

Gulf of Maine Atlantic Cod

2017 Assessment Update Report Supplemental Information

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

Last update: August 17, 2017

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Overview

This supplemental report is intended to augment the condensed assessment report. It contains more detailed information on assessment data preparations and inputs, in addition to providing detailed assessment model diagnostics and results. This report is not a substitute for the formal assessment report, but rather provides additional details that users of stock assessment information may find useful.

References

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Tables

Table 1. Summary of major regulatory actions that have affected the Gulf of Maine Atlantic cod fishery since 1973.

Date	Regulatory action	Cod end minimum mesh size (in)	Minimum fish size (in)		Commercial trip limits	Recreational trip limits	Closures	Differential DAS Counting
			Commercial	Recreational				
01/01/73		4.5	?	?				
01/01/77	Groundfish FMP	5.125	16	16				
01/01/82			17	15				
01/01/83		5.5						
01/01/89			19	19				
04/01/92					Shrimp trawl fishery: Nordmore grate regulation, groundfish bycatch prohibited			
05/01/94	Amendment 5	6.0						DAS monitoring w/ reduction schedule, mandatory reporting
05/01/96	Amendment 7		20					Accelerated DAS reduction
05/01/97	Framework 20		21		1000 lbs/day, 1500 lbs/day			
05/01/98	Framework 25				700 lbs/day		WGOM (Jeffreys Ledge, Stellwagen Bank)	
06/25/98					400 lbs/day			
02/01/99	Framework 26						Additional month-block closures for February to April	
05/01/99	Framework 27	6.5 square/6.0 diamond			200 lbs/day			
05/28/99					30 lbs/day			
08/03/99	Interim rule				100 lbs/day			
01/05/00	Framework 31				400 lbs/day (4000 lb/trip)		Additional month-block closures for February	
06/01/00	Framework 33	6.5 square/6.5 diamond						
11/01/00							One month closure of Cashes Ledge	
05/01/02	Interim rule		22	23	500 lb/day (4000 lb/trip)	10 cod/person	Additional month-block closures for May - June 2003; Cashes Ledge Closed year round	20% reduction in DAS
06/01/02	Revised interim rule	19						
08/01/02	Emergency rule	22				5 - 10 cod/person (seasonal)		
05/01/04	Amendment 13				800 lb/day (4000 lb/trip)		WGOM, Cashes Ledge and rolling closures continued	Further reduction in DAS
11/22/06	FW 42		24			Possession prohibited November to March 31st		DAS counted 2:1 in inshore GOM
05/01/09	Interim rule					Possession prohibited November to April 15		
05/01/10	Amendment 16				Common pool: 800 lb/day (4000 lb/trip)	10 cod/person, possession prohibited November to April 15	Some changes to rolling closures for sector vessels	DAS counted in 24 -hour blocks; no differential DAS counting except as AMs
05/01/12			19			9 cod/person, possession prohibited November to April 15		
07/01/13		19						Various DAS and trip limit adjustments to common pool vessels
05/01/14			21			9 cod/person, possession prohibited September to April 15		
11/13/14					200 lbs/trip	No retention allowed	Expanded cod mortality closures	
03/03/15					Trip limits removed for some sectors			
05/01/15			N/A			No retention allowed		
05/01/16						1 cod/person in August and September		

Table 2. Estimates of Gulf of Maine Atlantic cod catch (mt) by fleet (commercial, recreational) and disposition (landed, discarded) from 1982 to 2016. *Discard amounts have been adjusted to account for mortality assumptions adopted at the SAW/SARC 55 assessment (NEFSC 2013; commercial longline = 33%, commercial trawl = 75%, commercial gillnet = 80%) as well as a revised estimate of recreational discards (15%, Capizzano et al. 2016).*

Year	Recreational discards (mt)	Recreational landings (mt)	Commercial discards (mt)	Commercial landings (mt)	Total catch (mt)
1982	4.1	2,816.7	805.4	13,465.9	17,092.1
1983	8.8	1,772.8	829.1	13,867.4	16,478.1
1984	8.3	1,266.8	858.9	10,725.3	12,859.3
1985	8.4	2,765.9	962.9	10,645.3	14,382.5
1986	5.0	1,928.4	964.2	9,669.6	12,567.4
1987	24.0	3,547.2	884.0	7,526.2	11,981.4
1988	6.8	1,688.5	682.9	7,948.2	10,326.4
1989	38.0	1,957.2	786.9	10,550.7	13,332.8
1990	33.4	2,246.7	1,560.6	15,439.7	19,280.4
1991	34.0	2,287.2	663.9	17,959.0	20,944.1
1992	17.7	623.6	668.6	11,019.4	12,329.3
1993	51.0	1,011.9	479.8	8,366.7	9,909.4
1994	50.3	721.7	207.5	8,030.2	9,009.8
1995	48.1	627.2	235.4	6,606.8	7,517.5
1996	40.5	498.6	157.2	7,019.8	7,716.2
1997	29.4	236.3	87.1	5,432.1	5,784.9
1998	36.1	353.1	78.5	4,074.3	4,541.9
1999	35.8	577.2	1,021.9	1,407.4	3,042.3
2000	68.8	967.1	946.1	3,771.8	5,753.9
2001	113.7	1,967.6	1,545.4	4,314.4	7,941.2
2002	143.4	1,254.8	1,329.1	3,638.3	6,365.7
2003	141.2	1,607.7	741.0	3,865.6	6,355.5
2004	97.6	1,257.8	631.1	3,782.3	5,768.8
2005	129.0	1,301.5	269.5	3,557.6	5,257.6
2006	94.6	741.0	342.3	3,029.4	4,207.3
2007	154.4	1,162.5	178.4	3,989.8	5,485.0
2008	153.3	1,240.5	349.2	5,443.5	7,186.5
2009	142.4	1,399.3	752.3	5,952.9	8,246.7
2010	187.6	1,802.6	170.8	5,356.4	7,517.4
2011	163.9	1,812.6	98.8	4,597.9	6,673.2
2012	48.0	571.4	93.4	2,759.0	3,471.7
2013	69.4	705.4	51.5	950.8	1,777.1
2014	84.8	527.6	26.4	831.8	1,470.6
2015	79.7	4.5	14.0	227.0	325.2
2016	176.0	94.8	8.1	320.4	599.3

Table 3. Total numbers of Gulf of Maine Atlantic cod lengths sampled from commercial landings by market category and year between 1969 and 2016. Sampling intensity is expressed as metric tons landings per 100 lengths sampled (*200 metric tons per 100 lengths is an unofficial NAFO/ICNAF standard*). Cells shaded in grey indicate where lengths were aggregated semi-annually. Cells shaded orange indicate where lengths were aggregated annually. Aggregation occurred when length sampling was insufficient; a general criterion of 100 lengths/block was used to determine sufficiency.

Year	Scrod (0814)				Market (0813)				Large (0811)				Unclassified (0815)				Total lengths	Landings (mt)	Metric tons/100 lengths
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4			
1969																	114	7,828	6,867.0
1970																	387	7,512	1,941.0
1971																	0	7,193	
1972																	0	6,786	
1973																	0	6,061	
1974	102																203	7,425	3,657.8
1975		186		62													248	8,676	3,498.4
1976																	157	9,878	6,291.5
1977	101	66	402	1,012													2,525	11,993	475.0
1978	407	455	65														2,256	11,890	527.0
1979	56		58	116													755	10,972	1,453.3
1980	213	100	51														576	12,515	2,172.7
1981	52	57	81	236													1,189	12,382	1,041.3
1982	401	488	484	308													4,169	13,466	323.0
1983	712	626	578	253													5,294	13,867	261.9
1984	344	271	342	378													4,019	10,725	266.9
1985	263	352	449	241													5,284	10,645	201.5
1986	229	264	319	160													4,069	9,670	237.6
1987	281	232	165	271													3,188	7,526	236.1
1988	298	99	215	249													2,619	7,948	303.5
1989	154	170	201	174													2,718	10,551	388.2
1990	156	362	165	260													2,981	15,440	517.9
1991	100	533	192	215													4,676	17,959	384.1
1992	118	443	320	180													4,086	11,019	269.7
1993	159	173	174	55													1,753	8,367	477.3
1994		102	107	181													2,658	8,030	302.1
1995		211	196	107	249												2,557	6,607	258.4
1996		278	275	491	691												6,486	7,020	108.2
1997		520	848	188	751												7,559	5,432	71.9
1998		295	383		101												4,536	4,074	89.8
1999		385															1,073	1,407	131.2
2000		694	304	294	426												5,921	3,772	63.7
2001		189	215	216	404												7,117	4,314	60.6
2002		106	80	39													5,263	3,638	69.1
2003		254	66	214	73												11,479	3,866	33.7
2004		361	299	233	73												11,235	3,782	33.7
2005		73	193	324	506												10,404	3,558	34.2
2006		494	167	294	125												10,770	3,029	28.1
2007		291	174	315	293												10,689	3,990	37.3
2008		536	251	203	85												10,922	5,443	49.8
2009		407	62	141													14,871	5,953	40.0
2010		150	53	199													17,451	5,356	30.7
2011		287	320	144	577												18,682	4,598	24.6
2012		458	63	322													11,007	2,759	25.1
2013		236	181	282	385												8,071	951	11.8
2014		292	421	262	480												8,446	832	9.8
2015		140	95	44	31												5,362	227	4.2
2016		156	320		119												7,570	320	4.2

Table 4. Total numbers of Gulf of Maine Atlantic cod aged otoliths sampled from commercial landings by quarter between 1977 and 2016.

Year	1	2	Quarter	Total	Landings (mt)	Metric tons/100
	3	4				
1977	20	114	229	205	568	11,993
1978	124	124	115	20	383	11,890
1979	10	20	48	52	130	10,972
1980	35	27	15		77	12,515
1981	12	15	67	170	264	12,382
1982	194	237	251	183	865	13,466
1983	277	513	400	158	1,348	13,867
1984	245	350	296	337	1,228	10,725
1985	446	377	397	323	1,543	10,645
1986	243	360	398	173	1,174	9,670
1987	252	229	226	228	935	7,526
1988	131	223	187	196	737	7,948
1989	206	129	203	165	703	10,551
1990	140	302	171	150	763	15,440
1991	126	447	385	152	1,110	17,959
1992	220	298	264	178	960	11,019
1993	72	130	186	49	437	8,367
1994	21	195	149	308	673	8,030
1995	144	311	101	126	682	6,607
1996	190	315	426	449	1,380	7,020
1997	395	632	331	285	1,643	5,432
1998	192	325	276	199	992	4,074
1999	227	27	11		265	1,407
2000	639	481	205	396	1,721	3,772
2001	280	574	674	950	2,478	4,314
2002	1,320	301	437	347	2,405	3,638
2003	1,046	1,111	1,948	1,525	5,630	3,866
2004	1,880	1,011	425	228	3,544	3,782
2005	494	644	1,117	1,287	3,542	3,558
2006	1,109	806	1,225	1,197	4,337	3,029
2007	719	1,020	1,138	1,030	3,907	3,990
2008	858	1,225	1,213	1,173	4,469	5,443
2009	947	1,407	1,684	2,222	6,260	5,953
2010	1,335	1,235	1,856	1,103	5,529	5,356
2011	735	1,867	1,555	1,412	5,569	4,598
2012	767	1,368	914	837	3,886	2,759
2013	1,070	1,390	1,143	834	4,437	951
2014	614	1,026	767	713	3,120	832
2015	962	711	289	1,088	3,050	227
2016	1,297	894	862	942	3,995	320

Table 5. Total Gulf of Maine Atlantic cod commercial landings-at-age (numbers) from 1982 to 2016.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16
1982	0	27,609	1,335,509	1,634,173	1,116,072	619,571	51,241	69,146	59,375	43,415	32,683	6,285	898	0	0	0	0
1983	0	0	833,083	2,413,843	1,067,910	627,331	407,393	44,212	57,669	25,845	12,747	3,800	3,515	1,719	2,599	0	0
1984	0	2,782	425,538	1,227,232	1,504,575	396,710	195,918	96,402	9,105	16,794	14,229	11,957	2,335	3,863	1,235	0	0
1985	0	0	387,614	1,440,985	1,002,193	615,000	123,315	73,198	32,430	3,962	10,619	2,438	4,573	1,583	470	0	0
1986	0	0	85,363	2,187,322	818,717	239,742	161,736	38,700	27,497	19,813	4,745	1,497	3,940	2,434	306	0	0
1987	0	442	193,735	627,766	1,116,907	267,706	64,579	45,981	5,481	8,410	9,270	182	607	0	2,129	0	0
1988	0	0	167,468	1,356,369	907,960	400,942	58,792	21,864	20,247	3,257	2,438	1,213	0	0	606	0	0
1989	0	0	322,130	1,486,592	1,354,890	451,857	70,570	58,876	7,931	2,238	9,000	3,945	0	1,127	1,127	0	0
1990	0	0	210,618	3,403,626	2,227,578	452,797	151,887	25,246	24,675	7,680	16,034	11,764	2,353	3,597	0	0	0
1991	0	0	198,915	609,915	4,543,525	904,421	138,556	42,961	25,983	7,877	4,698	2,571	0	0	0	0	0
1992	0	0	302,552	527,720	432,280	1,969,905	213,021	77,420	5,837	4,488	1,042	0	0	0	0	0	0
1993	0	0	25,866	1,543,228	729,548	92,745	464,198	37,780	11,264	0	0	0	0	0	0	0	0
1994	0	0	29,014	1,055,313	1,170,244	240,940	63,586	69,917	28,114	6,108	384	1,008	0	0	0	0	0
1995	0	0	183,724	938,703	1,056,404	207,195	28,494	6,521	17,992	580	2,228	0	0	0	0	0	0
1996	0	0	55,763	507,349	1,763,068	375,559	35,144	3,903	413	845	0	0	0	0	0	0	0
1997	0	0	77,455	434,378	435,036	800,750	67,415	5,368	2,080	393	636	0	0	0	0	0	0
1998	0	0	87,919	391,916	544,744	139,369	187,088	27,507	4,853	1,495	762	0	0	0	0	0	0
1999	0	0	2,858	179,688	191,438	66,127	23,995	22,398	7,504	1,035	0	0	0	0	0	0	0
2000	0	0	102,341	258,469	501,545	124,105	66,295	9,007	6,465	0	0	0	0	0	0	0	0
2001	0	0	43,737	471,763	326,442	206,475	65,902	38,490	5,509	8,803	1,006	0	0	0	0	0	0
2002	0	0	1,439	111,287	433,957	170,415	102,971	41,667	12,019	3,750	4,055	434	80	0	40	0	0
2003	0	0	8,113	47,543	198,476	380,859	120,697	52,001	19,769	9,173	4,250	2,812	472	0	0	0	0
2004	0	0	492	142,749	130,172	220,142	170,502	52,305	26,442	13,941	6,789	1,414	620	0	0	0	0
2005	0	0	1,217	37,890	423,154	64,419	178,040	83,220	21,459	12,366	5,056	3,125	1,817	500	0	0	0
2006	0	0	777	115,306	181,958	300,653	21,412	62,692	29,111	10,477	5,994	2,537	1,242	953	180	0	0
2007	0	0	5,209	95,694	629,852	99,105	178,429	5,952	15,582	7,698	3,753	1,468	1,323	1,174	126	345	0
2008	0	0	4,142	283,069	465,757	600,316	53,944	82,494	2,490	6,652	3,224	986	473	367	234	104	21
2009	0	0	2,700	283,610	718,934	333,800	199,827	16,653	20,518	857	2,311	1,072	952	224	127	61	49
2010	0	0	1,683	121,449	578,192	463,641	114,076	59,845	8,069	2,947	446	476	162	112	17	28	0
2011	0	0	534	97,964	296,737	396,070	256,786	26,149	29,090	4,906	1,177	196	538	68	178	0	0
2012	0	0	10,688	128,853	288,100	174,639	109,225	53,408	7,150	2,173	1,149	31	0	93	0	0	0
2013	0	142	11,438	91,528	74,399	72,869	14,160	10,023	6,344	591	197	116	0	0	0	0	0
2014	0	0	11,474	109,780	113,811	36,559	17,115	5,273	1,416	647	48	21	5	0	5	0	0
2015	0	0	1,213	9,087	36,347	12,773	1,455	1,680	290	92	116	12	0	0	0	0	0
2016	0	0	452	21,504	26,618	36,862	3,841	1,236	604	141	42	47	0	0	0	0	0

Table 6. Coefficients of variation (CV) on the estimates of Gulf of Maine Atlantic cod commercial landings numbers-at-age from 1984 to 2016 (CVs greater than 0.3 are shaded grey). Note that prior to 1984 CVs could not be calculated due to the inability to identify discreet sampling events.

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15	Age 16
1984		0.74	0.12	0.04	0.02	0.04	0.06	0.06	0.17	0.16	0.22	0.20	0.39	0.29	0.69		
1985		0.08	0.06	0.04	0.03	0.05	0.05	0.10	0.25	0.14	0.27	0.35	0.48	0.76			
1986		0.18	0.05	0.04	0.06	0.08	0.14	0.13	0.20	0.44	0.56	0.37	0.65	0.89			
1987	1.35	0.19	0.07	0.04	0.07	0.09	0.15	0.29	0.28	0.43	0.90	0.44			0.68		
1988		0.29	0.06	0.05	0.06	0.09	0.15	0.24	0.48	0.81	0.81					1.32	
1989		0.38	0.08	0.09	0.07	0.14	0.24	0.33	0.56	0.23	0.34			0.68	0.69		
1990		0.26	0.07	0.08	0.13	0.24	0.47	0.36	0.41	0.26	0.28	0.67	0.70				
1991		0.23	0.15	0.04	0.11	0.12	0.23	0.31	0.27	1.02	0.64						
1992		0.18	0.20	0.13	0.06	0.11	0.18	0.62	0.56	0.88							
1993		0.89	0.09	0.18	0.29	0.11	0.34	0.41									
1994		0.49	0.10	0.07	0.27	0.25	0.21	0.22	0.64	1.02	0.89						
1995		0.25	0.12	0.09	0.10	0.35	0.23	0.21	1.05	0.61							
1996		0.27	0.10	0.04	0.14	0.20	0.28	0.95	0.69								
1997		0.20	0.09	0.07	0.06	0.14	0.32	0.27	0.62	0.60							
1998		0.16	0.11	0.07	0.15	0.15	0.27	0.37	0.49	0.99							
1999		0.19	0.12	0.31	0.36	0.23	0.17	0.58									
2000		0.14	0.08	0.06	0.12	0.23	0.49	0.55									
2001		0.24	0.06	0.07	0.08	0.11	0.14	0.30	0.28	0.59							
2002		1.11	0.22	0.05	0.09	0.07	0.11	0.15	0.29	0.26	0.48	1.21		1.38			
2003		0.35	0.17	0.05	0.03	0.06	0.07	0.10	0.17	0.19	0.23	0.46					
2004		1.38	0.11	0.07	0.07	0.06	0.09	0.13	0.21	0.23	0.49	0.75					
2005		0.66	0.15	0.05	0.08	0.09	0.08	0.12	0.12	0.15	0.21	0.26	0.42				
2006		1.02	0.17	0.06	0.04	0.14	0.09	0.09	0.14	0.11	0.17	0.22	0.27	0.56			
2007		0.49	0.13	0.04	0.08	0.10	0.27	0.19	0.12	0.15	0.25	0.23	0.27	0.69	0.46		
2008		0.72	0.10	0.05	0.05	0.13	0.08	0.39	0.16	0.17	0.29	0.38	0.44	0.56	0.80	1.43	
2009		0.52	0.10	0.05	0.09	0.07	0.18	0.12	0.25	0.17	0.26	0.26	0.40	0.59	0.90	1.01	
2010		0.50	0.12	0.04	0.04	0.08	0.10	0.13	0.16	0.38	0.34	0.66	0.67	1.38	1.42		
2011		0.28	0.04	0.02	0.01	0.01	0.02	0.02	0.07	0.14	0.34	0.26	0.72	0.45			
2012		0.35	0.09	0.05	0.07	0.07	0.10	0.29	0.35	0.23	0.95	0.62					
2013	1.31	0.17	0.05	0.06	0.06	0.11	0.10	0.14	0.24	0.35	0.41				1.32		
2014		0.19	0.05	0.04	0.09	0.12	0.21	0.21	0.20	0.49	0.67	1.38		1.32			
2015		0.38	0.10	0.04	0.07	0.18	0.17	0.27	0.38	0.57	0.98						
2016		0.54	0.10	0.05	0.04	0.09	0.19	0.20	0.32	0.62	0.48						
Average		1.14	0.41	0.10	0.06	0.09	0.13	0.18	0.26	0.34	0.43	0.48	0.52	0.50	0.86	0.90	1.22

Table 7. Mean weights-at-age (kg) of commercially landed Gulf of Maine Atlantic cod from 1982 to 2016.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16
1982		0.831	1.177	1.669	2.790	5.006	7.097	9.580	9.945	12.789	19.365	16.480	22.443				
1983			1.172	1.621	2.428	3.812	6.058	5.982	10.480	11.548	11.138	18.890	12.669	24.552	22.224		
1984		0.569	1.179	1.656	2.679	3.568	5.563	8.541	10.290	13.711	14.485	14.318	15.430	17.886	19.285		
1985			1.312	1.740	2.820	4.528	5.610	8.436	11.238	12.479	14.280	13.394	16.112	16.739	22.012		
1986			1.392	1.819	2.905	4.691	6.272	7.994	9.826	13.592	13.496	15.888	15.808	20.232	16.834		
1987		0.998	1.369	1.719	3.252	4.805	6.912	9.318	10.769	14.810	16.101	13.418	8.066		22.379		
1988			1.293	1.943	2.448	5.282	5.315	6.374	9.951	10.434	17.787	9.857			21.886		
1989			1.314	1.763	3.055	4.242	5.943	9.379	13.425	16.500	20.410	22.606		27.911	27.896		
1990			1.247	1.660	2.238	4.380	7.816	11.229	12.270	15.999	16.344	22.690	23.134	22.138			
1991			1.489	1.834	2.412	4.031	7.164	9.689	12.261	15.093	6.203		24.937				
1992			1.608	1.941	2.899	3.070	5.699	10.984	10.766	13.418	19.072						
1993			1.356	1.930	2.350	4.595	5.802	9.649	13.673								
1994			1.434	1.955	3.186	3.349	6.350	7.787	12.422	10.012	22.008	22.643					
1995			1.588	1.774	2.838	5.187	7.054	11.466	13.223	19.756	23.143						
1996			1.746	2.258	2.337	3.532	7.523	11.759	14.795	16.331							
1997			1.846	2.291	3.093	3.162	4.829	9.027	12.177	15.625	17.749						
1998			1.396	2.020	2.726	4.025	4.376	7.235	12.111	17.500	15.060						
1999			1.545	1.741	2.539	3.390	5.049	7.563	10.220	12.279							
2000			1.736	2.608	3.635	4.678	6.158	5.600	8.939								
2001			1.937	2.556	3.400	5.036	6.544	7.684	9.213	8.945	17.660						
2002			1.326	2.706	3.378	4.269	6.300	7.072	8.965	10.167	10.786	15.353	17.249		18.746		
2003			1.871	2.475	3.279	4.321	5.544	7.584	8.892	10.909	12.121	13.709	14.362				
2004			1.648	2.689	3.686	4.261	5.976	7.590	9.902	12.654	14.059	11.423	22.553				
2005			1.926	2.274	3.118	4.584	4.793	6.447	8.066	11.054	13.942	14.901	15.362	19.605			
2006			2.671	2.540	3.437	3.877	4.905	5.673	7.605	9.709	12.724	16.000	15.761	20.480	20.326		
2007			2.090	2.616	3.317	4.053	5.014	6.518	7.182	10.140	12.199	13.344	14.213	17.126	21.784	21.757	
2008			1.848	2.768	3.145	3.811	4.777	6.036	6.106	8.583	11.258	13.800	16.189	19.251	19.918	18.735	
2009			1.939	2.766	3.532	3.972	4.775	6.007	8.367	11.208	10.805	12.934	15.971	15.803	22.452	22.812	
2010			2.228	2.731	3.528	4.268	4.874	5.550	8.478	10.152	11.016	13.209	12.519	16.891	20.103	16.834	
2011			1.746	2.724	3.389	4.094	4.988	5.934	6.076	11.750	12.190	17.376	17.827	23.845	19.502		
2012			1.903	2.927	3.146	3.593	4.300	5.337	5.407	7.951	12.770	21.458		18.259			
2013	1.295	1.615	2.636	3.182	3.856	4.184	5.782	7.227	10.357	10.854	15.982						
2014		1.857	2.121	3.089	3.179	4.206	4.083	6.718	8.69	14.405	16.552	19.247		17.299			
2015		1.420	2.310	3.404	4.571	4.857	5.725	8.295	11.228	16.038	14.739						
2016		1.718	2.223	3.421	3.967	5.632	5.123	6.923	9.602	10.479	13.019						

Table 8. Total number of Gulf of Maine trips observed from 1989 to 2016, summarized by gear type. *The 2010-14 numbers include trips observed by both at-sea monitors and observers. The Gulf of Maine region is defined by statistical areas 464, 465, 467, 511-515.*

Year	Longline	Otter trawl		Shrimp trawl	Sink Gillnet		Total
		Small mesh (< 5.5")	Large mesh (>= 5.5")		Large mesh (5.5" - 7.99")	Extra large mesh (>= 8.0")	
1989		23	44	40	84		191
1990		8	26	31	120		185
1991	2	29	53	52	801		937
1992	9	15	45	82	896		1,047
1993	2	6	17	81	560		666
1994			9	77	82	7	175
1995		30	29	73	62	14	208
1996		40	19	35	39	10	143
1997		3	7	16	31	5	62
1998			7		78	6	91
1999		11	25		70	8	114
2000			122		70	19	211
2001		4	136	3	39	21	203
2002		34	199		62	25	320
2003	14	19	278	15	254	95	675
2004	8	68	321	12	587	340	1,336
2005	58	69	534	17	505	251	1,434
2006	36	24	209	20	109	35	433
2007	36	16	234	14	92	46	438
2008	20	12	260	19	130	49	490
2009	35	22	428	12	271	30	798
2010	52	30	685	15	1,080	379	2,241
2011	80	25	1,098	1	1,382	264	2,850
2012	113	31	1,177	19	1,166	119	2,625
2013	33	63	670	24	495	96	1,381
2014	31	50	662		735	154	1,632
2015	3	66	407		269	166	911
2016	9	56	334		182	97	687

Table 9. Estimates of total Gulf of Maine Atlantic cod commercial discards (mt) by gear from 1982 to 2016 by gear. Discards from 1982 to 1988 were estimated using hindcast procedures and discards from 1989 to 2016 were estimated from observer data. See NEFSC (2013) for a full description of the discard estimation methodologies. *Discard amounts have been adjusted to account for mortality assumptions adopted at the SAW/SARC 55 assessment (NEFSC 2013; commercial longline = 33%, commercial trawl = 75%, commercial gillnet = 80%).*

Year	Longline	Otter trawl		Sink Gillnet		Total	
		Small mesh (< 5.5")	Large mesh (>= 5.5")	Shrimp trawl	Large mesh (5.5" - 7.99")		
1982			618.0	100.8	86.7	805.4	
1983			633.1	112.1	83.9	829.1	
1984			603.0	160.0	96.0	858.9	
1985			660.4	217.9	84.7	962.9	
1986			597.4	266.4	100.4	964.2	
1987			541.9	242.1	100.1	884.0	
1988			428.4	151.7	102.8	682.9	
1989		4.2	474.1	179.5	129.0	786.9	
1990		0.6	1,097.3	287.5	175.2	1,560.6	
1991	0.1	0.6	434.7	143.7	84.8	663.9	
1992	2.6	0.0	545.1	34.2	86.6	668.6	
1993	93.0	0.0	259.6	4.4	122.9	479.8	
1994			114.7	5.3	84.1	207.5	
1995		5.8	106.8	2.8	103.8	235.4	
1996		2.3	17.6	2.1	116.2	157.2	
1997		11.6	19.5	3.3	47.2	87.1	
1998		0.0	8.1		66.0	78.5	
1999		8.2	578.5		428.8	6.5	1,021.9
2000			552.3		379.0	14.8	946.1
2001		0.1	611.1	0.0	890.8	43.4	1,545.4
2002		11.5	608.0		662.9	46.7	1,329.1
2003	21.9	15.4	387.6	1.8	257.4	56.8	741.0
2004	2.6	2.0	372.7	0.7	185.4	67.7	631.1
2005	40.9	2.7	116.2	0.8	87.6	21.3	269.5
2006	15.7	1.8	236.4	0.2	75.5	12.7	342.3
2007	22.2	1.4	71.8	0.6	66.9	15.4	178.4
2008	19.3	4.3	240.2	0.1	67.9	17.4	349.2
2009	6.3	1.4	503.9	0.1	210.6	29.9	752.3
2010	3.8	4.4	111.7	0.2	42.1	8.5	170.8
2011	10.5	3.2	54.5	0.0	27.6	3.0	98.8
2012	12.1	1.9	52.9	0.0	25.6	0.8	93.4
2013	10.7	0.5	30.8	0.0	8.3	1.1	51.5
2014	2.1	0.4	10.4		12.6	1.0	26.4
2015	0.0	0.5	4.7		7.7	1.0	14.0
2016	0.1	1.2	2.2		2.7	1.8	8.1

Table 10. Coefficients of variation (CV) for the Gulf of Maine Atlantic cod commercial discard (mt) estimates from 1989 to 2016 by gear; CVs greater than 0.3 are shaded in grey. *CVs are not available for hindcasted discards (pre-1989).*

Year	Longline	Otter trawl		Shrimp trawl	Sink Gillnet		Total
		Small mesh (< 5.5")	Large mesh (>= 5.5")		Large mesh (5.5" - 7.99")	Extra large mesh (>= 8.0")	
1989		0.67	0.34	0.25	0.29		0.22
1990		0.79	0.37	0.42	0.23		0.28
1991	0.40	0.60	0.37	0.32	0.10		0.26
1992	0.64	3.72	0.33	0.24	0.07		0.27
1993	0.20		0.44	0.13	0.09		0.22
1994			0.63	0.15	0.32	0.75	0.38
1995		0.24	0.59	0.24	0.26	0.45	0.31
1996		2.84	0.91	0.34	0.30	0.28	0.25
1997		0.25	0.44	0.41	0.42	0.85	0.25
1998			0.55		0.28	0.95	0.25
1999		0.62	0.56		0.37	0.51	0.36
2000			0.28		0.27	0.31	0.20
2001		1.84	0.27		0.52	0.58	0.31
2002		0.55	0.34		0.24	0.59	0.20
2003	0.30	0.72	0.29	0.42	0.14	0.28	0.16
2004	0.48	0.44	0.34	0.37	0.13	0.12	0.22
2005	0.24	0.27	0.19	0.38	0.13	0.12	0.11
2006	0.29	0.27	0.39	0.44	0.38	0.32	0.28
2007	0.17	0.43	0.22	0.70	0.29	0.31	0.13
2008	0.42	0.37	0.21	0.55	0.18	0.49	0.16
2009	0.17	0.28	0.14	0.64	0.19	0.49	0.11
2010	0.33	0.28	0.19	0.90	0.11	0.17	0.13
2011	0.18	0.41	0.09		0.04	0.07	0.06
2012	0.20	0.44	0.08	1.02	0.04	0.06	0.07
2013	0.62	0.63	0.27	0.95	0.07	0.21	0.26
2014	0.49	0.36	0.29		0.07	0.08	0.14
2015		0.25	0.23		0.28	0.22	0.17
2016	1.09	0.38	0.16		0.15	0.28	0.11

Table 11. Number of lengths of Gulf of Maine Atlantic cod commercial discards sampled from 1989 to 2016 by gear type and semester. Sampling intensity is expressed as metric tons landings per 100 lengths sampled (*200 metric tons per 100 lengths is an unofficial NAFO/ICNAF standard*). Colors denote specific gear/mesh sizes; in all years except 2003-2005, 2007/08 and 2010/11 the length frequency distributions from large mesh gillnet were applied to extra large mesh gillnet due to insufficient sampling. A general criterion of 50 lengths/block was used to determine sufficiency.

Year	Longline		Otter trawl - small mesh		Otter trawl - large mesh		Shrimp trawl		Gillnet - large mesh		Gillnet - extra large mesh		Total	Total discards (mt)	mt/100 lengths
	Semi 1	Semi 2	Semi 1	Semi 2	Semi 1	Semi 2	Semi 1	Semi 2	Semi 1	Semi 2	Semi 1	Semi 2			
1989			125	14	542	1053	2011	77		104			3926	1101.1	28.0
1990			**		587	818	607	31	138	3			2184	2198.2	100.6
1991	*		**		706	124	397		65	30			1322	933.5	70.6
1992	*		**		924	924	401	10	78	130			2467	943.8	38.3
1993	48		**		68	866	591		90	223			1886	812.4	43.1
1994			**		194		563	40	274	112		7	1190	280.8	23.6
1995			69		225	473	377	3	60	147	20	3	1377	314.9	22.9
1996			52	19	15	73	44	21	109	31	16	20	400	200.4	50.1
1997			7***		104	1	17*****		34	11	1	2	153	115.0	75.2
1998			***		5****				43	40	9	3	95	99.5	104.8
1999			6***			220			130	1156		14	1520	1382.1	90.9
2000			***		248	85			125	157	6	6	627	1281.3	204.3
2001			***		61	647			223	144	3	4	1082	2040.9	188.6
2002			192		104	1162			412	845	1	39	2755	1772.0	64.3
2003	718		173	131	1109	234	192		603	1352	38	205	4755	1037.6	21.8
2004	197		103	519	385	771	76		1165	1524	27	536	5303	860.6	16.2
2005	2283	147	180	183	986	2939	70		190	663	47	104	7792	431.0	5.5
2006	880	3	43	9	1899	339	96		44	59	6	15	3393	498.4	14.7
2007	817	327	1	62	1172	1103	12*****		91	310	53	164	4100	275.7	6.7
2008	958			18	2316	1639	42*****		142	73	72	26	5244	514.5	9.8
2009	552	187		22	2219	1744	2*****		502	112	7	15	5360	1041.8	19.4
2010	239	57	4	51	716	2672	5*****		289	903	30	94	5055	241.1	4.8
2011	1322	107		27	2522	3612			792	694	33	41	9150	152.6	1.7
2012	1188	278	9		2607	2509	3*****		897	623	10	11	8135	148.0	1.8
2013	1266		32	21	1523	726	*****		111	195	3	6	3883	89.0	2.3
2014	300			5	318	445			250	119		6	1443	38.5	2.7
2015				23	129	183			50	65	2	3	455	18.4	4.0
2016	11		12	7	94	75			17	29		6	251	10.9	4.3

Table 12. Total Gulf of Maine Atlantic cod commercial discards-at-age (numbers) from 1982 to 2016. *These estimates include gear-specific assumptions of discard survival.*

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13
1982	581	347,720	1,156,034	224,521	50,895	0	0	0	0	0	0	0	0	0
1983	13,645	562,544	1,281,940	158,839	5,416	0	0	0	0	0	0	0	0	0
1984	18,275	347,694	1,445,433	219,644	0	0	0	0	0	0	0	0	0	0
1985	67,101	459,681	1,162,717	516,585	0	0	0	0	0	0	0	0	0	0
1986	17,767	731,053	1,522,658	208,195	48,007	0	0	0	0	0	0	0	0	0
1987	100,702	252,248	1,375,956	406,263	0	0	0	0	0	0	0	0	0	0
1988	3,446	405,259	1,149,396	275,330	23,306	0	0	0	0	0	0	0	0	0
1989	43	157,339	733,450	415,475	51,442	5,129	1,380	502	109	0	0	0	0	0
1990	0	61,442	539,508	1,619,321	185,562	1,188	216	0	0	0	0	0	0	0
1991	3,251	115,661	244,750	156,398	273,359	23,658	945	211	0	494	22	0	0	0
1992	23,803	364,755	481,485	278,021	32,164	91,688	2,805	119	14	0	0	0	0	0
1993	26,570	100,225	345,799	212,563	62,392	47	682	187	0	0	0	0	0	0
1994	11,734	119,195	93,081	140,124	14,606	816	234	270	0	0	0	0	0	0
1995	11,572	75,059	57,584	104,772	42,720	3,914	413	0	0	0	0	0	0	0
1996	22,067	31,719	22,411	24,451	38,147	6,928	657	102	78	542	0	0	0	0
1997	1,472	66,116	33,817	27,941	5,256	13,811	766	120	0	0	0	0	0	0
1998	699	2,565	36,073	20,996	13,651	1,615	1,536	82	0	0	0	0	0	0
1999	63	58,620	35,442	77,449	78,134	64,863	19,741	22,472	3,779	32	0	0	0	0
2000	0	10,977	192,879	122,257	137,216	26,040	8,080	1,471	315	0	0	0	0	0
2001	0	584	166,381	181,295	117,448	89,585	23,098	9,463	1,433	1,304	0	0	0	0
2002	0	10,379	26,625	95,299	150,797	58,039	36,422	15,103	9,627	3,784	3,221	270	220	0
2003	22,873	30,227	60,078	48,552	131,760	95,818	18,452	5,589	1,985	819	315	204	15	0
2004	187	130,674	71,594	234,041	42,241	41,615	19,027	4,267	1,900	569	231	88	11	0
2005	1,487	19,746	72,822	27,925	88,613	2,854	7,378	2,689	588	435	156	176	80	43
2006	204	10,521	29,696	159,504	38,366	53,974	2,405	2,150	1,902	93	34	5	0	1
2007	407	10,720	49,447	57,421	49,909	4,291	2,782	49	53	6	0	2	0	0
2008	305	7,598	58,021	104,763	59,668	40,918	1,629	1,361	75	17	27	26	0	0
2009	81	5,791	52,840	167,603	143,740	56,239	26,856	734	1,259	13	33	7	0	8
2010	213	4,607	23,503	52,319	27,322	15,926	3,289	989	20	2	0	0	0	0
2011	27	1,612	13,351	31,934	28,579	6,662	1,533	153	29	87	0	0	0	0
2012	5	2,866	23,763	32,839	19,192	8,527	999	291	1	0	0	0	0	0
2013	119	1,930	25,249	15,987	8,015	3,454	427	21	1	0	0	0	0	0
2014	0	1,710	4,680	8,986	9,394	1,003	185	45	2	0	0	0	0	0
2015	0	311	8,528	1,866	1,847	240	56	24	3	0	0	0	0	0
2016	0	39	2,465	4,455	438	319	13	1	1	0	0	0	0	0

Table 13. Mean weights-at-age (kg) of commercially discarded Gulf of Maine Atlantic cod from 1982 to 2016.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13
1982	0.000	0.315	0.500	0.608	0.648									
1983	0.024	0.218	0.509	0.649	0.752									
1984	0.001	0.225	0.485	0.610										
1985	0.039	0.194	0.541	0.589										
1986	0.005	0.274	0.439	0.621	0.573									
1987	0.004	0.143	0.492	0.559										
1988	0.003	0.121	0.442	0.554	0.615									
1989	0.046	0.224	0.490	0.751	1.751	4.112	5.534	9.336	6.408					
1990		0.195	0.645	0.703	0.846	4.340	4.564							
1991	0.014	0.238	0.859	0.917	0.993	1.401	6.746	8.389		18.191	3.705			
1992	0.023	0.053	0.680	0.773	1.082	1.154	1.614	5.239	2.425					
1993	0.021	0.073	0.684	0.944	0.926	1.953	4.309	7.342						
1994	0.022	0.049	0.629	0.827	1.798	3.872	12.083	9.439						
1995	0.027	0.093	0.809	0.925	1.637	4.928	4.682							
1996	0.033	0.067	0.676	1.126	1.840	3.752	6.768	11.559	12.656	17.406				
1997	0.017	0.058	0.590	0.928	1.984	1.785	4.381	8.657						
1998	0.007	0.200	0.603	1.093	1.686	3.316	3.287	3.285						
1999	0.052	0.201	0.595	1.940	3.353	4.626	6.586	6.605	9.634	12.279				
2000		0.292	0.962	1.843	3.041	3.882	4.881	4.279	6.121					
2001	0.316	0.669	2.023	3.777	4.898	5.908	6.594	7.159	8.790					
2002	0.203	0.923	1.415	2.987	4.222	6.258	7.030	9.453	12.322	10.912	10.519	14.222		
2003	0.038	0.133	0.804	1.364	1.672	2.772	4.085	6.911	9.868	8.622	11.658	10.100	12.774	
2004	0.025	0.106	0.455	1.128	1.879	2.800	4.834	6.755	8.763	11.588	11.820	10.579	11.694	
2005	0.027	0.109	0.564	1.170	1.400	3.246	3.573	5.707	7.370	10.673	15.830	16.405	17.950	23.098
2006	0.069	0.276	0.665	1.066	1.494	1.604	1.871	3.857	2.822	7.902	8.238	13.434		13.434
2007	0.024	0.227	0.658	1.063	1.394	1.710	2.171	4.447	5.197	6.529		7.736		
2008	0.078	0.203	0.770	1.273	1.572	1.741	3.047	6.283	6.021	5.514	10.341	10.660		
2009	0.026	0.356	0.913	1.515	2.010	2.109	2.402	3.970	3.288	8.250	8.733	7.259		10.510
2010	0.023	0.251	1.047	1.251	1.743	1.912	1.962	2.184	4.322	8.210				
2011	0.122	0.361	0.875	1.181	1.303	1.473	1.592	1.669	2.623	16.409				
2012	0.011	0.376	0.910	1.126	1.284	1.303	1.489	1.724	3.881					
2013	0.030	0.511	0.794	1.123	1.266	1.353	1.434	1.669	2.100					
2014		0.478	0.789	1.085	1.073	1.496	2.298	1.790	7.281	7.610				
2015		0.248	0.627	1.245	2.727	4.491	4.451	4.459	6.100					
2016		0.186	0.642	1.040	2.411	2.905	3.369	3.778	3.950					

Table 14. Estimates of Gulf of Maine Atlantic cod recreational catch in numbers (000's) and weight (mt) from 1981 to 2016. Recreational releases reflect an assumed post-release mortality of 15% (Capizzano et al. 2016). *Coefficients of variation (CVs) on the 2004-2016 harvest estimates ranged from 0.09-0.27 and 0.08-0.23 for the releases.*

Year	Harvest (AB1)	Numbers (000s)			Biomass (mt)				Released/ harvest ratio
		Released (B2) w/ 100% discard mortality	Released (B2) w/ 15% discard mortality	Total catch w/ 15% discard mortality	Harvest (AB1)	Released (B2) w/ 100% discard mortality	Released (B2) w/ 15% discard mortality	Total catch w/ 15% discard mortality	
1981	2011.2	145.1	21.8	2032.9	4,111.5	62.8	9.4	4,121.0	0.07
1982	1368.7	71.6	10.7	1379.4	2,816.7	27.2	4.1	2,820.8	0.05
1983	937.1	174.2	26.1	963.3	1,772.8	58.6	8.8	1,781.6	0.19
1984	679.0	148.7	22.3	701.3	1,266.8	55.3	8.3	1,275.1	0.22
1985	1212.5	150.9	22.6	1235.2	2,765.9	56.2	8.4	2,774.3	0.12
1986	734.0	91.9	13.8	747.8	1,928.4	33.7	5.0	1,933.5	0.13
1987	1504.5	428.5	64.3	1568.8	3,547.2	160.0	24.0	3,571.2	0.28
1988	943.2	133.3	20.0	963.2	1,688.5	45.2	6.8	1,695.3	0.14
1989	893.2	432.6	64.9	958.1	1,957.2	253.6	38.0	1,995.2	0.48
1990	930.9	357.6	53.6	984.6	2,246.7	222.4	33.4	2,280.0	0.38
1991	1023.1	310.3	46.5	1069.6	2,287.2	226.7	34.0	2,321.2	0.30
1992	238.4	180.8	27.1	265.5	623.6	118.2	17.7	641.3	0.76
1993	568.3	568.0	85.2	653.5	1,011.9	339.8	51.0	1,062.9	1.00
1994	393.0	543.6	81.5	474.5	721.7	335.3	50.3	772.0	1.38
1995	378.6	516.2	77.4	456.0	627.2	320.5	48.1	675.3	1.36
1996	260.0	340.8	51.1	311.2	498.6	270.1	40.5	539.2	1.31
1997	105.0	227.0	34.1	139.0	236.3	195.9	29.4	265.7	2.16
1998	144.2	289.6	43.4	187.7	353.1	240.8	36.1	389.2	2.01
1999	184.7	359.7	54.0	238.7	577.2	238.8	35.8	613.0	1.95
2000	388.5	696.2	104.4	492.9	967.1	458.7	68.8	1,035.9	1.79
2001	755.6	992.0	148.8	904.4	1,967.6	758.3	113.7	2,081.3	1.31
2002	409.1	823.5	123.5	532.6	1,254.8	956.2	143.4	1,398.3	2.01
2003	454.9	837.8	125.7	580.6	1,607.7	941.4	141.2	1,748.9	1.84
2004	379.4	736.8	110.5	490.0	1,257.8	650.4	97.6	1,355.4	1.94
2005	446.9	1038.1	155.7	602.6	1,301.5	860.1	129.0	1,430.5	2.32
2006	188.7	708.4	106.3	295.0	741.0	631.0	94.6	835.6	3.75
2007	303.5	964.4	144.7	448.2	1,162.5	1,029.1	154.4	1,316.8	3.18
2008	382.6	952.1	142.8	525.4	1,240.5	1,022.3	153.3	1,393.8	2.49
2009	386.9	826.0	123.9	510.8	1,399.3	949.0	142.4	1,541.6	2.13
2010	503.9	1049.4	157.4	661.3	1,802.6	1,250.6	187.6	1,990.2	2.08
2011	526.2	901.0	135.1	661.4	1,812.6	1,092.7	163.9	1,976.5	1.71
2012	320.0	470.7	70.6	390.6	571.4	319.8	48.0	619.4	1.47
2013	391.7	641.6	96.2	487.9	705.4	461.4	69.2	774.6	1.64
2014	251.4	661.7	99.3	350.6	527.6	565.5	84.8	612.4	2.63
2015	5.8	496.8	74.5	80.3	4.5	531.2	79.7	84.2	86.0
2016	35.0	922.4	138.4	173.3	94.8	1173.4	176.0	270.8	26.4

Table 15. Number of lengths sampled from recreationally harvested (type A and B1) Gulf of Maine Atlantic cod by semester and year as estimated by the Marine Recreational Information Program from 1981 to 2016. Sampling intensity is expressed as metric tons of landings per 100 lengths sampled (*200 metric tons per 100 lengths is an unofficial NAFO/ICNAF standard*).

