

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



2021 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

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Period Covered: January 1, 2021 – December 31, 2021

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Date Submitted: 1/1/2022

Sport Fish Program
Massachusetts Fishery Resource Assessment: F-56-R-24
2021 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-third annual spring and fall bottom trawl surveys of Massachusetts territorial waters in 2021. 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-sixth annual seine survey of Nantucket Sound estuaries on the south shore of Cape Cod to assess southern New England stock winter flounder yoy cohort abundance. A report of the 2021 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 - 2021.

[Appendix C:](#) Corrections to the trawl survey database in 2021.

CRUISE RESULTS

R/V GLORIA MICHELLE

2021 Massachusetts Inshore Spring
Bottom Trawl Survey
Cruise No. 202191

CRUISE PERIOD AND AREA

From May 5 through May 22, 2021 the Massachusetts Division of Marine Fisheries conducted its 43rd 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. From 2010 through 2018, FSCS version 1.6 was utilized for electronic data collection. Starting in 2019, we upgraded to FSCS

version 2.0. 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.

To mitigate COVID-19 risks, the survey schedule was altered to have three 6-day legs, limiting the number of crew changes, with one day off between each leg for cleaning purposes. Each leg began and ended in Wood's Hole to reduce the number of port calls and we reduced the number of scientific crew to four per leg. As a result of these mitigation measures, only nine MADMf employees participated in the survey as part of the scientific party (Table 1).

CRUISE SUMMARY

99 stations were attempted in 16 sampling days (Figs 1 and 2, Table 2). 96 completed stations were considered acceptable for assessment of all species, SHG ≤ 136 (Table 3). Two stations were dropped South of Nantucket, one each in stratum 17 and 18, due to time constraints and vessel anchor issues. One station was dropped in stratum 26 due to hard bottom and 2 stations were dropped in western Cape Cod Bay, one each in stratum 27 and 29, due to the presence of right whales in the area. Two stations were dropped in stratum 35 due to adverse weather conditions and time constraints. Three attempted tows were aborted due to crossed doors and hard bottom (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). A few records were set on the 2021 spring survey. The first spring hogchoker was recorded at station 100 off West Island in Buzzard's Bay. The largest Biomass of scup (1,787kg) was recorded at station 91 South of L'Hommedieu Shoal in Nantucket Sound and the largest biomass of blue crab was recorded at station 89 near Edgartown Harbor. Moderate catches of winter flounder, silver hake, longhorn sculpin and YOY Atlantic cod were taken North of Cape Cod. Scup, Northern searobin and juvenile longfin squid were abundant throughout Nantucket Sound, Vineyard Sound and Buzzard's Bay.

Additional sampling goals were achieved (Table 7). To aid cooperative fisheries assessments, over 800 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 and American lobster. 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, contact Matthew Camisa at (508) 742-9743.

Table 1. MADMF 2021 Spring Cruise Staffing List

Scientific Party

Name	Affiliation	Num. Days
Matthew Camisa	MADMF	12
Brendan Reilly	MADMF	12
Vincent Manfredi	MADMF	10
Steve Voss	MADMF	6
Alex Boeri	MADMF	6
Ross Kessler	MADMF	6
Steve Wilcox	MADMF	4
Derek Perry	MADMF	4
Elise Koob	MADMF	4
		64

R/V Gloria Michelle Crew

Name	Affiliation	Num. Days
<i>Officers</i>		
Chris Gallagher	NOAA OIC	10
Ben VanDine	NOAA JOIC	9
Mike Abbott	NOAA-CORPS	5
Tyler Aldrich	NOAA-CORPS	4
<i>Deck Crew</i>		
George Morton	Contract Fisherman	14
Jason McGrath	Contract Fisherman	14
Pete Plantamura	NMFS-Sandy Hook	14

Table 2. Station Information for the 2021 Massachusetts Spring Inshore Bottom Trawl Survey
Cruise No. 202191

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
1	26	5/5/2021	9:18	19	41°48.33	-70°28.28	199	0.84	8.9
2	25	5/5/2021	13:10	9	42°09.33	-70°41.64	180	0.83	8.8
3	33	5/5/2021	15:45	21	42°18.34	-70°48.89	86	0.78	7.7
4	32	5/5/2021	17:04	14	42°17.70	-70°51.64	165	0.84	8.9
5	33	5/6/2021	6:22	24	42°23.64	-70°54.72	89	0.75	8.0
6	31	5/6/2021	7:40	11	42°26.10	-70°54.95	338	0.84	8.7
7	32	5/6/2021	8:45	16	42°26.28	-70°54.53	25	0.55	8.0
8	34	5/6/2021	10:41	31	42°22.99	-70°49.11	346	0.72	7.3
9	36	5/6/2021	13:40	77	42°27.65	-70°38.18	30	0.82	6.2
10	35	5/6/2021	15:35	46	42°30.95	-70°43.09	67	0.83	6.3
11	34	5/6/2021	16:45	34	42°32.48	-70°44.21	61	0.85	6.5
12	34	5/7/2021	6:56	34	42°49.25	-70°44.62	4	0.83	6.6
13	32	5/7/2021	8:21	16	42°44.60	-70°46.01	355	0.84	8.1
14	31	5/7/2021	10:00	10	42°43.59	-70°45.99	161	0.83	8.1
15	31	5/7/2021	11:13	9	42°41.71	-70°43.78	146	0.84	7.9
16	33	5/7/2021	12:22	22	42°41.84	-70°41.00	106	0.85	7.0
17	34	5/7/2021	13:35	31	42°42.88	-70°40.50	281	0.84	6.8
18	35	5/7/2021	15:26	44	42°41.89	-70°34.77	140	0.84	6.4
19	36	5/7/2021	16:33	84	42°39.75	-70°30.89	337	0.84	6.2
20	33	5/7/2021	18:19	28	42°36.71	-70°36.18	245	0.54	7.0
21	35	5/8/2021	7:24	42	42°35.52	-70°36.17	62	0.82	6.6
22	35	5/8/2021	8:44	52	42°34.16	-70°36.67	77	0.20	6.5
23	29	5/8/2021	16:00	38	41°58.56	-70°15.09	51	0.84	7.7
24	21	5/9/2021	6:52	62	42°05.47	-70°14.15	78	0.85	6.7
25	19	5/9/2021	8:25	24	42°05.82	-70°09.71	110	0.85	8.7
26	21	5/9/2021	10:17	64	42°06.58	-70°13.56	259	0.83	6.3
27	30	5/9/2021	11:54	60	42°04.36	-70°18.51	203	0.84	5.9
28	30	5/9/2021	13:14	58	42°04.78	-70°23.53	152	0.83	5.9
29	29	5/9/2021	14:47	52	42°07.43	-70°28.63	196	0.83	6.3
30	29	5/10/2021	6:14	47	42°01.48	-70°13.52	164	0.81	8.6
31	28	5/10/2021	7:38	36	41°56.65	-70°15.27	61	0.83	8.5
32	29	5/10/2021	9:40	46	41°58.93	-70°24.96	87	0.84	6.1
33	26	5/10/2021	11:59	15	41°50.73	-70°29.72	23	0.84	9.0
34	25	5/10/2021	13:02	9	41°50.20	-70°30.59	9	0.61	9.8
35	12	5/10/2021	16:12	12	41°35.77	-70°43.30	232	0.84	11.3
36	27	5/12/2021	8:41	24	41°48.95	-70°23.32	52	0.84	8.3
37	26	5/12/2021	10:10	17	41°47.94	-70°13.69	272	0.83	10.2
38	25	5/12/2021	11:53	9	41°49.20	-70°02.72	239	0.85	12.2
39	25	5/12/2021	13:06	12	41°46.62	-70°08.64	66	0.86	11.0

Table 2 continued.

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
40	26	5/12/2021	14:20	14	41°49.32	-70°08.49	95	0.19	11.1
41	27	5/12/2021	15:43	21	41°48.24	-70°17.72	131	0.83	9.8
42	28	5/12/2021	17:56	30	41°52.56	-70°21.62	147	0.85	8.1
43	28	5/13/2021	5:47	28	41°52.50	-70°26.21	166	0.85	8.0
44	28	5/13/2021	7:00	32	41°53.89	-70°20.95	267	0.85	8.0
45	26	5/13/2021	9:04	10	41°54.22	-70°07.19	234	0.86	11.2
46	27	5/13/2021	10:01	22	41°54.84	-70°09.04	228	0.84	10.5
47	27	5/13/2021	11:06	25	41°56.37	-70°08.78	201	0.86	10.4
48	28	5/13/2021	12:17	34	41°55.38	-70°13.87	63	0.84	8.6
49	17	5/14/2021	6:35	9	42°00.01	-70°00.62	349	0.85	9.9
50	18	5/14/2021	7:49	25	41°59.33	-69°58.78	196	0.84	9.0
51	17	5/14/2021	9:03	10	41°53.73	-69°57.21	0	0.85	9.6
52	20	5/14/2021	10:28	35	41°49.49	-69°53.26	3	0.83	8.4
53	20	5/14/2021	12:12	35	41°46.36	-69°52.08	11	0.83	8.4
54	18	5/14/2021	13:51	14	41°38.81	-69°55.11	40	0.84	9.6
55	17	5/14/2021	16:17	11	41°27.34	-70°00.66	21	0.84	10.3
56	18	5/15/2021	9:29	13	41°16.53	-70°19.36	294	0.82	11.1
57	17	5/15/2021	10:42	8	41°17.79	-70°17.80	145	0.85	11.4
58	19	5/15/2021	11:53	19	41°13.48	-70°13.31	314	0.82	10.8
59	18	5/15/2021	13:19	16	41°12.83	-70°10.27	290	0.85	11.0
60	11	5/16/2021	9:32	9	41°19.14	-70°28.56	268	0.82	12.1
61	12	5/16/2021	10:31	14	41°18.78	-70°30.60	290	0.83	10.5
62	13	5/16/2021	11:48	19	41°18.23	-70°31.99	294	0.83	9.9
63	11	5/16/2021	13:09	9	41°20.72	-70°35.26	275	0.81	12.2
64	12	5/16/2021	14:25	14	41°19.75	-70°40.07	283	0.83	11.0
65	13	5/16/2021	15:25	22	41°17.38	-70°44.19	54	0.85	9.6
67	14	5/16/2021	17:02	32	41°18.84	-70°52.31	164	0.82	8.4
68	13	5/17/2021	5:16	25	41°22.12	-70°49.42	94	0.84	10.4
69	14	5/17/2021	6:37	30	41°21.16	-70°56.52	81	0.84	7.6
70	12	5/17/2021	8:05	18	41°25.86	-71°02.73	155	0.81	10.4
71	11	5/17/2021	9:34	9	41°29.41	-71°03.05	346	0.82	11.0
72	13	5/17/2021	10:57	21	41°26.78	-71°00.90	197	0.53	10.8
73	12	5/17/2021	12:20	17	41°28.88	-70°52.23	237	0.84	11.3
74	15	5/19/2021	8:23	7	41°35.16	-70°16.56	107	0.82	14.5
75	15	5/19/2021	10:36	7	41°36.88	-70°12.09	266	0.55	14.2
76	15	5/19/2021	12:03	8	41°35.50	-70°03.13	26	0.83	13.1
77	15	5/19/2021	12:58	7	41°34.65	-70°01.33	300	0.74	11.9
78	16	5/19/2021	13:59	10	41°33.51	-70°06.04	3	0.84	13.9
79	15	5/19/2021	14:59	9	41°31.81	-70°05.32	49	0.85	13.4
80	16	5/19/2021	16:24	13	41°28.44	-70°10.60	108	0.54	13.8

Table 2 continued.

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
81	16	5/19/2021	17:59	14	41°23.10	-70°07.65	78	0.84	13.4
82	15	5/20/2021	6:31	8	41°21.12	-70°16.70	121	0.75	14.7
83	16	5/20/2021	7:57	14	41°21.87	-70°10.32	98	0.86	13.7
84	16	5/20/2021	9:16	14	41°20.33	-70°04.25	80	0.87	13.5
85	16	5/20/2021	11:01	12	41°28.21	-70°05.21	281	0.05	11.6
86	16	5/20/2021	11:33	12	41°28.27	-70°05.89	286	0.82	11.6
87	16	5/20/2021	13:03	13	41°25.50	-70°13.39	284	0.84	14.5
88	16	5/20/2021	14:24	22	41°27.39	-70°17.24	296	0.84	14.1
89	15	5/20/2021	16:14	8	41°24.30	-70°28.76	32	0.63	14.7
90	13	5/21/2021	5:47	22	41°29.13	-70°41.01	248	0.86	13.0
91	16	5/21/2021	7:50	20	41°29.59	-70°29.77	114	0.59	14.0
92	16	5/21/2021	8:55	15	41°26.28	-70°27.29	62	0.53	14.0
93	16	5/21/2021	11:04	18	41°30.50	-70°15.96	96	0.84	14.2
94	15	5/21/2021	12:23	6	41°31.62	-70°21.31	109	0.55	15.1
95	15	5/21/2021	14:21	8	41°33.59	-70°25.68	272	0.53	16.4
96	15	5/21/2021	16:57	7	41°32.05	-70°35.03	280	0.83	14.6
97	12	5/22/2021	5:36	15	41°34.10	-70°41.40	189	0.83	12.4
98	11	5/22/2021	7:05	9	41°38.06	-70°44.08	266	0.79	14.9
99	12	5/22/2021	8:08	12	41°35.94	-70°45.83	211	0.83	13.3
100	11	5/22/2021	9:06	7	41°36.32	-70°48.85	167	0.83	13.4

Table 3. Sampling Effort Assigned and Accomplished by Stratum, Cruise 202191.

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	
15	2	10	10		10	1
16	2	11	11		11	
17	3	5	4		4	
18	3	5	4		4	
19	3	2	2		2	
20	3	2	2		2	
21	3	2	2		2	
25	4	4	4		4	1
26	4	5	4		4	
27	4	5	4		4	
28	4	5	5		5	
29	4	5	4		4	
30	4	2	2		2	
31	5	3	3		3	1
32	5	3	3		3	
33	5	4	4		4	
34	5	4	4		4	
35	5	5	3		3	
36	5	2	2		2	
TOTALS		103	96	0	96	3

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 202191.
Not Advised for Indices of Abundance other than Spiny Dogfish.

Station	Stratum	SHG Location	Description
No sub-standard tows on cruise 202191			

Table 5. Attempted Tows Aborted During Cruise 202191.

