

R. Gulf of Maine Haddock by Jon Brodziak and Michele Traver

1.0 Background

The Gulf of Maine haddock stock was last assessed at the Groundfish Assessment Review Meeting in 2002 (Brodziak and Thompson 2002). Based on the 2002 assessment, stock biomass was overfished in 2001 (B_{2001} was 47% of B_{MSY}) and was not experiencing overfishing (F_{2001} was 52% of F_{MSY}). In this report, we update the Gulf of Maine haddock assessment using fishery data for 2001-2004 and available survey data for 2001-2005. Updated survey biomass and exploitation rate indices are used for stock status determination.

2.0 Assessment for 2005

2.1 2001-2004 Catches

US commercial haddock landings were prorated into Georges Bank and Gulf of Maine stock components using a standard algorithm. Revised prorated Gulf of Maine haddock commercial landings totaled 1,196 mt in 2001, a 0.5% increase over the value reported in the last assessment. Total commercial landings of Gulf of Maine haddock increased from a low of 182 mt in 1995 to over 1,021 mt in 2004. Despite recent increases, commercial landings in 2004 were still less than half of the average annual landings during 1982-1991 (2,564 mt).

Recreational landings of Gulf of Maine haddock were extracted from MRFSS databases for 2001-2004 (Scott Steinback, NEFSC, Personal communication). Revised recreational landings in 2001 totaled 206 mt in 2001, a 1.5% increase over the value reported in the last assessment. Recreational landings have averaged 204 mt per year since 2000 (Figure R1).

2.2 Survey Indices

NEFSC spring survey indices were computed for 2002-2005 (Table B2, Figure B2) and NEFSC autumn survey indices were computed for 2002-2004 (Table B2, Figure B2) using standardized research survey data.

3.0 Assessment Results

3.1 Index-Based Results

An updated index-based assessment was conducted. The 3-year average of the NEFSC autumn survey biomass constituted the stock biomass index, except for 1963-1964 where one- and two-year averages were used (Table R3). Total commercial fishery landings were used for the catch time series (Table R3). Exploitation rate indices for stock status determination were computed as the annual catch divided by the 3-year average stock biomass index (Table R3, Figure R3). The exploitation rate index in 2004 was 0.18, an increase of 50% over the 2001 exploitation rate (0.12) and roughly 78% of the F_{MSY} proxy (0.23).

3.2 Sensitivity of Calculated Exploitation Index to Recreational Landings

Recreational landings of Gulf of Maine haddock have increased in recent years to average almost 20% of annual commercial landings. The sensitivity of the calculated exploitation rate index to the inclusion of recreational landings in the catch time series was evaluated (Table R4). Results indicate that the 2004 exploitation rate index calculated using total commercial and recreational landings was 0.22, about 20% above the index derived using only commercial landings and almost equal to the F_{MSY} proxy.

4.0 Sources of Uncertainty

- Proration of landings are based on preliminary logbook data and are subject to change.
- The amount of interchange between Gulf of Maine and Georges Bank haddock stocks is a source of uncertainty.

5.0 Summary Stock Status

5.1 Biological Reference Points

For Gulf of Maine haddock, the stock biomass index (B_{MSY}) and the proxy exploitation rate index (F_{MSY}) to produce MSY are $B_{MSY} = 22.17$ kg/tow and $F_{MSY} = 0.23$ (NEFSC 2002). The overfished threshold ($B_{THRESHOLD}$) for Gulf of Maine haddock is $B_{THRESHOLD} = \frac{1}{2} B_{MSY} = 11.08$ kg/tow. The overfishing threshold ($F_{THRESHOLD}$) for Gulf of Maine haddock is $F_{THRESHOLD} = F_{MSY} = 0.23$.

5.2 Stock Status in 2004

In 2004, the 3-year stock biomass index was 5.79 kg/tow (52% of $B_{THRESHOLD}$ and 26% of B_{MSY}) with a standard error of 1.06 kg/tow. Based on the biomass index, the Gulf of Maine haddock stock was overfished in 2004. In 2004, the exploitation rate index was 0.18 (78% of $F_{THRESHOLD}$). Therefore, overfishing was not occurring on the Gulf of Maine haddock stock in 2004.

