

**GARM-III Working Paper 1.1 TOR1: Section M and
GARM-III Working Paper 1.2 TOR1: Section M
Corrected: 2/22/08.
This replaces Section M in drafts dated Feb. 19, 2008
Pollock**

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**GARMIII Working Paper 1.1 TOR1: Section M
(corrected 2/22/08)
Pollock in SA 5&6**

By

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M1. Data summary of catch and abundance measures

Commercial landings: Commercial landings from the USA portion of the fishery in SA 5&6 were updated through 2006 (Table M1, Figure M1). Revised Canadian landings from Divs. 5Y and 5Z were also included through 2006. There was no need to apply the preferred allocation scheme reviewed at the GARMIII Data Meeting, October, 2007.

Commercial Biological Samples: Length and age samples continue to be collected from the USA and Canadian fisheries. For this assessment of the SA5&6 portion of the stock, length and age data have not been utilized since the 1992 assessment of the entire Divs 4VWX and SA 5&6 stock (Mayo and Figuerido 1993, NEFSC 1993a, 1993b) as noted in Section M2 below.

Commercial Discards: The extent of discarding in the commercial fishery has not been investigated to date.

Recreational Landings: USA Recreational landings are available in the MRFSS database (Table M2), but have not been formally included in the assessment.

Bottom trawl Surveys: Results (stratified mean number and weight (kg) per tow) from bottom trawl surveys conducted by NEFSC were updated through 2007 (Table M3, Figure M2).

Table M1. Commercial landings (mt) of pollock from SA5&6 by USA, Canadian and DWF fleets.

Pollock with TOTAL SA 5&6 Landings				Total includes CDN, DWF and USA			
Year	Autumn Biom Index	Total 5&6 Landings(mt)	000s mt	USA 5&6 Landings	Other 5&6 Landings	USA 5&6 Percent	Other 5&6 Percent
1960		10397	10.397	8186	2211	78.7	21.3
1961		8219	8.219	7861	358	95.6	4.4
1962		6151	6.151	5550	601	90.2	9.8
1963	4.939	6241	6.241	4673	1568	74.9	25.1
1964	2.716	9008	9.008	4768	4240	52.9	47.1
1965	2.362	9000	9.000	4916	4084	54.6	45.4
1966	1.795	9847	9.847	3171	6676	32.2	67.8
1967	1.310	8534	8.534	2784	5750	32.6	67.4
1968	2.654	5222	5.222	2981	2241	57.1	42.9
1969	3.424	9822	9.822	3507	6315	35.7	64.3
1970	1.699	11976	11.976	3592	8384	30.0	70.0
1971	2.189	15203	15.203	4732	10471	31.1	68.9
1972	3.279	13013	13.013	5243	7770	40.3	59.7
1973	4.037	13076	13.076	5731	7345	43.8	56.2
1974	1.542	12393	12.393	8050	4343	65.0	35.0
1975	1.494	13871	13.871	8577	5294	61.8	38.2
1976	8.567	13382	13.382	10244	3138	76.6	23.4
1977	5.628	16273	16.273	12729	3544	78.2	21.8
1978	3.862	22305	22.305	17545	4760	78.7	21.3
1979	4.074	18452	18.452	15420	3032	83.6	16.4
1980	2.647	23539	23.539	17905	5634	76.1	23.9
1981	1.083	22068	22.068	18018	4050	81.6	18.4
1982	1.364	19466	19.466	14092	5374	72.4	27.6
1983	1.274	17816	17.816	13433	4383	75.4	24.6
1984	0.564	20633	20.633	17343	3290	84.1	15.9
1985	1.742	21069	21.069	19305	1764	91.6	8.4
1986	1.089	26507	26.507	24316	2191	91.7	8.3
1987	1.223	23467	23.467	20251	3216	86.3	13.7
1988	1.787	17648	17.648	14900	2748	84.4	15.6
1989	0.619	12434	12.434	10518	1916	84.6	15.4
1990	0.994	11518	11.518	9432	2086	81.9	18.1
1991	0.649	10053	10.053	7882	2171	78.4	21.6
1992	0.910	10671	10.671	7192	3479	67.4	32.6
1993	0.505	10238	10.238	5676	4562	55.4	44.6
1994	0.328	7332	7.332	3769	3563	51.4	48.6
1995	0.504	4611	4.611	3358	1253	72.8	27.2
1996	0.654	4420	4.420	2963	1457	67.0	33.0
1997	1.003	5794	5.794	4252	1542	73.4	26.6
1998	0.772	7865	7.865	5583	2282	71.0	29.0
1999	1.532	5726	5.726	4595	1131	80.2	19.8
2000	0.844	5376	5.376	4043	1333	75.2	24.8
2001	2.448	5784	5.784	4111	1673	71.1	28.9
2002	1.855	5354	5.354	3580	1774	66.9	33.1
2003	2.197	6735	6.735	4794	1941	71.2	28.8
2004	1.925	7245	7.245	5061	2184	69.9	30.1
2005	2.533	9346	9.346	7498	1848	80.2	19.8
2006	0.959	7043	7.043	6067	976	86.1	13.9
2007	0.754				647		

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Table M2. Recreational catch of pollock from SA5&6.