Station	Stratum	SHG Location	Description
22	35	177 Southeast of Gloucester	Doors crossed
40	26	173 Eastern Cape Cod Bay	Hung down
85	16	174 Eastern Nantucket Sound	Hung down

Table 6a. Total Catch Numbers and Weights Observed on the 2021
Massachusetts Spring Inshore Bottom Trawl Survey - Cruise 202191- Sorted by Number

Species Code	Common Name	Count	Weight (kg)
143	SCUP	52,656	11,716.044
171	NORTHERN SEAROBIN	7,265	1,380.068
73	ATLANTIC COD	5,039	48.878
106	WINTER FLOUNDER	4,442	690.834
503	LONGFIN SQUID	3,824	70.699
72	SILVER HAKE	3,534	288.340
131	BUTTERFISH	3,507	149.806
163	LONGHORN SCULPIN	3,442	510.950
77	RED HAKE	1,426	147.098
105	YELLOWTAIL FLOUNDER	1,138	234.051
26	LITTLE SKATE	893	467.285
193	OCEAN POUT	889	348.266
313	ATLANTIC ROCK CRAB	827	136.909
33	ALEWIFE	815	43.896
317	SPIDER CRAB UNCL	678	84.150
301	AMERICAN LOBSTER	610	204.203
102	AMERICAN PLAICE	578	63.145
23	WINTER SKATE	513	269.031
141	BLACK SEA BASS	493	145.527
108	WINDOWPANE	477	96.551
78	SPOTTED HAKE	425	8.254
181	NORTHERN SAND LANCE	401	2.873
32	ATLANTIC HERRING	379	10.144
103	SUMMER FLOUNDER	320	143.377
104	FOURSPOT FLOUNDER	146	28.060
177	TAUTOG	132	96.045
348	NORTHERN MOONSNAIL	119	19.975
172	STRIPED SEAROBIN	80	31.807
318	HORSESHOE CRAB	74	85.004
337	KNOBBED WHELK	71	19.921
176	CUNNER	66	3.320
336	CHANNELED WHELK	66	13.316
43	BAY ANCHOVY	66	0.203
121	ATLANTIC MACKEREL	65	4.255
401	SEA SCALLOP	51	2.738
164	SEA RAVEN	48	18.234
34	BLUEBACK HERRING	37	1.751
312	JONAH CRAB	36	6.675
74	HADDOCK	35	24.433
35	AMERICAN SHAD	34	1.441
13	SMOOTH DOGFISH	28	82.871

Table 6a continued.

Species Code	Common Name	Count	Weight (kg)
75	POLLOCK	28	0.318
139	STRIPED BASS	23	37.619
117	SMALLMOUTH FLOUNDER	21	0.538
76	WHITE HAKE	21	5.829
314	BLUE CRAB	19	3.452
155	ACADIAN REDFISH	18	0.970
197	GOOSEFISH	13	1.468
182	SNAKEBLENNY	12	0.412
36	ATLANTIC MENHADEN	11	3.688
322	LADY CRAB	9	0.844
323	MANTIS SHRIMP UNCL	9	0.490
402	BAY SCALLOP	8	0.683
403	ATLANTIC SURFCLAM	8	1.607
146	NORTHERN KINGFISH	3	0.457
502	NORTHERN SHORTFIN SQUID	3	0.031
180	ROCK GUNNEL	3	0.048
183	DAUBED SHANNY	3	0.052
409	OCEAN QUAHOG	2	0.266
45	RAINBOW SMELT	2	0.022
166	GRUBBY	2	0.038
162	SHORTHORN SCULPIN	1	0.250
24	CLEARNOSE SKATE	1	1.542
185	OYSTER TOADFISH	1	0.219
15	SPINY DOGFISH	1	0.864
22	BARNDOR SKATE	1	0.184
63	CONGER EEL	1	0.061
116	NORTHERN PIPEFISH	1	0.009
118	HOGCHOKER	1	0.298
413	NORTHERN QUAHOG	1	0.217
168	LUMPFISH	1	0.612
Totals		95,953	17,763.516

Table 6b. Total Catch Numbers and Weights Observed on the 2021
Massachusetts Spring Inshore Bottom Trawl Survey - Cruise 202191- Sorted by Weight

SPP CODE	COMMON NAME	COUNT	WEIGHT(kg)
143	SCUP	52,656	11,716.044
171	NORTHERN SEAROBIN	7,265	1,380.068
106	WINTER FLOUNDER	4,442	690.834
163	LONGHORN SCULPIN	3,442	510.950
26	LITTLE SKATE	893	467.285
193	OCEAN POUT	889	348.266
72	SILVER HAKE	3,534	288.340
23	WINTER SKATE	513	269.031
105	YELLOWTAIL FLOUNDER	1,138	234.051
301	AMERICAN LOBSTER	610	204.203
131	BUTTERFISH	3,507	149.806
77	RED HAKE	1,426	147.098
141	BLACK SEA BASS	493	145.527
103	SUMMER FLOUNDER	320	143.377
313	ATLANTIC ROCK CRAB	827	136.909
108	WINDOWPANE	477	96.551
177	TAUTOG	132	96.045
318	HORSESHOE CRAB	74	85.004
317	SPIDER CRAB UNCL	678	84.150
13	SMOOTH DOGFISH	28	82.871
503	LONGFIN SQUID	3,824	70.699
102	AMERICAN PLAICE	578	63.145
73	ATLANTIC COD	5,039	48.878
33	ALEWIFE	815	43.896
139	STRIPED BASS	23	37.619
172	STRIPED SEAROBIN	80	31.807
104	FOURSPOT FLOUNDER	146	28.060
74	HADDOCK	35	24.433
348	NORTHERN MOONSNAIL	119	19.975
337	KNOBBED WHELK	71	19.921
164	SEA RAVEN	48	18.234
336	CHANNELED WHELK	66	13.316
32	ATLANTIC HERRING	379	10.144
78	SPOTTED HAKE	425	8.254
312	JONAH CRAB	36	6.675
76	WHITE HAKE	21	5.829
121	ATLANTIC MACKEREL	65	4.255
36	ATLANTIC MENHADEN	11	3.688
314	BLUE CRAB	19	3.452

Table 6b continued.

SPP CODE	COMMON NAME	COUNT	WEIGHT(kg)
176	CUNNER	66	3.320
181	NORTHERN SAND LANCE	401	2.873
401	SEA SCALLOP	51	2.738
34	BLUEBACK HERRING	37	1.751
403	ATLANTIC SURFCLAM	8	1.607
24	CLEARNOSE SKATE	1	1.542
197	GOOSEFISH	13	1.468
35	AMERICAN SHAD	34	1.441
155	ACADIAN REDFISH	18	0.970
15	SPINY DOGFISH	1	0.864
322	LADY CRAB	9	0.844
402	BAY SCALLOP	8	0.683
168	LUMPFISH	1	0.612
117	SMALLMOUTH FLOUNDER	21	0.538
323	MANTIS SHRIMP UNCL	9	0.490
146	NORTHERN KINGFISH	3	0.457
182	SNAKEBLENNY	12	0.412
75	POLLOCK	28	0.318
118	HOGCHOKER	1	0.298
409	OCEAN QUAHOG	2	0.266
162	SHORTHORN SCULPIN	1	0.250
185	OYSTER TOADFISH	1	0.219
413	NORTHERN QUAHOG	1	0.217
43	BAY ANCHOVY	66	0.203
22	BARNDOR SKATE	1	0.184
63	CONGER EEL	1	0.061
183	DAUBED SHANNY	3	0.052
180	ROCK GUNNEL	3	0.048
166	GRUBBY	2	0.038
502	NORTHERN SHORTFIN SQUID	3	0.031
45	RAINBOW SMELT	2	0.022
116	NORTHERN PIPEFISH	1	0.009
Totals		95,953	17,763.516

Table 7. Number of individuals obtained for age, growth, maturity and special studies during Massachusetts DMF Cruise 202191.

Species	Maturity Observation	Age and Growth Collection		
		Scales	Otoliths	YOY
Atlantic Cod	53		53	
Haddock	14		14	
Summer Flounder	101		100	
Yellowtail Flounder	122		122	
Winter Flounder	321		318	
Black Sea Bass	145		143	
Scup	49		49	
Tautog	4		4	
American Lobster	270			
TOTAL	1,079	0	803	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).

YOY Atlantic cod saved for age and growth study (Dean).

Nantucket Sound whelk saved for age and growth study (Wilcox).

5 male smooth dogfish collected for University of Rochester Center for RNA Biology (Li).

Longfin squid were saved for Black Sea Bass rod and reel sampling (Glenn)

Figure 1.

Massachusetts Division of Marine Fisheries Inshore Bottom Trawl Survey

MDMF Trawl Survey Depth Strata

Depth (feet)

-  Deleted
-  0 to 30
-  31 to 60
-  61 to 90
-  91 to 120
-  121 to 180
-  181 +

 Indicates stratum number

A or B Indicates subregion

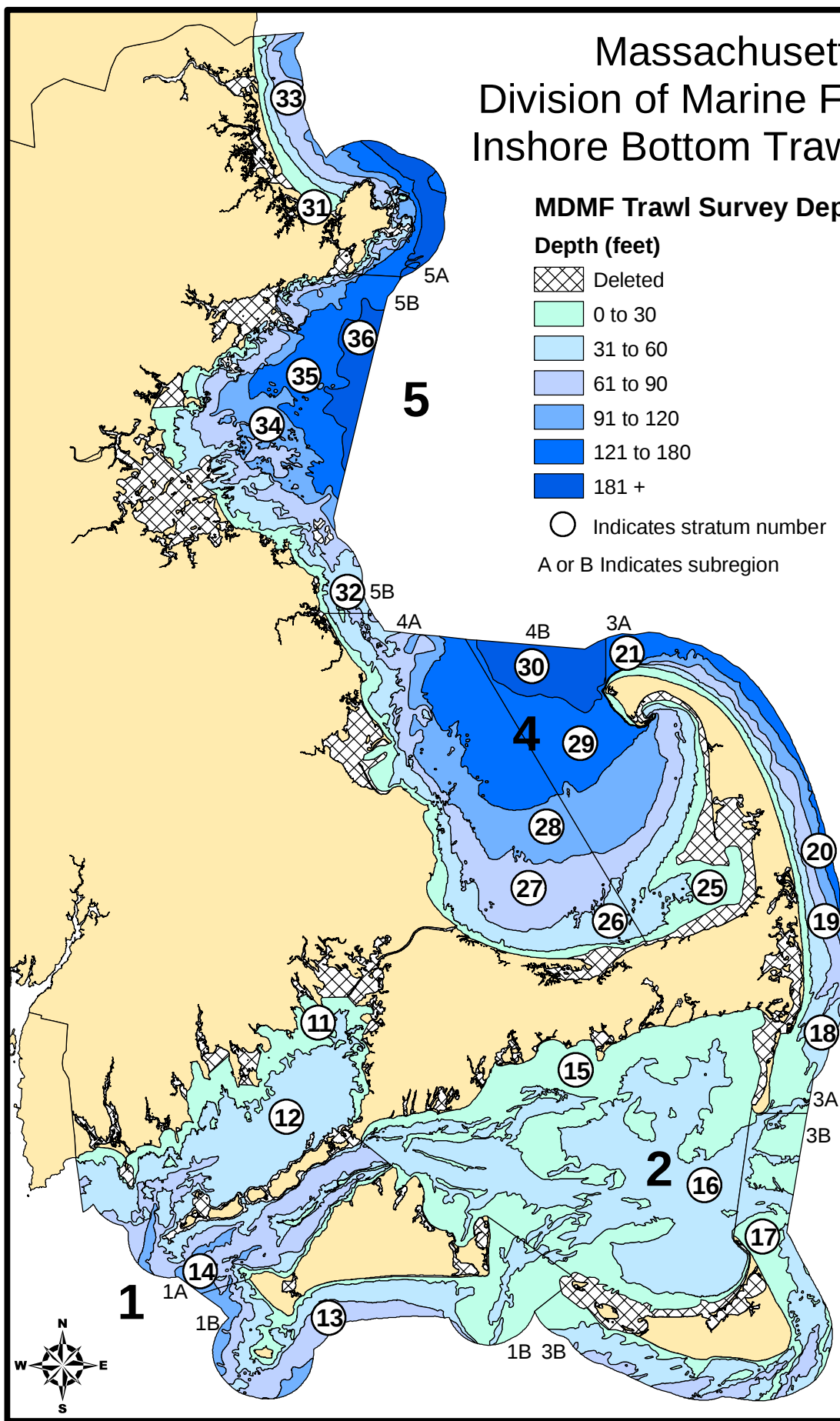


Figure 2.

Spring 2021 Mass Division of Marine Fisheries Bottom Trawl Survey Tow Locations

- Proposed Tow Circles
- 202191 Completed Tow Tracks
- ✕ 202191 Aborted Tows

Data label indicates day of month (May)