5.3 Comparison with Projected Amendment 13 Rebuilding Trajectory

The projected Amendment 13 rebuilding trajectory for Gulf of Maine haddock was compared to the 3-year survey (B_{2004}) and exploitation rate (E_{2004}) indices in 2004. For this stock, an adaptive rebuilding plan was adopted in which $F_{REBUILD} = F_{MSY} = 0.23$ during 2004-2008. The survey index on the rebuilding trajectory was projected to be $B_{REBUILD} = 21.43$ kg in 2004. For comparison, the approximate 80% confidence interval for B_{2004} was (4.43, 7.15) kg and the $B_{REBUILD}$ in 2004 does not within the probable range of B_{2004} . For the exploitation rate index, the value of $E_{2004} = 0.18$ was below the $F_{REBUILD}$ value for 2004. Overall, this suggests that current estimates of both stock biomass and exploitation rate are below the projected 2004 values on the adaptive rebuilding trajectory.

6.0 GARM Comments

The Panel discussed the recent increase in recreational landings, and its possible effects on the assessment. Recreational catch is regulated only by a minimum size restriction and has accounted for 15-20% of the total landings in recent years, but is not included in the assessment analyses.

The index-based assessment could be sensitive to the inclusion of these landings. The Panel recommended that recreational catch be included in future assessments.

A question was raised as to whether discards have been higher in the Gulf of Maine in recent years. Such a trend, in conjunction with the trend in recreational catches, could increase the exploitation rate index beyond what is accounted for in this model. The Panel's expectation is that discard rates probably have not increased, although effort may have increased due to fishing restrictions on Georges Bank. Furthermore, trip limits apply regardless of stock area, which suggests that these limits may not be as constraining in the Gulf of Maine as they are on Georges Bank. This may indicate a low discard rate in the Gulf of Maine.

The Panel noted that stock rebuilding is not occurring as rapidly as projected in 2003.

Research Recommendations

- Use an age-structured model.
- Include recreational catches with landings data.
- Recent exploitation indices and indices of abundance of the stock are similar to those seen in the 1970s and early 1980s. Investigate whether the current geographic distribution of the stock is also similar to those earlier periods.

7.0 References

Brodziak, J., and M. Thompson. 2002. Gulf of Maine haddock. In NEFSC, *Assessment of 20 northeast groundfish stocks through 2001*, pp. 298-305. *NEFSC Ref. Doc. 02-16*, 509 p. Available at: <http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0216/>

Northeast Fisheries Science Center [NEFSC]. 2001. Assessment of 19 Northeast groundfish stocks through 2000. NEFSC Reference Document 01-20, Woods Hole, MA, 02543.

Northeast Fisheries Science Center [NEFSC]. 2002. Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. NEFSC Reference Document 02-04, Woods Hole, MA, 02543.

Table R1.

Commercial landings (mt, live weight) of haddock from the Gulf of Maine (NAFO Division 5Y; U.S. statistical areas 511-515) from 1956-2004.

Year	United States	Canada	USSR	Other	Total
1956	7278	29	0	0	7307
1957	6141	25	0	0	6166
1958	7082	285	0	0	7367
1959	4497	163	0	0	4660
1960	4541	383	0	0	4924
1961	5297	112	0	0	5409
1962	5003	107	0	0	5110
1963	4742	3	44	0	4789
1964	5383	70	0	0	5453
1965	4204	159	0	0	4363
1966	4579	1125	0	0	5704
1967	4907	589	0	0	5496
1968	3437	120	0	0	3557
1969	2423	59	0	231	2713
1970	1457	38	0	67	1562
1971	1194	85	0	27	1306
1972	909	23	4	0	936
1973	509	49	0	0	558
1974	622	198	0	9	829
1975	1180	79	0	4	1263
1976	1865	91	0	0	1956
1977	3296	26	0	0	3322
1978	4538	641	0	0	5179
1979	4622	257	0	0	4879
1980	7270	203	0	0	7473
1981	5726	513	0	0	6239
1982	5645	1278	0	0	6923
1983	5594	2003	0	0	7597
1984	2793	1245	0	0	4038
1985	2234	781	0	0	3015
1986	1443	225	0	0	1668
1987	829	0	0	0	829
1988	436	0	0	0	436
1989	264	0	0	0	264
1990	433	0	0	0	433
1991	431	0	0	0	431
1992	312	0	0	0	312
1993	193	0	0	0	193
*1994	329	0	0	0	329
*1995	182	0	0	0	182
*1996	1061	0	0	0	1061
*1997	613	0	0	0	613
*1998	1037	0	0	0	1037
*1999	913	0	0	0	913
*2000	774	0	0	0	774
*2001	1196	0	0	0	1196
*2002	1211	0	0	0	1211
*2003	1221	0	0	0	1221
*2004	1021	0	0	0	1021
Average 1956-2004	2712	224	1	7	2943
Average 1980-1999	1887	312			2199
Average 2000-2004	1084				1084

