

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

1.0 Background

This stock was last assessed in 2001 and reviewed at SAW 33. An ASPIC model was used to estimate stock sizes and fishing mortality. Only fish > 60 cm were included to eliminate species identification as a source of uncertainty. Landings and discards were used in the model, which was tuned with spring and autumn survey biomass indices. Fishing mortality in 2000 was estimated to be more than twice the value for F_{msy} . Biomass estimates were less than $1/4 B_{msy}$. NEFSC spring and autumn research vessel bottom trawl survey indices had declined to near record low levels in 1999 but increased in 2000.

2.0 The Fishery

United States commercial landings of white hake increased to 3,364 metric tons (mt) in 2001, a 16% increase from 2000 (Table K1; Figure K1). Canadian landings declined to 228 mt (9% decline). Discard estimates were derived for 2001 using the same method as in the previous assessment. Discards increased 38% to 439 mt overall (Figure K1). Only otter trawl discards are used in the assessment. Such discards increased to 334 mt (34%).

3.0 2002 Assessment

Landings-at-length were estimated using port samples collected in 2001. The sampling intensity (Table K2) and coverage were adequate, except for the unclassified market category. As in the previous assessment, unclassified landings were low and were raised with the total at the end.

Discards-at-length were estimated using length samples from 2000 and 2001. The otter trawl sampling in the observer program was very low (one sample in the first half) in 2001 so pooling was necessary (Table K3). The possible mis-identification of species is a problem, particularly for estimation of discards. The length compositions of both the landings and discards were broken out into fish ≤ 60 cm and fish > 60 cm (Table K4, Figure K2). This length cutoff ensures that most of the fish > 60 cm are white hake since red hake do not reach this size. For years prior to 1985, an average proportion of fish > 60 cm for 1985-2000 was used to split the landings into two parts (75% > 60 cm). All discards prior to 1989 were assumed to be ≤ 60 cm. The NEFSC surveys were also split into two parts as in the commercial length compositions (Figure K2, Table K6). The rate of decline for the > 60 cm portion of the stock is apparently greater than that for the stock as a whole.

The ASPIC model from the previous assessment using catch of white hake greater than 60 cm was updated .

4.0 Assessment Results

NEFSC research vessel bottom trawl survey abundance and biomass indices for white hake remained relatively low through autumn 1999 (Table K5, Figure K3). Autumn indices increased sharply in 2000 and 2001.

Estimates of F_{msy} and B_{msy} from the > 60 cm ASPIC model changed significantly with the addition of one year of data. The estimated value for r , the intrinsic rate of increase, also changed (from 0.58 to 0.73). This value of r appears to be implausibly high for a gadid species which lives to be 20 years old. Therefore, the GARM did not accept the ASPIC model results.

Since the ASPIC model was not accepted, an alternative was developed. An index of relative exploitation (catch/survey biomass index) corresponding to a replacement ratio of 1.0, as described in NEFSC (2002) was developed for biomass indices and catches of white hake > 60 cm. Autumn NEFSC survey biomass indices from 1963 through 2001 (Figure K2) were used to calculate the replacement ratios, defined as the biomass index in the current year divided by the average biomass indices from the previous 5 years. The biomass indices and total catch (Figure K2) were used to compute the relative exploitation rates, defined as the catch in the current year divided by the 3 year average survey biomass index for the previous 2 years and the current year (Figure K4). These relative exploitation rates (or relative F) may be considered a proxy for F for white hake.

Prior to the 1980s, a high proportion of the replacement ratios equaled or exceeded 1.0 (Figure K4). During the 1980s and early 1990s, most of the replacement ratios were less than 1.0, with ratios greater than 1.0 appearing sporadically. The values for the last two years were greater than 1.0 due to the large increase in the survey biomass index in the last two years.

The relationship between replacement ratios and relative F was evaluated by a linear regression of the \log_e replacement ratio on \log_e relative F (NEFSC 2002) and the results were used to derive an estimate of relative F corresponding to a replacement ratio of 1.0 (Figure K4). Results for white hake were highly significant (NEFSC 2002). The regression indicates that, on average, when the relative F is greater than 0.55, the stock is not likely to replace itself.

The GARM decided to use the value of MSY estimated from the last accepted ASPIC model run at SAW 33. In evaluating this number, the GARM also looked at the relationship between the catches and survey indices. It appears that when catches exceeded 4,200 mt, the survey indices of biomass declined, and when catches dropped below this value, the indices either stabilized or increased. The value of 4,234 mt can then be used to derive B_{MSY} by dividing it by F_{MSY} . This gives a value of 7.70 kg/tow for B_{msy} .

