

R. Gulf of Maine Haddock by R.W. Brown

1.0 Background

The Gulf of Maine haddock stock was last assessed at SAW/SARC 2 in 1986 (NMFS-NEFSC 1986). At the time of the 1986 assessment, landings had declined from 7,600 mt in 1983 to 3,000 mt in 1985. Although no formal analysis of fishing mortality was attempted, fishing mortality was assumed to be relatively high. The fishery in the mid 1980s was being supported by spill over of large year classes from Georges Bank, and research vessel surveys indicated that recruitment in the Gulf of Maine was extremely poor. The Gulf of Maine haddock stock was not updated during the 1999 assessment process for groundfish stocks (NDWG 2000).

Although the last formal SAW/SARC assessment was in 1986, the Status of Stocks section for this stock has been updated on numerous occasions. In the most recent update (Brown 2000), both landings and research survey indices had declined sharply between the mid 1980s and the mid 1990s. Some increases in both landings and survey indices were observed in the late 1990s; however, the stock was determined to be in an overfished condition and that overfishing has been occurring with reference to the Amendment 9 MSY-based harvest control rule.

2.0 Fishery Catches and Research Survey Indices

Historical Landings

Following recruitment of the 1975 and 1978 year classes, landings of haddock in the Gulf of Maine exceeded 6,000 mt from 1980 to 1984. Landings declined steadily from 1982 and the mid 1990s, and reached a historic low of 112 mt in 1994. Landings have increased steadily since 1994 reaching 1,000 mt in 1998.

1999 Fishery

U.S. trip limit regulations for haddock continued to be liberalized in 1999, and regulations in 1999 were significantly more liberal in 1999 compared to the 1998 calendar year. The trip limit from January 1 to April 1999 was 3,000 pounds/day up to a maximum of 30,000 pounds/trip, 2,000 pounds/day up to a maximum of 20,000 pounds/trip from May 1 to November 4, 1999, and 5,000 pounds/trip up to a maximum of 50,000 pounds/trip from November 5 to December 31, 1999. However, landings of Gulf of Maine haddock declined from 1,018 mt in 1998 to 668 mt in 1999 (Table 1, Figure 1). Management measures designed to reduce mortality on Gulf of Maine cod may have reduced access to the Gulf of Maine haddock resource in 1999.

Fishery Independent Information

Abundance (stratified mean number/tow) and biomass (stratified mean weight/tow) survey indices are available for the U.S. Spring (1968 to 2000) and Autumn (1963 to 1999) surveys. Spring survey biomass and abundance indices declined from high levels in the late 1970s to record low levels by 1990 (Table R2; Figure R2). The spring surveys in 1987, 1989, 1990 and 1991 approached the level where the survey had difficulty detecting the presence of haddock in

Gulf of Maine strata. Survey indices in the 1990s have remained at chronic low levels, with the exception of 1997, 1999, and 2000 surveys (Table R2; Figure R2). The 1999 and 2000 abundance indices were the highest observed since 1981, and the biomass index in 2000 was the highest observed since 1985. Most of the tows indicating larger abundance occurred in areas bordering the Georges Bank stock boundary, rather than in areas where the stock was traditionally concentrated.

U.S. autumn survey abundance and biomass indices declined from very high levels in the mid - 1960s to low levels in the early 1970s. The indices increased during the late 1970's and early 1980s in response to recruitment of the 1975 and 1978 year classes, and subsequently declined steady to historic low levels in 1991. The autumn surveys in 1990 and 1991 approached the level where the survey had difficulty detecting the presence of haddock in Gulf of Maine strata. Abundance and biomass indices increased moderately in the mid 1990s and sharply beginning in 1996. The 1999 autumn survey abundance index (6.73 haddock/tow) and biomass index (4.91 kg/tow) were the highest observed since 1980 and 1985, respectively. However, these indices are less than 50% of levels observed during the mid 1960s.

Trends in exploitation indices (3 year moving average of catch (000s mt) divided by the U.S. autumn survey biomass index [kg/tow]) indicate that relative exploitation was relatively low during the 1960s, rose sharply during the early 1980s and again during the early 1990s (Figure R3). The exploitation index dropped sharply beginning in 1994 and has remained at moderate levels since.