Year	Total Catch of Pollock (Including Released Alive)			Retained Catch of Pollock (Excluding Released Alive)				AB1 Avg Wgt (kg)
	Numbers (000s)	SE	Weight (mt)	Numbers (000s)	SE	Weight (mt)	SE	
1981	2202.597	12.3	1147.835	740.502	18.9	1420.96	13.5	0.521128
1982	1501.501	17.3	1564.407	796.75	24.1	764.712	15.5	1.041896
1983	970.791	18.4	1313.17	580.53	44.9	429.17	20	1.352681
1984	507.367	22.2	179.2026	114.381	27.5	323.841	32.1	0.353201
1985	1483.535	35.4	278.1677	227.023	32.6	1210.768	42.8	0.187503
1986	511.961	20.6	174.5034	140.02	54.2	410.793	24.6	0.340853
1987	659.098	22.8	247.9167	91.781	27.9	244.004	20.3	0.376145
1988	1242.453	48.4	496.3026	142.315	23.7	356.274	19.9	0.399454
1989	531.496	19.5	373.7292	181.292	22	257.823	16.1	0.703165
1990	334.926	19.7	250.504	147.391	41	197.063	31.6	0.747938
1991	429.503	36.8	328.5824	78.492	27.6	102.6	18.8	0.765029
1992	160.795	15.9	87.35675	43.363	33.9	79.817	22.7	0.54328
1993	360.522	16	113.5653	48.465	21.1	153.856	20.2	0.315002
1994	854.196	20.4	447.2175	248.343	59.9	474.341	29.5	0.523554
1995	805.038	28.5	750.6147	241.997	50.4	259.543	32	0.932397
1996	458.146	18.4	549.648	332.605	47	277.235	25.6	1.199722
1997	284.267	17.1	369.0752	196.309	34.9	151.2	29	1.29834
1998	449.508	10.4	300.9334	122.628	41.7	183.171	17.8	0.669473
1999	561.784	13.5	230.2344	89.144	26.2	217.516	26.4	0.409827
2000	1075.624	9.7	976.4788	396.372	56.1	436.617	15.9	0.907825
2001	1058.024	7.6	1920.753	645.767	21.4	355.713	11.6	1.815416
2002	496.294	14.4	791.9331	381.65	22	239.175	15.8	1.595694
2003	355.607	15.2	209.7569	93.199	34	158.003	17.2	0.589856
2004	307.398	13.7	354.2965	257.587	20.2	223.49	16.8	1.152566
2005	254.001	12.5	533.4499	329.173	19.5	156.735	13.8	2.100188
2006	277.657	15.1	551.3888	346.692	23.9	174.58	20.9	1.985863

Table M3. Stratified mean catch per tow in weight (kg) and numbers for Scotian Shelf, Gulf of Maine, and Georges Bank pollock in NEFSC offshore spring and autumn bottom trawl surveys¹, 1963-2007³. Indices for the total stock and the mature component are listed.