The current value for biomass of 2.35 kg/tow is below that of $\frac{1}{2} B_{msy}$ and indicates that this stock is overfished. Likewise, the relative F value of 1.36 is above F_{msy} indicating that overfishing is occurring.

5.0 Biological Reference Points

The following biological reference point proxies were obtained from an index-based model of replacement ratios (NEFSC 2002) derived from indices of relative exploitation:

MSY	4,234 mt
B_{MSY}	7.70 kg/tow
F_{MSY}	0.55 (Relative F)

6.0 Trawl Warp Analyses

Analyses were conducted to determine the effects of increasing the survey biomass indices for 2000 and 2001 to account for possible trawl warp problems. Results are summarized in section 5.2 (Summary of Assessment Advice).

7.0 GARM comments

The GARM reviewed the ASPIC results for white hake and noted a significant change in the estimate of r from the last assessment. The GARM concluded that the ASPIC model does not provide reliable results for determining stock status and that stock status should be determined directly from the surveys.

8.0 Sources of Uncertainty

- Catch at age and length are not well characterized due to possible mis-identification of species in the commercial and sea sampling data, low sampling of commercial landings, and sparse discard data.
- Catchability of older ages and larger fish in the survey may be low.

9.0 References

NEFSC. 2001. 33rd Northeast Regional Stock Assessment Workshop (33rd SAW). Stock Assessment Review Committee (SARC) Consensus Summary of Assessments. NMFS/NEFSC, Woods Hole Laboratory Ref. Doc. 01-18.

NEFSC. 2002. Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. NMFS/NEFSC, Woods Hole Laboratory Ref. Doc. 02-04.

Table K1. Total Landings (mt, live) of white hake by country from the Gulf of Maine to Cape Hatteras (NAFO Subareas 5 and 6), 1964-2001.

	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	174	2624	0	2798
2000	224	2990	0	3214
2001	203	3482	0	3685

Table K2. Summary of US commercial white hake landings (mt), number of length samples (n), and number of fish measured(len) by market category and quarter from the Gulf of Maine to the Mid-Atlantic (SA 464,465, 511-515,521-526,533-539,611-626) for all gear types, 1985-2001.

Year		small					medium					large					unclassified				All		Sampling Intensity
		Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Total	mt/ sample
1985	mt	129	162	235	167	694	63	78	181	124	446	237	433	1135	623	2428	367	737	1690	988	3782	7349	272
	N	-	2	4	3	9	-	-	-	-	-	-	5	5	3	13	-	1	3	1	5	27	
	#fish	-	233	323	317	873	-	-	-	-	-	-	632	519	271	1422	-	101	293	104	498	2793	
1986	mt	59	134	105	100	398	86	89	55	54	284	274	422	835	417	1948	455	752	1578	694	3478	6107	235
	N	1	3	2	1	7	1	1	-	2	4	1	3	2	1	7	2	2	3	1	8	26	
	#fish	102	263	215	101	681	94	122	-	229	445	122	315	248	96	781	215	206	292	106	819	2726	
1987	mt	98	300	641	576	1616	13	49	122	123	306	171	326	943	372	1813	262	482	1035	301	2080	5814	194
	N	-	2	4	5	11	-	2	1	1	4	-	1	6	3	10	2	1	1	1	5	30	
	#fish	-	240	291	507	1038	-	203	91	109	403	-	111	518	236	865	218	140	112	125	595	2901	
1988	mt	181	549	893	397	2020	26	82	262	120	489	136	330	695	325	1486	73	137	437	134	782	4776	165
	N	5	6	3	5	19	1	1	1	-	3	1	1	2	1	5	-	1	-	1	2	29	
	#fish	558	764	240	478	2040	100	92	105	-	297	112	121	214	85	532	-	100	-	41	141	3010	
1989	mt	149	221	404	358	1132	41	54	124	68	287	188	473	904	470	2035	33	190	774	96	1092	4547	350
	N	1	1	2	2	6	-	-	1	-	1	-	-	2	2	4	1	-	1	-	2	13	
	#fish	91	94	213	195	593	-	-	103	-	103	-	-	206	204	410	100	-	106	-	206	1312	
1990	mt	207	411	885	450	1953	43	108	303	171	625	167	300	596	320	1382	24	182	580	176	962	4922	234
	N	3	4	4	2	13	-	-	2	1	3	2	-	1	1	4	-	-	-	1	1	21	
	#fish	309	408	399	151	1267	-	-	302	99	401	214	-	101	103	418	-	-	-	101	101	2087	
1991	mt	150	366	1215	612	2342	88	160	381	129	758	126	241	533	338	1238	52	358	714	138	1262	5601	156
	N	2	5	6	4	17	1	1	3	1	6	4	1	1	4	10	-	2	1	-	3	36	
	#fish	151	471	485	244	1351	103	100	382	100	685	375	99	96	539	1109	-	207	94	-	301	3446	
1992	mt	424	626	1735	848	3633	102	202	766	358	1428	231	351	699	371	1651	60	280	1246	141	1727	8439	211
	N	4	4	8	3	19	1	4	3	3	11	-	2	3	2	7	1	-	2	-	3	40	
	#fish	329	432	655	240	1656	80	388	266	317	1051	-	194	325	297	816	97	-	237	-	334	3857	
1993	mt	331	502	453	214	1500	161	397	1117	461	2136	173	476	795	416	1860	94	463	975	433	1965	7462	191
	N	2	5	4	1	12	2	3	2	1	8	2	3	7	2	14	-	2	2	1	5	39	
	#fish	150	504	275	50	979	184	309	196	95	784	199	262	676	175	1312	-	214	196	97	507	3582	
1994	mt	63	82	116	56	317	154	374	593	265	1386	206	481	687	407	1782	193	352	457	251	1252	4737	144
	N	-	2	4	1	7	-	2	3	3	8	-	3	4	2	9	-	2	4	3	9	33	
	#fish	-	167	386	100	653	-	230	305	272	807	-	303	363	304	970	-	236	431	372	1039	3469	

