United States Department of Interior
Fish and Wildlife Service
Region 5
Wildlife and Sport Fish Restoration Program

2018 Annual Performance Report

State:	Massachusetts
Agency:	Division of Marine Fisheries
Project Title:	Massachusetts Fishery Resource Assessment
	FA Grant Agreement: F-56-R
Segment Number:	24
ASAP ID No.	F12AF00099
Period Covered:	January 1, 2018 – December 31, 2018
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Submitted By:	Stephanie Cunningham, Federal Aid and Grants Coordinator
Date Submitted:	1/7/2019

Sport Fish Program
Massachusetts Fishery Resource Assessment: F-56-R-24
2018 Performance Report

List of Active Jobs:

Job No. 1: Fishery Resource Assessment, Coastal Massachusetts
The Massachusetts Division of Marine Fisheries Resource Assessment Project completed the forty-first annual spring and fall bottom trawl surveys of Massachusetts territorial waters in 2018. Detailed reports of the activities of each cruise follow.

Job No. 2: Winter Flounder Year-Class Strength
The Massachusetts Division of Marine Fisheries Resource Assessment Project completed the forty-third annual seine survey of Nantucket Sound estuaries on the south shore of Cape Cod to assess southern New England stock winter flounder young of the year cohort abundance. A report of the 2018 seine survey follows.

Appendix A: Indices of biomass, abundance, and recruitment for select species.

Appendix B: Trends in observed bottom temperatures - Massachusetts bottom trawl survey, 1978 - 2018.

Appendix C: Corrections to the trawl survey database in 2018.

CRUISE RESULTS

R/V GLORIA MICHELLE

2018 Massachusetts Inshore Spring
Bottom Trawl Survey
Cruise No. 201891

CRUISE PERIOD AND AREA

From May 7 through May 24, 2018 the Massachusetts Division of Marine Fisheries (MADMF) conducted its 41st spring bottom trawl survey. The survey extended from New Hampshire to Rhode Island boundaries seaward to three nautical miles including Cape Cod Bay and Nantucket Sound.

OBJECTIVES

Cruise objectives were 1) to determine the spring distribution, relative abundance, and size composition of fish and select invertebrate species; and 2) to collect biological samples. Requested special collections were also undertaken.

METHODS

The study area is stratified based on five bio-geographic regions and six depth zones (Fig. 1). Trawl sites are allocated in proportion to stratum area and randomly chosen in advance within each sampling stratum. Randomly chosen stations in locations known to be untowable due to hard bottom are reassigned. Sampling intensity is approximately 1 station per 19 square nautical miles. A minimum of two stations are assigned to each stratum.

A standard tow of 20-minute duration at 2.5 knots was attempted at each station during daylight hours with a 3/4 size North Atlantic type two seam otter trawl (11.9 m headrope/15.5 m footrope) rigged with a 7.6 cm rubber disc sweep; 19.2 m, 9.5 mm chain bottom legs; 18.3 m, 9.5 mm wire top legs; and 1.8 X 1.0 m, 147 kg wooden trawl doors. The codend contains a 6.4 mm knotless liner to retain small fish. Prior to setting the net at each station, NOAA Corps officers surveyed the site by visually scanning for buoys marking fixed gear as well as determining the suitability of the bottom for towing the net based on the sounder image. Whenever necessary, sites were relocated due to untowable bottom or concentrations of fixed gear. Abbreviated tows of 13-19 minute duration were accepted as valid and expanded to the 20 minute standard.

Standard bottom trawl survey techniques were used when processing the catch. The total weight and length-frequency of each species were recorded directly into Fisheries Scientific Computer System (FSCS) data tables. Collections of age and growth material, and biological observations were undertaken during the measuring operation. Specimens were also saved to fulfill requests. Bottom temperatures were continuously recorded with an Onset Water Temp Pro v2 attached to the net's headrope.

Thirty-one MADMF employees participated in the survey as part of the scientific party, joined by one employee from Massachusetts Coastal Zone Management (MCZM) (Table 1). Two NOAA Corps officers operated the research vessel and fishing gear assisted by four additional NOAA officers, one employee from NMFS, and one contract fisherman.

CRUISE SUMMARY

105 stations were attempted in 18 sampling days (Figs 1 and 2, Table 2). Ninety-eight completed stations were considered acceptable for assessment of all species, SHG <=136 (Table 3). Five station assignments were not completed with acceptable trawl hauls due to sand waves, fixed gear and right whale activity. Three stations in stratum 16 were dropped due to sand waves and commercial squid fleet presence in our proposed circle. One station in stratum 32 was dropped due to right whale feeding activity in the circle and one station in stratum 35 was dropped due to fixed gear interactions. Seven attempted tows were aborted due to fixed gear, crossed doors, hard bottom, right whales and winch operator error (Table 5, Fig. 3).

The primary goal of tallying weight, number, and a representative length frequency of each fish species in the catches was accomplished (Tables 6a and 6b). Two interesting records were set on the 2018 spring survey. The largest abundance of spotted hake (736) was recorded at station 90 off Westport in Buzzards Bay and the largest abundance of smooth dogfish (163) was recorded at station 103 off Falmouth in Nantucket Sound. Moderate catches of winter flounder, whiting, and longhorn sculpin were taken North of Cape Cod. Scup, northern searobin, longfin squid and little skate were abundant throughout Nantucket Sound, Vineyard Sound and Buzzard's Bay.

Additional sampling goals were achieved (Table 7). To aid cooperative fisheries assessments, over 1,450 scale/otolith/operculum samples, as well as sex and maturity observations, were taken from Atlantic cod, haddock, summer flounder, yellowtail flounder, winter flounder, black sea bass, scup, tautog, American lobster and jonah crabs. Additional samples were collected to assist ongoing research by fisheries scientists from MDMF and other labs in the region.

For further information on this survey or others in the time series, please contact Matthew Camisa at (508) 742-9743.

Table 1. MADMF Spring Cruise 2018 Staffing List

Scientific Party

Name	Affiliation	Num. Days
Mark Szymanski	MADMF	10
Matthew Camisa	MADMF	9
Vincent Manfredi	MADMF	9
Steve Voss	MADMF	7
Bob Glenn	MADMF	5
Elise Koob	MADMF	5
Greg Decelles	MADMF	4
John Logan	MADMF	4
Kim Trull	MADMF	4
Ross Kessler	MADMF	4
Brad Schondelmeier	MADMF	3
Brendan Reilly	MADMF	3
Mike Trainor	MADMF	3
Tiffany Cunningham	MADMF	3
Alex Boeri	MADMF	2
Chrissy Petitpas	MADMF	2
Erin Burke	MADMF	2
Mark Rousseau	MADMF	2
Pooja Potti	MADMF	2
Steve Wilcox	MADMF	2
Anna Webb	MADMF	1
Christine Cassidy	MADMF	1
Dave Chosid	MADMF	1
Derek Perry	MADMF	1
Jared Silva	MADMF	1
Kate Frew	MADMF	1
Liz Morrissey	MADMF	1
Melissa Campbell	MADMF	1
Mike Pol	MADMF	1
Scott Elzey	MADMF	1
Tracy Pugh	MADMF	1
Bob Boeri	MCZM	1
		97

R/V Gloria Michelle Crew

Name	Affiliation	Num. Days
Officers		
Andrew Reynaga	NOAA OIC	18
Chris Gallagher	NOAA JOIC	18
Ben VanDine	NOAA-CORPS	5
Calandria Decastro	NOAA-CORPS	5
Carmen Defazzio	NOAA-CORPS	5
Pete Gleichauf	NOAA-CORPS	3
Deck Crew		
George Morton	Contract Fisherman	18
Pete Plantamura	NMFS-Sandy Hook	13

Table 2. Station Information for the 2018 Massachusetts Spring Inshore Bottom Trawl Survey
Cruise No. 201891

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
1	26	5/7/2018	6:12	18	41°49.33	-70°29.67	179	0.85	7.4
2	25	5/7/2018	7:18	12	41°51.18	-70°30.71	176	0.84	8.6
3	28	5/7/2018	9:03	36	41°58.40	-70°30.71	149	0.84	5.3
4	29	5/7/2018	12:09	39	41°57.43	-70°26.46	321	0.83	5.2
5	28	5/7/2018	13:30	33	41°53.74	-70°25.83	334	0.85	5.2
6	28	5/7/2018	14:48	30	41°52.55	-70°22.99	4	0.85	5.4
7	27	5/7/2018	16:04	26	41°50.22	-70°24.63	25	0.87	5.9
8	27	5/8/2018	6:22	23	41°47.16	-70°21.10	278	0.85	6.1
9	26	5/8/2018	7:30	17	41°45.42	-70°21.31	283	0.84	7.5
10	25	5/8/2018	10:09	8	41°44.81	-70°18.26	73	0.84	9.1
11	26	5/8/2018	11:32	18	41°47.56	-70°15.31	72	0.86	7.2
12	26	5/8/2018	12:52	15	41°48.27	-70°11.03	119	0.64	9.3
13	25	5/8/2018	14:08	8	41°48.72	-70°04.16	281	0.83	11.3
14	25	5/8/2018	15:15	10	41°46.96	-70°08.07	47	0.84	10.0
15	35	5/9/2018	9:37	43	42°19.25	-70°42.26	258	0.52	5.0
16	35	5/9/2018	10:45	41	42°19.08	-70°42.62	242	0.55	5.0
17	34	5/9/2018	11:52	38	42°18.97	-70°43.45	156	0.63	5.0
18	33	5/9/2018	13:08	20	42°18.30	-70°48.65	58	0.84	5.9
19	32	5/9/2018	15:09	13	42°17.63	-70°51.49	70	0.84	7.1
20	31	5/9/2018	16:16	10	42°17.35	-70°51.81	125	0.84	8.4
21	34	5/10/2018	6:36	36	42°23.54	-70°49.55	154	0.70	5.4
22	33	5/10/2018	7:56	25	42°23.52	-70°54.45	63	0.76	6.0
23	32	5/10/2018	9:12	13	42°27.09	-70°54.64	187	0.24	7.4
24	36	5/10/2018	11:49	79	42°28.47	-70°37.78	192	0.74	4.8
25	35	5/10/2018	13:08	56	42°31.05	-70°40.57	178	0.64	4.8
26	35	5/10/2018	14:27	46	42°31.08	-70°43.09	138	0.53	4.9
27	32	5/11/2018	7:01	14	42°41.45	-70°42.64	314	0.84	6.3
28	31	5/11/2018	9:05	10	42°49.86	-70°48.21	355	0.83	8.3
29	33	5/11/2018	10:23	28	42°47.08	-70°45.32	341	0.32	5.3
30	33	5/11/2018	11:09	27	42°46.97	-70°45.44	342	0.83	5.2
31	31	5/11/2018	12:19	9	42°45.31	-70°47.17	347	0.83	7.2
32	33	5/11/2018	13:49	24	42°44.05	-70°44.01	328	0.84	5.3
33	34	5/11/2018	15:14	35	42°42.13	-70°37.36	282	0.85	5.1
34	35	5/12/2018	6:30	51	42°35.14	-70°35.45	45	0.59	4.9
35	35	5/12/2018	8:18	47	42°36.13	-70°34.60	56	0.63	4.8
36	34	5/12/2018	10:54	33	42°39.37	-70°34.08	52	0.54	5.0
37	35	5/12/2018	13:13	45	42°36.92	-70°33.61	236	0.55	4.9
38	36	5/12/2018	14:53	89	42°40.52	-70°31.53	163	0.85	4.7
39	30	5/13/2018	9:39	61	42°04.92	-70°22.10	21	0.84	4.9
40	29	5/13/2018	11:10	52	42°01.17	-70°24.42	341	0.84	4.9
41	29	5/13/2018	12:37	49	42°00.00	-70°23.68	167	0.83	5.0
42	29	5/13/2018	13:55	54	42°02.44	-70°19.51	159	0.83	5.0
43	27	5/14/2018	6:33	27	41°50.84	-70°18.54	285	0.55	5.9
44	27	5/14/2018	7:54	24	41°50.52	-70°14.63	66	0.84	6.0
45	28	5/14/2018	9:22	32	41°54.24	-70°12.45	50	0.85	5.8
46	29	5/14/2018	10:55	53	42°01.31	-70°15.48	129	0.84	5.2
47	26	5/14/2018	12:38	17	42°01.26	-70°06.87	174	0.83	6.8
48	27	5/14/2018	13:41	22	42°01.56	-70°08.93	170	0.55	5.9
49	27	5/14/2018	14:28	20	42°01.75	-70°08.61	167	0.55	6.0
50	28	5/14/2018	15:28	30	42°00.71	-70°10.19	202	0.84	5.8
51	30	5/15/2018	7:16	64	42°06.23	-70°16.62	74	0.86	5.0

Table 2 continued.

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
52	21	5/15/2018	8:44	65	42°06.44	-70°14.71	67	0.79	5.3
53	21	5/15/2018	10:18	42	42°06.53	-70°09.82	84	0.55	6.3
54	17	5/15/2018	11:23	9	42°05.10	-70°08.27	287	0.82	9.2
55	20	5/15/2018	14:03	37	42°03.13	-70°00.89	330	0.84	6.3
56	19	5/16/2018	4:47	26	41°57.92	-69°57.62	112	0.66	8.2
57	20	5/16/2018	6:54	33	41°49.96	-69°53.48	174	0.84	7.4
58	18	5/16/2018	9:10	13	41°38.93	-69°55.06	29	0.86	7.9
59	17	5/16/2018	10:25	10	41°35.53	-69°56.95	42	0.77	8.5
60	18	5/16/2018	11:38	13	41°36.31	-69°54.87	14	0.50	7.8
61	16	5/16/2018	13:42	16	41°28.13	-70°02.49	19	0.78	9.7
62	17	5/16/2018	15:44	10	41°27.54	-70°01.05	71	0.85	8.8
63	17	5/17/2018	7:41	8	41°22.96	-69°59.20	172	0.84	10.2
64	18	5/17/2018	8:44	11	41°23.26	-69°57.60	168	0.85	9.4
65	15	5/17/2018	12:20	10	41°23.96	-70°19.49	82	0.82	12.9
66	16	5/17/2018	13:29	13	41°24.98	-70°16.50	41	0.64	12.9
67	16	5/17/2018	15:03	13	41°29.94	-70°25.06	123	0.63	13.3
68	15	5/18/2018	8:19	8	41°32.36	-70°17.05	229	0.83	12.4
69	16	5/18/2018	10:27	11	41°36.16	-70°04.37	228	0.59	12.9
70	15	5/18/2018	11:42	9	41°35.97	-70°08.57	78	0.84	13.5
71	15	5/18/2018	13:05	10	41°33.70	-70°14.01	54	0.83	13.1
72	16	5/18/2018	16:25	14	41°19.97	-70°06.28	32	0.85	12.8
73	15	5/19/2018	6:27	8	41°23.47	-70°11.47	69	0.84	10.2
74	16	5/19/2018	7:29	10	41°25.60	-70°08.48	271	0.84	8.8
75	16	5/19/2018	8:48	12	41°28.61	-70°12.48	294	0.54	9.4
76	15	5/19/2018	9:50	8	41°32.67	-70°11.53	249	0.82	11.5
77	15	5/19/2018	11:56	9	41°35.14	-70°22.11	249	0.83	14.1
78	15	5/19/2018	13:42	7	41°31.69	-70°21.00	117	0.85	13.1
79	11	5/20/2018	6:51	8	41°39.42	-70°42.76	249	0.50	12.7
80	12	5/20/2018	9:13	14	41°34.23	-70°45.86	230	0.84	12.2
81	12	5/20/2018	11:07	15	41°29.18	-70°47.58	226	0.61	12.1
82	12	5/20/2018	12:12	16	41°31.50	-70°47.84	228	0.84	11.9
83	12	5/20/2018	13:44	18	41°31.09	-70°49.66	254	0.84	11.8
84	12	5/20/2018	15:34	17	41°27.23	-70°54.13	69	0.59	11.6
85	11	5/21/2018	6:25	9	41°25.23	-70°45.36	57	0.79	11.9
86	13	5/21/2018	7:55	25	41°23.09	-70°46.64	40	0.75	12.0
87	13	5/21/2018	9:09	24	41°22.28	-70°50.14	63	0.84	11.5
88	13	5/21/2018	10:15	27	41°24.39	-70°51.65	200	0.63	11.5
89	14	5/21/2018	11:32	34	41°21.49	-70°55.71	222	0.83	11.0
90	11	5/21/2018	13:43	9	41°30.00	-71°04.03	159	0.79	12.0
91	17	5/22/2018	8:09	9	41°17.14	-70°19.53	92	0.85	12.7
92	11	5/22/2018	9:59	9	41°17.00	-70°24.48	26	0.87	12.6
93	18	5/22/2018	13:17	14	41°13.55	-70°03.31	243	0.76	10.8
94	19	5/22/2018	14:44	23	41°12.42	-70°07.69	262	0.55	10.3
95	18	5/22/2018	15:56	14	41°13.70	-70°10.61	290	0.83	10.9
96	11	5/23/2018	5:06	8	41°19.08	-70°29.02	253	0.85	11.7
97	12	5/23/2018	6:15	16	41°19.67	-70°35.12	90	0.84	11.9
98	13	5/23/2018	7:17	20	41°18.55	-70°34.75	93	0.85	11.6
99	13	5/23/2018	9:13	27	41°14.46	-70°46.24	13	0.70	10.4
100	12	5/23/2018	10:25	12	41°16.98	-70°45.73	25	0.83	11.0
101	14	5/23/2018	11:49	33	41°18.90	-70°52.36	149	0.10	N/A
102	14	5/23/2018	12:21	33	41°18.87	-70°52.36	153	0.85	10.3
103	15	5/24/2018	6:33	10	41°32.45	-70°30.52	244	0.85	14.8
104	16	5/24/2018	8:17	21	41°29.59	-70°29.90	109	0.82	14.0
105	15	5/24/2018	10:39	8	41°25.23	-70°25.71	10	0.55	11.4

Table 3. Sampling Effort Assigned and Accomplished by Stratum, Cruise 201891.

Stratum	Region	Assigned Stations	Number of Stations Completed			Aborted Tows
			All Accepted	Sub-Standard	Standard	
11	1	5	5		5	
12	1	7	7		7	
13	1	5	5		5	
14	1	2	2		2	1
15	2	10	10		10	
16	2	11	8		8	
17	3	5	5		5	
18	3	5	5		5	
19	3	2	2		2	
20	3	2	2		2	
21	3	2	2		2	
25	4	4	4		4	
26	4	5	5		5	
27	4	5	5		5	1
28	4	5	5		5	
29	4	5	5		5	
30	4	2	2		2	
31	5	3	3		3	
32	5	3	2		2	1
33	5	4	4		4	1
34	5	4	4		4	
35	5	5	4		4	3
36	5	2	2		2	
TOTALS		103	98	0	98	7

Note:
Standard Tows. SHG <=136. Recommended for use in all indices of abundance.
Sub-Standard Tows. SHG 141 - 166. Not recommended for use in indices other than spiny dogfish.
Aborted Tows. Catch data not recommended for use.

Table 4. Sub-Standard Tows (SHG 141 - 166) Completed on Cruise 201891.
Not Advised for Indices of Abundance other than Spiny Dogfish.

Station	Stratum	SHG	Location	Description
No sub-standard tows on cruise 201891				

Table 5. Attempted Tows Aborted During Cruise 201891.

Station	Stratum	SHG	Location	Description
15	35	176	Outer Massachusetts Bay	Ghost trawl intercepted
23	32	171	Little Nahant Bay	Right whale surfaced while towing
26	35	177	Northern Massachusetts Bay	Doors crossed and net damaged
29	33	171	Off Plum Island	Spike on sounder
35	35	177	East of Gloucester	Doors crossed no damage
48	27	176	Outside Provincetown Harbor	Ghost trawl intercepted
101	14	171	Outer Vineyard Sound	Winch operator error

Table 6a. Total Catch Numbers and Weights Observed on the 2018
Massachusetts Spring Inshore Bottom Trawl Survey - Cruise 201891- Sorted by Number

Species Code	Common Name	Count	Weight (kg)
143	SCUP	39,098	7,956.877
171	NORTHERN SEAROBIN	6,342	1,213.569
32	ATLANTIC HERRING	6,256	6.680
72	SILVER HAKE	5,213	223.980
106	WINTER FLOUNDER	4,367	567.128
163	LONGHORN SCULPIN	4,118	689.144
181	NORTHERN SAND LANCE	2,769	24.194
131	BUTTERFISH	2,674	158.712
105	YELLOWTAIL FLOUNDER	2,546	537.035
26	LITTLE SKATE	2,071	1,141.474
74	HADDOCK	1,784	1,273.339
33	ALEWIFE	1,635	49.710
78	SPOTTED HAKE	1,574	28.221
73	ATLANTIC COD	1,551	48.638
77	RED HAKE	1,241	82.312
503	LONGFIN SQUID	1,233	37.843
313	ATLANTIC ROCK CRAB	1,118	187.709
317	SPIDER CRAB UNCL	850	116.193
108	WINDOWPANE	684	125.794
301	AMERICAN LOBSTER	643	202.560
141	BLACK SEA BASS	548	165.066
102	AMERICAN PLAICE	477	77.383
193	OCEAN POUT	451	110.431
23	WINTER SKATE	391	262.431
322	LADY CRAB	343	34.279
103	SUMMER FLOUNDER	301	167.927
34	BLUEBACK HERRING	264	5.271
172	STRIPED SEAROBIN	179	71.992
13	SMOOTH DOGFISH	171	504.850
336	CHANNELED WHELK	141	23.679
348	NORTHERN MOONSNAIL	139	16.734
104	FOURSPOT FLOUNDER	103	26.531
35	AMERICAN SHAD	86	2.129
318	HORSESHOE CRAB	79	76.454
337	KNOBBED WHELK	79	28.770
312	JONAH CRAB	70	13.390
121	ATLANTIC MACKEREL	43	6.007
177	TAUTOG	43	18.912
401	SEA SCALLOP	40	3.928

Table 6a continued.

