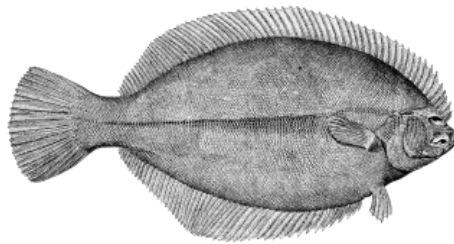


# **Gulf of Maine (GOM) Winter Flounder**

## **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**

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## Tables

Table 1. Winter flounder commercial landings (metric tons) for the Gulf of Maine stock (U.S. statistical reporting areas 511 to 515, 464 and 465. Landings from 1964-1977 is taken from SARC 21, 1982-1993 is estimated from the WODETS data, 1994-2016 is estimated using the trip based allocated AA tables.

Year	metric tons	Year	Metric tons
1964	1,081	1990	1,116
1965	665	1991	1,008
1966	785	1992	825
1967	803	1993	611
1968	864	1994	543
1969	975	1995	707
1970	1,092	1996	606
1971	1,113	1997	569
1972	1,085	1998	643
1973	1,080	1999	350
1974	885	2000	535
1975	1,181	2001	700
1976	1,465	2002	694
1977	2,161	2003	755
1978	2,194	2004	623
1979	2,021	2005	336
1980	2,437	2006	201
1981	2,407	2007	254
1982	2,793	2008	288
1983	2,096	2009	283
1984	1,699	2010	140
1985	1,582	2011	173
1986	1,188	2012	348
1987	1,140	2013	218
1988	1,250	2014	213
1989	1,253	2015	186
1990	1,116	2016	188

Table 2. Gulf of Maine winter flounder commercial landings (metric tons) by gear.

Year	Trawl	Shrimp	Gillnet	Other	Total
1982	2,485	151	59	99	2,793
1983	1,819	142	54	80	2,096
1984	1,438	139	26	96	1,699
1985	1,446	62	16	59	1,582
1986	912	69	164	42	1,188
1987	848	97	135	60	1,140
1988	1,016	61	161	12	1,250
1989	1,008	58	138	48	1,253
1990	857	25	214	21	1,116
1991	868	22	94	25	1,008
1992	632	17	160	16	825
1993	460	1	138	13	611
1994	438	0	100	5	543
1995	511	1	184	10	706
1996	464	0	135	6	606
1997	426	0	134	9	569
1998	461	0	176	6	643
1999	248	0	101	1	350
2000	412	0	122	1	535
2001	531	0	160	9	700
2002	596	0	82	15	694
2003	565	0	185	5	755
2004	427	0	137	59	623
2005	230	0	67	38	336
2006	133	0	47	21	201
2007	163	0	53	38	254
2008	196	0	57	35	288
2009	202	0	67	14	283
2010	83	0	49	7	139
2011	112	0	50	12	173
2012	248	0	57	43	348
2013	177	0	32	9	218
2014	145	0	27	41	213
2015	139	0	15	32	186
2016	102	0	27	59	188

Table 3. Estimated MRIP number (000's) and weight for Gulf of Maine winter flounder caught, landed, and discarded in the recreational fishery.

year	Numbers (000's)				Metric tons
	Catch	Landed	Released	15% Release	Landed
	A+B+B2	A+B1	B2	Mortality	A+B1
1981	6,200	5,433	767	115	2,554
1982	8,207	7,274	933	140	1,876
1983	2,169	1,988	181	27	868
1984	2,477	2,285	191	29	1,300
1985	3,694	3,220	474	71	1,896
1986	946	691	255	38	523
1987	3,070	2,391	679	102	1,809
1988	953	841	111	17	345
1989	1,971	1,678	294	44	620
1990	786	652	134	20	370
1991	213	154	59	9	91
1992	186	137	48	7	90
1993	398	249	150	22	140
1994	232	145	88	13	83
1995	150	83	67	10	40
1996	183	98	86	13	56
1997	192	64	129	19	43
1998	109	65	44	7	30
1999	109	65	44	7	33
2000	146	59	87	13	32
2001	173	72	102	15	45
2002	101	61	40	6	42
2003	86	52	34	5	32
2004	62	46	16	2	29
2005	82	40	42	6	23
2006	75	50	25	4	34
2007	75	49	26	4	28
2008	249	179	70	10	124
2009	190	97	94	14	60
2010	154	88	65	10	40
2011	138	80	58	9	37
2012	66	47	19	3	22
2013	64	44	20	3	29
2014	150	95	55	8	55
2015	79	45	34	5	27
2016	192	40	15	2	24

Table 4. Gulf of Maine winter flounder estimated large mesh trawl, shrimp and gillnet discard ratios (discard/sum all species kept), estimated discard CVs, and estimated discards in metric tons.

Discard Ratio				CV			Metric Tons		
year	trawl		gillnet	trawl		gillnet	trawl		gillnet
	lg mesh	shrimp		lg mesh	shrimp		lg mesh	shrimp	
2004	0.0022	0.0035	0.0011	0.28	0.27	0.27	60.61	3.83	7.65
2005	0.0025	0.0063	0.0003	0.27	0.41	0.22	46.95	5.52	2.21
2006	0.0019	0.0012	0.0001	0.32	0.33	0.42	20.89	1.49	0.85
2007	0.0032	0.0010	0.0002	0.33	0.33	0.39	29.73	2.08	1.33
2008	0.0015	0.0018	0.0002	0.24	0.26	0.43	17.12	3.40	1.76
2009	0.0015	0.0046	0.0003	0.19	0.33	0.29	16.19	5.62	2.31
2010	0.0004	0.0016	0.0001	0.26	0.42	0.16	4.80	5.61	0.82
2011	0.0005	0.0001	0.0001	0.11	0.00	0.09	5.95	0.36	0.90
2012	0.0013	0.0008	0.0002	0.11	0.29	0.08	17.08	1.41	1.16
2013	0.0009	0.0070	0.0001	0.17	0.32	0.18	9.74	1.36	0.45
2014	0.0009	0.0000	0.0001	0.28	0.00	0.15	9.61	0.00	0.42
2015	0.0003	0.0000	0.0001	0.18	0.00	0.23	3.17	0.00	0.18
2016	0.0006	0.0000	0.0001	0.27	0.00	0.33	5.35	0.00	0.33

Table 5. Gulf of Maine winter flounder composition of the catch by weight (mt). A 50% mortality rate is assumed on gillnet, large mesh, and shrimp discards while a 15% mortality rate is assumed on recreational discards.

year	Landings		Discards				Total
	recreational	commercial	recreational	gillnet	lg mesh	shrimp	
1981	2,270						
1982	3,024	2,793	11		343	7	6,178
1983	817	2,096	2		112	8	3,035
1984	1,103	1,699	3		67	12	2,883
1985	1,629	1,582	8		93	14	3,327
1986	411	1,188	5	12	63	16	1,696
1987	1,443	1,140	12	12	81	25	2,713
1988	537	1,250	2	12	106	19	1,927
1989	1,035	1,253	6	4	11	5	2,315
1990	344	1,116	3	22	5	21	1,511
1991	86	1,008	1	3	17	21	1,136
1992	77	825	1	12	7	24	947
1993	134	611	3	19	4	7	777
1994	77	543	2	6	6	6	640
1995	40	707	1	12	8	8	777
1996	52	606	2	6	2	7	675
1997	32	569	3	38	5	14	660
1998	27	643	1	7	7	4	690
1999	34	350	1	4	9	1	399
2000	31	535	2	12	3	3	587
2001	37	700	3	3	14	2	759
2002	35	694	1	5	17	0	752
2003	29	755	1	3	13	2	803
2004	29	623	1	4	30	2	689
2005	23	336	2	1	23	3	388
2006	34	201	1	0	10	1	248
2007	28	254	1	1	15	1	300
2008	124	288	3	1	9	2	426
2009	60	283	4	1	8	3	359
2010	40	140	3	0	2	3	188
2011	38	173	4	0	3	0	219
2012	22	348	1	1	9	1	381
2013	29	218	1	0	5	1	254
2014	55	213	2	0	5	0	275
2015	27	186	1	0	2	0	217
2016	24	188	6	0	3	0	221

Table 6. NEFSC and MDMF survey indices of abundance for Gulf of Maine winter flounder. Indices are stratified mean number and mean weight (kg) per tow. NEFSC indices are for inshore strata (58,59,60,61,65,66) and offshore strata (26,27,38,39,40). NEFSC indices are calculated with trawl door conversion factors where appropriate. NEFSC GOM length based Bigelow conversions were applied from 2009-2016. NEFSC fall 2010 (bold) did not sample Cape Cod Bay. NEFSC indices use SHG (136; prior 2009) and TOGA (132x; post 2008) for the tow evaluation criteria. MDMF indices use SHG (136) tow evaluation criteria for all years.

year	NEFSC spring		NEFSC fall		MA spring		MA fall	
	number	weight	number	weight	number	weight	number	weight
1978					98.26	20.43	57.45	12.22
1979	4.49	1.73	6.00	2.60	71.83	15.79	134.25	32.84
1980	5.59	2.39	13.14	6.55	72.14	19.11	83.81	17.87
1981	6.46	2.12	4.18	3.03	106.34	30.38	50.85	13.60
1982	7.67	3.02	4.20	1.92	61.61	14.71	108.20	24.42
1983	12.37	5.65	10.30	3.52	112.49	28.98	76.66	15.14
1984	5.15	1.98	7.73	3.11	68.95	16.72	39.54	12.21
1985	3.47	1.42	7.64	2.32	54.21	15.30	48.68	8.29
1986	2.34	1.00	2.50	0.94	68.98	16.35	44.65	6.92
1987	5.61	1.50	1.61	0.49	85.18	18.64	54.43	8.02
1988	6.90	1.65	3.00	1.03	54.04	11.27	38.42	8.24
1989	3.72	1.32	6.40	2.01	64.70	13.94	39.25	8.60
1990	5.42	2.25	3.53	1.18	82.13	14.38	67.66	13.22
1991	4.52	1.44	7.04	1.47	46.63	11.51	103.42	17.91
1992	3.93	1.16	10.45	3.10	79.00	15.36	87.58	15.09
1993	1.56	0.35	7.56	1.86	78.02	12.05	93.53	15.11
1994	3.48	0.89	4.87	1.32	72.58	9.78	67.79	13.25
1995	12.19	3.15	4.77	1.45	89.36	14.96	76.74	15.09
1996	2.74	0.73	10.10	3.12	70.49	12.08	77.01	13.14
1997	2.81	0.67	10.01	2.95	85.40	12.96	78.40	14.44
1998	2.00	0.53	3.22	0.99	77.77	13.47	98.45	15.45
1999	6.51	1.98	10.92	3.27	80.78	14.96	125.74	23.20
2000	10.38	2.89	12.70	5.07	162.19	34.16	99.95	25.10
2001	5.24	1.66	8.79	3.13	89.74	24.51	81.07	17.74
2002	12.07	3.69	10.69	4.00	91.08	22.39	65.81	16.26
2003	7.84	2.54	10.18	4.31	83.69	17.32	90.48	15.80
2004	3.88	1.10	2.76	0.87	79.11	11.20	107.59	14.09
2005	6.92	2.06	8.81	2.31	94.04	11.98	78.59	11.81
2006	4.17	1.21	7.12	2.35	85.55	14.43	86.98	15.46
2007	2.50	0.72	6.38	1.82	53.58	10.06	76.67	11.60
2008	11.54	2.18	13.32	4.69	46.86	8.42	90.92	18.09
2009	7.80	1.68	13.16	3.16	71.32	12.28	109.00	22.68
2010	5.00	1.18	<b>15.82</b>	<b>3.31</b>	68.23	13.68	104.67	18.61
2011	3.34	0.77	9.87	2.61	66.49	9.13	152.61	25.43
2012	7.96	1.67	8.12	1.85	71.54	10.88	83.23	14.09
2013	5.63	1.19	4.53	1.29	58.52	10.41	47.84	9.61
2014	7.88	1.69	6.73	2.01	30.88	5.35	65.67	10.06
2015	5.54	1.41	8.08	2.00	88.72	10.29	124.5	18.4
2016	10.33	2.27	8.31	1.96	172.25	18.827	78.1	15.4
2017	6.44	1.39			71.315	11.926		

Table 7. Survey total area coverage, average tow footprint, expansion factors, tow duration and average numbers per tow for non-overlapping strata used in the combined estimate.

	<b>Combined Survey Estimate</b>		
	<b>NEFSC</b>	<b>MDMF</b>	<b>MENH</b>
<b>survey area (nm2)</b>	<b>2,990</b>	<b>309</b>	<b>3,475</b>
<b>Avg tow (wing area swept)</b>	<b>0.00700</b>	<b>0.00385</b>	<b>0.00462</b>
<b>Total area/tow footprint</b>	<b>427,143</b>	<b>80,343</b>	<b>752,154</b>
<b>Tow duration</b>	<b>20 min</b>	<b>20 min</b>	<b>20 min</b>
<b>Numbers per tow</b>	<b>34-65</b>	<b>80</b>	<b>35</b>



Table 8. Survey total area coverage, average tow footprint, kg/tow expansion factors and tow duration for the different surveys and survey non overlapping components (NEFSC combined, MDMF near shore, MENH state waters). NEFSC combined (offshore (39,40,26) = 2322 nm<sup>2</sup> + NEFSC inshore overlap (59,60,61,64,65,66) = 668 nm<sup>2</sup>), MDMF overlap (27,28,29,30,34,35,36) = 484 nm<sup>2</sup>, MDMF near shore (25,26,31,32,33) = 309 nm<sup>2</sup>.

A. Wing spread							
	NEFSC (Bigelow)			Gloria Michele (MDMF)			MENH
	inshore				near		state
	overlap	Fall 2010	combined	overlap	Fall 2010	shore	waters
survey area (nm2)	668	2,638	2,990	484	633	309	3,475
Avg tow (area swept)	0.0070	0.0070	0.0070	0.0038	0.0038	0.0038	0.0046
Total area/tow footprint	95,429	376,857	427,143	125,845	164,587	80,343	752,165
Tow duration	20 min	20 min	20 min	20 min	20 min	20 min	20 min
B. Door spread							
	NEFSC (Bigelow)			Gloria Michele (MDMF)			MENH
	inshore				near		state
	overlap	Fall 2010	combined	overlap	Fall 2010	shore	waters
survey area (nm2)	668	2,638	2,990	484	633	309	3,475
Avg tow (area swept)	0.0173	0.0173	0.0173	0.0125	0.0125	0.0125	0.0123
Total area/tow footprint	38,657	152,662	173,032	38,758	50,690	24,744	282,469
Tow duration	20 min	20 min	20 min	20 min	20 min	20 min	20 min

Table 9. Total estimated 30+ cm biomass (mt) based on wing spread. Catch estimates of FMSY and 75%FMSY catch (mt) for the combined survey estimated for spring 2009 to 2017 and fall 2009 to 2016 using a q assumption of 0.866 (Miller et al., 2017) and the SARC 52 q=0.6 assumption are shown. The proportion of the 30+cm biomass in each survey area is also shown. Note; NENH spring 2017 was not available. \* Fall 2010 estimate is based on a different strata set since the NEFSC fall survey did not cover Cape Cod bay strata.