Table K2.cont.

1995	mt	39	43	98	56	245	140	238	616	399	1393	197	398	595	374	1564	134	225	504	268	1130	4333	361
	N	-	1	1	1	3	-	2	2	1	5	-	2	-	1	3	-	1	-	-	1	12	
	#fish	-	107	97	105	309	-	191	222	111	524	-	221	-	103	324	-	100	-	-	100	1257	
1996	mt	23	34	80	43	181	96	207	531	269	1103	208	331	416	280	1234	110	152	339	169	769	3287	122
	N	-	-	-	-	-	1	-	4	4	9	-	2	4	5	11	1	1	3	2	7	27	
	#fish	-	-	-	-	-	101	-	435	541	1077	-	202	451	759	1412	127	72	326	220	745	3234	
1997	mt	31	58	124	83	295	76	113	369	193	751	146	146	438	335	1065	34	28	26	26	113	2225	32
	N	4	2	4	2	12	3	7	6	13	29	5	7	7	9	28	-	-	-	1	1	70	
	#fish	458	206	430	261	1355	276	694	564	1200	2734	541	720	678	896	2835	-	-	-	58	58	6982	
1998	mt	31	54	128	105	318	55	77	218	152	502	159	311	571	407	1449	28	23	34	14	100	2370	74
	N	1	2	1	1	5	3	-	3	2	8	7	2	8	1	18	-	-	1	-	1	32	
	#fish	53	220	120	59	452	327	-	402	305	1034	684	213	1311	110	2318	-	-	118	-	118	3922	
1999	mt	50	76	103	87	317	85	110	236	149	580	303	468	633	257	1661	11	14	25	16	66	2624	119
	N	-	-	1	-	1	1	1	3	4	9	1	6	2	3	12	-	-	-	-	-	22	
	#fish	-	-	119	-	119	111	102	315	313	841	166	665	202	327	1360	-	-	-	-	-	2320	
2000	mt	55	70	81	81	286	118	202	289	201	811	293	497	596	446	1833	14	15	20	12	60	2990	120
	N	4	-	-	1	5	5	1	5	4	15	1	1	-	3	5	-	-	-	-	-	25	
	#fish	428	-	-	123	551	527	106	573	450	1656	103	126	-	336	565	-	-	-	-	-	2772	
2001	mt	59	122	167	177	525	131	155	219	310	815	413	497	697	434	2041	10	22	57	12	101	3482	97
	N	2	3	2	2	9	2	1	2	2	7	3	4	7	6	20	-	-	-	-	-	36	
	# fish	231	329	213	224	997	221	100	235	215	771	328	456	797	660	2241	-	-	-	-	-	4009	

Table K3. Summary of Domestic Observer number of number of trips (trips) and number of age samples taken (age) by gear type, half year, and catch disposition, 1989-2001.