Survey indices at age for both the U.S. spring and autumn surveys indicate the presence of strong year classes through the assessment period. Both surveys exhibit large abundance indices for the 1963, 1975, and 1978 year classes (Figures R4 and R5). Survey indices during the 1980s indicate very low levels of recruitment. During the 1990s, survey indices at age reflect an increase in recruitment and some broadening of age structure. Survey indices corresponding to the 1998 year class are the largest observed since the early 1980s.

3.0 Harvest Control Rule Evaluation

The MSY-based harvest control rule for Gulf of Maine haddock is outlined as follows:

A maximum sustainable yield of 2,700 mt can be produced when relative stock biomass is 8.25 kg/tow (B_{MSY} proxy) and the relative exploitation index (catch/autumn biomass index) is 0.29 (f_{MSY} proxy). The maximum fishing mortality rate should be less than f_{MSY} when stock biomass exceeds B_{MSY} , and less than the fishing mortality that would allow rebuilding in five years when biomass is below B_{MSY} . Since the intrinsic rate of population growth ($r=0.20$) is less than other stocks where a 10 year rebuilding schedule was recommended, it is recommended that the minimum biomass threshold should be the biomass that can be rebuilt to B_{MSY} in five years with no fishing ($F = 0.00$). This biomass level is slightly greater than $\frac{1}{2} B_{MSY}$ (average autumn survey biomass index of 4.38 kg /tow).

The harvest control is shown graphically in Figure R6. Based on 1997 to 1999 autumn survey results, the current biomass proxy (3.41 kg/tow) is less than $B_{\text{threshold}}$ (4.38 kg/tow), and the F proxy (0.247) is greater than 1999 F_{Target} proxy of 0.00.

4.0 Conclusions

In recent years, exploitation indices have declined from previously high levels, and there has been a moderate increase in landings that appears to be associated with higher levels of abundance. U.S. spring and autumn survey indices provide evidence of increases in abundance and biomass within the stock area. Survey abundance at age indices provide evidence for broadening of the size and age structure of the population. Recent survey indices for younger ages provide evidence of significantly improved recruitment, especially indices corresponding to the 1998 year class. Despite indications of increased abundance and recruitment, biomass remains well below B_{MSY} .

5.0 Sources of Uncertainty

- There is insufficient length and age sampling of U.S. commercial landings to reliably estimate catch at age for this stock.
- The magnitude of discarding due to bycatch and in response to U.S. management regulations is uncertain.

6.0 References

Brown, R. 2000. Haddock. Status of Fishery Resources off the Northeastern United States for 1999. Electronic Publication: <http://www.nefsc.nmfs.gov/sos/spsyn/pg/haddock/>

NDWG (Northern Demersal Working Group, Northeast Regional Stock Assessment Workshop). 2000. Assessment of 11 northeast groundfishstocks through 1999. Report of the SAW Northern Demersal Working Group. A Report to the NEFMC Multi-Species Monitoring Committee. NMFS, NEFSC Reference Document 00-5.

NMFS-NEFSC. 1986. Report of the Second NEFC Stock Assessment Workshop (Second SAW). NMFS, NEFSC, Woods Hole Laboratory Reference Document 86-09.

Table R1. Commercial landings (mt, live weight) of haddock from the Gulf of Maine (NAFO Division 5Y; U.S. statistical areas 511-515) from 1960-1999.

Year	United States	Canada	USSR	Other	Total
1960	4541	383	--	--	4924
1961	5297	112	--	--	5409
1962	5003	107	--	--	5110
1963	4742	3	44	--	4789
1964	5383	70	--	--	5453
1965	4204	159	--	--	4363
1966	4579	1125	--	--	5704
1967	4907	589	--	--	5496
1968	3437	120	--	--	3557
1969	2423	59	--	231	2713
1970	1457	38	--	67	1562
1971	1194	85	--	27	1306
1972	909	23	4	--	936
1973	509	49	--	--	558
1974	622	198	--	9	829
1975	1180	79	--	4	1263
1976	1865	91	--	--	1956
1977	3296	26	--	--	3322
1978	4538	641	--	--	5179
1979	4622	257	--	--	4879
1980	7270	203	--	--	7473
1981	5726	513	--	--	6239
1982	5645	1278	--	--	6923
1983	5594	2003	--	--	7597
1984	2793	1245	--	--	4038
1985	2234	781	--	--	3025
1986	1443	225	--	--	1668
1987	829	--	--	--	829
1988	436	--	--	--	436
1989	264	--	--	--	264
1990	433	--	--	--	433
1991	431	--	--	--	431
1992	312	--	--	--	312
1993	193	--	--	--	193
1994 ¹	112	--	--	--	112
1995 ¹	192	--	--	--	192
1996 ¹	257	--	--	--	257
1997 ¹	616	--	--	--	616
1998 ¹	1018	--	--	--	1018
1999 ¹	668	--	--	--	668