*U.S. landings from 1994-2004 are provisional.

Table R2. NEFSC spring and fall survey indices for Gulf of Maine haddock, 1963-2005.

Year	NEFSC Spring				NEFSC Fall			
	NEFSC Spring Number per Tow	Spring Number per Tow	Spring Weight (kg) per Tow	Spring Weight per Tow	NEFSC Fall Number per Tow	Fall Number per Tow	NEFSC Fall Weight (kg) per Tow	Fall Weight per Tow
1963					69.55	20.46	50.70	8.36
1964					14.18	5.43	18.83	3.52
1965					17.43	6.34	17.64	4.00
1966					11.65	3.88	13.86	4.03
1967					12.19	3.09	16.85	4.44
1968	6.01	1.91	7.89	2.19	8.56	1.43	17.24	2.90
1969	3.78	0.81	7.38	1.87	5.45	1.37	12.85	3.05
1970	0.91	0.23	1.73	0.47	2.92	0.67	7.35	1.66
1971	0.88	0.44	2.52	1.20	2.88	1.01	8.14	2.86
1972	0.86	0.33	0.87	0.56	1.98	0.50	3.04	1.10
1973	1.20	0.35	1.60	0.65	4.17	0.91	8.58	2.90
1974	1.44	0.61	1.06	0.47	2.69	1.64	3.35	1.13
1975	2.77	0.81	3.48	1.65	4.54	1.24	6.81	2.26
1976	8.33	3.01	6.35	2.49	6.04	1.50	8.04	2.37
1977	6.80	2.30	6.73	2.80	8.30	2.88	8.75	2.62
1978	1.36	0.62	1.43	0.45	9.78	1.77	21.66	4.30
1979	3.33	0.69	3.95	0.93	6.17	1.30	15.57	3.52
1980	2.70	0.98	2.67	1.35	7.15	2.67	9.84	2.54
1981	4.41	0.96	3.55	0.85	4.46	0.88	10.87	2.64
1982	2.05	0.73	2.56	0.97	2.63	1.00	4.16	1.30
1983	3.68	1.68	3.57	1.72	2.60	0.82	5.22	1.61
1984	1.10	0.50	1.14	0.53	1.70	0.51	3.89	1.16
1985	1.77	0.74	1.88	0.62	4.08	1.78	6.15	1.99
1986	0.71	0.36	1.28	0.70	0.62	0.28	1.39	0.59
1987	0.09	0.04	0.06	0.04	1.04	0.35	2.65	0.75
1988	0.19	0.11	0.30	0.20	0.34	0.23	1.48	1.13
1989	0.08	0.07	0.12	0.11	0.28	0.12	0.63	0.33
1990	0.02	0.01	0.00	0.00	0.15	0.06	0.43	0.17
1991	0.07	0.04	0.07	0.05	0.14	0.09	0.12	0.09
1992	0.19	0.12	0.27	0.27	0.21	0.13	0.09	0.06
1993	0.45	0.23	0.20	0.16	0.87	0.71	0.47	0.45
1994	0.40	0.15	0.25	0.11	0.33	0.15	0.22	0.21
1995	0.81	0.41	0.35	0.17	0.98	0.60	1.10	0.50
1996	0.31	0.10	0.34	0.13	2.41	0.97	3.54	1.63
1997	1.94	0.85	1.22	0.69	2.69	1.07	2.42	0.75
1998	0.20	0.09	0.11	0.05	3.13	1.73	2.92	1.32
1999	4.27	1.87	1.11	0.44	6.73	2.12	4.91	1.25
2000	3.61	1.62	1.82	0.83	16.59	8.29	14.03	6.10
2001	2.36	1.55	3.22	2.31	9.96	2.92	11.98	3.33
2002	5.70	3.22	2.79	0.99	3.92	1.49	4.84	1.75
2003	3.19	0.87	3.91	1.20	4.73	1.15	5.36	1.37
2004	1.06	0.40	1.20	0.53	5.70	1.64	7.17	2.28
2005	0.86	0.38	0.97	0.51				
Average 1963-2005	2.10	0.79	2.10	0.82	6.47	2.08	8.22	2.15
Average 1980-1999	1.27	0.50	1.05	0.46	2.13	0.81	3.13	1.03
Average 2000-2005	2.80	1.34	2.32	1.06	8.18	3.10	8.68	2.96