		Sink Gill Net						Otter Trawl				Grand			
		Half 1		Half 2		Total		Half 1		Half 2		Total		Total	
		Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc
1989	trips			14	1	14	1	4	10	3	19	7	29	21	30
	len			512	2	512	2	123	916	154	1734	277	2650	789	2652
1990	trips	6		8	1	14	1	3	4	1	5	4	9	18	10
	len	206		1197	32	1403	32	69	53	138	312	207	365	1610	397
1991	trips	20	1	89	7	109	8	2	1	3	2	5	3	114	11
	len	2526	135	9973	30	12499	165	53	180	413	45	466	225	12965	390
1992	trips	34	1	182	4	216	5	7	6	2	4	9	10	225	15
	len	1620	1	8473	4	10093	5	265	17	59	144	324	161	10417	166
1993	trips	26	1	129	10	155	11	8	20	5	2	13	22	168	33
	len	1276	1	4001	13	5277	14	681	333	658	44	1339	377	6616	391
1994	trips	10		81	3	91	3	12	37	8	7	20	44	111	47
	len	44		1835	12	1879	12	247	570	489	294	736	864	2615	876
1995	trips	9	1	117	7	126	8	12	49	9	10	21	59	147	67
	len	167	1	2638	30	2805	31	1111	1375	697	372	1808	1747	4613	1778
1996	trips	11	2	78	2	89	4	8	16	6	13	14	29	103	33
	len	70	13	826	3	896	16	284	526	331	381	615	907	1511	923
1997	trips	8		24	2	32	2	5	9	6	6	11	15	43	17
	len	85		427	4	512	4	117	93	110	64	227	157	739	161
1998	trips	8		31	1	39	1	3	2	1	1	4	3	43	4
	len	36		411	1	447	1	39	17	12	2	51	19	498	20
1999	trips	6		17	3	23	3	1		7	17	8	17	31	20
	len	79		218	20	297	20	23		113	287	136	287	433	307
2000	trips	7	2	5		12	2	7	5	15	10	22	15	34	17
	len	47	9	143		190	9	421	119	475	76	896	195	1086	204
2001	trips	1	1	6	1	7	2	1	1	4		5	1	12	3
	len	15	3	4501	2	4516	5	46	43	2217		2263	43	6779	48

Table K4. Commercial catch of white hake by size group.

Year	> 60 cm			<= 60 cm		
	Landings	Discards	Total	Landings	Discards	Total
1964	2284	0	2284	761	664	1425
1965	1963	0	1963	654	408	1062
1966	1173	0	1173	391	298	689
1967	857	0	857	286	288	574
1968	971	0	971	324	325	649
1969	1037	0	1037	346	370	716
1970	1600	0	1600	533	582	1115
1971	2173	0	2173	724	760	1484
1972	2359	0	2359	786	678	1464
1973	2551	0	2551	850	767	1617
1974	3004	0	3004	1001	731	1732
1975	2864	0	2864	954	536	1490
1976	3224	0	3224	1075	634	1709
1977	4113	0	4113	1371	914	2285
1978	3790	0	3790	1263	862	2125
1979	3224	0	3224	1075	813	1888
1980	3790	0	3790	1263	1049	2312
1981	4817	0	4817	1606	1372	2978
1982	5209	0	5209	1736	1525	3261
1983	5414	0	5414	1805	1923	3728
1984	5828	0	5828	1943	2037	3980
1985	6306	0	6306	1987	2176	4163
1986	6405	0	6405	654	1845	2499
1987	5025	0	5025	1353	1895	3248
1988	3295	0	3295	2041	1444	3485
1989	3944	0	3944	1186	2050	3236
1990	3156	0	3156	2330	4297	6627
1991	3824	0	3824	2347	1350	3697
1992	6147	0	6147	3434	715	4149
1993	5576	0	5576	3583	603	4186
1994	3985	55	4040	1706	177	1883
1995	2185	2	2187	2625	133	2758
1996	2850	0	2850	806	517	1323
1997	2248	75	2323	270	147	417
1998	2421	78	2499	173	160	333
1999	2530	565	3095	269	1509	1778
2000	2999	17	3016	215	263	478
2001	3093	107	3200	593	264	857

Table K5. 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), 1963-2002.

Year	Spring			Autumn		
	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	7.57	6.72	43.8
2001	4.81	5.18	48.4	5.74	7.97	52.7
2002	5.13	6.32	49.0			

Table K6. NEFSC autumn and spring survey indices by size group.