Year	Semester		Total	AB1 estimated numbers (000s)	AB1 Landings (mt)	Lengths per 1000 fish	mt per 100 lengths
	1	2					
1981	355	366	721	2,011	4,112	0.4	570.3
1982	320	276	596	1,369	2,817	0.4	472.6
1983	609	560	1,169	937	1,773	1.2	151.7
1984	394	391	785	679	1,267	1.2	161.4
1985	272	155	427	1,213	2,766	0.4	647.7
1986	77	90	167	734	1,928	0.2	1154.8
1987	167	367	534	1,505	3,547	0.4	664.3
1988	325	213	538	943	1,689	0.6	313.9
1989	208	352	560	893	1,957	0.6	349.5
1990	160	210	370	931	2,247	0.4	607.2
1991	377	83	460	1,023	2,287	0.4	497.2
1992	710	268	978	238	624	4.1	63.8
1993	136	200	336	568	1,012	0.6	301.2
1994	333	485	818	393	722	2.1	88.2
1995	663	434	1,097	379	627	2.9	57.2
1996	585	515	1,100	260	499	4.2	45.3
1997	190	392	582	105	236	5.5	40.6
1998	447	215	662	144	353	4.6	53.3
1999	111	117	228	185	577	1.2	253.1
2000	70	77	147	389	967	0.4	657.9
2001	124	121	245	756	1,968	0.3	803.1
2002	181	196	377	409	1,255	0.9	332.8
2003	361	322	683	455	1,608	1.5	235.4
2004	1,203	1,137	2,340	379	1,258	6.2	53.8
2005	1,242	1,370	2,612	447	1,302	5.8	49.8
2006	948	628	1,576	189	741	8.4	47.0
2007	907	696	1,603	304	1,162	5.3	72.5
2008	1,632	724	2,356	383	1,240	6.2	52.7
2009	1,837	1,122	2,959	387	1,399	7.6	47.3
2010	1,736	1,220	2,956	504	1,803	5.9	61.0
2011	1,750	998	2,748	526	1,813	5.2	66.0
2012	1,098	1,361	2,459	320	571	7.7	23.2
2013	1,543	1,160	2,703	390	705	6.9	26.1
2014	798	517	1,315	251	528	5.2	40.1
2015	13	21	34	6	5	5.9	13.3
2016	46	274	320	35	95	9.1	29.6

Table 16. Number of lengths sampled from recreationally discarded (type B2) Gulf of Maine Atlantic cod by semester and year as estimated by the Marine Recreational Information Program from 2004 to 2016. Length samples of recreationally discarded (i9 samples) Atlantic cod were unavailable prior to 2004. Sampling intensity is expressed as metric tons landings per 100 lengths sampled (*200 metric tons per 100 lengths is an unofficial NAFO/ICNAF standard*). Reported release estimates have not been adjusted to account for post-release survival/mortality.

Year	Semester		Total	B2 releases (000s)	B2 releases (mt)	Lengths per thousand fish	Metric tons per 100 lengths
	1	2					
2004	602	467	1,069	737	650	1.5	60.8
2005	591	632	1,223	1,038	860	1.2	70.3
2006	1,023	618	1,641	708	631	2.3	38.5
2007	754	880	1,634	964	1,029	1.7	63.0
2008	1,304	740	2,044	952	1,022	2.1	50.0
2009	816	973	1,789	826	949	2.2	53.0
2010	823	1,085	1,908	1,049	1,251	1.8	65.5
2011	533	974	1,507	901	1,093	1.7	72.5
2012	468	948	1,416	471	320	3.0	22.6
2013	795	595	1,390	640	461	2.2	33.2
2014	630	202	832	662	565	1.3	68.0
2015	493	436	929	497	531	1.9	57.2
2016	878	729	1,607	922	1173	1.7	73.0

Table 17. Total Gulf of Maine Atlantic cod recreational landings-at-age (numbers) from 1981 to 2016.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15
1981	0	159,922	623,992	622,091	426,564	69,951	42,612	7,392	29,365	0	25,105	0	4,184	0	0	0
1982	765	67,908	420,464	427,446	263,437	129,184	14,639	24,905	13,178	3,904	574	0	2,296	0	0	0
1983	0	14,924	315,694	339,632	128,267	76,679	45,287	5,810	4,873	1,777	1,390	802	2,004	0	0	0
1984	0	11,741	224,928	226,199	139,013	40,743	23,707	9,247	390	420	350	627	0	432	1,153	0
1985	0	35,163	368,684	438,416	149,622	123,096	38,047	33,994	15,929	2,206	5,509	316	1,005	532	0	0
1986	0	21,723	120,551	351,802	124,583	39,540	40,989	9,316	10,691	6,281	3,579	865	3,202	865	0	0
1987	0	16,878	348,751	517,856	457,592	77,647	24,836	35,051	8,978	8,452	6,339	1,878	282	0	0	0
1988	0	3,134	197,888	449,655	225,659	46,787	8,638	3,696	6,000	0	0	1,753	0	0	0	0
1989	0	3,619	116,660	436,314	242,898	64,122	15,197	10,911	1,329	2,127	0	0	0	0	0	0
1990	0	2,812	40,204	449,749	295,754	87,368	36,966	4,457	11,742	1,887	0	0	0	0	0	0
1991	0	3,614	35,323	152,702	701,569	106,170	11,169	12,368	0	0	143	0	0	0	0	0
1992	0	2,101	21,451	43,626	35,194	123,077	10,143	2,642	193	0	0	0	0	0	0	0
1993	0	1,913	42,807	343,796	133,450	10,536	32,237	3,594	0	0	0	0	0	0	0	0
1994	0	475	13,965	243,207	103,423	24,535	2,404	3,971	600	370	0	0	0	0	0	0
1995	0	25	35,494	187,086	144,820	9,965	1,024	0	192	0	0	0	0	0	0	0
1996	0	0	11,977	64,661	162,532	19,752	850	34	0	236	0	0	0	0	0	0
1997	0	78	5,075	31,836	21,300	42,823	3,631	35	192	0	0	0	0	0	0	0
1998	218	0	9,310	52,886	52,992	11,547	15,851	1,107	315	0	0	0	0	0	0	0
1999	0	552	5,301	53,525	61,018	39,039	9,650	14,515	1,105	0	0	0	0	0	0	0
2000	0	0	52,606	130,285	163,854	25,350	10,670	2,007	3,741	0	0	0	0	0	0	0
2001	0	0	42,329	386,498	214,243	84,322	17,177	9,279	1,320	464	0	0	0	0	0	0
2002	0	0	310	57,771	233,715	73,361	23,839	9,622	6,047	785	1,454	0	2,170	0	0	0
2003	0	0	4,884	37,189	149,359	188,046	41,113	18,104	7,470	5,073	1,170	1,724	817	0	0	0
2004	0	147	1,936	99,906	69,323	119,952	57,873	13,763	7,309	3,330	2,651	1,240	2,014	0	0	0
2005	0	1,845	11,149	49,574	273,540	18,925	54,781	23,221	6,609	4,216	1,421	780	736	109	0	0
2006	48	1,075	1,876	30,336	44,161	74,006	4,993	15,542	8,982	3,582	2,281	869	519	375	65	0
2007	0	113	3,709	39,717	174,103	23,561	38,516	2,323	5,249	6,278	3,315	2,287	1,056	2,520	231	568
2008	0	532	7,588	87,345	124,884	126,728	11,273	16,650	771	1,941	1,901	577	2,216	111	0	46
2009	0	773	2,989	92,086	160,389	67,189	46,071	4,486	8,061	946	1,380	865	1,162	486	0	28
2010	0	149	4,229	93,712	201,373	136,159	38,631	20,283	5,083	2,206	161	1,489	329	79	0	0
2011	64	1,543	3,362	62,827	175,906	167,660	92,194	9,587	10,638	1,420	555	239	103	0	122	0
2012	0	3,652	20,798	101,732	116,139	57,367	14,684	5,100	427	80	14	0	0	0	0	0
2013	435	1,661	66,937	165,806	100,486	45,074	8,158	2,532	585	10	2	2	0	0	0	0
2014	0	1,258	18,542	91,137	95,596	30,425	10,439	3,329	434	206	0	0	0	0	0	0
2015	0	686	3,192	1,138	718	35	7	0	0	0	0	0	0	0	0	0
2016	0	218	1,912	10,958	9,081	11,581	812	339	51	23	0	0	0	0	0	0

Table 18. Mean weights-at-age (kg) of recreationally landed Gulf of Maine Atlantic cod from 1981 to 2016.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15
1981		0.341	0.995	1.524	2.915	4.715	5.645	5.863	8.359		12.339		18.100			
1982	0.022	0.372	0.848	1.401	2.209	5.362	6.955	9.732	8.990	11.008	11.547		21.416			
1983		0.378	0.791	1.398	2.401	3.772	6.032	6.745	8.393	9.627	15.175	19.306	19.182			
1984		0.372	0.775	1.365	2.668	4.005	5.349	6.559	6.583	8.955	11.743	13.474		17.780	27.103	
1985		0.346	0.752	1.281	2.810	5.310	6.771	8.645	11.257	11.854	12.252	8.049	9.297	8.332		
1986		0.375	0.668	1.589	2.770	5.308	7.418	8.584	11.185	11.839	14.266	14.560	22.376	14.560		
1987		0.243	0.900	1.472	2.696	4.196	8.162	10.978	11.301	12.673	13.141	13.835	8.332			
1988		0.170	0.787	1.528	2.188	4.550	4.414	5.123	10.614				10.175			
1989		0.539	0.989	1.500	2.700	4.579	6.191	8.715	7.616	17.137						
1990		0.132	0.916	1.439	2.261	4.965	7.351	8.502	10.658	13.166						
1991		0.180	1.088	1.499	2.025	3.388	6.933	13.033				3.838				
1992		0.106	1.360	1.715	2.541	2.923	4.437	9.324	2.516							
1993		0.184	0.805	1.566	1.827	2.890	3.791	11.707								
1994		0.136	1.169	1.514	2.262	2.270	5.374	5.751	18.165	2.156						
1995		0.509	1.432	1.514	1.769	3.381	2.479		4.244							
1996			1.483	1.809	1.863	2.502	9.632	8.622		13.434						
1997	0.010	0.307	1.626	1.924	2.389	2.396	2.964	6.038	11.932							
1998		0.101	1.600	2.071	2.435	3.491	3.179	4.591	12.220							
1999		0.290	1.296	1.943	2.951	3.687	5.490	5.561	7.637							
2000			1.561	1.961	2.718	3.199	5.103	5.023	10.277							
2001			1.709	2.199	2.659	3.732	5.019	6.259	10.560	5.813						
2002			1.275	2.135	2.581	3.048	5.265	6.429	7.919	8.984	10.569		21.420			
2003			1.954	2.237	2.525	3.225	4.822	8.064	9.802	11.167	11.115	15.401	21.534			
2004		0.241	0.659	1.970	2.538	2.798	4.186	6.770	9.845	12.793	13.988	15.064	21.047			
2005	0.104	0.137	0.720	1.881	2.317	3.587	3.954	6.309	7.933	9.639	12.595	14.195	15.497	15.689		
2006		0.175	0.540	2.087	3.010	3.404	5.045	5.866	8.509	10.753	13.381	15.469	15.445	18.706	19.820	
2007		0.252	1.355	2.352	2.856	3.385	4.847	6.546	9.595	12.928	13.248	15.300	16.332	16.882	15.964	
2008		0.364	0.938	2.406	2.746	3.252	4.122	6.318	6.517	11.426	12.996	14.253	24.159	16.454	15.522	
2009		0.214	0.929	2.592	3.158	3.622	4.863	7.270	9.659	12.774	12.372	15.138	17.785	20.460	13.434	
2010		0.297	1.352	2.399	3.089	3.910	4.740	6.424	9.712	11.673	9.051	14.720	14.488	9.863		
2011	0.104	0.236	0.831	2.528	2.973	3.531	4.338	4.891	5.286	11.779	15.046	18.459	13.612		14.328	
2012		0.160	1.256	1.486	1.878	2.020	2.734	3.349	3.605	7.285	9.417					
2013	0.057	0.576	1.248	1.796	1.963	2.209	2.255	2.682	4.266	8.922	6.017	7.240				
2014		0.260	1.496	1.833	2.197	2.406	3.128	3.852	6.032	5.504						
2015		0.225	0.589	1.102	1.605	2.239	2.408									
2016		0.052	0.467	2.106	2.972	3.311	4.385	4.480	4.659	7.240						

Table 19. Total Gulf of Maine Atlantic cod recreational discards-at-age (numbers) from 1981 to 2016. *Estimates include assumptions of 15% discard survival.*

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9
1981	0	6,788	12,289	2,681	0	0	0	0	0	0
1982	0	2,806	7,267	526	139	0	0	0	0	0
1983	0	10,014	15,660	450	0	0	0	0	0	0
1984	0	4,054	16,829	1,428	0	0	0	0	0	0
1985	0	5,408	12,656	4,575	0	0	0	0	0	0
1986	0	3,962	9,237	246	337	0	0	0	0	0
1987	0	6,113	49,938	8,224	0	0	0	0	0	0
1988	0	3,344	14,019	2,639	0	0	0	0	0	0
1989	0	2,739	37,481	23,354	1,313	0	0	0	0	0
1990	0	636	11,107	37,535	4,364	0	0	0	0	0
1991	0	1,176	10,300	11,858	21,409	1,801	0	0	0	0
1992	0	1,723	12,329	9,099	1,223	2,644	99	0	0	0
1993	0	1,896	48,918	24,727	9,659	0	0	0	0	0
1994	0	2,163	32,931	43,479	2,965	0	0	0	0	0
1995	0	1,924	21,330	45,636	8,245	289	0	0	0	0
1996	0	2,908	10,709	15,616	20,069	1,821	0	0	0	0
1997	0	1,475	10,568	12,701	3,088	5,888	330	0	0	0
1998	0	1,688	18,880	13,252	8,777	144	699	0	0	0
1999	0	7,388	23,626	18,589	3,003	1,157	156	42	0	0
2000	0	6,891	68,608	22,763	5,535	572	56	0	0	0
2001	0	0	70,752	62,107	13,158	2,574	211	0	0	0
2002	0	3,226	6,609	55,296	47,085	10,991	122	0	197	0
2003	0	7,336	26,256	17,264	51,242	20,688	2,880	0	0	0
2004	0	1,947	18,476	74,235	8,707	6,504	644	9	2	0
2005	0	2,314	54,091	22,208	74,442	1,076	1,554	31	5	0
2006	21	4,936	14,246	61,507	10,610	13,712	717	256	247	1
2007	11	825	27,590	55,217	53,861	3,953	3,199	2	5	0
2008	51	2,509	32,427	57,825	29,597	19,615	485	303	5	2
2009	8	2,685	23,315	49,775	32,330	10,767	4,766	137	118	0
2010	0	1,948	24,078	71,281	35,634	18,813	4,247	1,409	0	0
2011	394	3,827	19,811	41,380	50,255	14,991	3,948	420	125	0
2012	100	6,567	27,849	25,304	7,814	2,841	92	32	2	0
2013	0	2,517	62,371	23,441	6,247	1,520	127	17	1	0
2014	24	12,335	14,603	31,493	36,140	3,924	568	169	0	0
2015	0	4,488	34,974	16,595	16,759	1,346	259	95	3	0
2016	86	2,196	23,422	82,262	16,022	13,777	480	98	17	0

Table 20. Mean weights-at-age (kg) of recreationally discarded Gulf of Maine Atlantic cod from 1981 to 2016.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9
1981		0.367	0.456	0.492						
1982		0.307	0.400	0.450	0.509					
1983		0.260	0.386	0.326						
1984		0.288	0.387	0.436						
1985		0.272	0.395	0.426						
1986		0.319	0.380	0.429	0.499					
1987		0.221	0.393	0.371						
1988		0.185	0.357	0.438						
1989		0.395	0.524	0.692	0.867					
1990		0.231	0.528	0.637	0.786					
1991		0.234	0.536	0.776	0.819	0.818				
1992		0.217	0.590	0.724	0.837	0.902	0.868			
1993		0.252	0.487	0.769	0.794					
1994		0.283	0.470	0.740	0.683					
1995		0.302	0.520	0.635	0.870	0.931				
1996		0.277	0.655	0.827	0.902	0.918				
1997		0.196	0.685	0.915	1.095	1.092	1.294			
1998		0.203	0.630	1.007	1.072	1.211	1.365			
1999		0.301	0.535	0.869	1.078	1.157	1.097	1.456		
2000		0.275	0.574	0.911	1.109	1.003	1.211			
2001			0.581	0.886	1.098	1.105	1.290			
2002		0.156	0.468	1.035	1.406	1.444	1.371		1.937	
2003		0.345	0.544	1.223	1.327	1.507	1.422			
2004		0.209	0.552	0.893	1.221	1.368	1.743	2.962	4.009	
2005		0.225	0.499	0.990	1.025	1.011	1.318	2.012	2.516	
2006	0.083	0.309	0.551	0.854	1.201	1.330	1.255	1.719	1.668	2.644
2007	0.048	0.168	0.626	1.041	1.270	1.578	1.510	3.378	3.952	
2008	0.115	0.316	0.757	1.095	1.285	1.279	1.666	2.471	2.561	6.092
2009	0.057	0.317	0.797	1.183	1.297	1.380	1.417	1.988	1.669	5.791
2010		0.282	0.894	1.114	1.418	1.460	1.381	1.609		
2011	0.081	0.322	0.758	1.205	1.337	1.535	1.648	1.771	2.148	
2012	0.000	0.298	0.571	0.777	0.931	0.979	2.747	3.907	6.487	
2013		0.345	0.623	0.893	1.072	1.216	1.418	1.632	2.045	
2014	0.048	0.375	0.784	0.979	0.898	1.142	1.318	1.305		
2015		0.229	0.602	1.342	1.820	2.787	2.767	3.420	5.685	
2016	0.010	0.156	0.574	1.214	1.929	2.159	2.650	3.439	4.256	

Table 21. Total catch-at-age (numbers) of Gulf of Maine Atlantic cod from 1982 to 2016 with an age 9⁺ group. *Only ages 1 through the 9⁺ group are used as assessment model inputs.*

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9
1982	1,346	446,043	2,919,274	2,286,666	1,430,543	748,755	65,880	94,051	72,553	90,055
1983	13,645	587,482	2,446,377	2,912,764	1,201,593	704,010	452,680	50,022	62,542	56,198
1984	18,275	366,271	2,112,728	1,674,503	1,643,588	437,453	219,625	105,649	9,495	53,395
1985	67,101	500,252	1,931,671	2,400,561	1,151,815	738,096	161,362	107,192	48,359	33,213
1986	17,767	756,738	1,737,809	2,747,565	991,644	279,282	202,725	48,016	38,188	47,527
1987	100,702	275,681	1,968,380	1,560,109	1,574,499	345,353	89,415	81,032	14,459	37,549
1988	3,446	411,737	1,528,771	2,083,993	1,156,925	447,729	67,430	25,560	26,247	9,267
1989	43	163,697	1,209,721	2,361,735	1,650,543	521,108	87,147	70,289	9,369	19,564
1990	0	64,890	801,437	5,510,231	2,713,258	541,353	189,069	29,703	36,417	43,315
1991	3,251	120,451	489,288	930,873	5,539,862	1,036,050	150,670	55,540	25,983	15,805
1992	23,803	368,579	817,817	858,466	500,861	2,187,314	226,068	80,181	6,044	5,530
1993	26,570	104,034	463,390	2,124,314	935,049	103,328	497,117	41,561	11,264	0
1994	11,734	121,833	168,991	1,482,123	1,291,238	266,291	66,224	74,158	28,714	7,870
1995	11,572	77,008	298,132	1,276,197	1,252,189	221,363	29,931	6,521	18,184	2,808
1996	22,067	34,627	100,860	612,077	1,983,816	404,060	36,651	4,039	491	1,623
1997	1,472	67,669	126,915	506,856	464,680	863,272	72,142	5,523	2,272	1,029
1998	917	4,253	152,182	479,050	620,164	152,675	205,174	28,696	5,168	2,257
1999	63	66,560	67,227	329,251	333,593	171,186	53,542	59,427	12,388	1,067
2000	0	17,868	416,434	533,774	808,150	176,067	85,101	12,485	10,521	0
2001	0	584	323,199	1,101,663	671,291	382,956	106,388	57,232	8,262	11,577
2002	0	13,605	34,983	319,653	865,554	312,806	163,354	66,392	27,890	20,263
2003	22,873	37,563	99,331	150,548	530,837	685,411	183,142	75,694	29,224	26,844
2004	187	132,768	92,498	550,931	250,443	388,213	248,046	70,344	35,653	32,898
2005	1,487	23,905	139,279	137,597	859,749	87,274	241,753	109,161	28,661	31,016
2006	273	16,532	46,595	366,653	275,095	442,345	29,527	80,640	40,242	29,208
2007	418	11,658	85,955	248,049	907,725	130,910	222,926	8,326	20,889	32,150
2008	356	10,639	102,178	533,002	679,906	787,577	67,331	100,808	3,341	18,925
2009	89	9,249	81,844	593,074	1,055,393	467,995	277,520	22,010	29,956	10,582
2010	213	6,704	53,493	338,761	842,521	634,539	160,243	82,526	13,172	8,454
2011	485	6,982	37,058	234,105	551,477	585,383	354,461	36,309	39,882	9,589
2012	105	13,085	83,098	288,728	431,245	243,374	125,000	58,831	7,580	3,540
2013	554	6,250	165,995	296,762	189,147	122,917	22,872	12,593	6,931	918
2014	24	15,303	49,299	241,396	254,941	71,911	28,307	8,816	1,852	932
2015	0	5,485	47,907	28,686	55,671	14,394	1,777	1,799	296	220
2016	86	2,453	28,251	119,179	52,159	62,539	5,146	1,674	673	253

Table 22. Mean weights-at-age (kg) of the total catch Gulf of Maine Atlantic cod from 1982 to 2016 with an age 9⁺ group. Mean catch weights-at-age in the 9⁺ group were estimated using a numbers weighted approach. Cells shaded grey were imputed using a 5-year centered moving average. *Only ages 1 through the 9⁺ group are used as assessment model inputs.*

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9
1982	0.012	0.356	0.860	1.514	2.607	5.067	7.065	9.620	9.771	15.664
1983	0.024	0.223	0.770	1.542	2.418	3.808	6.055	6.071	10.317	13.325
1984	0.001	0.233	0.655	1.478	2.678	3.609	5.540	8.368	10.138	14.828
1985	0.039	0.206	0.735	1.406	2.819	4.658	5.884	8.502	11.244	13.676
1986	0.005	0.277	0.502	1.699	2.774	4.778	6.504	8.109	10.206	14.646
1987	0.004	0.152	0.648	1.328	3.090	4.668	7.259	10.036	11.099	14.582
1988	0.003	0.122	0.579	1.668	2.360	5.205	5.200	6.193	10.103	12.993
1989	0.046	0.234	0.759	1.526	2.960	4.282	5.980	9.276	12.519	20.913
1990	0.021	0.193	0.815	1.354	2.143	4.474	7.721	10.820	11.750	18.718
1991	0.014	0.236	1.125	1.611	2.287	3.899	7.144	10.429	12.261	14.031
1992	0.023	0.054	1.040	1.538	2.752	2.979	5.590	10.921	10.483	14.483
1993	0.021	0.078	0.712	1.759	2.164	4.420	5.670	9.817	13.673	15.701
1994	0.022	0.053	0.781	1.740	3.091	3.251	6.335	7.684	12.542	11.846
1995	0.027	0.098	1.343	1.625	2.660	5.096	6.865	11.466	13.128	22.443
1996	0.033	0.085	1.361	2.129	2.274	3.474	7.558	11.728	14.455	16.269
1997	0.017	0.061	1.406	2.158	3.035	3.088	4.714	9.000	12.156	16.938
1998	0.008	0.201	1.125	1.957	2.655	3.974	4.265	7.122	12.118	16.676
1999	0.052	0.213	0.670	1.771	2.792	3.911	5.684	6.707	9.811	12.279
2000	0.030	0.285	1.164	2.203	3.331	4.335	5.901	5.352	9.331	12.680
2001	0.045	0.316	0.958	2.249	3.184	4.690	6.149	7.273	9.072	9.559
2002	0.032	0.192	0.857	1.929	2.987	3.875	6.136	6.969	8.857	12.205
2003	0.038	0.174	0.879	1.914	2.480	3.719	5.170	7.649	9.191	12.058
2004	0.025	0.108	0.485	1.654	2.978	3.604	5.460	7.378	9.829	13.774
2005	0.027	0.122	0.563	1.701	2.505	4.280	4.543	6.398	8.020	12.465
2006	0.076	0.279	0.658	1.579	3.011	3.442	4.593	5.649	7.544	12.368
2007	0.025	0.223	0.765	1.864	3.001	3.781	4.899	6.513	7.782	13.296
2008	0.083	0.238	0.822	2.233	2.853	3.550	4.603	6.075	6.193	12.720
2009	0.029	0.333	0.914	2.253	3.199	3.638	4.502	6.171	8.475	13.826
2010	0.023	0.261	1.039	2.070	3.276	4.049	4.689	5.657	8.948	11.892
2011	0.086	0.312	0.821	2.192	2.961	3.837	4.767	5.593	5.851	12.947
2012	0.001	0.277	1.011	2.026	2.682	3.111	4.092	5.146	5.306	9.895
2013	0.051	0.479	0.969	1.948	2.384	3.149	3.429	5.146	6.976	11.143
2014	0.048	0.377	1.302	1.825	2.370	2.717	3.738	3.931	6.558	8.560
2015	0.036	0.229	0.626	1.633	2.882	4.397	4.530	5.586	8.244	13.956
2016	0.010	0.147	0.591	1.472	2.876	3.442	5.151	4.893	6.679	10.168
Average 2014-2016		0.251	0.840	1.643	2.709	3.519	4.473	4.803	7.160	10.894

Table 23. Mean January 1/spawning stock weights-at-age (kg) of Gulf of Maine Atlantic cod from 1982 to 2016 an age 9⁺ group. Mean weights-at-age were estimated by applying a Rivard-type approach (see NEFSC 2013) to numbers-weighted catch weights without mortality assumptions applied (uses all fish encountered). Cells shaded grey were imputed using a 5-year centered moving average. *Only ages 1 through the 9⁺ group are used as assessment model inputs.*

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9
1982	0.002	0.241	0.594	1.165	2.127	4.635	7.622	9.289	9.695	15.664
1983	0.008	0.050	0.501	1.114	1.894	3.136	5.539	6.549	9.962	13.325
1984	0.000	0.075	0.372	1.019	2.021	2.952	4.593	7.118	7.845	14.828
1985	0.015	0.014	0.403	0.910	2.013	3.532	4.608	6.863	9.700	13.676
1986	0.001	0.104	0.316	1.077	1.917	3.670	5.504	6.908	9.315	14.646
1987	0.001	0.028	0.406	0.777	2.273	3.574	5.889	8.079	9.487	14.582
1988	0.000	0.022	0.293	0.980	1.709	4.010	4.927	6.705	10.069	12.993
1989	0.022	0.027	0.292	0.887	2.179	3.172	5.578	6.945	8.799	20.913
1990	0.006	0.095	0.431	0.937	1.742	3.627	5.750	8.043	10.440	18.718
1991	0.007	0.071	0.450	1.083	1.689	2.846	5.654	8.972	11.518	14.060
1992	0.012	0.028	0.476	1.215	2.026	2.564	4.629	8.832	10.453	14.483
1993	0.012	0.046	0.191	1.254	1.702	3.449	4.083	7.388	12.219	15.708
1994	0.010	0.038	0.236	1.003	2.244	2.571	5.294	6.601	11.095	11.846
1995	0.012	0.051	0.275	0.946	2.021	3.934	4.722	8.526	10.045	22.443
1996	0.022	0.060	0.356	1.462	1.784	2.971	6.185	8.967	12.844	16.357
1997	0.005	0.049	0.391	1.466	2.407	2.571	3.973	8.245	11.940	16.938
1998	0.002	0.059	0.256	1.445	2.245	3.423	3.558	5.739	10.442	16.676
1999	0.022	0.044	0.343	1.196	2.237	3.139	4.752	5.301	8.351	12.279
2000	0.009	0.120	0.461	1.063	2.257	3.422	4.773	5.508	7.882	12.661
2001	0.023	0.097	0.456	1.305	2.420	3.851	5.091	6.513	6.912	9.538
2002	0.012	0.089	0.465	1.050	2.249	3.247	5.296	6.514	7.924	12.152
2003	0.022	0.089	0.346	1.053	1.742	2.977	4.118	6.837	8.011	12.023
2004	0.010	0.066	0.357	0.950	2.074	2.634	4.264	5.971	8.655	13.758
2005	0.008	0.061	0.243	0.832	1.613	3.279	3.871	5.869	7.681	12.474
2006	0.047	0.090	0.300	0.795	1.885	2.468	4.089	4.959	6.816	12.361
2007	0.009	0.128	0.447	0.909	1.754	3.008	3.767	5.180	6.578	13.295
2008	0.049	0.085	0.405	1.093	1.867	2.869	3.920	5.277	6.330	12.711
2009	0.013	0.173	0.477	1.212	2.262	2.896	3.679	5.186	7.048	13.813
2010	0.006	0.099	0.553	1.143	2.340	3.251	3.762	4.700	7.331	11.892
2011	0.043	0.086	0.460	1.257	1.920	3.206	4.095	4.765	5.531	12.957
2012	0.000	0.156	0.485	1.114	2.048	2.657	3.796	4.848	5.329	9.895
2013	0.018	0.020	0.466	1.085	1.854	2.735	3.144	4.565	5.984	11.143
2014	0.022	0.137	0.617	1.037	1.657	2.247	3.235	3.506	5.790	8.560
2015	0.017	0.105	0.478	1.172	1.799	2.561	2.957	4.212	5.449	13.956
2016	0.001	0.075	0.364	0.877	1.790	2.458	4.057	4.114	5.693	10.168
2014-2016 average		0.105	0.486	1.028	1.749	2.422	3.416	3.944	5.644	10.895

Table 24. Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl survey and Massachusetts Division of Marine Fisheries (MADMF) spring bottom trawl survey indices for Gulf of Maine Atlantic cod from 1963 to 2017. *Note: the NEFSC spring survey did not begin until 1968 and 1978 for the MADMF spring survey, the 2017 fall survey has not been conducted at the time of this report. Model inputs include only years 1982 to 2016.*

Year	Abundance (numbers/tow)			Biomass (kg/tow)	
	NMFS spring	NMFS fall	MADMF spring	NMFS spring	NMFS fall
1963		5.914			17.950
1964		4.015			22.799
1965		4.500			12.089
1966		3.720			12.838
1967		2.603			9.313
1968	5.329	4.374		17.480	19.437
1969	3.215	2.758		13.100	15.154
1970	2.191	4.905		11.089	16.442
1971	1.429	4.361		6.996	16.528
1972	2.057	9.301		8.029	12.988
1973	7.525	4.452		18.807	8.758
1974	2.902	4.328		7.418	8.959
1975	2.512	6.143		6.039	8.619
1976	2.782	2.148		7.556	6.740
1977	3.872	3.073		8.541	10.199
1978	2.050	5.773	48.993	7.697	12.899
1979	3.644	3.142	96.559	7.555	13.927
1980	2.155	7.035	65.979	6.232	14.202
1981	4.832	2.349	69.406	10.650	7.533
1982	3.763	7.769	25.842	8.616	15.919
1983	3.912	2.786	54.873	10.962	8.416
1984	3.667	2.449	10.330	6.143	8.735
1985	2.517	2.821	8.455	7.645	8.264
1986	1.957	1.950	24.089	3.476	4.715
1987	1.083	2.996	17.206	1.976	3.394
1988	3.127	5.903	22.242	3.603	6.616
1989	2.112	4.553	52.244	2.424	4.535
1990	2.362	2.986	32.409	3.077	4.912
1991	2.393	1.252	13.699	2.891	2.782
1992	2.435	1.434	16.924	8.626	2.448
1993	2.507	1.232	92.659	5.875	1.002
1994	1.271	2.130	16.358	2.427	2.737
1995	1.930	2.008	23.364	2.432	3.665
1996	2.465	1.327	12.961	5.427	2.351
1997	2.192	0.872	17.887	5.616	1.872
1998	1.710	0.843	27.570	4.180	1.500
1999	2.301	1.807	161.058	5.089	3.505
2000	3.083	2.604	50.771	3.211	4.652
2001	2.147	1.980	41.844	6.215	7.324
2002	3.724	5.328	24.338	10.934	24.659
2003	3.677	2.529	1120.371	9.495	5.988
2004	0.981	3.533	131.589	2.412	4.906
2005	1.765	1.338	193.262	2.701	2.897
2006	1.363	3.594	1077.030	2.702	4.229
2007	12.393	1.992	61.576	15.811	2.714
2008	7.990	3.460	482.100	10.823	5.307
2009	1.535	3.441	480.516	3.234	5.776
2010	3.540	0.719	8.075	5.700	1.985
2011	0.894	0.996	59.064	2.133	2.667
2012	1.061	0.452	11.465	1.930	1.024
2013	0.909	0.587	2.314	1.678	1.068
2014	0.582	1.269	19.857	1.323	2.662
2015	4.088	0.376	4.790	8.017	1.282
2016	1.864	1.527	5.062	3.364	4.389
2017	1.264		105.903	3.740	1.440
Avg	2.861	3.106	119.776	6.462	7.746
Min	0.582	0.376	2.314	1.323	1.002
Max	12.393	9.301	1120.371	18.807	24.659
					26.445

Table 25. Coefficients of variation (CV) for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl survey and Massachusetts Division of Marine Fisheries (MADMF) spring bottom trawl survey indices for Gulf of Maine Atlantic cod from 1963 to 2017. *Note: the NEFSC spring survey did not begin until 1968 and 1978 for the MADMF spring survey, the 2017 fall survey has not been conducted at the time of this report. Model inputs include only years 1982 to 2016.*

Year	Abundance (numbers/tow)			Biomass (kg/tow)		
	NMFS spring	NMFS fall	MADMF spring	NMFS spring	NMFS fall	MADMF spring
1963		0.25			0.40	
1964		0.42			0.50	
1965		0.27			0.26	
1966		0.22			0.23	
1967		0.23			0.23	
1968	0.13	0.18		0.15	0.20	
1969	0.32	0.15		0.32	0.22	
1970	0.22	0.31		0.24	0.24	
1971	0.19	0.20		0.22	0.31	
1972	0.21	0.53		0.22	0.21	
1973	0.33	0.15		0.40	0.27	
1974	0.19	0.25		0.20	0.20	
1975	0.22	0.22		0.25	0.16	
1976	0.18	0.20		0.16	0.23	
1977	0.26	0.12		0.20	0.12	
1978	0.20	0.19	0.15	0.21	0.15	0.14
1979	0.24	0.12	0.29	0.18	0.13	0.23
1980	0.16	0.26	0.12	0.18	0.15	0.13
1981	0.20	0.23	0.20	0.20	0.23	0.28
1982	0.22	0.65	0.22	0.22	0.69	0.18
1983	0.26	0.17	0.16	0.22	0.19	0.16
1984	0.47	0.22	0.28	0.34	0.32	0.25
1985	0.21	0.18	0.21	0.22	0.36	0.18
1986	0.31	0.23	0.52	0.20	0.22	0.36
1987	0.26	0.29	0.21	0.31	0.23	0.28
1988	0.21	0.34	0.20	0.28	0.23	0.24
1989	0.19	0.22	0.26	0.21	0.17	0.33
1990	0.24	0.19	0.29	0.26	0.20	0.34
1991	0.25	0.25	0.20	0.25	0.26	0.12
1992	0.31	0.21	0.27	0.38	0.25	0.31
1993	0.23	0.25	0.35	0.33	0.25	0.29
1994	0.23	0.31	0.22	0.22	0.29	0.24
1995	0.28	0.30	0.26	0.27	0.32	0.24
1996	0.25	0.26	0.22	0.28	0.27	0.31
1997	0.17	0.30	0.23	0.19	0.29	0.25
1998	0.34	0.35	0.26	0.32	0.28	0.46
1999	0.25	0.18	0.37	0.32	0.20	0.26
2000	0.21	0.31	0.39	0.15	0.34	0.45
2001	0.30	0.25	0.43	0.31	0.28	0.56
2002	0.20	0.58	0.09	0.22	0.68	0.39
2003	0.21	0.31	0.49	0.37	0.25	0.22
2004	0.24	0.32	0.45	0.28	0.22	0.27
2005	0.24	0.06	0.23	0.26	0.22	0.20
2006	0.19	0.30	0.33	0.25	0.18	0.18
2007	0.66	0.38	0.27	0.55	0.29	0.25
2008	0.70	0.38	0.20	0.60	0.27	0.22
2009	0.30	0.53	0.36	0.31	0.44	0.19
2010	0.64	0.28	0.23	0.43	0.35	0.45
2011	0.28	0.31	0.55	0.20	0.34	0.44
2012	0.22	0.21	0.26	0.22	0.23	0.40
2013	0.28	0.26	0.26	0.29	0.25	0.31
2014	0.23	0.47	0.15	0.24	0.45	0.44
2015	0.35	0.27	0.27	0.32	0.27	0.21
2016	0.55	0.53	0.31	0.51	0.51	0.36
2017	0.21		0.41	0.17		0.32
Avg	0.27	0.28	0.28	0.27	0.28	0.29
Min	0.13	0.06	0.09	0.15	0.12	0.12
Max	0.70	0.65	0.55	0.60	0.69	0.56