Q=0.87	30+ Biomass proportion			Total 30+ biomass	FMSY	75%FMSY
	NEFSC	MDMF	MENH			
Spring 2009	0.56	0.25	0.19	3,709	853	640
Spring 2010	0.45	0.33	0.21	2,996	689	517
Spring 2011	0.40	0.33	0.28	1,773	408	306
Spring 2012	0.66	0.21	0.13	2,698	620	465
Spring 2013	0.51	0.33	0.16	2,230	513	385
Spring 2014	0.58	0.12	0.30	2,924	673	504
Spring 2015	0.54	0.21	0.25	2,750	632	474
Spring 2016	0.49	0.24	0.27	3,397	781	586
Spring 2017	0.60	0.40	NA	1,774	408	306
Fall 2009	0.90	0.06	0.03	5,274	1213	910
Fall 2010*	0.69	0.26	0.05	4,393	1010	758
Fall 2011	0.81	0.14	0.05	4,618	1062	797
Fall 2012	0.82	0.09	0.09	2,312	532	399
Fall 2013	0.73	0.11	0.16	2,032	467	350
Fall 2014	0.88	0.07	0.05	3,225	742	556
Fall 2015	0.77	0.17	0.06	2,307	531	398
Fall 2016	0.86	0.09	0.05	2,585	595	446
Q=0.6	30+ Biomass Proportion			Total 30+ biomass	FMSY	75%FMSY
	NEFSC	MDMF	MENH			
Spring 2009	0.56	0.25	0.19	5,354	1231	924
Spring 2010	0.45	0.33	0.21	4,324	995	746
Spring 2011	0.40	0.33	0.28	2,559	589	442
Spring 2012	0.66	0.21	0.13	3,894	896	672
Spring 2013	0.51	0.33	0.16	3,219	740	555
Spring 2014	0.58	0.12	0.30	4,221	971	728
Spring 2015	0.54	0.21	0.25	3,969	913	685
Spring 2016	0.49	0.24	0.27	4,903	1128	846
Spring 2017	0.60	0.40	NA	2,560	589	442
Fall 2009	0.90	0.06	0.03	7,612	1751	1313
Fall 2010*	0.69	0.26	0.05	6,341	1458	1094
Fall 2011	0.81	0.14	0.05	6,666	1533	1150
Fall 2012	0.82	0.09	0.09	3,337	768	576
Fall 2013	0.73	0.11	0.16	2,932	674	506
Fall 2014	0.88	0.07	0.05	4,655	1071	803
Fall 2015	0.77	0.17	0.06	3,330	766	574
Fall 2016	0.86	0.09	0.05	3,731	858	644

## Figures

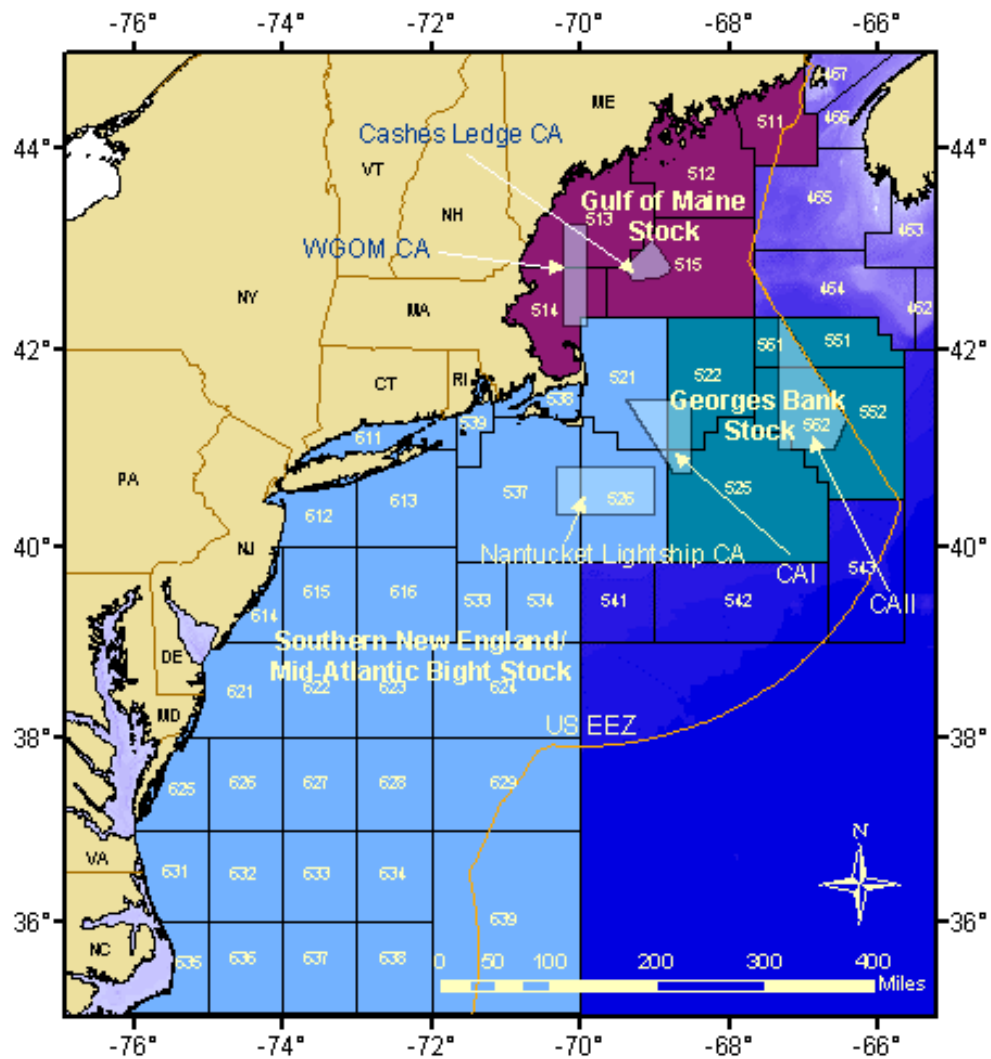


Figure 1. Statistical areas used to define winter flounder stocks. The Gulf of Maine stock includes area 511-515.

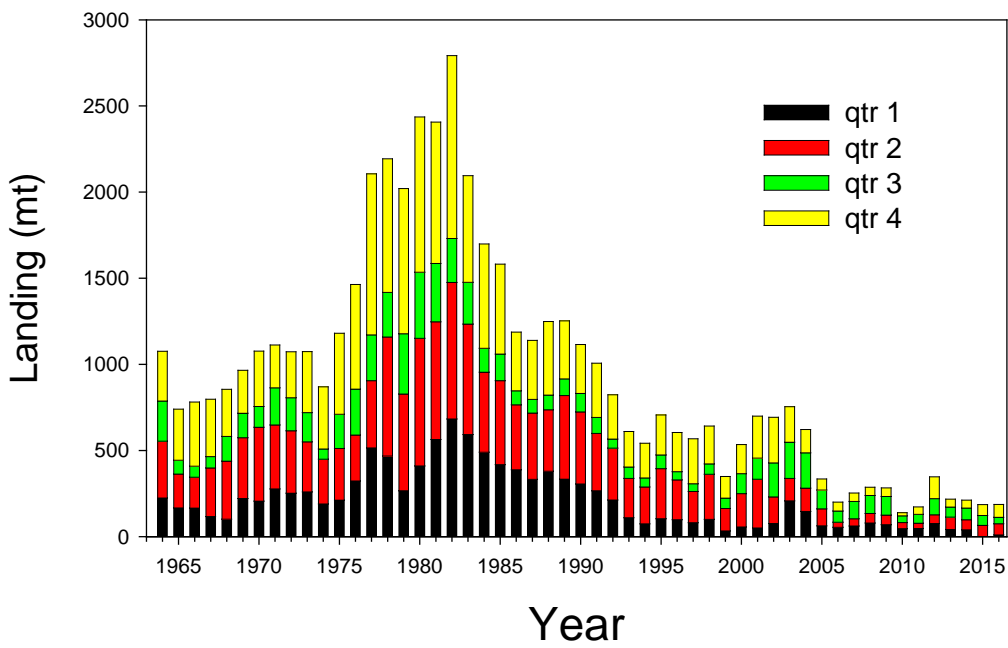
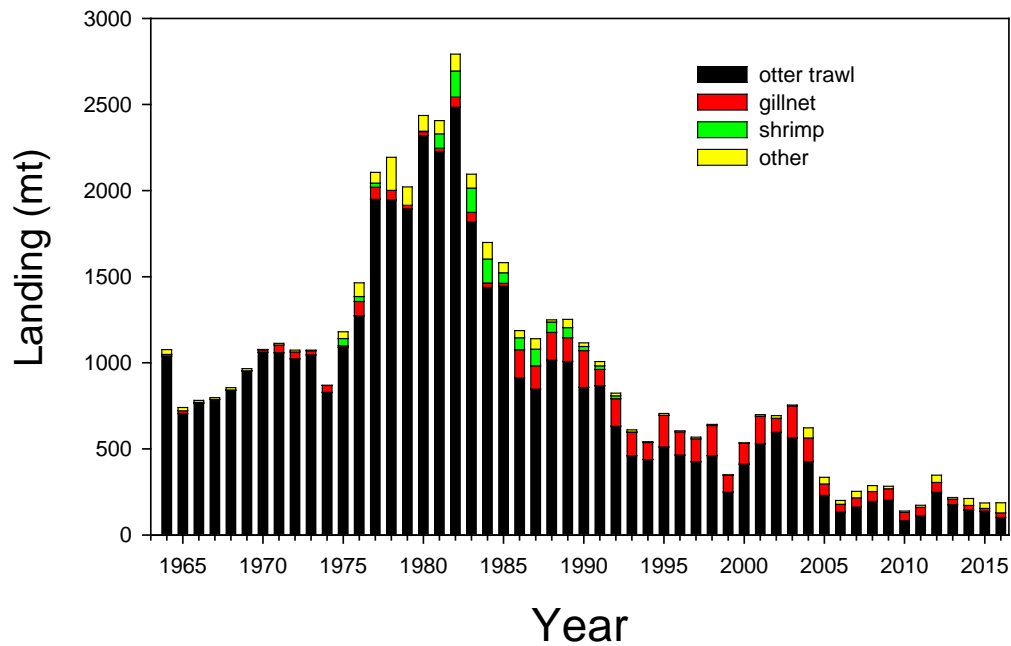


Figure 2. Gulf of Maine winter flounder commercial landings by gear (top) and quarter (bottom) 1964-2016.

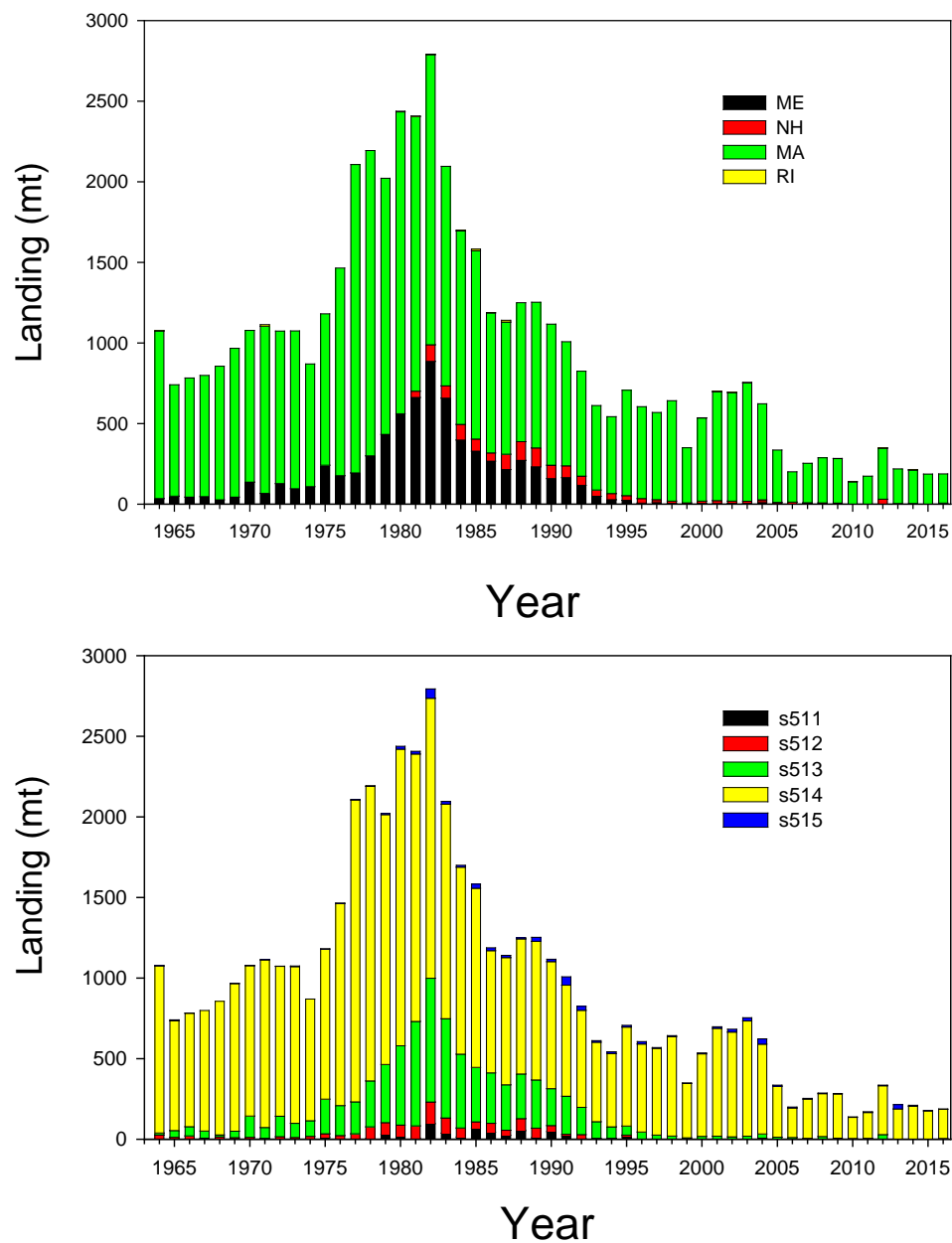


Figure 3. Gulf of Maine winter flounder commercial landings by state (top) and statistical area (bottom) 1964-2016.