¹ U.S. landings from 1994-1999 are provisional.

Table R2. Stratified and standardized mean number and mean weight (kg) per tow of haddock caught in the U.S. spring and autumn bottom trawl surveys from 1963-1999. An exploitation index has been calculated based on a 3 year moving average of landings (000s mt) / autumn survey biomass index (kg/tow).

Year	Spring Survey		Autumn Survey		Exploitation Index (catch/Autumn survey biomass)
	Number/Tow	Weight (kg)/tow	Number/tow	Weight (kg)/tow	
1963			69.54	50.69	
1964			14.17	18.82	0.168
1965			17.43	17.64	0.308
1966			11.65	13.85	0.322
1967	<i>Spring survey initiated in 1968</i>		12.186	16.85	0.319
1968	6.00	7.88	7.64	15.48	0.260
1969	3.78	7.37	5.45	12.85	0.218
1970	0.90	1.72	2.91	7.35	0.195
1971	0.87	2.52	2.87	8.13	0.202
1972	0.86	0.86	1.98	3.03	0.141
1973	1.20	1.57	4.16	8.58	0.155
1974	1.43	1.05	2.68	3.34	0.129
1975	2.77	3.48	5.53	8.61	0.202
1976	8.32	6.35	6.03	8.04	0.257
1977	6.79	6.72	8.29	8.75	0.277
1978	1.35	1.43	9.16	20.93	0.308
1979	3.33	4.63	5.52	13.72	0.394
1980	2.69	3.38	7.15	9.83	0.565
1981	4.40	4.48	3.86	9.34	0.884
1982	2.04	2.55	2.62	4.16	1.109
1983	3.67	3.56	2.59	5.21	1.398
1984	1.09	1.14	1.69	3.89	0.961
1985	1.77	1.88	4.07	6.14	0.764
1986	0.70	1.28	0.62	1.39	0.542
1987	0.09	0.06	1.03	2.64	0.532
1988	0.18	0.30	0.33	1.47	0.322
1989	0.08	0.12	0.28	0.63	0.446
1990	0.02	0.00	0.14	0.43	0.954
1991	0.07	0.06	0.14	0.12	1.829
1992	0.19	0.27	0.21	0.09	1.370
1993	0.45	0.20	0.86	0.47	0.791
1994	0.40	0.25	0.32	0.21	0.278
1995	0.80	0.35	0.97	1.09	0.115
1996	0.30	0.33	2.40	3.54	0.151
1997	1.93	1.22	2.68	2.42	0.213
1998	0.19	0.11	3.13	2.91	0.224
1999	4.26	1.10	6.73	4.91	
2000	3.61	1.81	<i>To be conducted in October 2000</i>		