Table 26. Northeast Fisheries Science Center (NEFSC) spring survey abundance indices-at-age (numbers/tow) from 1970 to 2017 for Gulf of Maine Atlantic cod. Note: age data are not available prior to 1970. Model inputs include only years 1982 to 2016.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16	Age17
1970	0.000	0.159	0.124	0.053	0.089	0.315	0.453	0.602	0.058	0.054	0.083	0.130	0.054	0.000	0.020	0.000	0.000	0.000
1971	0.000	0.055	0.110	0.113	0.268	0.090	0.106	0.287	0.185	0.158	0.039	0.020	0.000	0.000	0.000	0.000	0.000	0.000
1972	0.000	0.353	0.153	0.508	0.198	0.205	0.053	0.083	0.119	0.290	0.029	0.021	0.029	0.000	0.017	0.000	0.000	0.000
1973	0.000	0.000	4.326	0.942	0.615	0.344	0.163	0.116	0.172	0.274	0.190	0.072	0.113	0.112	0.089	0.000	0.000	0.000
1974	0.000	0.476	0.081	1.534	0.177	0.223	0.085	0.000	0.068	0.040	0.053	0.044	0.057	0.000	0.030	0.000	0.036	0.000
1975	0.006	0.086	0.674	0.121	1.207	0.193	0.066	0.000	0.010	0.025	0.028	0.035	0.062	0.000	0.000	0.000	0.000	0.000
1976	0.000	0.032	0.272	1.127	0.136	0.900	0.105	0.066	0.043	0.000	0.009	0.000	0.028	0.065	0.000	0.000	0.000	0.000
1977	0.000	0.029	0.274	0.475	1.984	0.146	0.800	0.000	0.126	0.000	0.000	0.000	0.000	0.032	0.000	0.000	0.006	0.000
1978	0.000	0.050	0.067	0.322	0.403	0.733	0.093	0.239	0.014	0.109	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.000	0.470	1.407	0.186	0.473	0.308	0.536	0.095	0.105	0.013	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.000	0.107	0.417	0.527	0.122	0.230	0.269	0.353	0.000	0.113	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.000	1.089	0.621	0.850	1.326	0.327	0.303	0.080	0.138	0.098	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.000	0.372	0.991	0.555	0.705	0.869	0.088	0.118	0.000	0.056	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.013	0.609	0.968	1.042	0.456	0.329	0.254	0.061	0.000	0.079	0.020	0.021	0.045	0.000	0.016	0.000	0.000	0.000
1984	0.000	0.151	1.263	1.011	0.850	0.244	0.052	0.097	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.000	0.029	0.249	0.665	0.613	0.708	0.109	0.092	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.000	0.536	0.259	0.769	0.203	0.082	0.051	0.039	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.000	0.000	0.000
1987	0.000	0.030	0.471	0.191	0.216	0.078	0.000	0.070	0.012	0.000	0.000	0.000	0.000	0.015	0.000	0.000	0.000	0.000
1988	0.000	0.780	0.893	0.796	0.266	0.229	0.088	0.045	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.000	0.017	0.618	0.710	0.632	0.061	0.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1990	0.000	0.000	0.237	1.336	0.666	0.071	0.024	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.027	0.078	0.236	1.747	0.243	0.043	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.000	0.050	0.247	0.225	0.254	1.360	0.214	0.074	0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.000	0.191	0.521	0.809	0.354	0.088	0.445	0.056	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.015	0.316	0.406	0.203	0.085	0.054	0.136	0.011	0.028	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.000	0.038	0.170	1.155	0.346	0.146	0.063	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.000	0.057	0.022	0.586	1.355	0.385	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.000	0.159	0.139	0.390	0.271	0.874	0.244	0.115	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.000	0.018	0.228	0.364	0.503	0.146	0.396	0.025	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.000	0.166	0.342	0.731	0.345	0.299	0.136	0.271	0.000	0.000	0.000	0.000	0.000	0.011	0.000	0.000	0.000	0.000
2000	0.026	1.173	0.737	0.438	0.485	0.099	0.092	0.011	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.000	0.029	0.340	0.684	0.522	0.346	0.065	0.097	0.055	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.000	0.340	0.045	0.560	1.571	0.608	0.342	0.185	0.057	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.075	0.825	0.059	0.719	1.082	0.397	0.308	0.087	0.086	0.031	0.011	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.000	0.136	0.045	0.230	0.116	0.209	0.213	0.011	0.011	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.000	0.029	0.739	0.082	0.619	0.012	0.141	0.129	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2006	0.000	0.212	0.237	0.434	0.049	0.197	0.024	0.126	0.069	0.000	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2007	0.000	0.099	3.423	3.077	4.452	0.444	0.782	0.076	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2008	0.000	0.079	1.165	3.930	1.582	1.099	0.053	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2009	0.000	0.065	0.195	0.364	0.421	0.263	0.199	0.010	0.018	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2010	0.000	0.070	1.352	1.149	0.407	0.323	0.156	0.043	0.016	0.010	0.005	0.000	0.010	0.000	0.000	0.000	0.000	0.000
2011	0.000	0.005	0.024	0.140	0.383	0.189	0.086	0.033	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2012	0.001	0.085	0.138	0.262	0.288	0.186	0.061	0.034	0.004	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2013	0.000	0.012	0.283	0.224	0.163	0.165	0.044	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2014	0.000	0.006	0.022	0.090	0.253	0.129	0.035	0.034	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2015	0.000	0.031	0.826	1.119	1.748	0.262	0.077	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2016	0.000	0.060	0.130	1.238	0.199	0.221	0.005	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2017	0.000	0.004	0.031	0.171	0.478	0.301	0.259	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 27. Northeast Fisheries Science Center (NEFSC) fall survey abundance indices-at-age (numbers/tow) from 1970 to 2016 for Gulf of Maine Atlantic cod. Note: age data are not available prior to 1970. Model inputs include only years 1982 to 2016.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14	Age15	Age16	Age17
1970	0.000	1.686	0.265	0.506	0.340	0.491	0.428	0.823	0.131	0.090	0.037	0.037	0.073	0.000	0.000	0.000	0.000	
1971	1.322	0.210	0.223	0.189	0.614	0.428	0.511	0.214	0.294	0.202	0.061	0.041	0.054	0.000	0.000	0.000	0.000	
1972	0.000	5.695	1.120	1.587	0.188	0.074	0.097	0.035	0.121	0.371	0.000	0.000	0.000	0.016	0.000	0.000	0.000	
1973	0.766	0.196	2.148	0.184	0.532	0.189	0.060	0.021	0.042	0.167	0.133	0.000	0.000	0.017	0.000	0.000	0.000	
1974	0.283	1.113	0.262	1.952	0.106	0.267	0.000	0.032	0.051	0.053	0.000	0.145	0.000	0.000	0.063	0.000	0.000	
1975	0.000	0.199	3.066	0.136	2.349	0.252	0.106	0.020	0.000	0.000	0.000	0.006	0.009	0.000	0.000	0.000	0.000	
1976	0.000	0.209	0.216	0.590	0.107	0.821	0.051	0.123	0.000	0.000	0.031	0.000	0.000	0.000	0.000	0.000	0.000	
1977	0.000	0.061	0.420	0.463	1.157	0.139	0.602	0.026	0.076	0.022	0.052	0.000	0.023	0.031	0.000	0.000	0.000	
1978	0.241	1.411	0.360	1.148	0.662	1.445	0.105	0.261	0.008	0.094	0.000	0.022	0.000	0.017	0.000	0.000	0.000	
1979	0.000	0.377	0.604	0.131	0.697	0.325	0.753	0.041	0.145	0.000	0.052	0.000	0.000	0.005	0.013	0.000	0.000	
1980	0.027	1.329	2.536	1.680	0.514	0.273	0.355	0.206	0.026	0.013	0.000	0.040	0.000	0.014	0.000	0.022	0.000	
1981	0.010	0.585	0.401	0.482	0.509	0.094	0.108	0.043	0.088	0.000	0.028	0.000	0.000	0.000	0.000	0.000	0.000	
1982	0.000	0.834	3.244	2.458	1.010	0.224	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1983	0.000	0.306	0.914	0.811	0.226	0.228	0.219	0.000	0.000	0.000	0.018	0.028	0.037	0.000	0.000	0.000	0.000	
1984	0.000	0.513	0.419	0.586	0.400	0.196	0.173	0.067	0.000	0.016	0.000	0.000	0.045	0.035	0.000	0.000	0.000	
1985	0.164	0.503	0.914	0.630	0.215	0.223	0.070	0.000	0.042	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1986	0.000	0.393	0.405	0.645	0.350	0.068	0.048	0.000	0.000	0.044	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1987	0.129	0.570	1.388	0.595	0.203	0.112	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1988	0.000	1.889	2.366	1.070	0.351	0.162	0.000	0.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1989	0.000	0.137	2.476	1.459	0.281	0.147	0.054	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1990	0.000	0.057	0.218	1.797	0.583	0.285	0.034	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1991	0.009	0.149	0.146	0.231	0.634	0.062	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1992	0.059	0.289	0.449	0.145	0.044	0.322	0.126	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1993	0.042	0.199	0.578	0.358	0.017	0.000	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1994	0.032	0.184	0.909	0.825	0.085	0.051	0.000	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1995	0.009	0.067	0.308	1.226	0.304	0.082	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1996	0.029	0.122	0.379	0.232	0.516	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1997	0.000	0.297	0.096	0.159	0.169	0.151	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1998	0.049	0.092	0.334	0.110	0.185	0.041	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1999	0.025	0.432	0.375	0.590	0.244	0.127	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2000	0.008	0.540	0.982	0.399	0.490	0.142	0.012	0.000	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2001	0.018	0.000	0.143	0.768	0.489	0.333	0.127	0.080	0.000	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2002	0.000	0.269	0.104	0.319	2.696	1.084	0.724	0.087	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2003	0.542	0.461	0.186	0.217	0.513	0.455	0.071	0.062	0.000	0.011	0.000	0.011	0.000	0.000	0.000	0.000	0.000	
2004	1.369	0.658	0.166	0.570	0.264	0.255	0.162	0.056	0.013	0.010	0.011	0.000	0.000	0.000	0.000	0.000	0.000	
2005	0.034	0.153	0.378	0.078	0.456	0.023	0.090	0.082	0.023	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2006	0.064	1.240	0.599	1.009	0.254	0.289	0.037	0.053	0.034	0.000	0.000	0.015	0.000	0.000	0.000	0.000	0.000	
2007	0.016	0.131	0.863	0.396	0.497	0.023	0.067	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2008	0.165	0.658	1.219	1.060	0.189	0.139	0.000	0.000	0.000	0.010	0.021	0.000	0.000	0.000	0.000	0.000	0.000	
2009	0.022	0.666	2.105	0.301	0.266	0.039	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2010	0.004	0.091	0.122	0.196	0.203	0.077	0.011	0.010	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	
2011	0.036	0.060	0.093	0.210	0.305	0.179	0.078	0.005	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2012	0.000	0.079	0.087	0.135	0.092	0.032	0.011	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2013	0.011	0.020	0.242	0.222	0.064	0.014	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2014	0.000	0.385	0.344	0.331	0.177	0.016	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2015	0.000	0.004	0.123	0.060	0.128	0.055	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2016	0.003	0.000	0.059	1.006	0.199	0.224	0.031	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Table 28. Massachusetts Division of Marine Fisheries (MADMF) spring survey abundance indices-at-age (numbers/tow) from 1982 to 2016 for Gulf of Maine Atlantic cod. *Note that age data are not available prior to 1982 and 2017 spring survey age data have not been aged at the time of this report. Model inputs include only years 1982 to 2016.*

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	Age14
1982	1.691	13.194	6.624	2.935	1.045	0.225	0.027	0.051	0.050	0.000	0.000	0.000	0.000	0.000	
1983	0.718	30.256	17.620	4.577	0.452	1.108	0.075	0.035	0.033	0.000	0.000	0.000	0.000	0.000	
1984	0.257	1.975	5.016	2.093	0.778	0.087	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1985	1.569	1.656	2.719	1.989	0.522	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1986	1.075	17.889	3.547	0.889	0.542	0.123	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1987	0.725	8.644	5.331	2.074	0.170	0.141	0.053	0.000	0.000	0.070	0.000	0.000	0.000	0.000	
1988	1.909	10.194	6.952	1.961	1.176	0.000	0.049	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1989	0.265	21.496	22.947	6.875	0.501	0.126	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1990	4.942	5.370	5.012	14.718	2.147	0.219	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1991	0.355	5.335	2.279	1.792	3.690	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1992	1.506	4.390	5.686	3.448	0.484	1.301	0.066	0.044	0.000	0.000	0.000	0.000	0.000	0.000	
1993	80.115	2.811	6.121	2.554	0.813	0.170	0.074	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1994	4.627	5.405	3.883	1.704	0.630	0.108	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1995	12.000	5.955	2.447	2.407	0.521	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1996	8.844	0.775	0.499	0.955	1.590	0.299	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1997	12.445	2.896	1.035	0.920	0.190	0.384	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1998	23.481	1.492	0.919	0.779	0.638	0.034	0.211	0.017	0.000	0.000	0.000	0.000	0.000	0.000	
1999	143.000	11.832	2.407	2.275	0.735	0.631	0.036	0.127	0.017	0.000	0.000	0.000	0.000	0.000	
2000	2.151	35.360	6.995	2.371	2.320	0.789	0.643	0.063	0.082	0.000	0.000	0.000	0.000	0.000	
2001	25.987	0.084	4.998	4.717	3.465	1.868	0.356	0.252	0.117	0.000	0.000	0.000	0.000	0.000	
2002	0.924	19.340	0.220	1.379	1.146	0.561	0.319	0.111	0.253	0.025	0.049	0.000	0.012	0.000	
2003	1094.143	17.060	5.507	0.439	1.943	0.924	0.226	0.077	0.015	0.025	0.000	0.014	0.000	0.000	
2004	116.149	8.914	1.881	2.631	0.375	1.028	0.488	0.080	0.030	0.000	0.014	0.000	0.000	0.000	
2005	179.479	5.524	4.128	0.802	1.962	0.263	0.664	0.243	0.094	0.105	0.000	0.000	0.000	0.000	
2006	1053.701	9.992	7.140	3.930	0.526	1.530	0.110	0.058	0.000	0.017	0.028	0.000	0.000	0.000	
2007	49.323	3.776	3.079	2.303	2.163	0.343	0.519	0.025	0.046	0.000	0.000	0.000	0.000	0.000	
2008	456.954	7.275	10.336	3.242	2.288	1.695	0.155	0.155	0.000	0.000	0.000	0.000	0.000	0.000	
2009	466.098	8.907	2.350	1.654	1.046	0.348	0.112	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2010	1.165	2.418	1.390	1.426	0.816	0.678	0.133	0.000	0.000	0.000	0.050	0.000	0.000	0.000	
2011	55.378	0.326	1.001	0.621	0.933	0.559	0.139	0.086	0.021	0.000	0.000	0.000	0.000	0.000	
2012	6.239	3.368	0.671	0.446	0.304	0.415	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2013	1.254	0.284	0.237	0.145	0.232	0.162	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2014	17.764	1.034	0.250	0.573	0.131	0.055	0.034	0.017	0.000	0.000	0.000	0.000	0.000	0.000	
2015	3.454	0.360	0.297	0.288	0.285	0.023	0.000	0.084	0.000	0.000	0.000	0.000	0.000	0.000	
2016	4.659	0.068	0.260	0.033	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2017															

Table 29. Maine-New Hampshire spring and fall inshore bottom trawl survey indices and coefficients of variation (CV) for Gulf of Maine Atlantic cod from 2000 to 2016. Includes regions 1 through 5 and depth strata 1 through 4. The fall 2000- 2002 and spring 2001-2002 indices were calculated using only three depth strata - a fourth depth stratum was added to the survey in 2003. Fixed stations have not been included in the calculation of the indices. *Data courtesy of S. Sherman, ME DMR. Note that the ME NH survey is not used as an input to the assessment model.*

Year	Spring				Fall			
	Biomass (kg/tow)	CV	Abundance (numbers/tow)	CV	Biomass (kg/tow)	CV	Abundance (numbers/tow)	CV
2000					1.32	1.49	3.91	1.16
2001	0.32	0.63	2.14	0.51	0.18	0.57	2.84	0.59
2002	2.29	0.74	5.66	0.91	0.30	0.65	0.85	0.49
2003	0.94	0.53	1.23	0.43	1.64	0.32	3.53	0.40
2004	0.63	0.55	6.30	0.57	1.00	0.59	2.76	0.71
2005	2.22	1.30	5.46	0.89	2.17	1.23	3.88	0.81
2006	0.76	1.20	1.24	0.59	1.84	1.28	3.31	1.14
2007	1.04	0.39	2.25	0.65	1.78	1.26	2.34	1.24
2008	1.49	0.90	3.38	0.97	0.52	0.76	1.08	0.63
2009	2.25	0.74	2.52	0.58	0.51	0.17	1.16	0.48
2010	1.43	0.78	1.79	0.52	0.70	0.45	0.67	0.35
2011	0.57	0.56	1.64	1.11	0.45	0.76	1.06	0.36
2012	0.68	0.50	1.86	0.64	0.17	0.59	0.29	0.54
2013	0.13	0.75	0.24	0.96	0.11	0.80	0.13	0.55
2014	0.56	0.50	4.49	0.95	0.09	1.03	0.44	0.45
2015	0.07	0.64	0.93	0.58	0.07	0.67	1.23	0.21
2016	0.21	0.56	1.43	0.43	0.19	1.01	0.29	0.95

Table 30. Summary of Gulf of Maine Atlantic cod ASAP model diagnostics and terminal estimates from the M=0.2 and M-ramp models. See NEFSC (2013) for a full description of model configurations - no changes have been made to the model configurations as part of the 2017 Update.

Model	M=0.2	M-ramp
Description	M=0.2	M=0.2 (1982-1988), linear ramp (1989-2002), M=0.4 (2003-2016)
Maximum gradient (conv. criteria < 1e-4)	1.14E-04	1.54E-04
Number of parameters	103	103
Objective function	6382	6369
Components of objective function		
Recruit devs	8	4
Suvey age comps	2151	2149
Catch age comps	4328	4330
Index fit	-1	-10
Catch fit	-104	-104
RMSE		
Catch	0.25	0.18
NEFSC spring	1.30	1.19
NEFSC fall	1.06	1.06
MADMF spring	1.39	1.30
Index total	1.26	1.19
Recruit devs	1.91	1.64
SSB₁₉₈₂ (mt)	23,173	22,629
SSB₂₀₁₆ (mt)	3,046	3,262
F_{mult}, 2016	0.228	0.237
Median recruitment₁₉₈₂₋₂₀₁₄ (000s)	4,390	8,508
Geometric mean recruitment₂₀₁₂₋₂₀₁₆ (000s)	1,174	2,067
Mohn's rho (7 year peel)		
SSB	0.53	0.30
F_{mult}	-0.31	-0.17
Age 1 N	0.88	0.41
Survey catchability (q)		
NEFSC spring	1.08 (0.16)	0.94 (0.17)
NEFSC fall	0.64 (0.22)	0.55 (0.23)
MADMF spring	0.21 (0.12)	0.14 (0.12)

Table 31. Comparison of the fleet and index selectivity parameters and the corresponding coefficients of variation (CV) from the Gulf of Maine Atlantic cod M=0.2 and M-ramp models. *Ages where CV values are null are fixed parameters within the model (see NEFSC 2013 for a full description of selectivity assumptions).*

Block/survey	Parameter	M=0.2		M-ramp	
		Value	CV	Value	CV
Block 1 (1982-1988)	A_{50}	2.33	0.05	2.33	0.05
	slope up	0.46	0.09	0.45	0.09
Block 2 (1989 - 2004)	A_{50}	3.33	0.02	3.36	0.02
	slope up	0.55	0.05	0.52	0.05
Block 3 (2005-2016)	A_{50}	3.66	0.03	3.71	0.03
	slope up	0.57	0.05	0.54	0.05
NEFSC spring	Age1	0.04	0.23	0.03	0.23
	Age2	0.14	0.19	0.12	0.19
	Age3	0.30	0.18	0.27	0.18
	Age4	0.54	0.18	0.52	0.18
	Age5	0.74	0.19	0.73	0.18
	Age6	1.00		1.00	
	Age7	1.00		1.00	
	Age8	1.00		1.00	
	Age9 ⁺	1.00		1.00	
	Age1	0.15	0.25	0.12	0.25
NEFSC fall	Age2	0.35	0.24	0.31	0.24
	Age3	0.56	0.24	0.54	0.24
	Age4	0.80	0.24	0.79	0.24
	Age5	0.93	0.26	0.95	0.26
	Age6	1.00		1.00	
	Age7	1.00		1.00	
	Age8	1.00		1.00	
	Age9 ⁺	1.00		1.00	
	Age1	1.00		1.00	
	Age2	0.69	0.15	0.78	0.15
MADMF spring	Age3	0.69	0.17	0.85	0.17
	Age4	0.72	0.21	0.93	0.20
	Age5	0.74	0.29	0.99	0.29
	Age6	0.55	0.56	0.75	0.56
	NEFSC spring	1.08	0.16	0.94	0.17
Survey catchability (q)	NEFSC fall	0.64	0.64	0.55	0.23
	MADMF spring	0.21	0.21	0.14	0.12

Table 32. Gulf of Maine Atlantic cod January 1 biomass and spawning stock biomass from 1982 to 2016 as estimated from the M=0.2 and M-ramp models.

Year	M=0.2		M-ramp	
	January 1 biomass (mt)	Spawning stock biomass (mt)	January 1 biomass (mt)	Spawning stock biomass (mt)
1982	38,326	23,173	37,902	22,629
1983	28,502	17,312	28,250	16,942
1984	22,960	14,186	22,823	13,915
1985	21,379	13,001	21,316	12,804
1986	20,383	12,134	20,384	11,995
1987	19,711	11,733	19,778	11,660
1988	20,048	12,297	20,352	12,389
1989	27,325	16,443	28,364	16,871
1990	33,794	21,393	35,650	22,341
1991	27,930	18,030	29,573	18,909
1992	18,777	11,203	20,231	11,880
1993	13,899	7,986	15,424	8,701
1994	12,848	7,446	14,812	8,473
1995	13,084	8,499	15,733	10,091
1996	13,328	8,796	16,570	10,803
1997	11,225	7,432	14,843	9,674
1998	9,856	6,585	13,927	9,133
1999	10,470	7,208	15,872	10,459
2000	14,783	9,548	22,745	13,846
2001	18,402	12,547	27,950	18,503
2002	16,739	12,456	25,434	18,272
2003	14,146	10,336	20,879	14,707
2004	12,601	9,035	18,559	12,749
2005	10,868	7,589	15,795	10,555
2006	10,645	7,211	15,858	10,067
2007	13,643	9,048	19,880	12,221
2008	15,158	10,165	20,853	13,267
2009	15,660	10,490	20,926	13,390
2010	13,038	8,881	16,686	10,931
2011	9,074	5,703	11,121	6,805
2012	5,034	2,836	6,403	3,451
2013	2,942	1,661	3,908	2,118
2014	2,881	1,449	4,052	1,896
2015	3,242	1,897	4,407	2,366
2016	4,199	3,046	4,832	3,262

Table 33. Gulf of Maine Atlantic cod fishing mortality-at-age from 1982 to 2016 as estimated from the M = 0.2 model.

Year	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9 ⁺	F _{full}
1982	0.038	0.240	0.595	0.712	0.728	0.730	0.730	0.730	0.730	0.730
1983	0.045	0.286	0.711	0.851	0.870	0.872	0.873	0.873	0.873	0.873
1984	0.040	0.256	0.637	0.762	0.780	0.782	0.782	0.782	0.782	0.782
1985	0.047	0.300	0.746	0.893	0.913	0.916	0.916	0.916	0.916	0.916
1986	0.043	0.274	0.681	0.816	0.834	0.836	0.837	0.837	0.837	0.837
1987	0.042	0.270	0.671	0.804	0.822	0.824	0.824	0.824	0.824	0.824
1988	0.032	0.205	0.509	0.610	0.623	0.625	0.625	0.625	0.625	0.625
1989	0.013	0.077	0.330	0.717	0.886	0.922	0.928	0.929	0.929	0.929
1990	0.016	0.094	0.407	0.883	1.091	1.134	1.142	1.143	1.143	1.143
1991	0.018	0.104	0.451	0.979	1.209	1.258	1.266	1.267	1.267	1.267
1992	0.020	0.113	0.486	1.056	1.304	1.356	1.365	1.366	1.366	1.366
1993	0.022	0.128	0.552	1.199	1.481	1.540	1.550	1.551	1.552	1.552
1994	0.021	0.120	0.518	1.125	1.389	1.445	1.454	1.456	1.456	1.456
1995	0.014	0.082	0.354	0.768	0.949	0.986	0.993	0.994	0.994	0.994
1996	0.015	0.085	0.366	0.795	0.982	1.021	1.028	1.029	1.029	1.029
1997	0.013	0.076	0.328	0.713	0.881	0.916	0.922	0.923	0.923	0.923
1998	0.012	0.068	0.292	0.633	0.782	0.813	0.819	0.819	0.820	0.820
1999	0.007	0.039	0.170	0.369	0.455	0.474	0.477	0.477	0.477	0.477
2000	0.009	0.050	0.217	0.472	0.583	0.606	0.610	0.611	0.611	0.611
2001	0.010	0.058	0.250	0.544	0.672	0.699	0.703	0.704	0.704	0.704
2002	0.008	0.045	0.194	0.422	0.521	0.542	0.545	0.546	0.546	0.546
2003	0.009	0.053	0.228	0.495	0.611	0.636	0.640	0.640	0.640	0.640
2004	0.010	0.054	0.235	0.510	0.630	0.655	0.659	0.660	0.660	0.660
2005	0.008	0.042	0.194	0.521	0.736	0.793	0.804	0.806	0.806	0.806
2006	0.006	0.035	0.163	0.438	0.620	0.668	0.677	0.678	0.679	0.679
2007	0.006	0.035	0.163	0.440	0.621	0.669	0.678	0.680	0.680	0.680
2008	0.008	0.046	0.211	0.568	0.804	0.866	0.877	0.879	0.880	0.880
2009	0.009	0.052	0.240	0.646	0.913	0.984	0.997	0.999	1.000	1.000
2010	0.010	0.054	0.251	0.675	0.954	1.028	1.042	1.044	1.045	1.045
2011	0.014	0.080	0.370	0.996	1.408	1.517	1.537	1.541	1.542	1.542
2012	0.017	0.096	0.443	1.192	1.685	1.815	1.839	1.843	1.844	1.844
2013	0.016	0.087	0.402	1.081	1.528	1.646	1.668	1.672	1.673	1.673
2014	0.015	0.085	0.393	1.056	1.493	1.608	1.630	1.634	1.634	1.634
2015	0.002	0.011	0.050	0.136	0.192	0.206	0.209	0.210	0.210	0.210
2016	0.002	0.012	0.055	0.147	0.208	0.224	0.227	0.228	0.228	0.228

Table 34. Gulf of Maine Atlantic cod fishing mortality-at-age from 1982 to 2016 as estimated from the M-ramp model.

Year	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9 ⁺	F _{full}
1982	0.037	0.244	0.610	0.730	0.746	0.748	0.748	0.749	0.749	0.749
1983	0.045	0.291	0.729	0.872	0.892	0.894	0.894	0.894	0.894	0.894
1984	0.040	0.261	0.654	0.782	0.800	0.802	0.802	0.802	0.802	0.802
1985	0.047	0.306	0.766	0.916	0.937	0.939	0.939	0.939	0.939	0.939
1986	0.043	0.278	0.696	0.833	0.851	0.853	0.853	0.853	0.853	0.853
1987	0.042	0.272	0.681	0.816	0.834	0.836	0.836	0.836	0.836	0.836
1988	0.031	0.202	0.507	0.607	0.621	0.622	0.622	0.622	0.622	0.622
1989	0.010	0.066	0.317	0.730	0.904	0.937	0.942	0.943	0.943	0.943
1990	0.013	0.080	0.385	0.885	1.097	1.137	1.143	1.144	1.144	1.144
1991	0.014	0.086	0.416	0.957	1.186	1.229	1.236	1.237	1.237	1.237
1992	0.015	0.093	0.447	1.028	1.274	1.320	1.328	1.329	1.329	1.329
1993	0.016	0.104	0.500	1.151	1.425	1.478	1.486	1.487	1.487	1.487
1994	0.015	0.093	0.446	1.026	1.272	1.318	1.325	1.327	1.327	1.327
1995	0.009	0.060	0.290	0.668	0.828	0.858	0.863	0.863	0.863	0.863
1996	0.009	0.060	0.287	0.660	0.817	0.847	0.852	0.852	0.853	0.853
1997	0.008	0.050	0.242	0.558	0.691	0.716	0.720	0.721	0.721	0.721
1998	0.007	0.042	0.201	0.464	0.574	0.595	0.599	0.599	0.599	0.599
1999	0.004	0.024	0.114	0.263	0.326	0.338	0.340	0.340	0.340	0.340
2000	0.005	0.030	0.147	0.338	0.419	0.434	0.436	0.437	0.437	0.437
2001	0.005	0.034	0.165	0.380	0.470	0.487	0.490	0.491	0.491	0.491
2002	0.004	0.026	0.127	0.291	0.361	0.374	0.376	0.376	0.376	0.376
2003	0.005	0.031	0.152	0.349	0.432	0.448	0.451	0.451	0.451	0.451
2004	0.005	0.033	0.160	0.369	0.457	0.473	0.476	0.476	0.477	0.477
2005	0.004	0.024	0.127	0.377	0.547	0.589	0.596	0.597	0.597	0.597
2006	0.003	0.021	0.109	0.325	0.471	0.507	0.513	0.514	0.514	0.514
2007	0.004	0.022	0.114	0.338	0.490	0.527	0.533	0.534	0.534	0.534
2008	0.005	0.029	0.152	0.451	0.653	0.703	0.711	0.713	0.713	0.713
2009	0.005	0.033	0.175	0.521	0.755	0.812	0.822	0.823	0.824	0.824
2010	0.006	0.036	0.188	0.560	0.812	0.874	0.885	0.886	0.886	0.886
2011	0.009	0.054	0.284	0.844	1.224	1.317	1.332	1.335	1.335	1.335
2012	0.010	0.064	0.337	1.002	1.453	1.563	1.582	1.585	1.585	1.585
2013	0.009	0.057	0.300	0.893	1.294	1.392	1.409	1.412	1.412	1.412
2014	0.009	0.055	0.289	0.860	1.247	1.342	1.358	1.360	1.361	1.361
2015	0.001	0.008	0.040	0.119	0.172	0.185	0.187	0.187	0.188	0.188
2016	0.002	0.010	0.050	0.150	0.218	0.234	0.237	0.237	0.237	0.237

Table 35. Gulf of Maine Atlantic cod January 1 numbers-at-age (000s) from 1982 to 2016 as estimated from the $M = 0.2$ model. Recruitment summary statistics reported (i.e., median and geometric mean) are provided for various time periods relevant to reference point determination and stock projections.

Year	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9 ⁺	Total
1982	10,552	12,016	5,069	2,928	1,739	158	215	146	245	33,068
1983	11,408	8,320	7,742	2,290	1,176	688	62	85	154	31,925
1984	11,479	8,930	5,117	3,114	800	403	235	21	82	30,182
1985	8,887	9,027	5,658	2,216	1,190	301	151	88	39	27,557
1986	14,029	6,941	5,473	2,197	743	391	98	50	42	29,963
1987	14,869	11,002	4,319	2,267	795	264	139	35	32	33,723
1988	27,800	11,669	6,874	1,807	831	286	95	50	24	49,436
1989	4,213	22,041	7,783	3,383	804	365	125	42	32	38,788
1990	4,182	3,404	16,715	4,579	1,352	271	119	41	24	30,686
1991	7,420	3,368	2,536	9,112	1,550	372	71	31	17	24,477
1992	7,304	5,965	2,484	1,323	2,803	379	87	17	11	20,371
1993	9,442	5,863	4,363	1,250	377	623	80	18	6	22,023
1994	3,187	7,560	4,224	2,057	309	70	109	14	4	17,534
1995	3,390	2,555	5,489	2,060	547	63	14	21	3	14,143
1996	2,718	2,736	1,927	3,155	783	173	19	4	7	11,524
1997	4,421	2,193	2,058	1,094	1,167	240	51	6	3	11,233
1998	3,848	3,572	1,664	1,213	439	396	79	17	3	11,230
1999	7,587	3,113	2,733	1,018	527	164	144	28	7	15,323
2000	4,390	6,169	2,451	1,888	576	274	84	73	18	15,923
2001	1,128	3,563	4,803	1,614	964	263	122	37	40	12,535
2002	4,935	914	2,752	3,061	767	403	107	50	31	13,021
2003	1,794	4,009	715	1,856	1,644	373	192	51	38	10,672
2004	5,868	1,455	3,113	466	926	730	162	83	39	12,843
2005	3,539	4,759	1,128	2,015	229	404	311	69	51	12,506
2006	5,893	2,876	3,737	761	980	90	150	114	44	14,644
2007	4,397	4,794	2,273	2,599	402	432	38	62	65	15,063
2008	3,082	3,577	3,789	1,581	1,371	177	181	16	53	13,826
2009	2,025	2,502	2,798	2,511	733	503	61	62	23	11,218
2010	1,188	1,643	1,945	1,802	1,078	241	154	18	26	8,094
2011	1,233	963	1,274	1,239	751	340	71	44	13	5,927
2012	1,526	995	728	720	375	150	61	12	10	4,578
2013	842	1,228	740	383	179	57	20	8	3	3,460
2014	3,129	678	922	405	106	32	9	3	2	5,286
2015	1,215	2,523	510	510	115	20	5	1	1	4,900
2016	457	993	2,043	397	364	78	13	3	1	4,350
1982-2014 median	4,390									
2012-2016 geomean	1,174									

Table 36. Gulf of Maine Atlantic cod January 1 numbers-at-age (000s) from 1982 to 2016 as estimated from the M-ramp model. Recruitment summary statistics reported (i.e., median and geometric mean) are provided for various time periods relevant to reference point determination and stock projections.

Year	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9 ⁺	Total
1982	10,898	12,195	5,105	2,910	1,700	154	206	139	229	33,535
1983	11,795	8,594	7,826	2,271	1,148	660	60	80	142	32,575
1984	11,799	9,234	5,260	3,092	777	385	221	20	74	30,862
1985	9,216	9,280	5,824	2,240	1,157	286	141	81	35	28,261
1986	14,370	7,199	5,598	2,218	734	371	92	45	37	30,663
1987	15,584	11,273	4,465	2,286	790	256	130	32	29	34,844
1988	29,991	12,236	7,032	1,849	828	281	91	46	22	52,376
1989	4,702	23,801	8,182	3,466	825	364	123	40	30	41,533
1990	4,890	3,772	18,064	4,830	1,355	271	116	39	22	33,358
1991	8,995	3,836	2,767	9,769	1,583	359	69	29	15	27,424
1992	9,400	6,980	2,768	1,436	2,951	381	83	16	10	24,024
1993	13,097	7,214	4,955	1,379	400	643	79	17	5	27,790
1994	4,768	9,836	4,964	2,294	333	73	112	14	4	22,399
1995	5,542	3,552	6,777	2,402	621	71	15	22	4	19,005
1996	4,873	4,108	2,502	3,793	922	203	22	5	8	16,436
1997	8,508	3,541	2,839	1,378	1,438	299	64	7	4	18,077
1998	7,793	6,129	2,445	1,618	573	524	106	23	4	19,214
1999	16,311	5,566	4,226	1,437	732	232	208	42	10	28,763
2000	9,727	11,451	3,830	2,656	778	372	117	104	26	29,061
2001	2,526	6,754	7,750	2,307	1,322	357	168	53	59	21,296
2002	11,240	1,736	4,508	4,539	1,090	571	152	71	47	23,954
2003	4,135	7,579	1,145	2,689	2,297	515	266	70	55	18,750
2004	13,444	2,758	4,923	659	1,272	999	220	113	54	24,442
2005	7,911	8,965	1,788	2,811	306	540	417	92	70	22,899
2006	12,937	5,282	5,865	1,056	1,292	119	201	154	60	26,965
2007	9,293	8,642	3,467	3,525	511	541	48	81	86	26,194
2008	6,243	6,207	5,669	2,075	1,685	210	214	19	65	22,388
2009	3,955	4,165	4,042	3,266	886	588	70	70	28	17,069
2010	2,289	2,637	2,700	2,274	1,300	279	175	21	29	11,704
2011	2,405	1,525	1,705	1,499	870	387	78	48	14	8,531
2012	3,010	1,598	968	860	432	172	70	14	11	7,135
2013	1,606	1,997	1,004	463	212	68	24	10	3	5,386
2014	5,590	1,066	1,264	499	127	39	11	4	2	8,602
2015	1,999	3,713	676	634	141	25	7	2	1	7,198
2016	699	1,338	2,470	436	378	80	14	4	2	5,420
1982-2014 median	8,508									
2012-2016 geomean	2,067									

Table 37. Inputs to the Gulf of Maine Atlantic cod yield per recruit (YPR) and projection calculations for the M=0.2 and M-ramp model scenarios. Weights are based on an average of the most recent three years (2014-2016).

Age	Natural mortality	Fraction mature	Jan1/SSB weights (kg)	Mid-year weights (kg)	Catch weights (kg)	Fishery selectivity ($M = 0.2$)	Fishery selectivity (M -ramp)
1	0.200	0.087	0.105	0.253	0.251	0.009	0.007
2	0.200	0.318	0.486	0.720	0.840	0.052	0.041
3	0.200	0.697	1.028	1.379	1.643	0.240	0.213
4	0.200	0.919	1.749	2.065	2.709	0.646	0.632
5	0.200	0.982	2.422	2.971	3.519	0.913	0.916
6	0.200	0.996	3.416	3.837	4.473	0.984	0.986
7	0.200	0.999	3.944	4.429	4.803	0.997	0.998
8	0.200	1.000	5.644	7.006	7.160	1.000	1.000
9 ⁺	0.200	1.000	10.895	10.894	10.894	1.000	1.000

Table 38. Target fishing mortality, yield per recruit, spawning biomass per recruit and mean age for a range of fishing mortality reference points.

Model	Reference point	F	YPR (kg)	SSB/R (kg)	Mean age (years)
M=0.2	F_0	0.000	0.000	17.628	5.52
	$F_{0.1}$	0.186	1.255	6.755	3.63
	F_{MAX}	0.394	1.375	3.648	2.99
	$F_{40\%}$	0.174	1.232	7.078	3.69
M-ramp (M=0.2)	F_0	0.000	0.000	17.628	5.52
	$F_{0.1}$	0.188	1.261	6.762	3.63
	F_{MAX}	0.405	1.384	3.622	2.99
	$F_{40\%}$	0.177	1.240	7.052	3.68

Table 39. Biological reference points and stock status for Gulf of Maine Atlantic cod based on the 2014 (Palmer 2014) and 2015 (NEFSC 2015) assessment updates and the current 2017 assessment update. Intervals shown are the 5th and 95th percentiles.

Assessment	Proxy reference points	M=0.2	M-ramp
2014 update	F _{full} , 2013	1.33 (0.89 - 1.92)	1.24 (0.84 - 1.78)
	F _{MSY}	0.18	0.18
	F _{full} , 2013/F _{MSY}	7.39	6.89
	Overfishing	Yes	Yes
	SSB ₂₀₁₃ (mt)	2,063 (1,561 - 2,774)	2,432 (1,819 - 3,230)
	SSB _{MSY} (mt)	47,184 (32,903 - 67,045)	69,621 (53,349 - 89,302)
	SSB ₂₀₁₃ /SSB _{MSY}	0.04	0.03
	Overfished	Yes	Yes
	MSY (mt)	7,753 (5,355 - 11,162)	11,388 (8,624 - 14,750)
2015 update	Median age1 recruitment (000s)	4,665 (1,414 - 14,649)	9,173 (2,682 - 16,262)
	F _{full} , 2014	0.956 (0.664 - 1.387)	0.932 (0.654 - 1.304)
	F _{MSY}	0.185	0.187
	F _{full} , 2014/F _{MSY}	5.11	4.98
	Overfishing	Yes	Yes
	SSB ₂₀₁₄ (mt)	2,225 (1,713 - 2,892)	2,536 (1,942 - 3,298)
	SSB _{MSY} (mt)	40,187 (27,551 - 58,228)	59,045 (44,976 - 76,525)
	SSB ₂₀₁₄ /SSB _{MSY}	0.06	0.04
	Overfished	Yes	Yes
2017 update	MSY (mt)	6,797 (4,608 - 9,990)	10,043 (7,560 - 13,130)
	Median age1 recruitment (000s)	4,406 (1,458 - 14,450)	8,965 (2,489 - 15,908)
	F _{full} , 2016	0.228 (0.165 - 0.316)	0.237 (0.169 - 0.331)
	F _{MSY}	0.174	0.177
	F _{full} , 2016/F _{MSY}	1.31	1.34
	Overfishing	Yes	Yes
	SSB ₂₀₁₆ (mt)	3,046 (2,301 - 4,025)	3,262 (2,464 - 4,270)
	SSB _{MSY} (mt)	40,604 (27,631 - 58,553)	59,714 (44,732 - 77,611)
	SSB ₂₀₁₆ /SSB _{MSY}	0.08	0.05
	Overfished	Yes	Yes
	MSY (mt)	7,049 (4,699 - 10,380)	10,502 (7,734 - 13,822)
	Median age1 recruitment (000s)	4,377 (1,161 - 14,434)	8,464 (2,353 - 15,934)

Table 40. Short-term projections (2018-2020) of total fishery yield and spawning stock biomass for Gulf of Maine Atlantic cod based on a $F_{MSY\text{-proxy}}$ ($F_{40\%}$) harvest strategy. These projections have assumed the geometric mean recruitment of the 2012-2016 period for estimating 2017 age-1 recruitment. For age-1 recruitment in 2018 and beyond the projections assume 1982-2014 median recruitment ($M=0.2 \sim 4.4$ million fish, $M\text{-ramp} \sim 8.5$ million fish) when spawning stock biomass is above 6,300 mt in the $M=0.2$ model and 7,900 mt in the $M\text{-ramp}$ model. At spawning stock levels below these thresholds, recruitment declines linearly to zero. Catch in 2017 has been assumed to be 428 mt (*J Cournane, NEFMC PDT*). There are two sets of projections for both the $M=0.2$ and $M\text{-ramp}$ models. For the $M=0.2$ model, the first projection assumes 2016 conditions as determined from the $M=0.2$ model with no adjustment for retrospective error, the second applies a retrospective adjustment based on $\rho=0.53$ ($(1/\rho+1)=0.66$). The two $M\text{-ramp}$ projections differ in the assumed natural mortality rate in subsequent years. One is set at $M=0.2$ while the other is set at $M=0.4$ to bracket the range of natural mortality rates used in the $M\text{-ramp}$ model.

Harvest strategy	Year	Input	M=0.2 model						M-ramp model					
			No retro adjustment			Retrospective adjustment			M=0.2			M=0.4		
			Catch (mt)	Spawning stock biomass (mt)	F_{full}	Catch (mt)	Spawning stock biomass (mt)	F_{full}	Catch (mt)	Spawning stock biomass (mt)	F_{full}	Catch (mt)	Spawning stock biomass (mt)	F_{full}
F_{MSY}	2016	Model result	599	3,046	0.228	599	1,997	0.332	599	3,262	0.237	599	3,262	0.237
	2017	Assumed catch	428	4,648	0.092	428	3,041	0.142	428	4,470	0.100	428	4,245	0.110
	2018	Projection	1,084	5,574	0.174	693	3,569	0.174	1,066	5,558	0.177	791	4,312	0.177
	2019	Projection	1,181	6,553	0.174	758	4,214	0.174	1,215	7,070	0.177	741	4,572	0.177
	2020	Projection	1,326	8,401	0.174	855	5,426	0.174	1,505	10,046	0.177	769	5,529	0.177

Figures

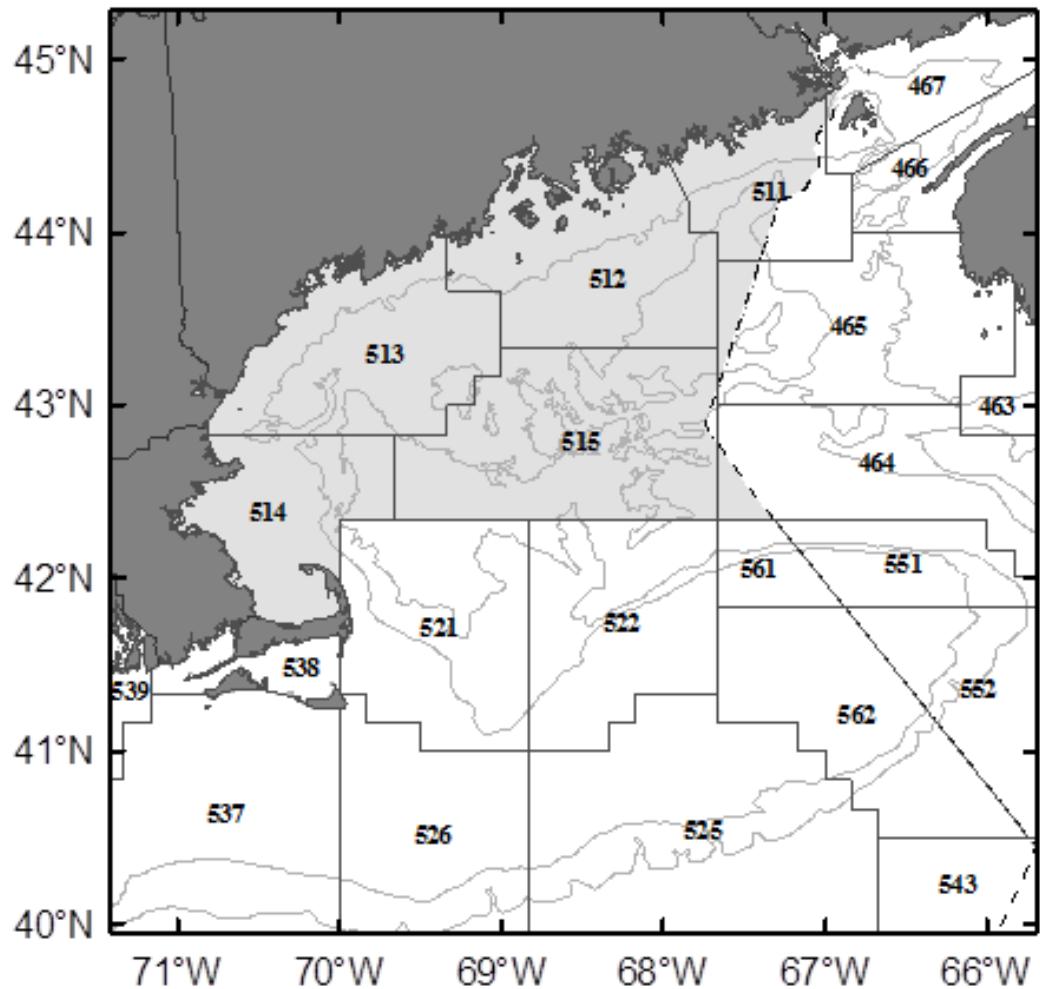


Figure 1. Map of the Gulf of Maine Atlantic cod (*Gadus morhua*) management and assessment area (shaded grey). The United States exclusive economic zone (EEZ) is defined by the dashed line.