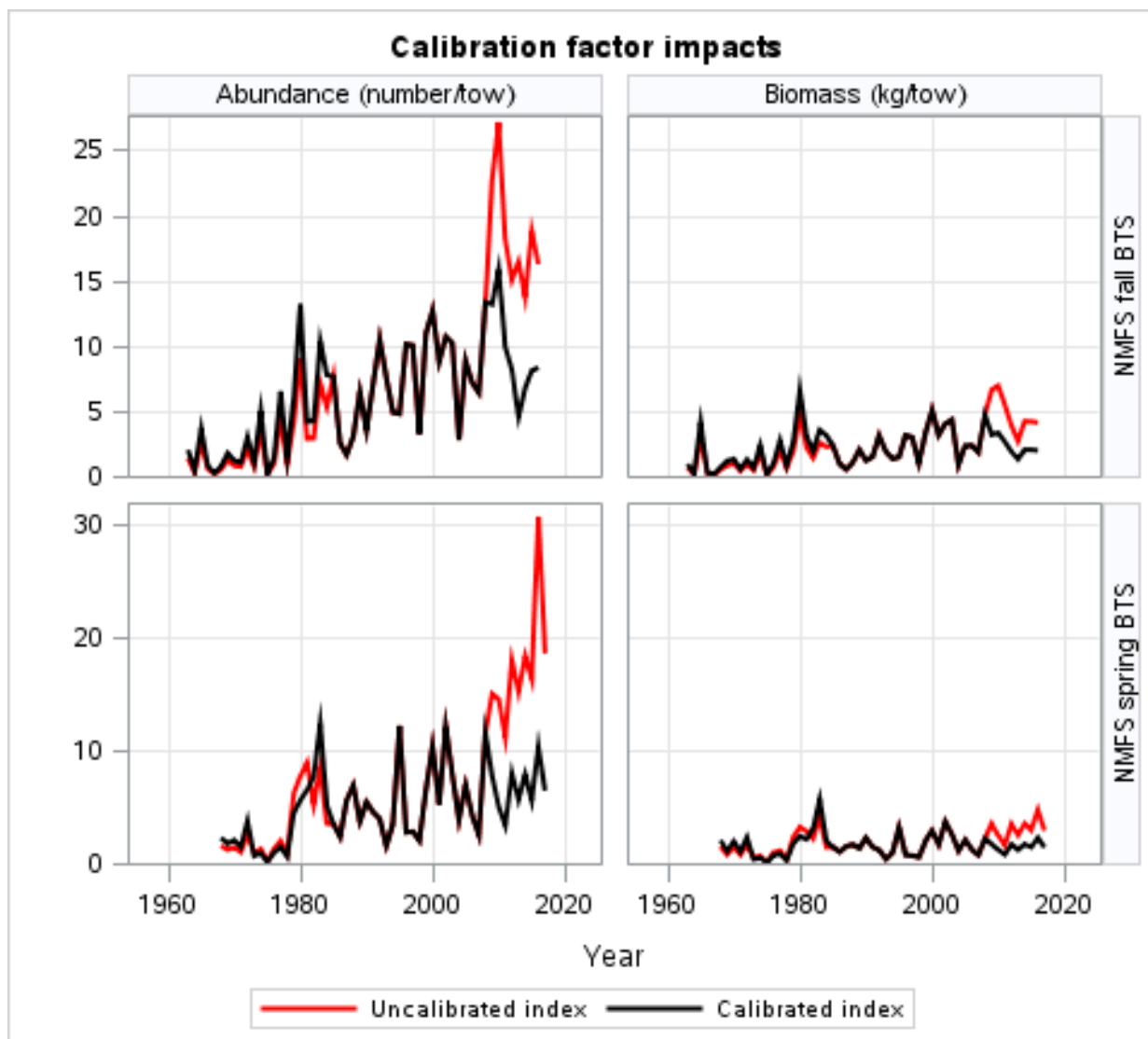


Figure 4. NEFSC calibrated and uncalibrated spring and fall survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder. Trawl door and F/V Bigelow conversion factors are for calibrated indices.

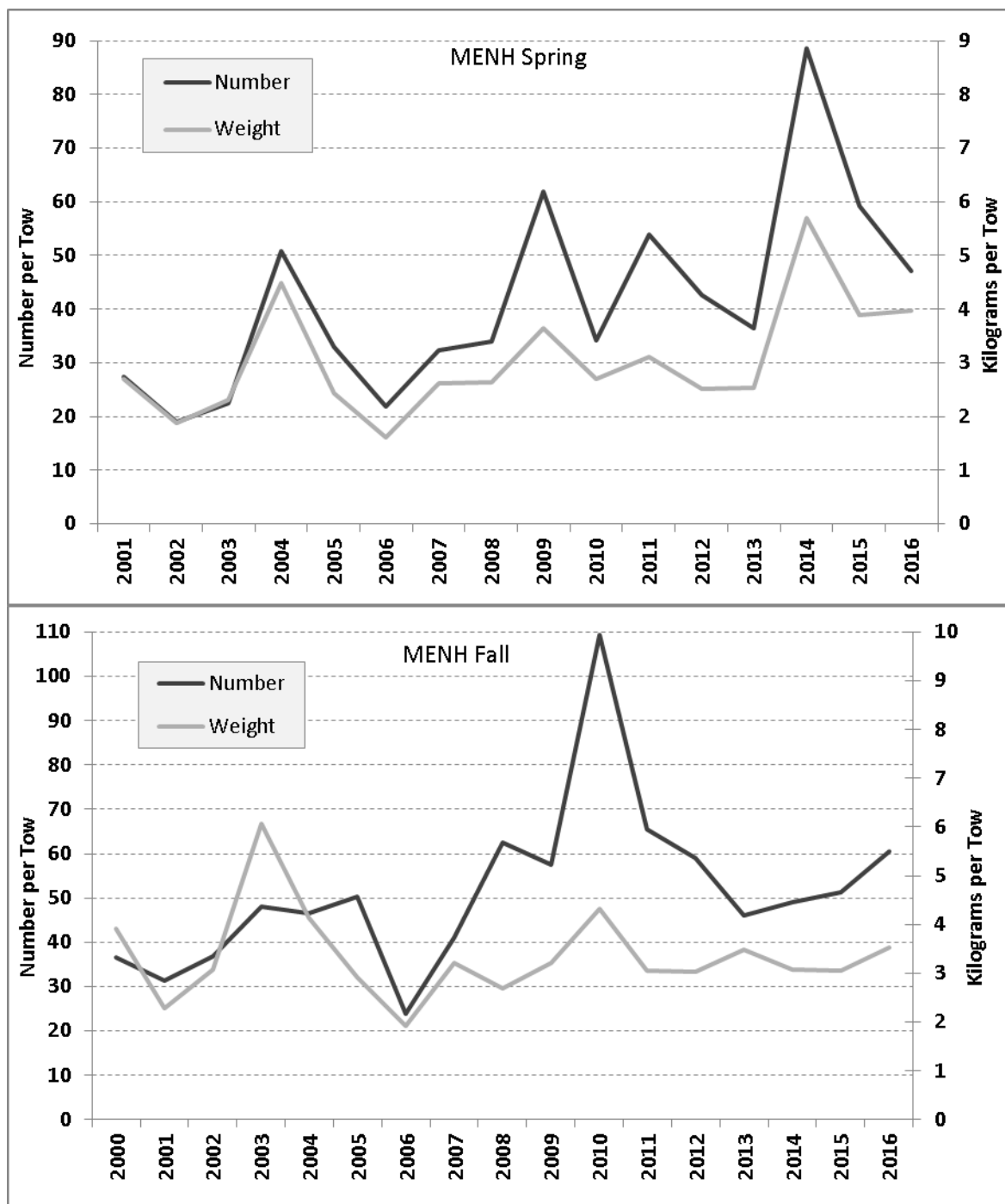


Figure 5. MENH spring and fall survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder.

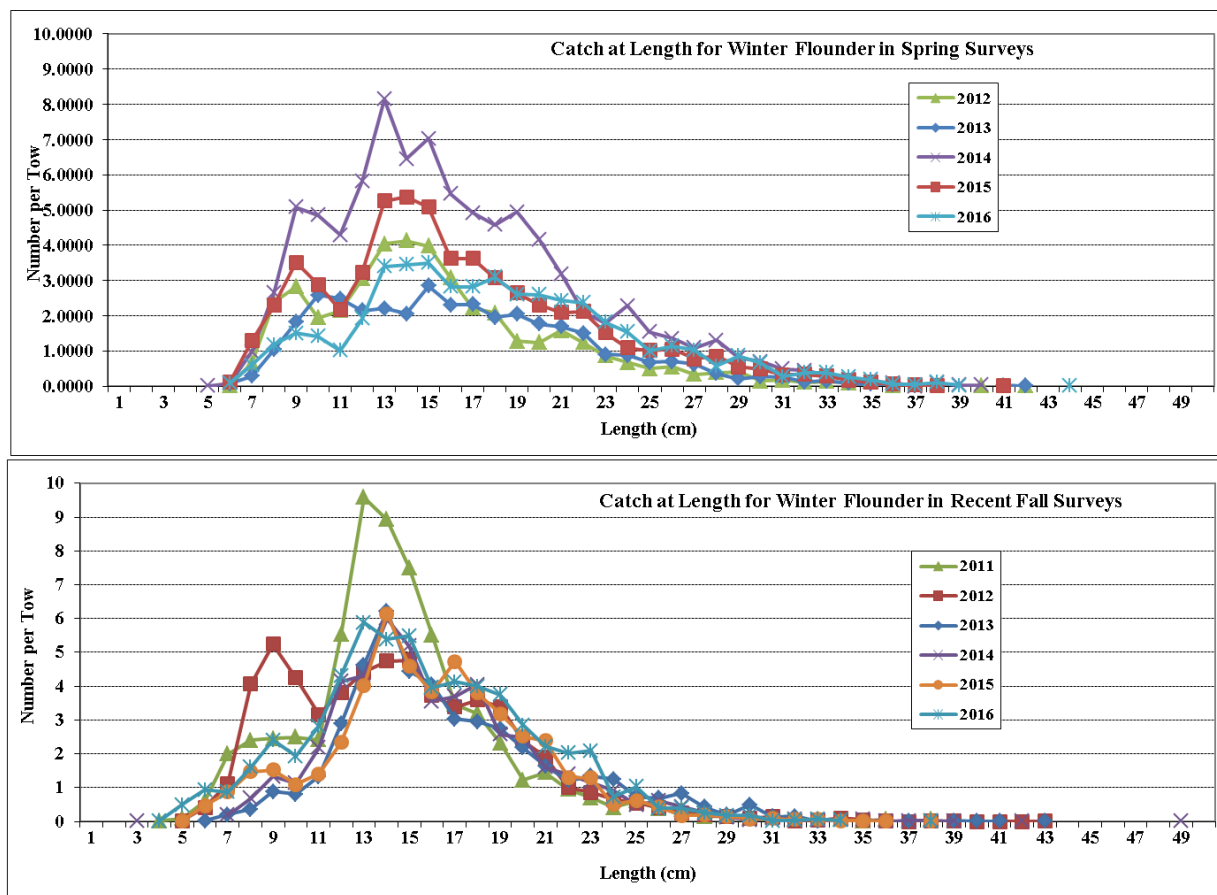


Figure 6. Numbers per tow at length from the inshore MENH survey. Relatively few fish 30 cm and greater are caught in the MENH survey.



## Combined Surveys 30+ Biomass Estimate

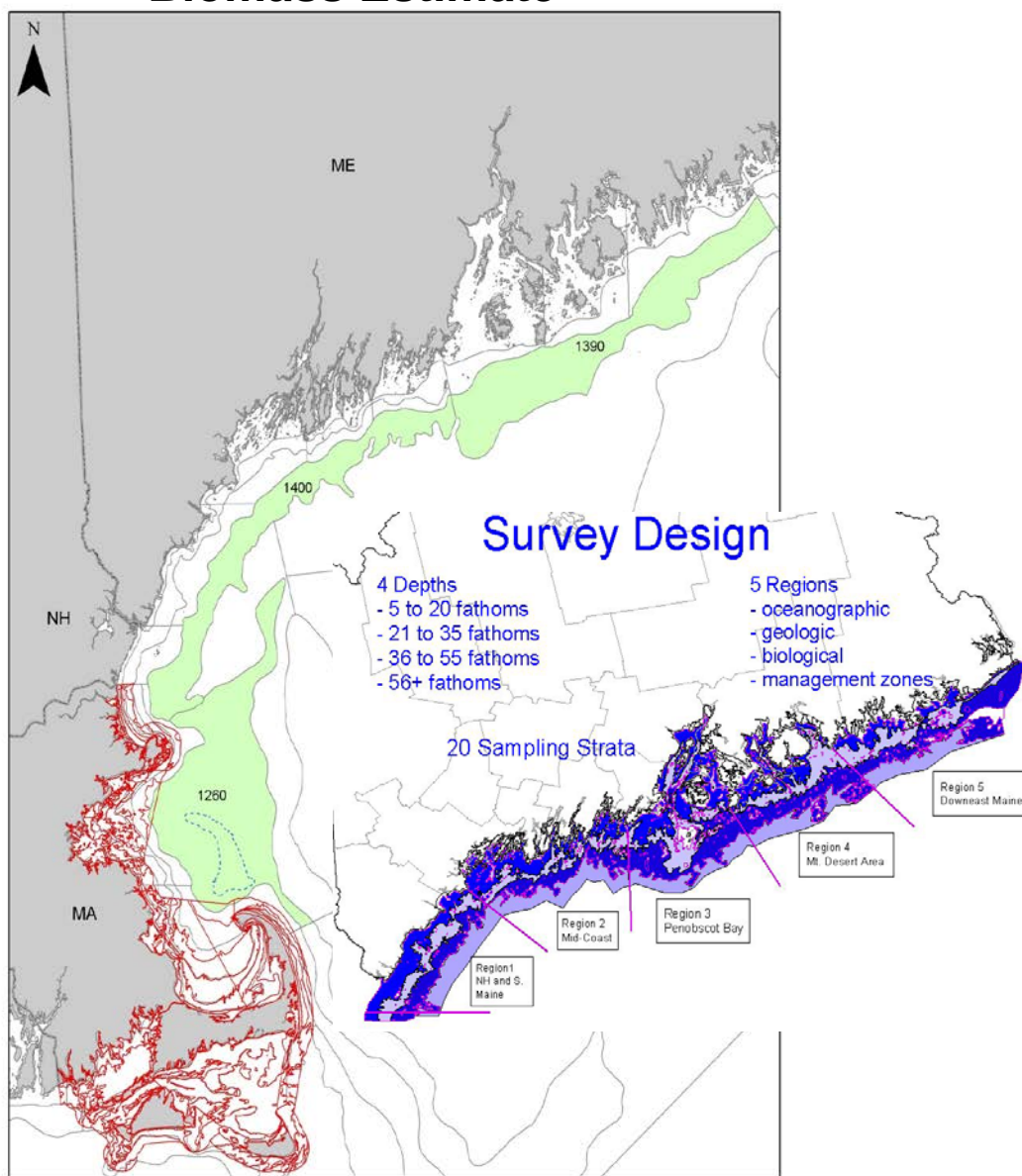


Figure 7. NEFSC, MDMF, and MENH survey areas used in the combined survey 30+ cm biomass estimate. Green shaded areas are the NEFSC offshore strata used for the 30+ biomass estimate.