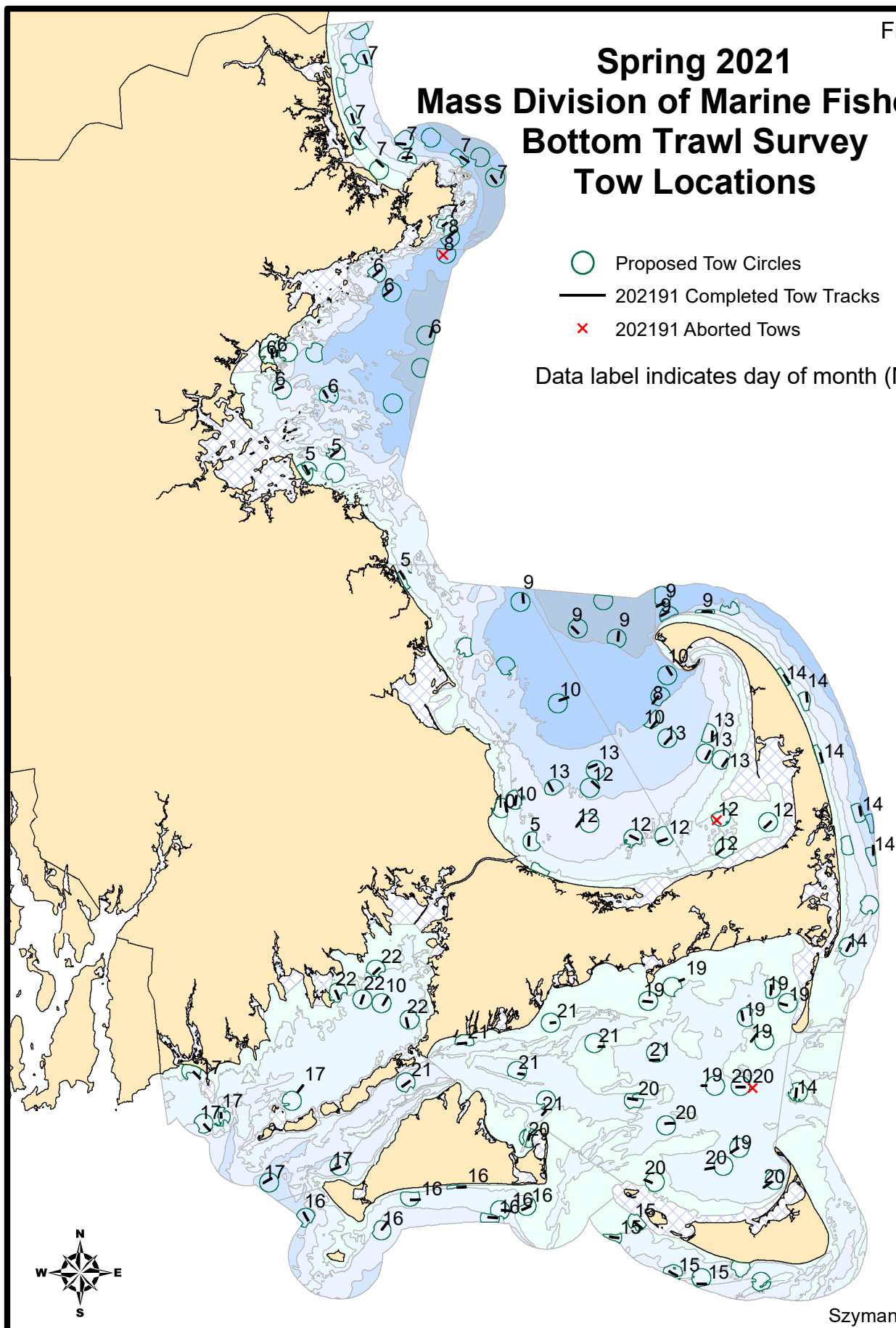
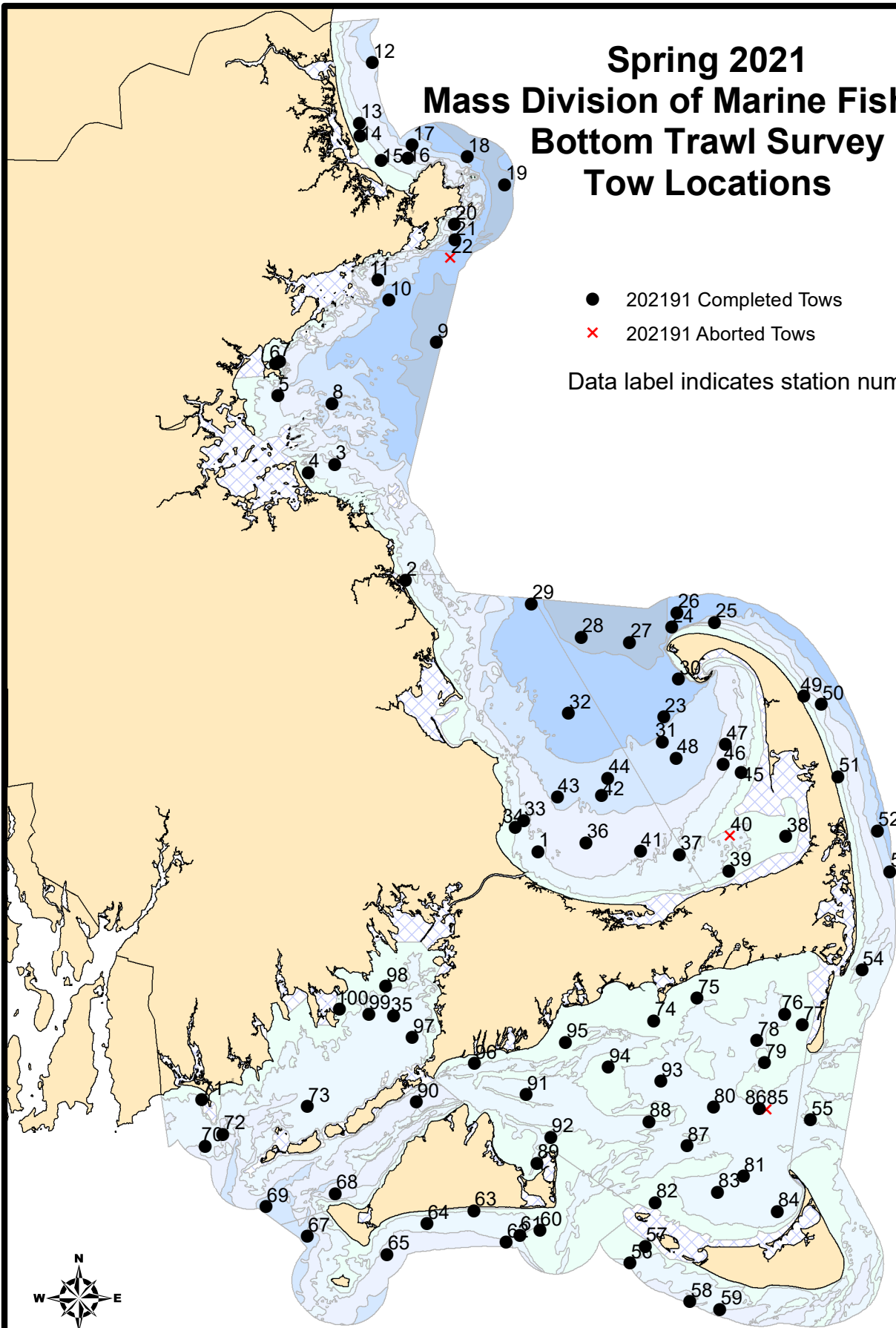


Figure 3.

Spring 2021 Mass Division of Marine Fisheries Bottom Trawl Survey Tow Locations

- 202191 Completed Tows
- ✕ 202191 Aborted Tows

Data label indicates station number



Spring 2021 Trawl Survey Highlights



CRUISE RESULTS

R/V GLORIA MICHELLE

2021 Massachusetts Inshore Fall
Bottom Trawl Survey
Cruise No. 202192

CRUISE PERIOD AND AREA

From September 7 through September 21, 2021 the Massachusetts Division of Marine Fisheries conducted its 43rd 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. From 2010 through 2018, FSCS version 1.6 was utilized for electronic data collection. Starting in 2019, we upgraded to FSCS

version 2.0. 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.

To mitigate COVID-19 risks, the survey schedule was altered slightly to reduce the number of crew changes and provide greater flexibility in scheduling based on weather and survey progress. Twenty-four MADMF employees participated in the survey as part of the scientific party along with one biologist from Responsible Offshore Science Alliance (Table 1).

CRUISE SUMMARY

102 stations were attempted in 15 sampling days (Figs 1 and 2, Table 2). 96 completed stations were considered acceptable for assessment of all species, SHG ≤ 136 (Table 3). One station was dropped South of Nantucket in stratum 17 due to time constraints. Two stations were dropped in stratum 35 and one each in stratum 27, 28, 32 and 34 due to fixed gear. Six attempted tows were aborted due to fixed gear, crossed doors, hard bottom, net problems and algae (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). Several records were set on the 2021 fall survey. The first Atlantic stingray and smooth puffer fish were recorded at station 80 in outer Buzzard's Bay. The largest Biomass of juvenile bluefish (24.5kg) was recorded at station 72 in upper Buzzard's Bay and the largest biomass of weakfish (20.9kg) and brown shrimp (2.1kg) were recorded at station 78 off Horseneck beach in Westport. The largest abundance of silver rag (17) was recorded at station 40 in outer Cape Cod Bay and the largest abundance of sea raven (37) was recorded at station 49 off Nauset Inlet. The largest fall tow of yellowtail flounder (747 fish weighing 156.2kg) was recorded at station 36 South of Gloucester Harbor. Moderate catches of winter flounder, red hake and juvenile longfin squid were taken North of Cape Cod. Juvenile 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, over 530 otolith samples, as well as sex and maturity observations, were taken from haddock, summer flounder, yellowtail flounder, winter flounder, black sea bass, scup, tautog and American lobster. Additional samples were collected to assist ongoing research by fisheries scientists from MADMF and other labs in the region.

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

Table 1. MADMF 2021 Fall Cruise Staffing List

Scientific Party

Name	Affiliation	Num. Days
Vincent Manfredi	MADMF	9
Mark Szymanski	MADMF	9
Matthew Camisa	MADMF	8
Steve Voss	MADMF	5
Brendan Reilly	MADMF	4
Scott Schaeffer	MADMF	4
Anna Dorrance	MADMF	2
Bob Glenn	MADMF	2
Ross Kessler	MADMF	2
Derek Perry	MADMF	2
Chrissy Petitpas	MADMF	2
John Sheppard	MADMF	2
David Chosid	MADMF	1
Scott Elzey	MADMF	1
Kim Fine	MADMF	1
Elise Koob	MADMF	1
Maggie Leary	MADMF	1
Tracy Pugh	MADMF	1
Caitlyn Riley	MADMF	1
Jared Silva	MADMF	1
Kristen Thibeault	MADMF	1
Rachel Vollemans	MADMF	1
Anna Webb	MADMF	1
Steve Wilcox	MADMF	1
Mike Pol	ROSA	1
		64

R/V Gloria Michelle Crew

Name	Affiliation	Num. Days
<i>Officers</i>		
Ben VanDine	NOAA OIC	15
Alex Creed	NOAA JOIC	15
Tyler Aldrich	NOAA-CORPS	8
Luke Petzy	NOAA-CORPS	7
<i>Deck Crew</i>		
George Morton	Contract Fisherman	15
Jason McGrath	Contract Fisherman	15

Table 2. Station Information for the 2021 Massachusetts Fall Inshore Bottom Trawl Survey
Cruise No. 202192

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
1	28	9/7/2021	6:23	29	41°52.83	-70°26.55	165	0.85	12.0
2	29	9/7/2021	8:56	42	41°59.27	-70°28.19	68	0.54	11.0
3	29	9/7/2021	11:59	43	41°56.79	-70°24.38	11	0.81	11.1
4	28	9/7/2021	13:28	33	41°53.40	-70°21.79	260	0.81	12.1
5	26	9/7/2021	15:20	18	41°51.43	-70°29.27	196	0.51	17.8
6	26	9/7/2021	16:20	18	41°49.15	-70°29.01	201	0.83	17.1
7	25	9/8/2021	5:42	9	41°45.86	-70°26.89	302	0.50	19.0
8	27	9/8/2021	6:58	24	41°48.13	-70°20.21	239	0.83	14.9
9	26	9/8/2021	8:15	15	41°46.36	-70°16.26	249	0.83	19.1
10	26	9/8/2021	9:54	16	41°48.48	-70°10.23	252	0.53	20.0
11	25	9/8/2021	11:11	10	41°49.21	-70°02.81	221	0.81	21.0
12	25	9/8/2021	12:40	11	41°50.45	-70°09.83	207	0.83	20.1
13	27	9/8/2021	13:40	24	41°52.36	-70°11.81	208	0.51	14.5
14	26	9/8/2021	14:52	13	41°55.20	-70°07.33	195	0.56	20.7
15	28	9/8/2021	15:56	30	41°56.24	-70°10.99	205	0.83	11.8
16	27	9/9/2021	8:16	27	42°06.67	-70°34.63	151	0.53	11.4
17	25	9/9/2021	9:30	10	42°08.81	-70°41.25	154	0.83	14.5
18	31	9/9/2021	11:50	11	42°17.38	-70°51.79	145	0.68	15.9
19	32	9/9/2021	12:52	14	42°17.54	-70°51.66	63	0.53	15.1
20	33	9/9/2021	14:36	23	42°18.82	-70°48.63	100	0.59	12.1
21	34	9/9/2021	16:09	34	42°23.45	-70°49.68	124	0.53	11.2
22	33	9/10/2021	6:55	26	42°24.89	-70°53.38	211	0.79	11.7
23	32	9/10/2021	8:48	12	42°27.14	-70°54.60	153	0.85	12.6
24	34	9/10/2021	10:29	32	42°26.72	-70°51.19	120	0.52	12.1
25	35	9/10/2021	12:57	50	42°30.94	-70°43.14	67	0.52	10.2
26	35	9/10/2021	14:29	60	42°30.42	-70°40.67	209	0.17	N/A
27	36	9/10/2021	15:50	66	42°30.10	-70°39.63	337	0.81	9.9
28	34	9/11/2021	7:52	32	42°49.62	-70°44.52	313	0.53	10.9
29	33	9/11/2021	9:07	24	42°46.76	-70°45.50	153	0.83	11.3
30	33	9/11/2021	10:13	27	42°42.94	-70°42.21	310	0.85	11.2
31	31	9/11/2021	11:19	8	42°41.89	-70°43.89	128	0.84	14.6
32	31	9/11/2021	12:09	9	42°40.58	-70°41.30	293	0.83	13.5
33	32	9/11/2021	13:12	16	42°41.51	-70°41.82	123	0.82	12.0
34	34	9/12/2021	8:40	31	42°43.03	-70°40.13	313	0.82	10.9
35	35	9/12/2021	11:20	51	42°35.30	-70°34.84	237	0.58	9.9
36	35	9/13/2021	6:18	58	42°33.66	-70°36.36	251	0.53	10.0
37	36	9/13/2021	7:28	73	42°29.87	-70°37.23	46	0.68	9.8
38	36	9/13/2021	8:47	77	42°28.57	-70°37.93	242	0.75	9.8
39	29	9/13/2021	12:52	50	42°05.95	-70°28.39	359	0.84	9.7

Table 2 continued.

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
40	30	9/13/2021	14:07	58	42°06.03	-70°24.95	26	0.85	9.3
41	28	9/14/2021	7:24	35	41°57.30	-70°13.95	209	0.85	11.1
42	27	9/14/2021	8:50	23	42°00.86	-70°09.09	171	0.85	11.3
43	29	9/14/2021	10:16	40	41°58.90	-70°16.68	140	0.85	10.7
44	29	9/14/2021	11:34	49	42°00.50	-70°21.96	91	0.86	10.1
45	30	9/14/2021	13:13	58	42°04.82	-70°16.14	79	0.84	9.9
46	21	9/14/2021	14:27	64	42°06.36	-70°14.34	80	0.87	10.4
47	18	9/14/2021	15:55	16	42°05.48	-70°08.77	119	0.86	15.3
48	19	9/15/2021	6:02	30	41°57.37	-69°56.90	170	0.50	11.6
49	20	9/15/2021	7:58	35	41°50.00	-69°53.45	190	0.85	10.1
50	21	9/15/2021	8:57	40	41°49.28	-69°52.33	186	0.85	10.1
51	20	9/15/2021	10:03	36	41°47.15	-69°52.18	193	0.83	11.2
52	17	9/15/2021	11:11	6	41°47.51	-69°55.50	205	0.85	14.8
53	19	9/15/2021	12:34	23	41°43.80	-69°52.44	193	0.69	12.6
54	18	9/15/2021	13:50	17	41°40.51	-69°52.50	230	0.85	15.6
55	17	9/15/2021	15:12	9	41°36.40	-69°55.96	237	0.86	18.1
56	18	9/16/2021	7:07	10	41°22.38	-69°57.47	7	0.83	20.6
57	17	9/16/2021	8:46	9	41°22.06	-69°59.11	9	0.54	21.4
58	16	9/16/2021	10:40	9	41°24.11	-70°08.41	76	0.86	22.4
59	16	9/16/2021	11:49	12	41°28.30	-70°08.72	122	0.85	20.9
60	16	9/16/2021	12:49	9	41°29.88	-70°09.35	245	0.86	20.6
61	16	9/16/2021	13:51	14	41°29.20	-70°12.73	224	0.85	22.5
62	15	9/16/2021	15:52	8	41°19.84	-70°02.90	61	0.85	22.4
63	15	9/17/2021	6:37	8	41°20.86	-70°15.63	309	0.57	21.4
64	16	9/17/2021	7:59	12	41°22.26	-70°10.17	76	0.85	22.1
65	16	9/17/2021	10:05	12	41°33.76	-70°08.33	83	0.85	22.6
66	15	9/17/2021	11:04	7	41°35.59	-70°10.16	106	0.87	22.7
67	15	9/17/2021	12:07	8	41°36.49	-70°13.07	104	0.85	22.8
68	16	9/17/2021	13:23	8	41°32.84	-70°14.96	121	0.86	22.7
69	15	9/17/2021	14:31	8	41°35.07	-70°15.24	287	0.84	23.0
70	16	9/17/2021	15:45	10	41°33.30	-70°18.68	272	0.83	23.0
71	15	9/17/2021	16:54	10	41°34.99	-70°21.99	281	0.82	23.1
72	12	9/18/2021	5:59	11	41°35.75	-70°41.98	200	0.54	21.9
73	12	9/18/2021	6:57	11	41°37.16	-70°44.18	72	0.55	22.5
74	11	9/18/2021	7:45	8	41°37.55	-70°44.82	48	0.84	22.6
75	11	9/18/2021	9:07	10	41°35.33	-70°48.25	4	0.84	22.4
76	12	9/18/2021	10:24	15	41°31.04	-70°47.75	54	0.55	21.4
77	12	9/18/2021	12:09	13	41°28.85	-71°00.49	84	0.86	21.5
78	11	9/18/2021	13:34	9	41°30.02	-71°04.12	121	0.86	21.4
79	12	9/18/2021	14:49	18	41°25.30	-71°02.02	331	0.83	20.9
80	13	9/18/2021	16:20	18	41°27.66	-70°57.30	232	0.56	21.0

Table 2 continued.