Year	Autumn		Spring	
	> 60	<= 60	> 60	<= 60
1964	3.25	0.89		
1965	4.60	2.26		
1966	4.00	3.67		
1967	1.77	1.85		
1968	2.20	2.34	0.98	0.76
1969	8.38	4.71	3.58	1.52
1970	7.76	5.07	9.12	2.74
1971	8.00	4.10	3.62	1.52
1972	7.04	6.05	8.95	3.71
1973	8.22	5.23	7.01	5.21
1974	8.19	2.80	10.34	3.65
1975	4.46	2.77	7.48	3.74
1976	6.83	3.73	12.90	4.10
1977	9.07	4.67	7.97	3.04
1978	8.46	4.08	4.97	1.17
1979	6.97	3.34	2.83	2.14
1980	11.60	5.06	8.73	5.23
1981	8.44	3.72	13.47	6.45
1982			6.15	2.76
1983	6.06	4.73	1.54	1.58
1984	5.05	3.18	2.68	1.49
1985	5.49	4.24	3.06	2.32
1986	4.38	7.18	2.29	3.32
1987	4.56	5.06	2.56	3.88
1988	5.41	4.48	1.90	1.80
1989	3.84	5.39	1.80	1.42
1990	3.79	6.79	12.14	6.22
1991	4.83	7.37	2.76	3.38
1992	4.14	7.10	2.30	4.81
1993	4.90	6.76	2.68	4.16
1994	2.46	4.56	1.23	1.94
1995	2.96	5.23	1.96	2.06
1996	3.34	3.01	1.77	1.30
1997	2.60	1.95	0.14	0.75
1998	1.64	2.64	0.26	0.84
1999	1.26	2.17	1.43	1.53
2000	2.91	3.81	1.08	2.26
2001	2.89	5.08	2.16	3.02
2002			3.44	1.73

Table K7. Three-year moving average of the NEFSC autumn survey index and the relative F values used in the index-based model of replacement ratios.

Year	Survey Index	Relative F
1965	3.92	0.50
1966	3.95	0.30
1967	3.46	0.25
1968	2.66	0.36
1969	4.12	0.25
1970	6.11	0.26
1971	8.05	0.27
1972	7.60	0.31
1973	7.75	0.33
1974	7.82	0.38
1975	6.96	0.41
1976	6.49	0.50
1977	6.79	0.61
1978	8.12	0.47
1979	8.17	0.39
1980	9.01	0.42
1981	9.00	0.54
1982	9.09	0.57
1983	7.25	0.75
1984	6.12	0.95
1985	5.53	1.14
1986	4.97	1.29
1987	4.81	1.04
1988	4.78	0.69
1989	4.60	0.86
1990	4.35	0.73
1991	4.15	0.92
1992	4.25	1.44
1993	4.63	1.21
1994	3.84	1.05
1995	3.44	0.64
1996	2.92	0.98
1997	2.97	0.78
1998	2.52	0.99
1999	1.83	1.69
2000	1.94	1.56
2001	2.35	1.36