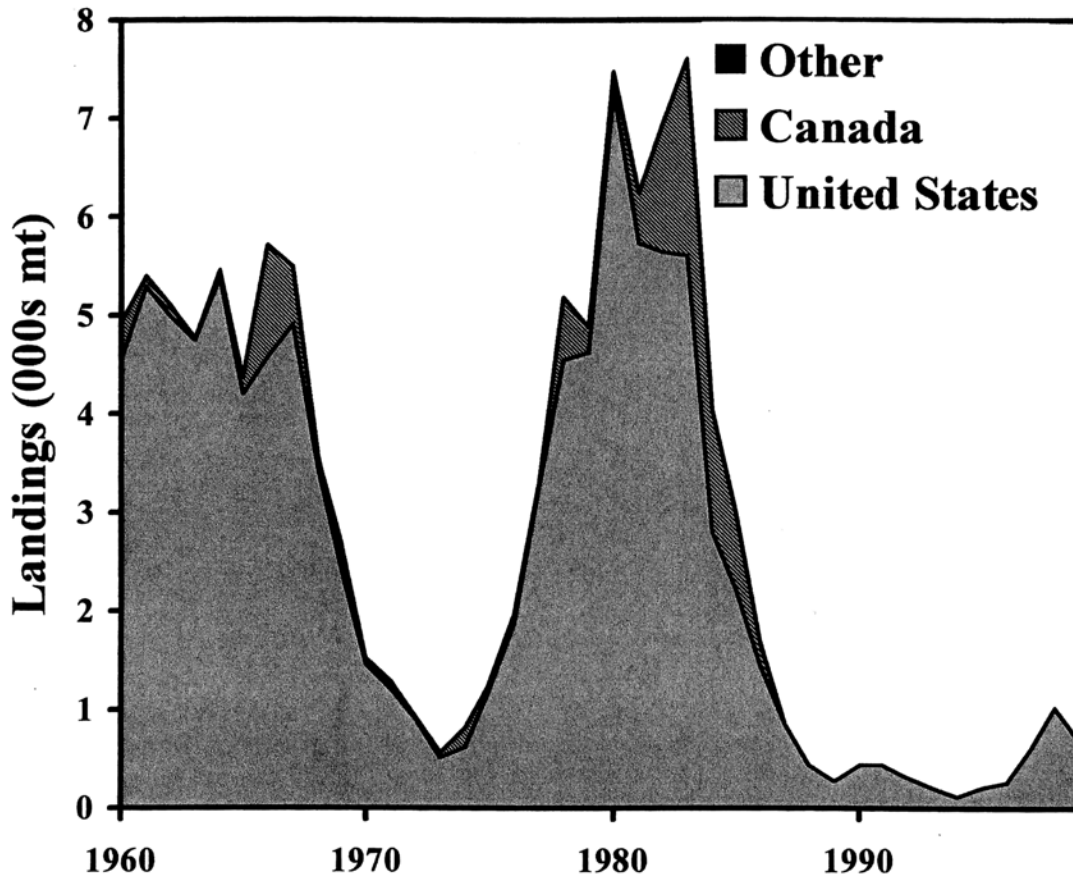


Figure R1. Landings (live weight, mt) of Gulf of Maine haddock from 1960 – 1999.