Station	Stratum	Date	Time (est)	Depth (m)	Latitude	Longitude	Course	Distance (nmi)	Bottom temp °C
81	15	9/19/2021	7:20	9	41°32.33	-70°16.83	249	0.83	22.8
82	15	9/19/2021	8:30	7	41°31.17	-70°19.74	312	0.85	22.6
83	16	9/19/2021	9:45	16	41°29.26	-70°15.44	339	0.85	22.3
84	15	9/19/2021	10:52	6	41°28.76	-70°15.90	162	0.87	22.3
85	16	9/19/2021	12:00	16	41°25.68	-70°14.22	121	0.56	22.2
86	16	9/19/2021	12:55	11	41°26.17	-70°16.41	90	0.84	22.1
87	15	9/19/2021	14:37	8	41°28.64	-70°22.44	350	0.75	22.8
88	14	9/20/2021	7:28	32	41°21.54	-70°54.54	229	0.67	19.3
89	13	9/20/2021	8:51	27	41°18.90	-70°51.02	178	0.86	20.3
90	13	9/20/2021	10:15	24	41°15.39	-70°46.03	35	0.41	20.4
91	14	9/20/2021	12:06	28	41°13.30	-70°46.06	53	0.56	19.2
92	13	9/20/2021	13:32	22	41°18.26	-70°41.97	91	0.79	20.6
93	12	9/20/2021	14:39	15	41°19.65	-70°41.25	101	0.71	21.1
94	12	9/20/2021	16:10	12	41°19.91	-70°32.74	113	0.55	20.5
95	11	9/20/2021	16:56	9	41°20.54	-70°31.18	284	0.85	21.7
96	17	9/21/2021	5:52	9	41°14.70	-70°10.20	332	0.82	20.8
97	18	9/21/2021	6:59	15	41°12.86	-70°09.18	285	0.87	20.8
98	18	9/21/2021	8:16	15	41°13.56	-70°03.34	260	0.81	20.5
99	19	9/21/2021	9:44	23	41°12.40	-70°08.71	293	0.88	19.9
100	11	9/21/2021	12:13	10	41°16.94	-70°24.57	46	0.86	20.1
101	13	9/21/2021	16:01	23	41°22.57	-70°53.53	106	0.88	20.3
102	13	9/21/2021	17:00	24	41°23.68	-70°55.14	80	0.86	20.5

Table 3. Sampling Effort Assigned and Accomplished by Stratum, Cruise 202192.

Stratum	Region	Assigned Stations	Number of Stations Completed			Aborted Tows
			All Accepted	Sub-Standard	Standard	
11	1	5	5		5	1
12	1	7	7		7	
13	1	5	5		5	
14	1	2	2		2	
15	2	10	10		10	
16	2	11	11		11	
17	3	5	4		4	1
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	4		4	
28	4	5	4		4	
29	4	5	5		5	
30	4	2	2		2	
31	5	3	3		3	1
32	5	3	2		2	
33	5	4	4		4	
34	5	4	3		3	
35	5	5	3		3	
36	5	2	2		2	
TOTALS		103	96	0	96	6

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 202192.
Not Advised for Indices of Abundance other than Spiny Dogfish.

Station	Stratum	SHG Location	Description
No sub-standard tows on cruise 202192			

Table 5. Attempted Tows Aborted During Cruise 202192.

Station	Stratum	SHG Location	Description
19	32	East of Nantasket Beach	Fixed Gear
24	34	East of Nahant	Net Problem
26	35	South of Gloucester	Fixed Gear
27	36	South of Gloucester	Doors Crossed
48	19	East of Wellfleet	Hard Bottom
90	13	NE of Nomans	Weed Tow

Table 6a. Total Catch Numbers and Weights Observed on the 2021
Massachusetts Fall Inshore Bottom Trawl Survey - Cruise 202192- Sorted by Number

Species Code	Common Name	Count	Weight (kg)
143	SCUP	356,581	3,107.485
503	LONGFIN SQUID	33,874	284.944
131	BUTTERFISH	32,320	458.141
43	BAY ANCHOVY	12,618	14.523
77	RED HAKE	3,428	428.495
106	WINTER FLOUNDER	3,392	732.693
141	BLACK SEA BASS	3,312	83.820
132	ATLANTIC MOONFISH	2,588	15.189
105	YELLOWTAIL FLOUNDER	2,360	471.654
72	SILVER HAKE	1,557	139.285
301	AMERICAN LOBSTER	1,352	637.468
145	WEAKFISH	1,018	52.369
163	LONGHORN SCULPIN	903	99.032
102	AMERICAN PLAICE	876	82.130
26	LITTLE SKATE	721	385.225
313	ATLANTIC ROCK CRAB	577	60.479
108	WINDOWPANE	428	75.203
211	ROUND SCAD	411	3.265
103	SUMMER FLOUNDER	376	226.188
135	BLUEFISH	368	27.677
13	SMOOTH DOGFISH	364	290.657
32	ATLANTIC HERRING	259	23.795
23	WINTER SKATE	229	254.773
317	SPIDER CRAB UNCL	227	21.806
322	LADY CRAB	207	19.273
193	OCEAN POUT	188	20.589
146	NORTHERN KINGFISH	158	17.428
176	CUNNER	153	1.379
171	NORTHERN SEAROBIN	148	12.527
913	BROWN SHRIMP	146	2.072
117	SMALLMOUTH FLOUNDER	141	1.878
209	BIGEYE SCAD	127	3.075
312	JONAH CRAB	102	17.027
172	STRIPED SEAROBIN	98	22.397
104	FOURSPOT FLOUNDER	97	14.062
343	BLUE MUSSEL	97	1.005
402	BAY SCALLOP	95	5.668
401	SEA SCALLOP	91	2.300
177	TAUTOG	81	8.044
164	SEA RAVEN	72	23.648
78	SPOTTED HAKE	70	9.762
149	SPOT	55	7.772
15	SPINY DOGFISH	51	77.045

Table 6a continued.

Species Code	Common Name	Count	Weight (kg)
435	INSHORE LIZARDFISH	47	4.645
197	GOOSEFISH	34	8.330
213	SILVER RAG	33	0.738
208	MACKEREL SCAD	31	0.354
155	ACADIAN REDFISH	31	1.349
181	NORTHERN SAND LANCE	30	0.267
36	ATLANTIC MENHADEN	26	1.661
212	ROUGH SCAD	23	0.395
33	ALEWIFE	21	1.199
35	AMERICAN SHAD	18	0.770
556	GLASSEYE SNAPPER	16	0.359
74	HADDOCK	16	6.067
118	HOGCHOKER	15	1.822
76	WHITE HAKE	13	2.600
116	NORTHERN PIPEFISH	12	0.071
337	KNOBBED WHELK	11	2.395
323	MANTIS SHRIMP UNCL	10	0.268
318	HORSESHOE CRAB	10	12.865
695	GUAGUANCHE	10	0.190
348	NORTHERN MOONSNAIL	10	0.289
73	ATLANTIC COD	8	0.070
195	SMOOTH PUFFER	7	0.448
107	WITCH FLOUNDER	6	1.095
196	NORTHERN PUFFER	6	0.333
439	SNAKEFISH	6	0.130
83	FOURBEARD ROCKLING	5	0.430
166	GRUBBY	5	0.027
139	STRIPED BASS	4	16.929
516	BLOTCHED SWIMMING CRAB	4	0.052
24	CLEARNOSE SKATE	4	8.142
120	BLUESPOTTED CORNETFISH	4	0.071
180	ROCK GUNNEL	4	0.018
75	POLLOCK	4	0.131
165	ALLIGATORFISH	3	0.016
204	BANDED RUDDERFISH	3	0.978
657	DWARF GOATFISH	3	0.068
4	ROUGHTAIL STINGRAY	3	229.252
22	BARNDOR SKATE	3	0.841
314	BLUE CRAB	3	0.439
570	CREVALLE JACK	3	0.212
34	BLUEBACK HERRING	3	0.070
201	PLANEHEAD FILEFISH	3	0.142
129	BLUE RUNNER	3	0.129
182	SNAKEBLENNY	2	0.120

Table 6a continued.

Species Code	Common Name	Count	Weight (kg)
336	CHANNELED WHELK	2	0.518
121	ATLANTIC MACKEREL	2	0.222
185	OYSTER TOADFISH	2	0.692
502	NORTHERN SHORTFIN SQUID	2	0.462
45	RAINBOW SMELT	2	0.013
373	ATLANTIC STINGRAY	1	3.050
63	CONGER EEL	1	0.032
192	ATLANTIC WOLFFISH	1	3.220
489	RED CORNETFISH	1	0.057
101	ATLANTIC HALIBUT	1	0.360
Totals		462,847	8,558.650

Table 6b. Total Catch Numbers and Weights Observed on the 2021
Massachusetts Fall Inshore Bottom Trawl Survey - Cruise 202192- Sorted by Weight

Species Code	Common Name	Count	Weight (kg)
143	SCUP	356,581	3,107.485
106	WINTER FLOUNDER	3,392	732.693
301	AMERICAN LOBSTER	1,352	637.468
105	YELLOWTAIL FLOUNDER	2,360	471.654
131	BUTTERFISH	32,320	458.141
77	RED HAKE	3,428	428.495
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4	ROUGHTAIL STINGRAY	3	229.252
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72	SILVER HAKE	1,557	139.285
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171	NORTHERN SEAROBIN	148	12.527
78	SPOTTED HAKE	70	9.762
197	GOOSEFISH	34	8.330
24	CLEARNOSE SKATE	4	8.142
177	TAUTOG	81	8.044
149	SPOT	55	7.772
74	HADDOCK	16	6.067
402	BAY SCALLOP	95	5.668
435	INSHORE LIZARDFISH	47	4.645

Table 6b continued.

Species Code	Common Name	Count	Weight (kg)
211	ROUND SCAD	411	3.265
192	ATLANTIC WOLFFISH	1	3.220
209	BIGEYE SCAD	127	3.075
373	ATLANTIC STINGRAY	1	3.050
76	WHITE HAKE	13	2.600
337	KNOBBED WHELK	11	2.395
401	SEA SCALLOP	91	2.300
913	BROWN SHRIMP	146	2.072
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176	CUNNER	153	1.379
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439	SNAKEFISH	6	0.130
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182	SNAKEBLENNY	2	0.120
116	NORTHERN PIPEFISH	12	0.071
120	BLUESPOTTED CORNETFISH	4	0.071

Table 6b continued.

Species Code	Common Name	Count	Weight (kg)
73	ATLANTIC COD	8	0.070
34	BLUEBACK HERRING	3	0.070
657	DWARF GOATFISH	3	0.068
489	RED CORNETFISH	1	0.057
516	BLOTCHED SWIMMING CRAB	4	0.052
63	CONGER EEL	1	0.032
166	GRUBBY	5	0.027
180	ROCK GUNNEL	4	0.018
165	ALLIGATORFISH	3	0.016
45	RAINBOW SMELT	2	0.013
Totals		462,847	8,558.650

Table 7. Number of individuals obtained for age, growth, maturity and special studies during Massachusetts DMF Cruise 202192.

Species	Maturity Observation	Age and Growth Collection		
		Scales	Otoliths	YOY
Haddock	8		8	
Summer Flounder	97		96	
Yellowtail Flounder	131		131	
Winter Flounder	218		217	
Black Sea Bass	62		61	
Scup	21		21	
Tautog	2		2	
American Lobster	631			
 TOTAL	 1,170	 0	 536	 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).

YOY Atlantic cod saved for age and growth study (Dean).

6 Alewives saved for histology study (Schultz).

Sea herring saved for an energetics study (Warren).

Longfin squid were saved for Black Sea Bass rod and reel sampling (Glenn).

Assorted species saved for Umass fisheries lab (Jordaan).

Figure 1.

Massachusetts Division of Marine Fisheries Inshore Bottom Trawl Survey

MDMF Trawl Survey Depth Strata

Depth (feet)

-  Deleted
-  0 to 30
-  31 to 60
-  61 to 90
-  91 to 120
-  121 to 180
-  181 +

○ Indicates stratum number

A or B Indicates subregion

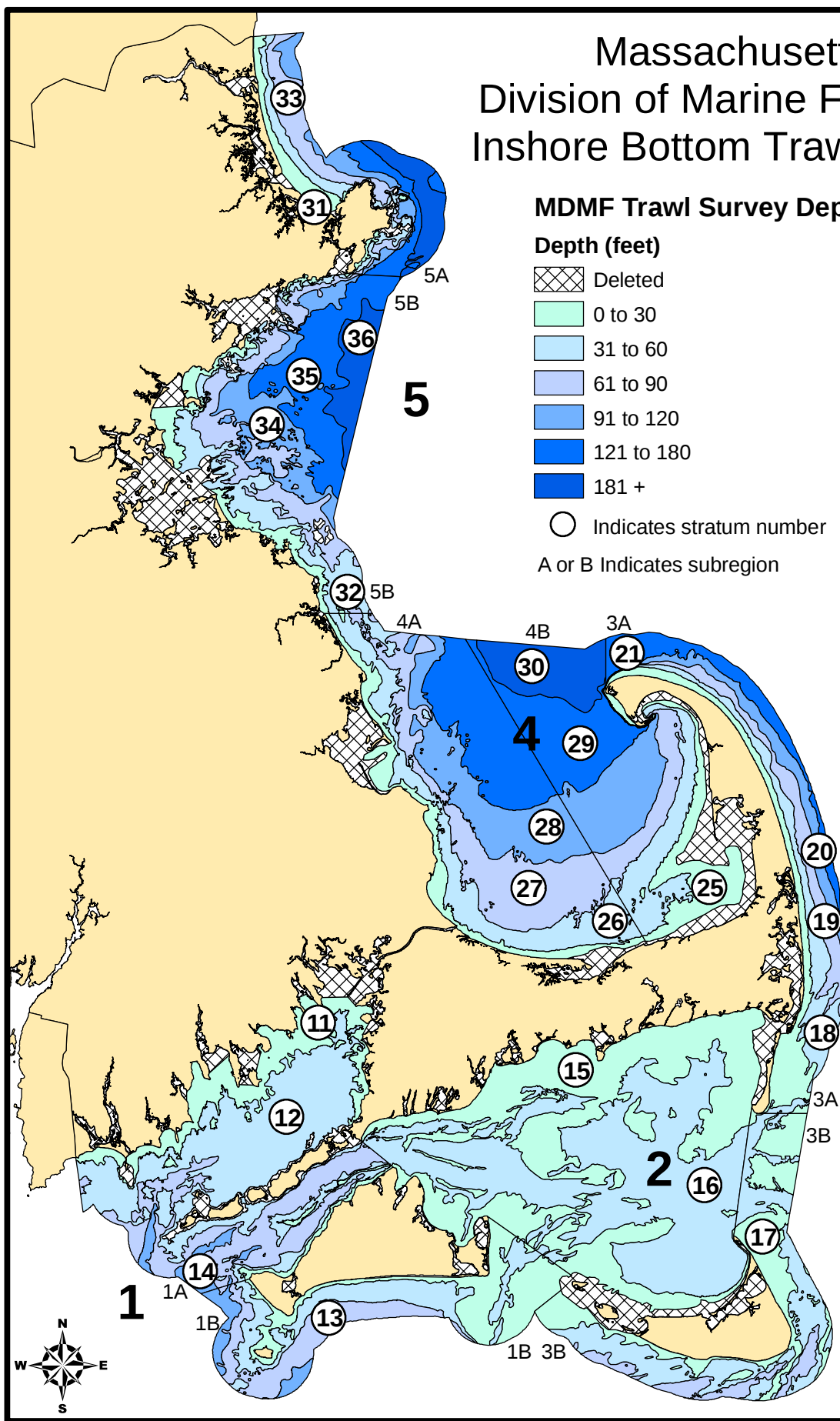


Figure 2.