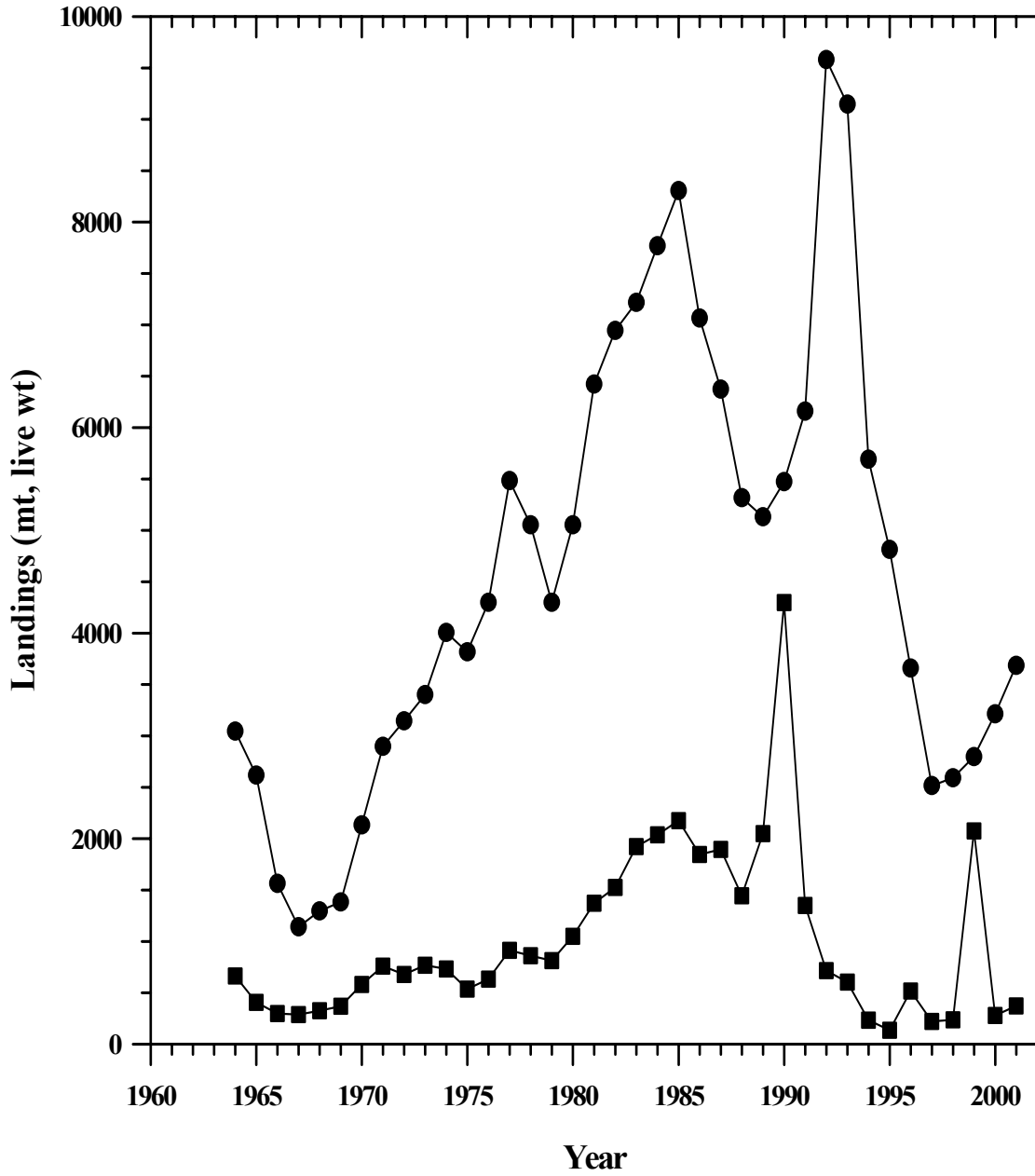
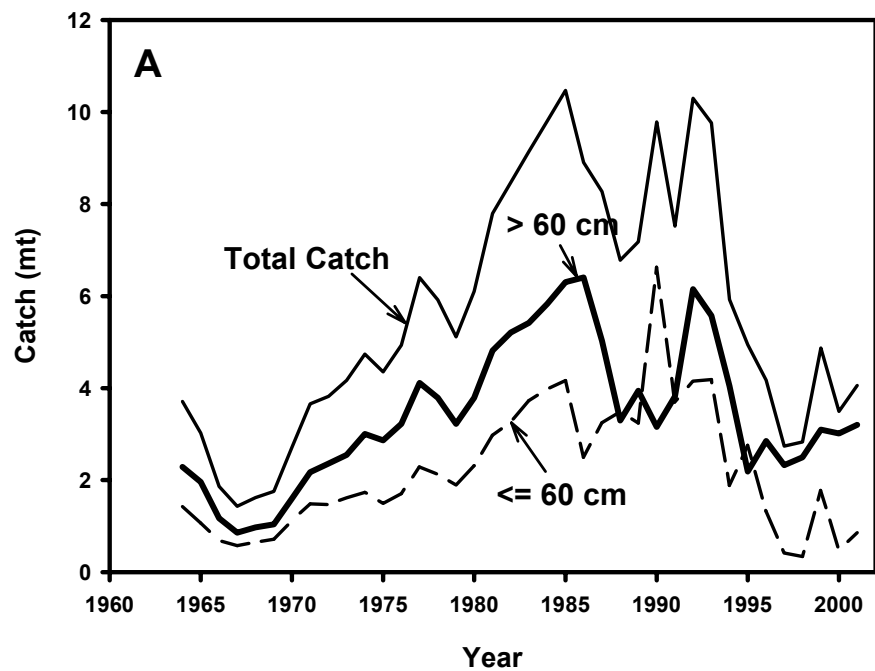


Figure K1. Total landings (circles) and discards (squares) of white hake from the Gulf of Maine to Mid-Atlantic region, 1964-2001.