Species Code	Common Name	Count	Weight (kg)
117	SMALLMOUTH FLOUNDER	33	0.656
164	SEA RAVEN	30	12.547
176	CUNNER	21	1.470
45	RAINBOW SMELT	19	0.116
36	ATLANTIC MENHADEN	19	7.057
343	BLUE MUSSEL	18	2.626
403	ATLANTIC SURFCLAM	11	6.563
331	SEA URCHIN AND SAND DOLLAR UNCL	9	0.009
75	POLLOCK	5	0.115
197	GOOSEFISH	4	2.182
409	OCEAN QUAHOG	4	1.079
139	STRIPED BASS	4	9.790
43	BAY ANCHOVY	3	0.001
344	WAVED WHELK	3	0.157
155	ACADIAN REDFISH	3	0.175
113	ATLANTIC SILVERSIDE	2	0.014
183	DAUBED SHANNY	2	0.007
180	ROCK GUNNEL	2	0.011
323	MANTIS SHRIMP UNCL	2	0.091
502	NORTHERN SHORTFIN SQUID	1	0.038
63	CONGER EEL	1	0.260
314	BLUE CRAB	1	0.183
2	SEA LAMPREY	1	0.014
413	NORTHERN QUAHOG	1	0.523
28	THORNY SKATE	1	1.170
182	SNAKEBLENNY	1	0.041
101	ATLANTIC HALIBUT	1	0.065
165	ALLIGATORFISH	1	0.005
306	NORTHERN SHRIMP	-	0.441
Totals		91,918	16,334.682

Table 6b. Total Catch Numbers and Weights Observed on the 2018
Massachusetts Spring Inshore Bottom Trawl Survey - Cruise 201891- Sorted by Weight

SPP CODE	COMMON NAME	COUNT	WEIGHT(kg)
143	SCUP	39,098	7,956.877
74	HADDOCK	1,784	1,273.339
171	NORTHERN SEAROBIN	6,342	1,213.569
26	LITTLE SKATE	2,071	1,141.474
163	LONGHORN SCULPIN	4,118	689.144
106	WINTER FLOUNDER	4,367	567.128
105	YELLOWTAIL FLOUNDER	2,546	537.035
13	SMOOTH DOGFISH	171	504.850
23	WINTER SKATE	391	262.431
72	SILVER HAKE	5,213	223.980
301	AMERICAN LOBSTER	643	202.560
313	ATLANTIC ROCK CRAB	1,118	187.709
103	SUMMER FLOUNDER	301	167.927
141	BLACK SEA BASS	548	165.066
131	BUTTERFISH	2,674	158.712
108	WINDOWPANE	684	125.794
317	SPIDER CRAB UNCL	850	116.193
193	OCEAN POUT	451	110.431
77	RED HAKE	1,241	82.312
102	AMERICAN PLAICE	477	77.383
318	HORSESHOE CRAB	79	76.454
172	STRIPED SEAROBIN	179	71.992
33	ALEWIFE	1,635	49.710
73	ATLANTIC COD	1,551	48.638
503	LONGFIN SQUID	1,233	37.843
322	LADY CRAB	343	34.279
337	KNOBBED WHELK	79	28.770
78	SPOTTED HAKE	1,574	28.221
104	FOURSPOT FLOUNDER	103	26.531
181	NORTHERN SAND LANCE	2,769	24.194
336	CHANNELED WHELK	141	23.679
177	TAUTOG	43	18.912
348	NORTHERN MOONSNAIL	139	16.734
312	JONAH CRAB	70	13.390
164	SEA RAVEN	30	12.547
139	STRIPED BASS	4	9.790
36	ATLANTIC MENHADEN	19	7.057
32	ATLANTIC HERRING	6,256	6.680
403	ATLANTIC SURFCLAM	11	6.563
121	ATLANTIC MACKEREL	43	6.007
34	BLUEBACK HERRING	264	5.271
401	SEA SCALLOP	40	3.928
343	BLUE MUSSEL	18	2.626

Table 6b continued.

SPP CODE	COMMON NAME	COUNT	WEIGHT(kg)
197	GOOSEFISH	4	2.182
35	AMERICAN SHAD	86	2.129
176	CUNNER	21	1.470
28	THORNY SKATE	1	1.170
409	OCEAN QUAHOG	4	1.079
117	SMALLMOUTH FLOUNDER	33	0.656
413	NORTHERN QUAHOG	1	0.523
306	NORTHERN SHRIMP	-	0.441
63	CONGER EEL	1	0.260
314	BLUE CRAB	1	0.183
155	ACADIAN REDFISH	3	0.175
344	WAVED WHELK	3	0.157
45	RAINBOW SMELT	19	0.116
75	POLLOCK	5	0.115
323	MANTIS SHRIMP UNCL	2	0.091
101	ATLANTIC HALIBUT	1	0.065
182	SNAKEBLENNY	1	0.041
502	NORTHERN SHORTFIN SQUID	1	0.038
2	SEA LAMPREY	1	0.014
113	ATLANTIC SILVERSIDE	2	0.014
180	ROCK GUNNEL	2	0.011
331	SEA URCHIN AND SAND DOLLAR UNCL	9	0.009
183	DAUBED SHANNY	2	0.007
165	ALLIGATORFISH	1	0.005
43	BAY ANCHOVY	3	0.001
Totals		91,918	16,334.682

Table 7. Number of individuals obtained for age, growth, maturity and special studies during Massachusetts DMF Cruise 201891.

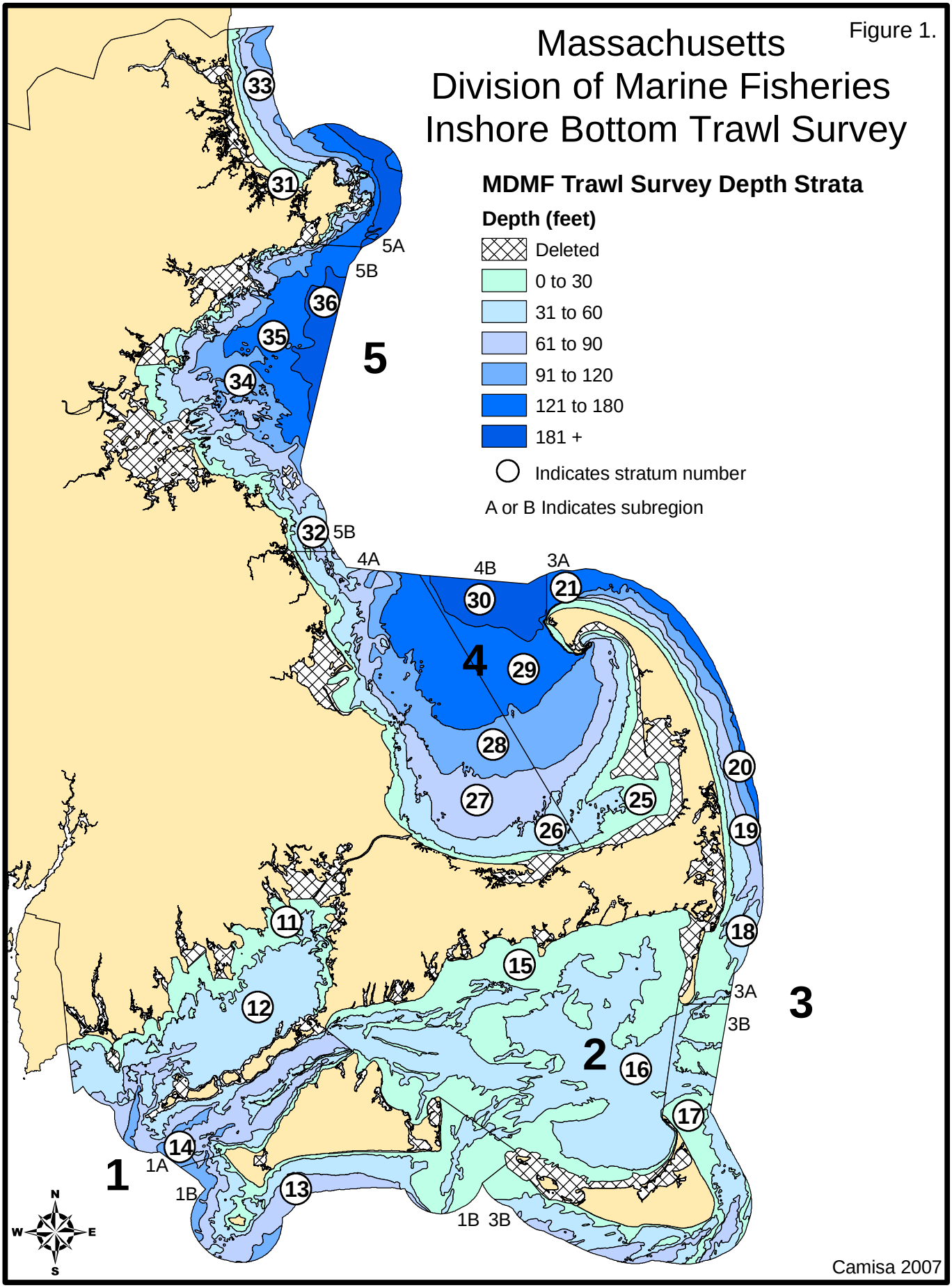
Species	Maturity Observation	Age and Growth Collection Scales	Otoliths	YOY
Atlantic Cod	48		48	
Haddock	95		95	
Summer Flounder	189		189	
Yellowtail Flounder	351	351		
Winter Flounder	541		541	
Black Sea Bass	133		133	
Scup	61		61	
Tautog	21		21	
American Lobster	31			
Jonah crab (Female)	5			
TOTAL	1,475	351	1,088	0

OTHER COLLECTIONS:

All jonah crabs measured to 0.1 cm carapace width and egg bearing female crabs status recorded for size at maturity study (Perry).
800+ YOY Atlantic cod saved for age and growth study (Dean).
2 silversides and 1 ocean quahog saved for Ocean Genome project (Bernados).
Nantucket Sound whelk saved for age and growth study (Wilcox).
57 black sea bass saved for classroom dissection (Golet).
6 black sea bass saved for maturity study (Koob).
600+ river herring saved for age and growth study (Armstrong).
47 various individuals saved for seal predation study (Lyssikatos).
Longfin squid egg mops saved for mortality study (Hendrickson).
1 tautog saved for age and growth (Elzey).

Figure 1.

Massachusetts Division of Marine Fisheries Inshore Bottom Trawl Survey



Camisa 2007

Figure 2.

Spring 2018
Mass Division of Marine Fisheries
Bottom Trawl Survey
Tow Locations

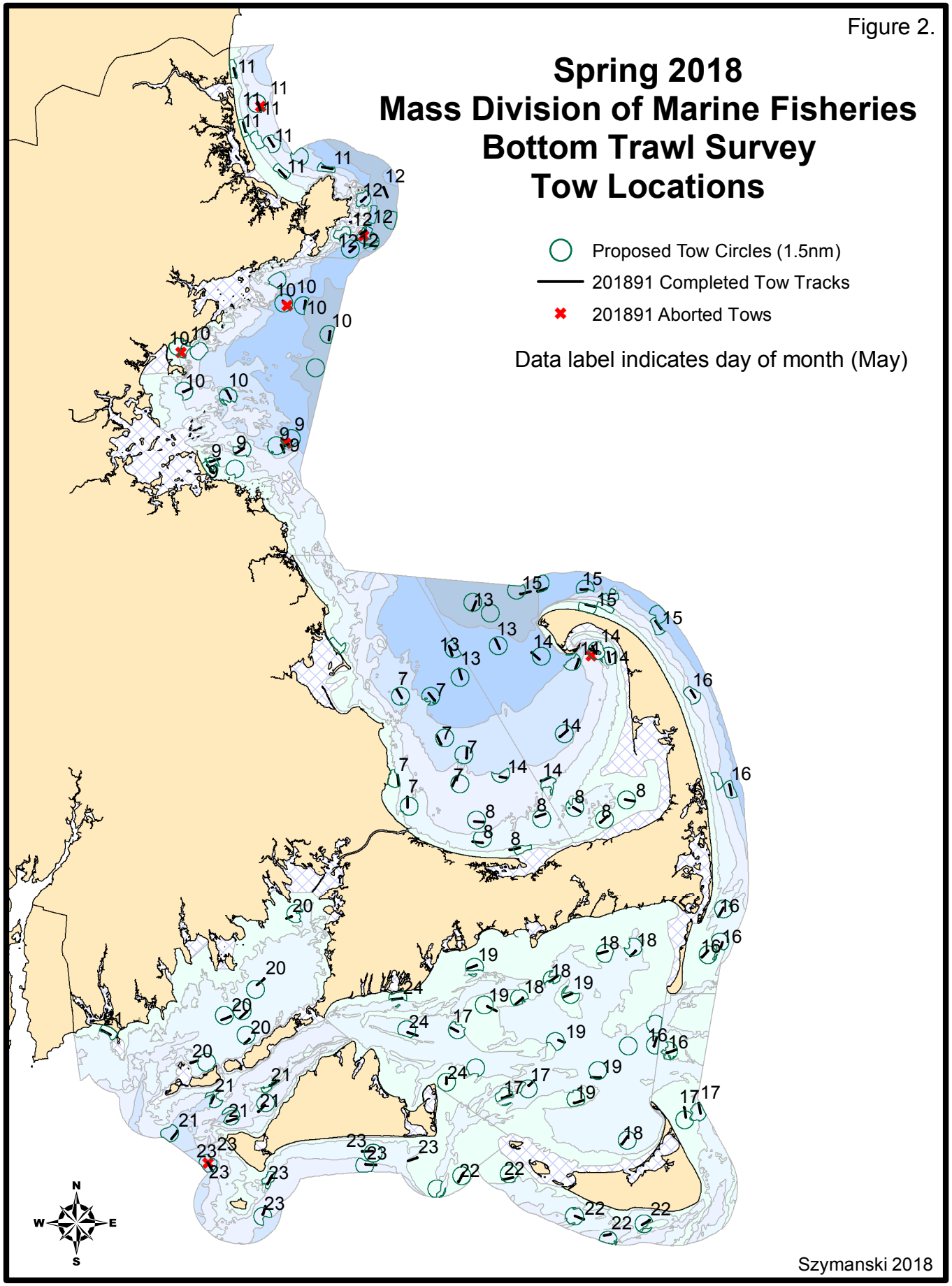
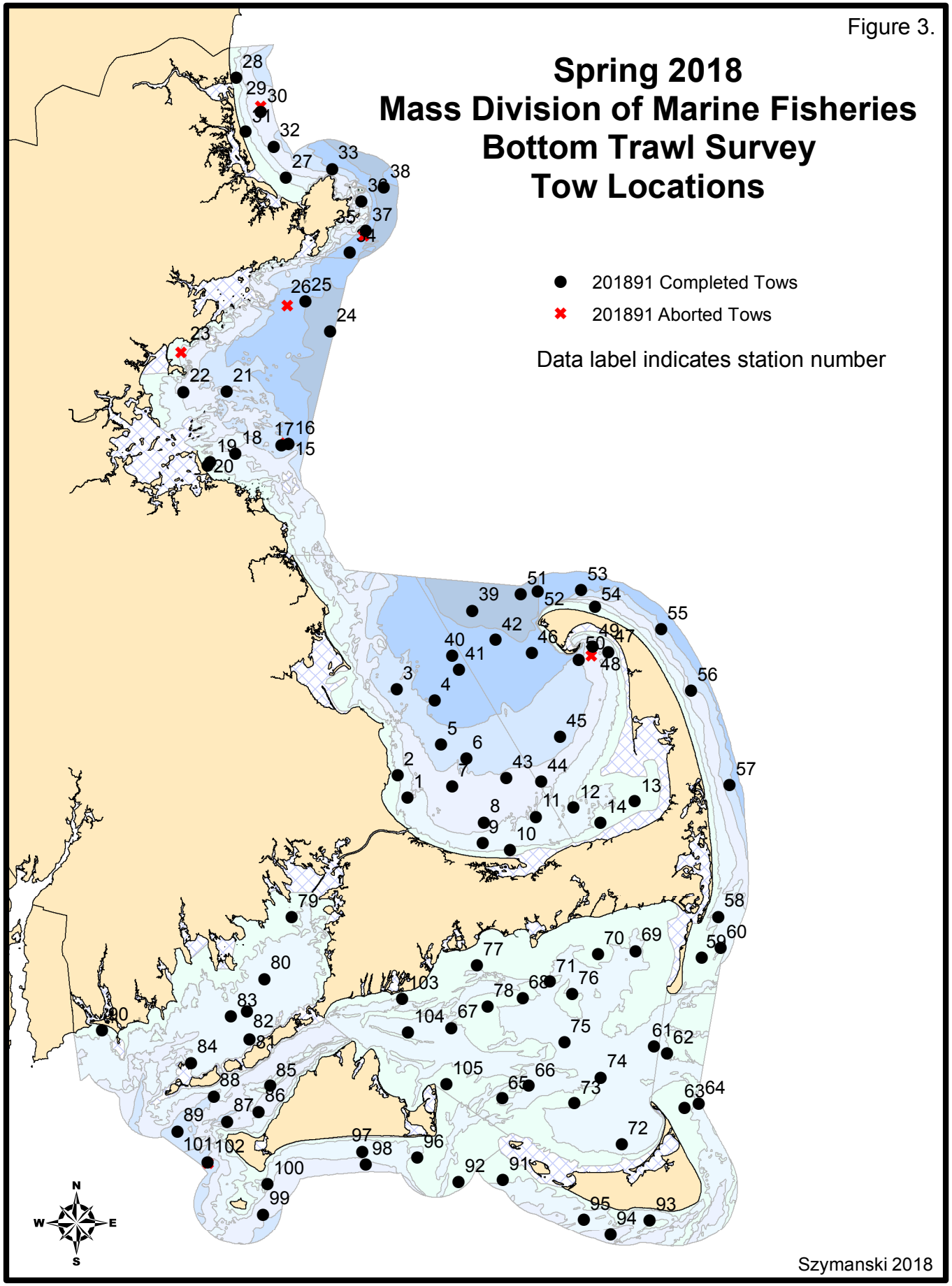


Figure 3.

Spring 2018
Mass Division of Marine Fisheries
Bottom Trawl Survey
Tow Locations



CRUISE RESULTS

R/V GLORIA MICHELLE

2018 Massachusetts Inshore Fall
Bottom Trawl Survey
Cruise No. 201892

CRUISE PERIOD AND AREA

From September 4 through September 23, 2018 the Massachusetts Division of Marine Fisheries (MADMF) conducted its 41st fall bottom trawl survey. The survey extended from New Hampshire to Rhode Island boundaries seaward to three nautical miles including Cape Cod Bay and Nantucket Sound.

OBJECTIVES

Cruise objectives were 1) to determine the fall distribution, relative abundance, and size composition of fish and select invertebrate species; and 2) to collect biological samples. Requested special collections were also undertaken.

METHODS

The study area is stratified based on five bio-geographic regions and six depth zones (Fig. 1). Trawl sites are allocated in proportion to stratum area and randomly chosen in advance within each sampling stratum. Randomly chosen stations in locations known to be untowable due to hard bottom are reassigned. Sampling intensity is approximately 1 station per 19 square nautical miles. A minimum of two stations are assigned to each stratum.

A standard tow of 20-minute duration at 2.5 knots was attempted at each station during daylight hours with a 3/4 size North Atlantic type two seam otter trawl (11.9 m headrope/15.5 m footrope) rigged with a 7.6 cm rubber disc sweep; 19.2 m, 9.5 mm chain bottom legs; 18.3 m, 9.5 mm wire top legs; and 1.8 X 1.0 m, 147 kg wooden trawl doors. The codend contains a 6.4 mm knotless liner to retain small fish. Prior to setting the net at each station, NOAA Corps officers surveyed the site by visually scanning for buoys marking fixed gear as well as determining the suitability of the bottom for towing the net based on the sounder image. Whenever necessary, sites were relocated due to untowable bottom or concentrations of fixed gear. Abbreviated tows of 13-19 minute duration were accepted as valid and expanded to the 20 minute standard.

Standard bottom trawl survey techniques were used when processing the catch. The total weight and length-frequency of each species were recorded directly into Fisheries Scientific Computer System (FSCS) data tables. Collections of age and growth material, and biological observations were undertaken during the measuring operation. Specimens were also saved to fulfill requests. Bottom temperatures were continuously recorded with an Onset Water Temp Pro v2 attached to the net's headrope.

Twenty-nine MADMF employees participated in the survey as part of the scientific party, joined by two scientists from the National Marine Fisheries Service and one student from Northeastern University (Table 1). Two NOAA Corps officers operated the research vessel and fishing gear assisted by one additional NOAA officer, three employees from NMFS, and one contract fisherman.

CRUISE SUMMARY

95 stations were attempted in 16 sampling days (Figs 1 and 2, Table 2). Ninety completed stations are considered acceptable for assessment of all species, SHG <=136 (Table 3). Thirteen station assignments were not completed with acceptable trawl hauls due to adverse weather conditions, hard bottom and fixed gear. Strong Northerly and Easterly winds forced us to make several schedule changes and prevented us from completing seven stations in strata 12, 15, 16, 17, 33 and 34. One station was dropped in stratum 16 due to sand waves and one station was dropped in stratum 27 due to a large catch of sulfur sponge. Two stations in stratum 35, one station in stratum 28 and one station in stratum 15 were dropped due to fixed gear. Four attempted tows were aborted due to hard bottom, ghost gear and sulfur sponge (Table 5, Fig. 3).

The primary goal of tallying weight, number, and a representative length frequency of each fish species in the catches was accomplished (Tables 6a and 6b). Three interesting records were set on the 2018 fall survey. The first harvestfish were recorded at station 30 off West Island in Buzzard's Bay and the first Northern stargazer was recorded at station 44 North of Muskeget Island in Nantucket Sound. Also, the largest abundance of gray triggerfish (22) was recorded at station 47 Northeast of Muskeget Island. Moderate catches of winter flounder, American lobster, whiting and red hake were taken North of Cape Cod. Scup, longfin squid and butterfish were abundant throughout Nantucket Sound, Vineyard Sound and Buzzard's Bay.

Additional sampling goals were achieved (Table 7). To aid cooperative fisheries assessments, 875 otolith samples, as well as sex and maturity observations, were taken from Atlantic cod, haddock, summer flounder, yellowtail flounder, winter flounder, black sea bass, scup, tautog, American lobster and jonah crabs. Additional samples were collected to assist ongoing research by fisheries scientists from MDMF and other labs in the region.

For further information on this survey or others in the time series, please contact Matthew Camisa at (508) 742-9743.

