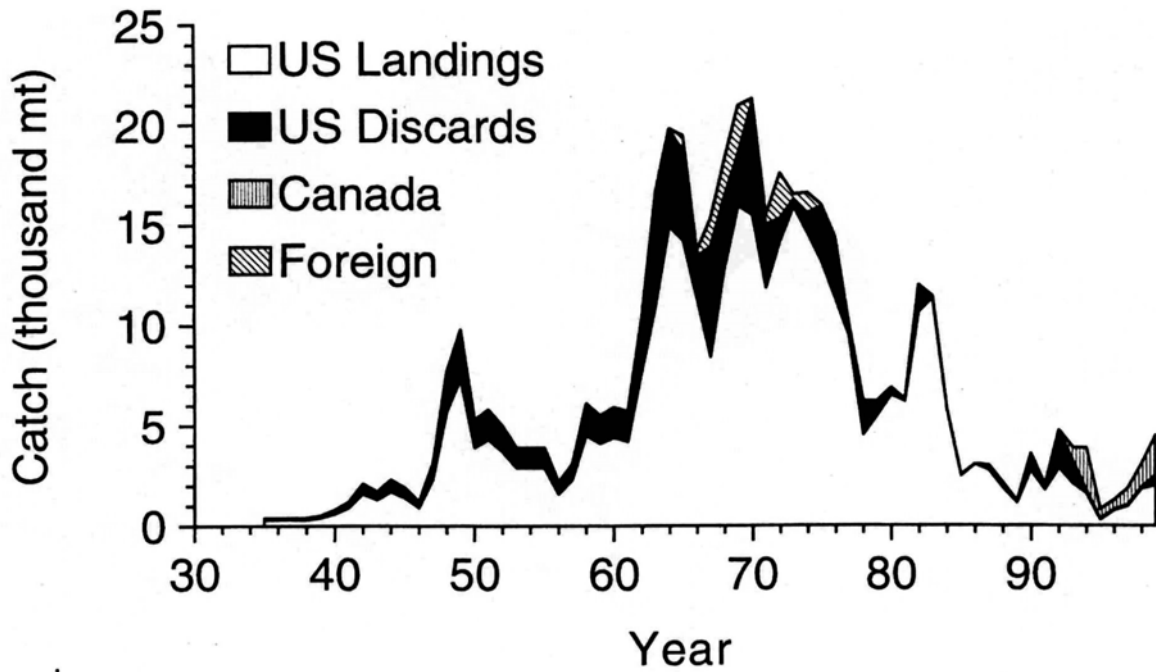|	1994	1995	1996	1997	1998	1999
1	00	00	00	00	00	00
2	646	1276	2296	3559	4140	12745
3	1189	969	2451	4317	5684	8675
4	536	439	923	2547	3865	7374
5	208	103	272	689	1675	3644
6	37	27	31	222	419	1054
1+	2618	2814	5973	11335	15783	33491

Figure C1. Total catch of Georges Bank yellowtail flounder.