Gulf of Maine-Georges Bank White Hake

Trends in Catch



Trends in Biomass

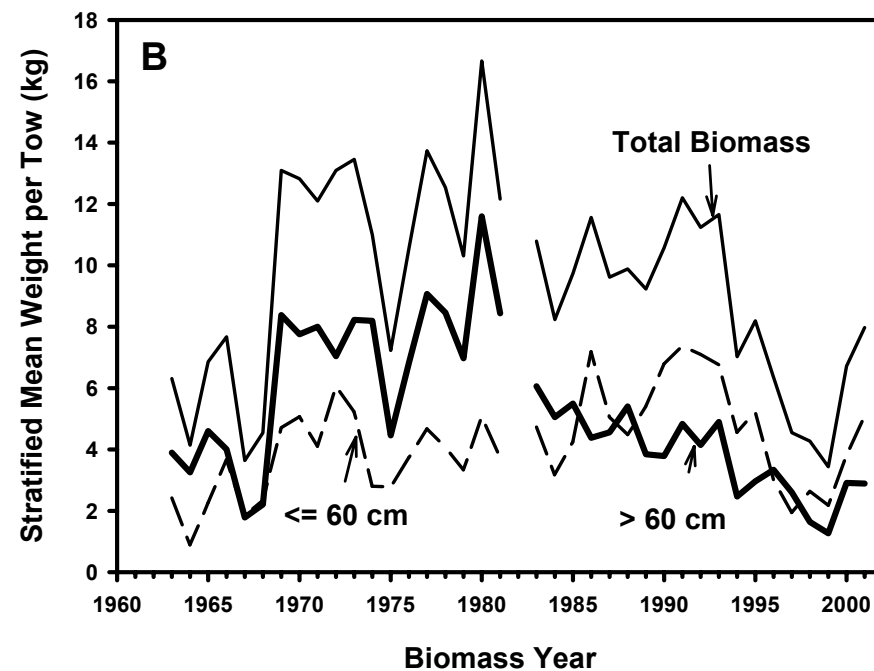


Figure K2. Trends in catch (Panel A) and survey indices of biomass (Panel B) by size class.

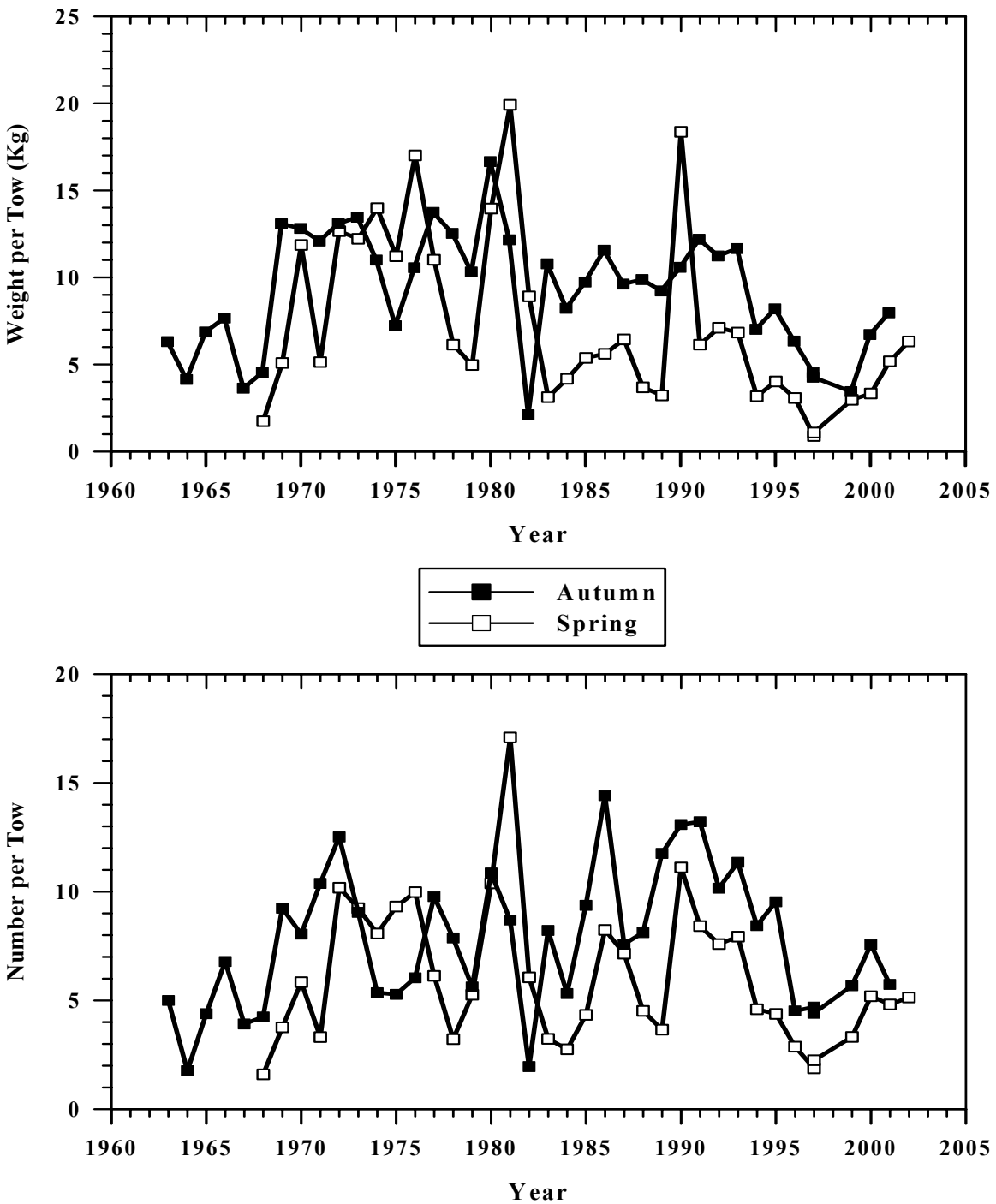


Figure K3. White hake indices of biomass (top panel) and abundance (bottom panel) from the NEFSC bottom trawl spring (solid line) and autumn (dashed line) surveys in the Gulf of Maine to Northern Georges Bank region (offshore strata 21-30, 33-40), 1963-2002.