	NEFSC Spring Survey ²								NEFSC Autumn Survey							
	Total Biomass		Mature Biomass		Total Numbers		Mature Numbers		Total Biomass		Mature Biomass		Total Numbers		Mature Numbers	
	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans
1963	-	-	-	-	-	-	-	-	5.502	4.939	5.164	4.636	1.401	1.289	1.113	1.024
1964	-	-	-	-	-	-	-	-	4.755	2.716	4.092	2.337	1.770	1.136	0.975	0.626
1965	-	-	-	-	-	-	-	-	2.977	2.362	2.657	2.108	0.903	0.847	0.555	0.521
1966	-	-	-	-	-	-	-	-	2.567	1.795	2.003	1.401	1.060	0.637	0.488	0.293
1967	-	-	-	-	-	-	-	-	1.973	1.310	1.809	1.201	0.560	0.478	0.391	0.334
1968	4.537	2.876	4.292	2.721	1.121	0.932	0.677	0.563	3.494	2.654	3.343	2.539	0.758	0.696	0.569	0.522
1969	2.723	2.584	2.404	2.281	1.157	1.014	0.519	0.455	7.208	3.424	6.994	3.322	1.395	0.884	1.248	0.791
1970	5.295	3.920	4.928	3.648	1.659	1.449	0.994	0.868	2.251	1.699	2.082	1.571	0.609	0.588	0.377	0.364
1971	3.474	2.831	3.266	2.661	0.973	0.897	0.593	0.547	4.365	2.189	3.833	1.922	1.201	0.778	0.612	0.396
1972	5.003	3.618	4.051	2.930	3.871	2.140	0.867	0.479	4.589	3.279	4.079	2.915	1.448	1.174	0.733	0.594
1973	4.927	3.835	3.508	2.731	4.329	1.710	1.018	0.402	4.683	4.037	4.382	3.778	1.267	1.106	0.865	0.755
1974	3.951	4.157	3.553	3.738	1.344	1.176	0.755	0.661	3.332	1.542	2.912	1.348	0.953	0.576	0.654	0.395
1975	5.919	5.580	5.409	5.099	1.621	1.298	1.014	0.812	2.087	1.494	1.905	1.364	0.718	0.493	0.381	0.262
1976	7.204	7.490	6.798	7.068	1.612	1.483	1.227	1.129	18.261	8.567	17.406	8.166	4.038	1.895	3.674	1.724
1977	3.591	3.295	3.205	2.941	1.717	1.318	0.882	0.677	9.376	5.628	8.789	5.276	2.272	1.303	1.739	0.997
1978	5.130	3.107	4.272	2.587	1.898	0.835	1.091	0.480	6.275	3.862	6.033	3.713	1.064	0.723	0.790	0.537
1979	4.585	3.750	4.348	3.556	1.036	0.939	0.785	0.712	4.770	4.074	4.504	3.847	0.865	0.719	0.718	0.597
1980	4.191	3.531	3.711	3.127	1.451	1.069	0.987	0.727	3.298	2.647	3.202	2.570	0.580	0.544	0.470	0.441
1981	5.749	5.391	5.415	5.078	1.395	1.221	0.989	0.866	2.683	1.083	2.178	0.879	1.033	0.341	0.672	0.222
1982	6.372	3.349	5.839	3.069	3.755	1.767	2.076	0.977	2.118	1.364	1.966	1.266	0.759	0.574	0.493	0.373
1983	1.592	1.018	1.533	0.980	0.897	0.662	0.251	0.185	2.989	1.274	2.834	1.208	0.976	0.579	0.479	0.284
1984	3.119	2.298	3.002	2.212	1.084	0.914	0.688	0.580	0.909	0.564	0.778	0.483	0.421	0.367	0.188	0.164
1985	29.132	8.446	26.404	7.655	14.587	2.725	12.014	2.244	2.114	1.742	1.875	1.545	1.080	0.708	0.454	0.298
1986	8.256	4.283	8.123	4.214	1.973	1.333	1.686	1.139	1.707	1.089	1.466	0.935	0.898	0.571	0.528	0.336
1987	2.778	1.870	2.510	1.690	1.616	0.738	0.599	0.274	2.035	1.223	1.924	1.156	0.597	0.506	0.383	0.325
1988	2.015	1.384	1.950	1.339	0.907	0.758	0.339	0.283	13.021	1.787	12.088	1.659	3.754	0.869	3.131	0.725
1989	5.216	2.156	5.041	2.084	1.998	1.024	1.577	0.808	1.223	0.619	0.723	0.366	1.883	0.771	0.461	0.189
1990	1.821	1.165	1.675	1.072	0.760	0.560	0.442	0.326	2.079	0.994	1.888	0.903	0.823	0.586	0.502	0.357
1991	5.051	2.797	4.738	2.624	2.303	1.399	1.762	1.070	1.055	0.649	0.851	0.524	0.728	0.535	0.409	0.301
1992	3.349	2.166	3.139	2.030	1.787	1.242	0.755	0.525	1.697	0.910	1.507	0.808	1.051	0.643	0.520	0.318
1993	1.602	1.248	1.358	1.058	1.648	1.163	0.534	0.377	0.769	0.505	0.570	0.374	1.043	0.567	0.195	0.106
1994	1.065	0.840	0.972	0.767	0.562	0.504	0.380	0.341	0.603	0.328	0.500	0.272	0.422	0.311	0.270	0.199
1995	3.716	1.307	2.659	0.935	3.432	0.820	1.984	0.474	1.017	0.504	0.787	0.390	0.840	0.465	0.516	0.286
1996	1.080	0.758	1.023	0.718	0.650	0.510	0.342	0.268	1.060	0.654	0.862	0.532	1.009	0.666	0.435	0.287
1997	4.573	2.060	3.866	1.742	3.369	1.802	1.693	0.906	1.512	1.003	1.095	0.726	1.766	0.921	0.611	0.319
1998	2.643	1.564	2.139	1.266	2.609	1.506	0.900	0.520	1.308	0.772	0.860	0.508	2.104	0.748	0.539	0.192
1999	1.069	0.862	0.745	0.601	2.165	1.022	0.419	0.198	3.099	1.532	2.595	1.283	2.414	1.394	1.161	0.670
2000	1.369	0.997	1.222	0.890	1.502	0.973	0.434	0.281	1.441	0.844	0.522	0.306	2.770	1.333	0.583	0.278
2001	2.029	1.275	1.854	1.165	1.693	1.272	0.728	0.547	3.567	2.448	3.067	2.105	2.385	1.811	1.361	1.033
2002	1.578	1.247	1.475	1.166	0.760	0.630	0.482	0.400	5.920	1.855	5.420	1.698	3.135	1.460	2.305	1.073
2003	0.890	0.667	0.731	0.548	1.439	0.734	0.242	0.123	7.951	2.197	6.348	1.754	7.363	2.043	4.790	1.329
2004	0.744	0.585	0.703	0.553	0.487	0.380	0.180	0.140	4.206	1.925	3.440	1.574	3.221	1.395	2.122	0.919
2005	5.620	2.377	5.459	2.305	2.016	1.235	1.588	0.973	7.415	2.533	6.507	2.223	4.769	1.636	2.700	0.926
2006	2.589	1.493	2.534	1.467	0.972	0.758	0.766	0.597	1.856	0.959	1.578	0.815	1.591	0.568	0.574	0.205
2007	4.671	2.655	4.466	2.538	1.988	1.423	1.425	0.805	1.394	0.754	1.314	0.711	0.607	0.438	0.404	0.292