Fall 2021 Mass Division of Marine Fisheries Bottom Trawl Survey Tow Locations

- Proposed Tow Circles
- 202192 Completed Tow Tracks
- ✕ 202192 Aborted Tows

Data label indicates day of month (September)

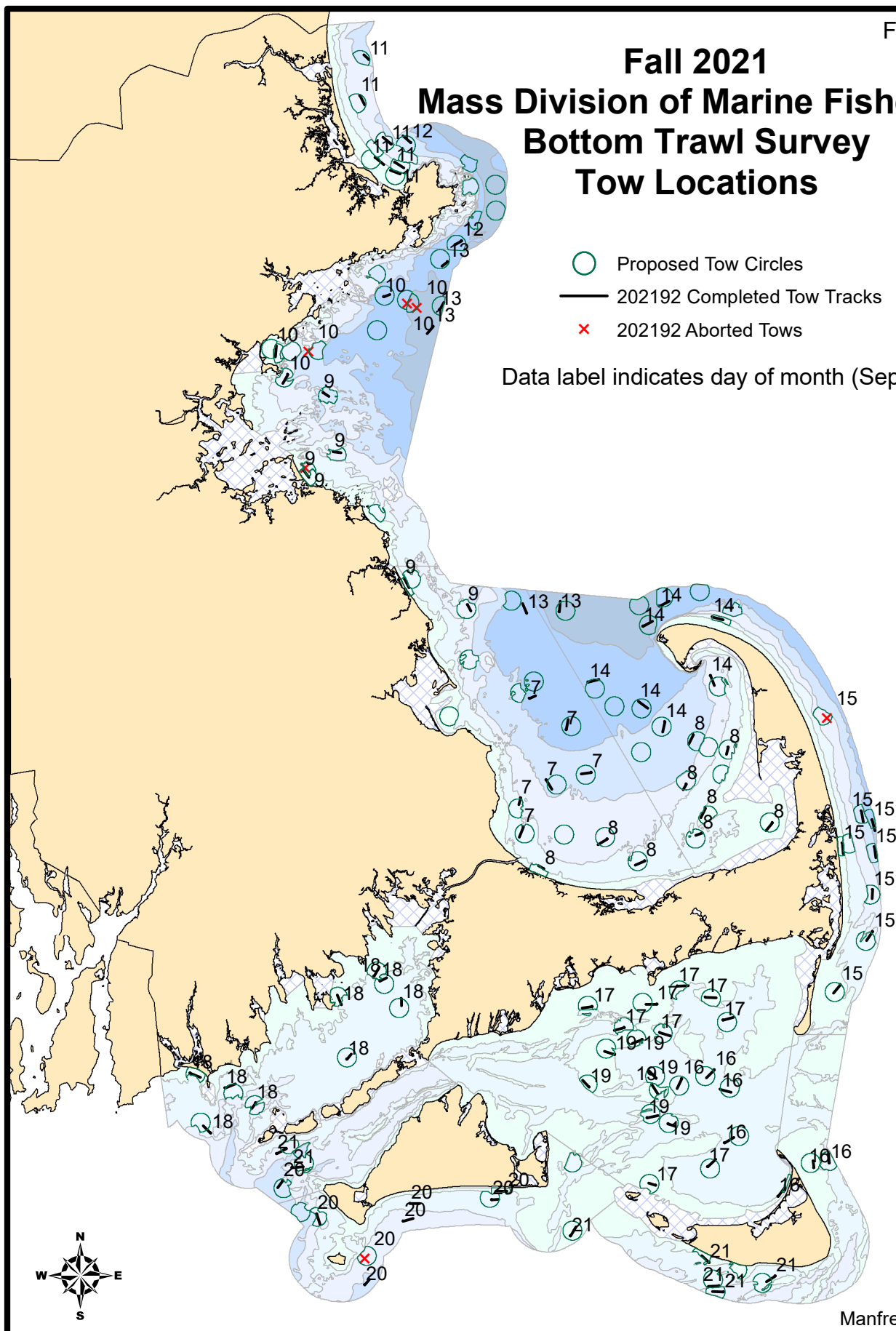
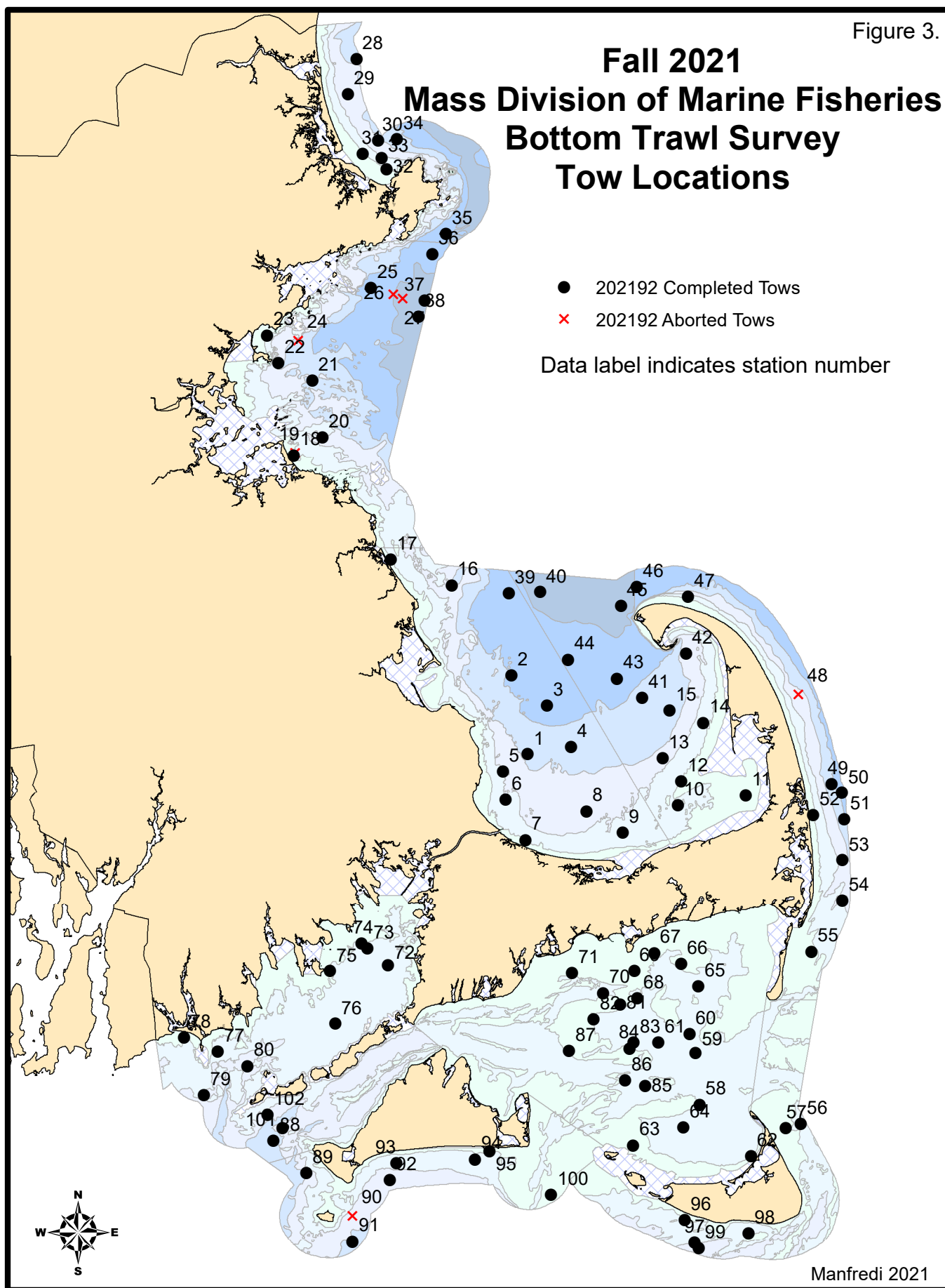


Figure 3.

Fall 2021 **Mass Division of Marine Fisheries** **Bottom Trawl Survey** **Tow Locations**

- 202192 Completed Tows
- ✕ 202192 Aborted Tows

Data label indicates station number



Fall 2021 Trawl Survey Highlights



SURVEY REPORT
2021 Nantucket Sound Estuarine Winter Flounder
Young of the Year (YOY)
Seine Survey

SURVEY PERIOD AND AREA

From June 18 – July 6, 2021 the Massachusetts Division of Marine Fisheries (MDMF) conducted its 46th 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 ProTM) 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. Eight MADMFF employees participated in the survey as part of the scientific party (Table 1).

RESULTS

141 seine hauls were conducted at 49 stations over 9 sampling days. At Stage Harbor, Sears Point has undergone beach nourishment to stabilize the foot of a rock revetment installed in 2019-2020. Conditions to seine this site were improved from 2020, so an alternate was unnecessary for at least another year. Replicate hauls were dropped at five stations due to shoreline vegetation, coastal armor induced erosion, obstructions and excessive algal biomass:

Washburn Island 3, Bluff Point 2, Heirs Landing, Mill Pond and Vineyard Avenue. Thirty-eight species were encountered in 2021 (Table 2). New species occurrences were also recorded this year. Northern Sennet and Guagaunche, two pantropical barracuda species, occurred in multiple stations. The 2021 pooled (all estuaries combined) winter flounder YOY index is (0.223 YOY / m²), just barely above the timeseries median (Figure 2, Table 3). The Age 1+ winter flounder index remained below the timeseries median for the 12th consecutive year (Figure 3). Only Cotuit Bay's estuary-specific index increased in 2021, the rest declined (Figure 4). The YOY summer flounder index decreased but remains above the median recruitment level (Figure 5). The blue crab index is a new timeseries record observation (Figure 6). All bottom temperature monitors were collected and successfully downloaded (Figure 7). For further information on this survey or additional data, please contact Vincent M. Manfredi (508)-742-9732.

Table 1. 2021 Seine Survey Staffing List

Name	Affiliation	Num. Days
John Boardman	MDMF	1
Maggie Leary	MDMF	1
John Logan	MDMF	2
Vincent Manfredi	MDMF	9
Brendan Reilly	MDMF	1
Caitlyn Riley	MDMF	1
Mark Szymanski	MDMF	2
Steven Voss	MDMF	1

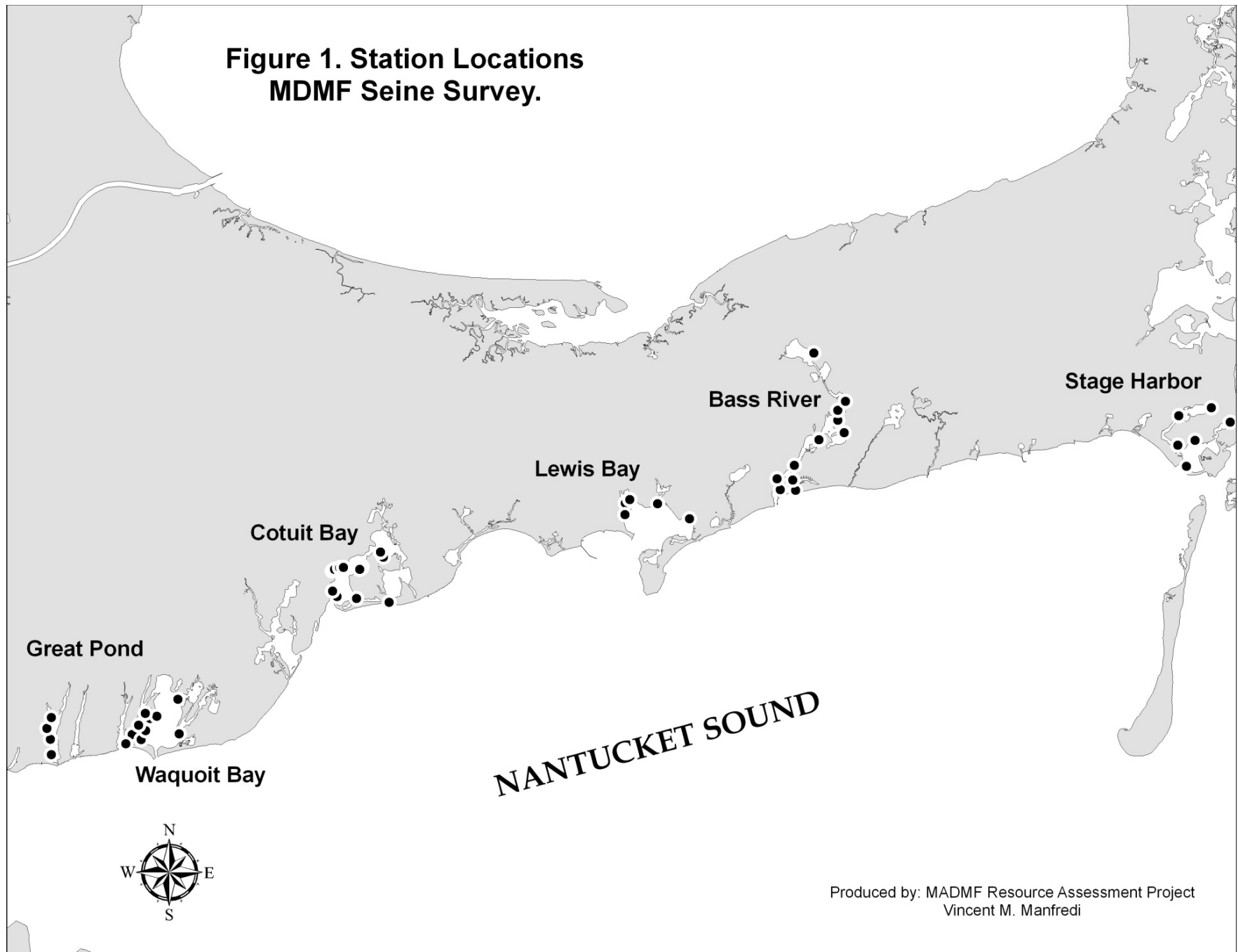
Table 2. Catch Observations of All Recorded Species During the 2021 Seine Survey
(for species marked present, counts are not taken but presence is noted at all hauls)