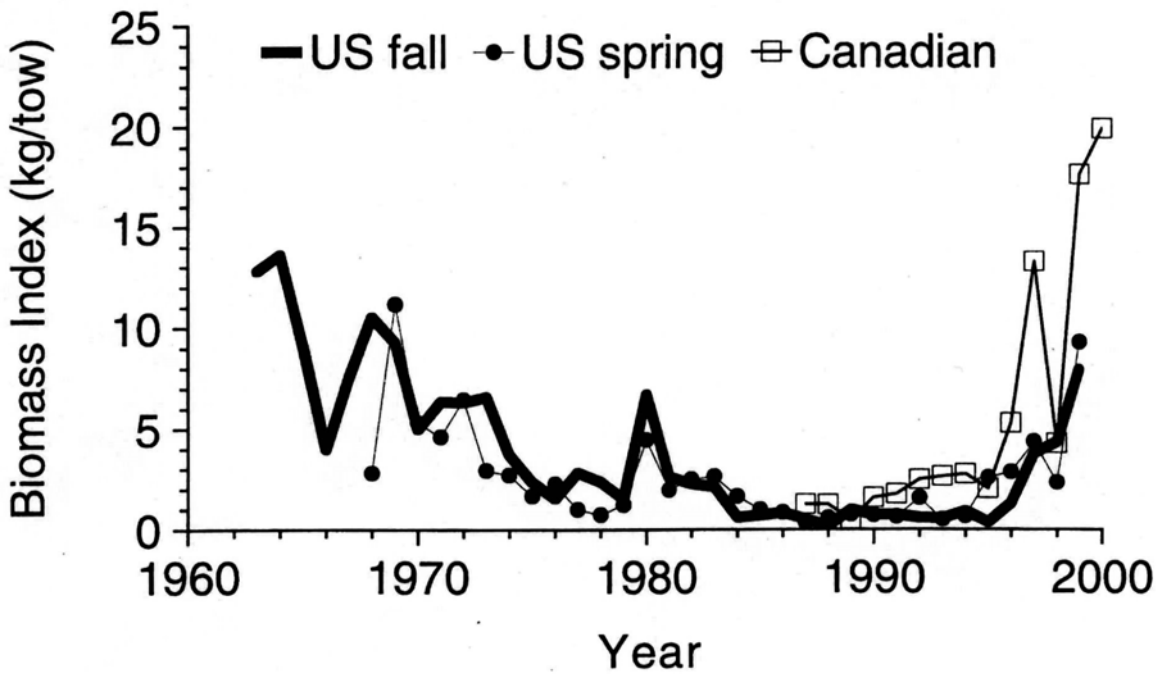

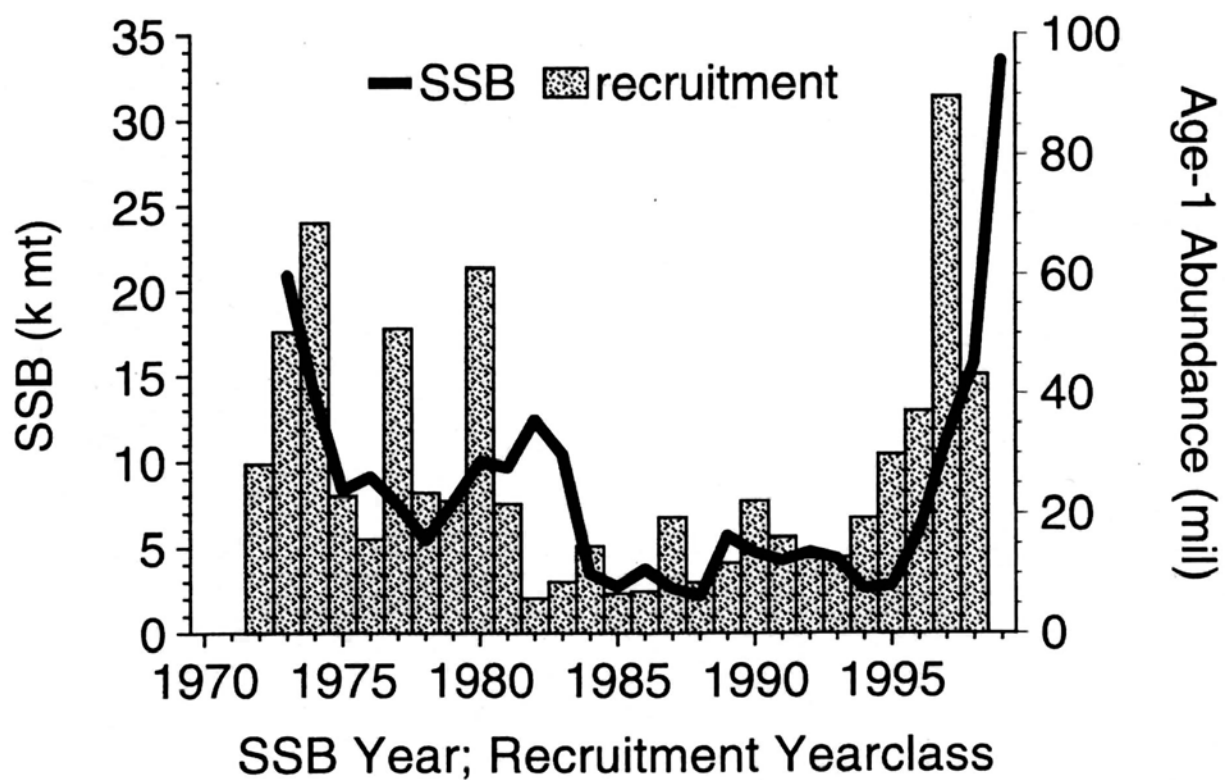