¹ NEFSC Strata 01130-01300, 01330-01340, 01360-01400.

² The "36 Yankee" trawl was used from 1970-1972, and 1982-2002; the "41 Yankee" trawl was used from 1973-1981.

No gear conversion factors are available to adjust for differences in fishing power.

³ BMV oval doors were used from 1970-1984; since 1985 Portuguese polyvalent doors have been used. No door conversion factors were applied. Surveys performed using *R/V Albatross IV* and *R/V Delaware II*; No vessel conversion factors were applied.

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Table M4. Assessment measures used to evaluate the SA 5&6 component of the pollock stock.

Year	Autumn Kg/tow	Landings (mt)	Landings (000s mt)	Exploitation Ratio	Replacement Ratio
1963	4.939	6241	6.241		
1964	2.716	9008	9.008		
1965	2.362	9000	9.000	2.695	
1966	1.795	9847	9.847	4.298	
1967	1.310	8534	8.534	4.683	
1968	2.654	5222	5.222	2.720	1.011
1969	3.424	9822	9.822	3.988	1.580
1970	1.699	11976	11.976	4.620	0.736
1971	2.189	15203	15.203	6.238	1.006
1972	3.279	13013	13.013	5.447	1.454
1973	4.037	13076	13.076	4.127	1.524
1974	1.542	12393	12.393	4.197	0.527
1975	1.494	13871	13.871	5.883	0.586
1976	8.567	13382	13.382	3.460	3.416
1977	5.628	16273	16.273	3.112	1.487
1978	3.862	22305	22.305	3.706	0.908
1979	4.074	18452	18.452	4.081	0.966
1980	2.647	23539	23.539	6.673	0.560
1981	1.083	22068	22.068	8.483	0.219
1982	1.364	19466	19.466	11.464	0.394
1983	1.274	17816	17.816	14.364	0.489
1984	0.564	20633	20.633	19.331	0.270
1985	1.742	21069	21.069	17.656	1.256
1986	1.089	26507	26.507	23.423	0.903
1987	1.223	23467	23.467	17.366	1.014
1988	1.787	17648	17.648	12.916	1.516
1989	0.619	12434	12.434	10.279	0.483
1990	0.994	11518	11.518	10.163	0.769
1991	0.649	10053	10.053	13.333	0.568
1992	0.910	10671	10.671	12.540	0.863
1993	0.505	10238	10.238	14.880	0.509
1994	0.328	7332	7.332	12.619	0.446
1995	0.504	4611	4.611	10.347	0.744
1996	0.654	4420	4.420	8.922	1.129
1997	1.003	5794	5.794	8.044	1.729
1998	0.772	7865	7.865	9.714	1.289
1999	1.532	5726	5.726	5.195	2.349
2000	0.844	5376	5.376	5.123	0.945
2001	2.448	5784	5.784	3.597	2.547
2002	1.855	5354	5.354	3.120	1.406
2003	2.197	6735	6.735	3.109	1.474
2004	1.925	7245	7.245	3.636	1.084
2005	2.533	9346	9.346	4.213	1.366
2006	0.959	7043	7.043	3.900	0.438
2007	0.754				0.398