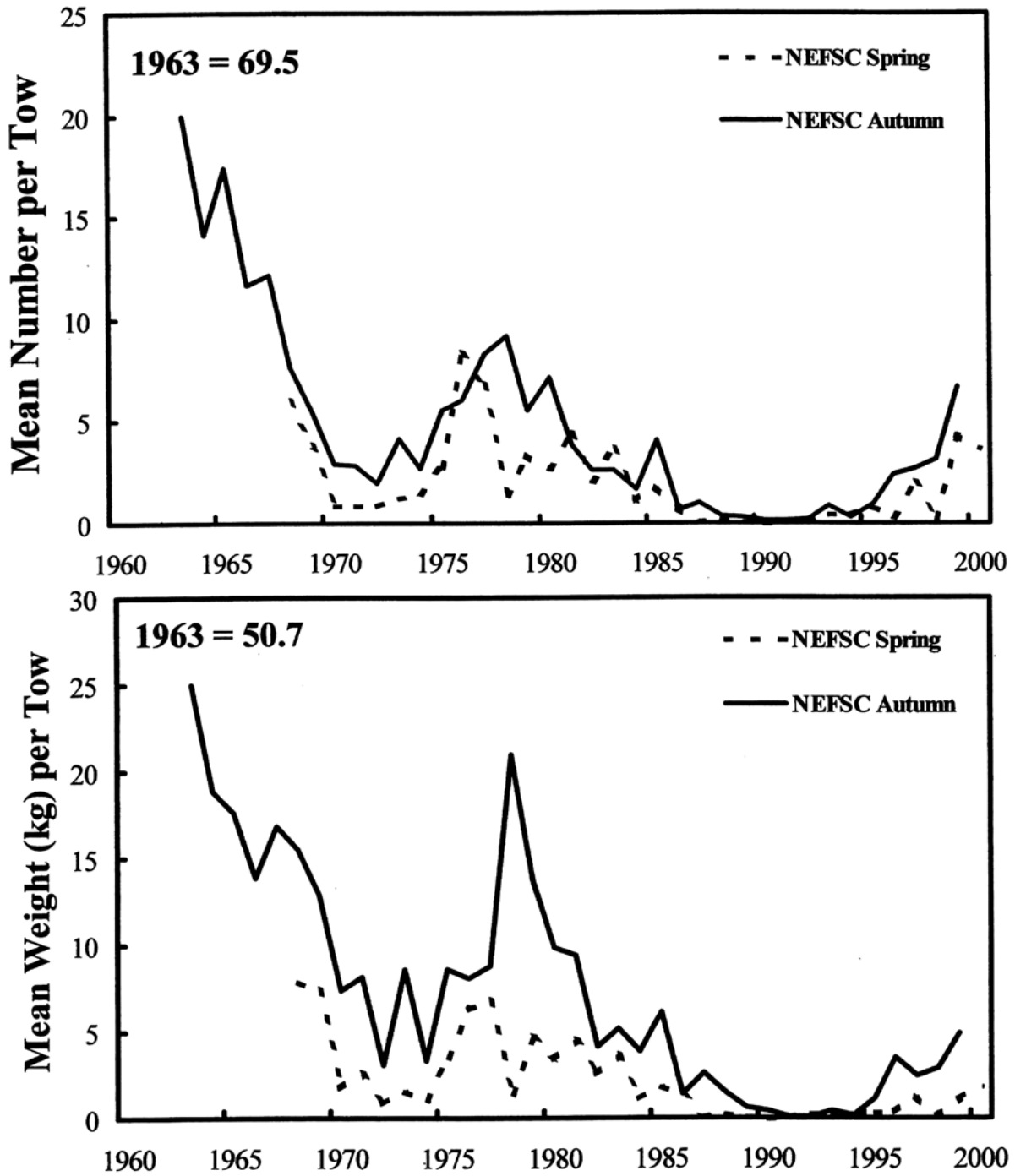


Figure R2. Northeast Fisheries Science Center research standardized and stratified survey abundance (mean number mean number per tow; top panel) and biomass (kg per tow, bottom panel) indices for Gulf of Maine haddock from 1963-1999. U.S. survey includes strata 01260-01280 and 01360-01400.