Common Name	Taxonomic Name	Total Number	% Occurrence
Atlantic Silverside	<i>Menidia menidia</i>	Present	92.9%
YOY Winter Flounder	<i>Pseudopleuronectes americanus</i>	1945	92.2%
Blue Crab	<i>Callinectes sapidus</i>	1083	80.9%
Striped Killifish	<i>Fundulus majalis</i>	Present	68.1%
Mud Snail	<i>Nassarius obsoletus</i>	Present	58.2%
Sand Shrimp	<i>Crangon septemspinosa</i>	Present	46.8%
Rainwater Killifish	<i>Lucania parva</i>	588	39.0%
Northern Pipefish	<i>Syngnathus fuscus</i>	Present	38.3%
Mummichog	<i>Fundulus heteroclitus</i>	Present	36.9%
Grass Shrimp	<i>Paelmonetes pugio</i>	Present	31.9%
Fourspine Stickleback	<i>Apeltes quadracus</i>	Present	27.7%
Northern Kingfish	<i>Menticirrhitis saxatilis</i>	120	21.3%
Green Crab	<i>Carcinus maenus</i>	92	16.3%
Spider Crab Uncl.	<i>Majidae</i>	56	15.6%
Alewife / Blueback Herring	<i>Alosa spp.</i>	183	14.2%
White Mullet	<i>Mugil curema</i>	176	13.5%
Atlantic Needlefish	<i>Strongylura marina</i>	27	12.8%
YOY Summer Flounder	<i>Paralichthys dentatus</i>	15	9.2%
Northern Puffer	<i>Sphoeroides maculatus</i>	20	8.5%
Sheepshead Minnow	<i>Cyprinodon variegatus</i>	Present	8.5%
Spot	<i>Leiostomus xanthurus</i>	45	6.4%
Lady Crab	<i>Ovalipes ocellatus</i>	16	6.4%
Grubby	<i>Myoxocephalus aeneus</i>	5	3.5%
Northern Sennet	<i>Sphyræna borealis</i>	22	2.8%
Naked Goby / Seaboard Goby	<i>Gobiosoma spp.</i>	7	2.8%
Threespine Stickleback	<i>Gasterosteus aculeatus</i>	Present	2.8%
Oyster	<i>Crassostrea virginica</i>	5	2.1%
Northern Sand Lance	<i>Ammodytes dubius</i>	29	1.4%
Striped Searobin	<i>Prionotus evolans</i>	3	1.4%
Smallmouth flounder	<i>Etropus microstomus</i>	2	1.4%
Bluefish	<i>Pomatomus saltatrix</i>	2	1.4%
Tautog	<i>Tautoga onitis</i>	2	1.4%
Horseshoe Crab	<i>Limulus polyphemus</i>	2	1.4%
Ribbed Mussel	<i>Guekensia demissus</i>	2	1.4%
Northern Quahog	<i>Mercenaria mercenaria</i>	2	1.4%
Mottled Dog Whelk	<i>Nassa vibex</i>	Present	1.4%
Blue Mussel	<i>Mytilus edulis</i>	3	0.7%
Bay Anchovy	<i>Anchoa mitchilli</i>	1	0.7%
American Eel	<i>Anguilla rostrata</i>	1	0.7%
Guaguaunche	<i>Sphyræna guaguauncho</i>	1	0.7%

Table 3. YOY Winter Flounder Abundance, All Estuaries. MDMF Seine Survey 1976-2021

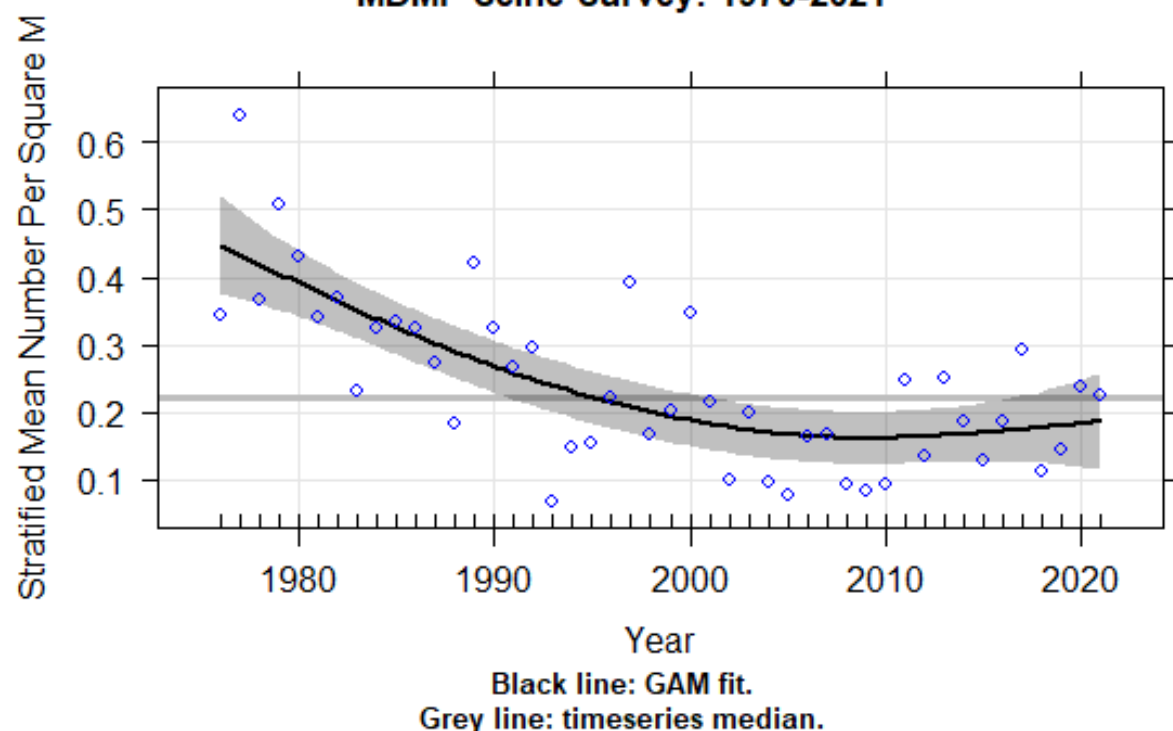
Year	Stratified Mean	Standard Error	Lower CI	Upper CI
1976	0.344	0.042	0.236	0.452
1977	0.641	0.062	0.508	0.774
1978	0.366	0.057	0.235	0.498
1979	0.507	0.060	0.366	0.648
1980	0.432	0.057	0.306	0.559
1981	0.340	0.056	0.208	0.471
1982	0.370	0.055	0.246	0.494
1983	0.231	0.027	0.176	0.287
1984	0.323	0.036	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
2019	0.145	0.019	0.104	0.185
2020	0.238	0.049	0.133	0.342
2021	0.223	0.031	0.160	0.286

**Figure 1. Station Locations
MDMF Seine Survey.**



Produced by: MDMF Resource Assessment Project
Vincent M. Manfredi

**Figure 2. YOY Winter Flounder Abundance
MDMF Seine Survey: 1976-2021**



**Figure 3. Age 1+ Winter Flounder Abundance
MDMF Seine Survey: 1983-2021**

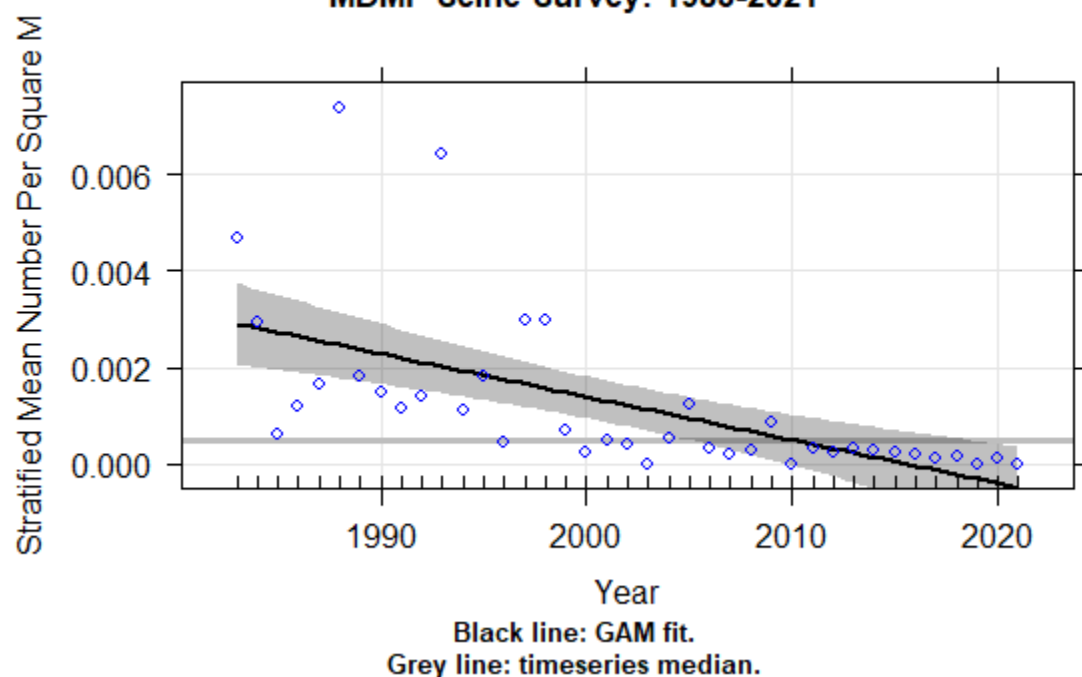
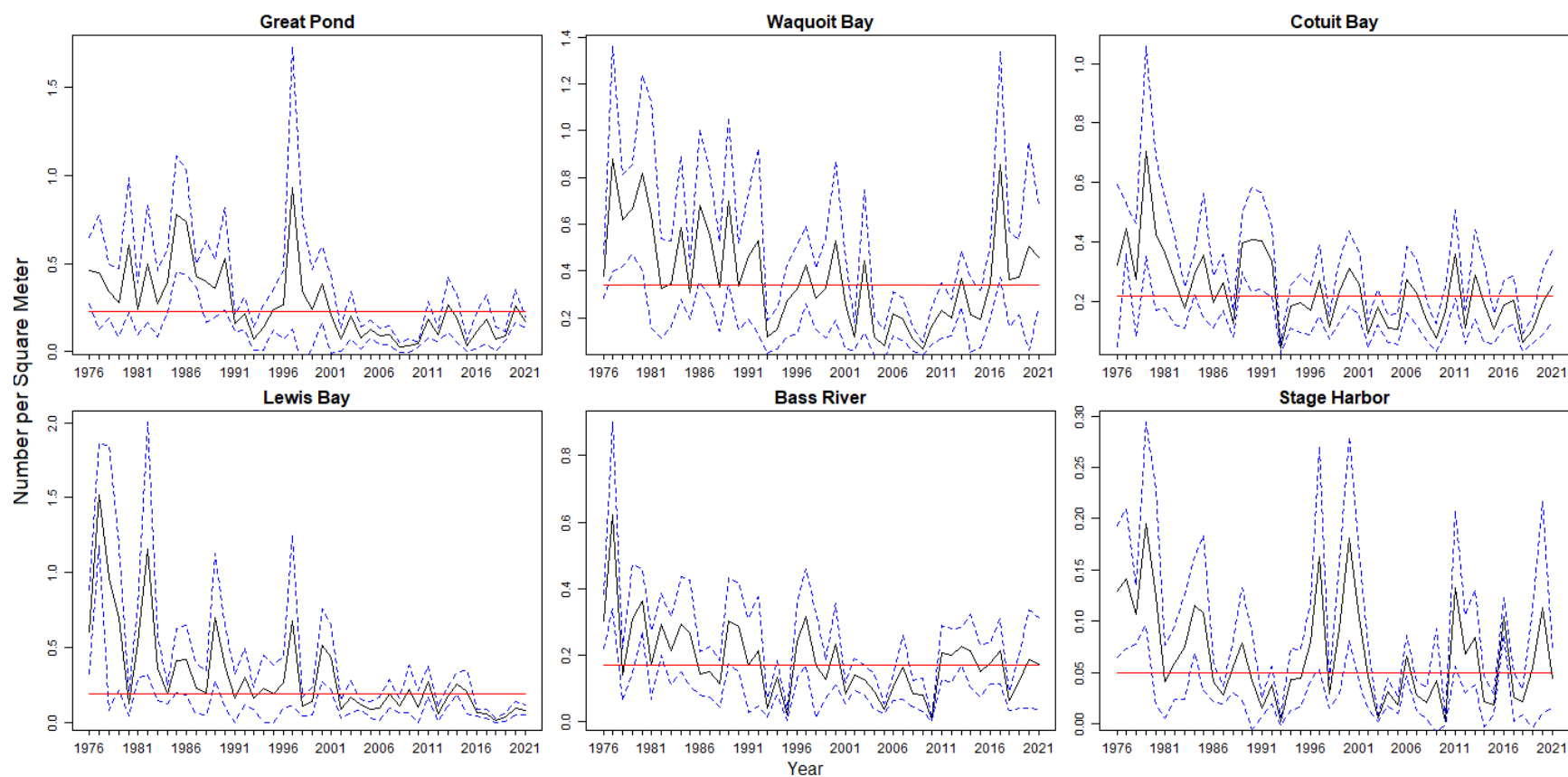
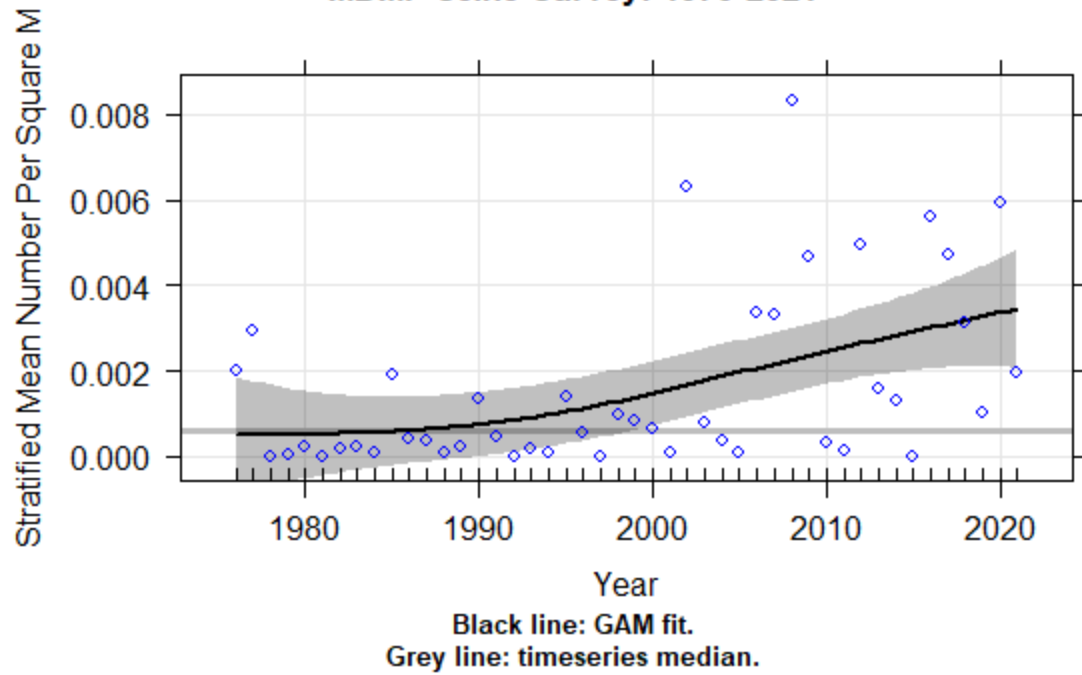


Figure 4. Abundance of YOY winter flounder by estuary, MDMF Seine Survey 1976 – 2021.