Table 1. MADMF Fall Cruise 2018 Staffing List

Scientific Party

Name	Affiliation	Num. Days
Matthew Camisa	MADMF	11
Mark Szymanski	MADMF	10
Vincent Manfredi	MADMF	8
Steve Voss	MADMF	6
Tiffany Cunningham	MADMF	6
Bob Glenn	MADMF	4
Brendan Reilly	MADMF	4
Elise Koob	MADMF	4
John Logan	MADMF	4
Sandra Sutherland	NMFS	4
Greg Decelles	MADMF	3
Kim Trull	MADMF	3
Brad Schondelmeier	MADMF	2
Chrissy Petitpas	MADMF	2
John Sheppard	MADMF	2
Mark Rousseau	MADMF	2
Mike Trainor	MADMF	2
Nicole Ward	MADMF	2
Steve Wilcox	MADMF	2
Josh Dayton	NMFS	2
Christine Cassidy	MADMF	1
Christy Draghetti	MADMF	1
Derek Perry	MADMF	1
Erich Druskat	MADMF	1
Iain Church	MADMF	1
Kathrine McCarthy	MADMF	1
Mike Pol	MADMF	1
Sarah Turner	MADMF	1
Scott Elzey	MADMF	1
Shaun Wallace	MADMF	1
Tracy Pugh	MADMF	1
Kristen Schmicker	NORTHEASTERN	1
		95

R/V Gloria Michelle Crew

Name	Affiliation	Num. Days
Officers		
Chris Gallagher	NOAA OIC	18
Ben VanDine	NOAA JOIC	18
Mike Ball	NOAA-CORPS	1
Deck Crew		
George Morton	Contract Fisherman	18
Christina Buscunyan	NMFS-Narragansett	9
Pete Plantamura	NMFS-Sandy Hook	7
Ashley Griffin	NMFS-Woods Hole	2

Table 2. Station Information for the 2018 Massachusetts Fall Inshore Bottom Trawl Survey
Cruise No. 201892

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
1	26	9/4/2018	5:59	19	41°47.62	-70°27.61	309	0.06	N/A
2	26	9/4/2018	6:47	19	41°47.61	-70°27.74	294	0.74	12.7
3	28	9/4/2018	8:45	35	41°57.24	-70°28.78	172	0.84	10.1
4	29	9/4/2018	12:14	45	41°59.77	-70°25.63	263	0.75	9.4
5	28	9/4/2018	14:26	35	41°54.40	-70°25.62	57	0.83	9.9
6	27	9/4/2018	16:13	25	41°49.64	-70°22.90	217	0.85	11.3
7	25	9/5/2018	5:41	11	41°46.10	-70°27.65	118	0.84	18.0
8	25	9/5/2018	8:03	10	41°44.86	-70°17.89	65	0.84	15.6
9	26	9/5/2018	9:40	17	41°47.64	-70°15.32	62	0.86	13.9
10	25	9/5/2018	11:40	6	41°48.26	-70°04.45	50	0.83	22.3
11	27	9/5/2018	14:16	25	41°51.80	-70°13.24	43	0.84	11.2
12	27	9/5/2018	16:15	27	41°50.63	-70°18.13	53	0.8	11.6
13	26	9/6/2018	6:14	19	41°51.32	-70°29.23	172	0.86	11.9
14	27	9/6/2018	9:15	26	42°02.59	-70°34.45	200	0.54	11.0
15	35	9/6/2018	12:08	41	42°19.34	-70°42.05	253	0.53	10.1
16	33	9/6/2018	13:46	21	42°18.48	-70°48.18	242	0.53	12.7
17	32	9/6/2018	17:07	12	42°17.50	-70°51.66	152	0.55	14.3
18	31	9/7/2018	6:35	9	42°24.97	-70°57.32	198	0.75	13.5
19	32	9/7/2018	8:48	13	42°26.31	-70°54.78	16	0.67	13.7
20	33	9/7/2018	10:04	26	42°26.92	-70°52.78	54	0.76	11.5
21	34	9/7/2018	12:23	31	42°26.17	-70°51.37	99	0.53	11.5
22	34	9/7/2018	14:06	32	42°23.37	-70°48.59	283	0.75	10.7
23	36	9/7/2018	17:04	69	42°29.87	-70°38.64	333	0.84	9.4
24	36	9/8/2018	6:22	76	42°43.19	-70°34.12	145	0.85	8.9
25	34	9/8/2018	8:25	31	42°42.00	-70°38.74	353	0.54	11.5
26	12	9/11/2018	7:05	17	41°27.54	-70°52.22	241	0.83	20.1
27	12	9/11/2018	8:18	17	41°30.28	-70°53.12	236	0.84	20.6
28	12	9/11/2018	9:26	18	41°31.13	-70°49.65	245	0.84	20.6
29	12	9/11/2018	10:41	15	41°32.37	-70°49.09	31	0.85	20.7
30	11	9/11/2018	12:02	10	41°35.50	-70°48.33	332	0.85	21.8
31	11	9/11/2018	13:35	9	41°37.62	-70°44.79	30	0.85	22.4
32	11	9/11/2018	14:34	8	41°38.30	-70°43.46	348	0.55	22.5
33	13	9/11/2018	16:40	21	41°28.68	-70°41.82	59	0.68	22.6
34	16	9/12/2018	6:19	19	41°31.57	-70°36.40	84	0.84	22.4
35	15	9/12/2018	7:28	9	41°32.46	-70°30.35	267	0.58	22.5
36	15	9/12/2018	9:43	8	41°34.29	-70°18.29	302	0.84	22.0
37	15	9/12/2018	10:51	9	41°31.90	-70°17.41	28	0.85	22.4
38	15	9/12/2018	12:24	8	41°37.40	-70°10.53	240	0.85	21.8
39	16	9/12/2018	13:31	13	41°35.11	-70°12.43	88	0.83	21.9
40	16	9/12/2018	14:56	12	41°30.66	-70°09.46	65	0.85	20.2
41	16	9/13/2018	7:04	16	41°28.01	-70°28.32	94	0.84	22.2
42	16	9/13/2018	8:02	13	41°26.01	-70°28.30	58	0.87	21.9
43	15	9/13/2018	9:25	8	41°25.98	-70°20.07	146	0.01	N/A
44	15	9/13/2018	10:57	9	41°24.32	-70°18.36	247	0.84	20.6
45	15	9/13/2018	12:51	10	41°24.69	-70°09.09	267	0.84	21.3
46	16	9/13/2018	13:51	14	41°22.87	-70°12.61	79	0.85	21.1
47	15	9/13/2018	15:02	8	41°21.11	-70°16.76	106	0.87	21.3
48	15	9/13/2018	16:43	10	41°19.28	-70°09.10	98	0.85	21.5

Table 2 continued.

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
49	16	9/14/2018	6:06	14	41°21.24	-70°10.97	114	0.86	21.2
50	17	9/14/2018	8:51	9	41°24.23	-69°58.39	223	0.84	17.7
51	17	9/14/2018	9:59	8	41°22.21	-69°59.16	183	0.83	18.9
52	18	9/14/2018	11:07	17	41°22.02	-69°57.10	175	0.63	16.1
53	18	9/14/2018	12:03	12	41°23.36	-69°57.59	167	0.87	16.0
54	16	9/14/2018	14:08	15	41°27.44	-70°02.84	275	0.77	18.7
55	28	9/15/2018	9:55	29	41°55.09	-70°11.22	229	0.85	12.7
56	26	9/15/2018	11:16	13	41°54.37	-70°07.88	201	0.85	18.1
57	25	9/15/2018	12:29	9	41°56.56	-70°05.79	191	0.84	18.7
58	26	9/15/2018	13:35	13	41°58.69	-70°06.29	178	0.86	17.6
59	27	9/15/2018	15:12	28	41°59.14	-70°08.03	171	0.71	13.8
60	28	9/15/2018	17:02	34	41°56.27	-70°13.82	45	0.85	11.1
61	29	9/16/2018	6:10	42	41°58.63	-70°16.99	48	0.84	11.0
62	30	9/16/2018	7:44	58	42°04.59	-70°21.21	120	0.84	10.0
63	30	9/16/2018	9:04	61	42°05.28	-70°14.88	244	0.85	10.0
64	21	9/16/2018	10:18	61	42°06.10	-70°12.61	236	0.87	10.1
65	17	9/16/2018	11:39	7	42°05.49	-70°11.55	108	0.85	18.7
66	17	9/16/2018	12:59	10	42°04.48	-70°06.41	121	0.83	16.3
67	20	9/16/2018	14:54	30	42°05.99	-70°09.24	83	0.56	10.2
68	29	9/17/2018	7:23	55	42°02.78	-70°21.86	165	0.84	10.2
69	29	9/17/2018	9:23	44	42°03.29	-70°30.29	135	0.83	10.7
70	29	9/17/2018	10:35	53	42°05.03	-70°26.91	272	0.76	10.0
71	35	9/17/2018	15:21	50	42°31.13	-70°42.11	243	0.68	10.3
72	35	9/18/2018	6:17	37	42°44.11	-70°40.26	131	0.57	11.9
73	33	9/18/2018	7:15	31	42°43.28	-70°42.19	153	0.84	12.2
74	31	9/18/2018	8:10	10	42°40.82	-70°42.16	99	0.85	16.8
75	32	9/18/2018	10:04	12	42°48.04	-70°47.72	158	0.57	16.1
76	31	9/18/2018	10:51	8	42°46.90	-70°47.82	167	0.84	17.6
77	11	9/20/2018	7:43	10	41°16.98	-70°24.56	32	0.84	19.6
78	19	9/20/2018	10:30	23	41°12.32	-70°08.70	80	0.81	19.5
79	18	9/20/2018	11:46	17	41°15.18	-70°13.71	111	0.84	19.6
80	12	9/20/2018	14:16	17	41°19.00	-70°32.80	93	0.86	19.8
81	11	9/20/2018	15:57	10	41°20.40	-70°41.68	93	0.84	20.4
82	13	9/20/2018	17:28	27	41°14.50	-70°46.28	23	0.56	19.0
83	12	9/21/2018	5:52	18	41°25.09	-70°51.49	257	0.84	20.2
84	13	9/21/2018	7:01	23	41°24.11	-70°54.01	243	0.84	19.8
85	14	9/21/2018	8:24	28	41°21.83	-71°00.32	325	0.84	19.8
86	14	9/21/2018	10:08	31	41°18.15	-70°51.89	331	0.84	18.2
87	13	9/21/2018	11:07	23	41°18.08	-70°50.71	347	0.84	18.8
88	13	9/21/2018	12:19	28	41°21.14	-70°53.80	56	0.84	19.1
89	18	9/23/2018	6:46	14	41°37.13	-69°54.56	198	0.85	16.2
90	18	9/23/2018	8:26	17	41°41.87	-69°54.16	7	0.83	14.6
91	19	9/23/2018	9:36	22	41°41.54	-69°53.19	117	0.09	N/A
92	20	9/23/2018	11:00	35	41°46.27	-69°52.07	339	0.55	11.5
93	19	9/23/2018	13:45	28	41°59.06	-69°58.31	335	0.55	13.7
94	21	9/23/2018	15:18	46	42°04.22	-70°00.88	329	0.86	10.7
95	20	9/23/2018	16:22	35	42°03.53	-70°01.23	327	0.79	11.3

Table 3. Sampling Effort Assigned and Accomplished by Stratum, Cruise 201892.

Stratum	Region	Assigned Stations	Number of Stations Completed			Aborted Tows
			All Accepted	Sub-Standard	Standard	
11	1	5	5		5	
12	1	7	6		6	
13	1	5	5		5	
14	1	2	2		2	
15	2	10	8		8	1
16	2	11	8		8	
17	3	5	4		4	
18	3	5	5		5	
19	3	2	2		2	1
20	3	2	2	1	2	
21	3	2	2		2	
25	4	4	4		4	
26	4	5	5		5	1
27	4	5	4		4	1
28	4	5	4		4	
29	4	5	5		5	
30	4	2	2		2	
31	5	3	3		3	
32	5	3	3		3	
33	5	4	3		3	
34	5	4	3		3	
35	5	5	3		3	
36	5	2	2		2	
TOTALS		103	90	1	90	4

Note:
Standard Tows. SHG <=136. Recommended for use in all indices of abundance.
Sub-Standard Tows. SHG 141 - 166. Not recommended for use in indices other than spiny dogfish.
Aborted Tows. Catch data not recommended for use.

Table 4. Sub-Standard Tows (SHG 141 - 166) Completed on Cruise 201892.
Not Advised for Indices of Abundance other than Spiny Dogfish.

Station	Stratum	SHG	Location	Description
92	20	141	Northeast of Chatham	Dogfish tow

Table 5. Attempted Tows Aborted During Cruise 201892.

Station	Stratum	SHG	Location	Description
1	26	175	Entrance to Cape Cod Canal	Starboad wing torn from hard bottom
43	15	171	Nantucket Sound main channel	Hung down
59	27	177	Inside Cape Cod Bay off Truro	Large catch of sulfur sponge
91	19	179	East of Nauset	Hung down

Table 6a. Total Catch Numbers and Weights Observed on the 2018
Massachusetts Fall Inshore Bottom Trawl Survey - Cruise 201892- Sorted by Number

Species Code	Common Name	Count	Weight (kg)
143	SCUP	249,727	1,802.181
131	BUTTERFISH	55,752	362.801
503	LONGFIN SQUID	19,070	139.326
141	BLACK SEA BASS	7,355	81.378
106	WINTER FLOUNDER	5,521	785.081
77	RED HAKE	4,183	462.989
72	SILVER HAKE	4,042	387.432
15	SPINY DOGFISH	3,949	11,110.743
301	AMERICAN LOBSTER	3,596	1,060.482
313	ATLANTIC ROCK CRAB	2,035	201.438
105	YELLOWTAIL FLOUNDER	1,867	315.896
26	LITTLE SKATE	1,731	925.151
23	WINTER SKATE	1,079	1,874.142
163	LONGHORN SCULPIN	1,042	121.988
108	WINDOWPANE	709	114.385
322	LADY CRAB	591	52.089
176	CUNNER	500	11.407
102	AMERICAN PLAICE	452	23.898
103	SUMMER FLOUNDER	445	292.916
312	JONAH CRAB	377	61.210
33	ALEWIFE	291	16.532
171	NORTHERN SEAROBIN	284	11.414
45	RAINBOW SMELT	276	7.013
317	SPIDER CRAB UNCL	266	16.426
35	AMERICAN SHAD	247	3.106
43	BAY ANCHOVY	238	0.470
116	NORTHERN PIPEFISH	191	0.370
13	SMOOTH DOGFISH	182	389.103
76	WHITE HAKE	175	10.528
117	SMALLMOUTH FLOUNDER	173	1.090
74	HADDOCK	170	51.422
104	FOURSPOT FLOUNDER	164	28.351
145	WEAKFISH	152	4.740
78	SPOTTED HAKE	137	15.906
193	OCEAN POUT	125	15.487
146	NORTHERN KINGFISH	119	11.781
132	ATLANTIC MOONFISH	111	0.468
502	NORTHERN SHORTFIN SQUID	108	17.364
177	TAUTOG	95	19.460
181	NORTHERN SAND LANCE	93	0.264
348	NORTHERN MOONSNAIL	60	4.465
337	KNOBBED WHELK	56	15.672
172	STRIPED SEAROBIN	51	22.190
318	HORSESHOE CRAB	45	58.396

Table 6a continued.

Species Code	Common Name	Count	Weight (kg)
401	SEA SCALLOP	45	5.901
343	BLUE MUSSEL	42	3.660
73	ATLANTIC COD	34	5.386
197	GOOSEFISH	32	23.214
331	SEA URCHIN AND SAND DOLLAR UNCL	28	0.747
202	GRAY TRIGGERFISH	22	22.310
135	BLUEFISH	20	0.776
107	WITCH FLOUNDER	18	4.066
164	SEA RAVEN	14	6.329
208	MACKEREL SCAD	10	0.016
32	ATLANTIC HERRING	8	1.050
129	BLUE RUNNER	7	0.536
180	ROCK GUNNEL	7	0.043
196	NORTHERN PUFFER	7	0.196
336	CHANNELED WHELK	7	1.742
36	ATLANTIC MENHADEN	5	1.956
168	LUMPFISH	4	1.307
749	HARVESTFISH	3	0.521
121	ATLANTIC MACKEREL	3	0.232
435	INSHORE LIZARDFISH	3	0.158
34	BLUEBACK HERRING	3	0.209
338	MOON SNAIL, SHARK EYE, AND BABY-EAR	3	0.174
83	FOURBEARD ROCKLING	3	0.173
403	ATLANTIC SURFCLAM	2	0.350
413	NORTHERN QUAHOG	2	1.008
118	HOGCHOKER	2	0.414
209	BIGEYE SCAD	2	0.108
323	MANTIS SHRIMP UNCL	2	0.076
314	BLUE CRAB	2	0.351
75	POLLOCK	2	0.244
24	CLEARNOSE SKATE	1	2.190
120	BLUESPOTTED CORNETFISH	1	0.002
439	SNAKEFISH	1	0.013
149	SPOT	1	0.125
31	ROUND HERRING	1	0.031
211	ROUND SCAD	1	0.029
833	SCRAWLED FILEFISH	1	0.052
179	NORTHERN STARGAZER	1	0.339
185	OYSTER TOADFISH	1	0.645
402	BAY SCALLOP	1	0.001
212	ROUGH SCAD	1	0.010
205	ATLANTIC SAURY	1	0.056
520	LONGFIN SQUID EGG MOPS	-	30.251
Totals		368,186	21,025.948

Table 6b. Total Catch Numbers and Weights Observed on the 2018
Massachusetts Fall Inshore Bottom Trawl Survey - Cruise 201892- Sorted by Weight

Species Code	Common Name	Count	Weight (kg)
15	SPINY DOGFISH	3,949	11,110.743
23	WINTER SKATE	1,079	1,874.142
143	SCUP	249,727	1,802.181
301	AMERICAN LOBSTER	3,596	1,060.482
26	LITTLE SKATE	1,731	925.151
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318	HORSESHOE CRAB	45	58.396
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164	SEA RAVEN	14	6.329
401	SEA SCALLOP	45	5.901
73	ATLANTIC COD	34	5.386
145	WEAKFISH	152	4.740
348	NORTHERN MOONSNAIL	60	4.465

Table 6b continued.

Species Code	Common Name	Count	Weight (kg)
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343	BLUE MUSSEL	42	3.660
35	AMERICAN SHAD	247	3.106
24	CLEARNOSE SKATE	1	2.190
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135	BLUEFISH	20	0.776
331	SEA URCHIN AND SAND DOLLAR UNCL	28	0.747
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435	INSHORE LIZARDFISH	3	0.158
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439	SNAKEFISH	1	0.013
212	ROUGH SCAD	1	0.010
120	BLUESPOTTED CORNETFISH	1	0.002
402	BAY SCALLOP	1	0.001
Totals		368,186	21,025.948

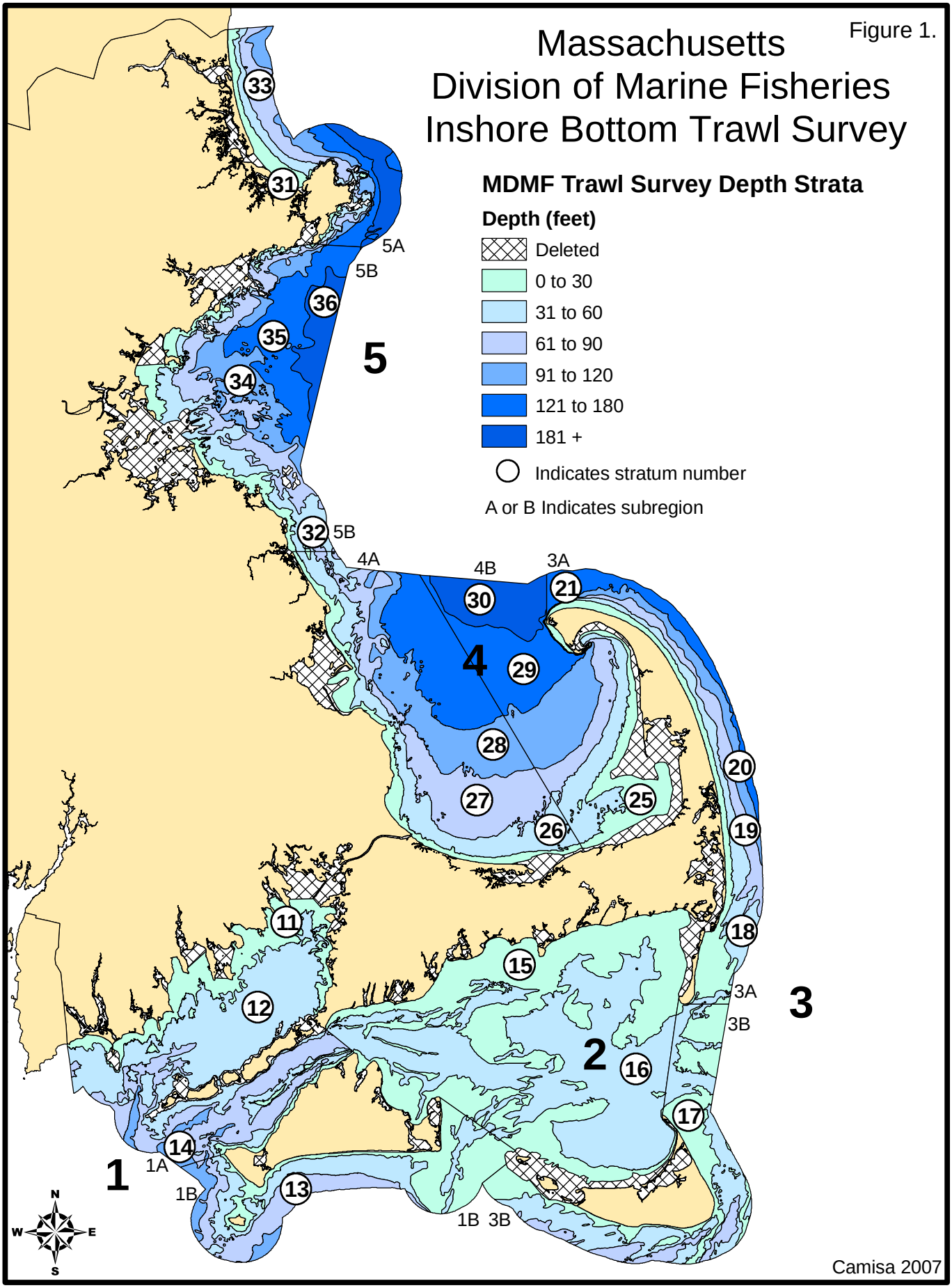
Table 7. Number of individuals obtained for age, growth, maturity and special studies during Massachusetts DMF Cruise 201892.

Species	Maturity Observation	Age and Growth Collection Scales	Otoliths	Opercula	YOY
Atlantic Cod	19		19		
Haddock	43		43		
Summer Flounder	219		218		
Yellowtail Flounder	186		186		
Winter Flounder	269		267		
Black Sea Bass	70		70		
Scup	46		46		
Tautog	28		26		49
American Lobster	98				
Jonah crab (Female)	1				
TOTAL	979	0	875	0	49

OTHER COLLECTIONS:
Jonah crabs measured to 0.1 cm carapace width and egg bearing status recorded for size at maturity study (D. Perry).
61 male jonah crabs tagged for migration study (D. Perry).
7 YOY cod for age and growth (Dean).
Longfin squid egg mops collected from 3 stations for genetics study (L. Hendrickson).
1 Atlantic saury, 3 Harvestfish and 2 Bigeye scad saved for ID
Various crustaceans and mollusks saved for sea turtle diet study (Logan).

Figure 1.

Massachusetts Division of Marine Fisheries Inshore Bottom Trawl Survey



Camisa 2007

Figure 2.