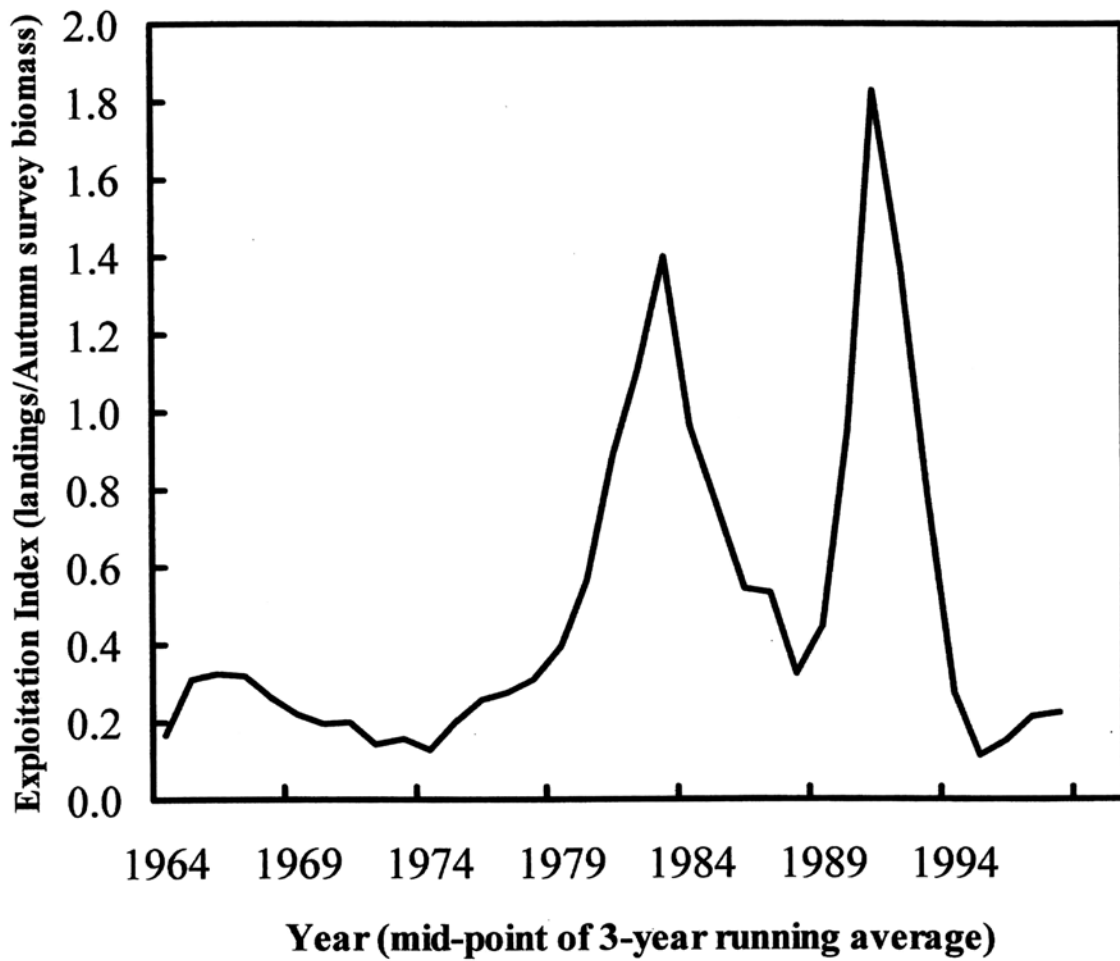


Figure R3. Exploitation index (landings [000s mt] / autumn survey biomass index [kg/tow]) for Gulf of Maine haddock.