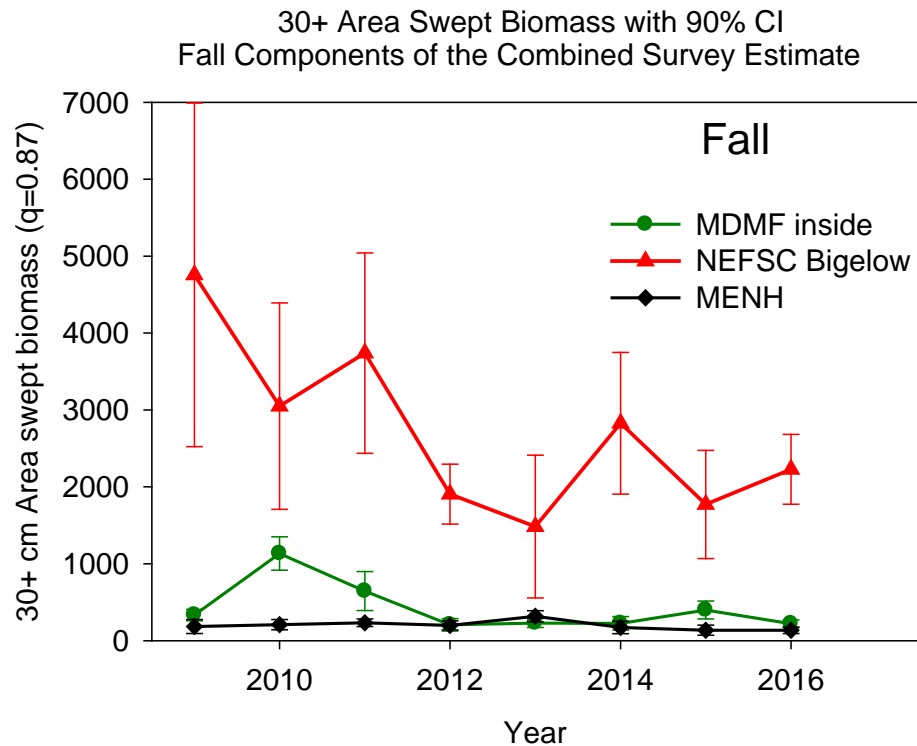
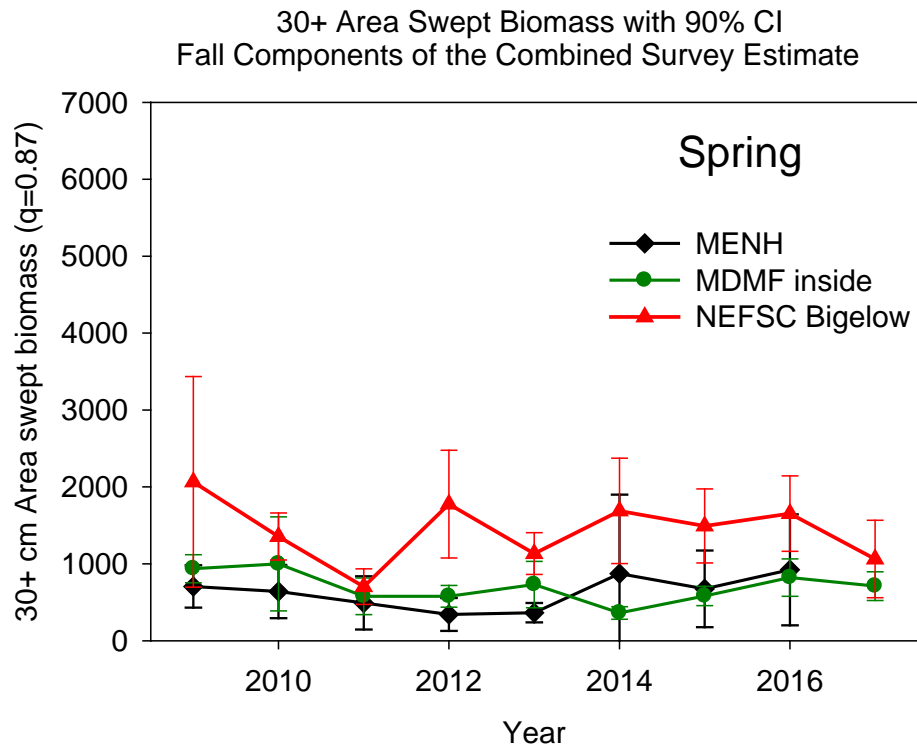


Figure 8. Bigelow spring and fall area-swept ( $Q=0.87$ ) exploitable (30+cm) biomass estimates by year with the associated 90% confidence intervals for the non-overlapping strata components used in the combine biomass estimate.

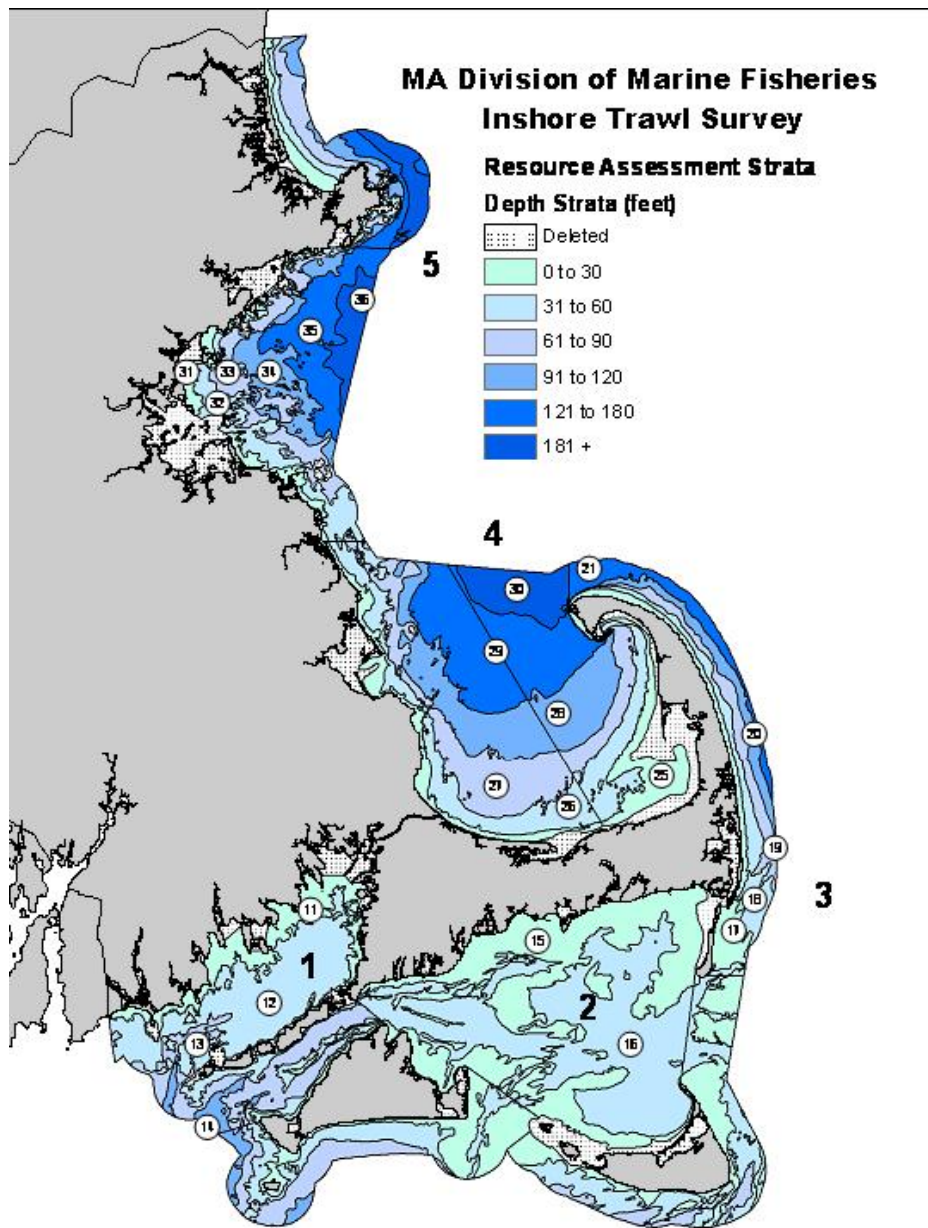


Figure 9. MDMF survey strata. The gulf of Maine winter flounder stock uses strata north of Cape Cod. Strata 25, 26, 31, 32 and 33 are used for the combined non-overlapping biomass estimate.

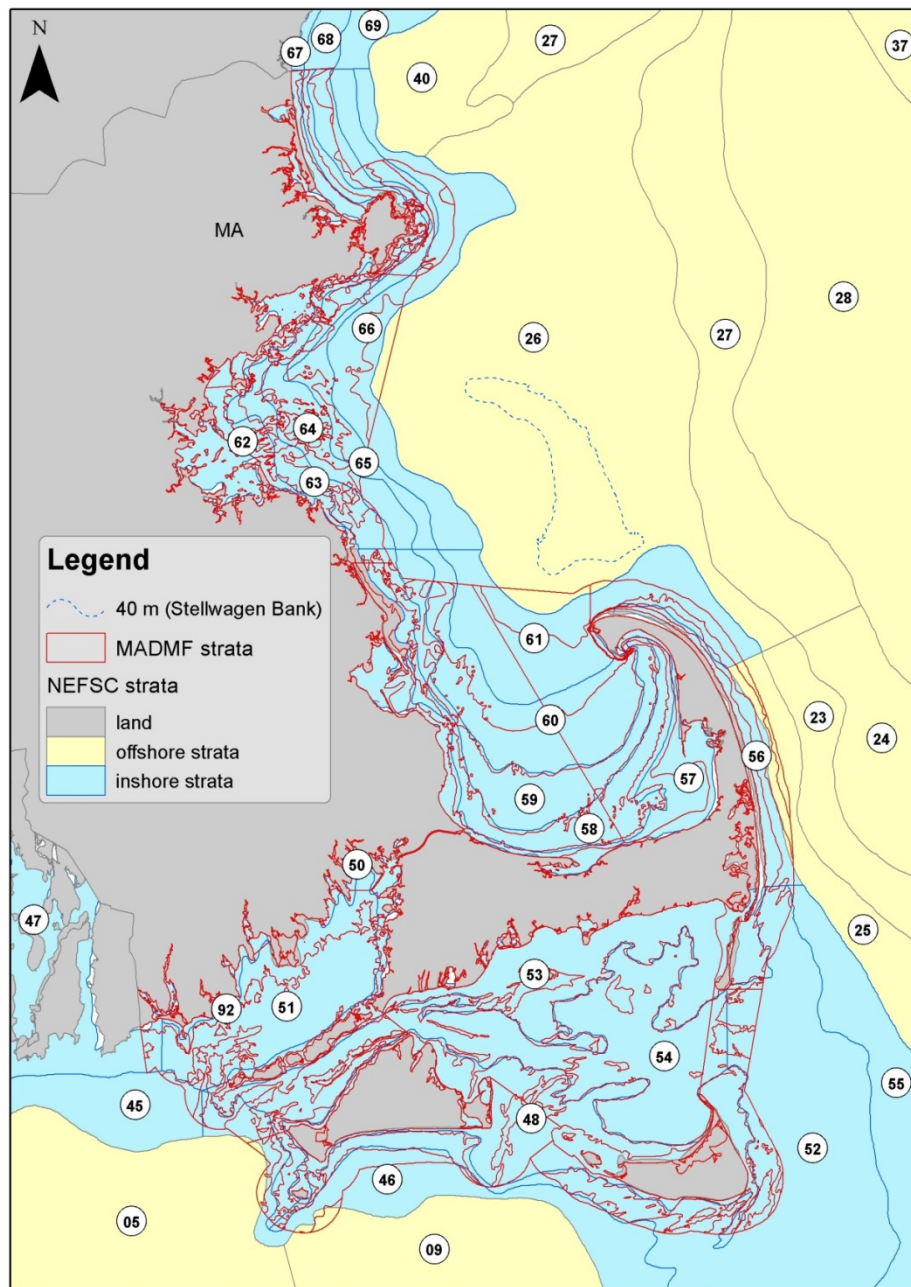


Figure 10. Gulf of Maine winter flounder inshore survey overlap between the NEFSC and MDMF surveys.

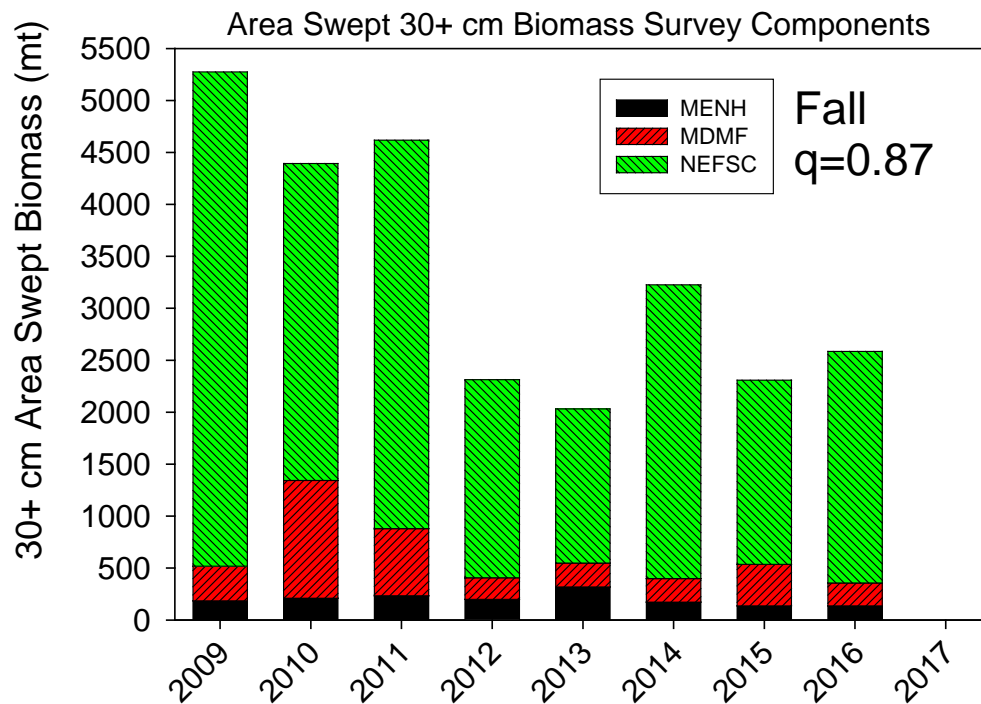
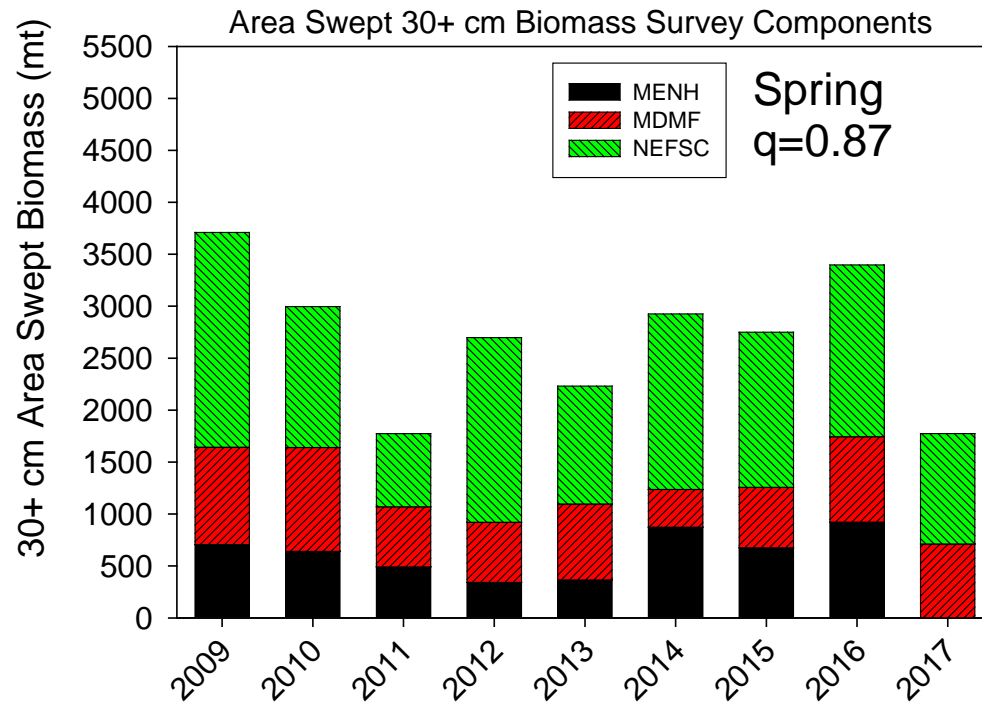