Table R3.

Exploitation rate index for Gulf of Maine haddock based on autumn NEFSC survey biomass index and annual commercial landings, 1963-2004.

Year	Commercial Landings	Survey Index	3-Year Average Survey Index	Exploitation Rate Index
1963	4.789	50.70	50.70	0.09
1964	5.453	18.83	34.76	0.16
1965	4.363	17.64	29.06	0.15
1966	5.704	13.86	16.78	0.34
1967	5.496	16.85	16.12	0.34
1968	3.557	15.48	15.40	0.23
1969	2.713	12.85	15.06	0.18
1970	1.562	7.35	11.90	0.13
1971	1.306	8.14	9.45	0.14
1972	0.936	3.04	6.18	0.15
1973	0.558	8.58	6.59	0.08
1974	0.829	3.35	4.99	0.17
1975	1.263	8.62	6.85	0.18
1976	1.956	8.04	6.67	0.29
1977	3.322	8.75	8.47	0.39
1978	5.179	20.93	12.57	0.41
1979	4.879	13.72	14.47	0.34
1980	7.473	9.84	14.83	0.50
1981	6.239	9.34	10.97	0.57
1982	6.923	4.16	7.78	0.89
1983	7.597	5.22	6.24	1.22
1984	4.038	3.89	4.43	0.91
1985	3.025	6.15	5.09	0.59
1986	1.668	1.39	3.81	0.44
1987	0.829	2.65	3.40	0.24
1988	0.436	1.48	1.84	0.24
1989	0.264	0.63	1.58	0.17
1990	0.433	0.43	0.85	0.51
1991	0.431	0.12	0.39	1.09
1992	0.312	0.09	0.21	1.46
1993	0.193	0.47	0.23	0.85
1994	0.329	0.22	0.26	1.27
1995	0.182	1.10	0.60	0.31
1996	1.061	3.54	1.62	0.66
1997	0.613	2.42	2.36	0.26
1998	1.037	2.92	2.96	0.35
1999	0.913	4.91	3.42	0.27
2000	0.774	14.03	7.29	0.11
2001	1.196	11.98	10.31	0.12
2002	1.211	4.84	10.28	0.12
2003	1.221	5.36	7.39	0.17
2004	1.021	7.17	5.79	0.18
Average 1963-2004	2.459	8.12	9.05	0.41
Average 1980-1999	2.200	3.05	3.64	0.64
Average 2000-2004	1.085	8.68	8.21	0.14

Table R4.