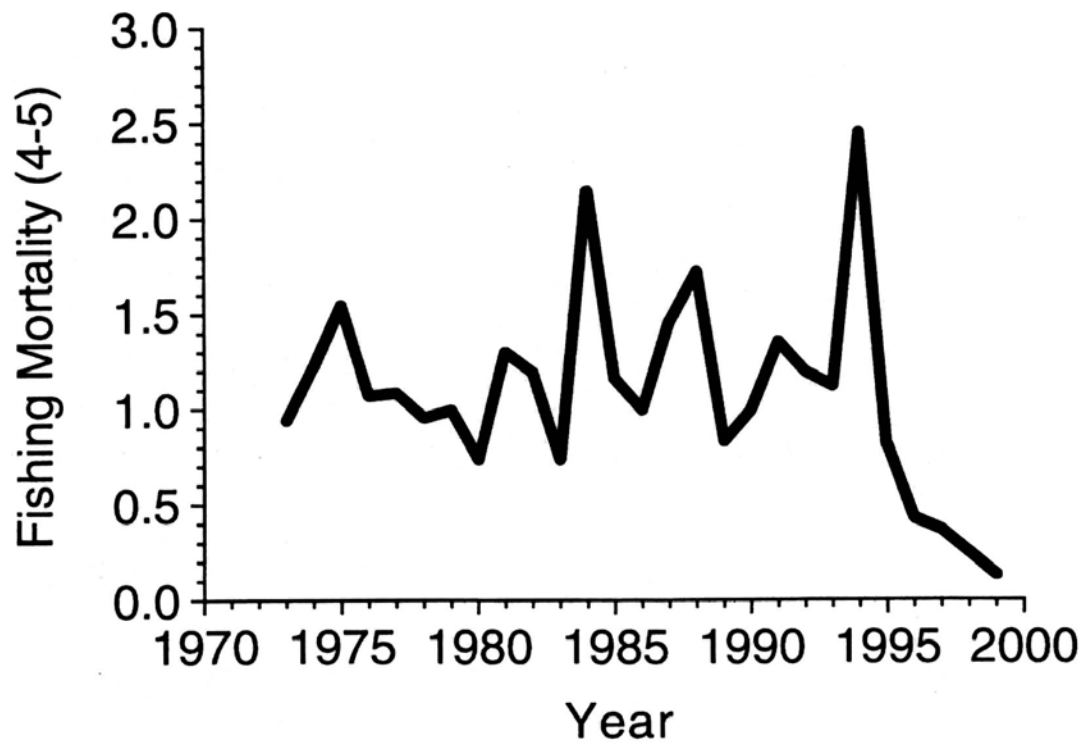Figure C2. Survey indices of Georges Bank yellowtail flounder biomass.