Gulf of Maine-Georges Bank White Hake

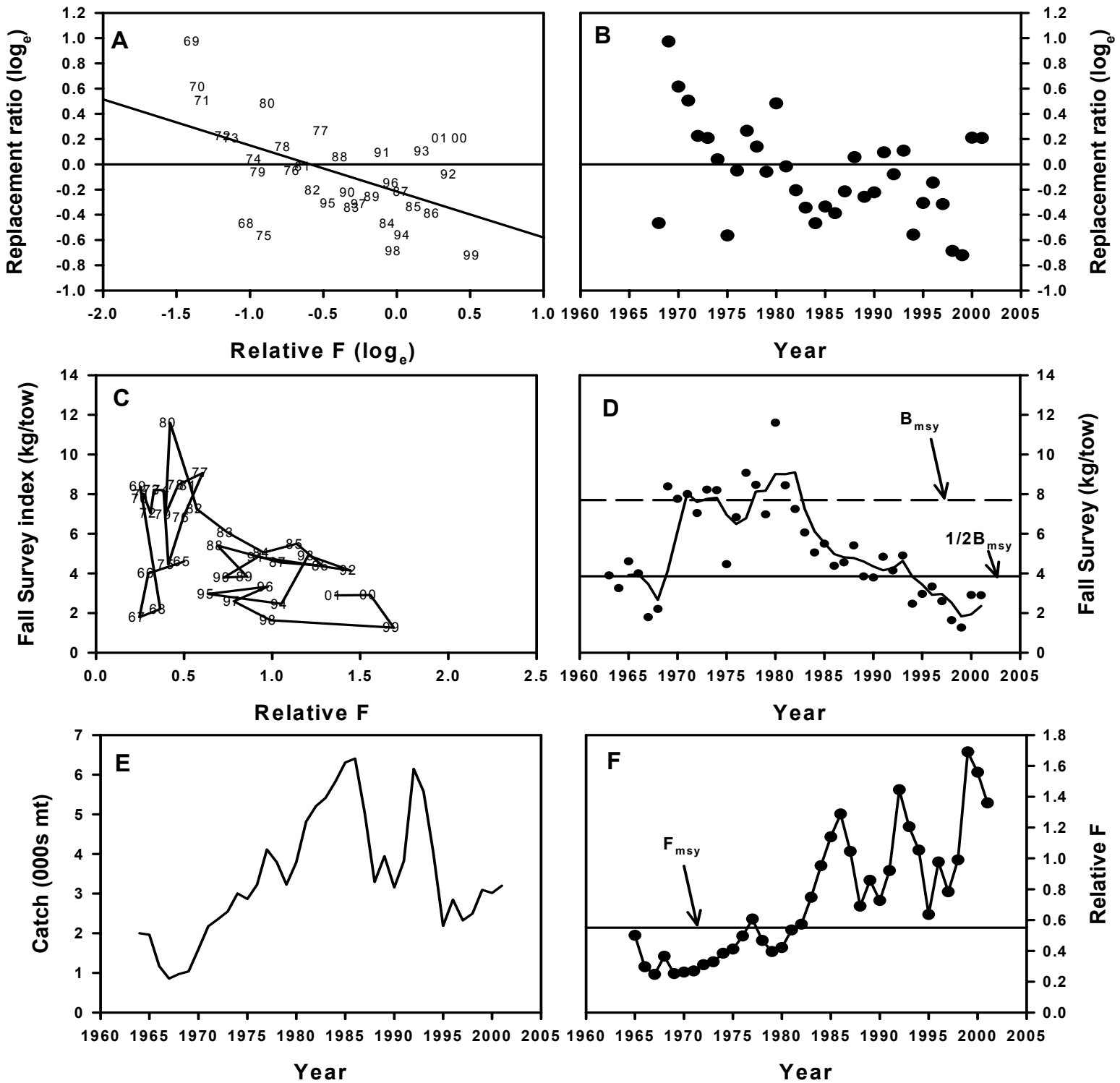


Figure K4. Six-panel plot depicting relationship between relative F and replacement ratio (A), trend in replacement ratio (B), relationship between biomass and relative F (C), trend in biomass (D), trend in catch (E), and trend in relative F (F).