Figure 11. 30+ cm area-swept biomass estimates for each survey (MENH, MDMF, NEFSC) for the spring (top; 2009-2017) and fall (bottom; 2009-2016) surveys assuming  $q=0.866$ . Note MENH survey is not available in the spring of 2017.

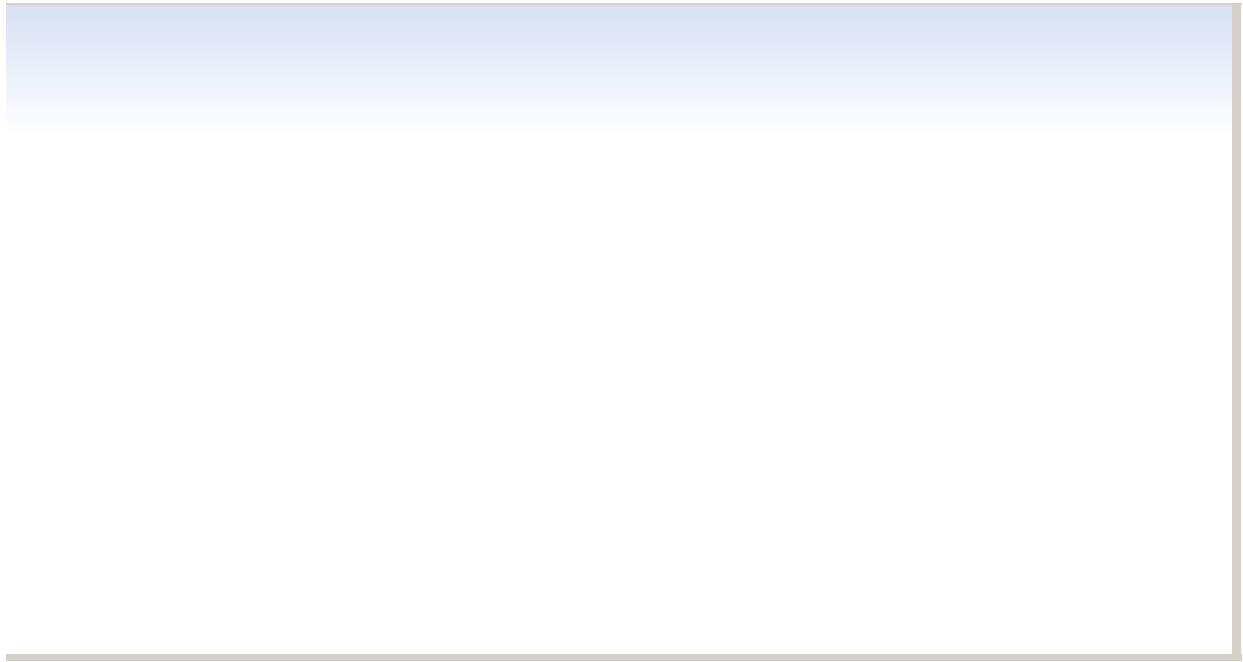


Figure 12. SARC 52 length based yield per recruit analysis using updated von Bertalanffy parameters estimated from the spring and fall 2006-2010 NEFSC surveys, maturity at length from the MDMF survey and assuming a natural mortality of 0.3.  $F_{40\%}$  was estimated at 0.31.

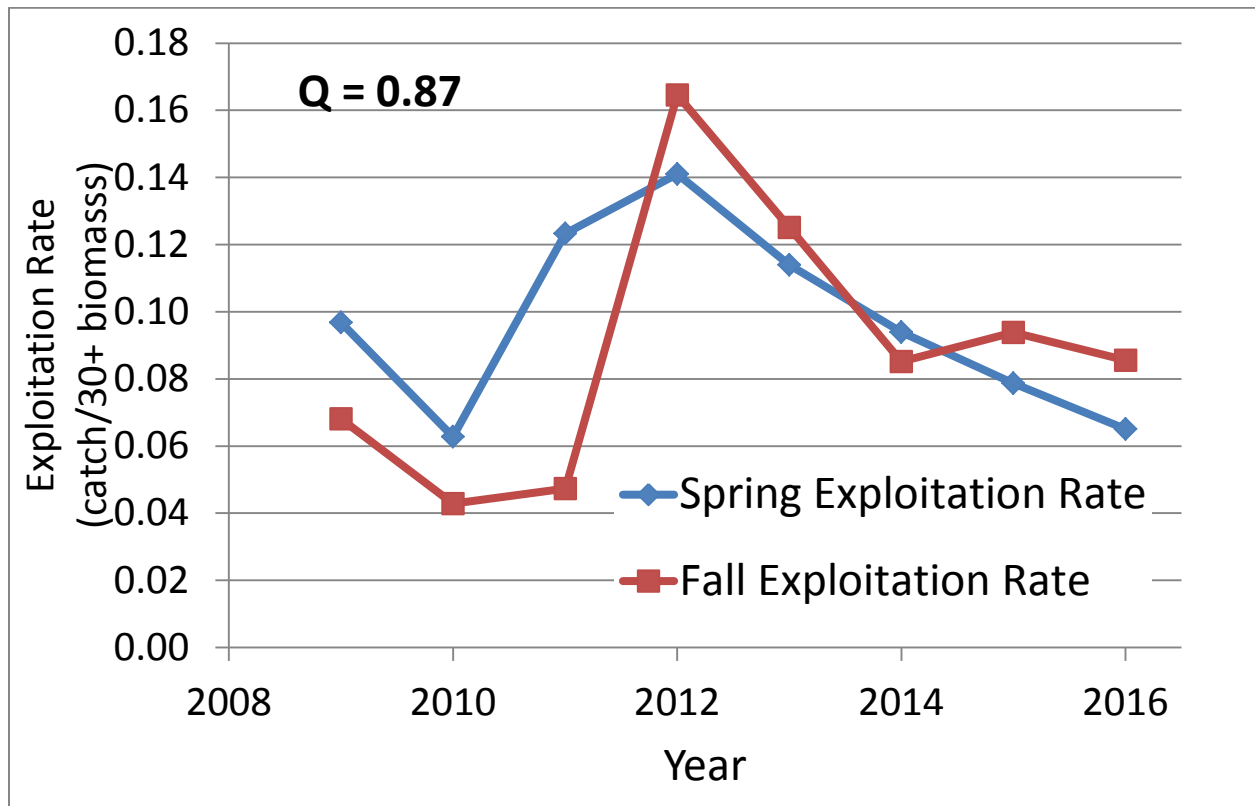


Figure 13. Estimated exploitation rates (catch/ 30+ cm biomass) from 2009-2016 using the spring and fall surveys assuming  $q=0.87$  on wing spread.



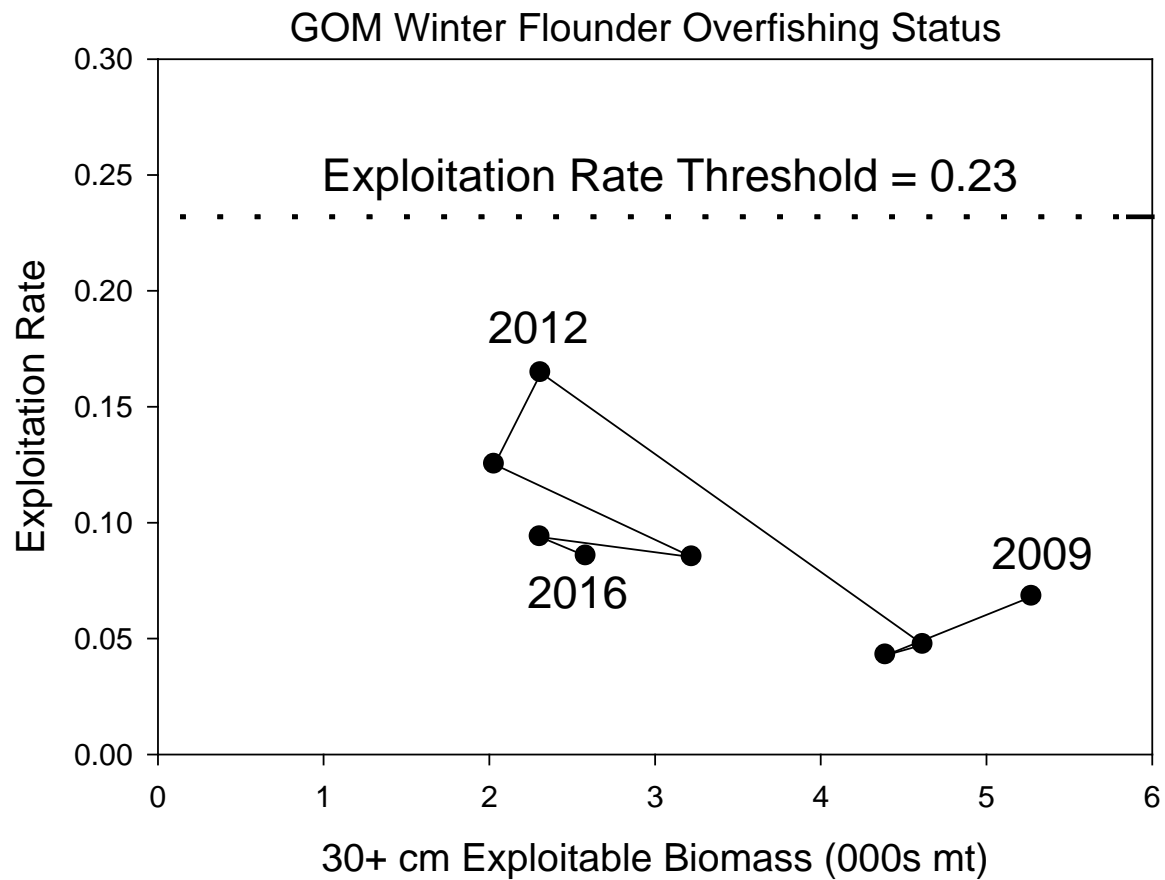


Figure 14. Stock status for Gulf of Maine winter flounder from 2009 through 2016 with respect to the  $F_{MSY}$  proxy.  $F_{40\%} = 0.31$ , which corresponds to an exploitation rate of 0.23.



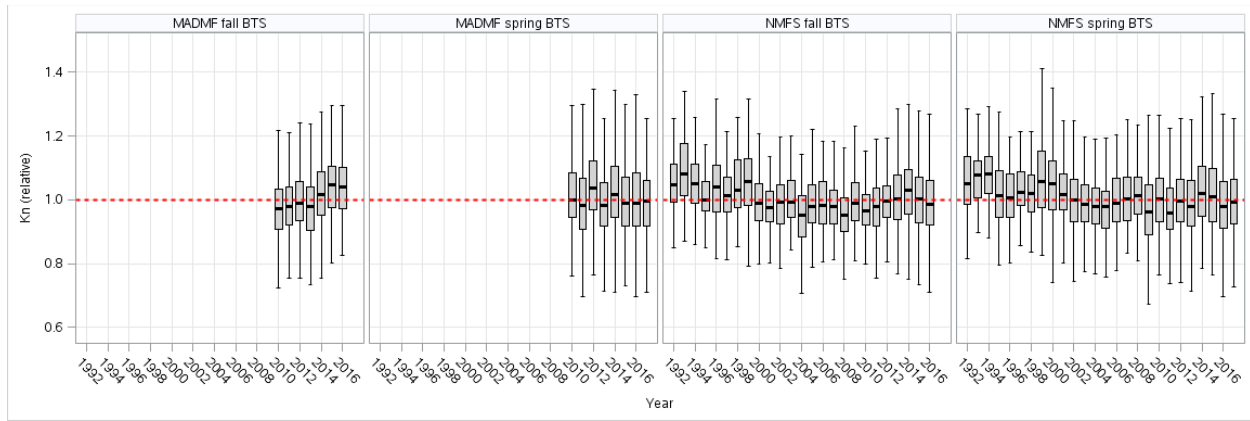


Figure 15. NEFSC and MDMF time series distribution of relative condition factor. It is calculated as the ratio of observed weight to predicted weight (Le Cren 1951).