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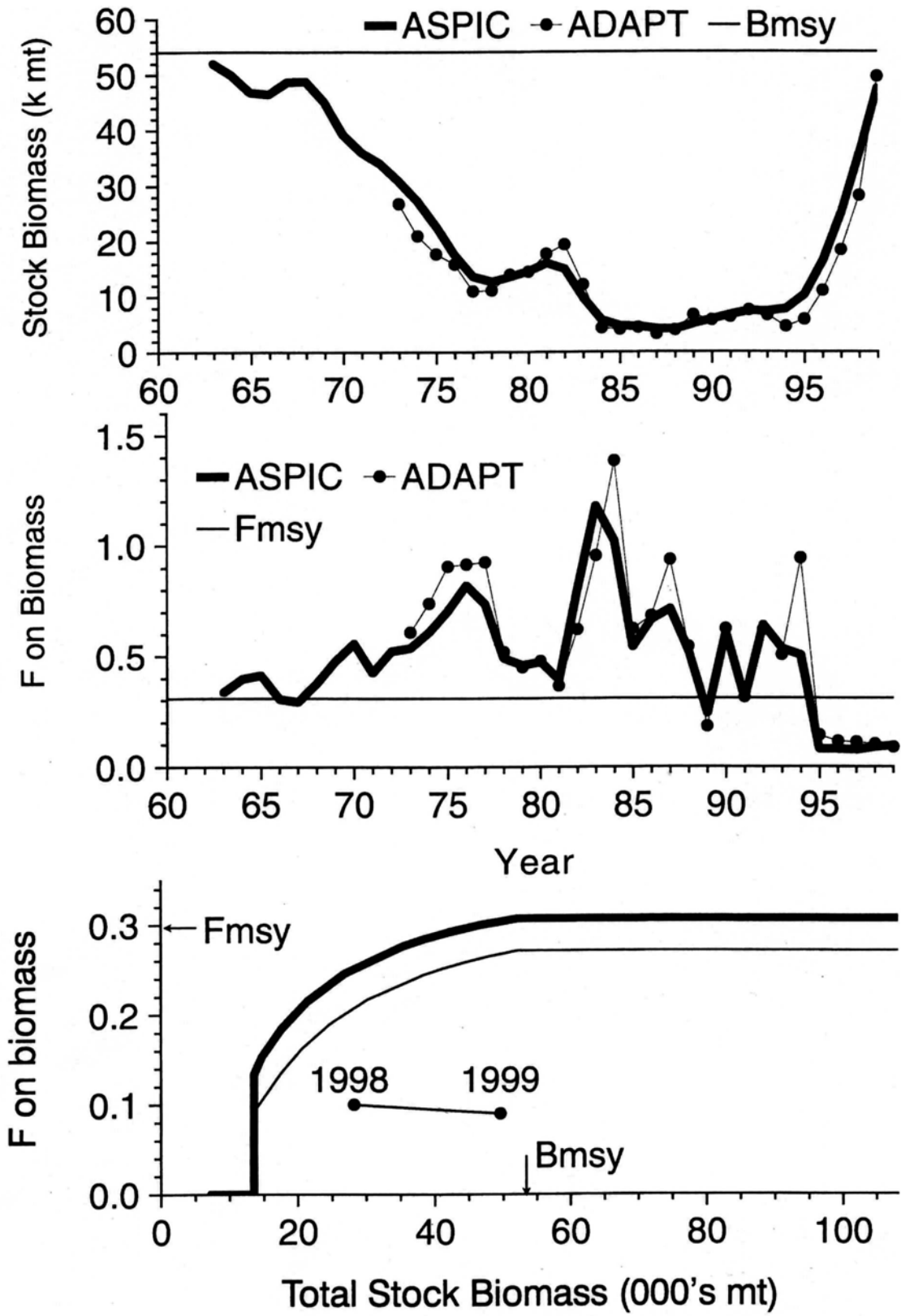Figure C3. Summary of Georges Bank yellowtail VPA results.