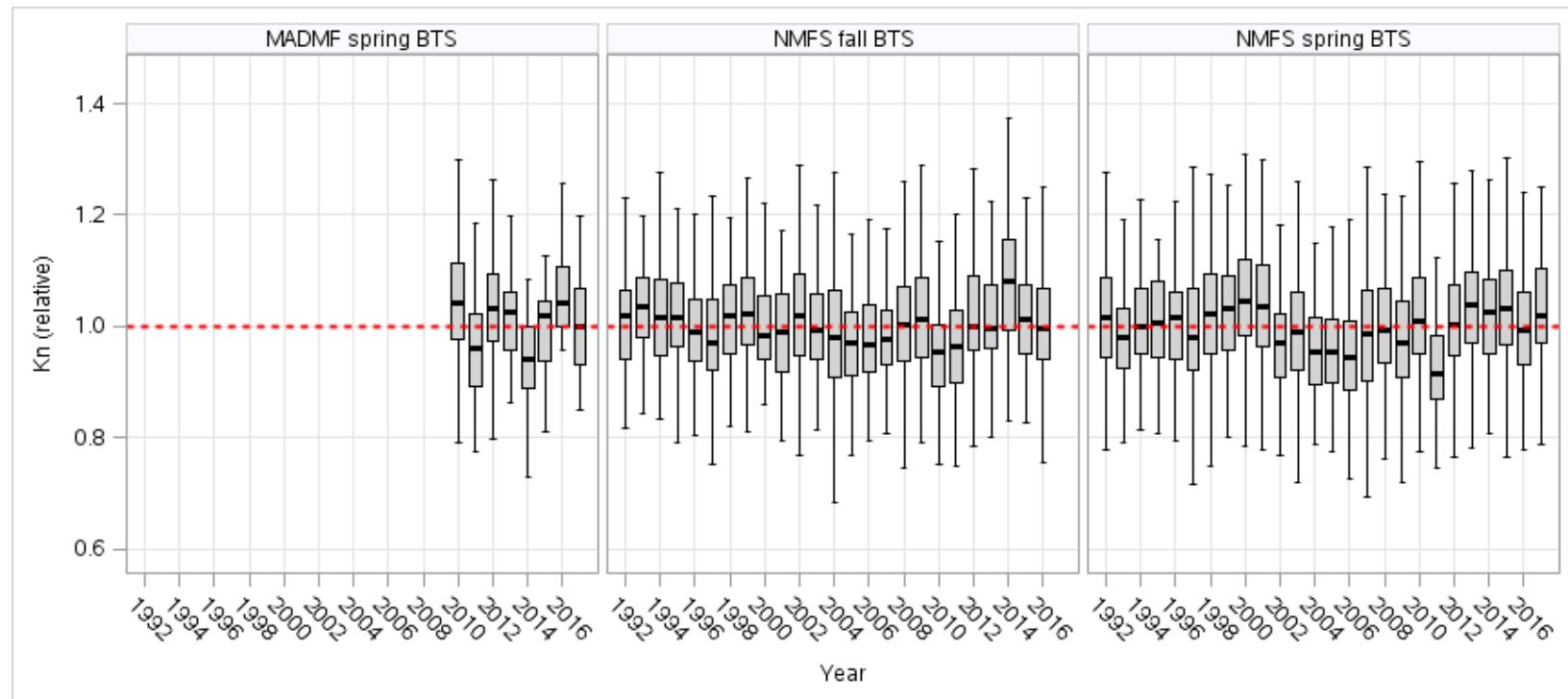


Figure 2. Annual trends in relative condition factor of Gulf of Maine Atlantic cod based on length and weight data collected from the Northeast Fisheries Science Center (NEFSC) and Massachusetts Division of Marine Fisheries (MADMF) bottom trawl surveys.

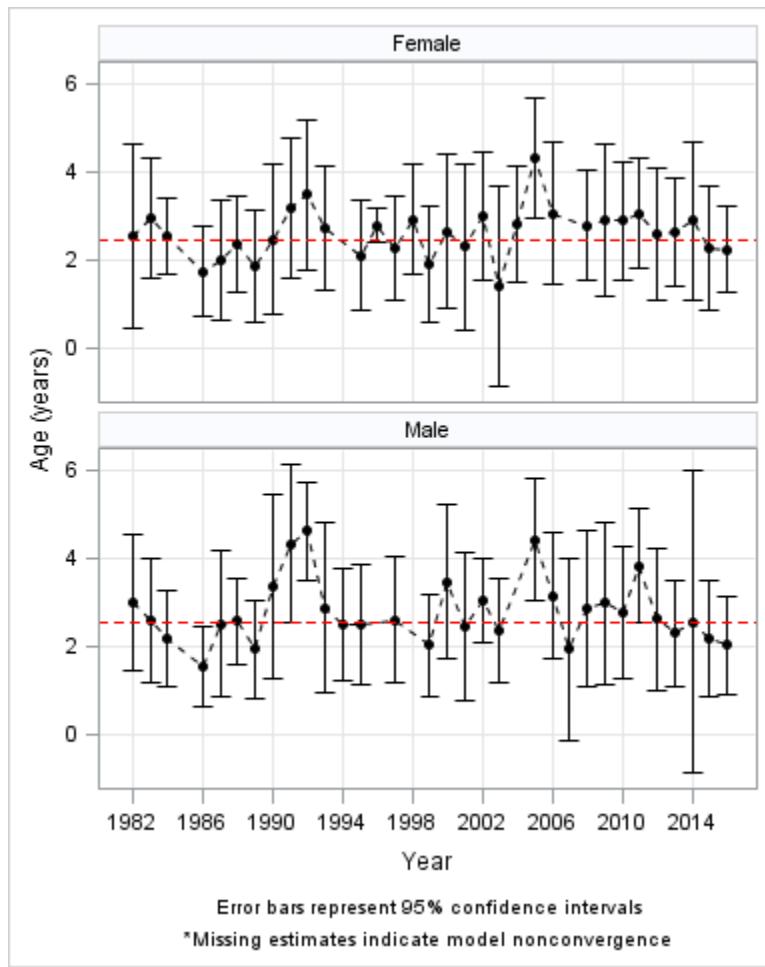


Figure 3. Annual average age-at-50% maturity ($A_{50\%}$) and corresponding 95% confidence intervals for female and male Gulf of Maine Atlantic cod from 1982 to 2016. Maturity has been estimated from data collected from the Northeast Fisheries Science Center (NEFSC) spring bottom trawl survey. *Missing years indicate when samples were insufficient to fit a logistic regression.*

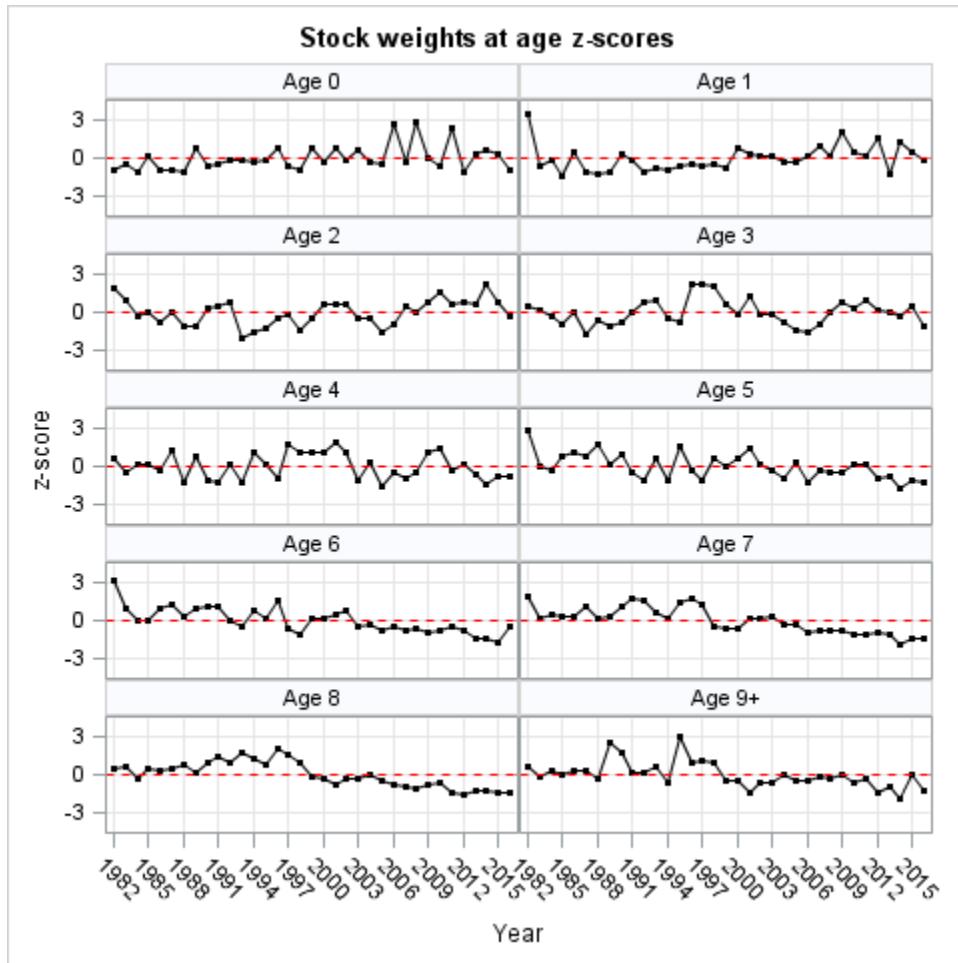


Figure 4. Average stock weights-at-age of ages 0 to 9⁺ Gulf of Maine Atlantic cod from 1982 to 2016. See NEFSC (2013) for a full description of the methods used to determine stock weights. Average weights are presented as z-scores ($[x-\mu]/\sigma$). Only ages 1 through the 9⁺ group are used as assessment model inputs.

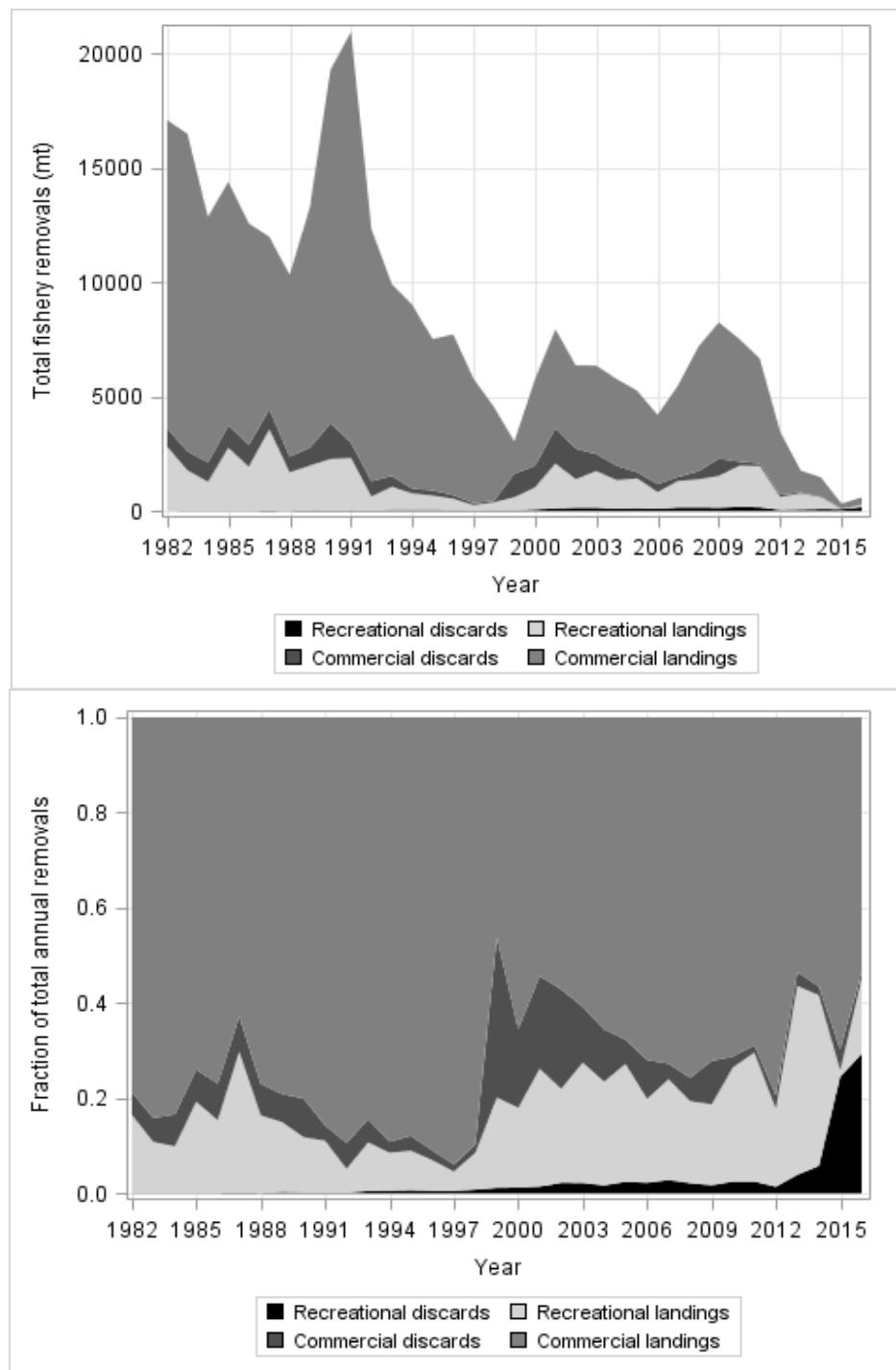


Figure 5. Total fishery removals of Gulf of Maine Atlantic cod between 1982 and 2016 by fleet (commercial and recreational) and disposition (landings and discards) in both absolute (top) and relative (bottom) scales. Note that reported discards include only dead discards (i.e., gear-specific mortality of discarded fish is accounted for as follows: commercial trawl=75%, commercial gillnet=80%, commercial longline=33% and recreational handline=15%).

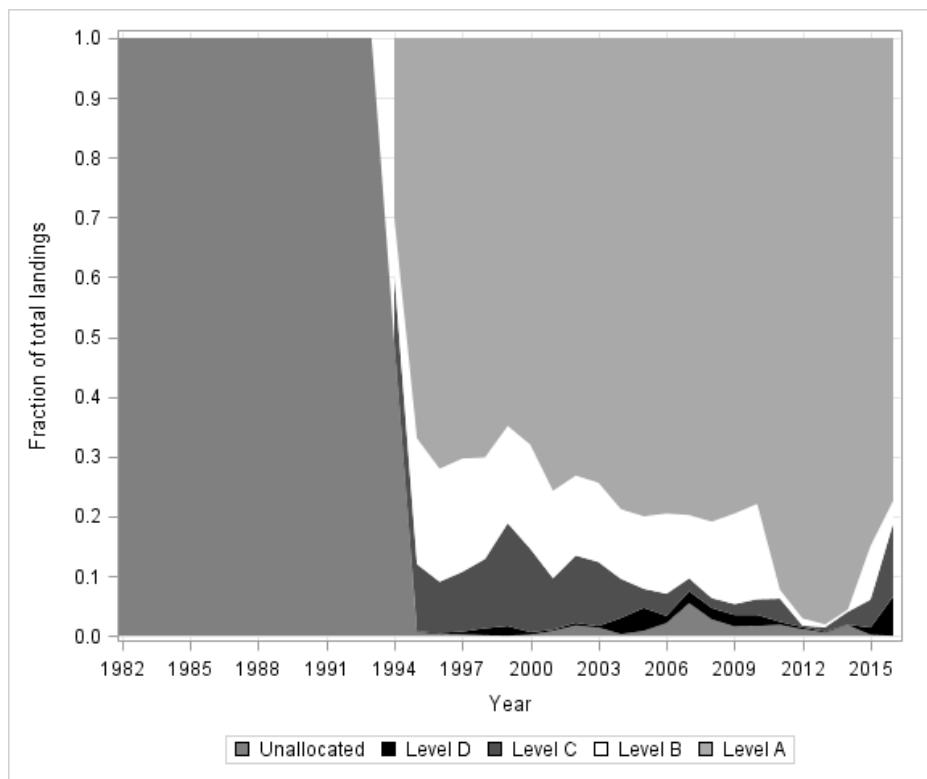


Figure 6. Fraction of the Gulf of Maine Atlantic cod commercial landings by allocation level between 1982 and 2016. Prior to 1994, landings were allocated based on a port interview process. From 1994 onward landings were allocated to statistical area and gear type based on a standardized allocation scheme (see NEFSC, 2013 for additional details).

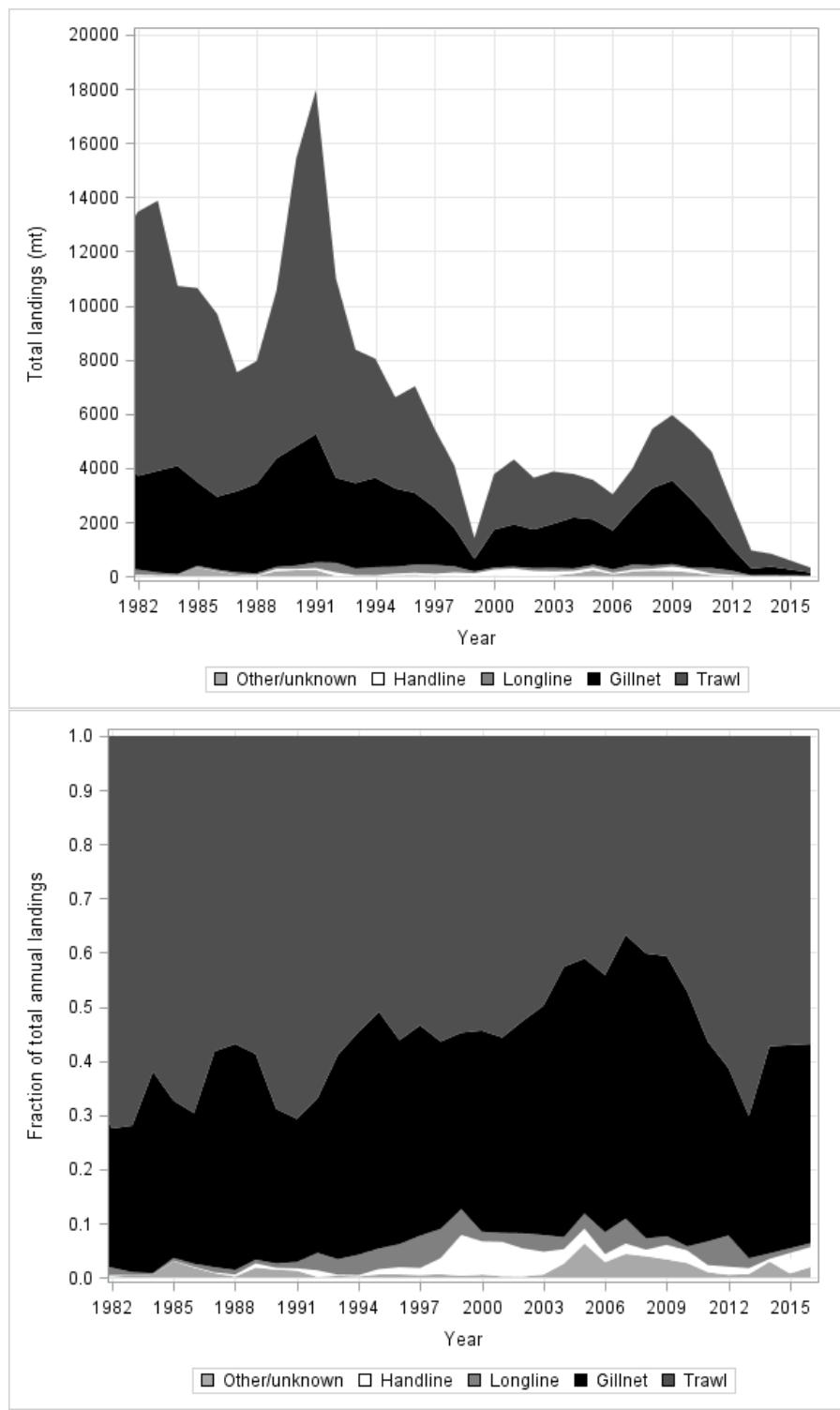


Figure 7. Total (top) and fractional (as a fraction of the total, bottom) commercial landings of Gulf of Maine Atlantic cod by gear type from 1982 to 2016.

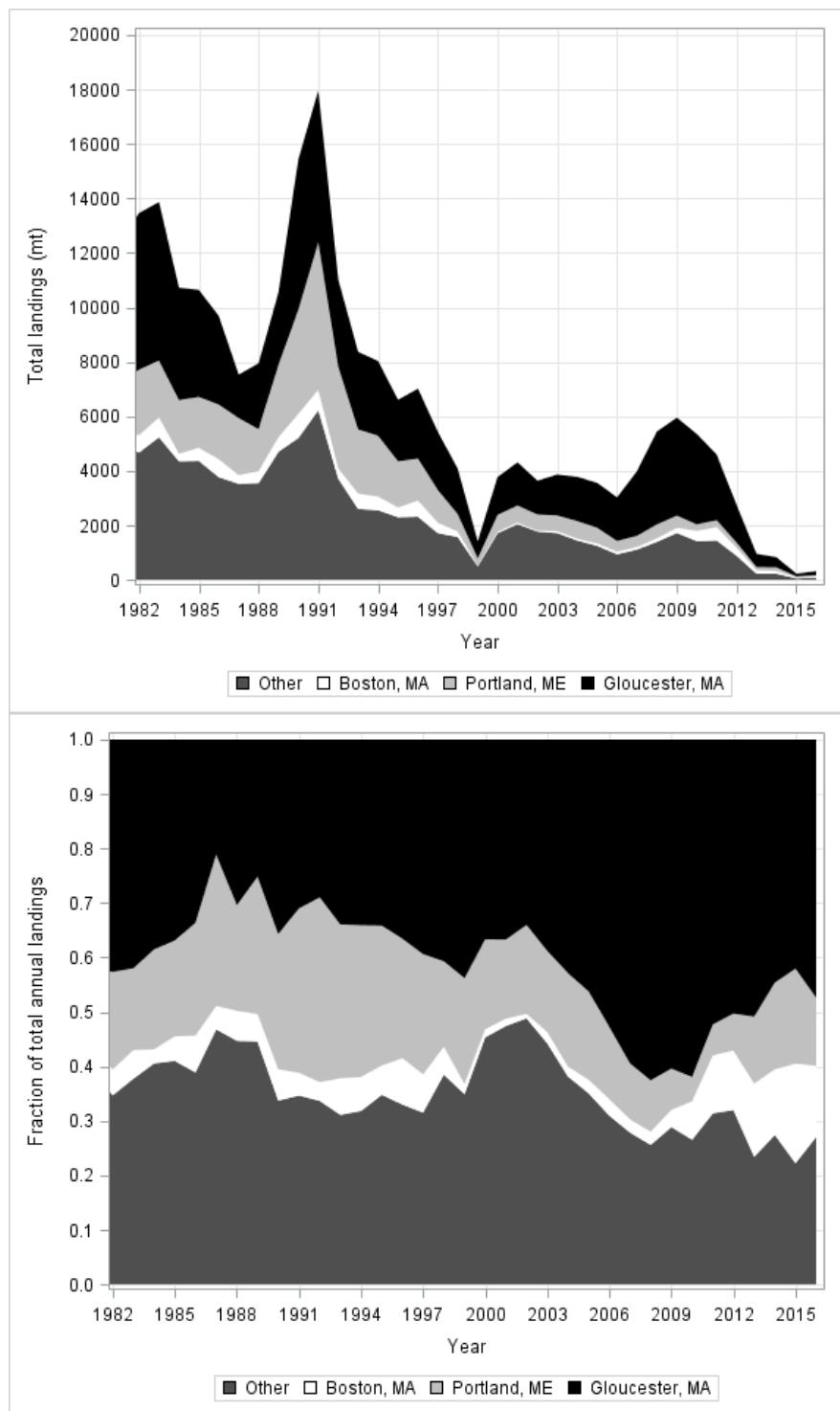


Figure 8. Total (top) and fractional (as a fraction of the total, bottom) commercial landings of Gulf of Maine Atlantic cod by port from 1982 to 2016.

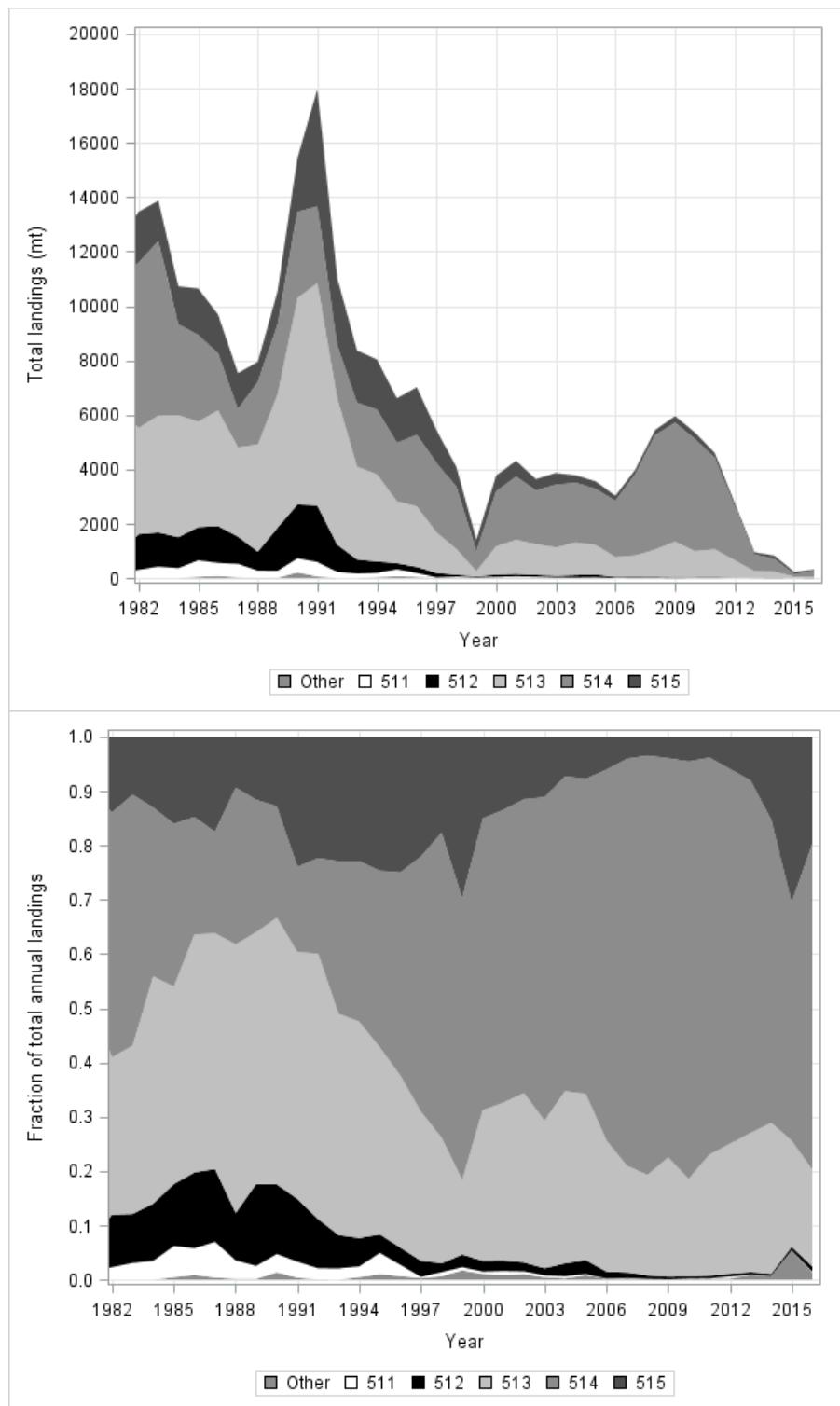


Figure 9. Total (top) and fractional (as a fraction of the total, bottom) commercial landings of Gulf of Maine Atlantic cod by statistical area from 1982 to 2016.

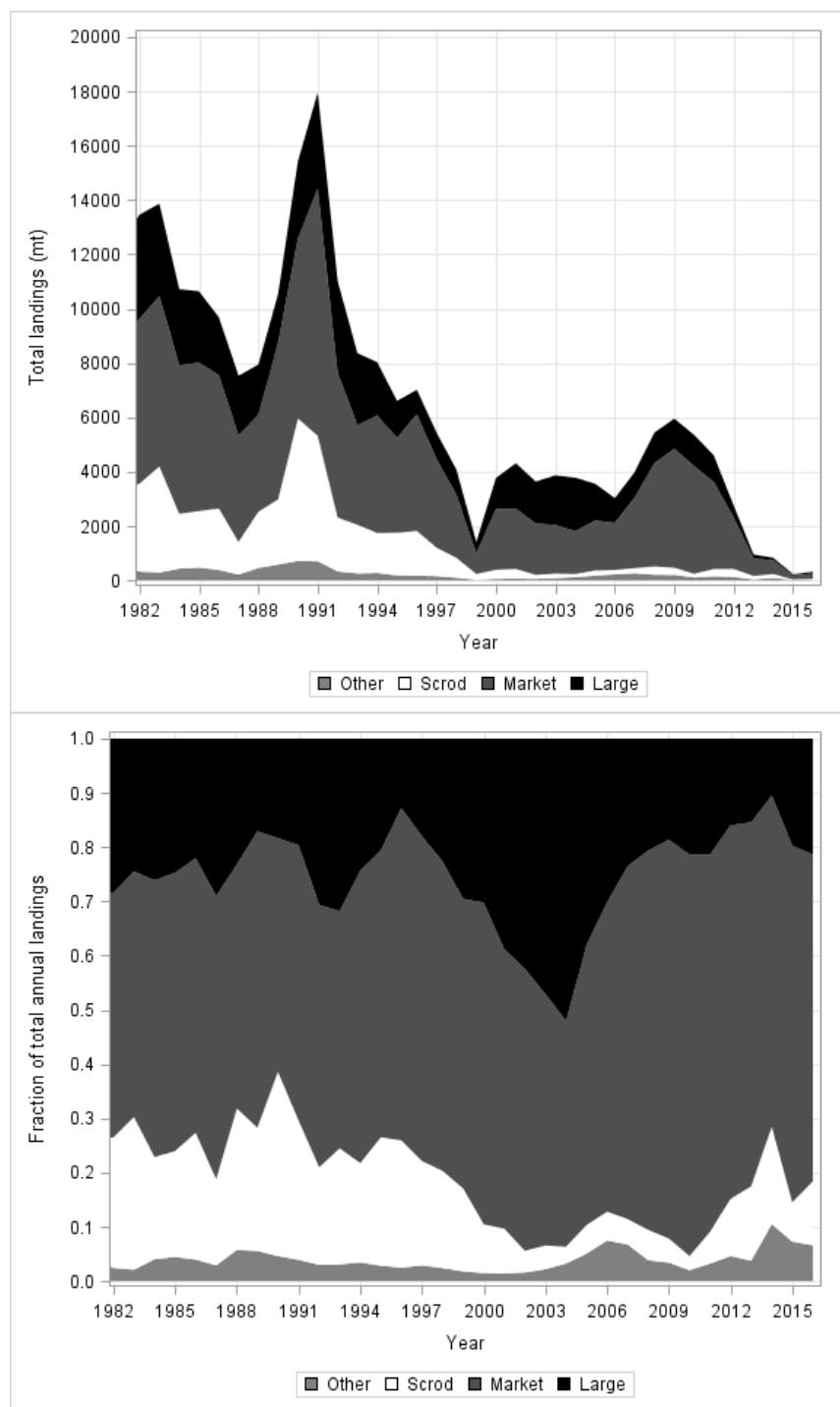


Figure 10. Total (top) and fractional (as a fraction of the total, bottom) commercial landings of Gulf of Maine Atlantic cod by market category from 1982 to 2016.

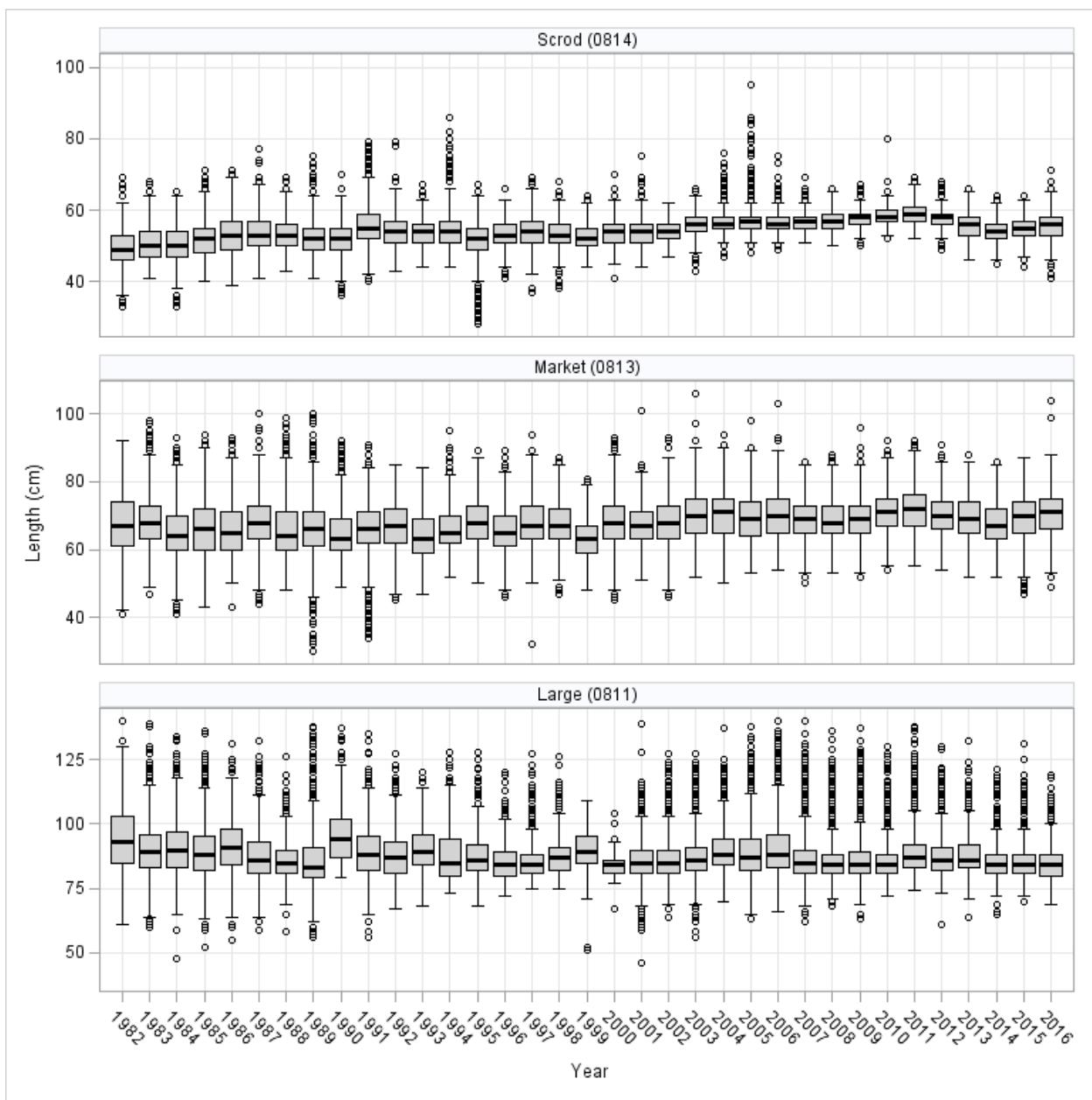


Figure 11. Box plot of the length distributions of Gulf of Maine Atlantic cod commercial landings over time, by market category.

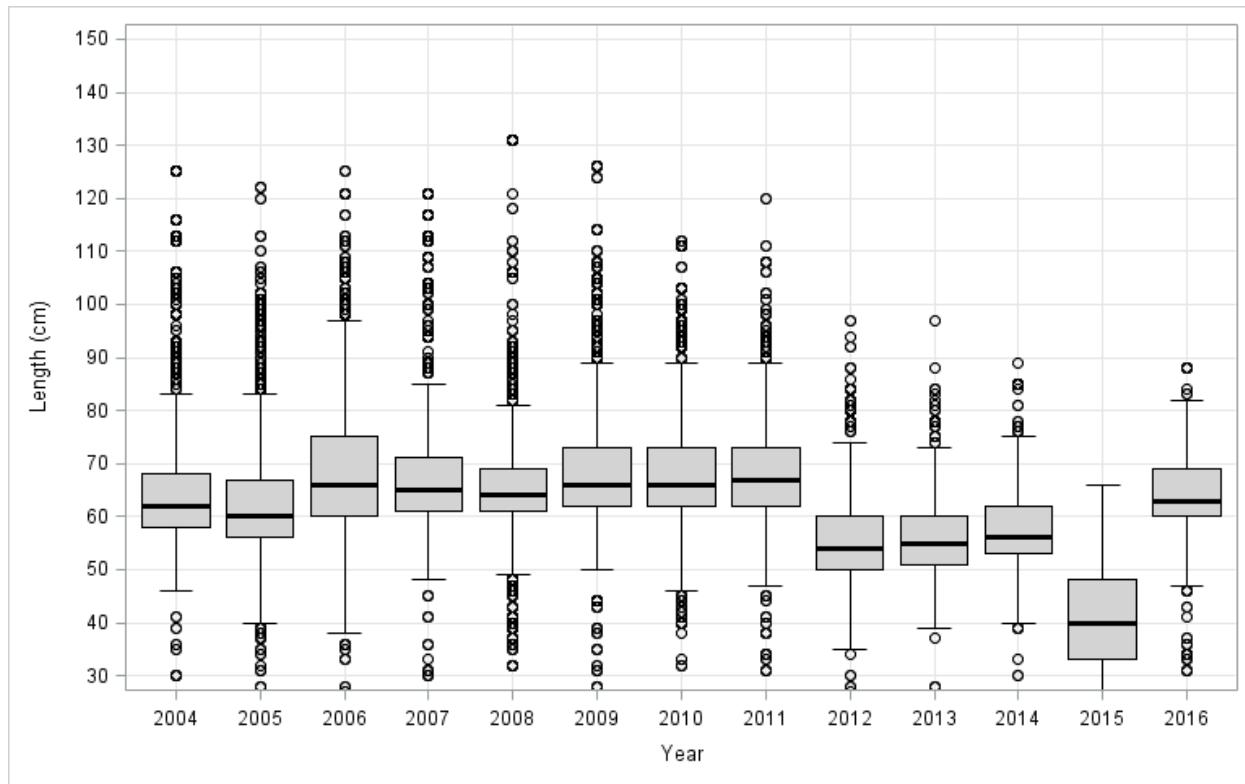


Figure 12. Box plot of length distributions of Gulf of Maine Atlantic cod recreational landings (AB1), 2004 to 2016.

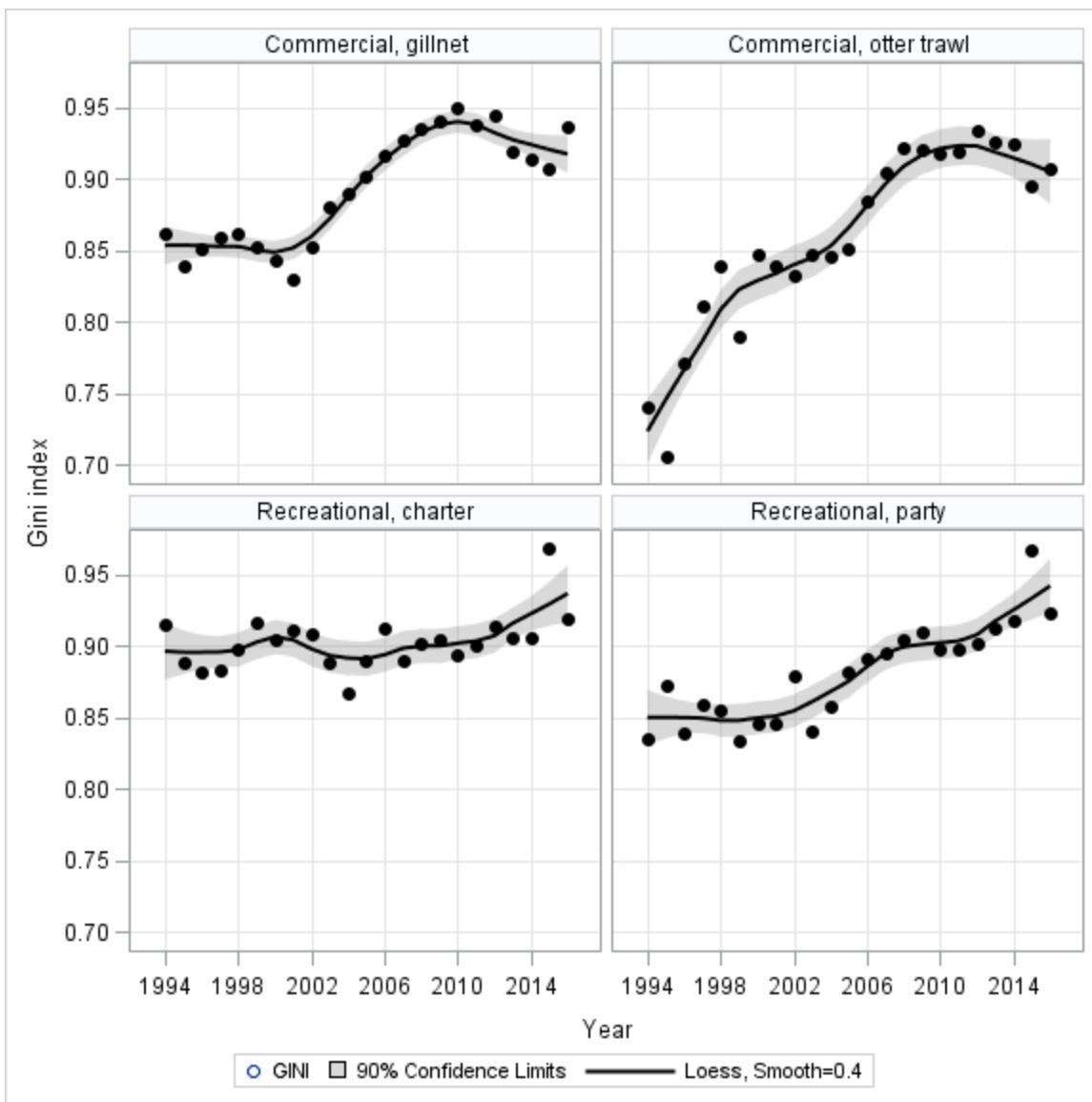


Figure 13. Gini indices of Gulf of Maine Atlantic cod landings by the commercial otter trawl and sink gillnet fleets and the recreational party and charter fleets from 1994-2016. Indices are based on the spatial distribution of the retained catch reported on vessel trip reports (VTRs).