Fall 2018
Mass Division of Marine Fisheries
Bottom Trawl Survey
Tow Locations

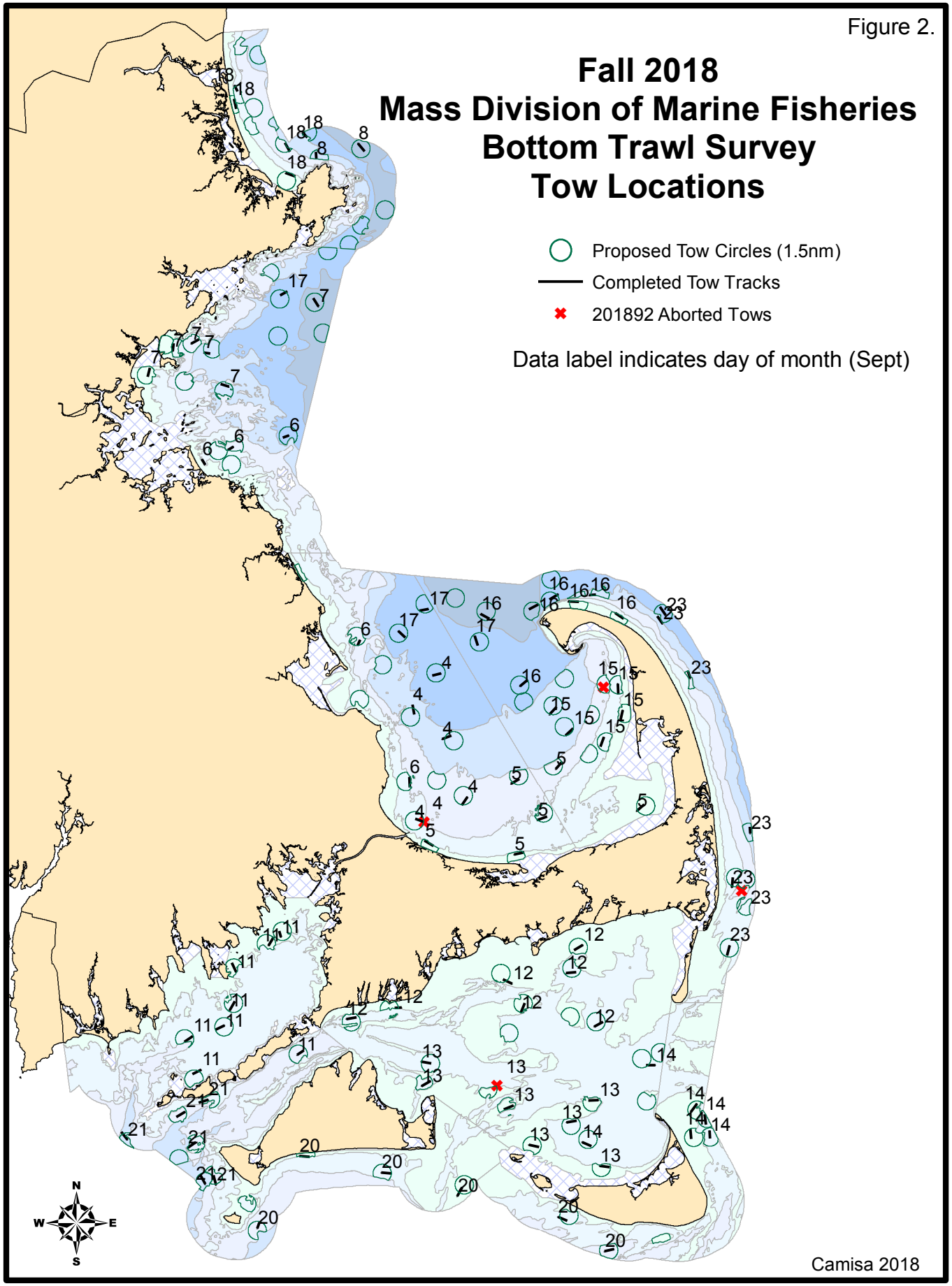
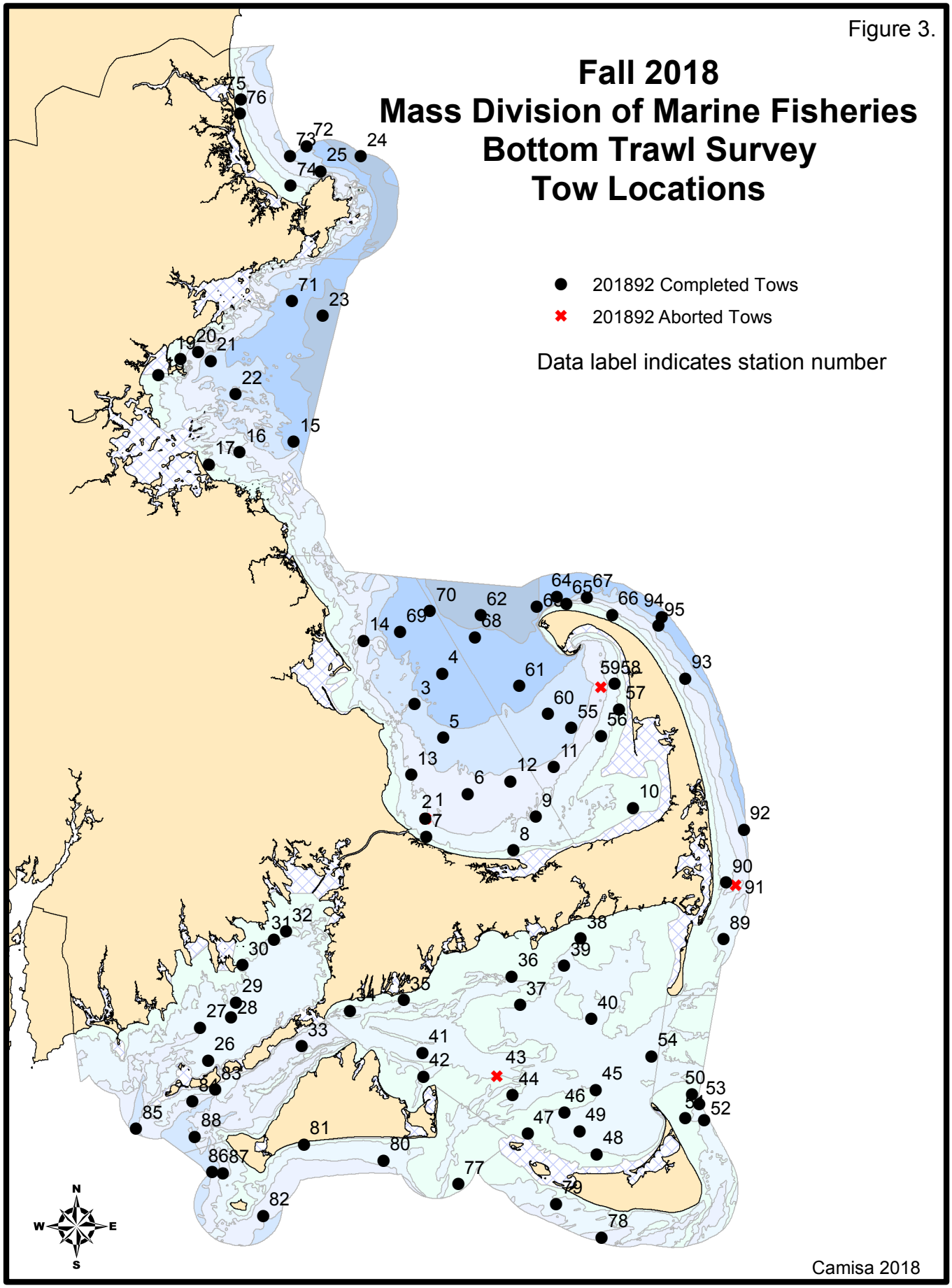


Figure 3.


Fall 2018
Mass Division of Marine Fisheries
Bottom Trawl Survey
Tow Locations
201892 Completed Tows
201892 Aborted Tows
Data label indicates station number
Camisa 2018
N
W
E
S





2018 Cruise Highlights
MADMF Trawl Survey




SURVEY REPORT
2018 Nantucket Sound Estuarine Winter Flounder
Young of the Year (YOY)
Seine Survey

SURVEY PERIOD AND AREA

From June 21 – July 3, 2018 the Massachusetts Division of Marine Fisheries (MDMF) conducted its 43rd Nantucket Sound Estuarine Winter Flounder YOY Seine Survey. The survey covers six Nantucket Sound estuaries on the south side of Cape Cod – Great Pond, Waquoit Bay, Cotuit Bay, Lewis Bay, Bass River and Stage Harbor (Figure 1).

OBJECTIVES

Survey objectives were 1) to provide a winter flounder YOY abundance index for the Southern New England Stock; and 2) count all commercially and recreationally important finfish and invertebrate species encountered. All species not counted are noted for presence.

METHODS

Seining of intertidal and shallow subtidal zones occurs from two hours before until two hours after high tide. Forty-nine fixed stations, originally chosen for efficient seining (i.e., smooth sediment bottom generally devoid of attached vegetation) and historic availability of 0-group winter flounder, were proportionately allocated by each estuary's littoral perimeter. A 6.4 meter straight seine of 4.8 mm nylon mesh equipped with a weighted lead line footrope to minimize escapement was set and hauled perpendicular to shore from depths between 0.9 to 1.2 meters. Winter flounder density (# YOY per square meter) was determined by aggregating catch from three replicate hauls at each station. Consistent area swept was maintained using a fixed-length spreader rope. Haul distance was calculated as the hypotenuse of a right triangle, using the measurements of distance over the water's surface and depth at the beginning of the seine haul. Distance over the water's surface was measured with a sonic digital rangefinder (SONIN Multi-Measure Combo Pro™) and water depth at the beginning of the seine haul was measured with a weighted and marked line. When inclement weather prevents use of the rangefinder, distance over ground was measured by pacing. Statistical analysis of seine data employed stratification techniques; each estuary was considered a stratum and each station's three replicate hauls were treated as one individual sample. Stratified mean density and confidence limits were derived from standard and modified formulae for mean and variance. Eleven MADMF employees participated in the survey as part of the scientific party (Table 1).

RESULTS

138 seine hauls were conducted at 49 stations over 9 sampling days. One haul was dropped at each of nine stations due to shoreline vegetation, shoreline alterations or obstructions; Stower Street in Great Pond, Washburn Island 4 in Waquoit Bay, Windmill, High Bank and Heirs Landing in Bass River, and Mill Pond, Wildlife Reserve, Vineyard Ave and Sears Point in Stage Harbor.

Thirty-six species were encountered in 2018 (Table 2). The 2018 pooled (all estuaries combined) winter flounder YOY index (0.111 YOY / m^2) was the lowest observation since 2010 (Figure 2, Table 3) and the Age 1+ winter flounder index remained below the timeseries median for the 9th consecutive year (Figure 3). All estuary specific indices for YOY winter flounder decreased in 2018 with the exception of Lewis Bay and Stage Harbor (Figure 4). The YOY Fluke index decreased, but remains within the top ten highest observations of the timeseries (Figure 5). The blue crab index decreased and is below the timeseries median (Figure 6). All bottom temperature monitors were collected and successfully downloaded with the exception of the Upper Great Pond Monitor, which was lost (Figure 7). For further information on this survey or additional data, please contact Vincent M. Manfredi (508)-742-9732.

Table 1. 2018 Seine Survey Staffing List

Name	Affiliation	Num. Days
Vincent Manfredi	MDMF	9
Mark Szymanski	MDMF	4
Dr. Greg Decelles	MDMF	2
Matthew Camisa	MDMF	1
Ian Church	MDMF	1
Karissa Collins	MDMF	1
Dr. Tiffany Cunnigham	MDMF	1
Derek Perry	MDMF	1
Dr. Tracy Pugh	MDMF	1
Brendan Riley	MDMF	1
Steve Wilcox	MDMF	1

Table 2. Catch Observations of All Recorded Species During the 2018 Seine Survey
(for species marked present, counts are not taken but presence is noted at all hauls)

Common Name	Taxonomic Name	Total Number	% Occurrence
Atlantic Silverside	*Menidia menidia*	Present	94.2%
YOY Winter Flounder	*Pseudopleuronectes americanus*	952	79.7%
Mud Snail	*Nassarius obsoletus*	Present	76.1%
Sand Shrimp	*Crangon septemspinosa*	Present	57.2%
Grass Shrimp	*Paelmonetes pugio*	Present	42.0%
Striped Killifish	*Fundulus majalis*	Present	37.7%
Blue Crab	*Callinectes sapidus*	178	32.6%
Green Crab	*Carcinus maenus*	114	31.9%
Northern Pipefish	*Sygnathus fuscus*	Present	23.9%
Mummichog	*Fundulus heteroclitus*	Present	18.8%
Alewife / Blueback Herring	*Alosa spp.*	384	17.4%
YOY Summer Flounder	*Paralichthys dentatus*	31	15.9%
Spider Crab Uncl.	*Majidae*	57	14.5%
White Mullet	*Mugil curema*	41	12.3%
Rainwater Killifish	*Lucania parva*	40	12.3%
Mottled Dog Whelk	*Nassa vibex*	Present	8.7%
Lady Crab	*Ovalipes ocellatus*	15	8.0%
Fourspine Stickleback	*Apeltes quadracus*	Present	5.1%
Naked Goby / Seaboard Goby	*Gobiosoma spp.*	9	5.1%
Horseshoe Crab	*Limulus polyphemus*	6	3.6%
Sheepshead Minnow	*Cyprinodon variegatus*	2	3.6%
Northern Kingfish	*Menticirrihitus saxatilis*	9	2.9%
Atlantic Herring	*Clupea harengus*	11	2.2%
Age 1+ Summer Flounder	*Paralichthys dentatus*	3	2.2%
American Eel	*Anguilla rostrata*	11	2.2%
Atlantic Needlefish	*Strongylura marina*	5	2.2%
Atlantic Menhaden	*Brevorrtia tyrannus*	4	1.4%
Bay Anchovy	*Anchoa mitchilli*	2	1.4%
Threespine Stickleback	*Gasterosteus aculeatus*	Present	1.4%
Grubby	*Myoxocephalus aeneus*	2	1.4%
Tautog	*Tautoga onitis*	3	1.4%
Oyster	*Crassostrea virginica*	5	1.4%
Age 1+ Winter Flounder	*Pseudopleuronectes americanus*	1	0.7%
Spot	*Leiostomus xanthurus*	4	0.7%
Striped Searobin	*Prionotus evolans*	1	0.7%
Atlantic Rock Crab	*Cancer irroratus*	2	0.7%
Asian Shore Crab	*Hemigrapsus sanguineus*	1	0.7%
Knobbed Whelk	*Busycon carica*	1	0.7%

Table 3. YOY Winter Flounder Abundance, All Estuaries. MDMF Seine Survey 1976-2018

Year	Stratified Mean	Standard Error	Lower CI	Upper CI
1976	0.344	0.042	0.236	0.452
1977	0.641	0.062	0.508	0.774
1978	0.366	0.057	0.235	0.498
1979	0.507	0.060	0.366	0.648
1980	0.432	0.057	0.306	0.559
1981	0.340	0.056	0.208	0.471
1982	0.370	0.055	0.246	0.494
1983	0.231	0.027	0.176	0.287
1984	0.323	0.036	0.248	0.399
1985	0.335	0.039	0.254	0.415
1986	0.325	0.039	0.244	0.406
1987	0.274	0.032	0.208	0.340
1988	0.184	0.024	0.133	0.234
1989	0.421	0.046	0.325	0.518
1990	0.325	0.038	0.247	0.402
1991	0.267	0.038	0.188	0.346
1992	0.294	0.047	0.196	0.392
1993	0.067	0.009	0.047	0.086
1994	0.148	0.019	0.108	0.188
1995	0.154	0.023	0.107	0.201
1996	0.221	0.027	0.165	0.277
1997	0.392	0.053	0.278	0.506
1998	0.165	0.029	0.104	0.226
1999	0.201	0.028	0.143	0.258
2000	0.347	0.043	0.258	0.435
2001	0.214	0.028	0.157	0.272
2002	0.100	0.011	0.077	0.122
2003	0.197	0.032	0.128	0.267
2004	0.095	0.012	0.070	0.120
2005	0.075	0.010	0.054	0.096
2006	0.164	0.018	0.126	0.202
2007	0.167	0.021	0.125	0.210
2008	0.092	0.011	0.069	0.115
2009	0.083	0.013	0.056	0.109
2010	0.092	0.014	0.063	0.122
2011	0.247	0.026	0.194	0.301
2012	0.135	0.014	0.106	0.163
2013	0.250	0.025	0.198	0.302
2014	0.186	0.028	0.130	0.242
2015	0.127	0.018	0.090	0.163
2016	0.187	0.020	0.146	0.228
2017	0.291	0.050	0.182	0.400
2018	0.111	0.021	0.065	0.156

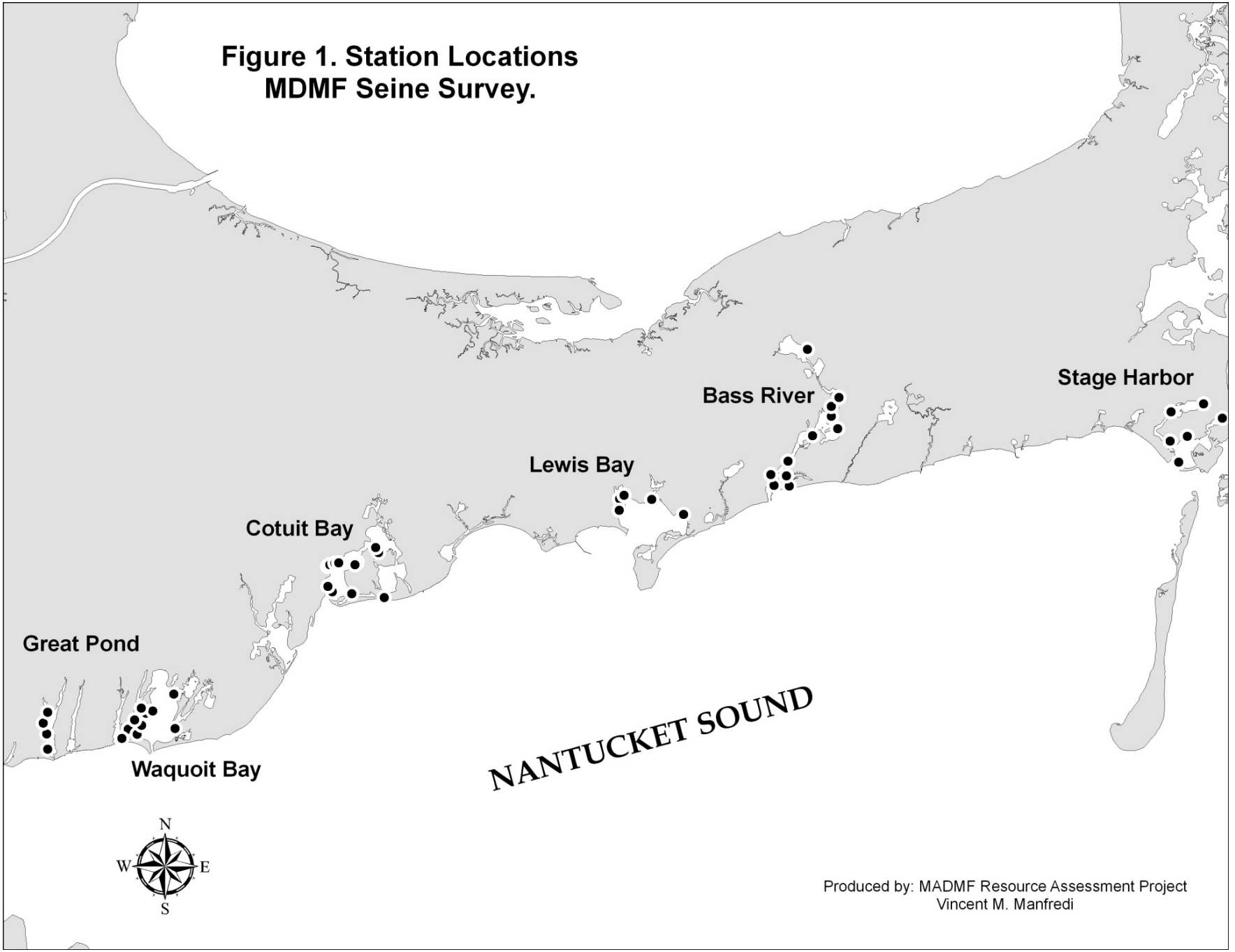
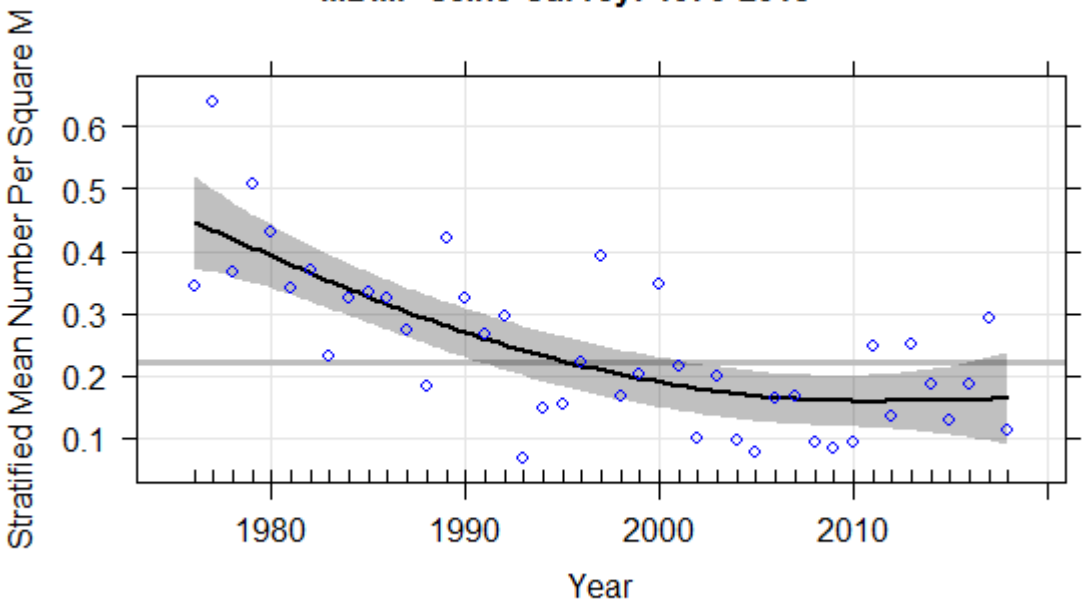


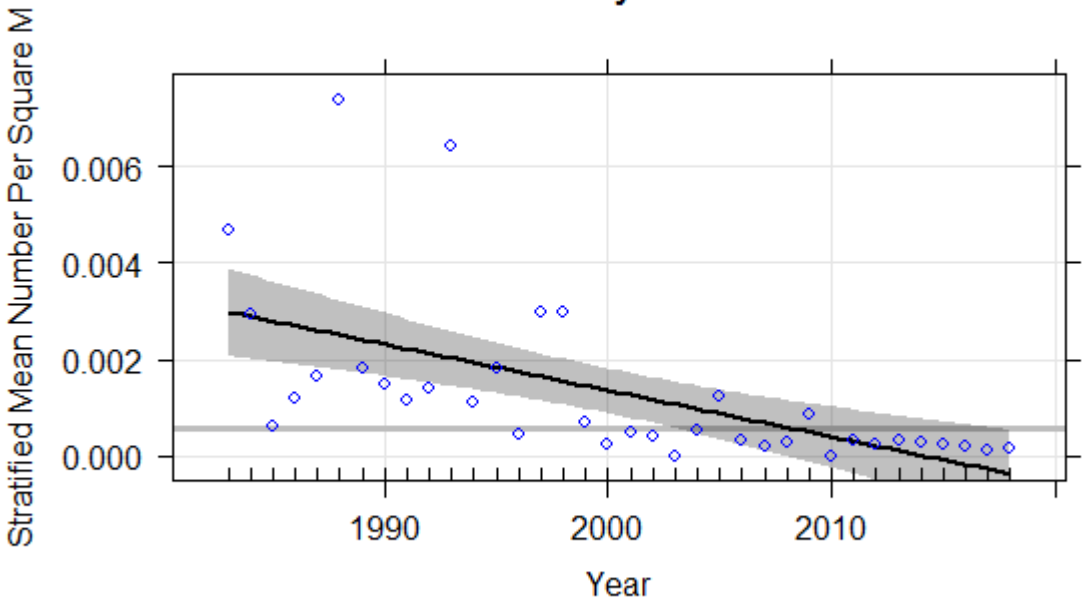
Figure 1. Station Locations
MDMF Seine Survey.
Stage Harbor
Bass River
Lewis Bay
Cotuit Bay
Great Pond
Waquoit Bay
NANTUCKET SOUND
N
W
E
S
Produced by: MADMF Resource Assessment Project
Vincent M. Manfredi

Figure 2. YOY Winter Flounder Abundance
MDMF Seine Survey: 1976-2018



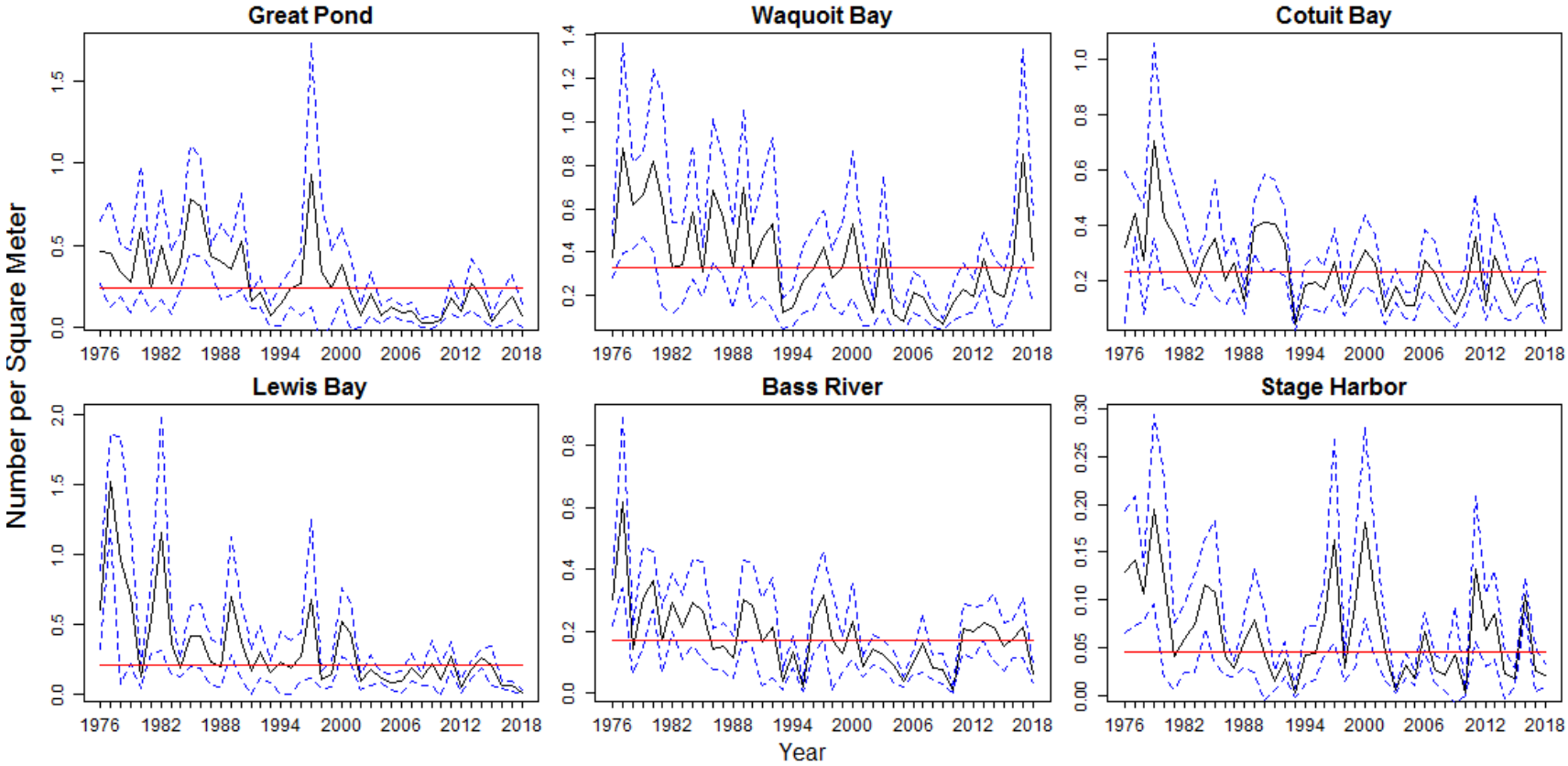
Black line: GAM fit.
Grey line: timeseries median.