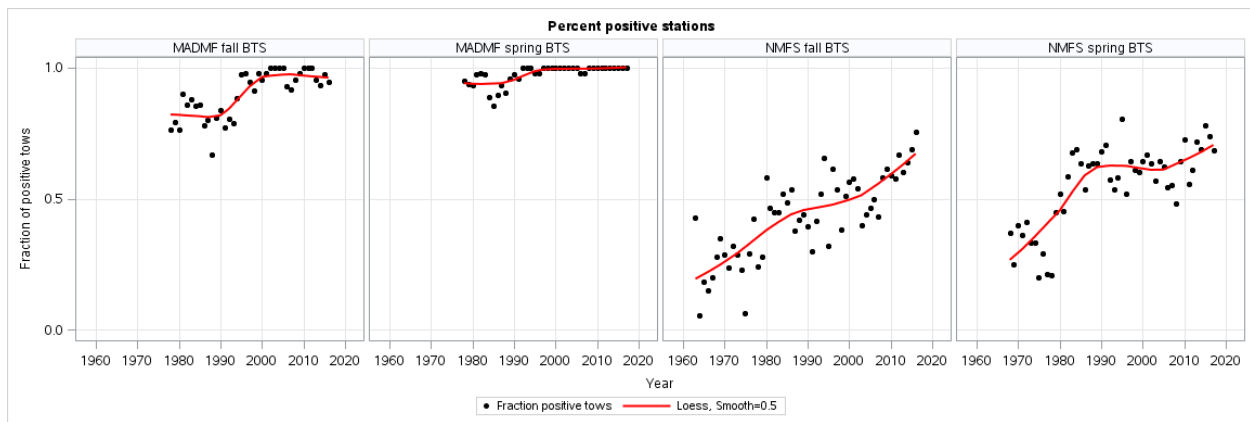


Figure 16. NEFSC and MDMF spring 1980 to 2016 and fall 1980 to 2014 percent of positive winter flounder tows.

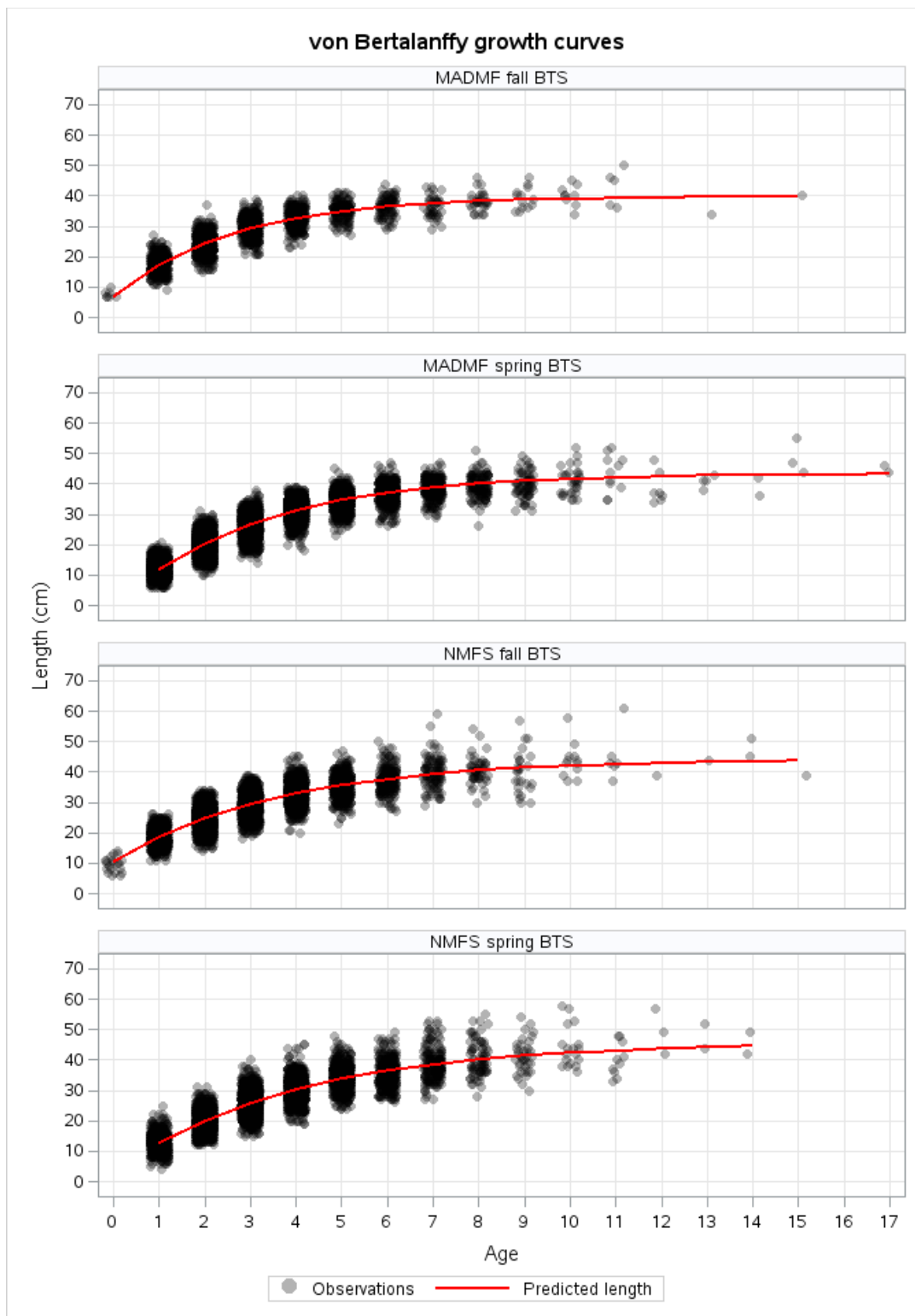


Figure 17. Fits of von Bertalanffy growth curves to the time series of available survey data.

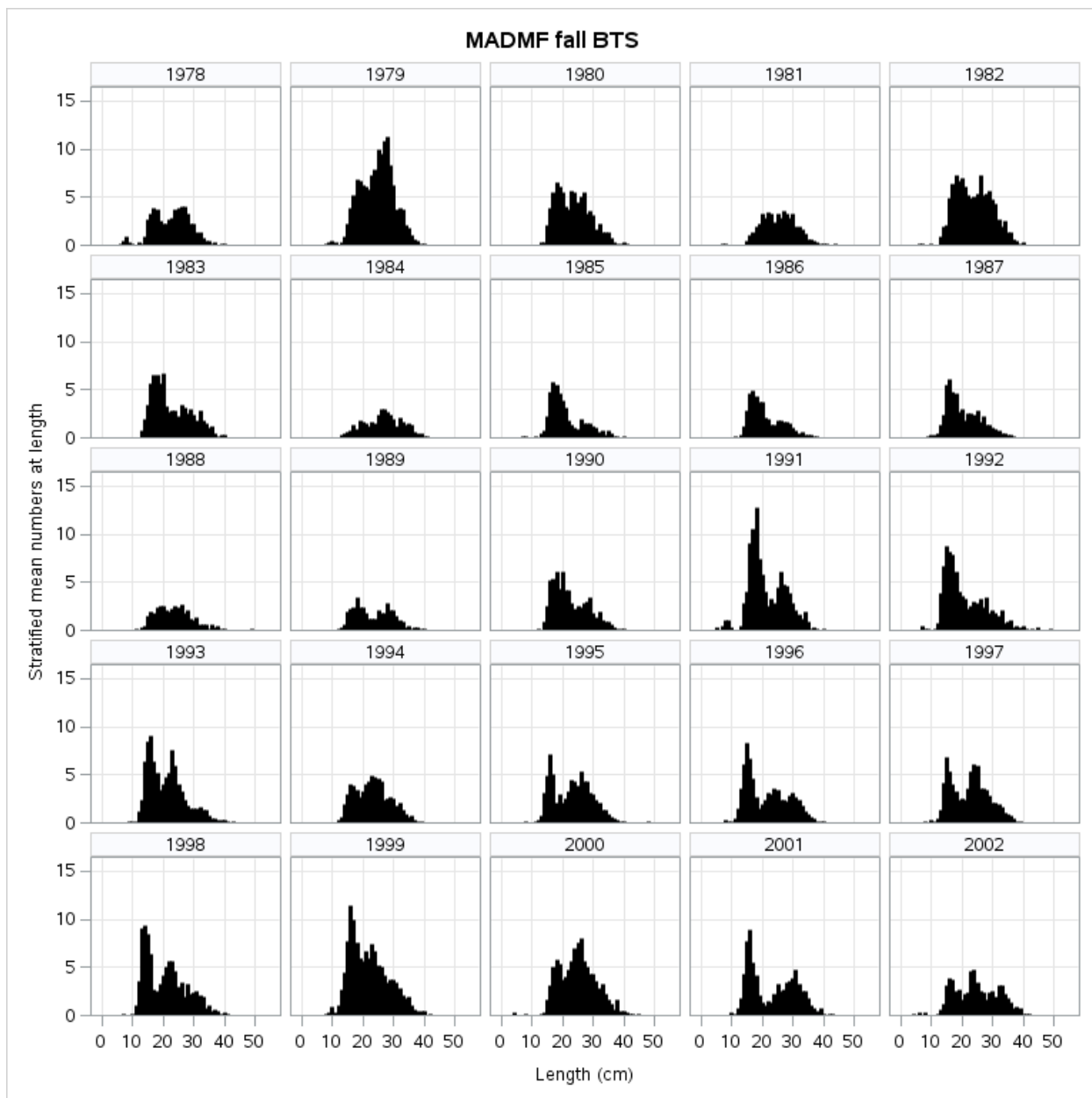


Figure 18. MADMF fall stratified mean numbers per tow at length from 1978-2002.

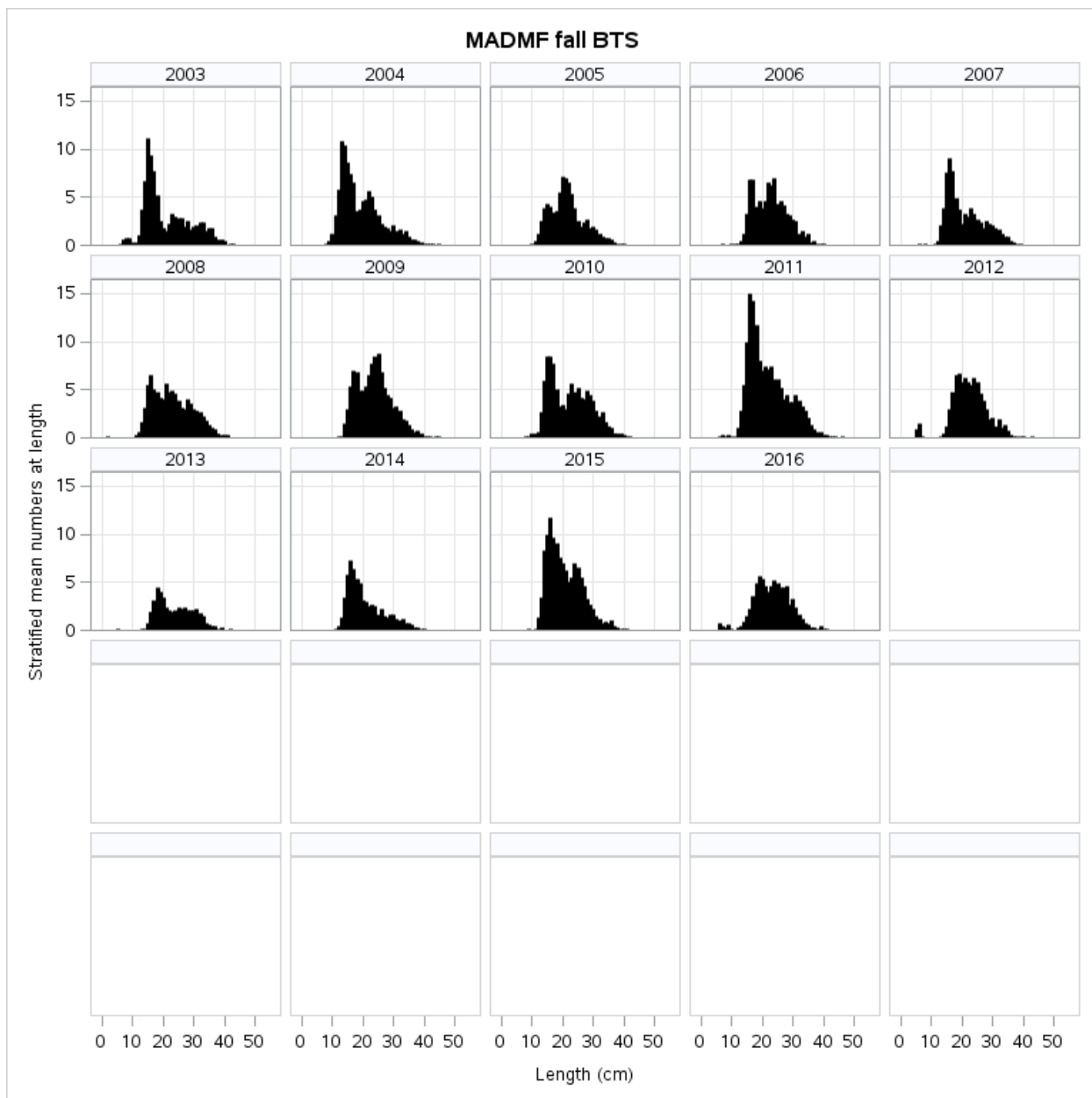


Figure 19. MADMF fall stratified mean numbers per tow at length from 2003-2016.

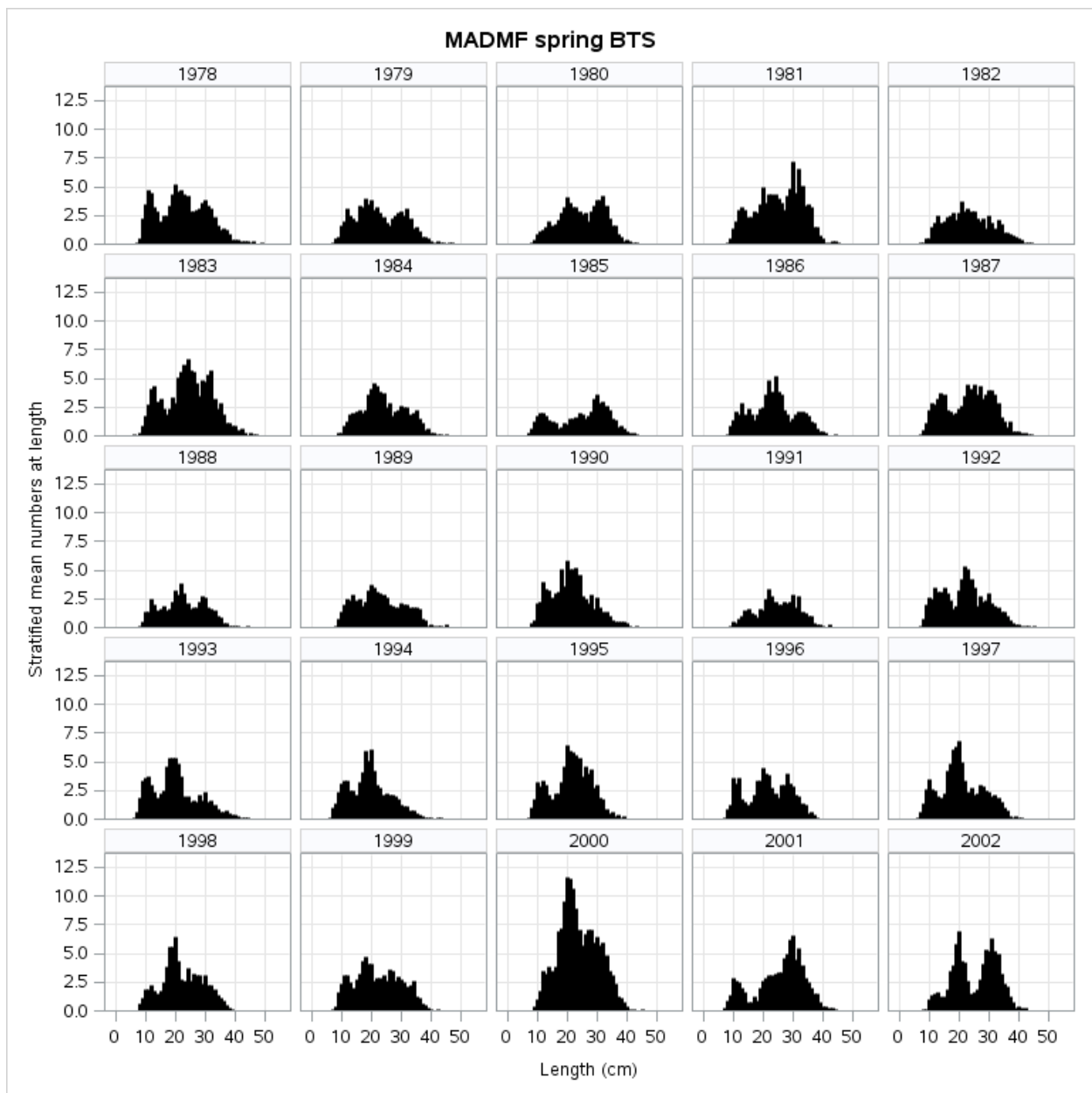


Figure 20. MADMF spring stratified mean numbers per tow at length from 1978-2002.