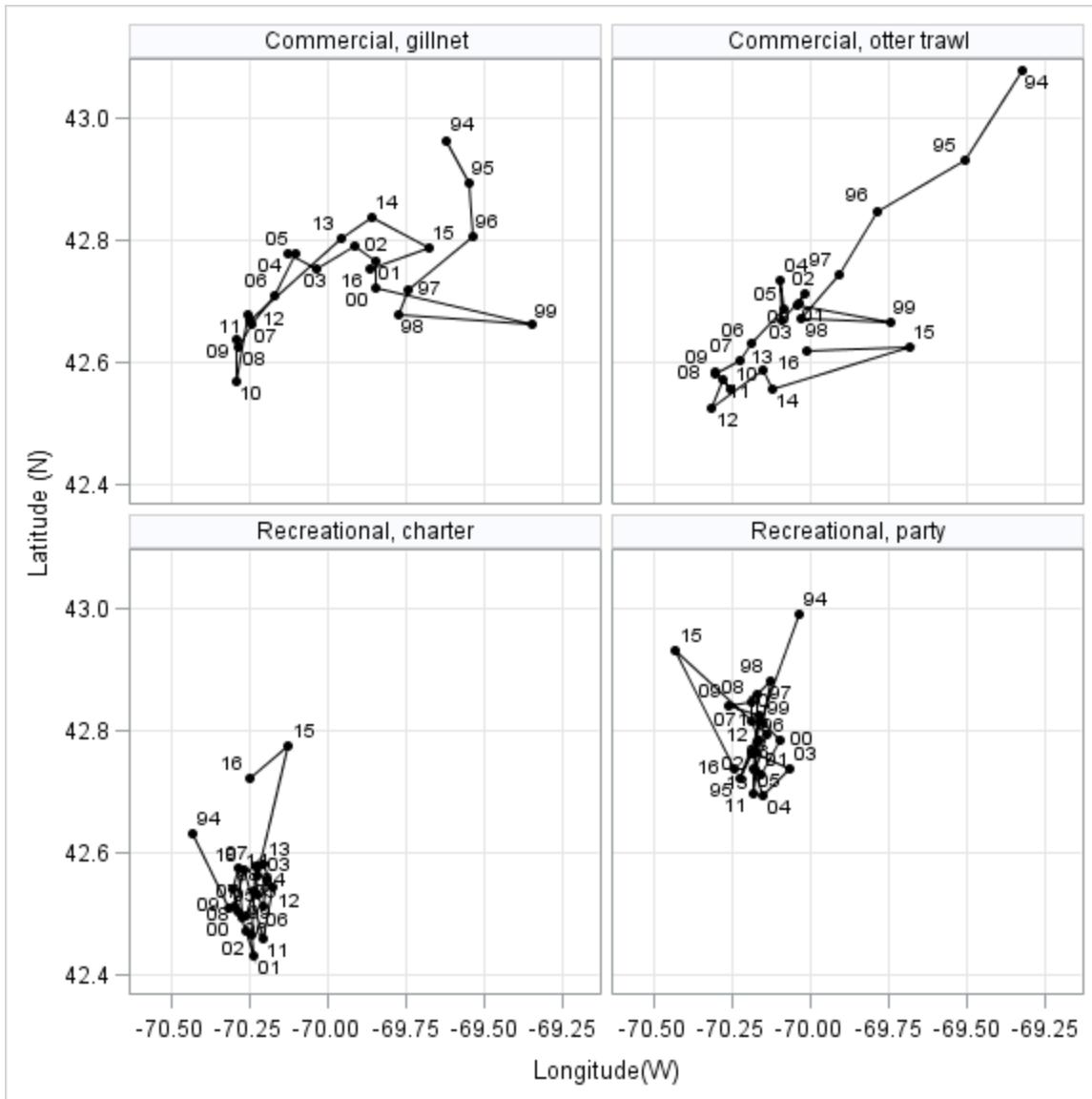


Figure 14. Landings-weighted mean location (centroid) of Gulf of Maine Atlantic cod commercial otter trawl and sink gillnet landings and the recreational party and charter fleets from 1994-2016. Centroids are based on the spatial distribution of the retained catch reported on vessel trip reports (VTRs).

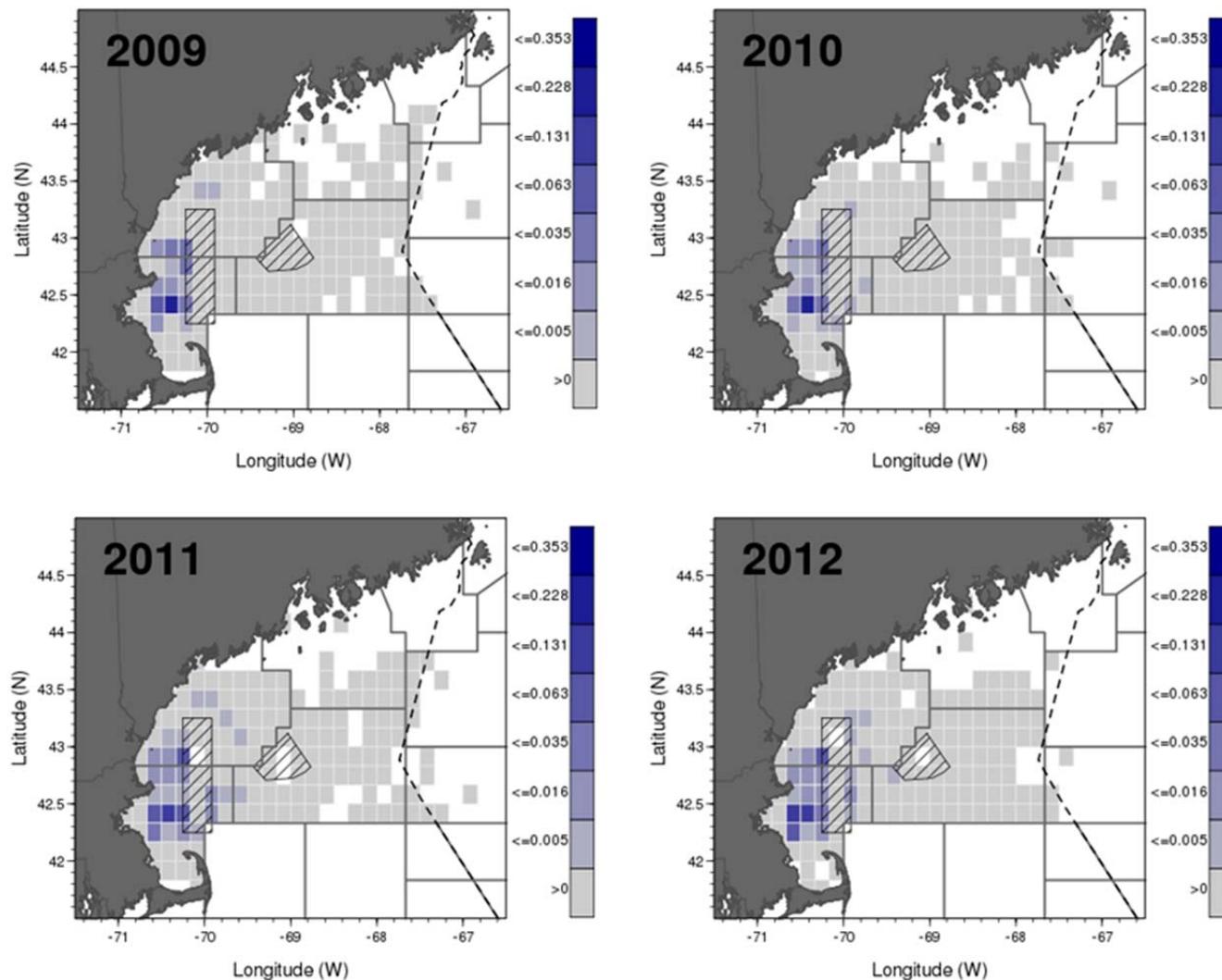


Figure 15. Fraction of total Gulf of Maine Atlantic cod commercial landings by ten minute square based on retained catch reported on vessel trip reports (VTRs) from 2009 through 2012.

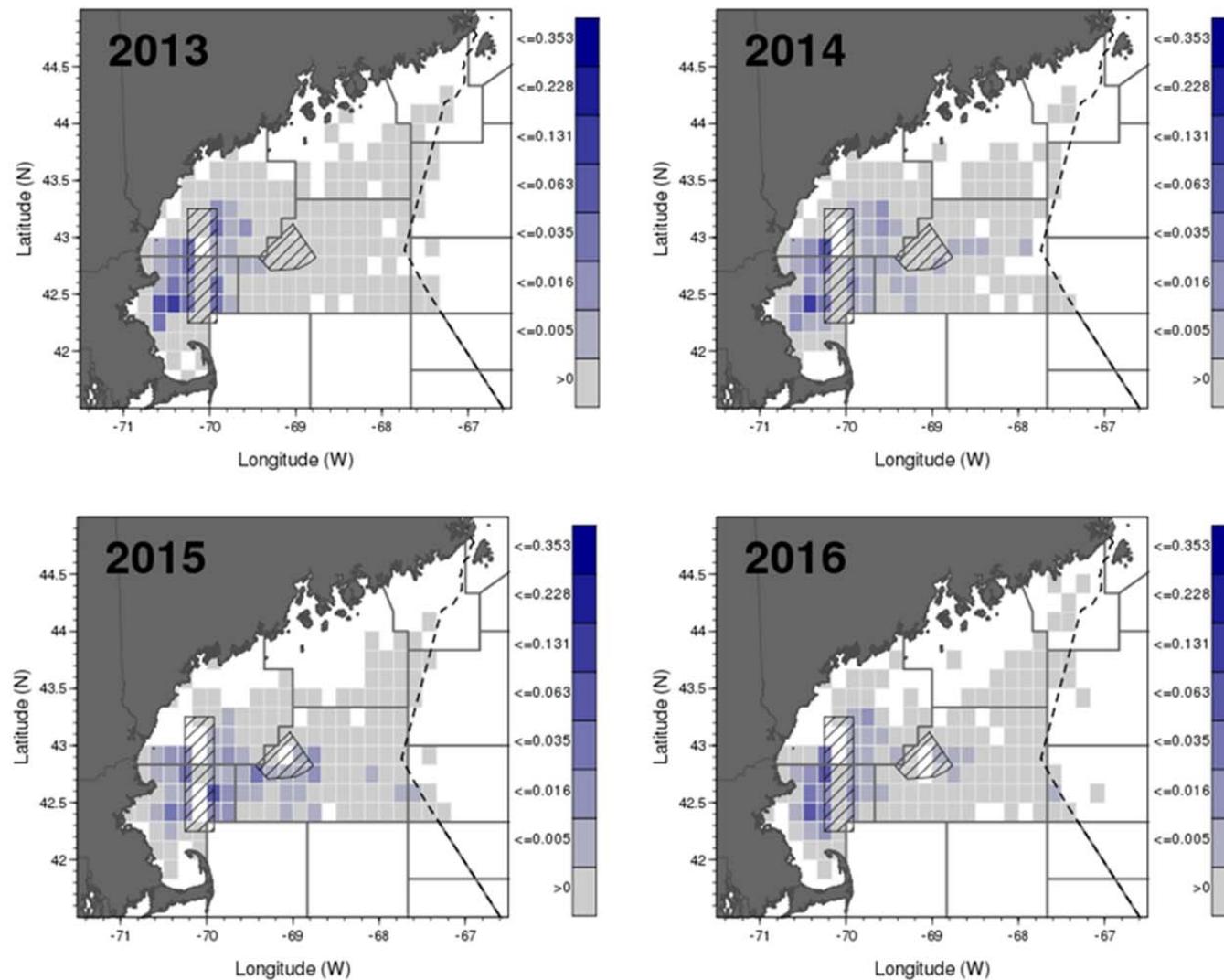


Figure 16. Fraction of total Gulf of Maine Atlantic cod commercial landings by ten minute square based on retained catch reported on vessel trip reports (VTRs) from 2013 through 2016.

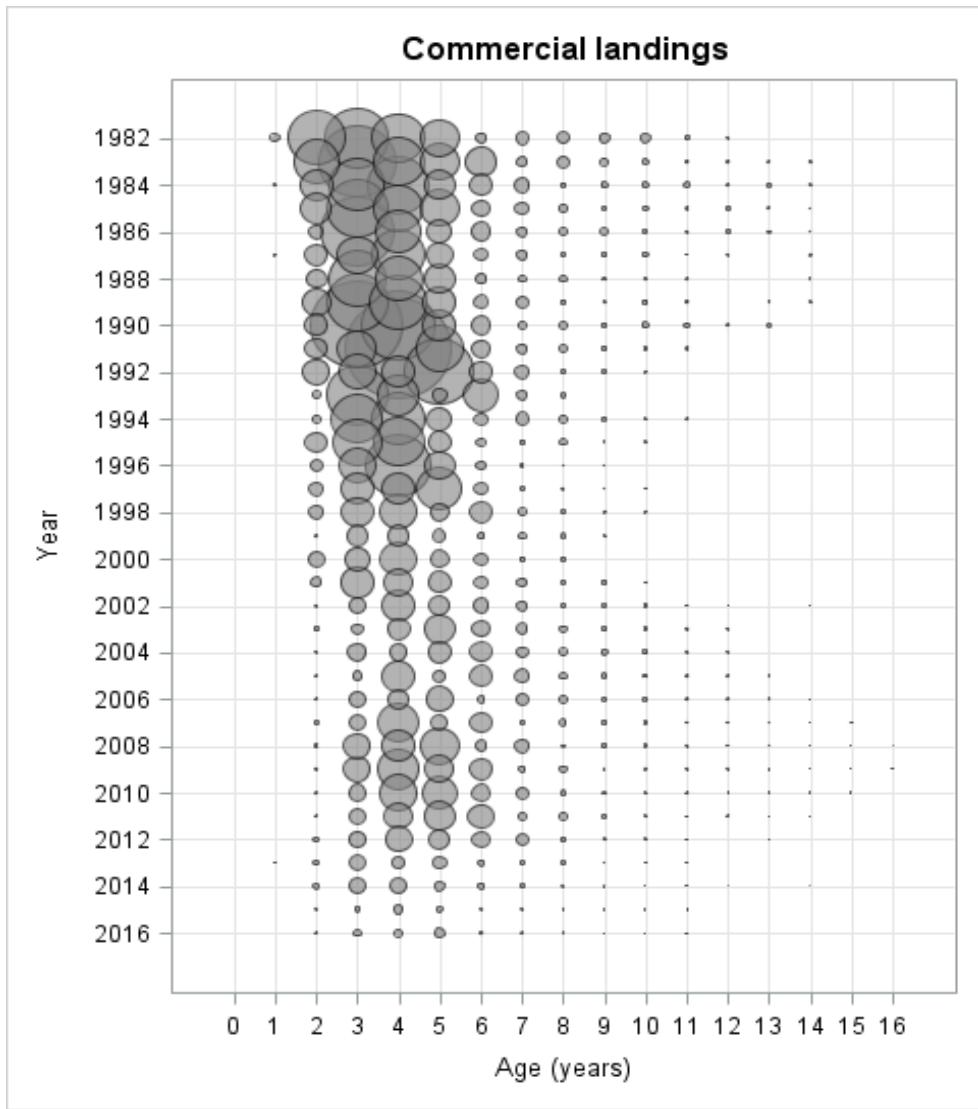


Figure 17. Commercial landings-at-age of Gulf of Maine Atlantic cod from 1982 to 2016. Note that scale has been adjusted to maximize visibility of catch-at-age (i.e., size of bubbles is not comparable between plots).

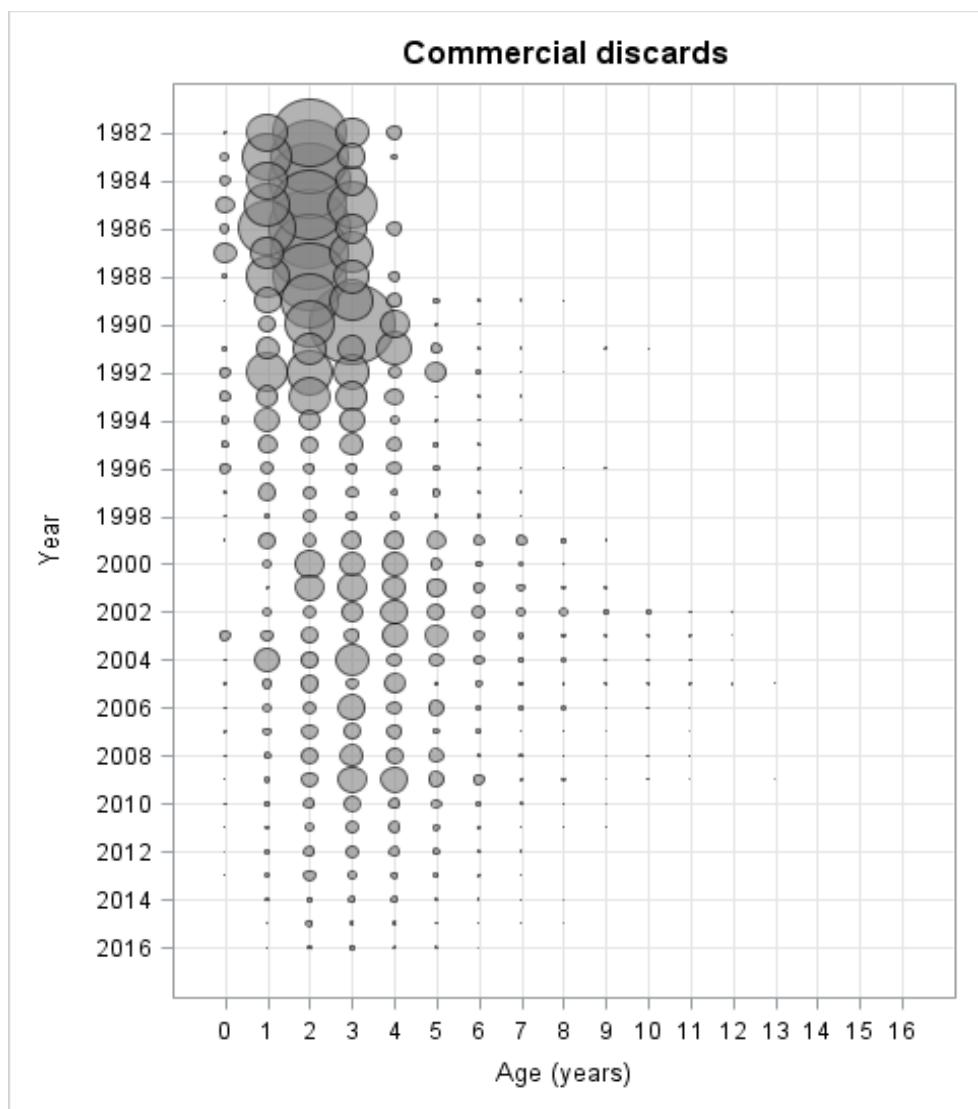


Figure 18. Commercial discards-at-age of Gulf of Maine Atlantic cod from 1982 to 2016. Note that scale has been adjusted to maximize visibility of catch-at-age (i.e., size of bubbles is not comparable between plots).

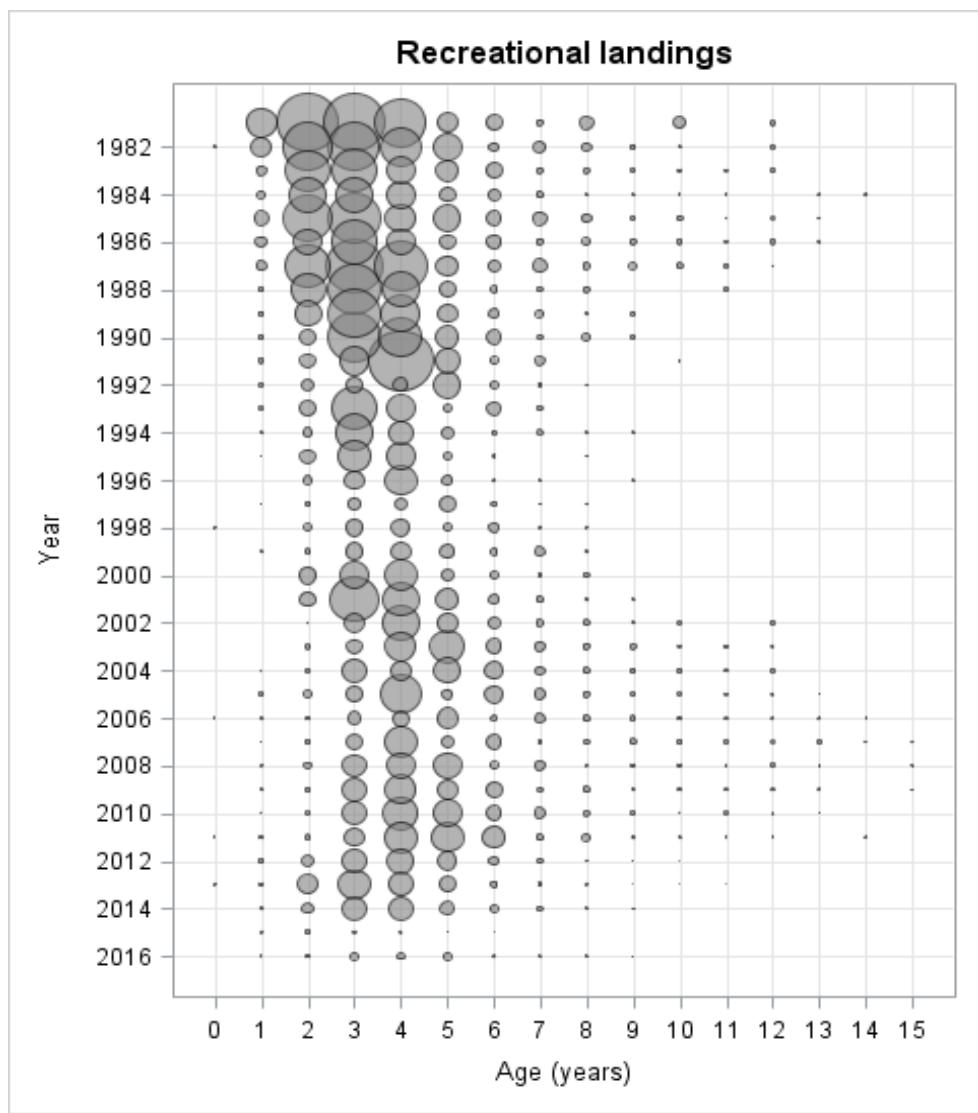


Figure 19. Recreational landings-at-age of Gulf of Maine Atlantic cod from 1981 to 2016. Note that scale has been adjusted to maximize visibility of catch-at-age (i.e., size of bubbles is not comparable between plots).

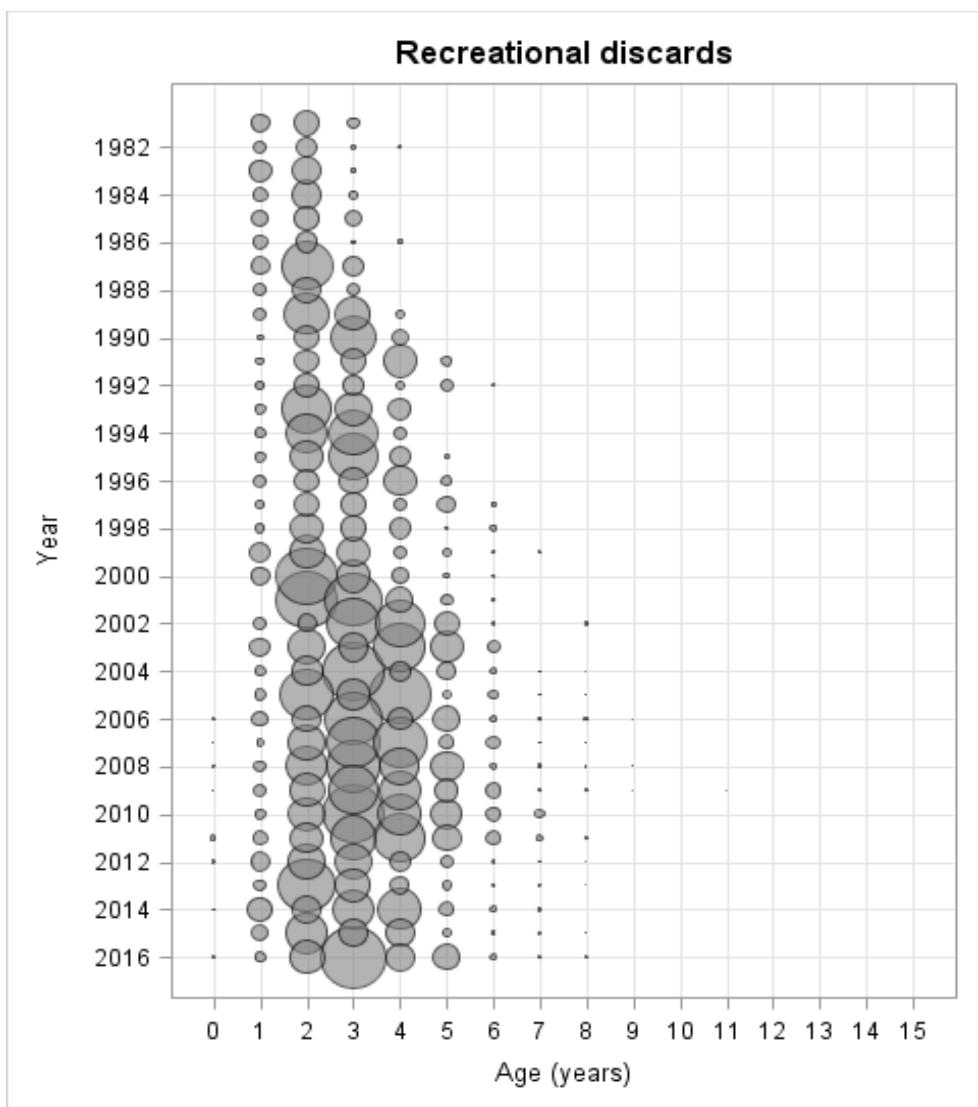


Figure 20. Recreational discards-at-age of Gulf of Maine Atlantic cod from 1981 to 2016. Note that scale has been adjusted to maximize visibility of catch-at-age (i.e., size of bubbles is not comparable between plots).

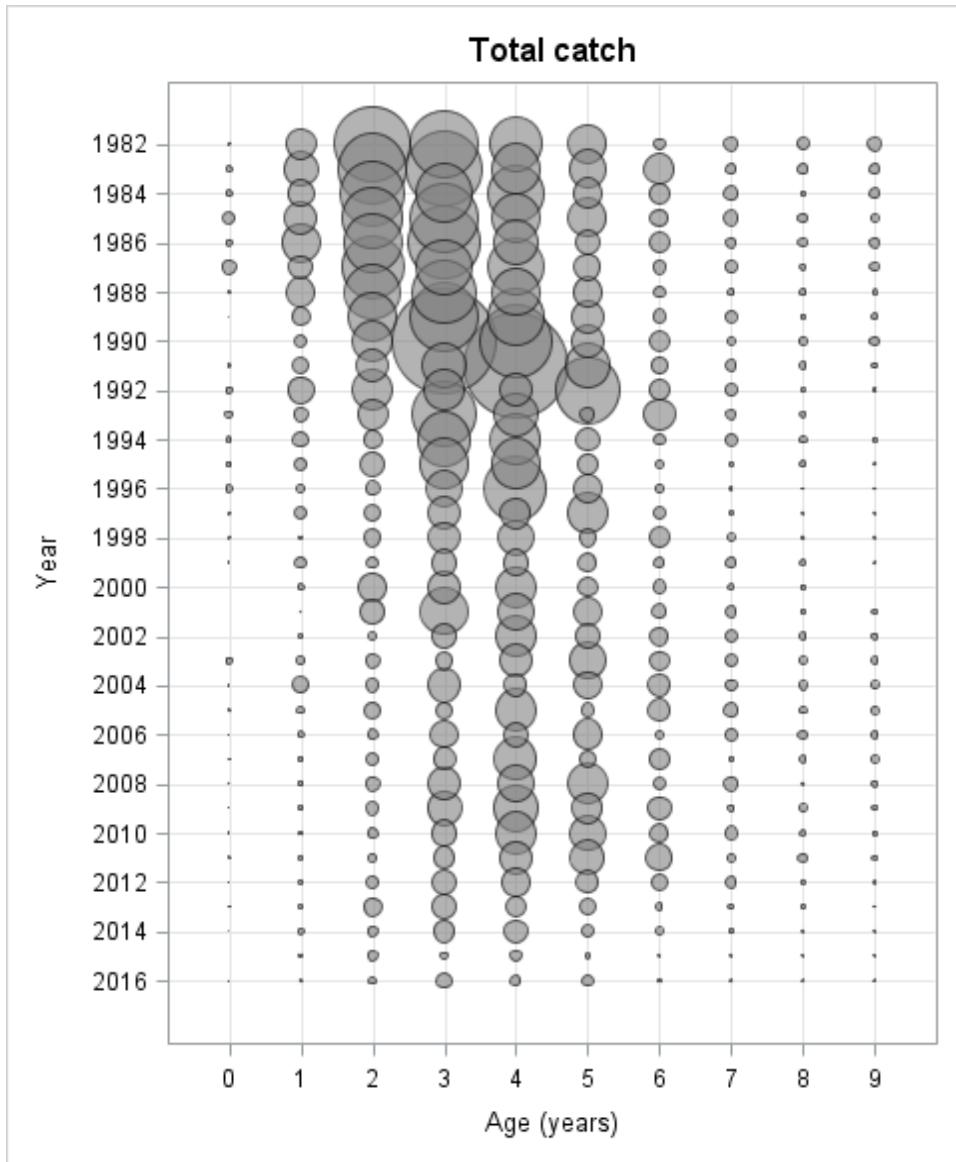


Figure 21. Total catch-at-age of Gulf of Maine Atlantic cod from 1982 to 2016. *Only ages 1 through the 9⁺ group are used as assessment model inputs. The scale has been adjusted to maximize visibility of catch-at-age (i.e., size of bubbles is not comparable between plots).*

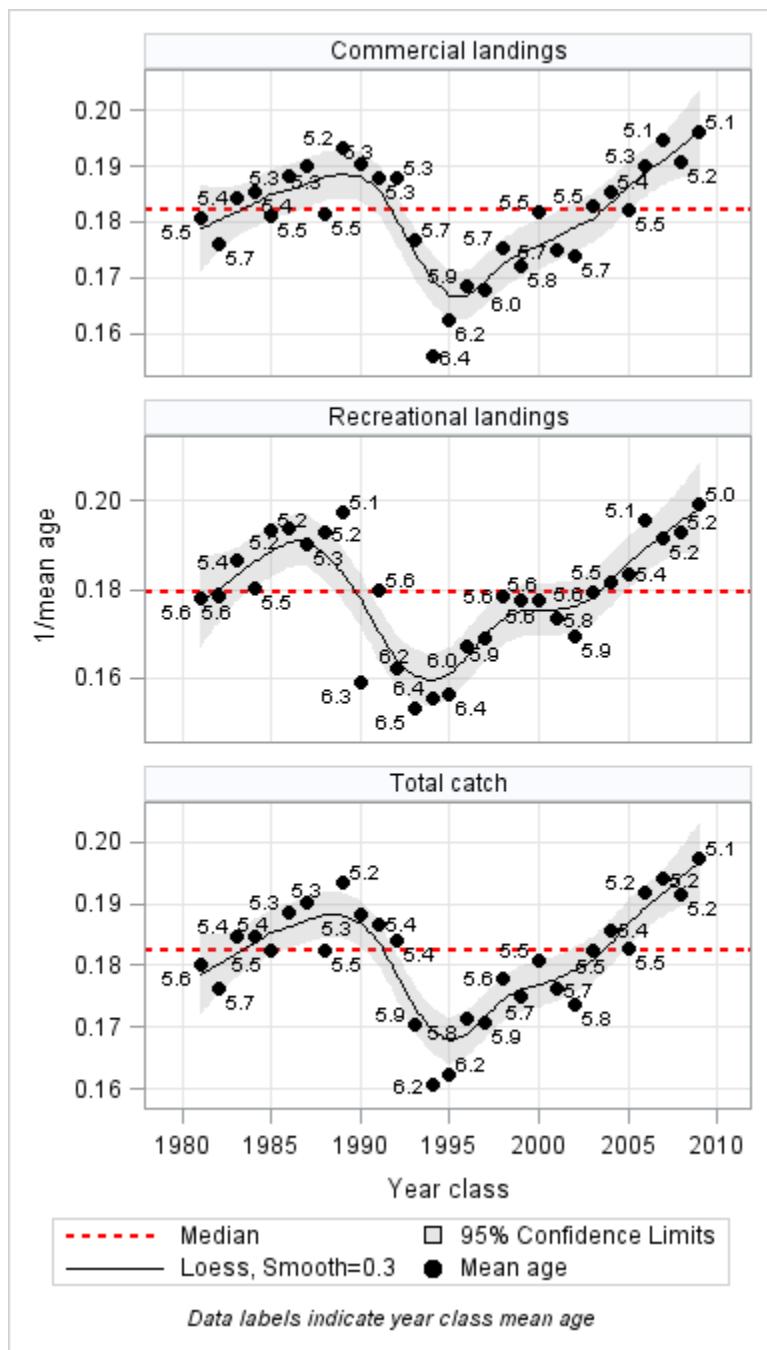


Figure 22. Trends in the inverse of the mean age of Gulf of Maine Atlantic cod in the commercial landings, recreational landings and total catch (landings and discards) for the 1981 to 2009 year classes. Mean age is estimated using ages approximating the range of full selectivity (ages 5-10).

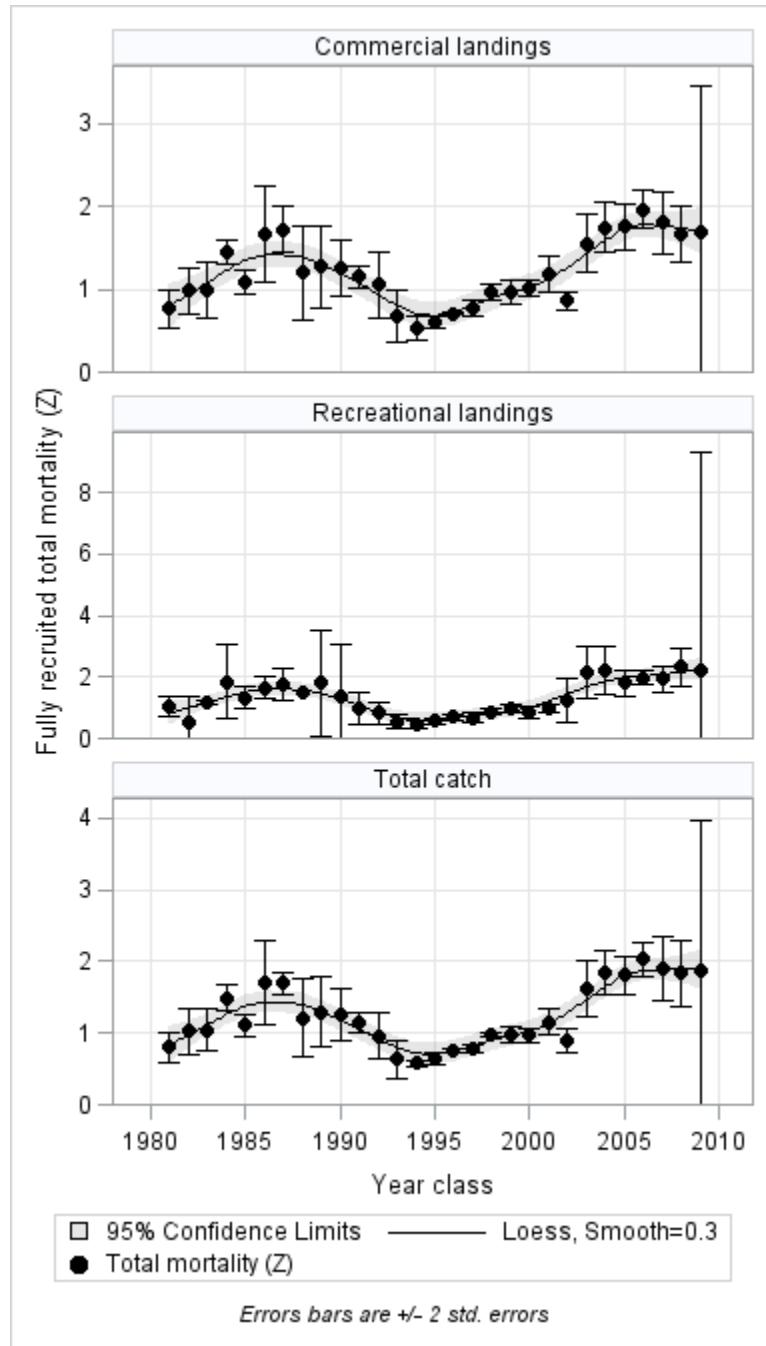


Figure 23. Trends in total mortality (Z) of Gulf of Maine Atlantic cod in the commercial landings, recreational landings and total catch (landings and discards) for the 1981 to 2009 year classes. Total mortality has been estimated using a catch curve analysis fit to the ages approximating the range of full selectivity (ages 5-10).

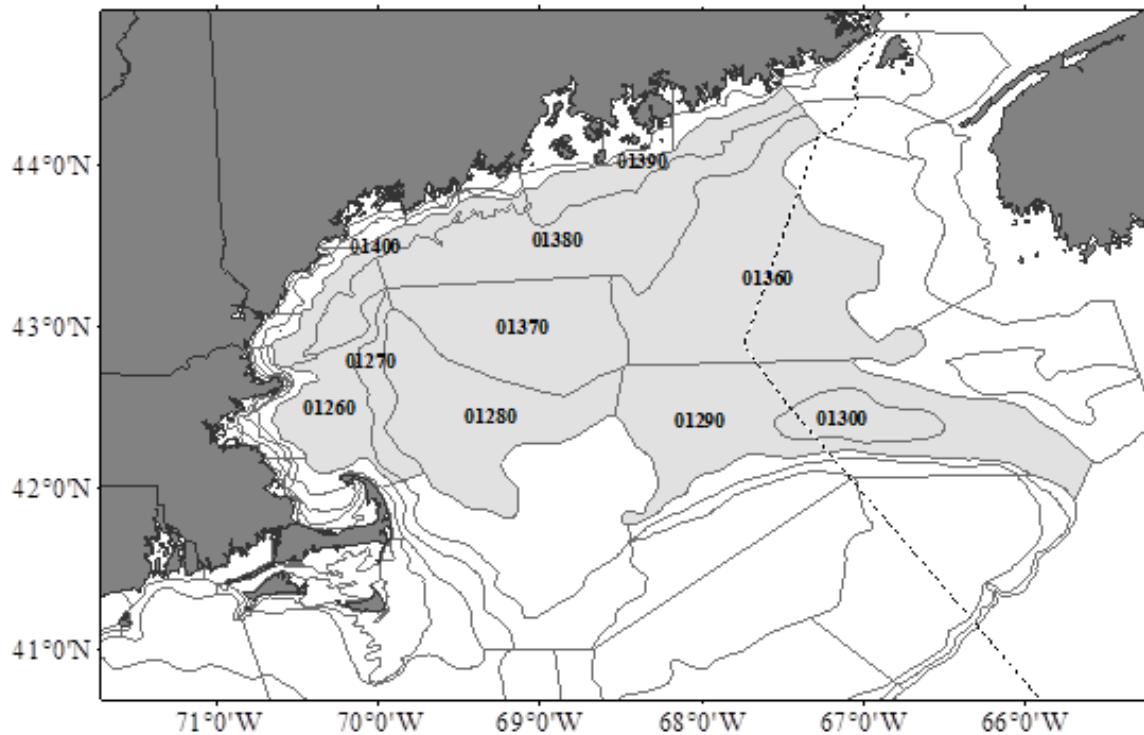


Figure 24. Map of the Northeast Fisheries Science Center (NEFSC) bottom trawl offshore survey strata used in the Gulf of Maine Atlantic cod stock assessment (light grey).

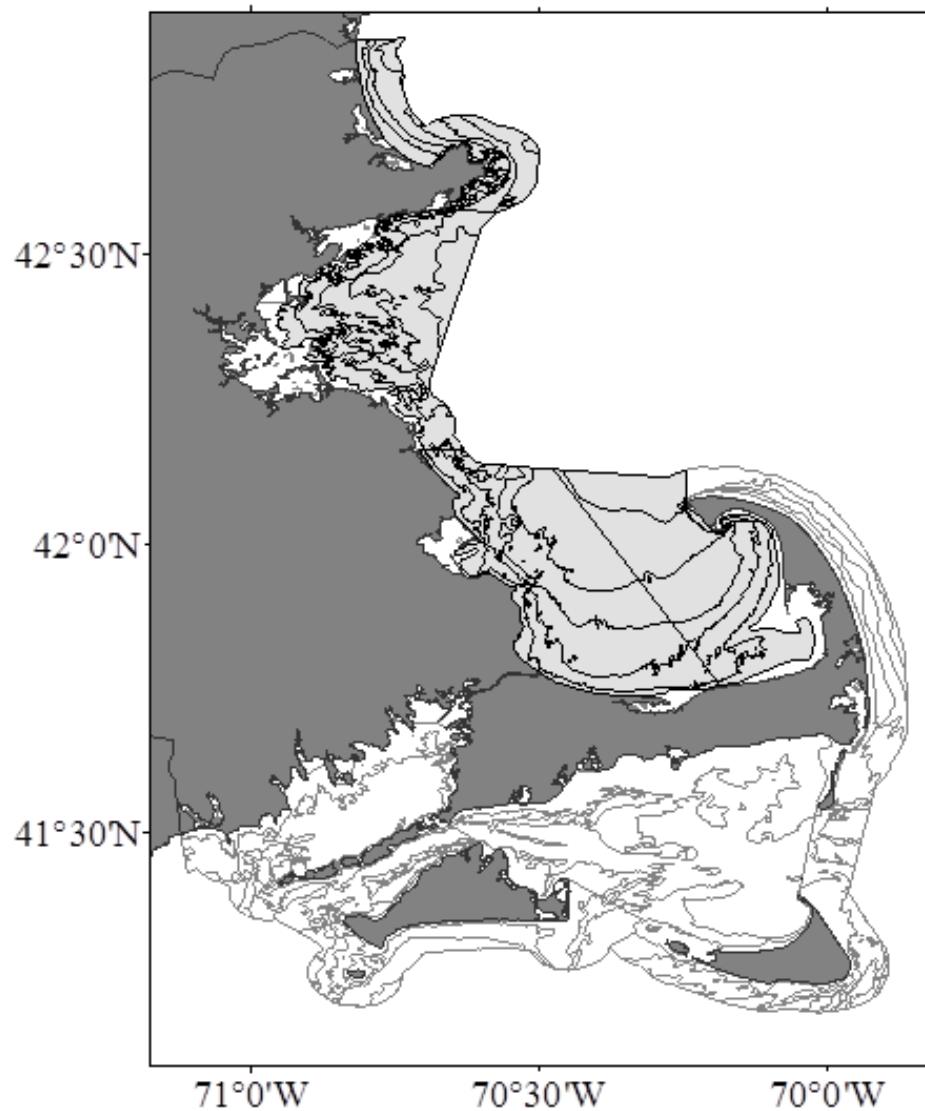


Figure 25. Map of the Massachusetts Department of Marine Fisheries (MADMF) bottom trawl survey strata used in the Gulf of Maine Atlantic cod stock assessment (light grey).