Figure 3. Age 1+ Winter Flounder Abundance
MDMF Seine Survey: 1983-2018



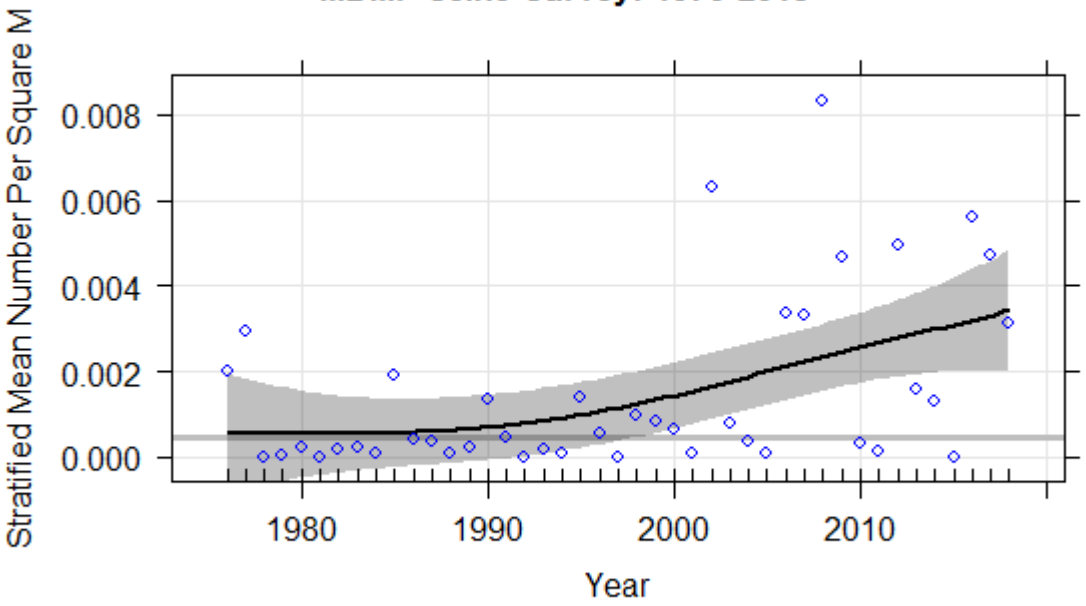
Black line: GAM fit.
Grey line: timeseries median.

Figure 4. Abundance of YOY winter flounder by estuary, MDMF Seine Survey 1976 – 2018.



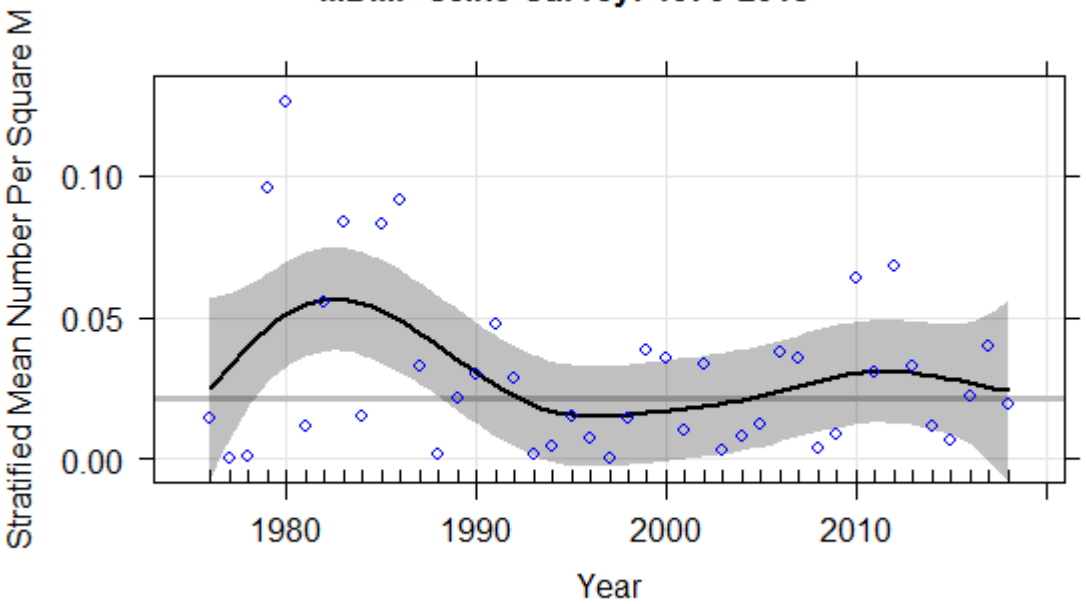
Dashed Lines = 95% Confidence Intervals
Horizontal Line = Timeseries Median for each Estuary
Note: y-axis scales differ in magnitude.

Figure 5. Summer Flounder Abundance
MDMF Seine Survey: 1976-2018



Black line: GAM fit.
Grey line: timeseries median.

Figure 6. Blue Crab Abundance
MDMF Seine Survey: 1976-2018



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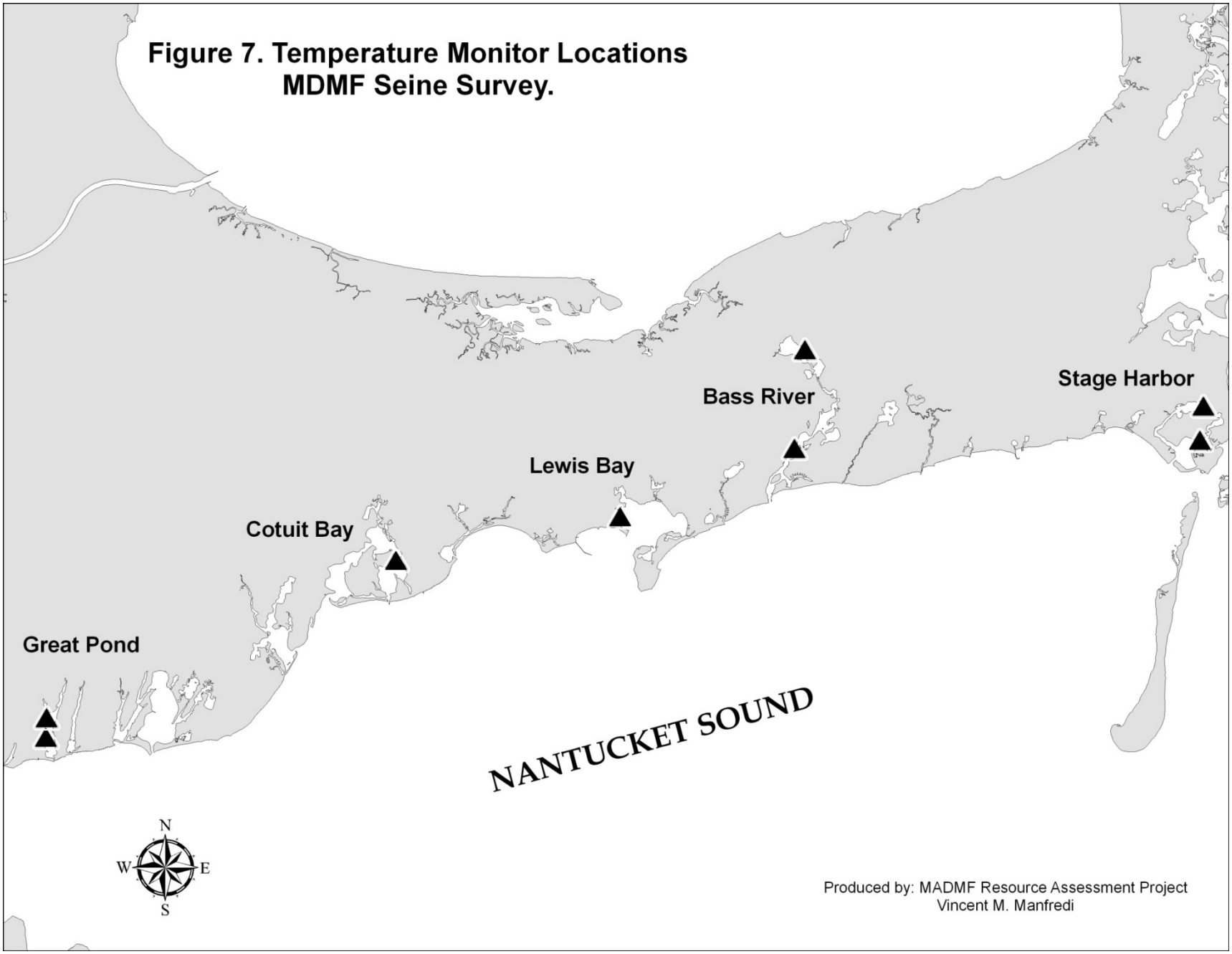


Figure 7. Temperature Monitor Locations
MDMF Seine Survey.
Stage Harbor
Bass River
Lewis Bay
Cotuit Bay
Great Pond
NANTUCKET SOUND
N
W
E
S
Produced by: MADMF Resource Assessment Project
Vincent M. Manfredi

2018 MADMF Seine Survey

Appendix A: Massachusetts Inshore Bottom Trawl Survey Indices of Biomass, Abundance, Recruitment, and Abundance at Age for Select Species

The Massachusetts Division of Marine Fisheries has been conducting a bottom trawl survey of Massachusetts territorial waters every spring and fall since 1978. Survey indices provide a useful fishery-independent metric for tracking the relative abundance or biomass of many demersal fish and invertebrates in the survey area. Updated survey indices are presented here for 1) species or stocks routinely requested by staff from within the Massachusetts Division of Marine Fisheries as well as by other governmental and non-governmental scientific bodies, academic researchers and consultants and/or 2) those species which have been a large part of the survey biomass and/or demonstrate a particularly strong trend over the time series.

Additional survey data can be requested by contacting Matthew Camisa at 508-742-9743 or matt.camisa@mass.gov.

Contents:

Figure 3 (a – b). Stratified mean number per tow with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF trawl survey.

(a) Spring **Channeled Whelk** Regions 1 - 2
(b) Fall **Channeled Whelk** Regions 1 - 2
(c) Fall **Knobbed Whelk** Regions 1 - 2
(d) Spring **Spotted Hake** Regions 1 - 5

Figure 4 (a & b). Pre-recruit stratified mean number per tow with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF trawl survey.

(a) Fall **Age-0 Scup** (<13 cm) Regions 1 – 3
(b) Fall **Age-0 Black Sea Bass** (<12 cm) Regions 1 - 3