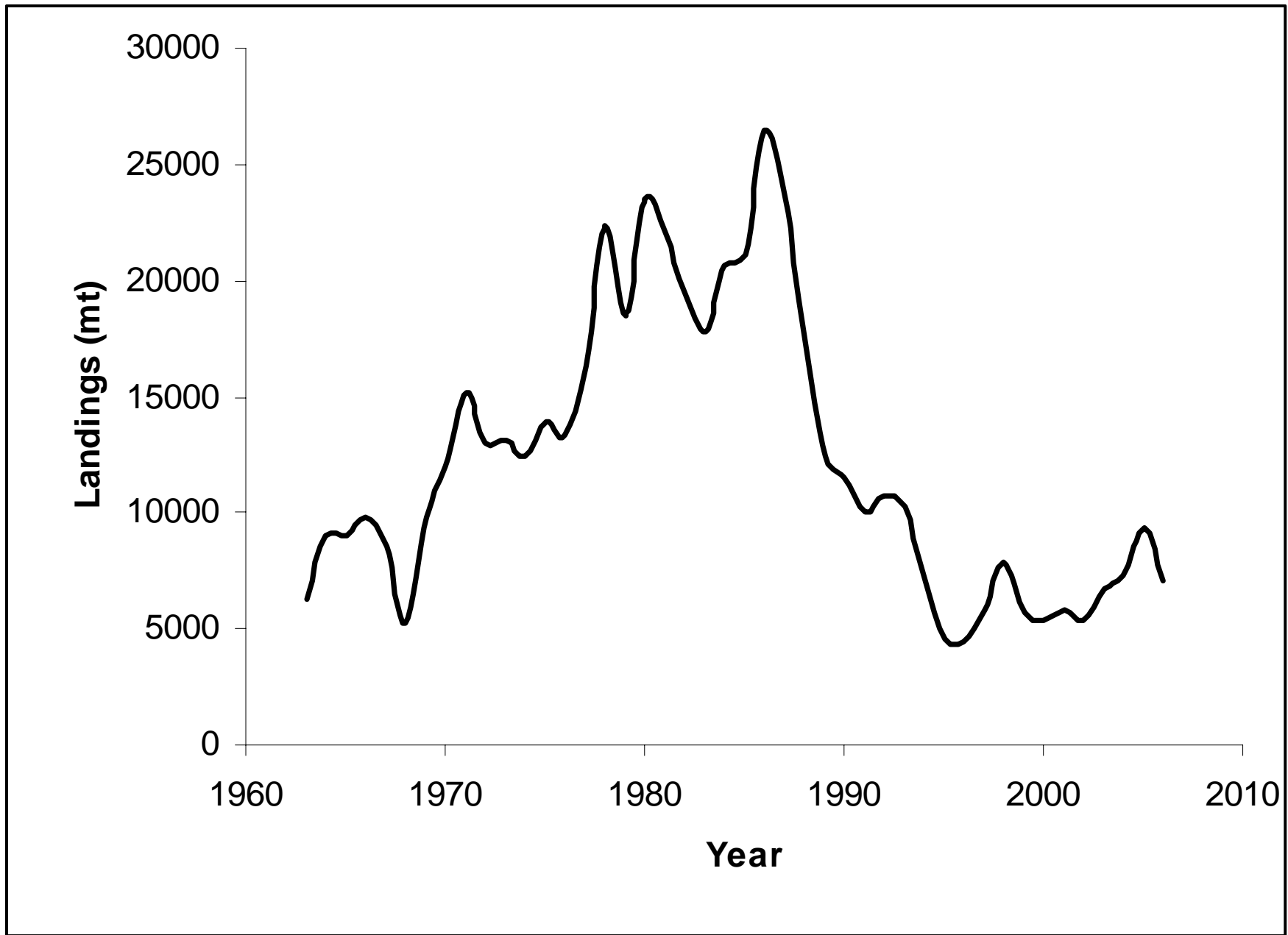


Figure M1. Total landings (mt) of pollock from SA 5&6.