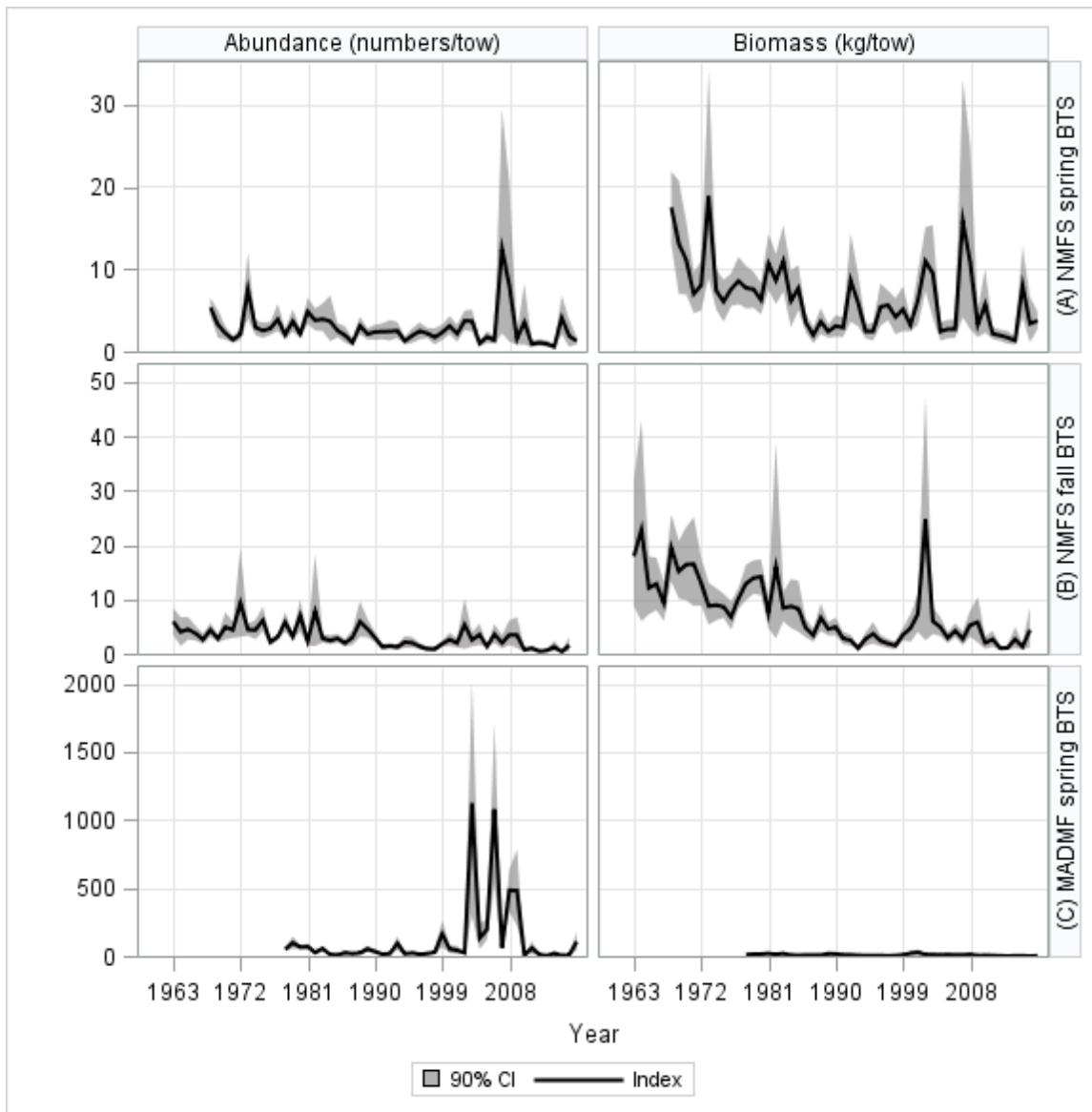


Figure 26. Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys and the Massachusetts Division of Marine Fisheries (MADMF) inshore spring survey abundance (left) and biomass (right) indices for Gulf of Maine Atlantic cod from 1963 to 2017. Note, the NEFSC spring survey did not begin until 1968 and the MADMF spring survey until 1978. The NEFSC fall 2017 survey has not been conducted at the time of this report.

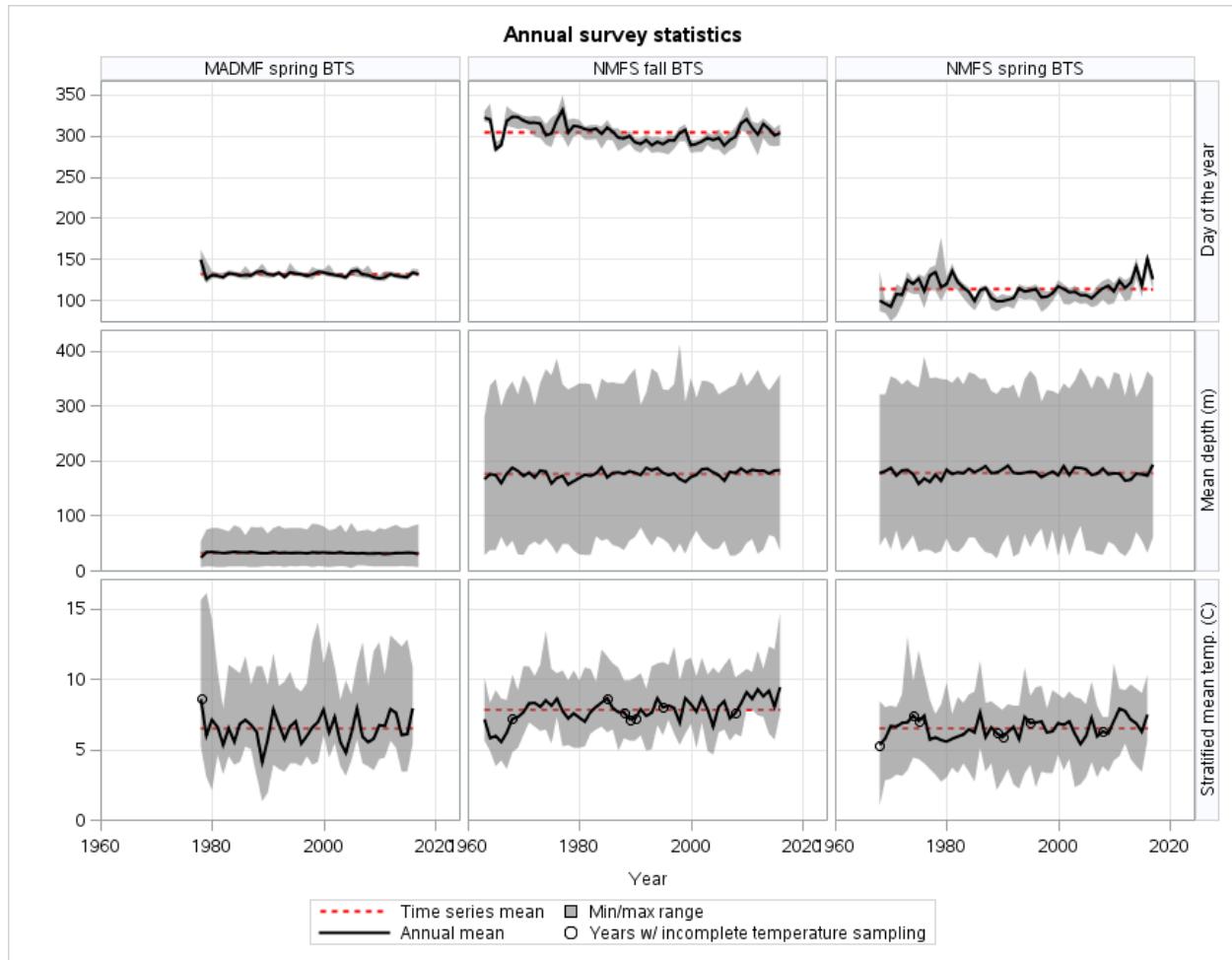


Figure 27. Mean day of the year of sampling in the Gulf of Maine by each of the three ongoing regional bottom trawl surveys used in the Gulf of Maine Atlantic cod assessment: Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys and the Massachusetts Division of Marine Fisheries (MADMF) inshore spring survey. Grey bands indicate the minimum and maximum for each survey/year. Day of the year is expressed as Julian days (e.g., January 1 is day 1 and December 31 is day 365/66). Years marked with circles in the mean temperature plot indicate years when not all survey stratum were sampled and therefore the mean temperature may not be representative of the entire survey area.



Figure 28. Gulf of Maine Atlantic cod abundance (numbers/tow) indices-at-age from the Northeast Fisheries Science Center (NEFSC) spring bottom trawl survey from 1970 to 2017. Note that scale has been adjusted to maximize visibility of indices-at-age (i.e., size of bubbles is not comparable between plots). Note that only years 1982 to 2016 are included as model inputs.



Figure 29. Gulf of Maine Atlantic cod abundance (numbers/tow) indices-at-age from the Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey from 1970 to 2016. Note that scale has been adjusted to maximize visibility of indices-at-age (i.e., size of bubbles is not comparable between plots). Note that only years 1982 to 2016 are included as model inputs.



Figure 30. Gulf of Maine Atlantic cod abundance (numbers/tow) indices-at-age from the Massachusetts Division of Marine Fisheries (MADMF) spring inshore trawl survey from 1970 to 2016. Note that there was insufficient age information available from the MADMF spring survey prior to 1982. The scale has been adjusted to maximize visibility of indices-at-age (i.e., size of bubbles is not comparable between plots). The 2017 MADMF spring ages were not available at the time of this report. Note that only years 1982 to 2016 are included as model inputs.

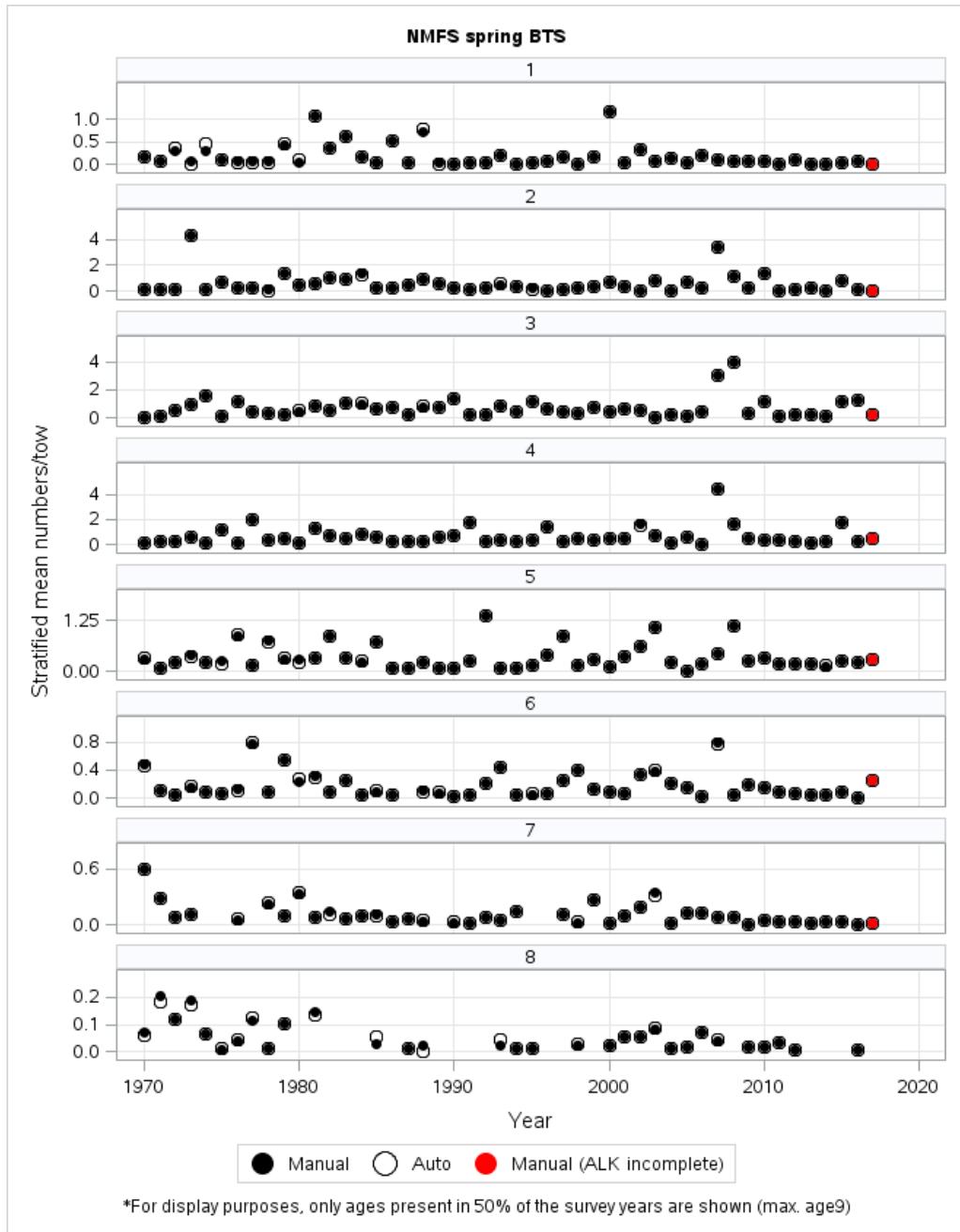


Figure 31. Comparison of the Gulf of Maine Atlantic cod abundance (numbers/tow) indices-at-age from the Northeast Fisheries Science Center (NEFSC) spring bottom trawl survey from 1970 to 2017 generated using a manual process to fill holes in the age-length key to that using an automated multinomial approach (see Gerritsen *et al.* 2006). *The age classes shown are restricted to only those ages that are present in ≥ 50% of the survey years examined.*

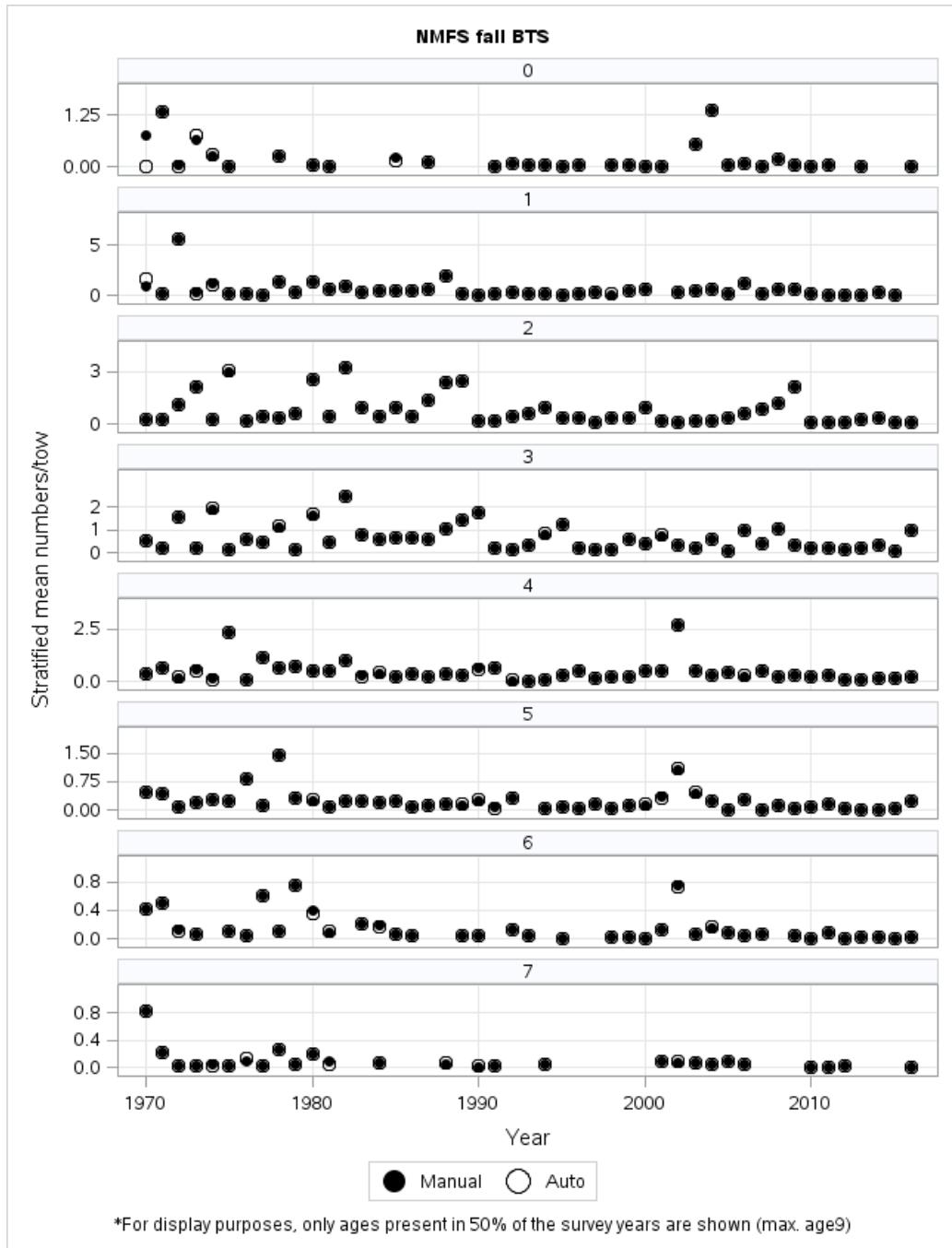


Figure 32. Comparison of the Gulf of Maine Atlantic cod abundance (numbers/tow) indices-at-age from the Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey from 1970 to 2016 generated using a manual process to fill holes in the age-length key to that using an automated multinomial approach (see Gerritsen *et al.* 2006). *The age classes shown are restricted to only those ages that are present in $\geq 50\%$ of the survey years examined.*

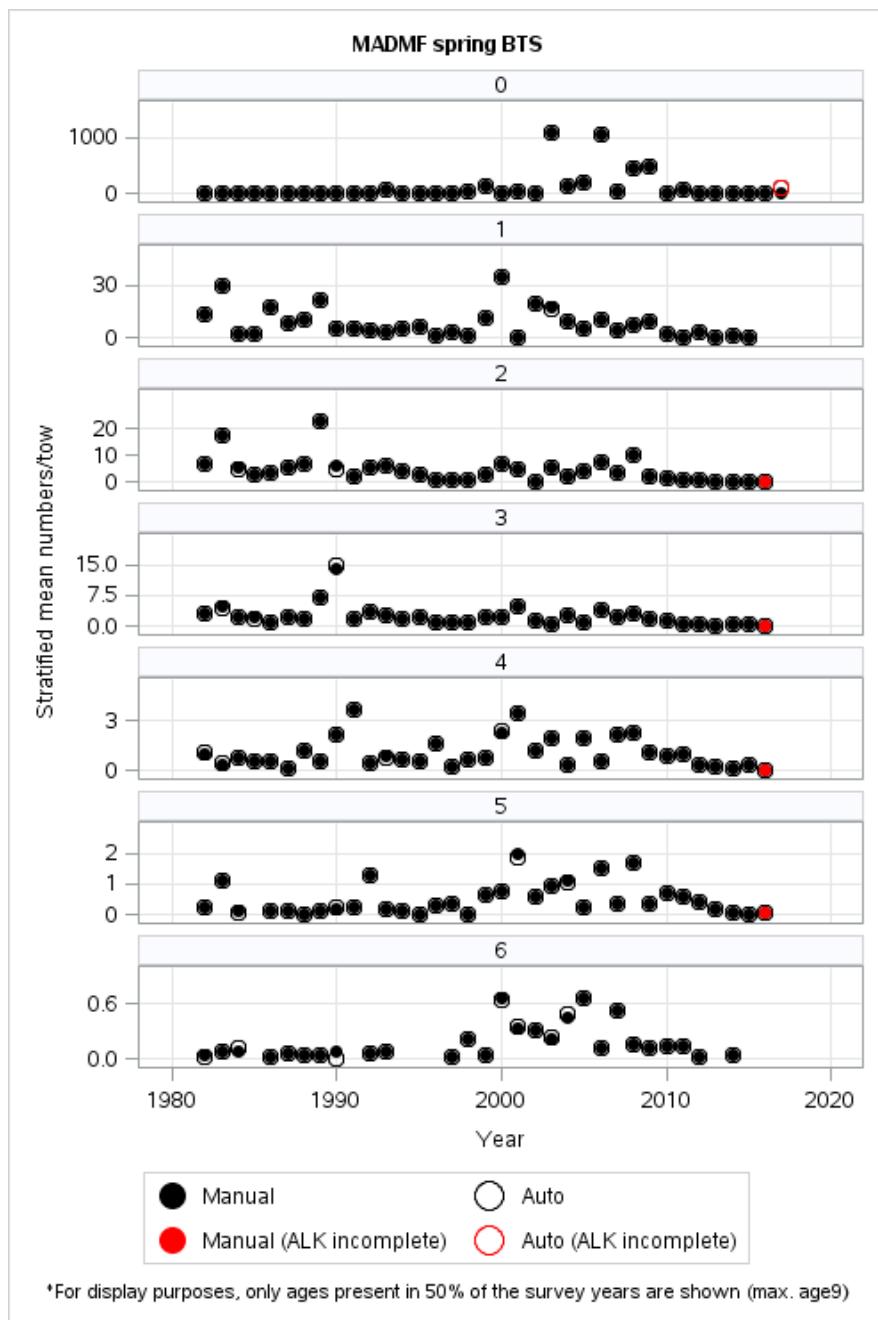


Figure 33. Comparison of the Gulf of Maine Atlantic cod abundance (numbers/tow) indices-at-age from the Massachusetts Division of Marine Fisheries (MADMF) spring inshore trawl survey from 1970 to 2016 generated using a manual process to fill holes in the age-length key to that using an automated multinomial approach (see Gerritsen *et al.* 2006). *The age classes shown are restricted to only those ages that are present in ≥ 50% of the survey years examined.*

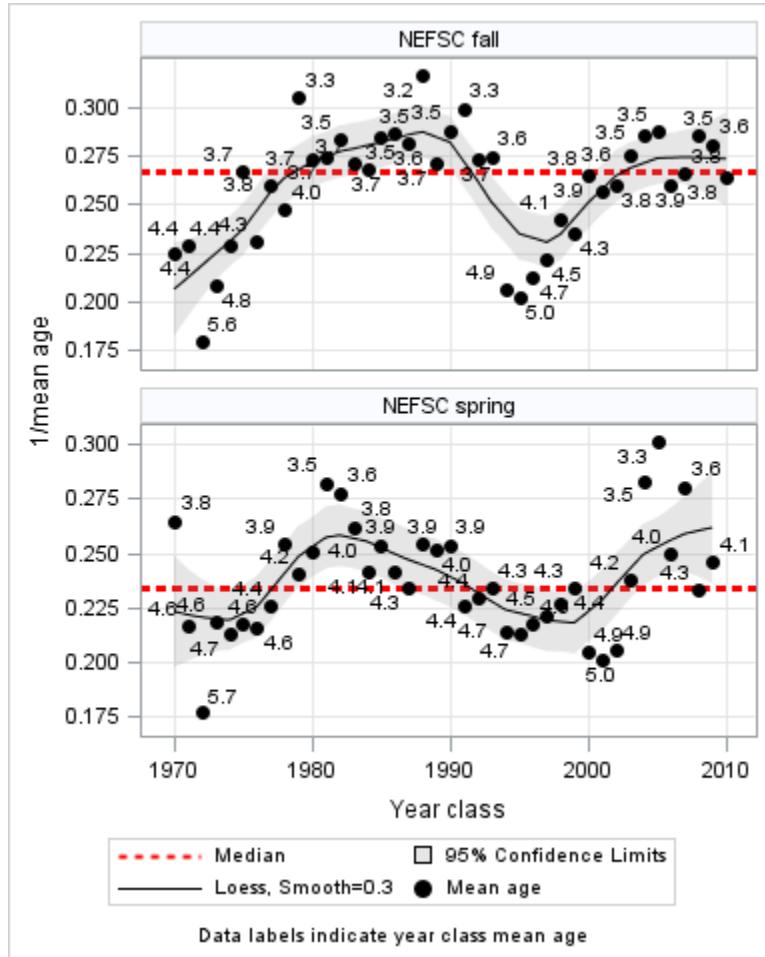


Figure 34. Trends in the inverse of the mean age of Gulf of Maine Atlantic cod in the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl survey for the 1970 to 2010 year classes. Mean age is estimated using ages approximating the range of full selectivity (ages 3-8).

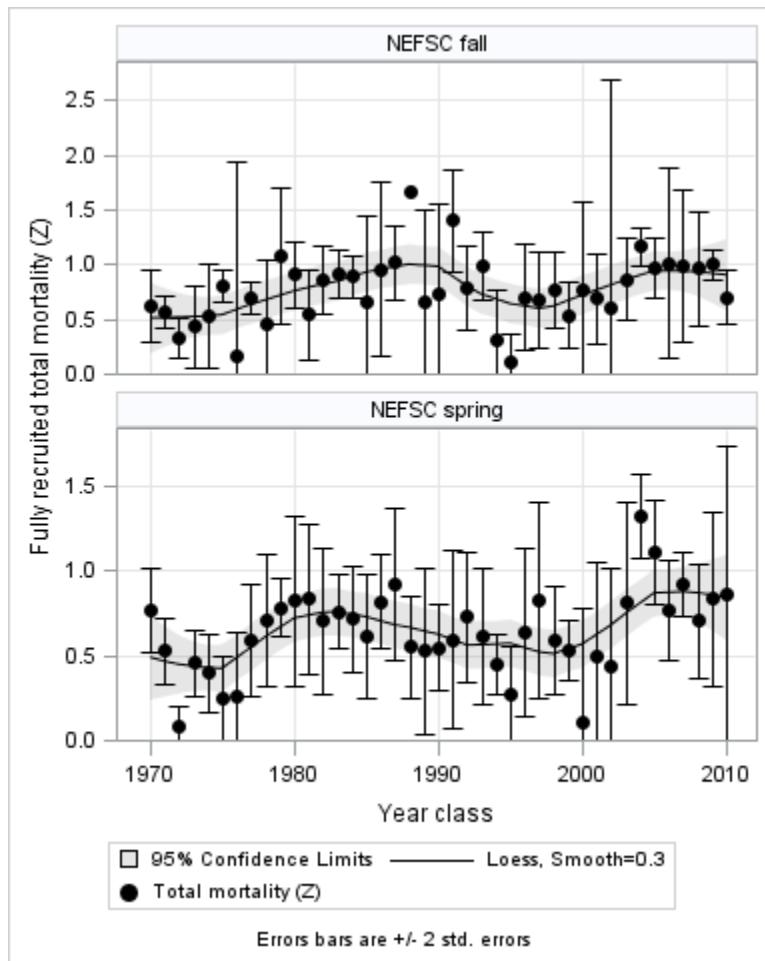


Figure 35. Trends in total mortality (Z) of Gulf of Maine Atlantic cod in the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl survey for the 1970 to 2010 year classes. Total mortality has been estimated using a catch curve analysis fit to the ages approximating the range of full selectivity (ages 3-8).

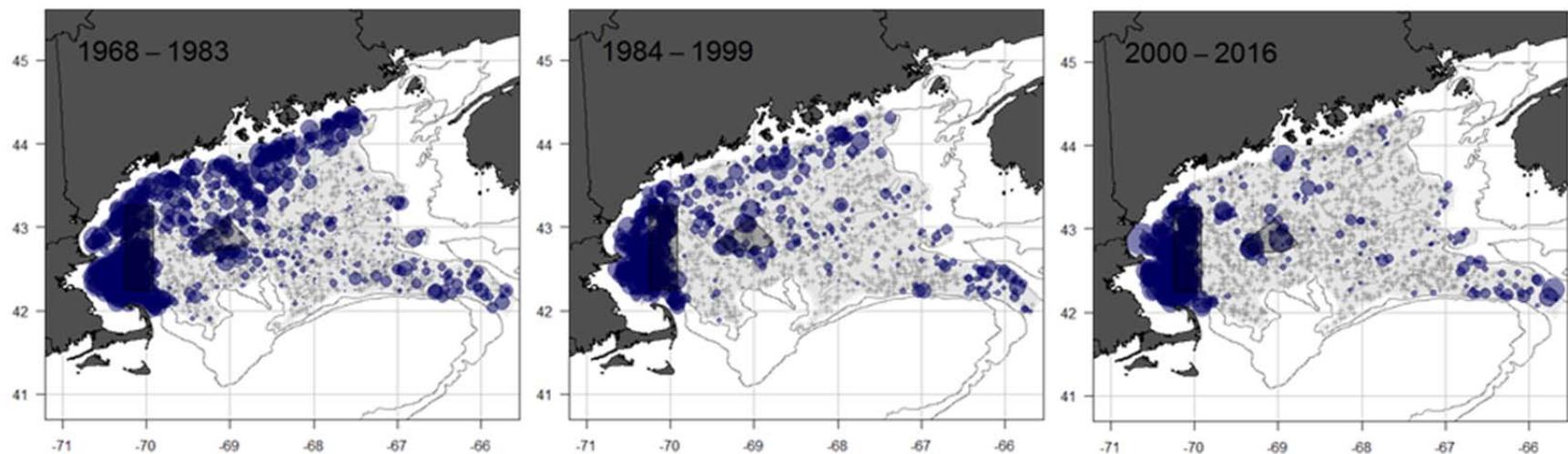


Figure 36. Spatial distribution of Gulf of Maine Atlantic cod catches (numbers/tow) from the Northeast Fisheries Science Center spring and fall bottom trawl survey from 1968 – 2016 in approximate fifteen year increments. The Western Gulf of Maine and Cashes Ledge closure areas are indicated by the grey shaded polygons.

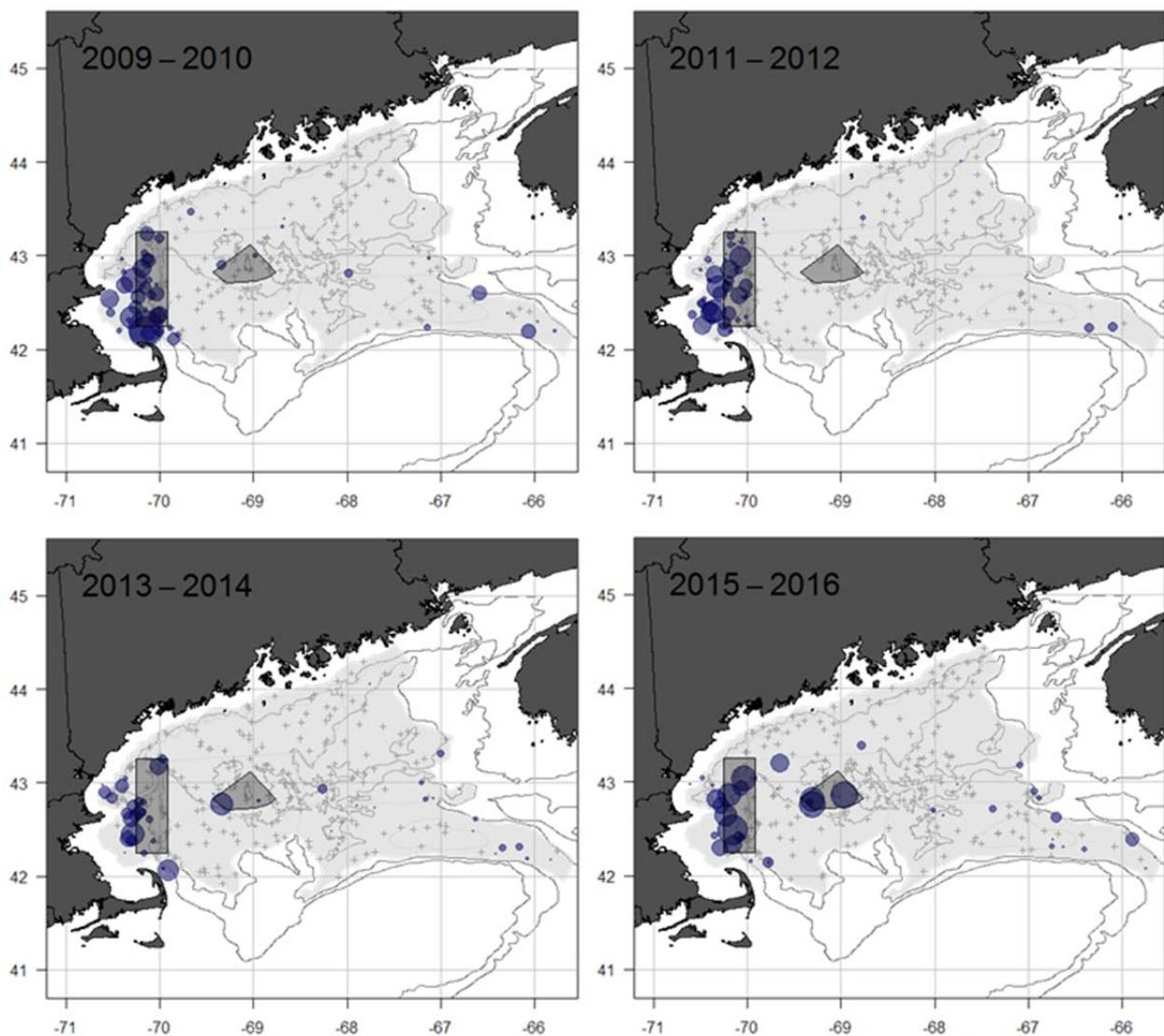


Figure 37. Spatial distribution of Gulf of Maine Atlantic cod catches (numbers/tow) from the Northeast Fisheries Science Center spring and fall bottom trawl surveys from 2009 to 2016 in two year increments. The Western Gulf of Maine and Cashes Ledge closure areas are indicated by the grey shaded polygons.

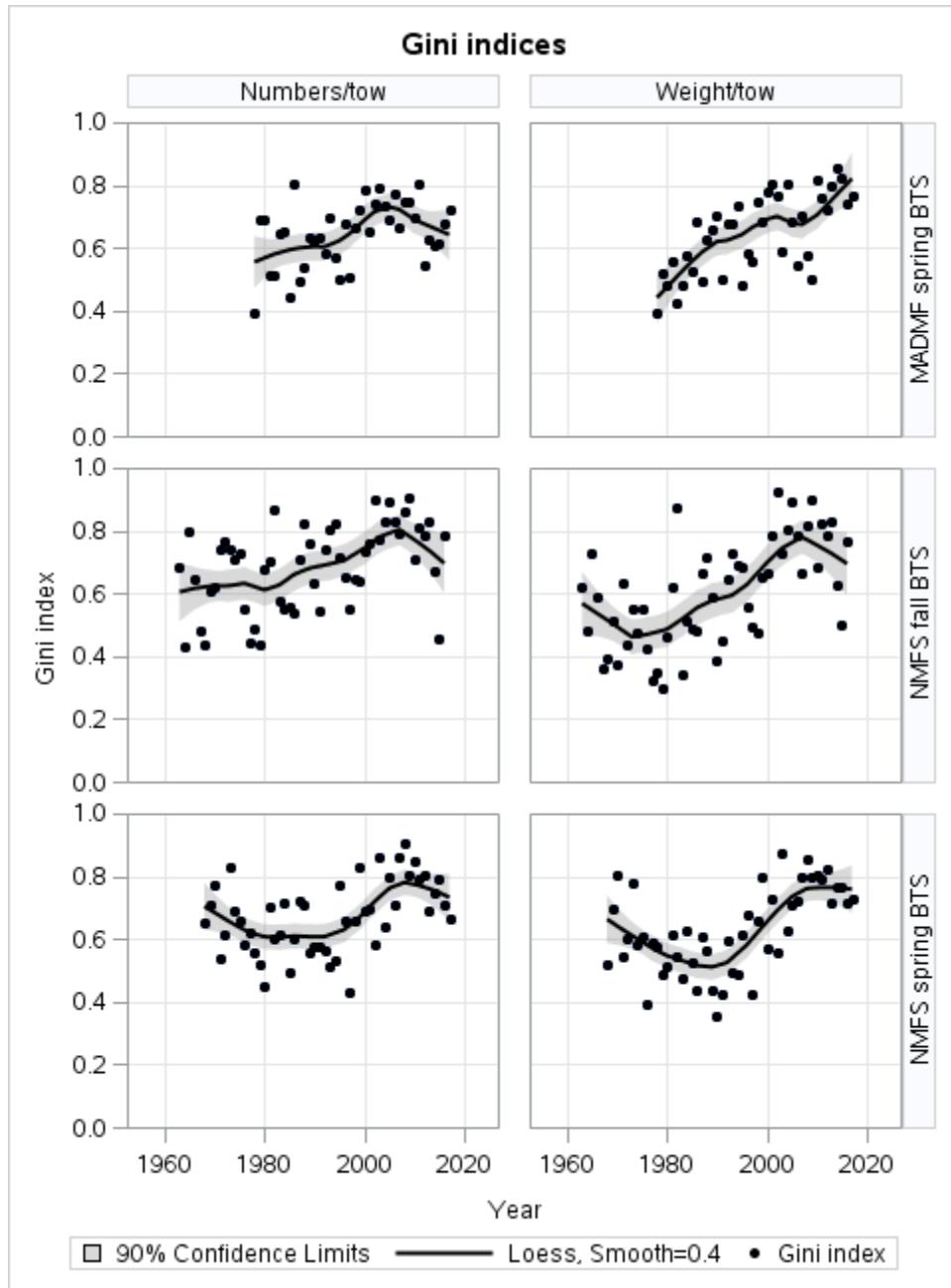


Figure 38. Gini indices for Gulf of Maine Atlantic cod from the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys and the Massachusetts Division of Marine Fisheries (MADMF) spring bottom trawl survey in terms of abundance (numbers/tow) and biomass (kg/tow) from 1963-2017. Note that the NEFSC spring survey did not begin until 1968 and the MADMF spring survey until 1978. The 2017 NEFSC fall survey had not been conducted at the time of this report.

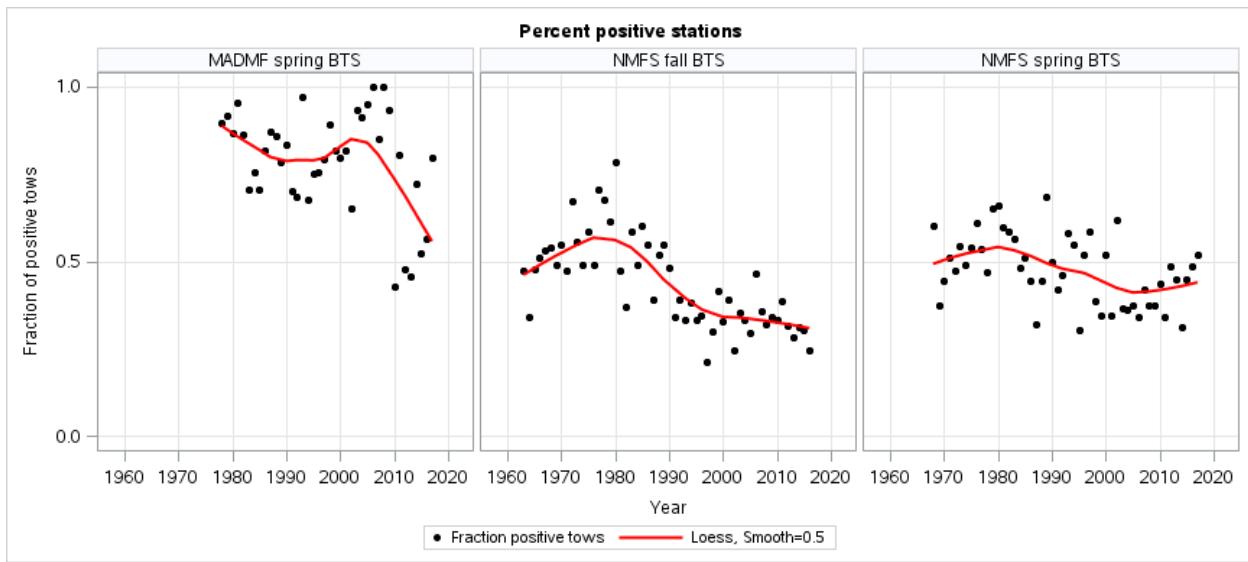


Figure 39. Fraction of Northeast Fisheries Science Center (NEFSC) spring and fall and Massachusetts Division of Marine Fisheries (MADMF) spring bottom trawl survey tows with positive catches of Gulf of Maine Atlantic cod from 1963-2017. Note that the NEFSC spring survey did not begin until 1968 and the MADMF spring survey until 1978. The 2017 NEFSC fall survey had not been conducted at the time of this report.