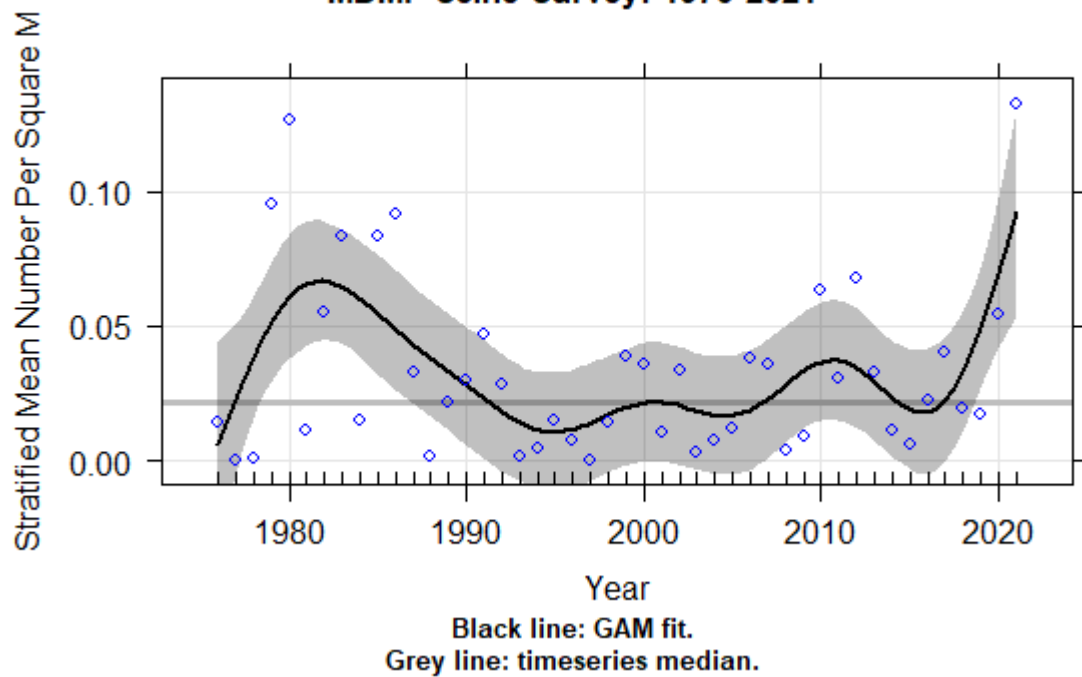


Dashed Lines = 95% Confidence Intervals
Horizontal Line = Timeseries Median for each Estuary
Note: y-axis scales differ in magnitude.

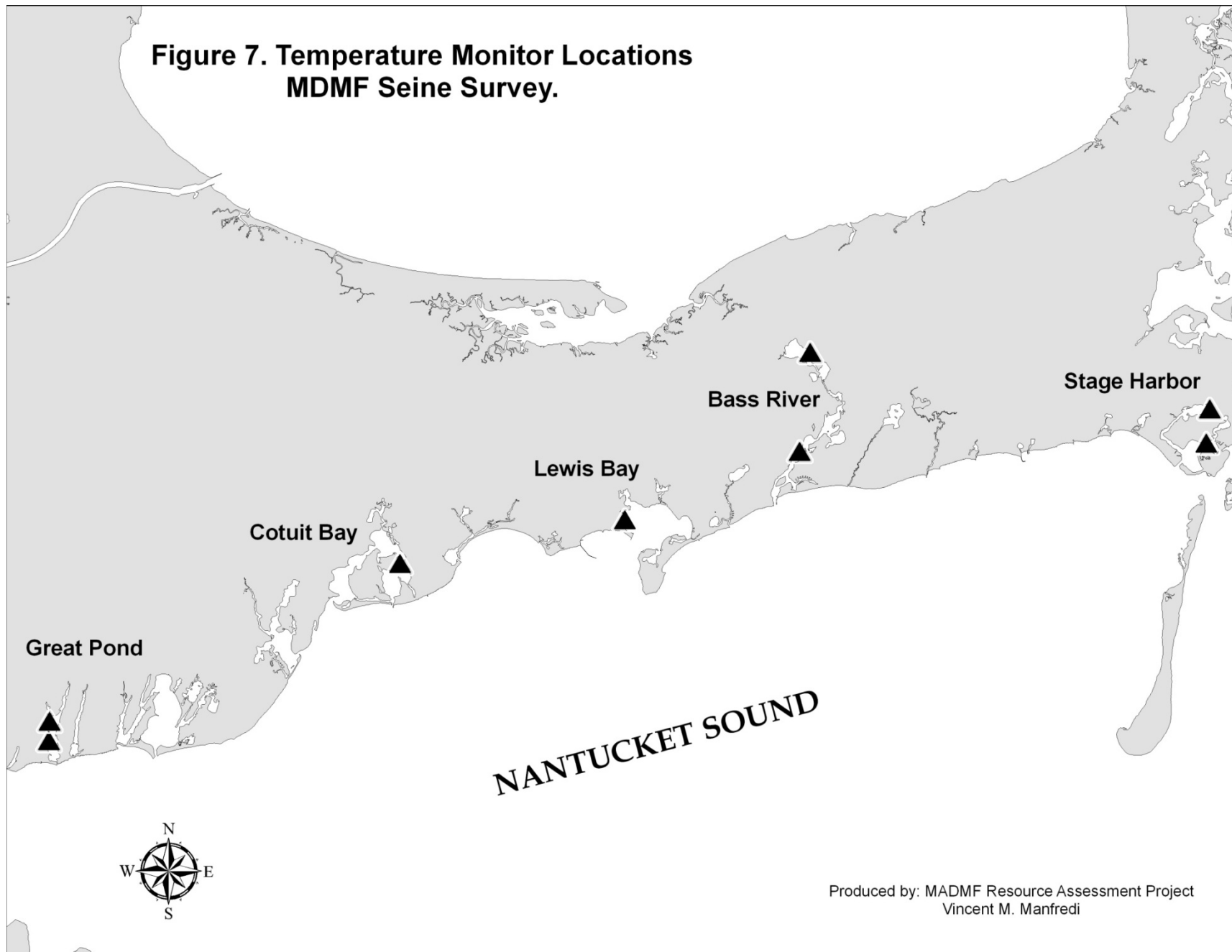
**Figure 5. YOY Summer Flounder Abundance
MDMF Seine Survey: 1976-2021**



**Figure 6. Blue Crab Abundance
MDMF Seine Survey: 1976-2021**



**Figure 7. Temperature Monitor Locations
MDMF 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.

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1978–2021 Massachusetts DMF trawl survey.

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- (c.) Spring **Winter Flounder** Regions 4 - 5
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- (f.) Fall **Summer Flounder** Regions 1 - 5
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- (p.) Fall **Winter Skate** Regions 1 - 3
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- (ee.) Fall **Lobster** Regions 4 - 5
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Figure 3 (a – b). Stratified mean number per tow with GAM smoothed trend line.
1978 – 2021 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 – 2021 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. Gulf of Maine (GOM) = Regions 4-5. Southern New England (SNE) = Regions 1-3.