Figure 1. Massachusetts trawl survey regions

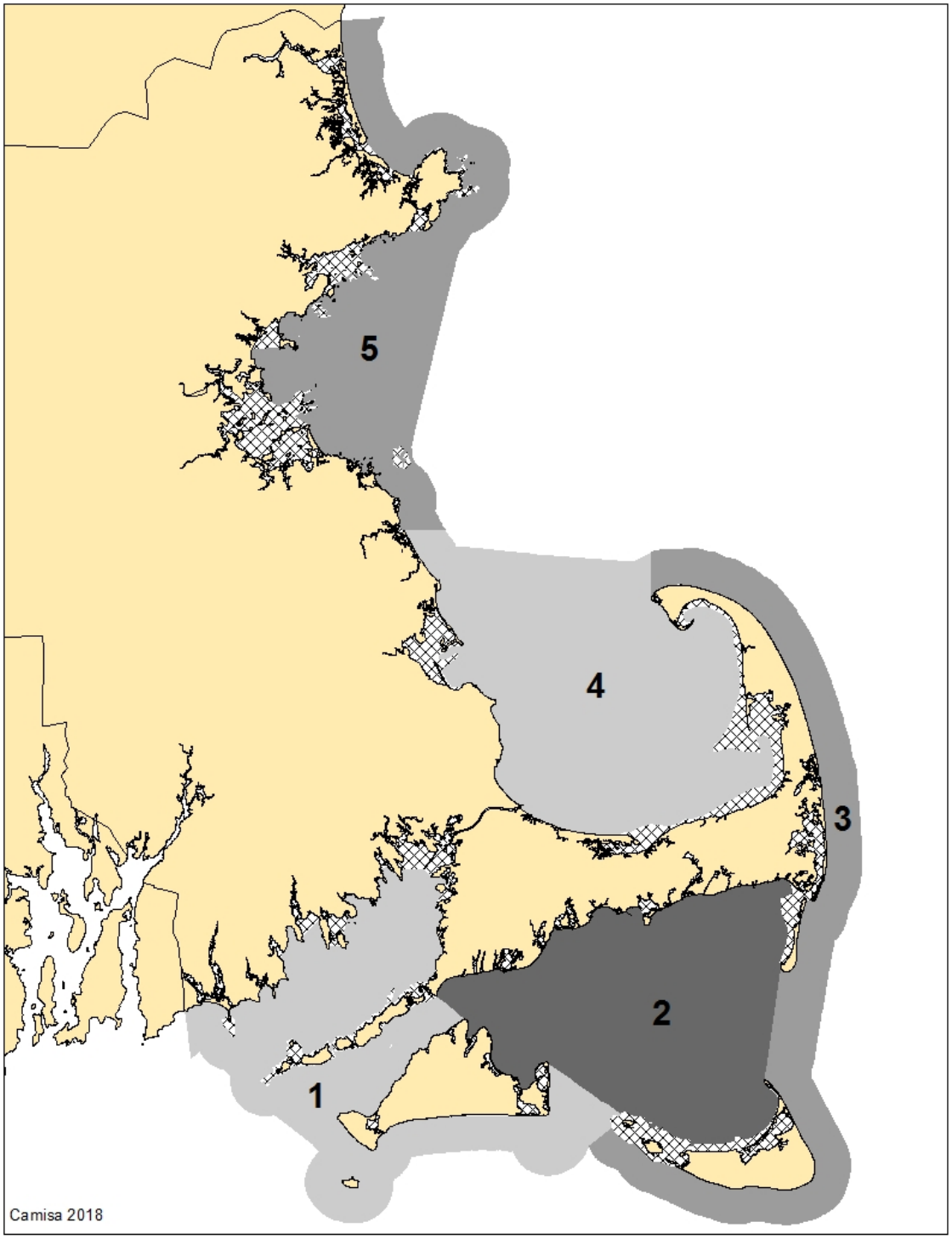


Figure 2. (a & b) Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

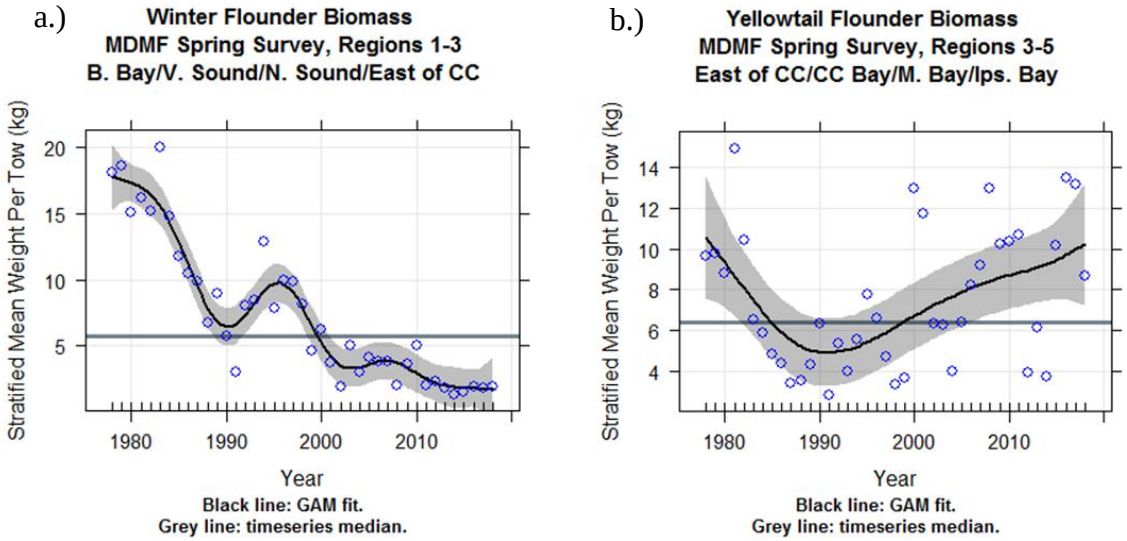


Figure 2. (c & d) Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

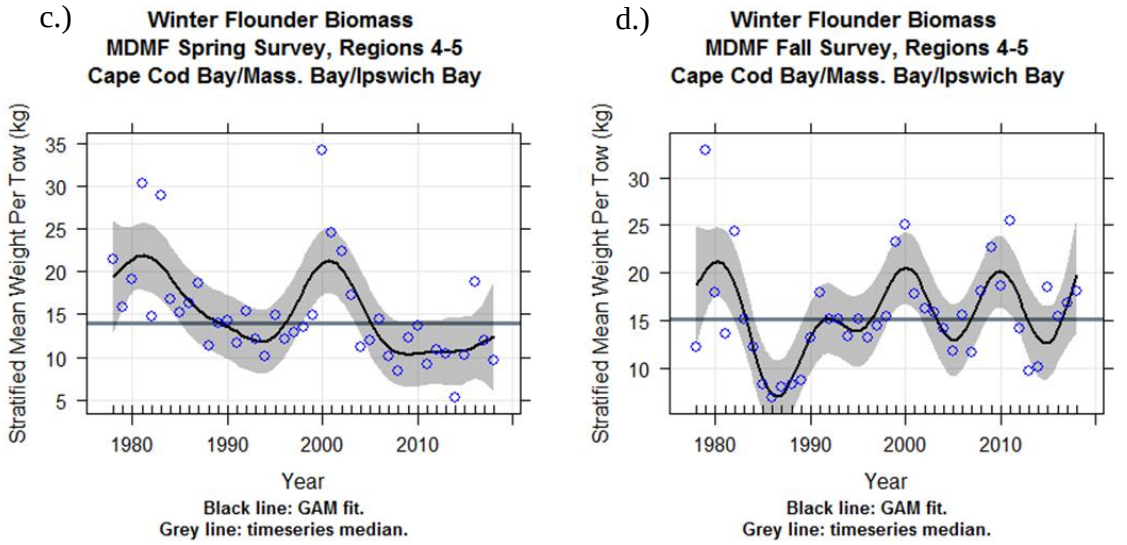


Figure 2. (e & f). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

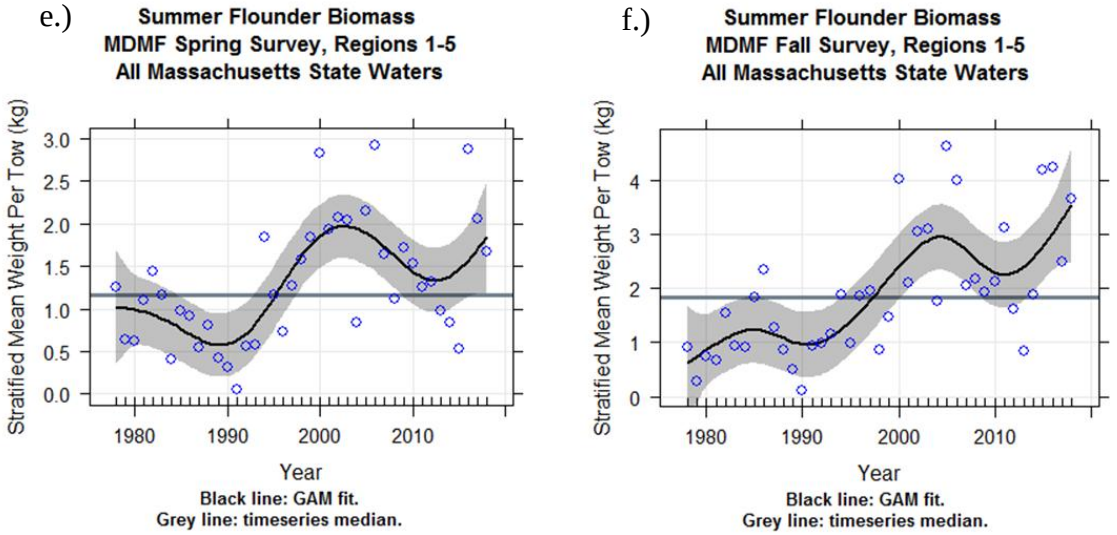


Figure 2. (g & h). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

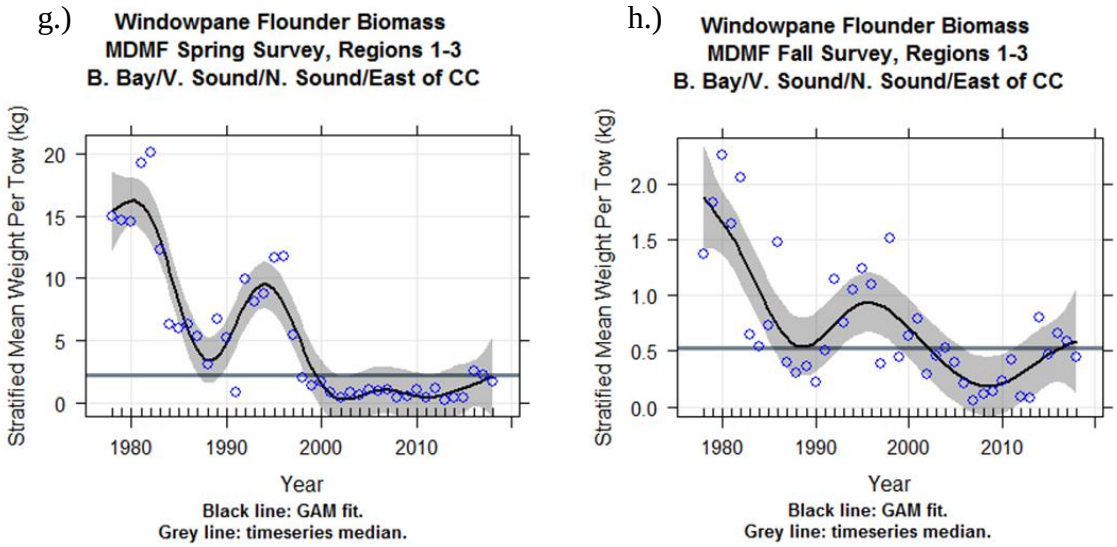


Figure 2. (i & j). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

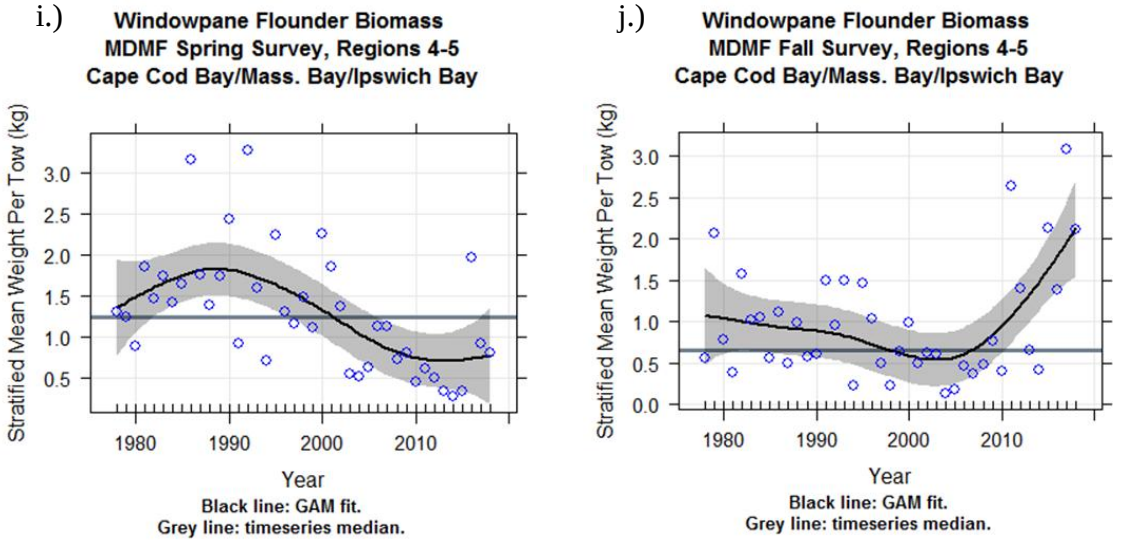


Figure 2. (k & l). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

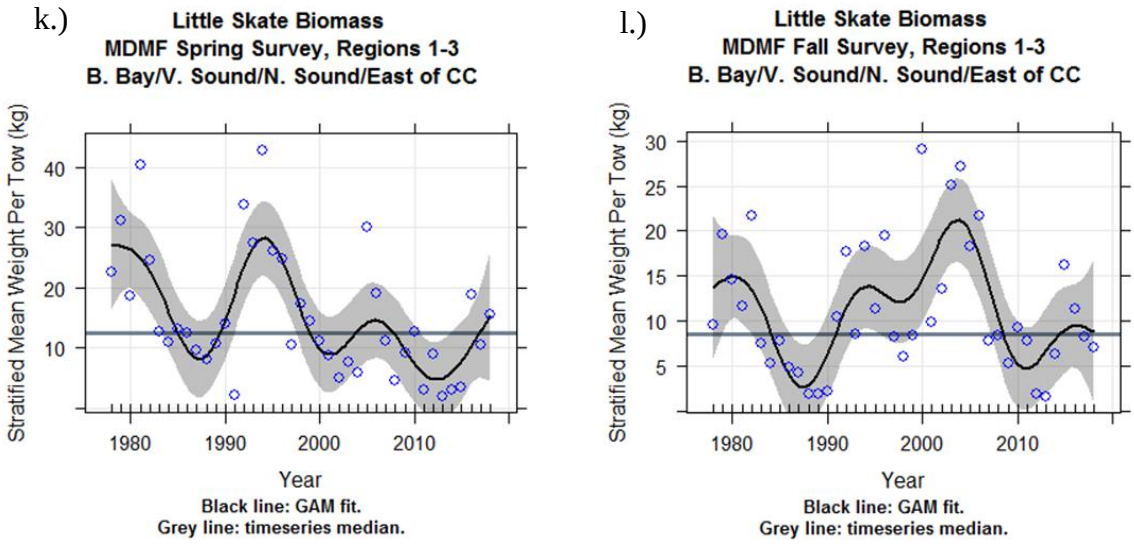


Figure 2. (m & n). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

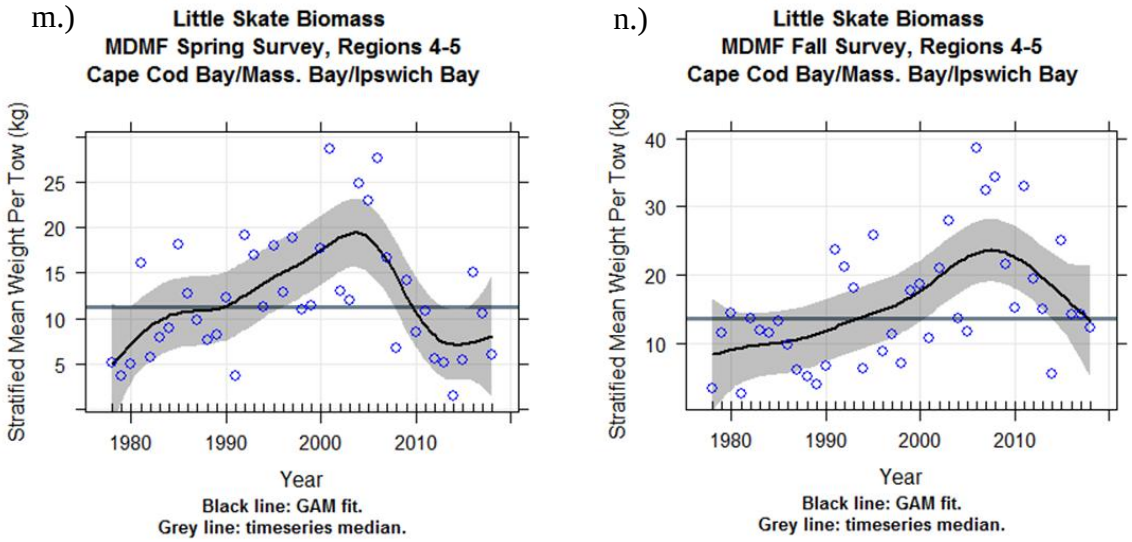


Figure 2. (o & p). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

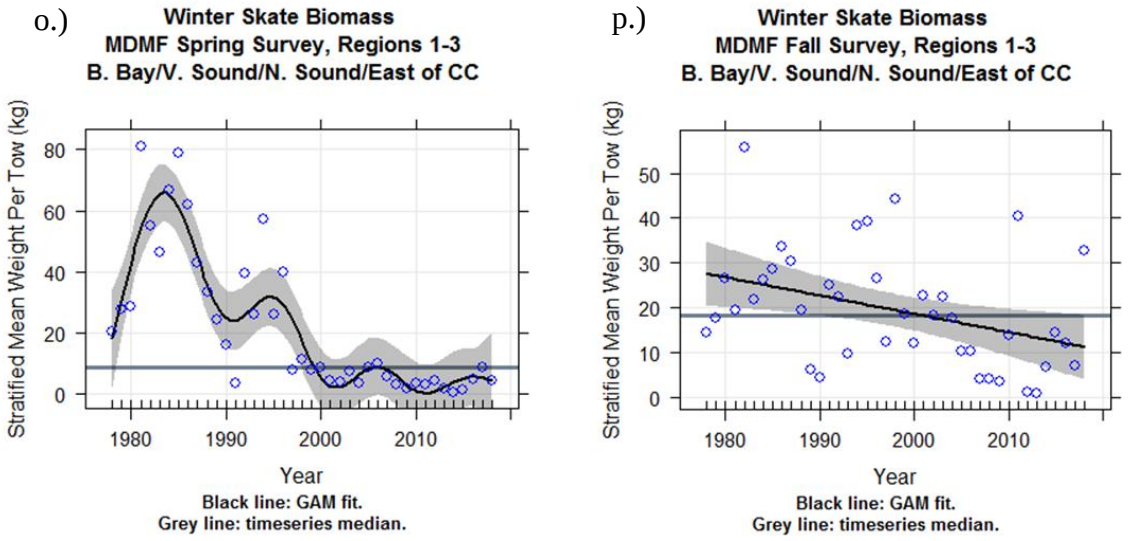
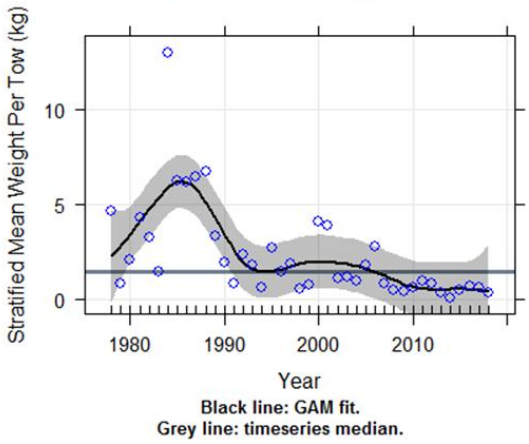


Figure 2. (q & r). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

q.)



r.)

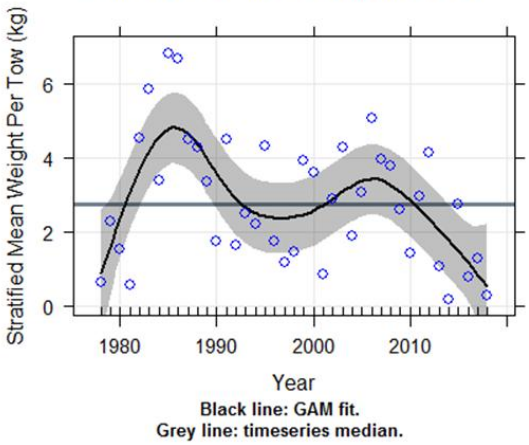
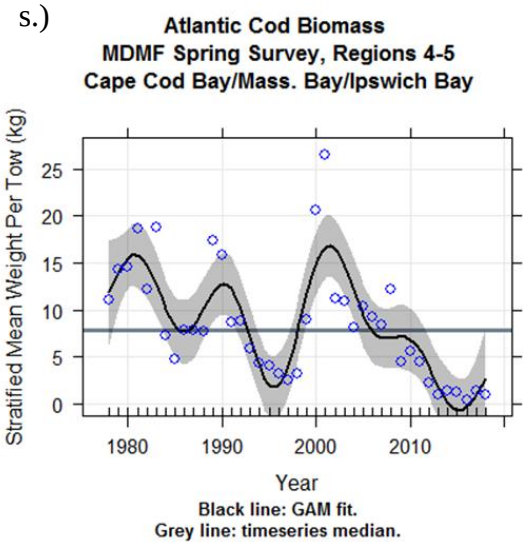


Figure 2. (s & t). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

s.)



t.)

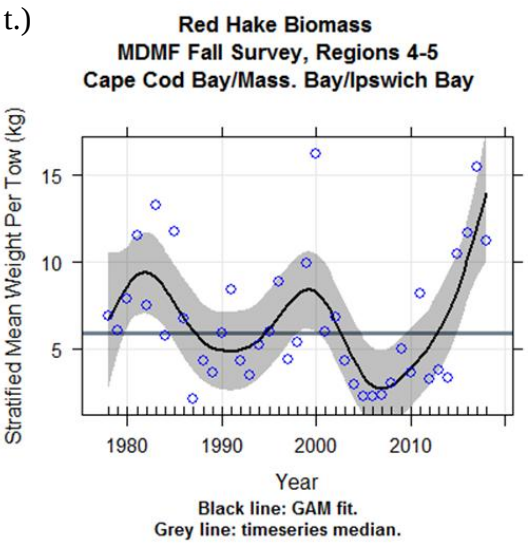


Figure 2. (u & v). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

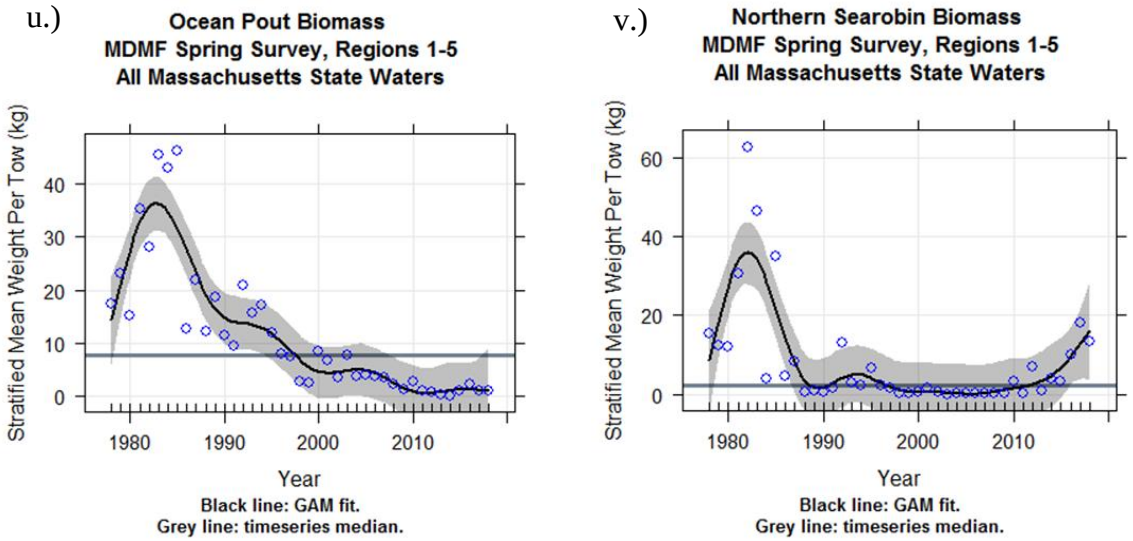


Figure 2. (w & x). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

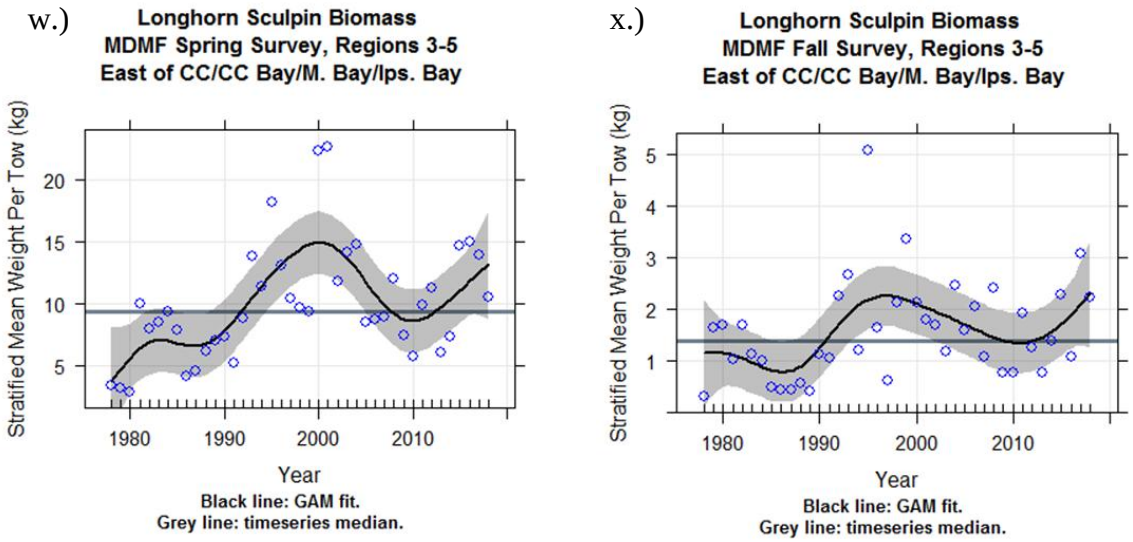


Figure 2. (y & z). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

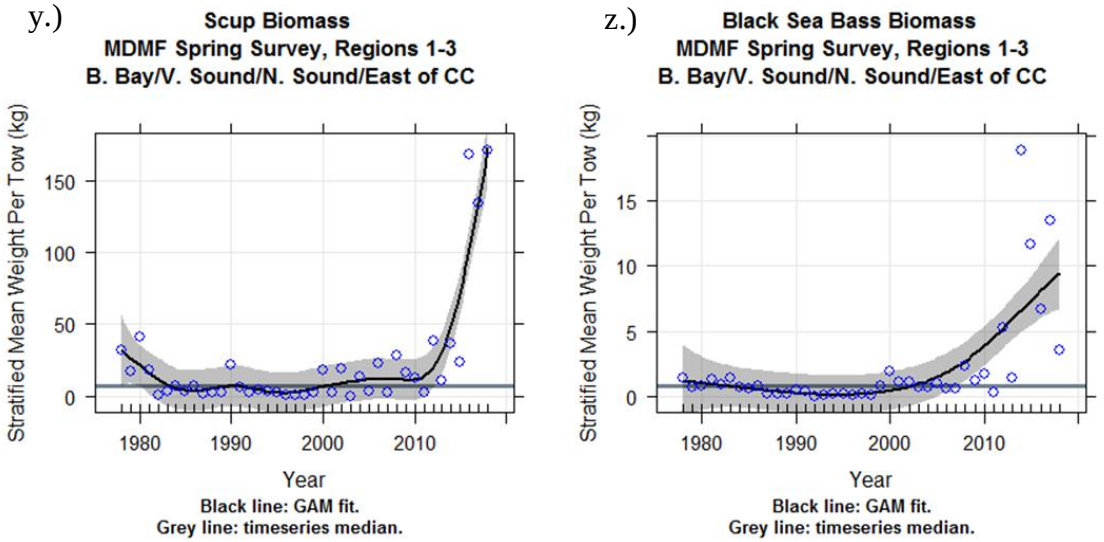


Figure 2. (aa & bb). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

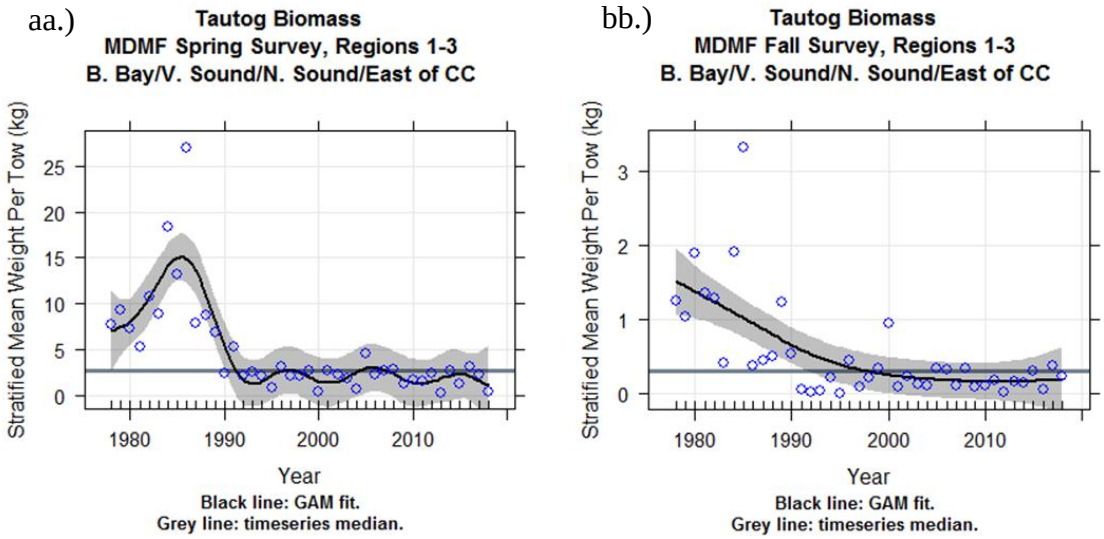


Figure 2. (cc & dd). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

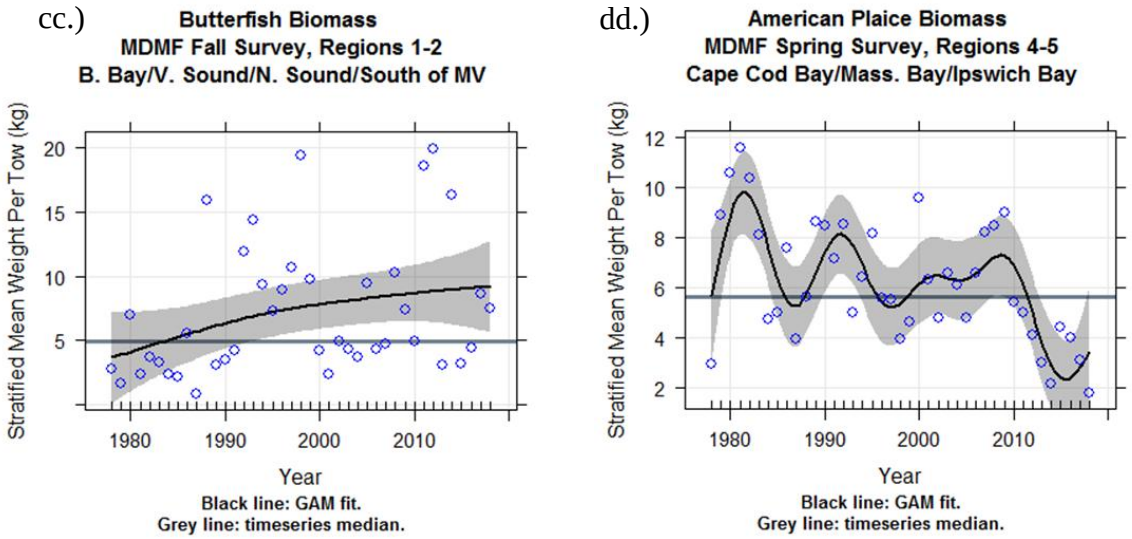


Figure 2. (ee & ff). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

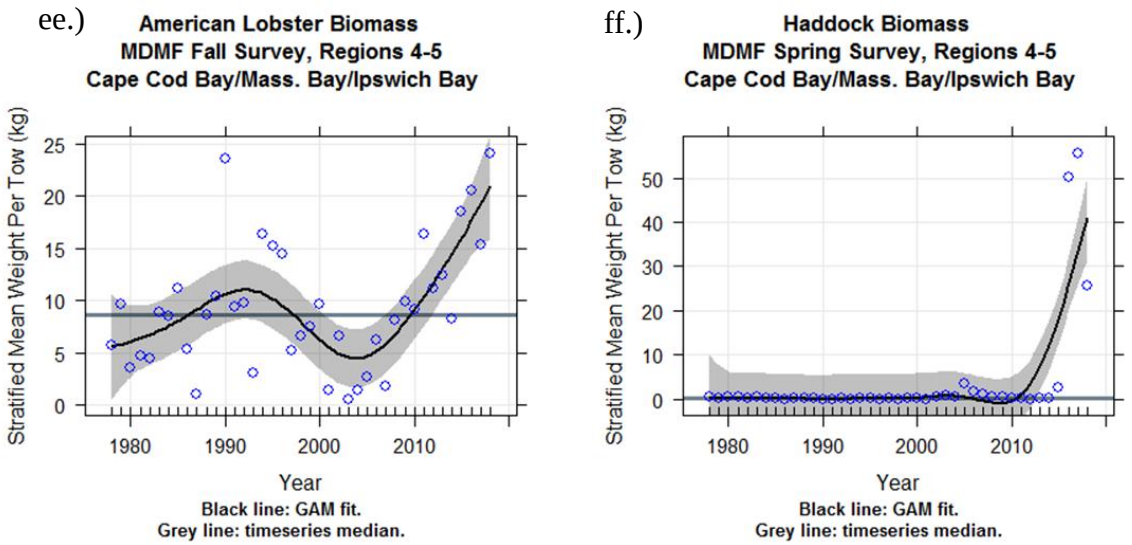


Figure 3. (a & b). Stratified mean number per tow with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