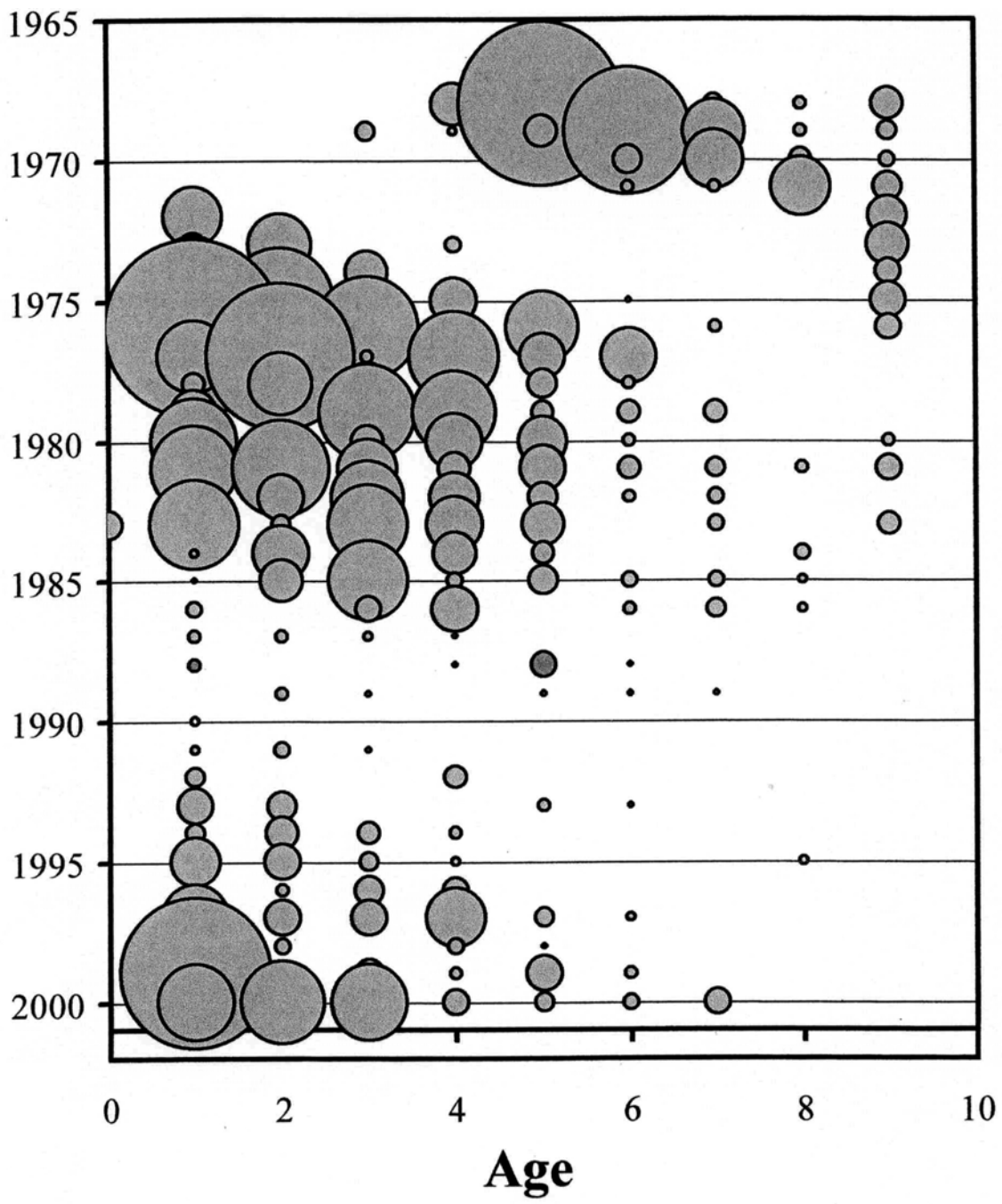


Figure R4. Abundance at age indices (standardized, stratified mean number per tow) from the Northeast Fisheries Science Center Spring research survey abundance, 1968-1999. The size of the bubbles indicates the relative magnitude of each index.