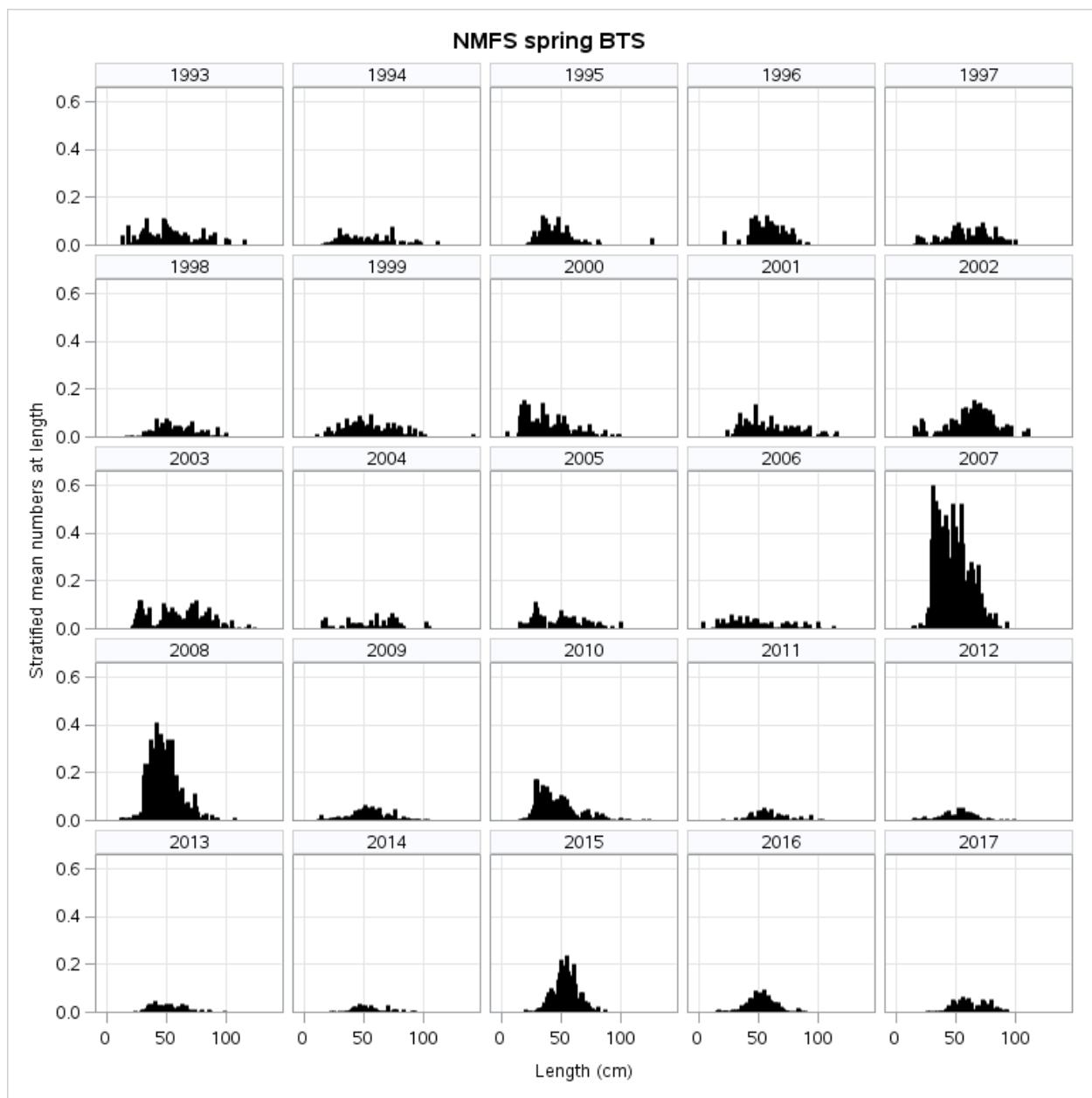


Figure 40. Gulf of Maine Atlantic cod abundance (numbers/tow) indices-at-length from Northeast Fisheries Science Center (NEFSC) spring bottom trawl survey from 1993 to 2017.

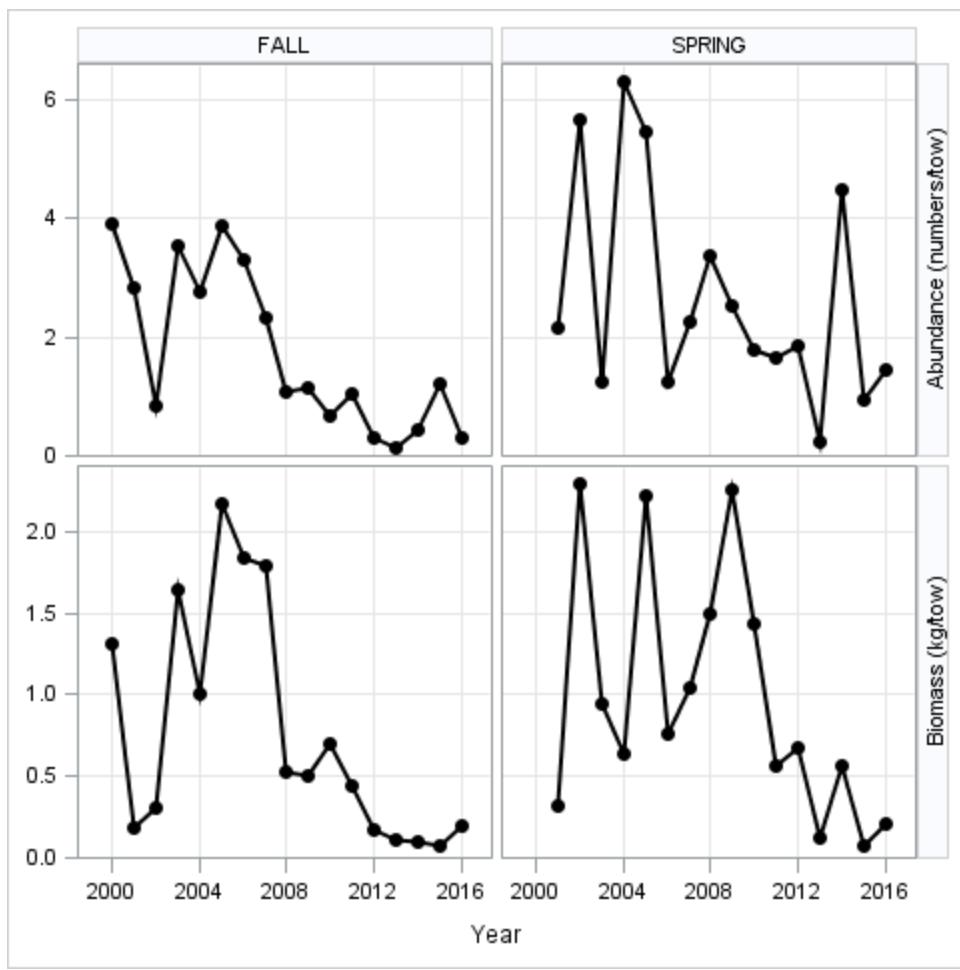


Figure 41. Maine-New Hampshire (ME-NH) spring and fall inshore bottom trawl survey abundance (top) and biomass (bottom) indices for Gulf of Maine Atlantic cod from 2000 to 2016. Note, the ME-NH spring survey did not begin until 2001. *Data courtesy of Sally Sherman (ME DMR).*

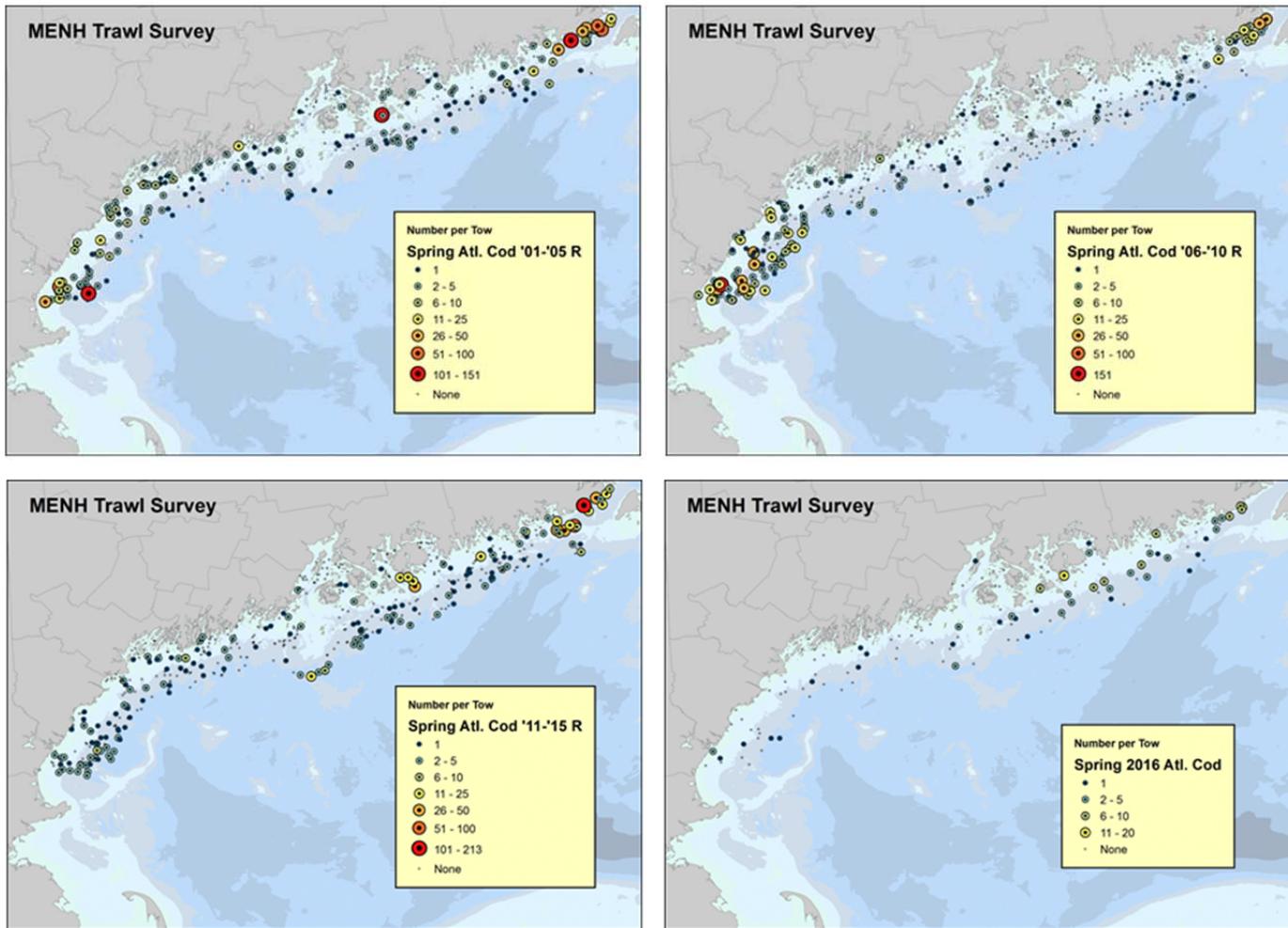


Figure 42. Spatial distribution of Gulf of Maine Atlantic cod catches (numbers/tow) from the Maine-New Hampshire (ME-NH) spring inshore bottom trawl survey from 2001 to 2016. *Figures courtesy of Sally Sherman (ME DMR). Note that the ME NH survey is not used as an input to the assessment model.*

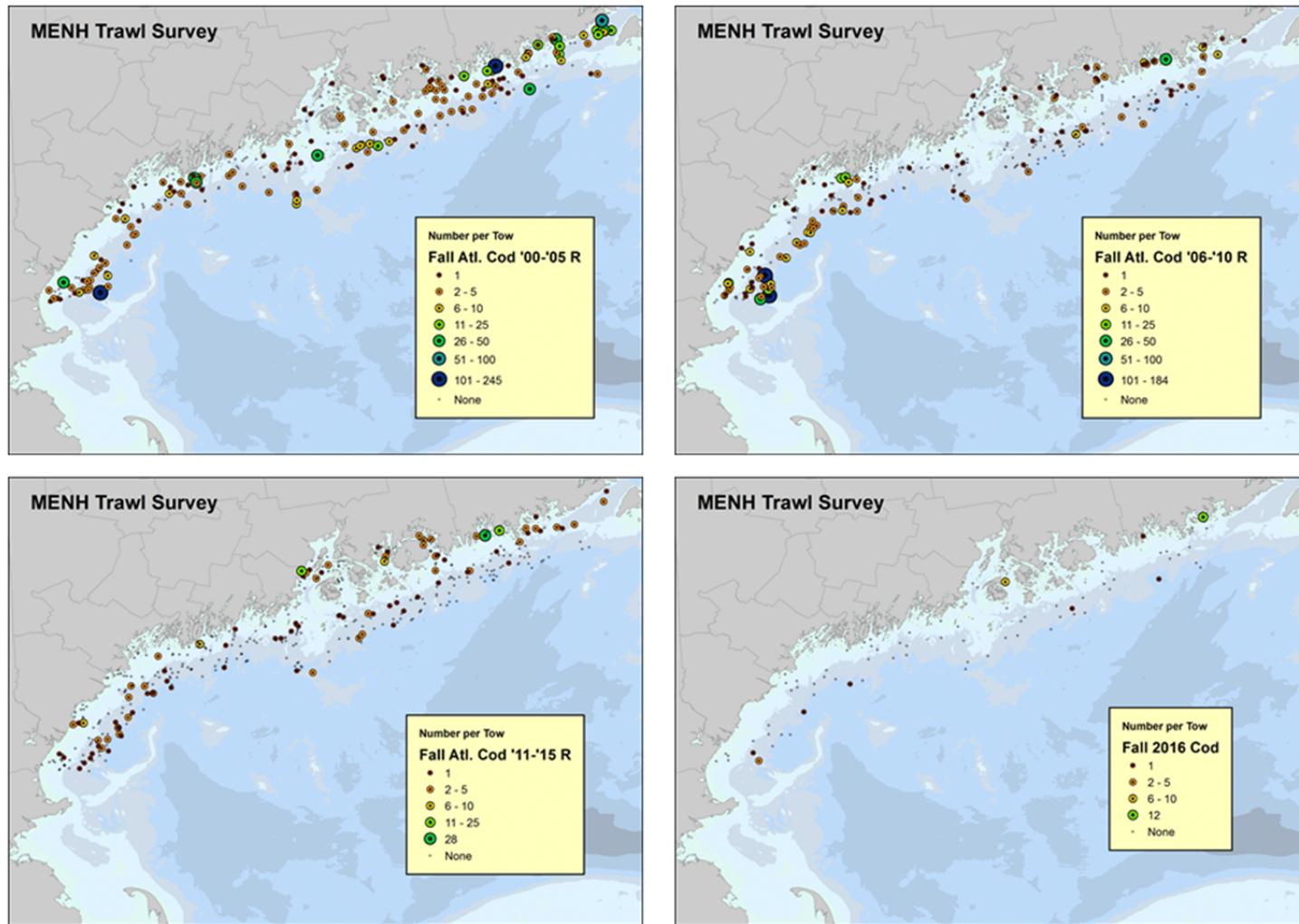


Figure 43. Spatial distribution of Gulf of Maine Atlantic cod (numbers/tow) from the Maine-New Hampshire (ME-NH) fall inshore bottom trawl survey from 2000 to 2016. *Figures courtesy of Sally Sherman (ME DMR). Note that the ME NH survey is not used as an input to the assessment model.*

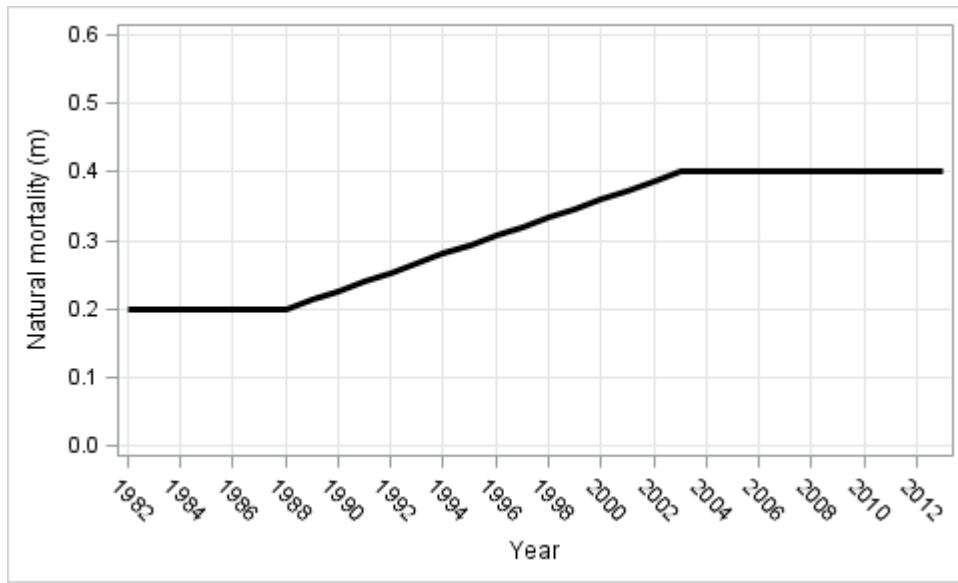


Figure 44. Time series of natural mortality used in the Gulf of Maine Atlantic cod natural M-ramp assessment model.

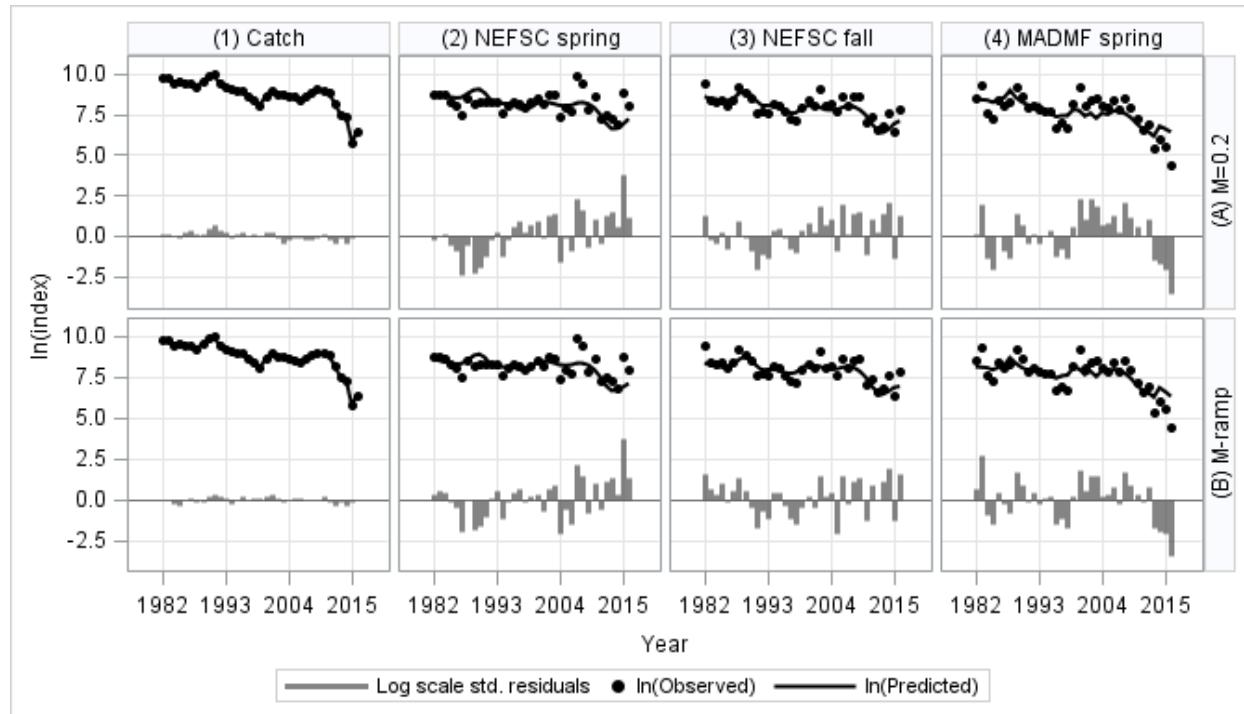


Figure 45. Comparison of model fits to aggregate catch and survey indices and the corresponding standardized residuals from the $M=0.2$ and M -ramp Gulf of Maine Atlantic cod assessment models.

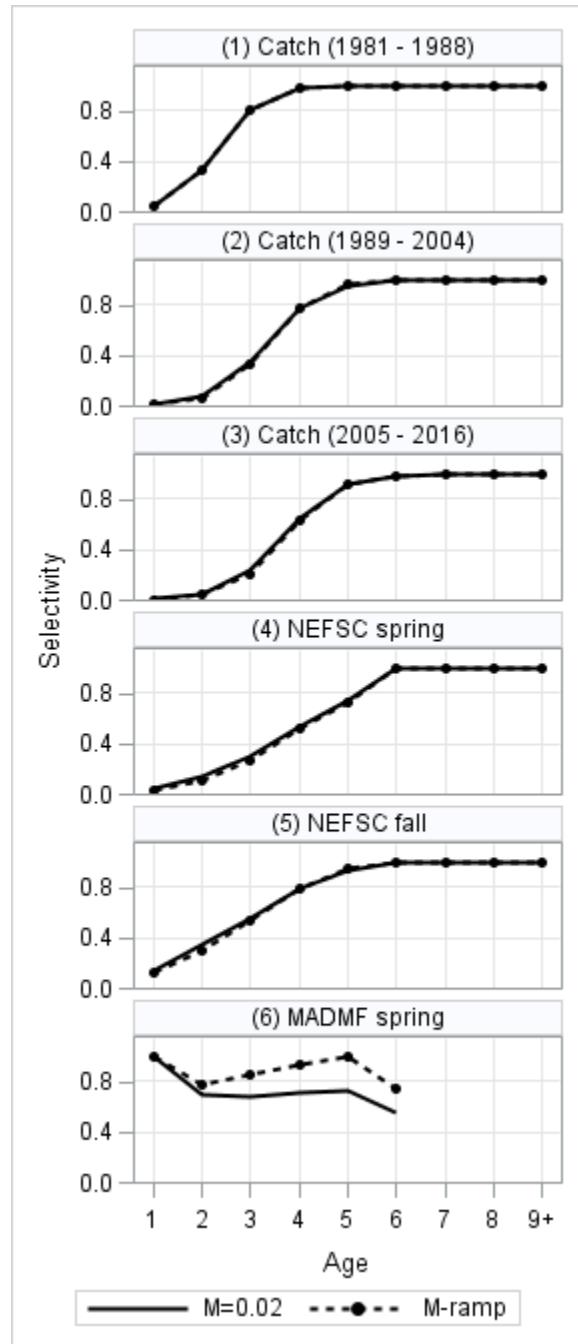


Figure 46. Estimated fishery selectivities for Gulf of Maine Atlantic cod from the $M=0.2$ and M -ramp assessment models.

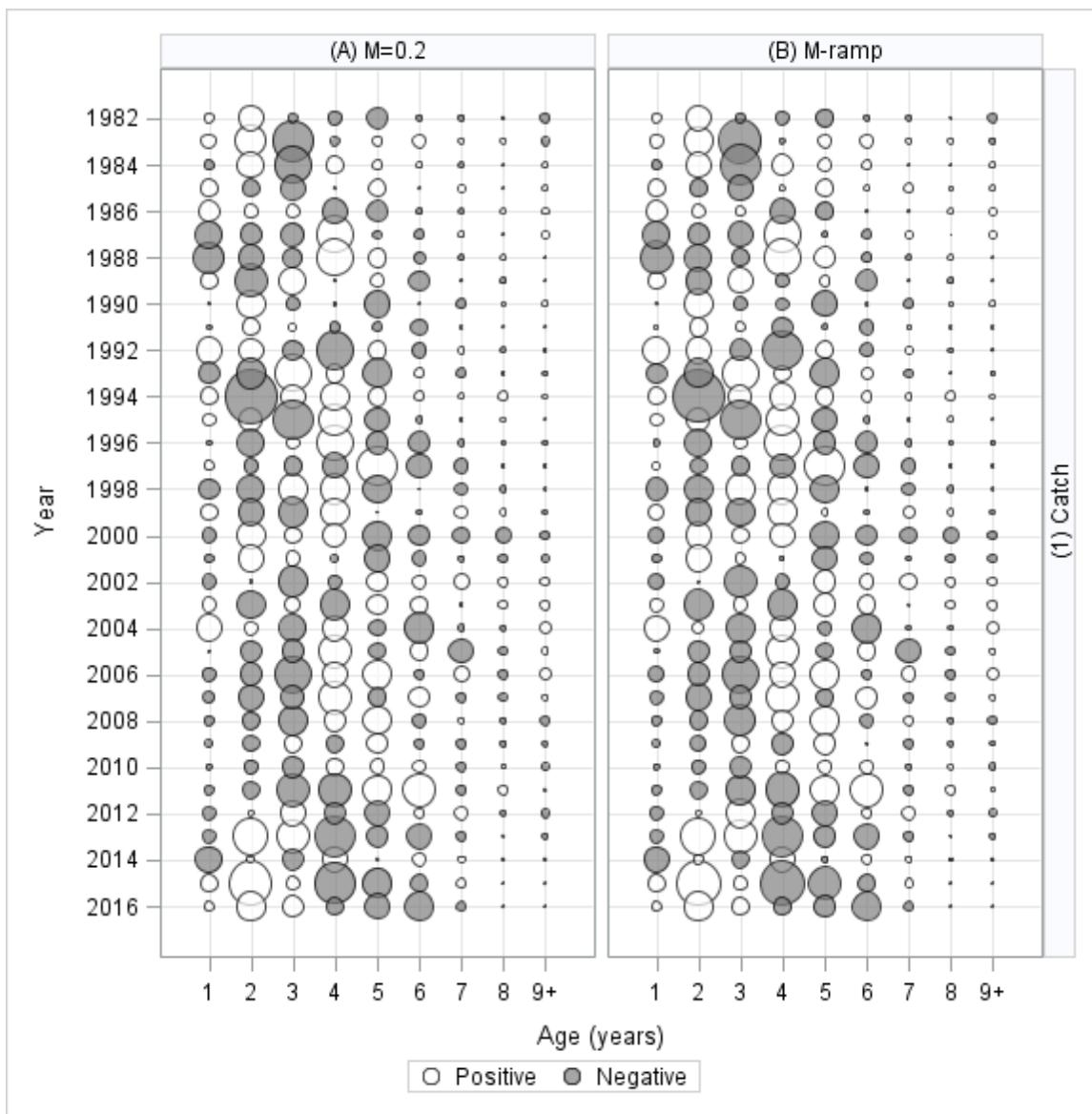


Figure 47. Model residuals of the fits to the Gulf of Maine Atlantic cod fishery catch-at-age for the M=0.2 and M-ramp assessment models.

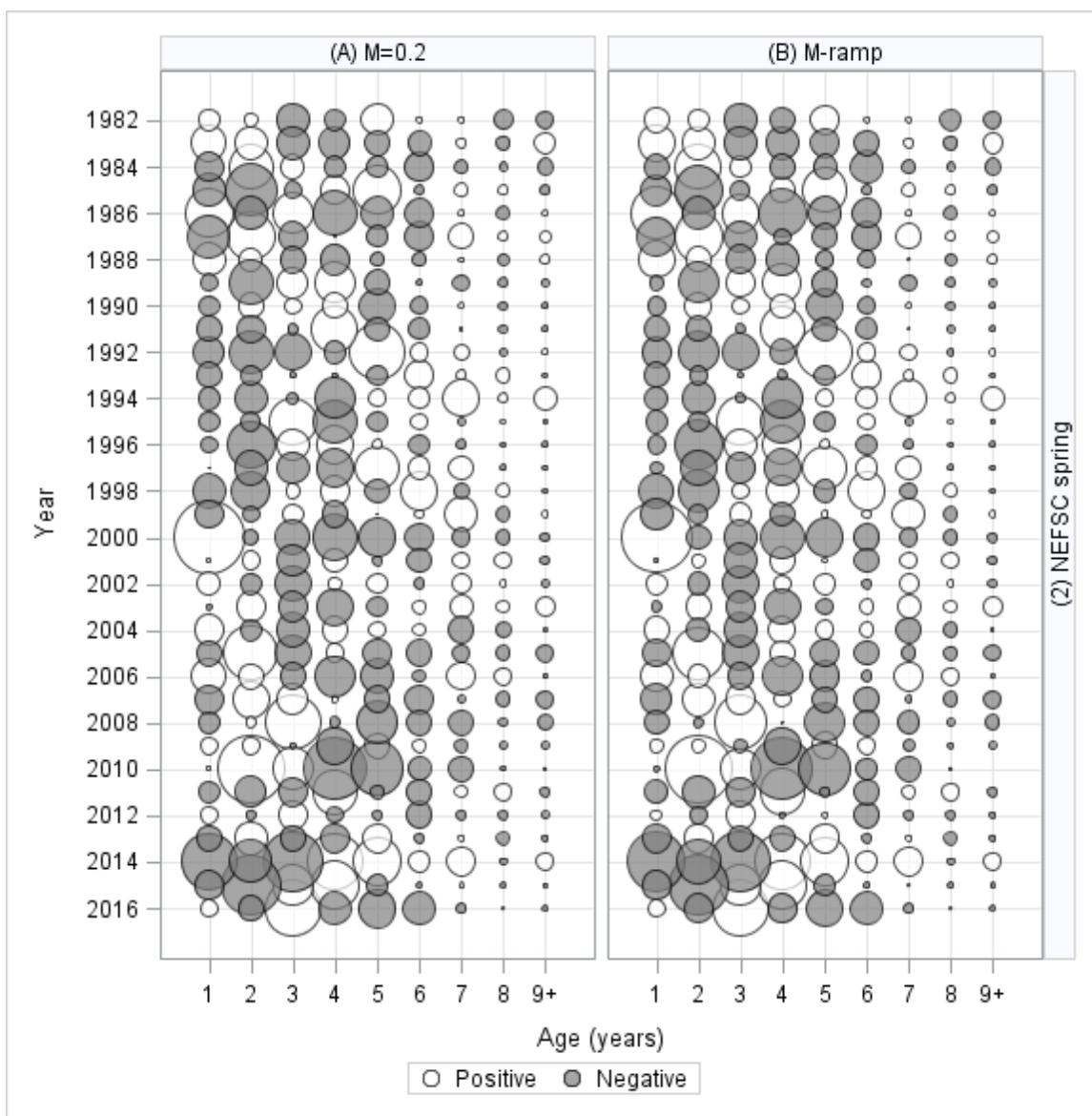


Figure 48. Model residuals of the fits to the NEFSC spring survey Gulf of Maine Atlantic cod indices-at-age for the M=0.2 and M-ramp assessment models.

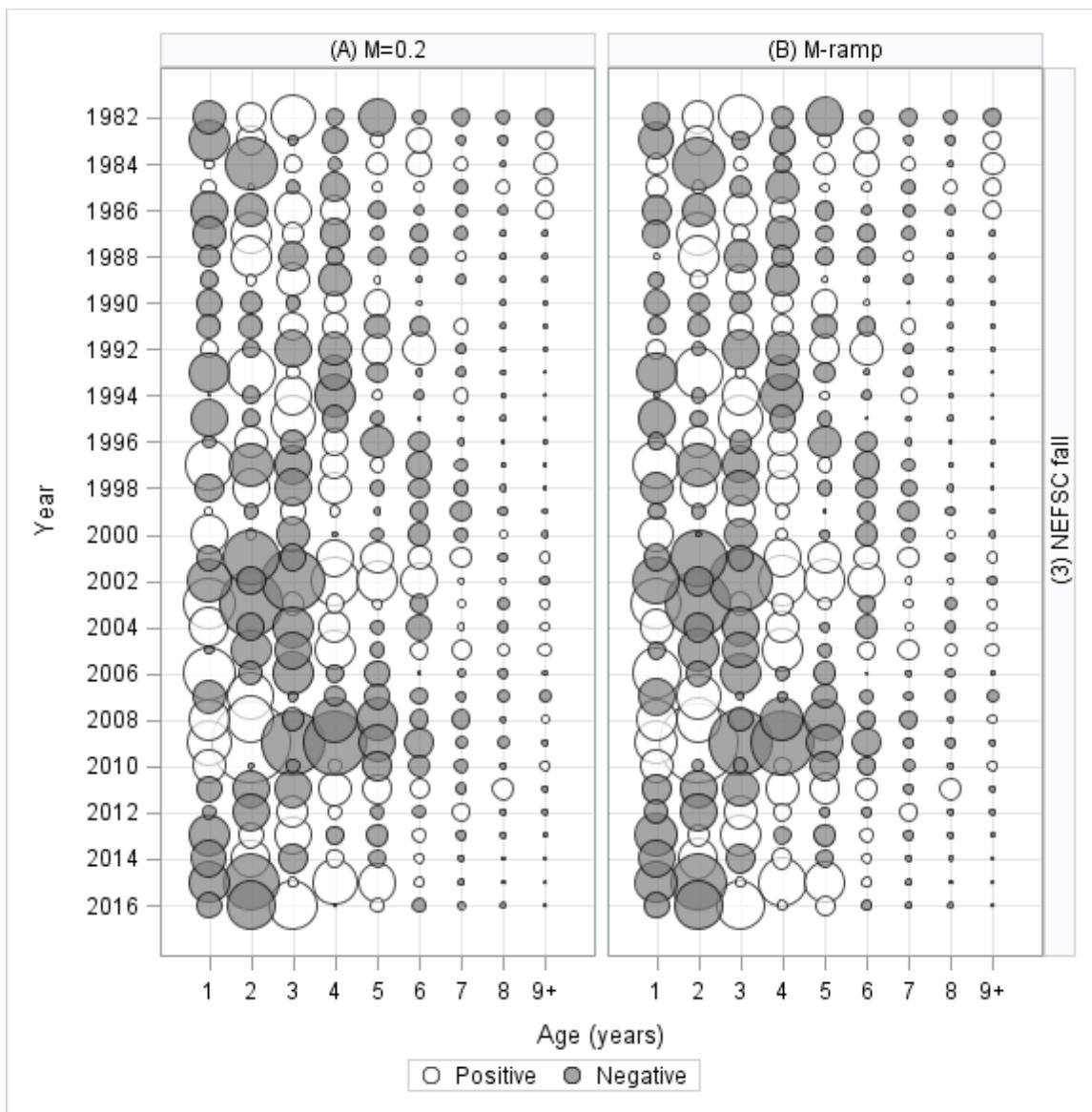


Figure 49. Model residuals of the fits to the NEFSC fall survey Gulf of Maine Atlantic cod indices-at-age for the $M=0.2$ and $M\text{-ramp}$ assessment models.

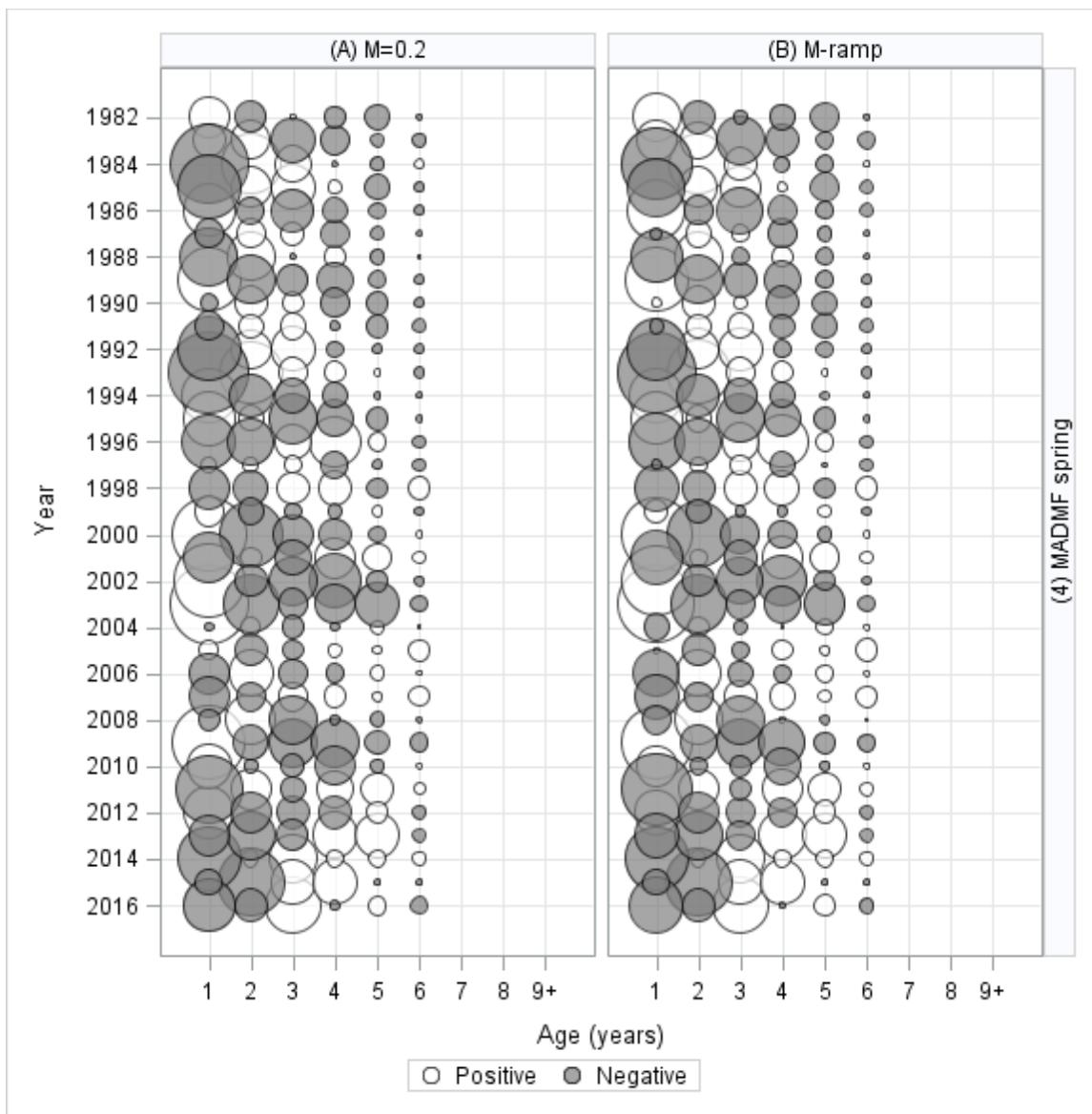


Figure 50. Model residuals of the fits to the MADMF spring survey Gulf of Maine Atlantic cod indices-at-age for the $M=0.2$ and M -ramp assessment models.

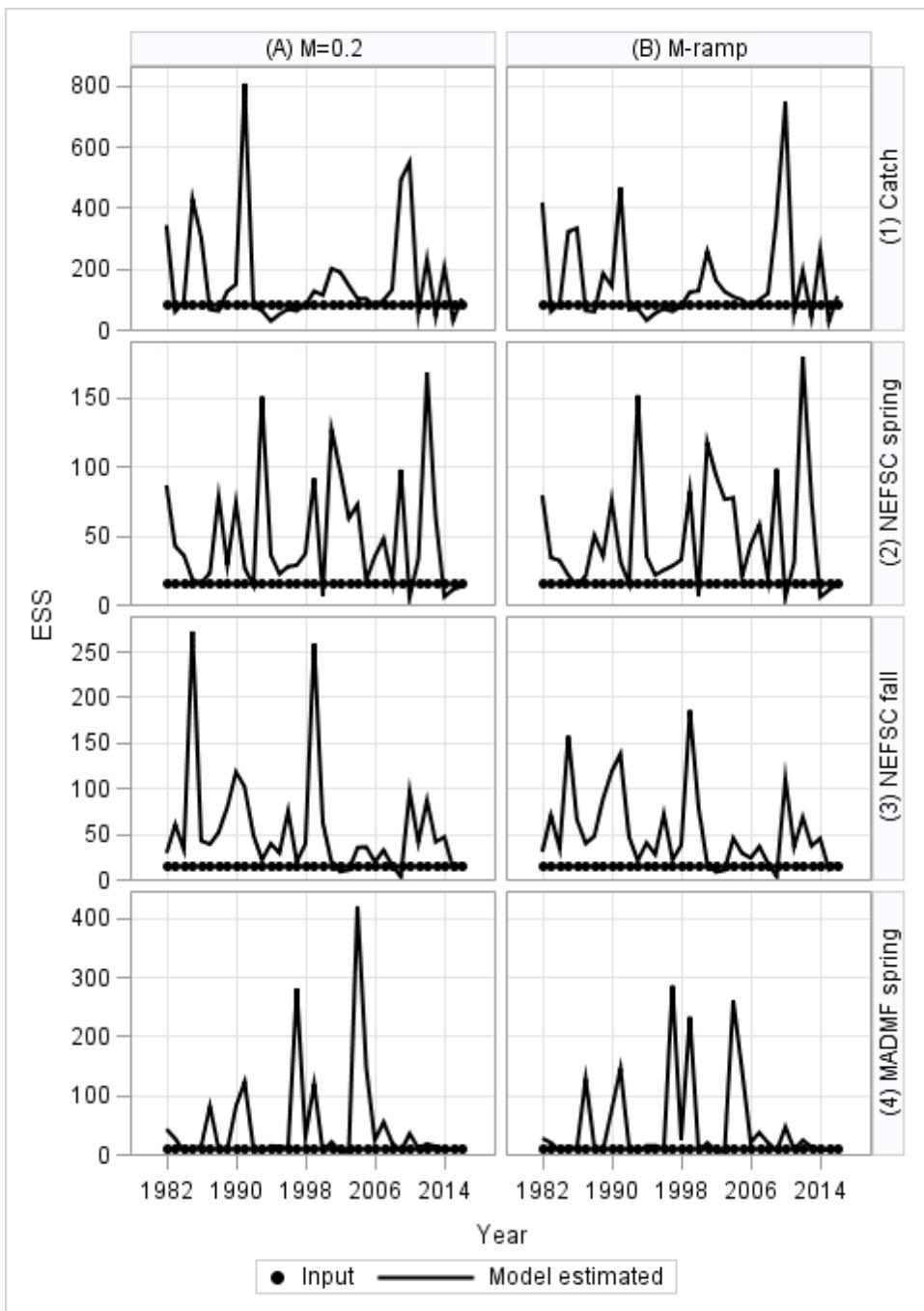


Figure 51. Comparison of the input and model estimated effective sample sizes (ESS) from the Gulf of Maine Atlantic cod M=0.2 and M-ramp assessment models. See NEFSC (2013) for a full description of the methods used to determine input ESS.

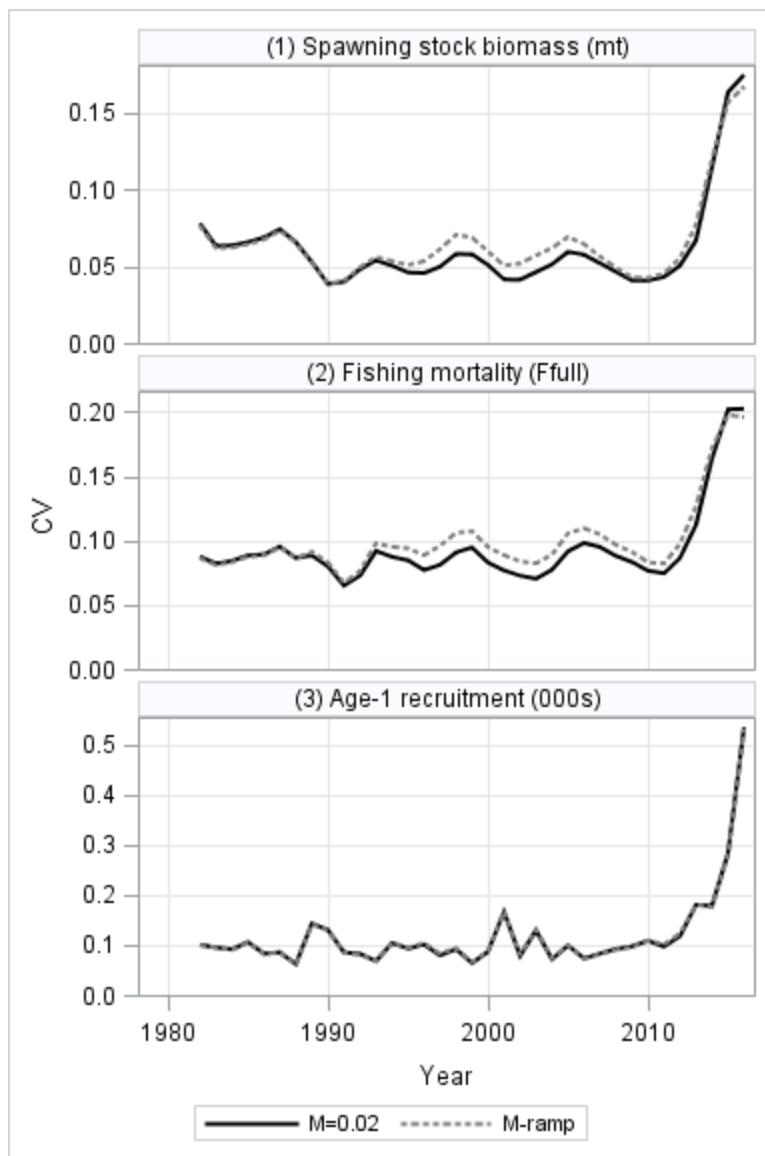


Figure 52. Coefficients of variation (CV) for the M=0.2 and M-ramp assessment model estimates of Gulf of Maine Atlantic cod spawning stock biomass, fully recruited fishing mortality and age-1 recruitment.