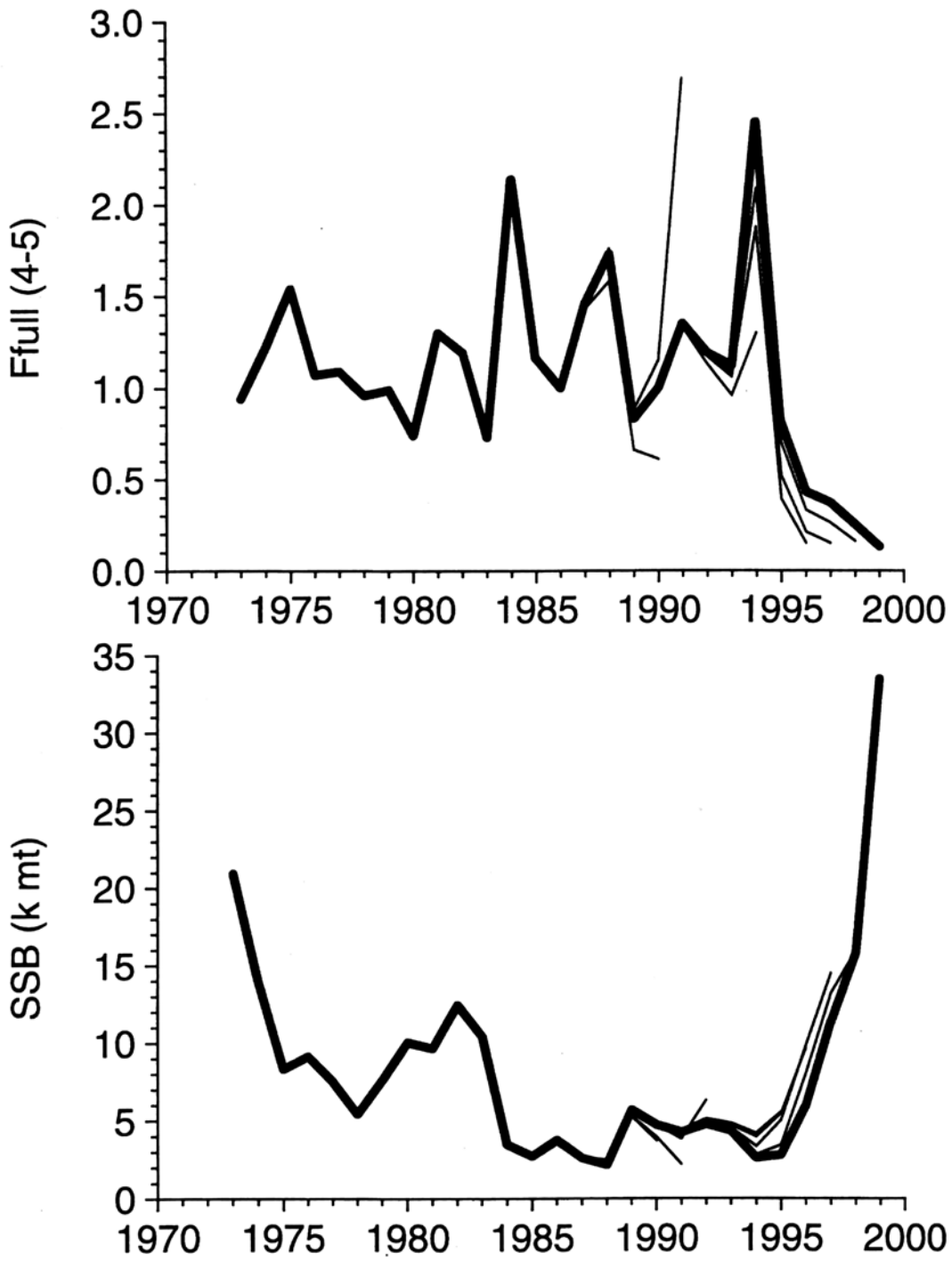Figure C4. Status of the Georges Bank yellowtail flounder stock.

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