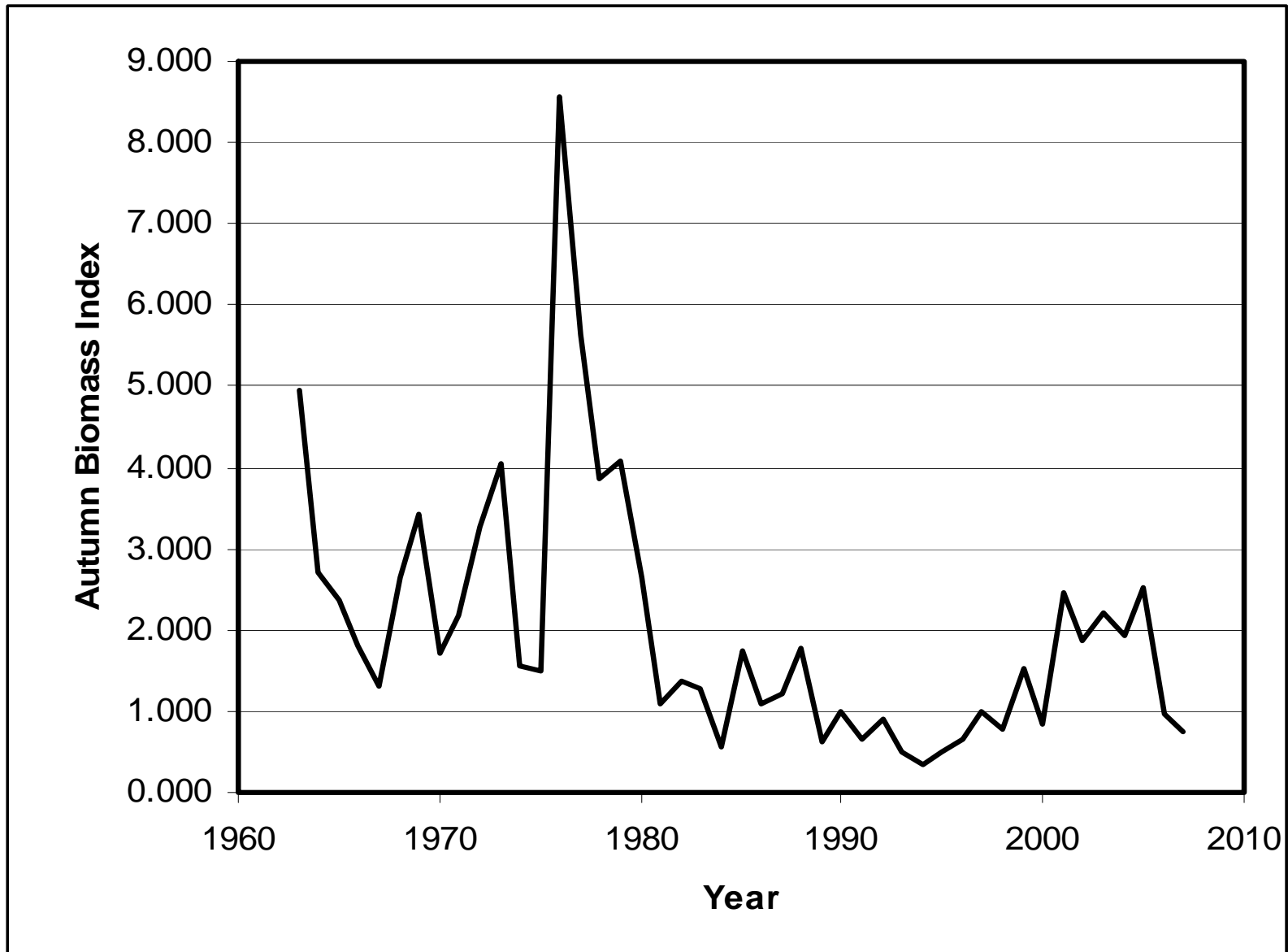


Figure M2. Log re-transformed biomass (stratified mean weight per tow [kg]) index for pollock from the NEFSC autumn bottom trawl surveys.