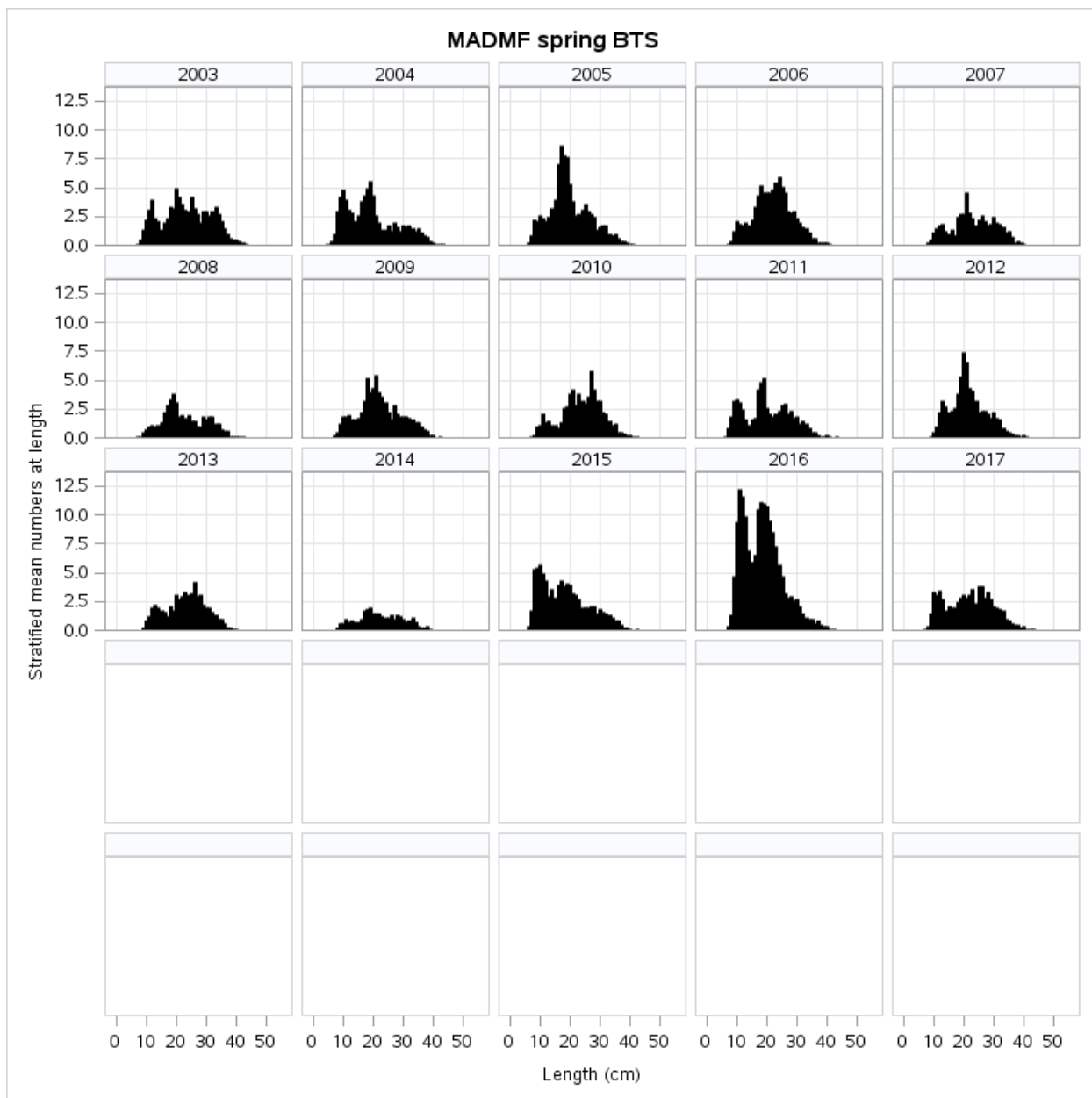


Figure 21. MADMF spring stratified mean numbers per tow at length from 2003-2017.

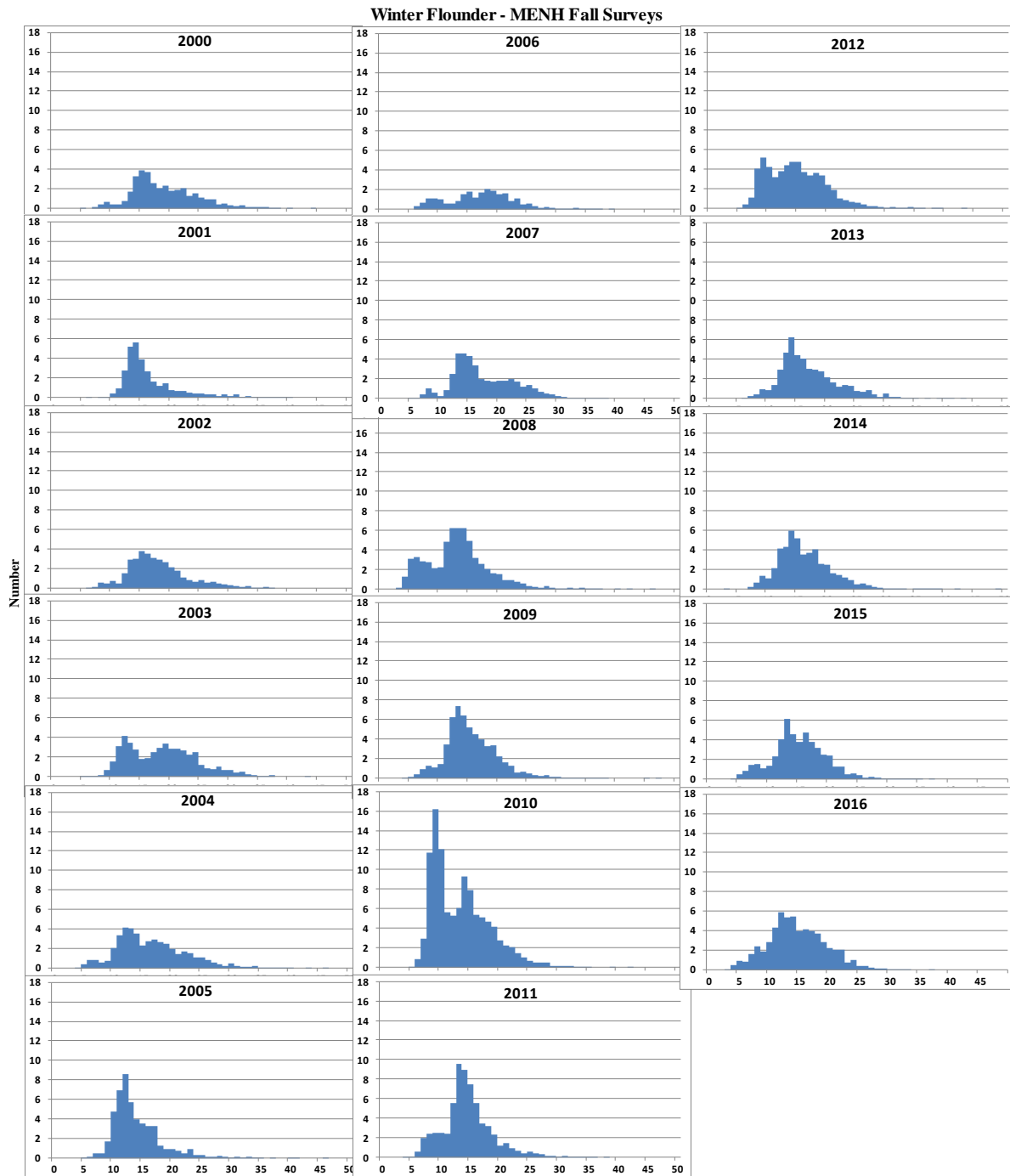


Figure 22. Stratified mean number of fish at length (cm; blue bars) for winter flounder from the 2000-2014 fall Maine-New Hampshire Trawl Survey (regions 1 through 5; strata 1 through 4). Fixed stations are not included.

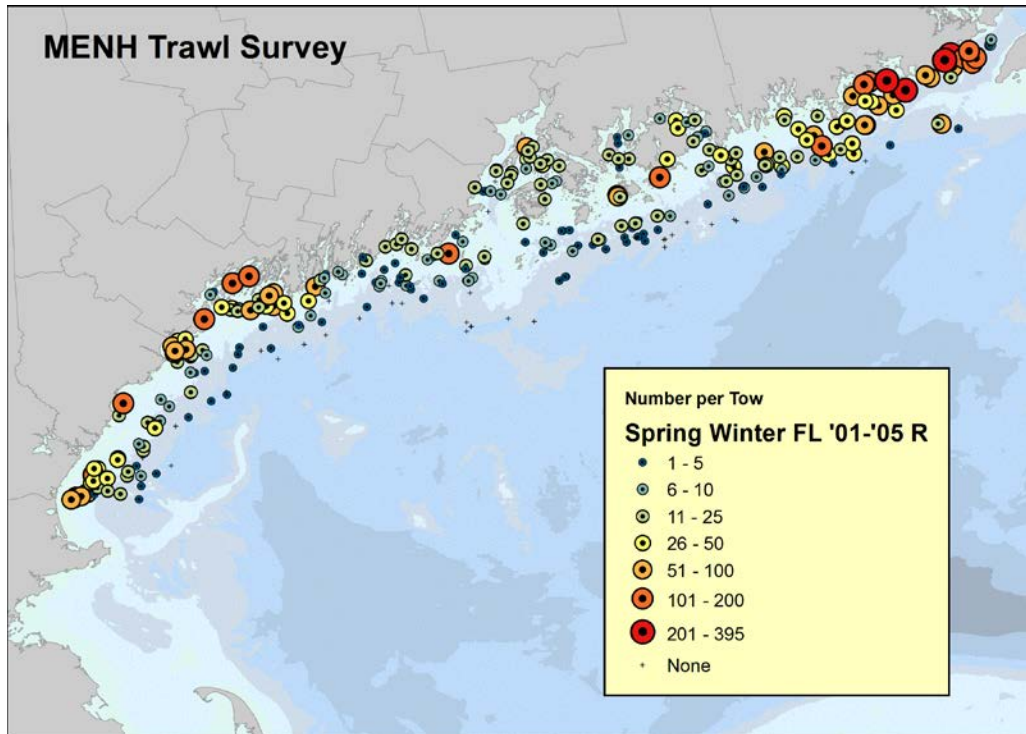


Figure 23. MENH spring survey catches for winter flounder. The color-shaded circles represent number of fish per tow during the 2001-2005 spring MENH trawl survey. The black '+' (plus symbol) represent no catch.

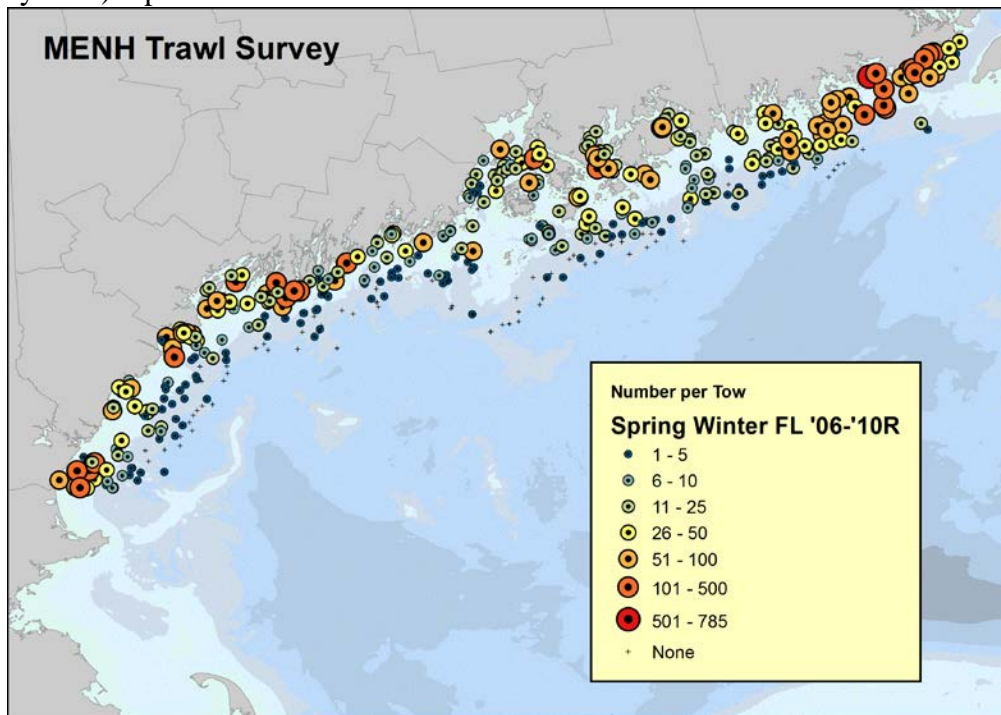


Figure 24. MENH spring survey catches for winter flounder. The color-shaded circles represent number of fish per tow during the 2006-2010 spring MENH trawl survey. The black '+' (plus symbol) represent no catch.