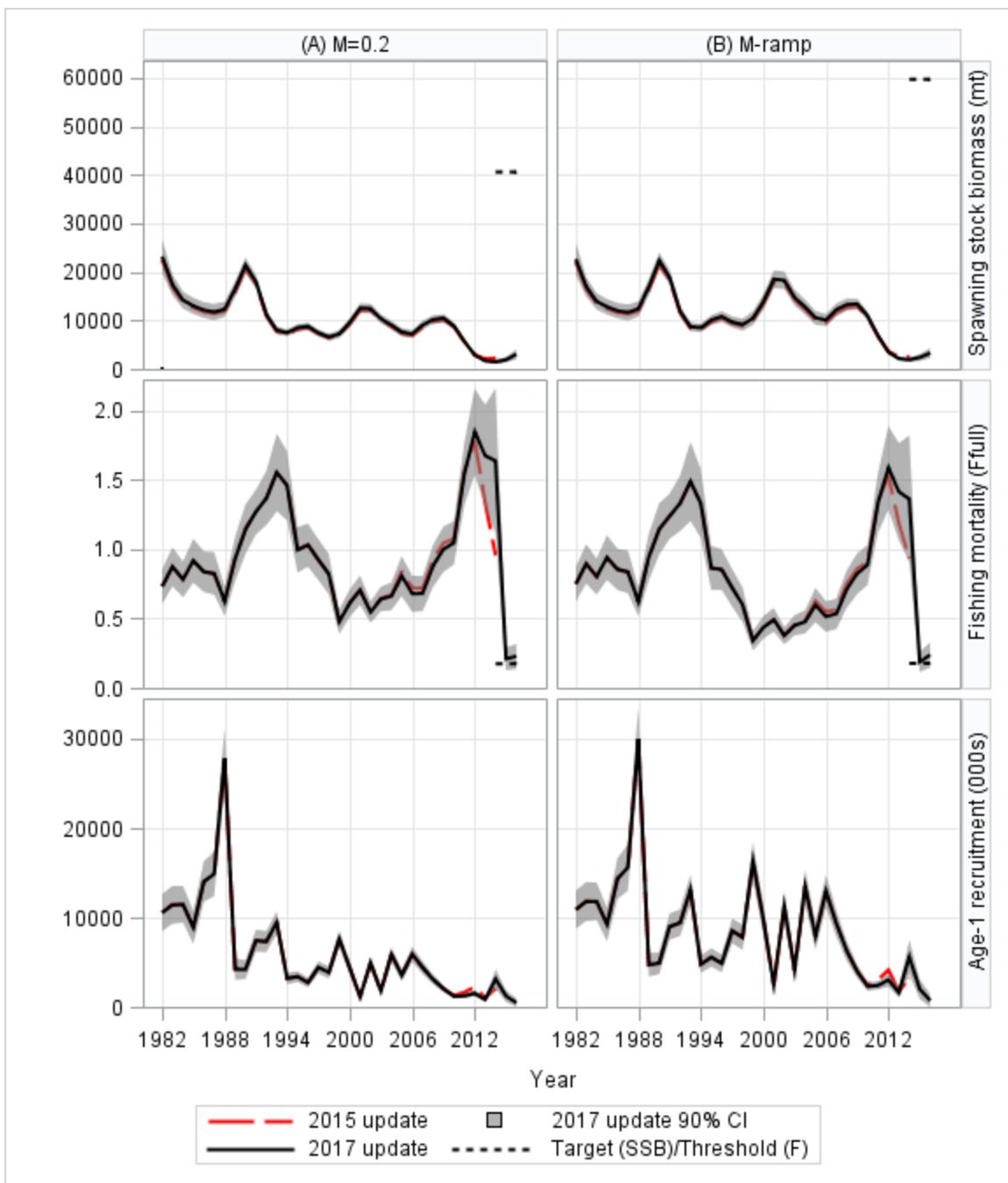


Figure 53. Estimated trends in the spawning stock biomass, fishing mortality and age-1 recruitment of Gulf of Maine Atlantic cod from 1982 to 2016 based on the M=0.2 (A) and M-ramp (B) model scenarios. The 2015 update results (NEFSC 2015) are shown in red for comparison.

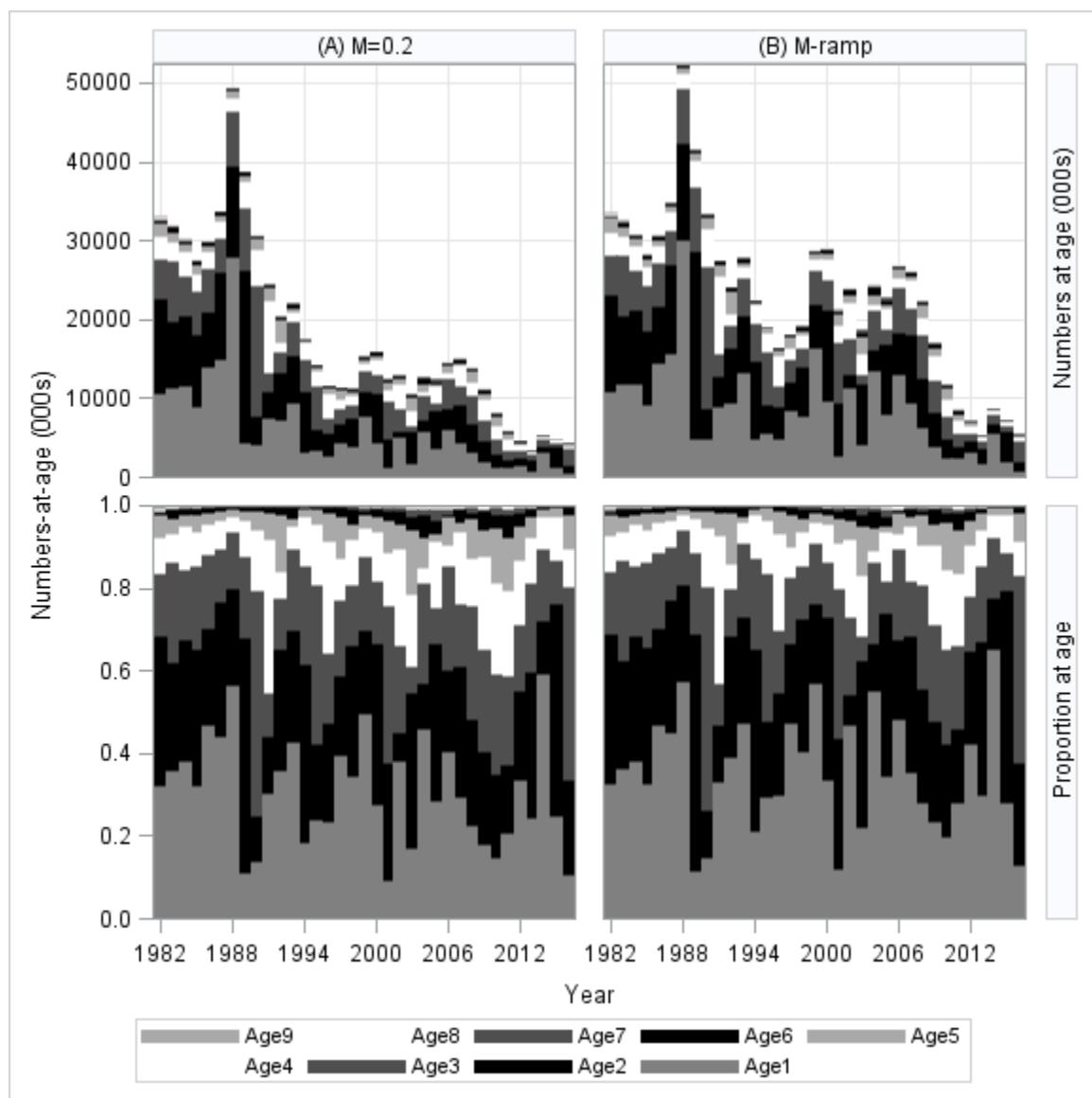


Figure 54. Model estimates of Gulf of Maine Atlantic cod numbers-at-age from 1982 to 2016 in absolute (top) numbers (000s) and relative (bottom) term for the M=0.2 and M-ramp models.

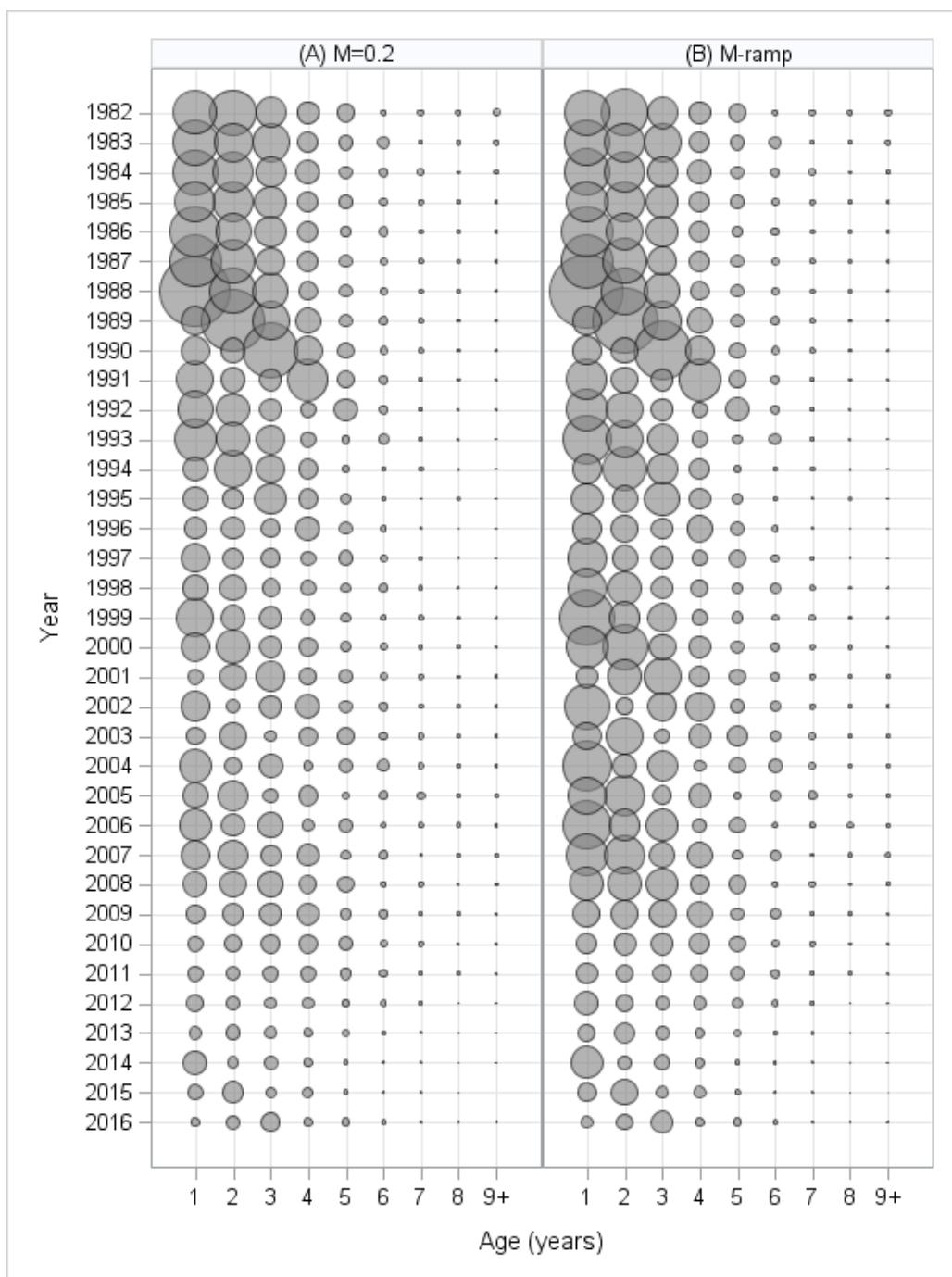


Figure 55. Estimated population numbers-at-age of Gulf of Maine Atlantic cod from 1982 to 2016 based on the M=0.2 (A) and M-ramp (B) model scenarios. *Note that the maximum age is a plus group.*

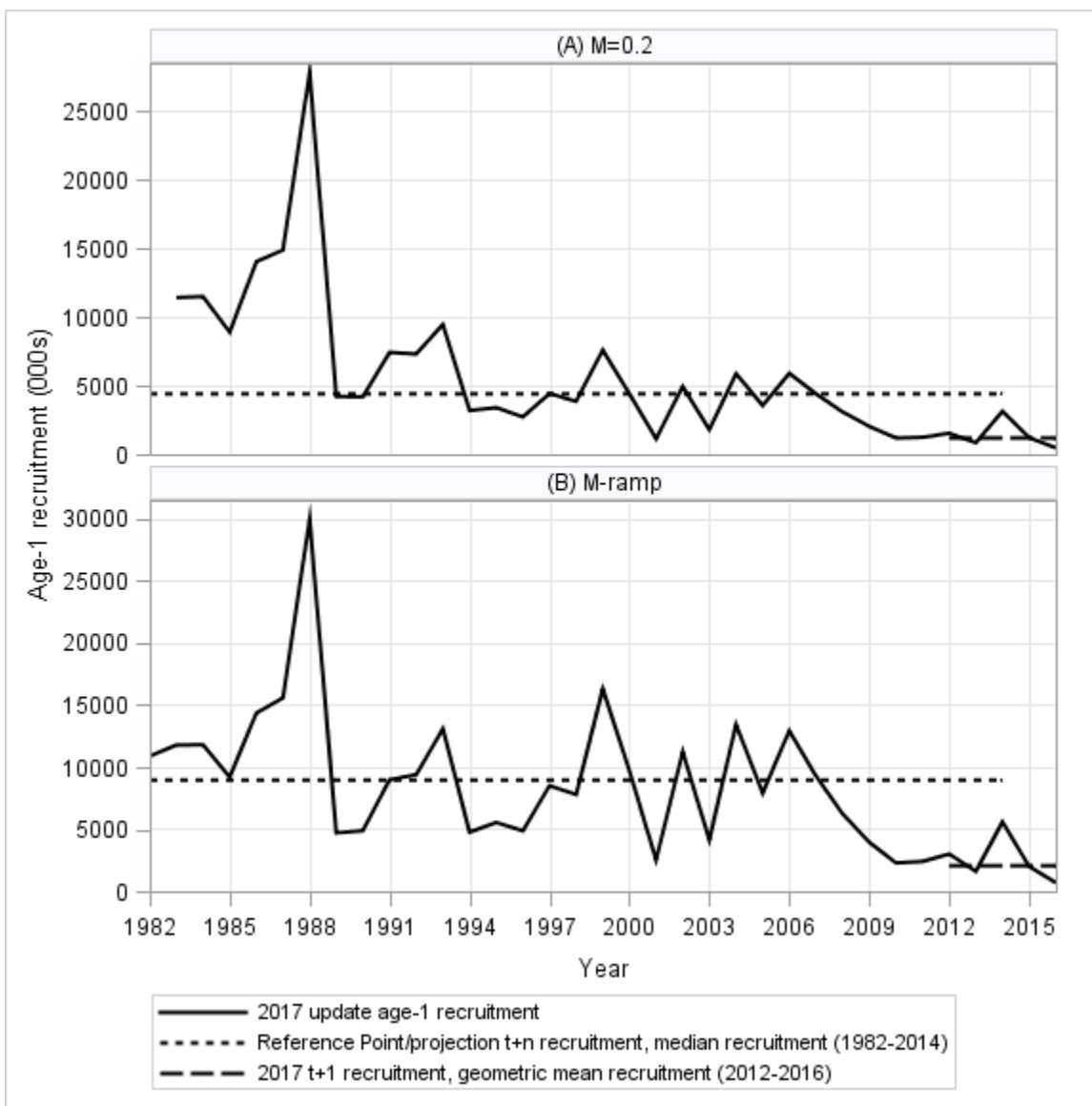


Figure 56. Comparison of the estimated Gulf of Maine Atlantic cod age-1 recruitment from 1982 to 2016 based on the M=0.2 (A) and M-ramp (B) model scenarios to the recruitment assumptions applied in the stock projections.

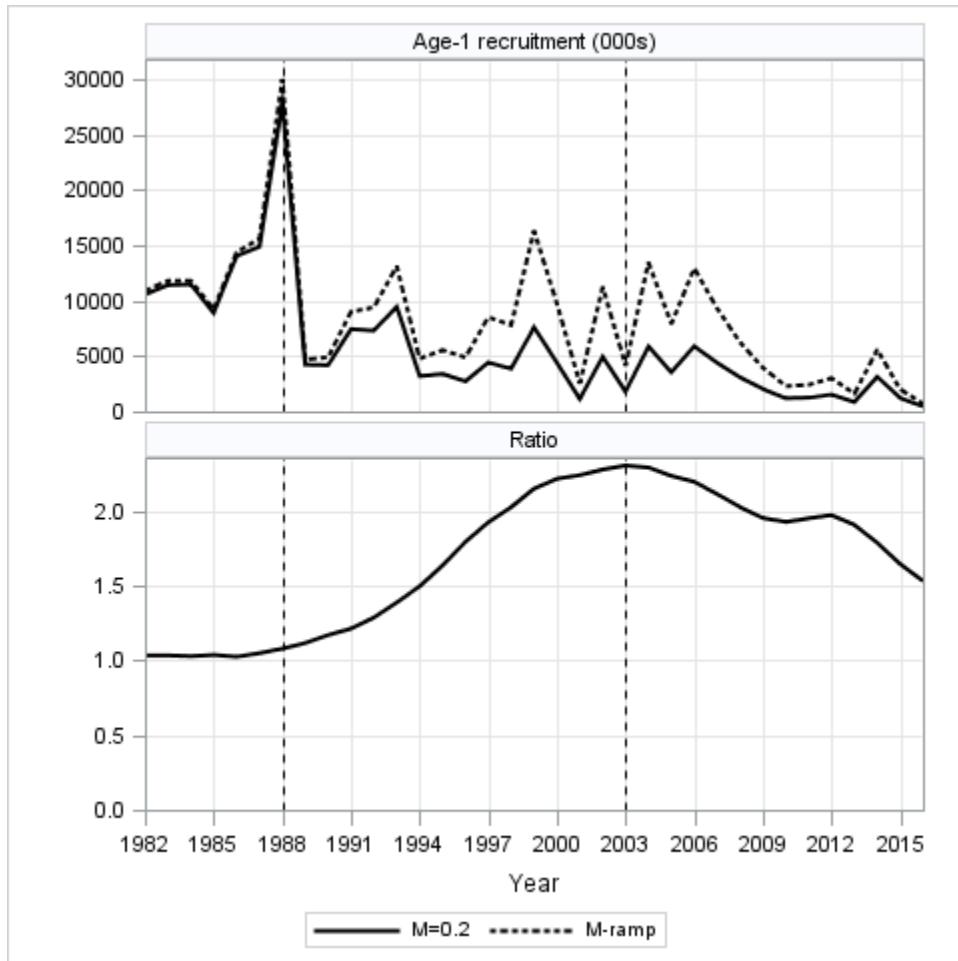


Figure 57. Comparison of the age-1 recruitment estimates from the Gulf of Maine Atlantic cod M=0.2 and M-ramp assessment models (top) and the ratio of the M-ramp to the M=0.2 estimated recruitment (bottom). The increased recruitment in the M-ramp model is a function of the increase in natural mortality from M=0.2 pre-1989 to M=0.4 post-2002.

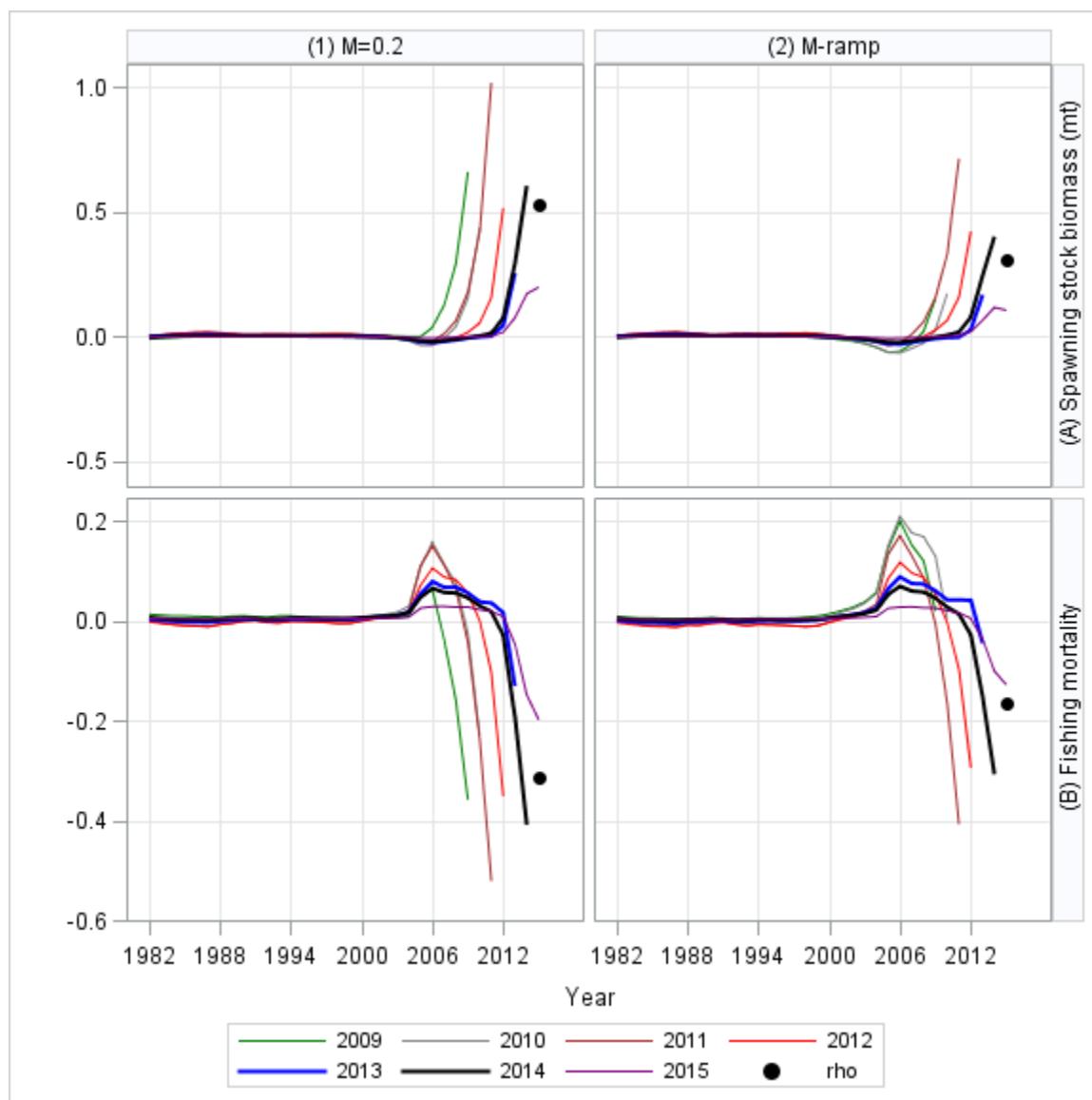


Figure 58. Relative model retrospective error for the Gulf of Maine Atlantic cod $M=0.2$ and M -ramp assessment models. The black circles indicate the Mohn's rho value based on a seven year retrospective peel.

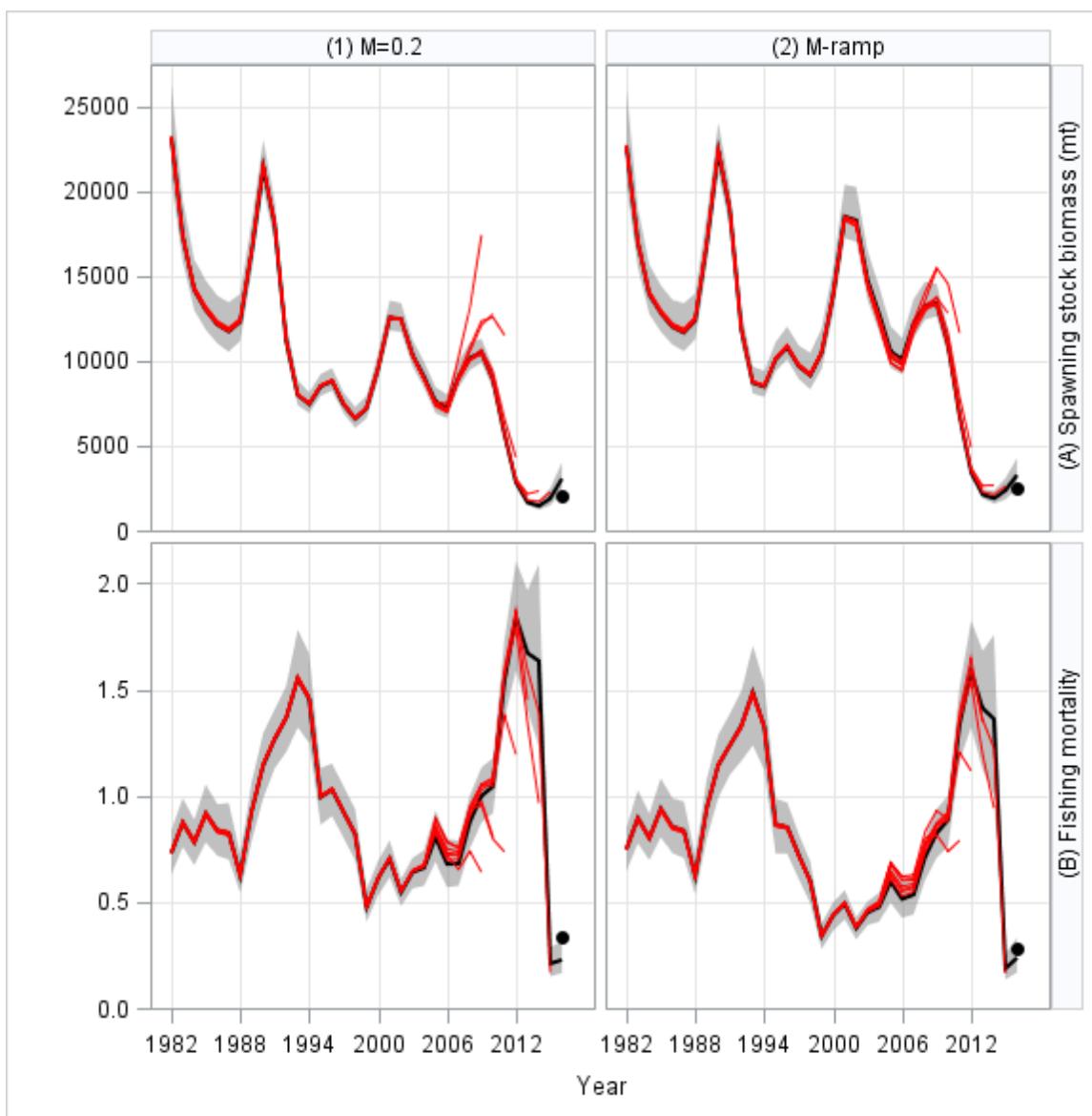


Figure 59. Model retrospective patterns (7-year peel) for sensitivity runs of the Gulf of Maine Atlantic cod M=0.2 and M-ramp assessment models. 90% posterior probability intervals of the terminal (2016) model run are indicated by the grey band and the rho adjusted value is indicated by the black circle.

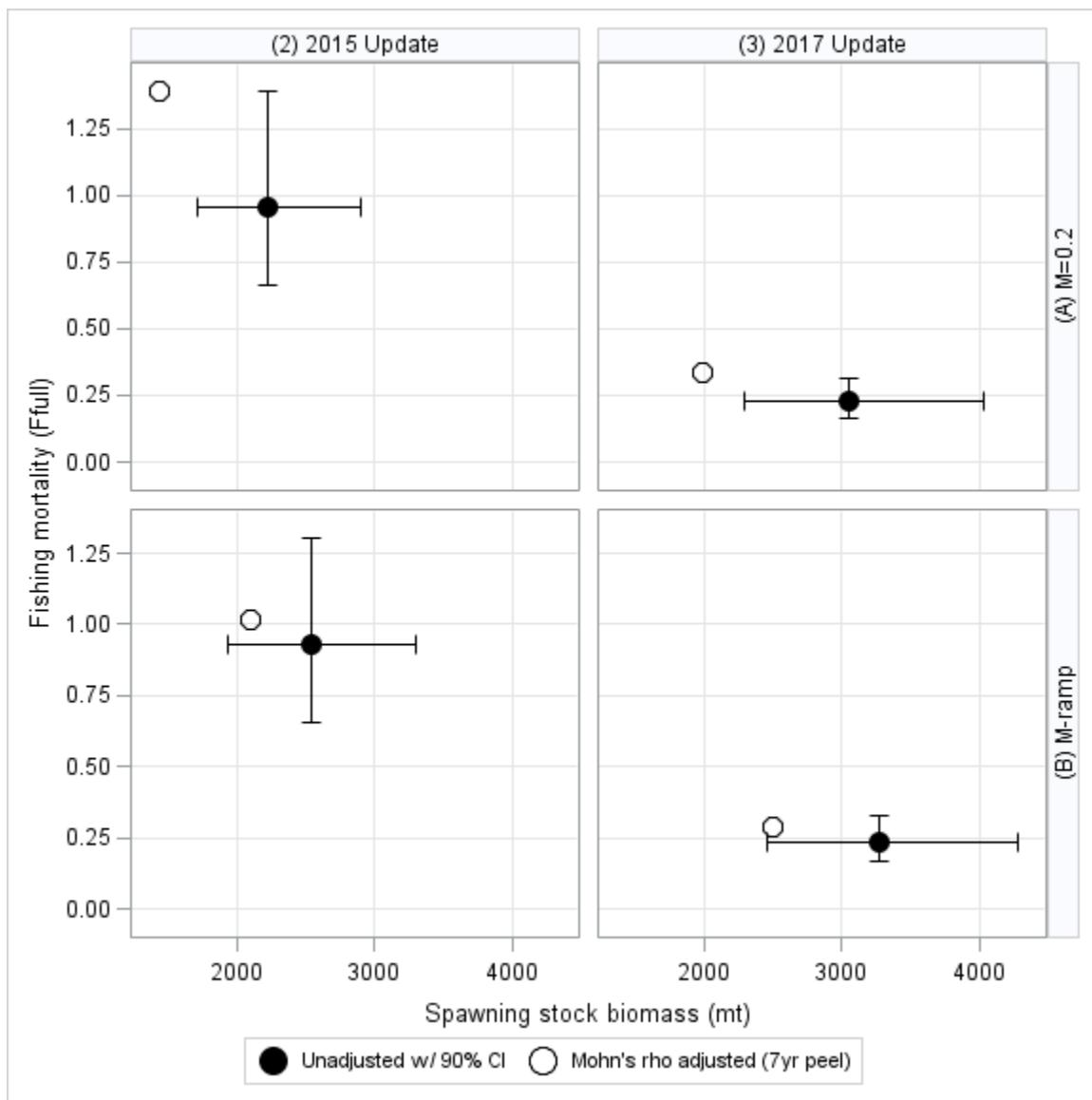


Figure 60. Cross plot of the Gulf of Maine Atlantic cod terminal (2014/2016) fully selected fishing mortality and spawning stock biomass for the M=0.2 and M-ramp models from both the 2015 (NEFSC 2015) and 2017 stock assessments updates. The error bars indicate the 90% posterior probability intervals on the terminal estimates. The rho adjusted value (7-year peel) is indicated by the open circle.

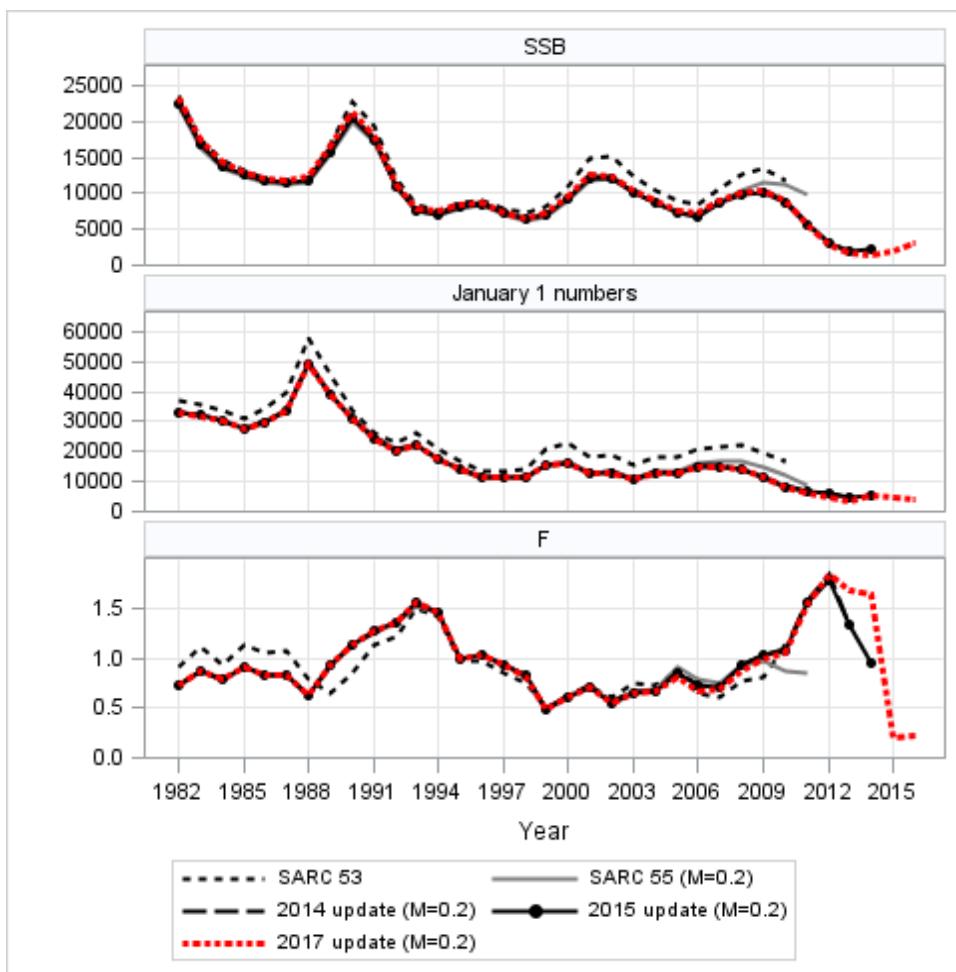


Figure 61. Historical model retrospective analysis comparing the model results (spawning stock biomass, January 1 population numbers and fishing mortality) of the SARC 53 (NEFSC 2011), SARC 55 (NEFSC 2013), 2014 update (Palmer 2014), 2015 update (NEFSC 2015), and 2017 update assessment of the Gulf of Maine Atlantic cod. Note that for the SARC 55, and 2014-2017 updates only the results for the $M=0.2$ model are shown to provide a direct comparison to the SARC 53 model results.

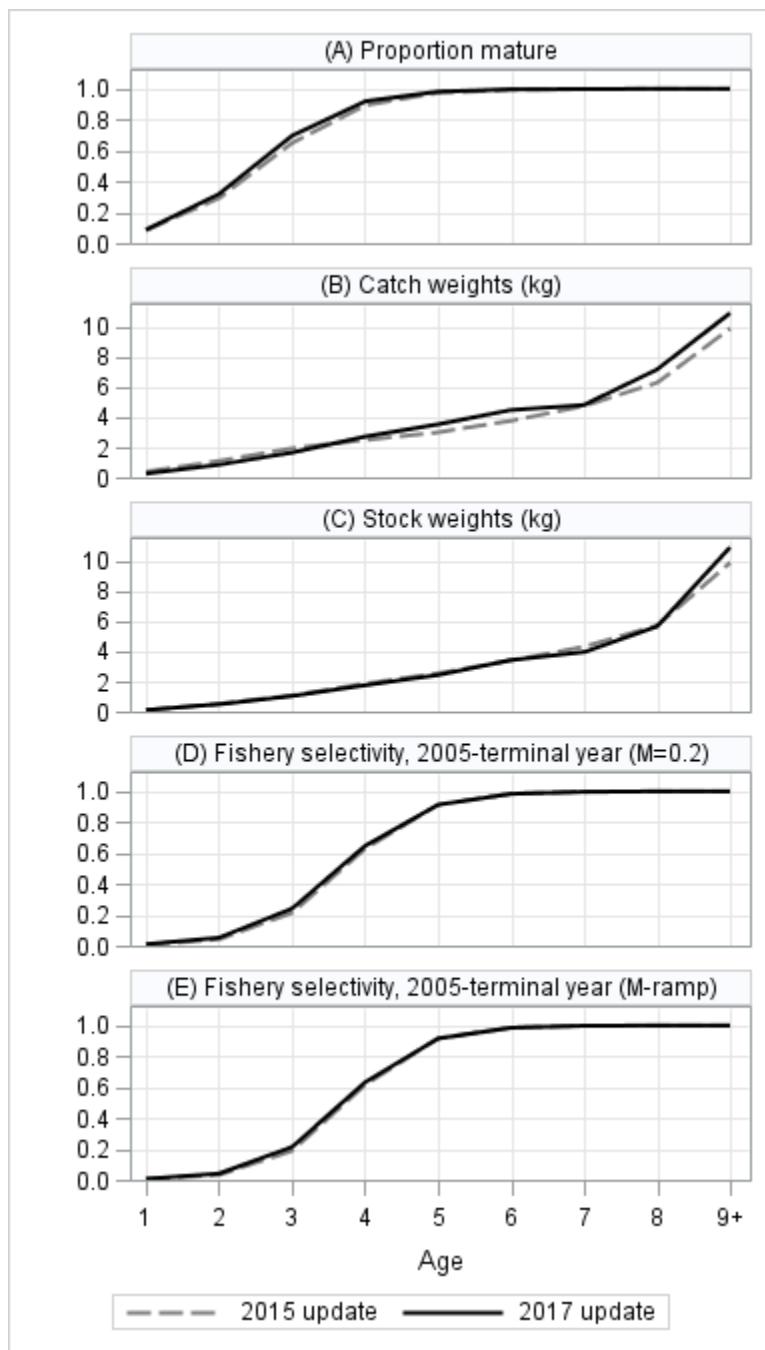


Figure 62. Comparison of the yield-per-recruit/projection inputs used for the 2015 (NEFSC 2015) and the current 2017 update of the Gulf of Maine Atlantic cod stock assessment.

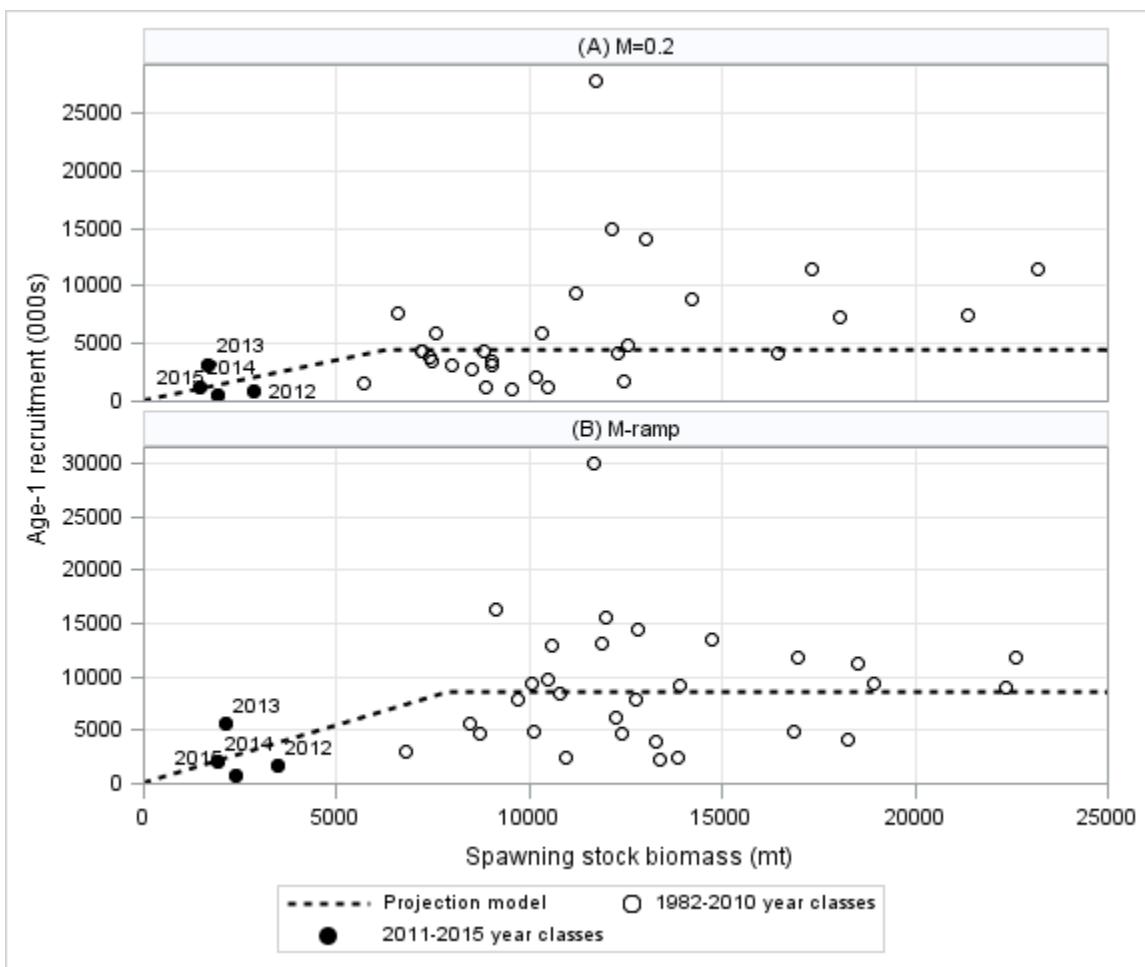


Figure 63. Scatterplot of Gulf of Maine Atlantic cod age-1 recruitment and spawning stock biomass as estimated from the M=0.2 and M-ramp models. The projection model used for the base projection model applies the same method as determined at SARC 55 (NEFSC 2013). The SSB hinge values are set at 6,300 mt for the M=0.2 model and 7,900 mt for the M-ramp model.