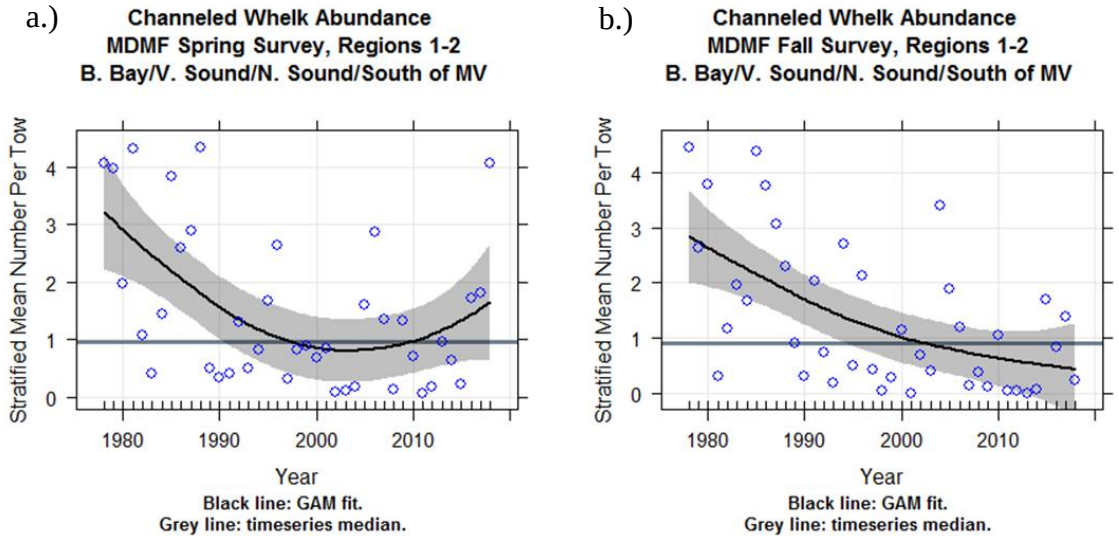


Figure 3. (c & d). Stratified mean number per tow with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

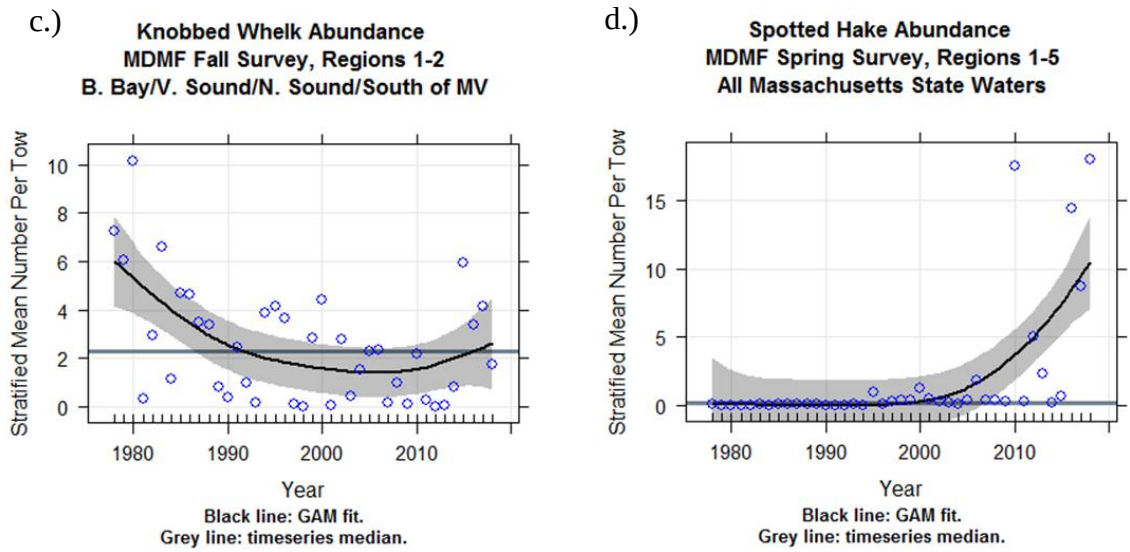
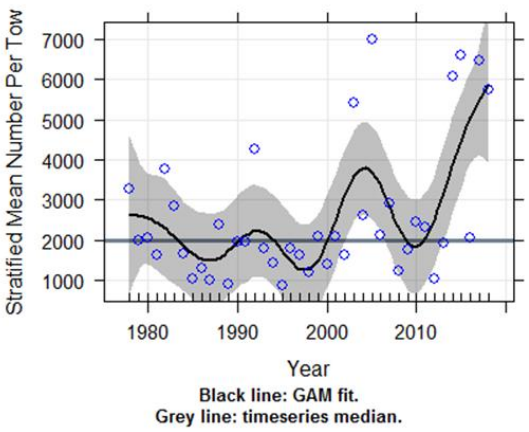
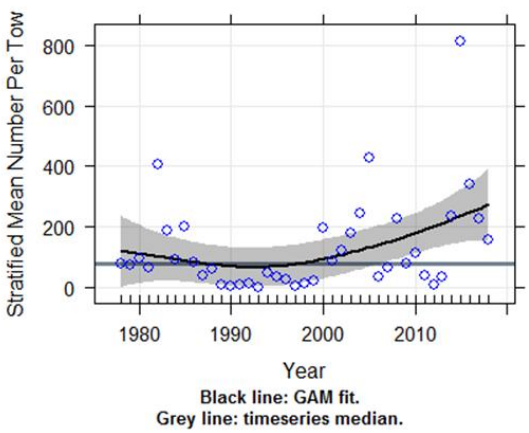


Figure 4. (a & b). Pre-recruit stratified mean number per tow with GAM smoothed trend line. 1978 – 2018 Massachusetts DMF Trawl survey.

a.)



b.)



Appendix B: Trends in Observed Bottom Temperatures on the Massachusetts Inshore Bottom Trawl Survey, 1978 – 2018.

A timeseries analysis of bottom temperatures recorded during spring and fall bottom trawl surveys is updated here to include 2018 observations. For a detailed interpretation and description of methods used in data preparation and analysis, refer to the 2006 annual report, (2006 Annual Performance Report, F-56-R, Massachusetts Fishery Resource Assessment, Appendix E).

There is one difference between the methods employed in 2006 and the methods reported here. Temperature observations from non-representative stations (SHG >136) are included in the dataset beginning in Fall 2004 as long as the tow duration is at least 5 minutes (the minimum time necessary for the temperature logger to acclimate). Some of these observations were omitted from the 2006 analysis. Elimination of temperature observations from non-representative stations had the effect of producing fall temperature data gaps in Region 3 where large dogfish catches frequently result in hauls of less than 13 minutes duration. These tows, though non-representative for generation of abundance and biomass indices for most species, are used when generating spiny dogfish indices. The temperature data collected at these 'dogfish tows' since 2004 is consistent with temperature data collected at all other stations utilizing the Onset Computer Corporation temperature loggers and is therefore included in the following temperature summaries. Please refer to Tables 1 and 2 for a listing of data gaps.

Table 1. Stratum mean bottom temperatures recorded on the MDMF spring survey, 1978 – 2018.

	Region 1				Region 2		Region 3					Region 4						Region 5					
Year	11	12	13	14	15	16	17	18	19	20	21	25	26	27	28	29	30	31	32	33	34	35	36
1978	12.1	11.8	13.1	13.0	13.2	11.5	10.3	11.5	10.5	6.5	11.5	11.1	10.7	7.8	7.8	8.2	11.65	7.8	6.8	7.2	7.9	N/A	N/A
1979	13.3	13.1	11.8	11.3	13.3	11.5	12.0	11.9	9.9	7.5	5.0	7.3	7.9	6.7	4.2	4.0	3.9	10.4	8.5	6.4	5.5	4.9	3.5
1980	12.5	11.7	11.8	11.1	12.2	11.1	10.2	11.5	10.1	8.0	7.4	7.8	9.8	8.1	8.0	7.2	7.2	6.7	5.6	5.3	6.5	5.2	4.2
1981	12.4	11.0	10.4	7.5	10.5	10.4	10.5	7.6	7.9	6.5	6.5	7.9	8.2	6.5	6.3	6.6	5.8	8.8	7.6	5.4	5.3	5.4	4.8
1982	11.7	10.5	9.8	5.8	11.4	11.0	10.9	8.9	8.0	6.6	4.6	7.0	5.8	5.6	4.9	4.4	4.4	7.1	6.3	5.1	4.7	4.7	4.3
1983	11.9	11.7	11.6	10.1	12.4	11.2	9.2	9.5	9.0	5.5	6.5	7.2	8.9	7.0	6.2	6.5	5.0	6.0	6.1	6.2	5.3	6.0	5.0
1984	12.1	11.0	10.6	10.1	12.3	11.9	9.3	9.6	9.6	5.2	4.5	7.6	8.1	4.8	4.5	4.1	4.0	7.3	6.6	5.2	5.1	4.9	4.9
1985	12.1	11.1	11.4	10.5	12.1	11.6	9.4	10.6	10.1	7.8	7.0	10.3	8.9	8.0	6.8	5.8	5.0	7.6	7.3	6.2	5.9	4.7	4.5
1986	10.1	10.8	9.7	9.1	10.5	9.9	9.0	9.0	8.3	7.5	5.7	10.0	8.5	7.3	7.5	6.4	5.3	8.1	7.5	6.2	6.0	5.5	5.3
1987	10.7	10.4	10.2	9.5	12.1	11.4	9.2	8.7	8.3	6.4	5.9	9.1	8.1	7.2	6.2	5.1	5.7	7.4	7.3	6.6	6.2	6.2	5.6
1988	10.8	10.4	10.0	9.1	11.5	11.1	8.6	8.4	8.6	6.0	5.5	9.4	8.1	7.2	5.9	4.8	4.4	7.7	6.8	5.8	5.3	4.6	4.1
1989	9.5	9.0	7.1	6.7	10.9	9.5	7.5	7.5	6.6	4.7	3.6	7.4	5.4	4.4	4.3	2.4	1.5	6.1	4.5	3.8	3.0	3.3	2.6
1990	10.4	10.5	9.4	7.6	12.0	11.0	9.9	8.8	9.2	5.9	3.8	9.0	8.0	7.5	4.7	4.0	3.5	6.5	6.6	5.9	4.5	3.7	2.6
1991	14.1	13.0	11.3	9.9	13.8	13.3	11.4	10.9	10.0	7.0	5.2	11.6	11.3	10.2	8.1	6.0	5.0	7.8	5.9	6.2	7.2	6.1	4.7
1992	9.9	9.2	8.6	8.1	11.4	10.3	9.2	8.1	7.9	7.5	6.5	8.7	8.1	8.0	7.0	5.9	5.2	8.4	8.1	6.7	5.4	4.1	3.8
1993	12.6	11.5	11.1	9.9	12.4	11.5	9.7	9.4	8.6	5.0	4.5	8.9	7.9	6.0	5.4	5.0	3.7	7.6	6.1	4.7	4.6	3.7	3.7
1994	10.3	9.9	9.6	9.1	10.3	9.8	9.4	9.4	7.8	6.5	5.7	9.2	8.9	8.3	6.7	6.0	4.7	8.4	7.2	4.7	5.1	4.0	4.3
1995	11.7	11.2	9.9	9.6	10.6	10.0	9.2	8.4	8.5	6.9	6.8	9.0	8.6	8.0	7.6	6.0	4.9	7.9	8.2	6.5	6.2	4.7	4.1
1996	11.6	11.3	10.3	9.8	11.7	11.5	9.4	8.4	8.5	6.4	5.4	7.3	7.4	5.9	5.4	4.6	4.1	6.1	6.3	4.2	4.1	4.0	4.0
1997	10.9	10.1	9.0	7.3	11.4	11.2	9.9	8.9	8.4	6.2	6.1	7.2	7.9	6.6	6.4	5.5	5.3	5.5	5.4	5.2	4.7	4.7	4.7
1998	11.0	11.1	11.0	10.2	10.5	9.6	9.2	9.1	7.7	7.4	6.1	9.3	8.2	7.0	6.8	5.6	5.0	8.5	7.8	6.0	5.0	4.3	4.2
1999	15.0	13.3	12.7	11.7	14.6	13.6	11.3	10.6	10.7	6.2	5.5	11.5	9.6	8.2	6.1	4.8	4.7	9.1	7.3	6.4	5.2	4.9	4.3
2000	12.1	12.0	11.2	10.8	13.3	12.2	11.1	9.9	10.4	7.6	7.2	10.2	9.5	7.4	7.1	6.3	6.5	9.7	10.0	8.1	7.2	6.2	6.0
2001	13.3	11.5	11.2	8.8	12.9	11.6	11.5	11.1	10.2	5.7	4.9	7.9	9.7	6.1	6.0	4.9	4.6	7.6	7.7	5.2	4.7	4.5	4.5
2002	12.2	11.7	11.5	10.8	12.2	12.0	9.6	9.1	9.8	7.5	6.3	9.4	9.1	8.0	7.5	6.3	5.6	7.9	8.0	6.7	6.2	5.7	5.5
2003	11.5	11.3	11.2	9.7	11.6	10.8	8.4	8.5	9.1	4.7	4.2	7.9	7.7	5.8	5.2	4.1	3.8	7.2	6.5	5.4	4.2	4.0	3.9
2004	13.3	12.1	11.7	9.3	12.9	11.8	9.9	9.0	8.3	4.5	3.9	7.6	7.6	4.7	4.1	3.6	3.5	6.0	5.1	3.8	3.6	3.4	3.2
2005	11.6	11.2	10.4	9.8	9.3	9.2	9.1	8.2	7.4	5.3	5.0	7.9	7.6	6.6	6.0	5.1	4.6	7.2	7.3	6.1	5.3	5.0	4.4
2006	11.4	10.5	9.9	9.2	12.1	10.9	11.0	10.7	10.4	7.5	6.4	10.1	9.6	8.5	7.3	6.8	6.5	8.0	8.4	8.1	7.0	6.7	6.2
2007	12.8	11.6	10.7	9.2	12.2	11.6	10.5	10.2	8.8	5.3	4.9	9.9	10.1	6.2	4.8	4.4	4.3	6.3	6.3	4.2	4.1	4.2	4.1
2008	11.3	13.1	10.2	10.0	10.5	10.2	9.2	9.0	7.8	5.3	4.6	8.7	7.3	5.5	4.7	4.6	3.9	7.2	7.5	4.8	4.0	4.0	3.8
2009	12.6	11.8	11.1	8.8	13.1	12.4	9.5	9.5	9.2	4.4	4.2	9.2	8.1	6.3	4.7	3.8	3.6	8.2	7.7	5.5	4.3	4.1	3.6
2010	11.6	11.7	11.1	10.0	12.7	12.0	10.1	9.4	9.3	7.5	4.8	11.0	10.8	8.5	5.2	4.5	4.5	7.8	7.4	5.3	4.7	4.6	4.6
2011	11.6	11.2	10.6	9.9	11.3	10.6	9.6	9.6	9.2	7.1	7.0	9.5	8.2	6.7	8.1	6.4	4.8	7.9	7.4	5.0	4.7	4.5	4.4
2012	15.4	13.5	13.2	11.8	14.4	13.8	11.4	11.2	11.6	8.3	7.2	11.2	9.9	8.5	7.3	6.6	6.3	8.9	8.4	7.5	6.6	6.2	5.7
2013	13.5	12.7	11.2	10.3	13.5	12.8	11.3	11.8	11.0	7.4	6.6	9.8	10.1	8.0	7.3	6.1	5.5	9.4	8.6	7.6	6.5	5.9	5.2
2014	13.4	12.1	11.0	10.9	13.2	11.8	9.9	9.5	8.7	5.1	4.2	9.3	8.3	7.4	6.0	4.1	3.4	6.7	6.6	5.6	4.7	4.1	3.9
2015	13.4	12.2	10.8	10.1	13.3	12.2	9.5	9.7	8.9	5.8	4.9	10.5	9.3	6.8	6.0	3.7	3.6	6.4	6.9	5.1	4.5	4.2	4.1
2016	13.0	12.1	10.5	9.7	13.8	13.0	10.3	10.5	11.4	8.7	6.8	9.9	9.6	9.6	9.4	6.6	6.0	8.2	8.3	7.1	6.0	5.9	5.5
2017	13.5	13.2	11.9	10.9	13.7	12.8	10.9	10.6	10.1	7.0	6.2	9.9	7.6	6.3	6.3	5.0	4.8	8.1	6.4	5.4	5.0	4.9	4.6
2018	12.2	11.8	11.4	10.7	12.7	11.7	9.9	9.4	9.3	6.9	5.8	9.8	7.6	6.0	5.5	5.1	5.0	8.0	6.7	5.6	5.1	4.9	4.8
Median	12.1	11.5	11.0	9.9	12.2	11.5	9.9	9.4	9.1	6.5	5.7	9.2	8.2	7.0	6.2	5.1	4.8	7.8	7.3	5.6	5.1	4.7	4.4
Mean	12.1	11.5	10.8	9.7	12.2	11.4	9.9	9.6	9.1	6.4	5.7	9.1	8.6	7.1	6.2	5.3	4.9	7.6	7.1	5.8	5.3	4.8	4.4
Maximum	15.4	13.5	13.2	13.0	14.6	13.8	12.0	11.9	11.6	8.7	11.5	11.6	11.3	10.2	9.4	8.2	11.7	10.4	10.0	8.1	7.9	6.7	6.2
Minimum	9.5	9.0	7.1	5.8	9.3	9.2	7.5	7.5	6.6	4.4	3.6	7.0	5.4	4.4	4.1	2.4	1.5	5.5	4.5	3.8	3.0	3.3	2.6

Table 2. Stratum mean bottom temperatures recorded on the MDMF fall survey, 1978 – 2018.