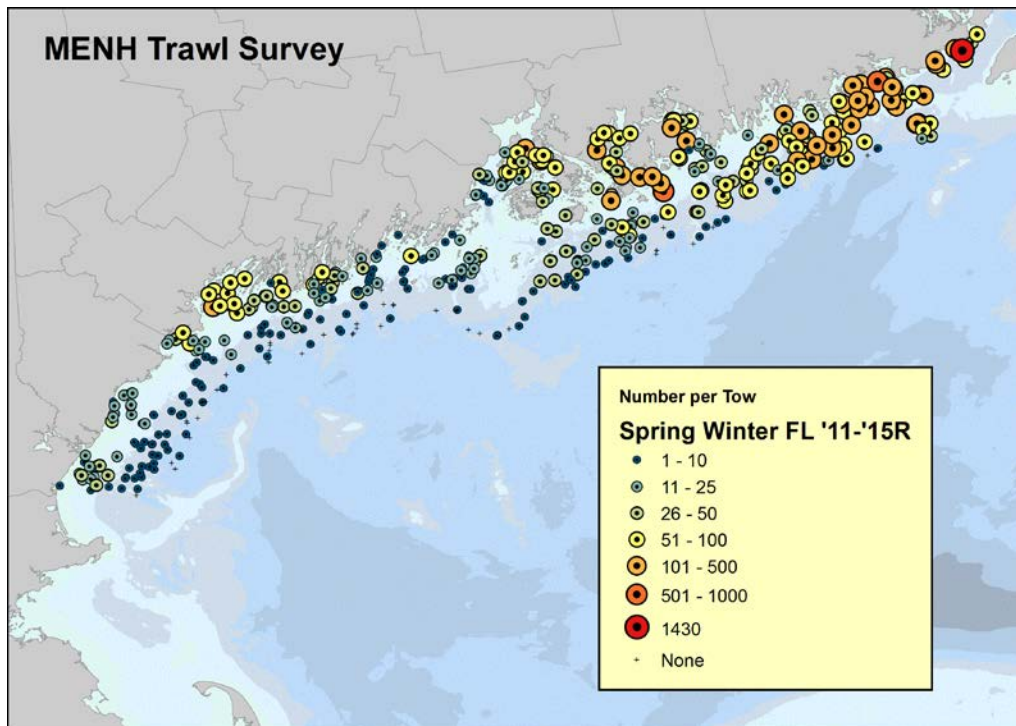


Figure 25. MENH spring survey catches for winter flounder. The color-shaded circles represent number of fish per tow during the 2011-2015 spring MENH trawl survey. The black '+' (plus symbol) represent no catch.

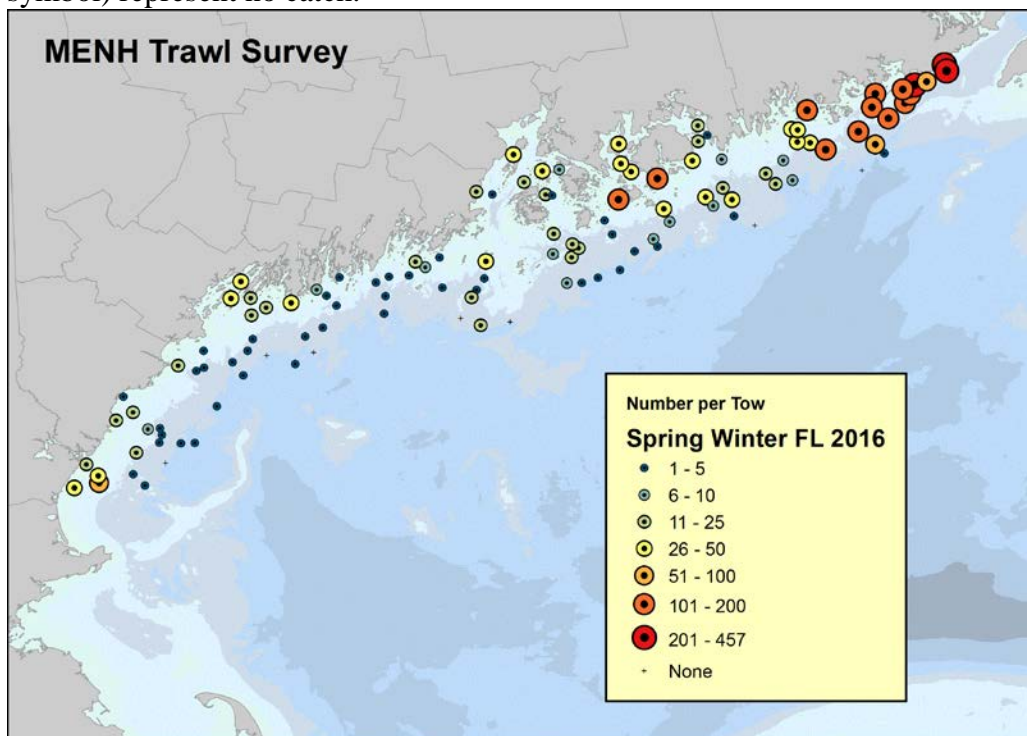


Figure 26. MENH spring survey catches for winter flounder. The color-shaded circles represent number of fish per tow during the 2016 spring MENH trawl survey. The black '+' (plus symbol) represent no catch.

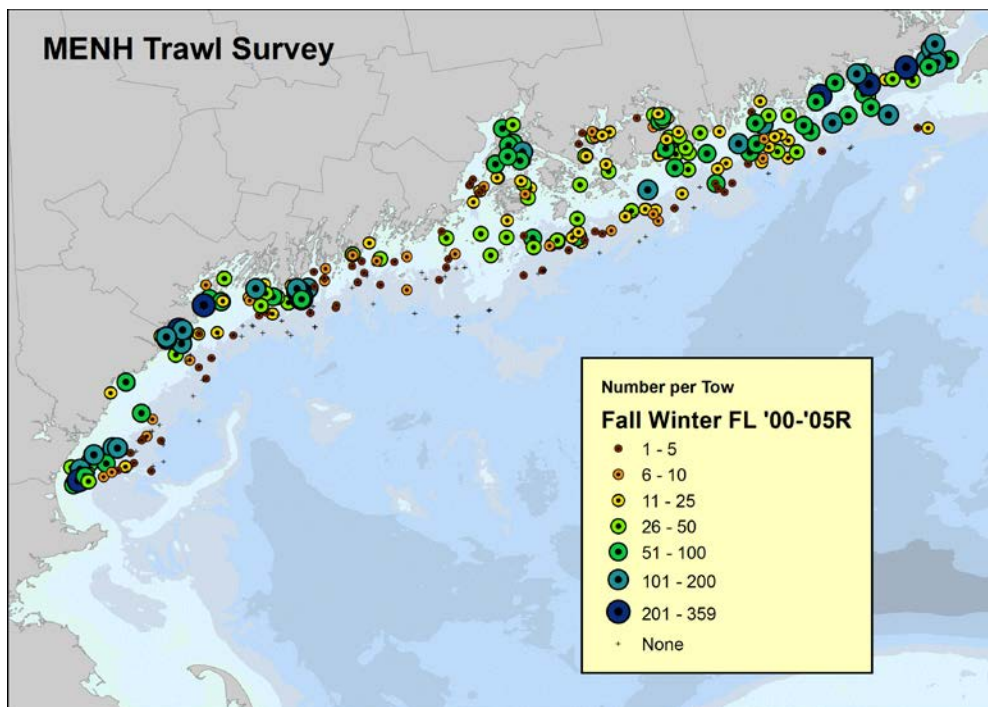


Figure 27. MENH fall survey catches for winter flounder. The color-shaded circles represent number of fish per tow during the 2000-2005 fall MENH trawl survey. The black '+' (plus symbol) represent no catch.

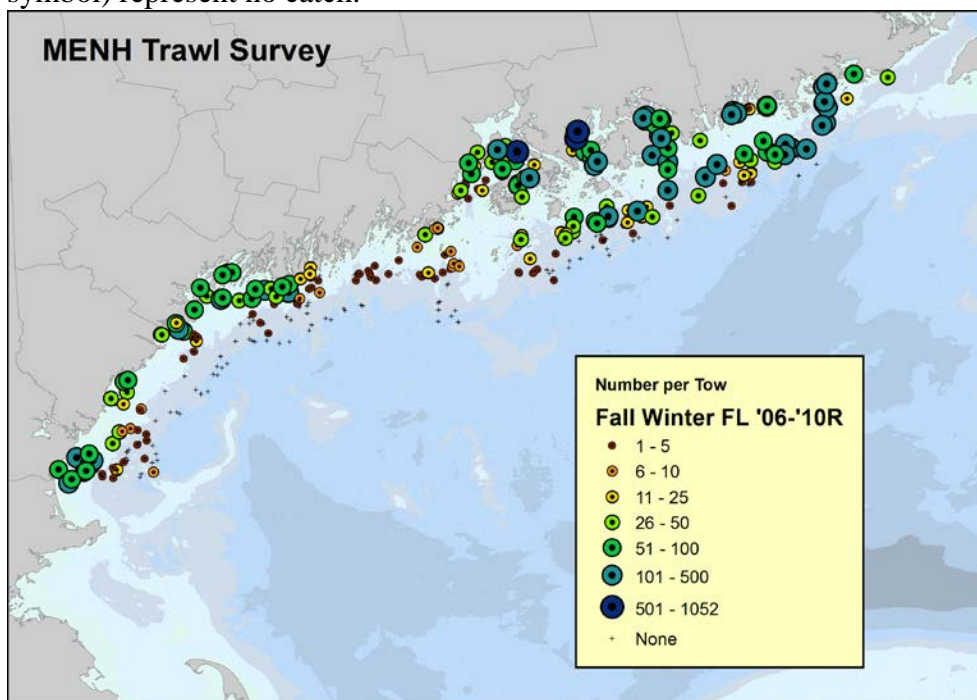


Figure 28. MENH fall survey catches for winter flounder. The color-shaded circles represent number of fish per tow during the 2006-2010 fall MENH trawl survey. The black '+' (plus symbol) represent no catch.

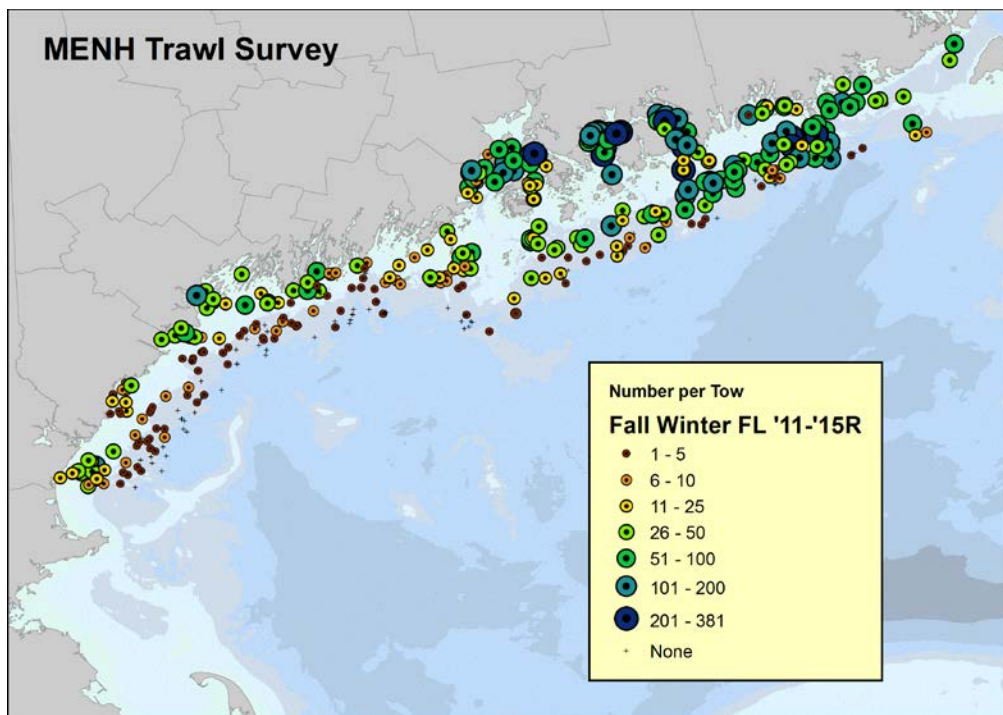


Figure 29. MENH fall survey catches for winter flounder. The color-shaded circles represent number of fish per tow during the 2011-2015 fall MENH trawl survey. The black '+' (plus symbol) represent no catch.

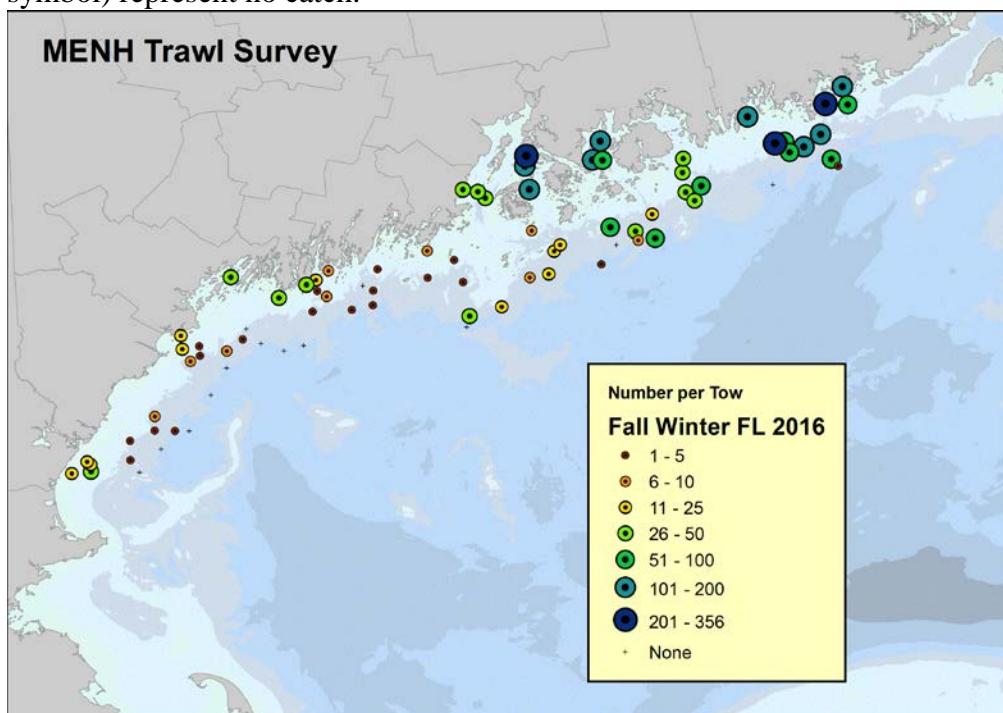


Figure 38. MENH fall survey catches for winter flounder. The color-shaded circles represent number of fish per tow during the fall 2016 MENH trawl survey. The black '+' (plus symbol) represent no catch.