Sensitivity analysis of the exploitation rate index
for Gulf of Maine haddock using total commercial
and recreational landings, 1963-2004

Year	Total Landings	Survey Index	3-Year Average Survey Index	Exploitation Rate Index
1963	4.789	50.70	50.70	0.09
1964	5.453	18.83	34.76	0.16
1965	4.363	17.64	29.06	0.15
1966	5.704	13.86	16.78	0.34
1967	5.496	16.85	16.12	0.34
1968	3.557	15.48	15.40	0.23
1969	2.713	12.85	15.06	0.18
1970	1.562	7.35	11.90	0.13
1971	1.306	8.14	9.45	0.14
1972	0.936	3.04	6.18	0.15
1973	0.558	8.58	6.59	0.08
1974	0.829	3.35	4.99	0.17
1975	1.263	8.62	6.85	0.18
1976	1.956	8.04	6.67	0.29
1977	3.322	8.75	8.47	0.39
1978	5.179	20.93	12.57	0.41
1979	4.879	13.72	14.47	0.34
1980	7.473	9.84	14.83	0.50
1981	6.239	9.34	10.97	0.57
1982	6.997	4.16	7.78	0.90
1983	7.634	5.22	6.24	1.22
1984	4.054	3.89	4.43	0.92
1985	3.024	6.15	5.09	0.59
1986	1.668	1.39	3.81	0.44
1987	0.856	2.65	3.40	0.25
1988	0.440	1.48	1.84	0.24
1989	0.282	0.63	1.58	0.18
1990	0.433	0.43	0.85	0.51
1991	0.431	0.12	0.39	1.09
1992	0.312	0.09	0.21	1.46
1993	0.193	0.47	0.23	0.85
1994	0.331	0.22	0.26	1.27
1995	0.347	1.10	0.60	0.58
1996	1.069	3.54	1.62	0.66
1997	0.657	2.42	2.36	0.28
1998	1.092	2.92	2.96	0.37
1999	0.941	4.91	3.42	0.28
2000	0.964	14.03	7.29	0.13
2001	1.402	11.98	10.31	0.14
2002	1.378	4.84	10.28	0.13
2003	1.429	5.36	7.39	0.19
2004	1.256	7.17	5.79	0.22