	Region 1				Region 2		Region 3					Region 4						Region 5					
Year	11	12	13	14	15	16	17	18	19	20	21	25	26	27	28	29	30	31	32	33	34	35	36
1978	16.0	16.3	14.7	14.5	16.1	16.5	13.0	13.7	12.6	7.8	16.5	12.0	9.4	9.6	8.2	7.0	13.7	13.6	9.2	9.5	8.1	6.5	N/A
1979	16.7	16.5	15.8	16.0	16.9	16.1	13.6	14.7	14.2	10.2	9.7	11.3	12.3	8.1	8.9	7.9	8.8	11.7	10.0	9.1	8.8	8.8	8.2
1980	18.1	18.5	17.4	16.5	19.9	19.8	15.5	15.1	13.7	8.4	10.6	18.7	12.9	9.6	9.2	8.6	8.8	12.3	10.5	10.9	9.2	9.1	8.4
1981	19.2	18.4	16.8	16.6	19.6	19.1	16.2	16.4	15.5	11.0	10.2	15.3	13.7	13.5	12.9	11.9	9.9	13.4	13.1	12.2	12.0	11.8	9.6
1982	17.3	17.4	16.9	15.4	18.3	18.3	15.9	14.7	12.6	10.4	7.7	16.1	12.3	9.2	7.8	7.5	7.8	13.0	12.5	9.4	7.5	7.7	7.1
1983	20.3	19.5	17.8	16.7	20.9	20.5	16.0	16.6	14.1	9.5	8.5	15.0	14.9	10.8	9.2	9.0	8.3	N/A	N/A	N/A	N/A	N/A	N/A
1984	18.6	18.5	17.2	14.7	18.6	18.6	15.5	15.5	13.9	8.7	7.3	15.4	13.0	10.0	8.8	6.9	6.4	10.0	9.1	7.5	7.5	7.5	7.4
1985	19.3	18.8	18.5	16.5	19.1	19.0	16.9	15.4	15.6	13.6	9.1	16.4	14.6	13.6	11.6	9.8	8.2	16.2	14.4	13.8	10.4	9.2	8.1
1986	16.9	17.8	16.0	15.5	17.3	17.4	15.0	13.3	14.0	12.3	8.5	17.2	13.1	10.6	9.7	9.0	8.4	11.4	11.0	10.2	9.9	8.9	7.8
1987	16.4	16.7	16.7	16.3	19.2	18.7	13.5	13.1	12.9	7.0	6.1	12.7	7.8	6.4	5.4	5.0	5.1	8.6	6.4	6.2	5.6	4.9	N/A
1988	16.0	16.2	15.5	14.3	16.1	16.7	13.0	12.7	12.9	7.3	5.7	15.1	11.0	9.6	8.1	6.6	5.9	10.7	10.1	8.5	6.9	6.4	N/A
1989	19.3	18.9	17.2	14.9	19.0	18.3	15.7	16.7	11.9	5.6	4.5	12.0	8.9	8.1	7.5	6.8	5.1	13.0	11.2	9.6	8.5	7.7	6.8
1990	19.0	19.0	18.4	17.5	20.5	20.3	17.3	16.7	16.4	11.5	9.5	17.9	16.3	14.2	10.3	9.1	7.2	14.6	11.6	10.9	10.5	9.1	7.8
1991	19.6	19.2	18.6	18.1	19.5	19.7	17.2	16.8	16.1	13.7	10.7	16.4	16.2	13.8	13.3	10.5	9.0	16.6	12.1	10.2	8.9	8.5	N/A
1992	18.2	18.0	17.6	16.5	19.6	19.4	15.3	12.8	13.2	7.7	6.5	14.1	12.0	8.7	7.7	6.7	6.2	11.7	10.0	9.4	8.0	6.8	6.2
1993	17.1	17.5	16.9	16.2	18.1	19.4	13.9	16.6	14.2	8.4	7.0	13.6	12.4	8.8	8.3	7.7	6.9	12.6	11.0	9.0	8.8	8.0	6.9
1994	18.2	18.1	17.2	16.6	18.8	18.9	16.6	16.3	15.9	14.1	12.6	16.4	16.6	15.5	14.8	10.6	9.7	15.8	15.2	13.4	12.4	10.1	9.8
1995	19.2	19.4	13.7	11.7	10.7	8.7	8.3	12.8	11.7	10.4	9.8	8.8	9.2	14.9	13.0	10.3	9.3	8.6	8.5	N/A	N/A	N/A	N/A
1996	18.8	16.8	17.6	16.5	18.2	18.6	16.2	17.0	15.3	10.2	8.2	16.6	15.4	13.5	13.0	9.4	8.6	16.5	16.2	12.8	10.0	8.3	8.0
1997	18.4	18.6	17.5	17.7	20.2	19.7	16.4	17.2	14.3	9.3	8.3	17.4	16.3	11.4	9.3	8.9	8.1	16.5	15.4	13.3	9.8	8.2	8.3
1998	18.7	18.1	16.6	15.2	19.0	19.4	15.4	14.9	13.8	6.3	6.5	14.3	10.7	9.4	8.8	6.4	5.7	13.9	10.8	8.4	7.9	6.8	N/A
1999	20.3	19.8	19.3	18.2	19.9	19.9	18.1	16.0	14.9	9.2	7.7	16.2	12.2	10.2	9.5	8.4	7.8	14.6	11.8	10.4	9.7	8.6	8.7
2000	18.9	18.7	17.0	16.2	20.4	20.0	18.0	17.3	16.6	10.4	9.4	18.5	17.7	12.4	10.1	9.2	8.8	16.7	15.1	11.0	10.4	9.7	8.9
2001	19.5	19.3	17.8	16.9	20.7	20.2	15.2	16.2	12.2	7.9	6.5	16.2	10.7	8.7	7.4	6.6	6.4	10.9	8.7	8.5	7.3	6.8	6.9
2002	19.4	19.2	17.0	16.8	20.4	20.3	18.1	16.8	16.5	10.7	9.4	18.8	18.1	14.4	12.6	10.1	8.7	17.9	16.7	12.5	10.2	9.2	8.1
2003	20.2	19.0	18.6	18.0	20.0	19.4	15.8	15.6	14.7	9.7	8.7	15.0	10.9	8.3	7.7	7.5	6.8	14.4	11.6	10.5	8.6	7.3	7.2
2004	17.5	17.4	16.7	15.5	18.0	17.6	14.7	13.2	11.2	7.5	6.7	12.0	9.2	8.4	7.3	6.8	6.1	14.0	12.2	9.1	8.0	7.5	6.3
2005	20.9	20.0	18.1	17.5	20.3	21.2	16.1	15.9	16.6	7.5	6.5	16.2	10.3	7.5	6.7	6.2	5.9	11.6	10.4	8.8	6.9	6.0	5.5
2006	18.9	18.6	17.0	16.5	19.5	19.3	17.0	16.3	15.8	10.1	8.7	16.4	14.1	11.1	10.7	9.1	7.9	17.2	16.4	11.8	10.0	8.4	7.7
2007	18.4	19.0	18.1	15.3	19.9	20.3	16.8	16.3	14.5	8.2	8.7	16.8	12.8	8.8	7.6	6.8	6.1	11.1	10.3	8.7	7.4	6.7	6.6
2008	19.8	20.1	19.1	18.2	20.8	20.2	18.2	16.9	14.3	8.4	7.7	19.8	19.2	12.0	9.4	8.4	7.4	15.4	13.3	10.7	8.9	8.4	7.6
2009	19.0	18.7	17.8	17.6	19.3	19.1	17.2	16.8	17.9	14.6	10.0	17.4	15.8	13.3	12.0	9.5	8.4	16.9	17.2	16.2	11.3	8.9	7.5
2010	18.7	18.5	17.1	16.3	19.6	19.7	17.3	17.0	15.1	10.9	8.9	15.9	15.6	13.5	9.6	8.0	7.7	13.8	11.7	10.5	9.1	8.5	8.0
2011	19.7	19.8	17.7	16.6	20.7	19.9	17.1	16.2	16.4	13.9	9.0	15.0	13.1	10.3	9.9	9.3	8.5	15.6	15.0	13.5	11.8	9.0	8.0
2012	19.6	20.2	18.8	17.8	20.3	21.3	17.0	17.3	19.4	9.0	8.3	11.8	10.4	9.5	8.9	8.8	8.5	13.0	11.8	10.4	9.6	8.9	8.9
2013	18.2	18.5	17.6	15.7	20.8	20.3	16.5	16.6	15.7	9.5	9.0	15.9	11.2	9.7	9.0	8.6	8.4	14.2	12.5	11.2	9.9	8.8	7.9
2014	20.3	20.4	19.0	17.2	21.2	20.5	17.9	15.6	16.3	8.9	7.8	16.8	12.7	9.0	8.1	7.3	6.9	11.3	11.1	9.1	8.4	7.9	7.3
2015	21.5	20.7	18.9	16.2	20.9	20.1	18.7	16.2	15.9	10.0	9.2	15.7	14.5	10.3	9.7	8.7	7.8	16.9	12.5	11.7	9.7	8.4	7.7
2016	21.1	20.4	18.3	16.8	21.2	21.2	18.2	18.2	18.8	12.5	10.4	19.3	17.7	16.0	13.0	9.9	9.4	18.3	17.7	14.3	10.9	10.1	13.4
2017	19.9	19.2	18.4	16.6	19.4	19.3	16.1	15.2	14.3	9.1	8.2	15.5	16.2	10.0	8.8	7.6	7.2	12.8	10.3	8.7	8.0	7.7	6.9
2018	21.3	20.3	19.9	19.0	21.7	21.2	17.9	16.5	16.6	11.0	10.4	18.7	14.8	11.3	11.0	10.3	10.0	16.0	14.7	12.1	11.2	10.8	9.2
Median	19.0	18.7	17.6	16.5	19.6	19.4	16.2	16.2	14.7	9.5	8.7	16.1	13.0	10.2	9.2	8.6	7.9	13.9	11.7	10.4	9.1	8.4	7.8
Mean	18.9	18.7	17.5	16.4	19.3	19.1	16.0	15.7	14.8	9.8	8.6	15.6	13.3	10.8	9.6	8.4	7.8	13.8	12.2	10.6	9.2	8.3	7.9
Maximum	21.5	20.7	19.9	19.0	21.7	21.3	18.7	18.2	19.4	14.6	16.5	19.8	19.2	16.0	14.8	11.9	13.7	18.3	17.7	16.2	12.4	11.8	13.4
Minimum	16.0	16.2	13.7	11.7	10.7	8.7	8.3	12.7	11.2	5.6	4.5	8.8	7.8	6.4	5.4	5.0	5.1	8.6	6.4	6.2	5.6	4.9	5.5

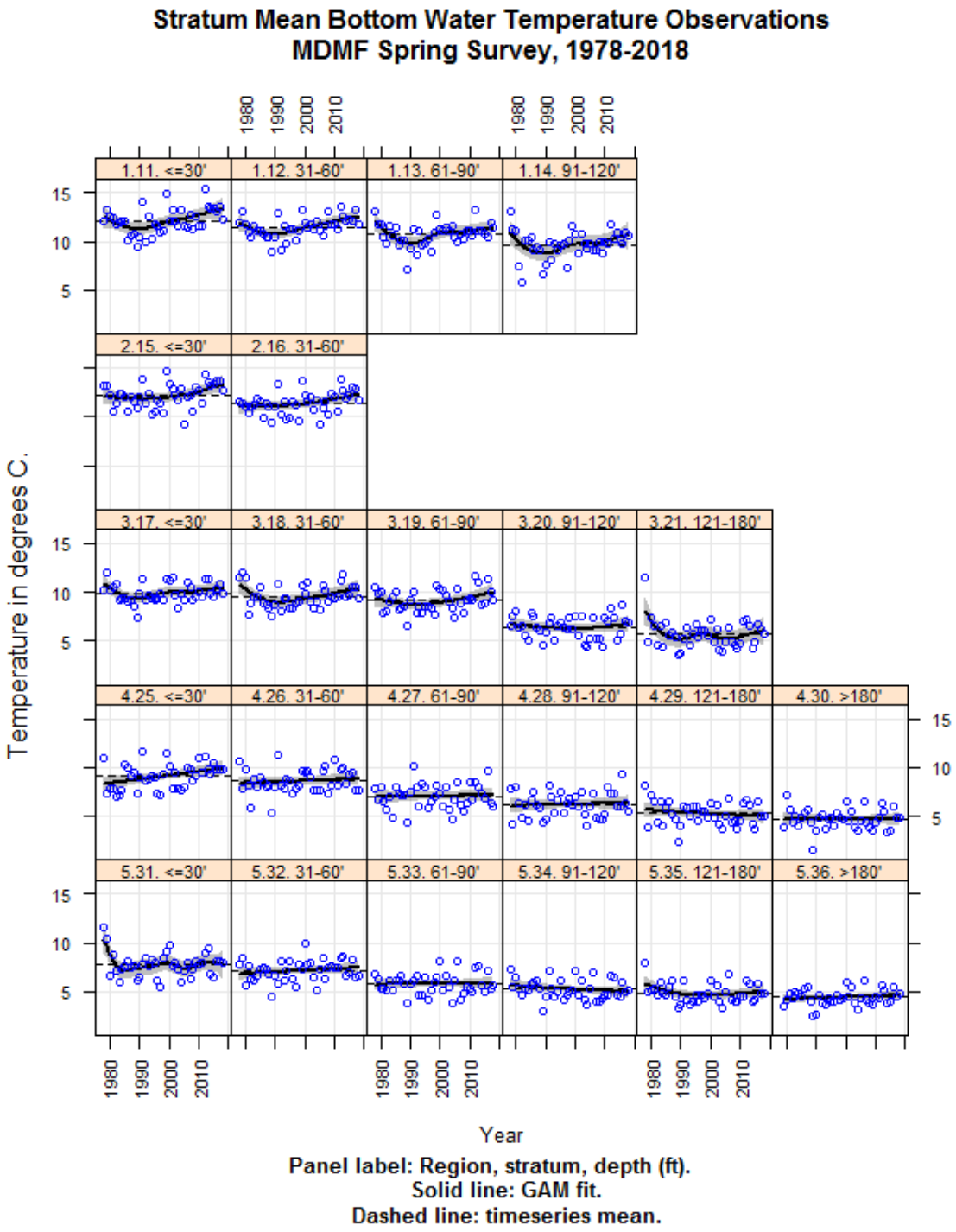

Stratum Mean Bottom Water Temperature Observations
MDMF Spring Survey, 1978-2018
1.11. <=30'
1.12. 31-60'
1.13. 61-90'
1.14. 91-120'
2.15. <=30'
2.16. 31-60'
3.17. <=30'
3.18. 31-60'
3.19. 61-90'
3.20. 91-120'
3.21. 121-180'
4.25. <=30'
4.26. 31-60'
4.27. 61-90'
4.28. 91-120'
4.29. 121-180'
4.30. >180'
5.31. <=30'
5.32. 31-60'
5.33. 61-90'
5.34. 91-120'
5.35. 121-180'
5.36. >180'
Temperature in degrees C.
Year
Panel label: Region, stratum, depth (ft).
Solid line: GAM fit.
Dashed line: timeseries mean.

Figure 1.

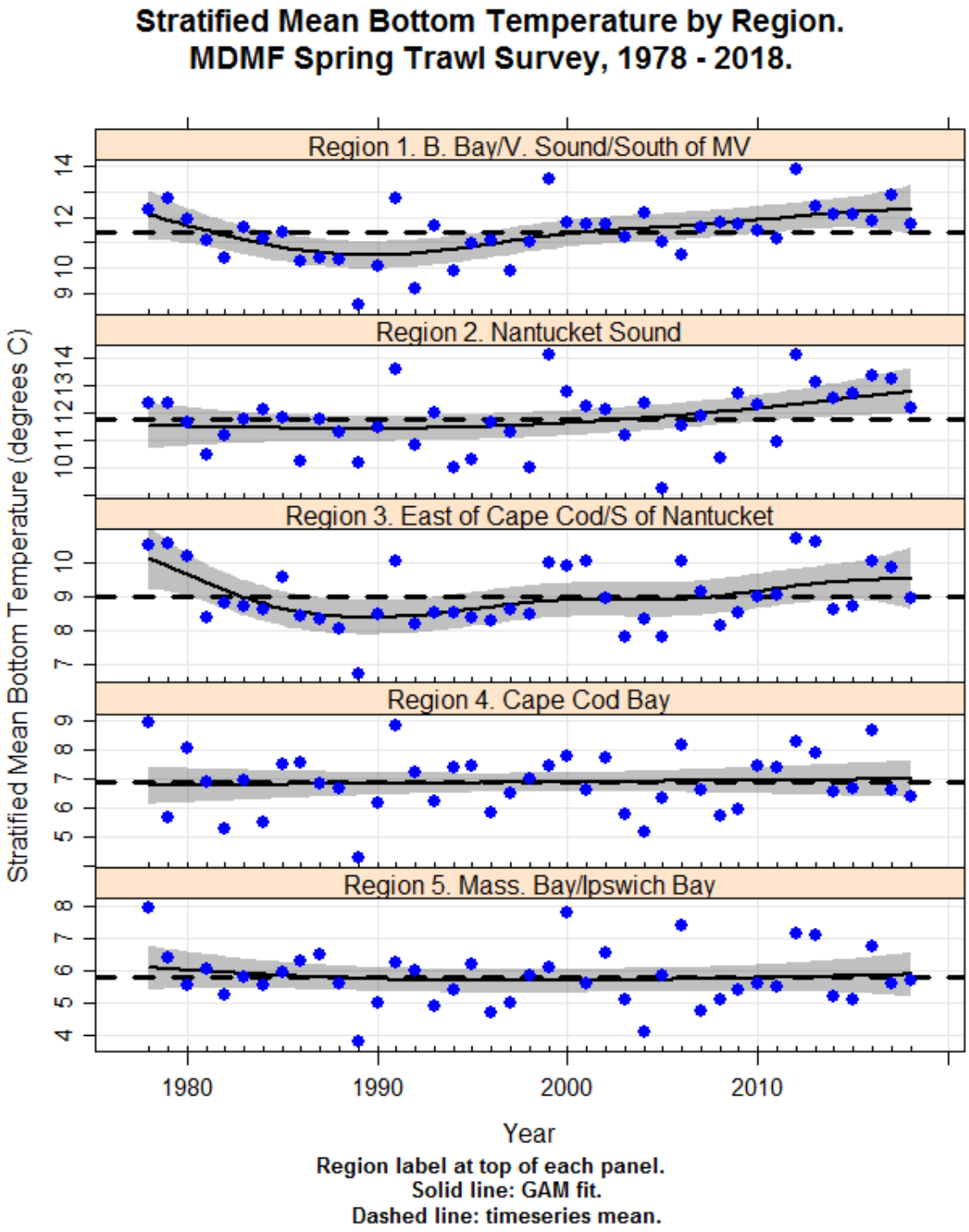

Stratified Mean Bottom Temperature by Region.
MDMF Spring Trawl Survey, 1978 - 2018.
Region 1. B. Bay/V. Sound/South of MV
Region 2. Nantucket Sound
Region 3. East of Cape Cod/S of Nantucket
Region 4. Cape Cod Bay
Region 5. Mass. Bay/Ipswich Bay
Stratified Mean Bottom Temperature (degrees C)
Year
1980
1990
2000
2010
Region label at top of each panel.
Solid line: GAM fit.
Dashed line: timeseries mean.

Figure 2.

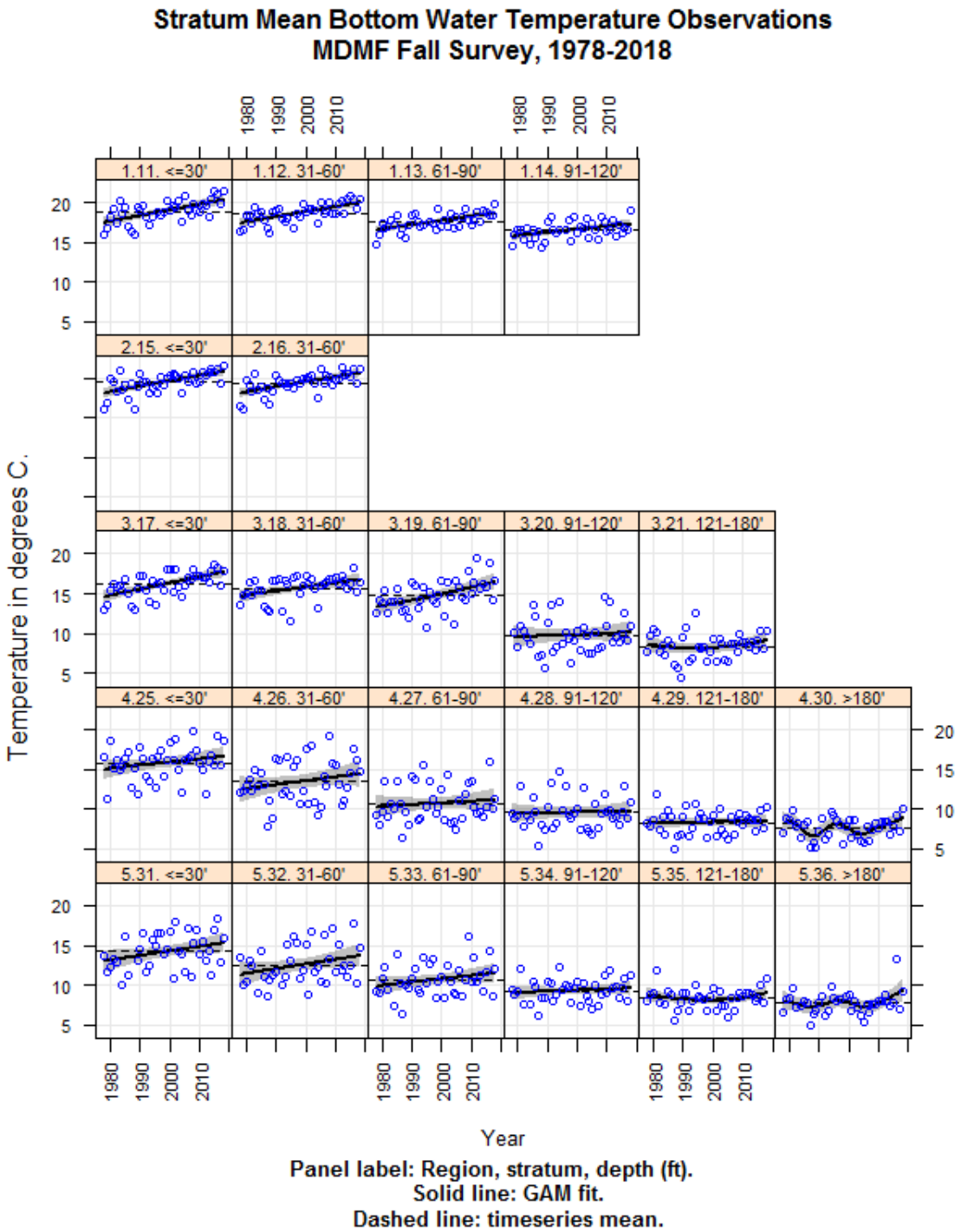

Stratum Mean Bottom Water Temperature Observations
MDMF Fall Survey, 1978-2018
1.11. <=30'
1.12. 31-60'
1.13. 61-90'
1.14. 91-120'
2.15. <=30'
2.16. 31-60'
3.17. <=30'
3.18. 31-60'
3.19. 61-90'
3.20. 91-120'
3.21. 121-180'
4.25. <=30'
4.26. 31-60'
4.27. 61-90'
4.28. 91-120'
4.29. 121-180'
4.30. >180'
5.31. <=30'
5.32. 31-60'
5.33. 61-90'
5.34. 91-120'
5.35. 121-180'
5.36. >180'
Temperature in degrees C.
Year
Panel label: Region, stratum, depth (ft).
Solid line: GAM fit.
Dashed line: timeseries mean.

Figure 3.

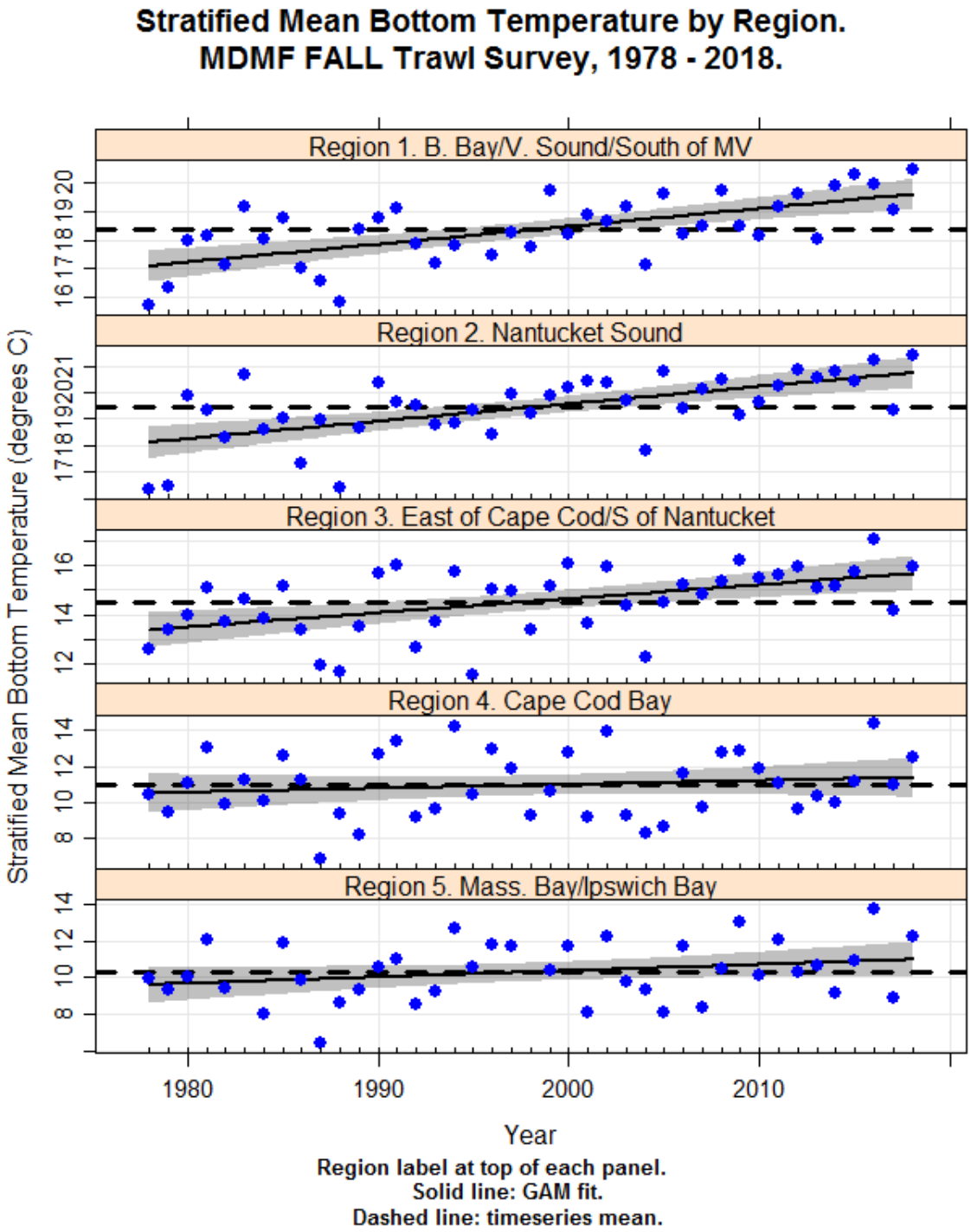

Stratified Mean Bottom Temperature by Region.
MDMF FALL Trawl Survey, 1978 - 2018.
Region 1. B. Bay/V. Sound/South of MV
Region 2. Nantucket Sound
Region 3. East of Cape Cod/S of Nantucket
Region 4. Cape Cod Bay
Region 5. Mass. Bay/Ipswich Bay
Stratified Mean Bottom Temperature (degrees C)
Year
1980
1990
2000
2010
Region label at top of each panel.
Solid line: GAM fit.
Dashed line: timeseries mean.

Figure 4.

Appendix C: Corrections to the trawl survey database in 2018.

Miscellaneous database corrections
1/10/2018 M.Camisa

Changes to UNION_FSCS_SVLEN

Cruise	station	svspp	sex	len reads	expnumlen reads	len should read	expnumlen should read
201792	0051	312	2	90	1	9.0	1
201792	0051	312	2	111	1	11.1	1

Changes to UNION_FSCS_SVSTA

Cruise	station	stratum	tow reads	tow should read
201792	0068	09150	068	003