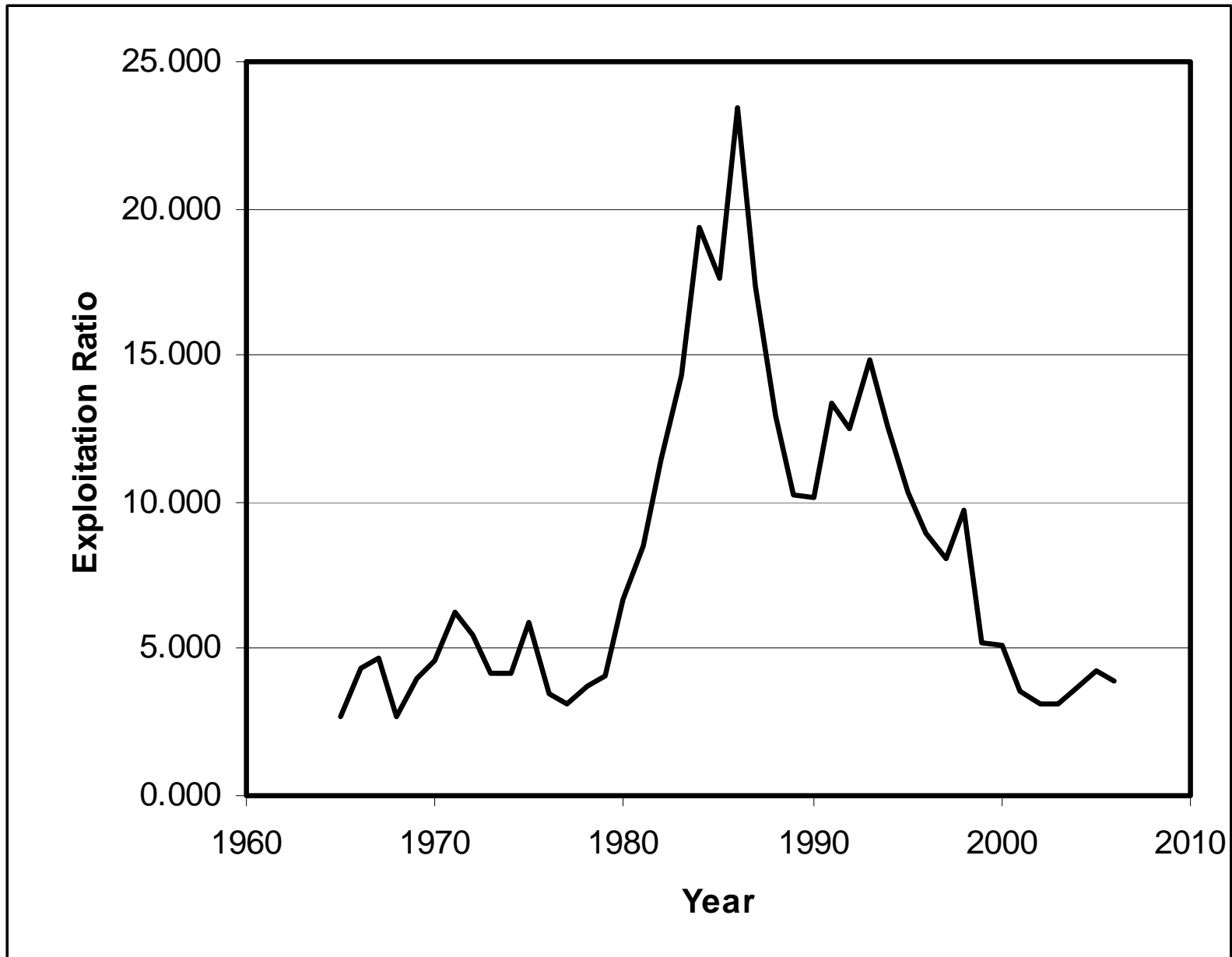


Figure M3. Exploitation Ratios (commercial landings/biomass index) for pollock in SA 5&6.