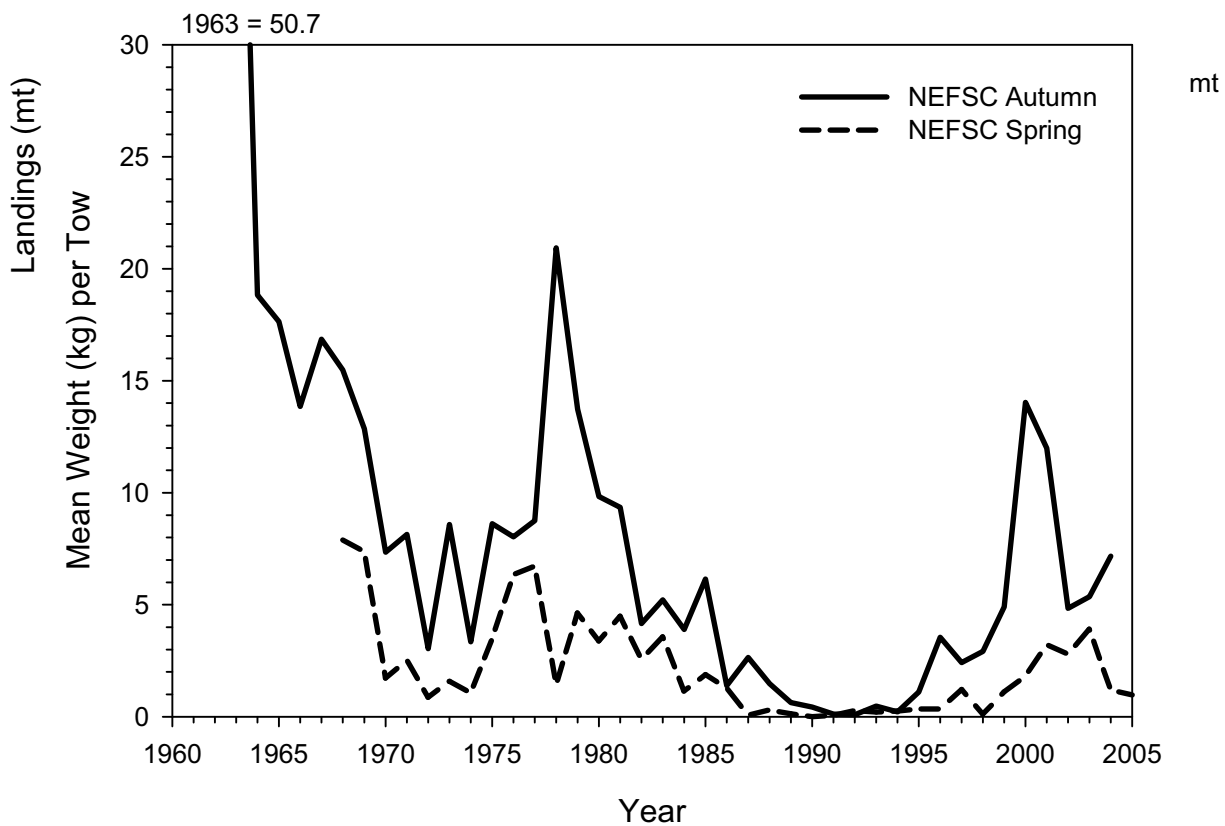
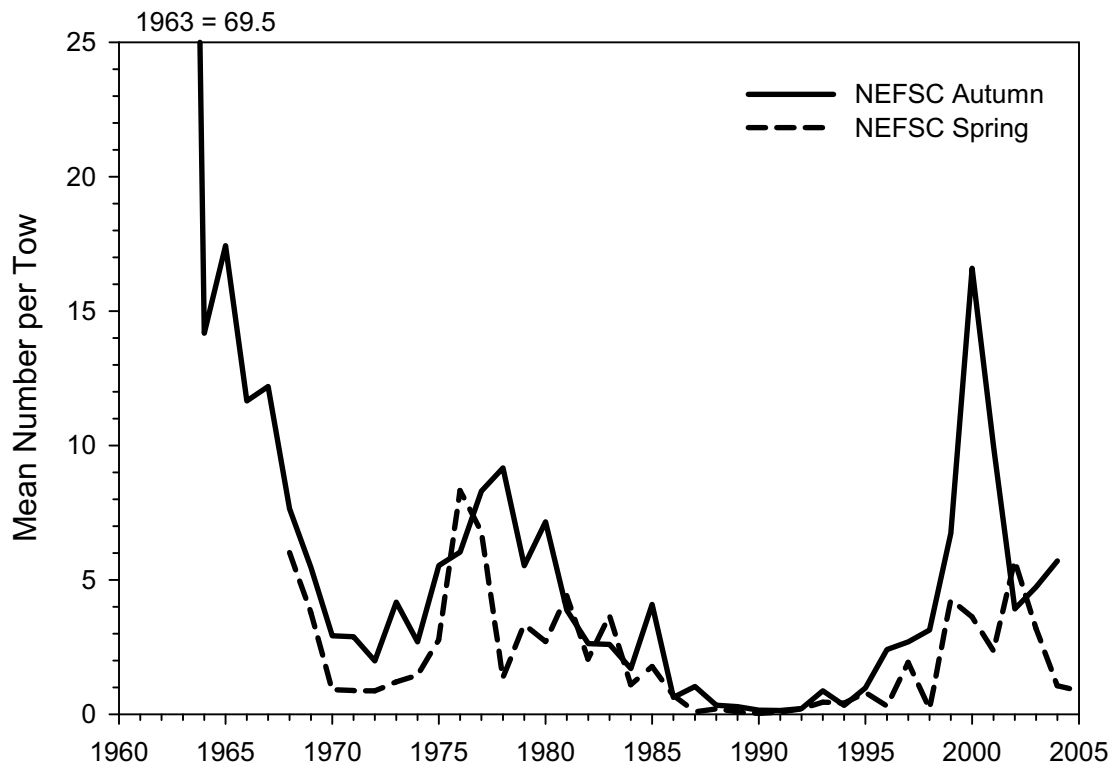


Figure R2. Northeast Fisheries Science Center research standardized and stratified survey abundance (mean number per tow; top panel) and biomass (kg per tow; bottom panel) indices for Gulf of Maine haddock from 1963-2002. U.S. survey includes strata 01260-01280 and 01360-01400.

Figure R3. Gulf of Maine haddock exploitation rate index, 1963-2000