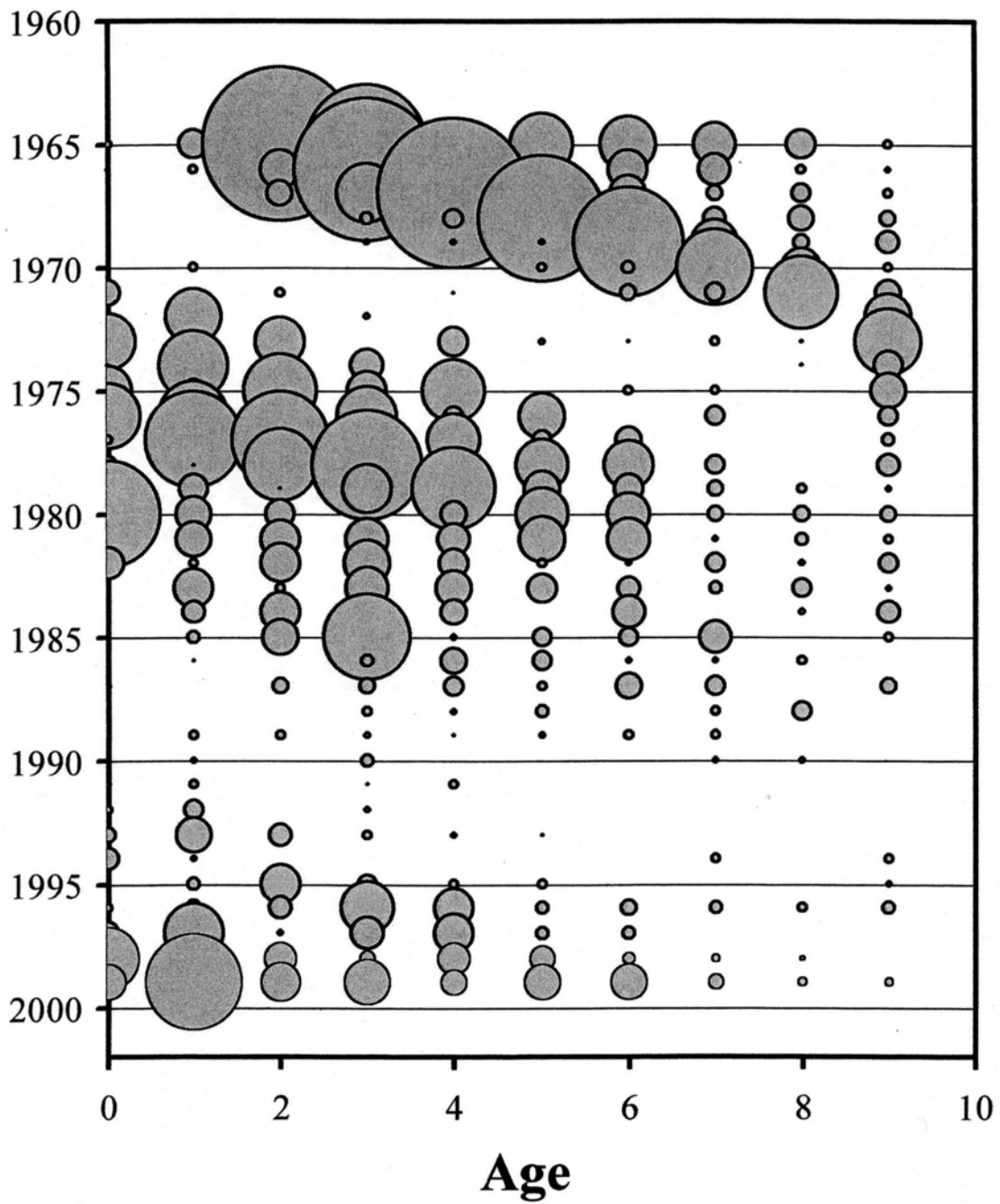


Figure R5. Abundance at age indices (standardized, stratified mean number per tow) from the Northeast Fisheries Science Center Autumn research survey abundance, 1968-1999. The size of the bubbles indicates the relative magnitude of each index.

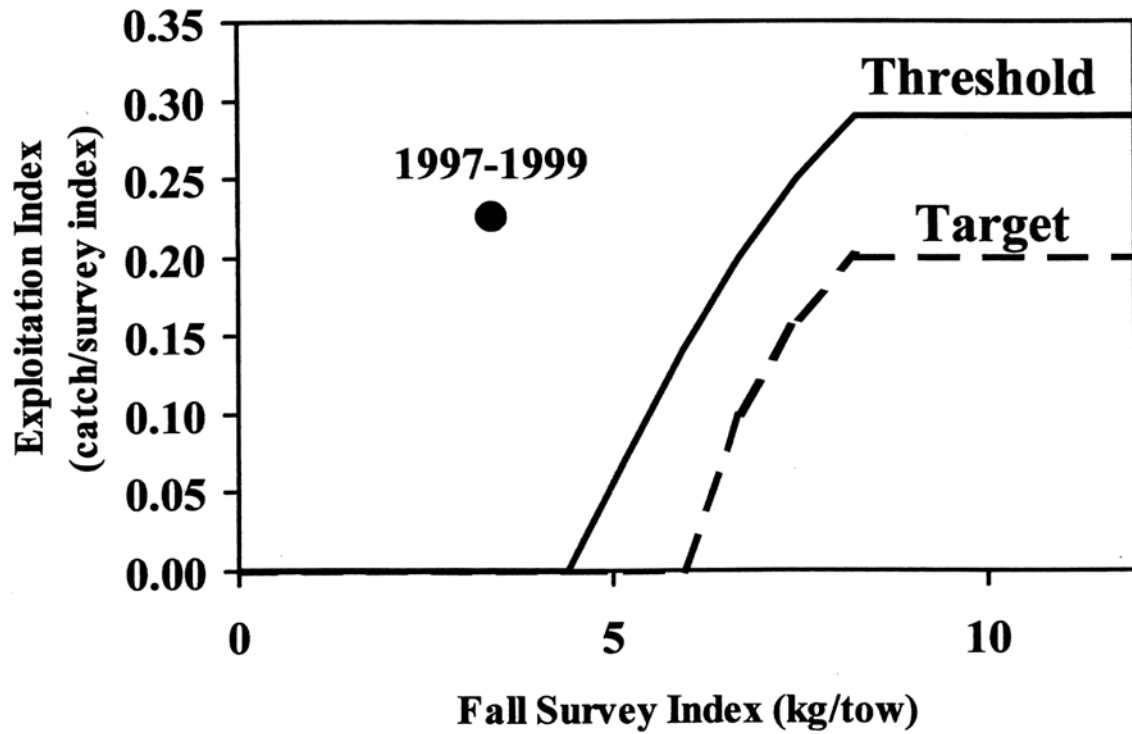


Figure R6. SFA harvest control rule for Gulf of Maine haddock based on proxies of MSY-based reference points and minimum biomass thresholds.