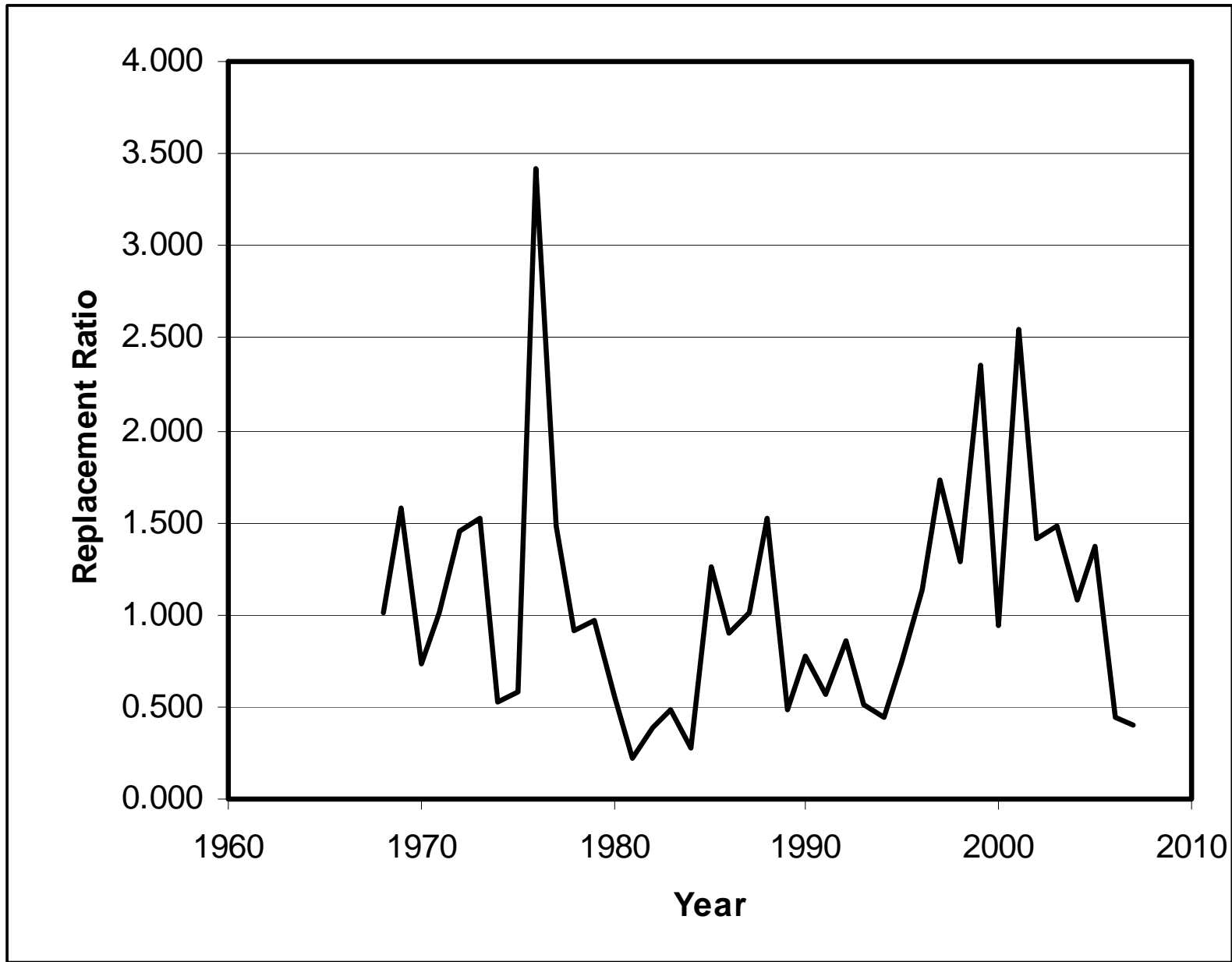


Figure M4. Replacement Ratios for pollock in SA 5&6.

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Pollock

	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	D							
Landings (000s mt)	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	2.113		
NEFSC Autumn survey wt/tow	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	5.343
Exploitation Ratio																																																				3.659	
Replacement Ratio																																																					3.346

Legend

●	○	○	○	●
Highest	2nd Highest	Middle	2nd Lowest	Lowest

D = Measure of Dispersion: Range/Median

M2. Overview of Model Selection

a. Description and history of current approach.

Pollock, *Pollachius virens* (L.) have traditionally been assessed as a unit stock from the Scotian Shelf (NAFO Divisions 4VWX) to Georges Bank, the Gulf of Maine and portions of the Mid-Atlantic region (Subareas 5 and 6). This stock was last assessed over its range *via* VPA at SAW 16 in 1993 (Mayo and Figuerido 1993, NEFSC 1993a, 1993b). At that time, spawning stock biomass had been declining since the mid-1980s, and was expected to reach its long-term average (144,000 mt). Fishing mortality was estimated to be 0.72 in 1992, above F20% (0.65) and well above Fmed (0.47). The stock was then considered to be fully exploited and at a medium biomass level.

The state of this stock was first evaluated *via* index assessment in 2000 (Mayo 2001). At that time, it was noted that biomass indices for the Gulf of Maine-Georges Bank portion of the stock, derived from NEFSC autumn bottom trawl surveys, had increased during the mid-1970s, declined sharply during the 1980s, but have been generally increasing since the mid-1990s. Indices derived from Canadian bottom trawl surveys, conducted on the Scotian Shelf, increased during the 1980s, but declined sharply during the early 1990s.

In 2002, index-based biological reference points were developed for a portion of the pollock stock primarily under US management jurisdiction (Subareas 5 and 6), including a portion of eastern Georges Bank (Subdivision 5Zc) that is under Canadian management jurisdiction (NEFSC 2002). The most recent assessment of the resource inhabiting the area comprising this management unit was conducted in October, 2005 at the second Groundfish Assessment Update Meeting (GARM II). At that time it was determined that the index of current biomass was greater than ½ of the Bmsy proxy reference point and that the index of current F was below the Fmsy proxy reference point (Mayo and Col 2002).

b. Key strengths and weaknesses.

The current AIM model provides proxy reference points and allows for projection of annual catch levels, but it does not provide absolute estimates of F and stock size. At the very least, inclusion of recreational catch in the AIM model should improve estimates of the exploitation ratio utilized by the model.

c. Feasibility of changing the assessment model

The current assessment is based on An Index Model (AIM) which incorporates age-aggregated information on exploitation (commercial landings) and resource biomass (Autumn NEFSC biomass index). An age-based assessment may be possible for this region if the age structure of all of the commercial landings can be attributed to SA 5&6. This must include the non-USA

components (Canadian and DWF) that were substantial since the early 1960s. This objective may be difficult to achieve because extensive borrowing of Canadian age length keys from Subarea 5 to was required to derive the age composition of the DWF catch in the 1960s and 1970s (Mayo et al. 1989) which was estimated on a stock-wide basis.

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