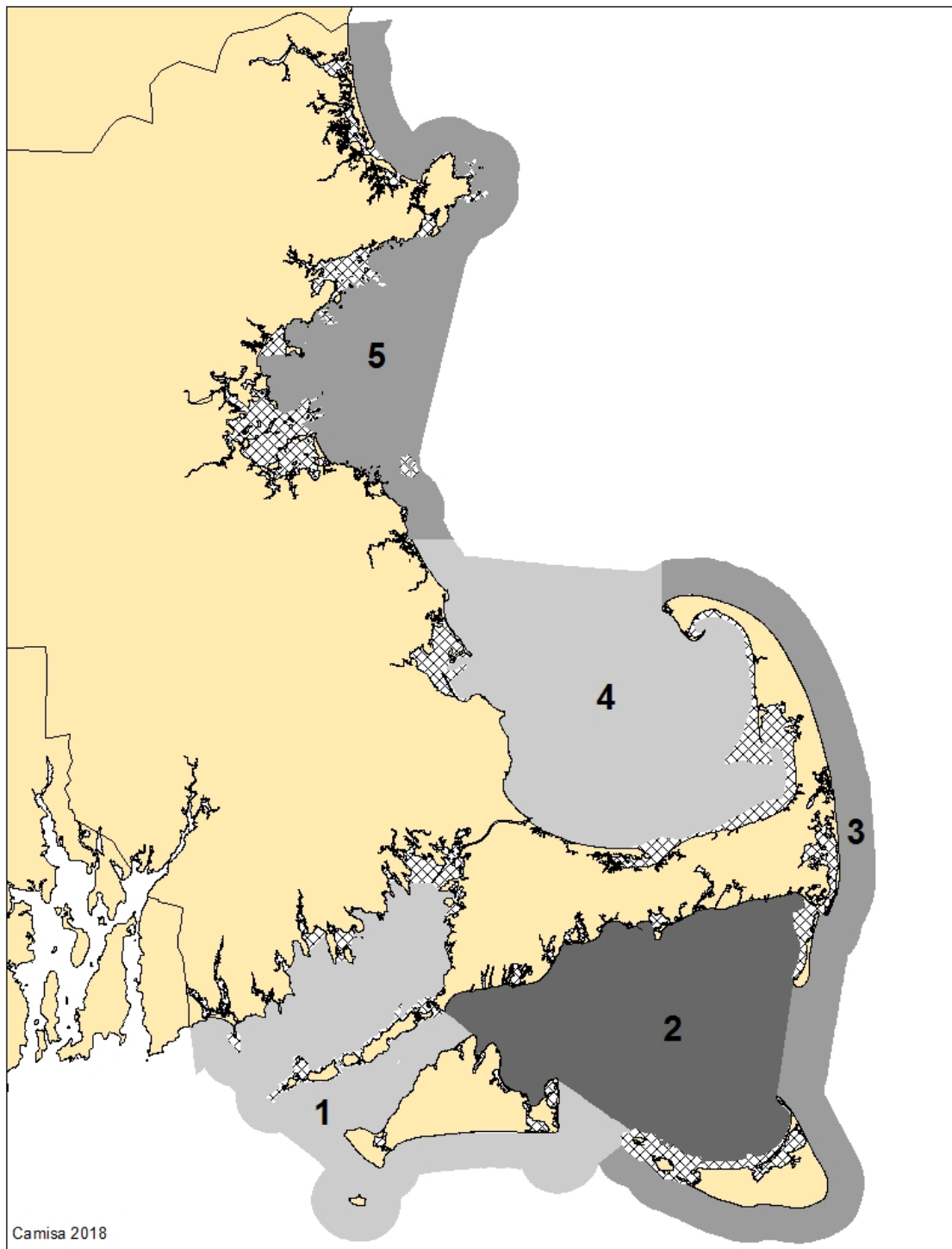


Figure 2. (a & b) Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

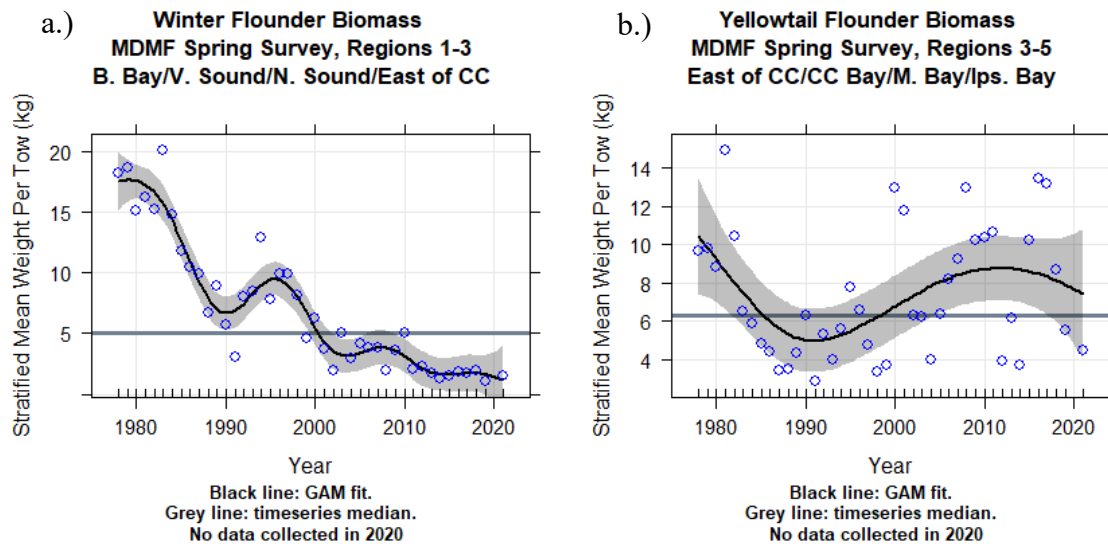


Figure 2. (c & d) Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

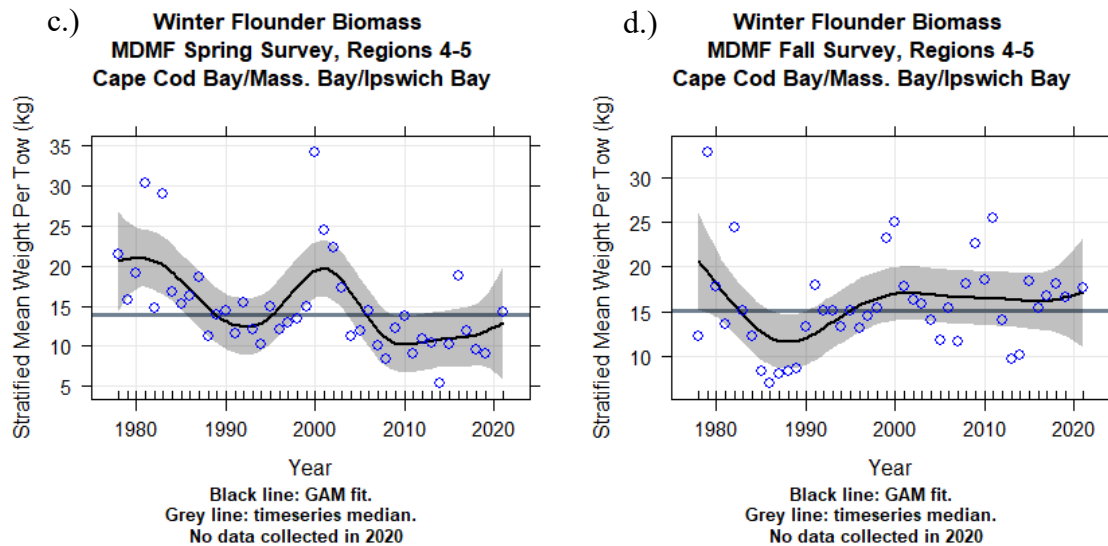


Figure 2. (e & f). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

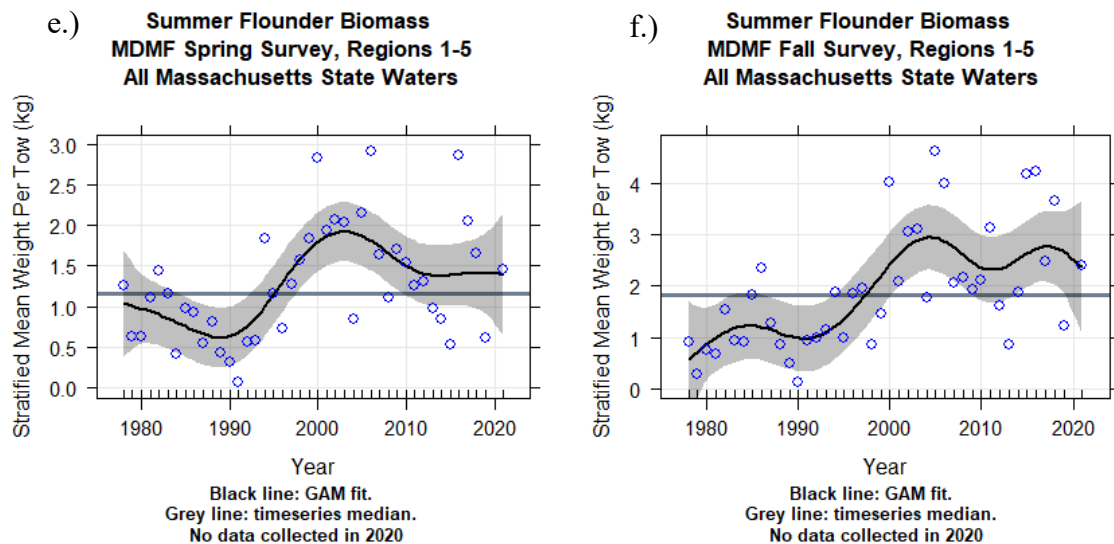


Figure 2. (g & h). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

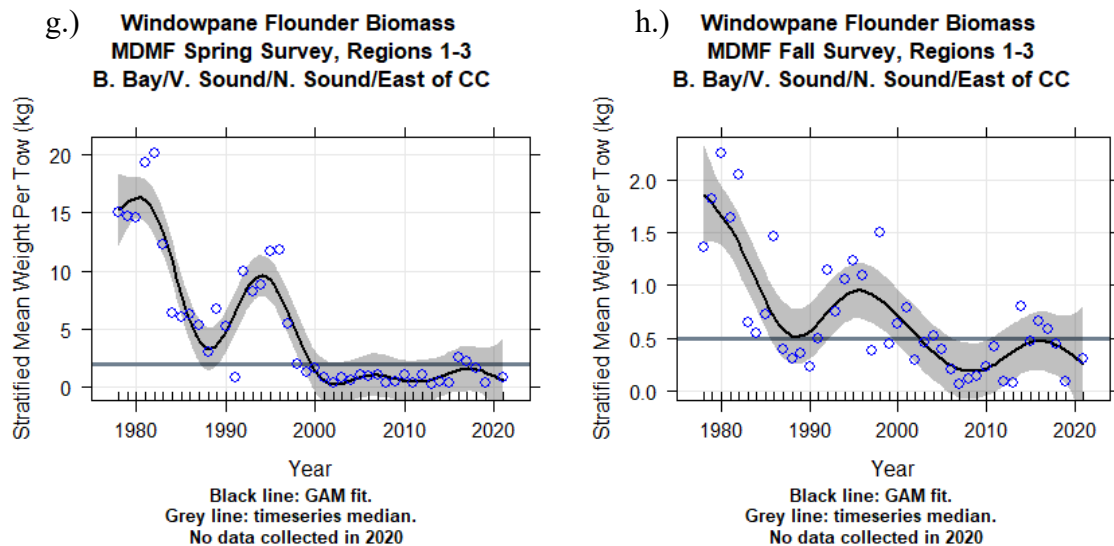


Figure 2. (i & j). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

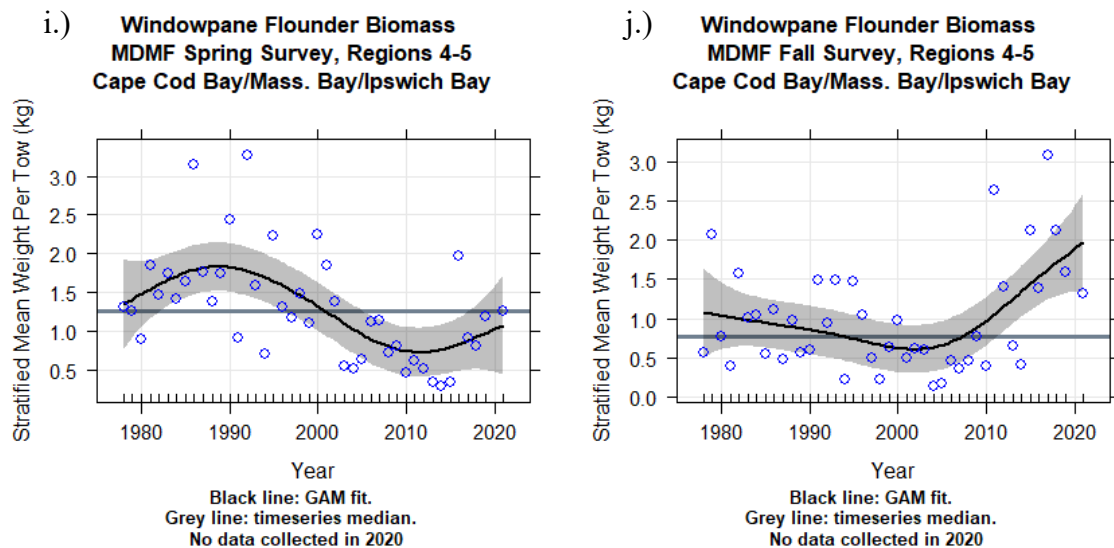


Figure 2. (k & l). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

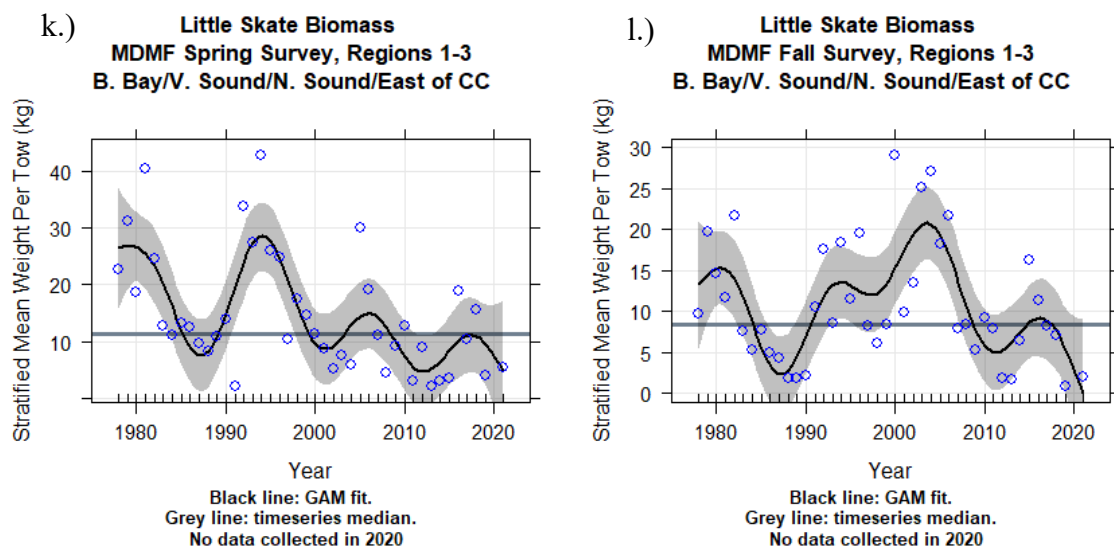


Figure 2. (m & n). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

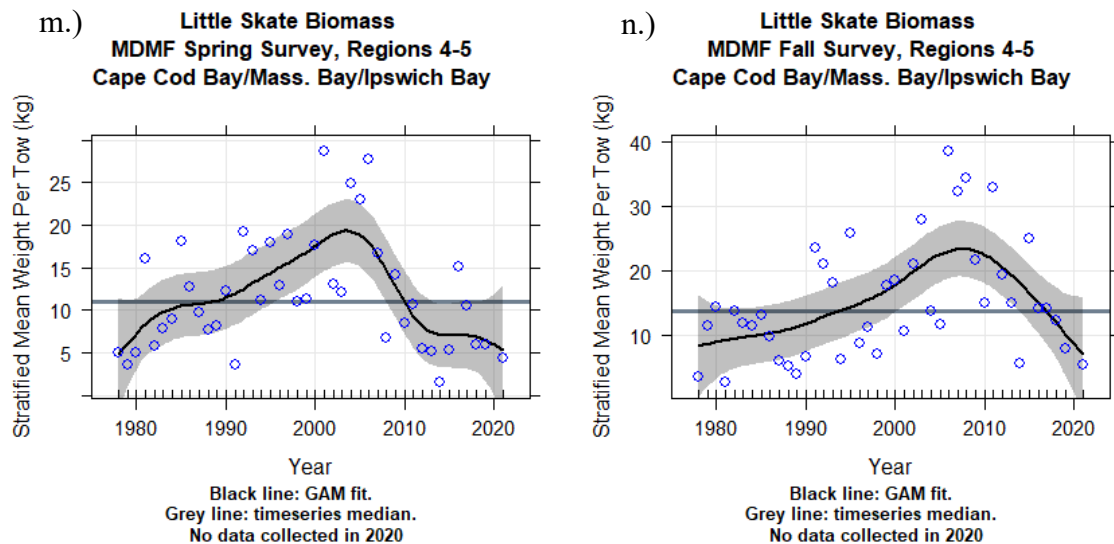


Figure 2. (o & p). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

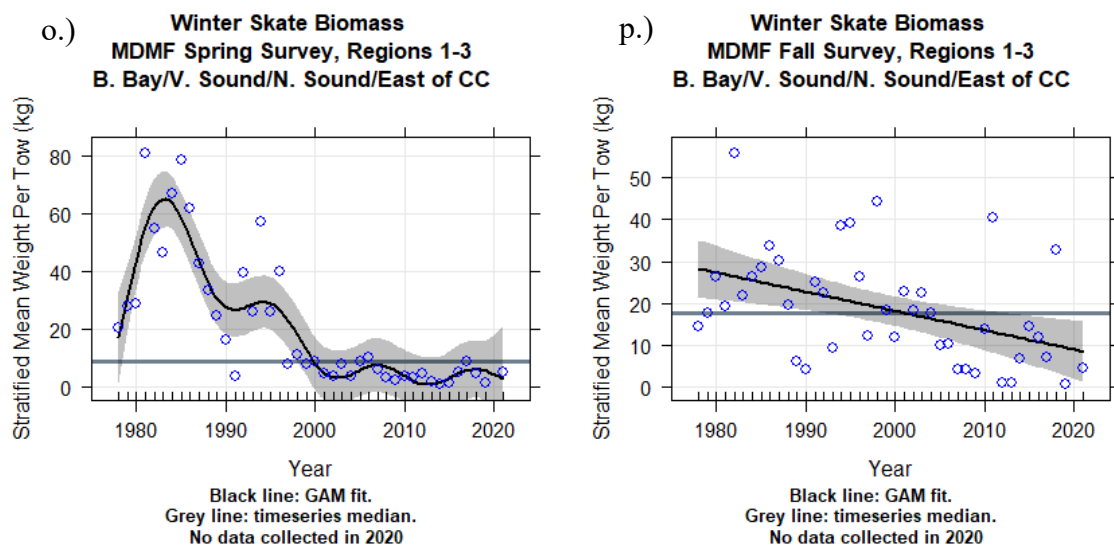


Figure 2. (q & r). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

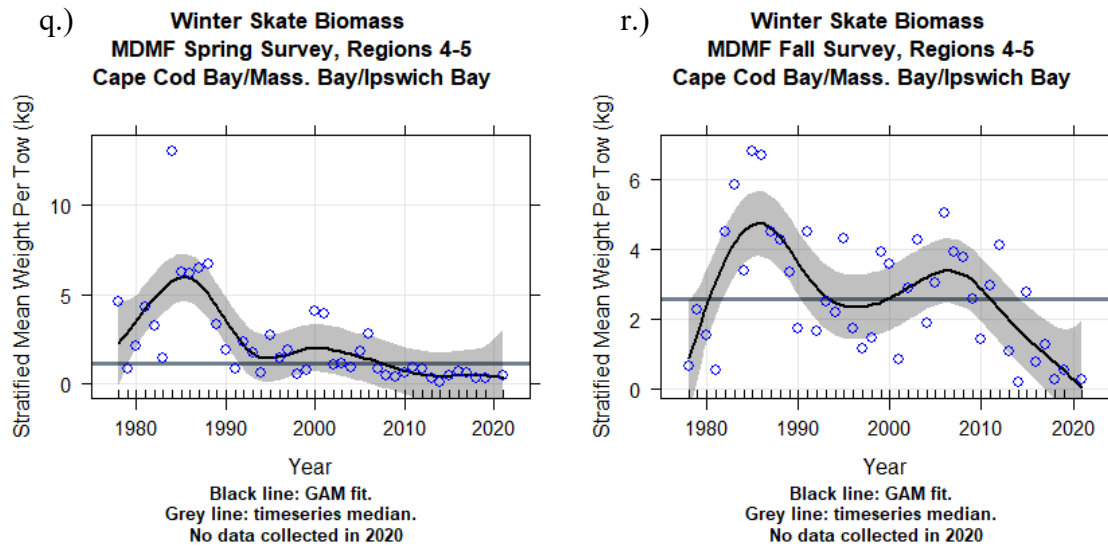


Figure 2. (s & t). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

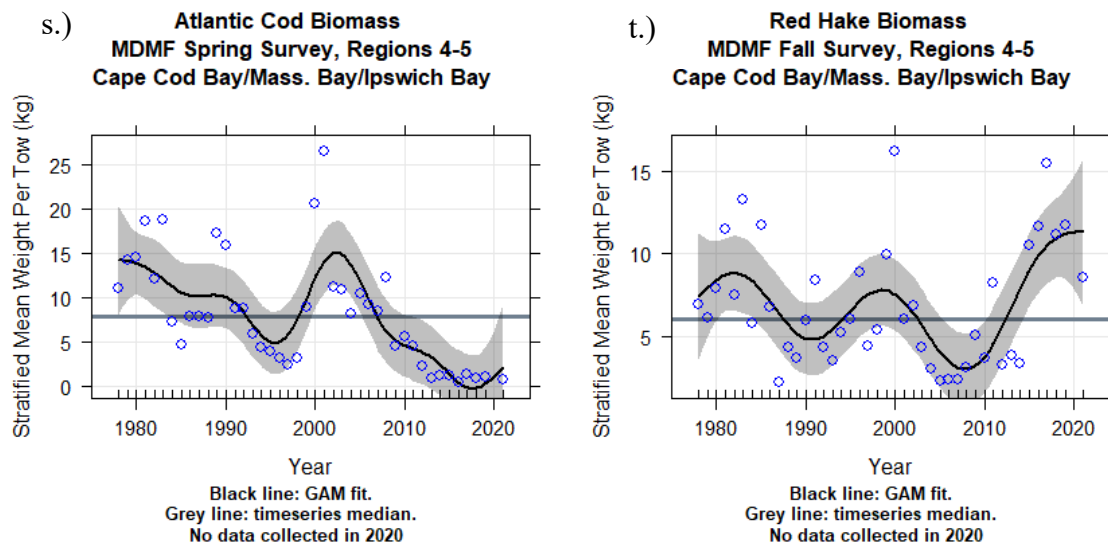


Figure 2. (u & v). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

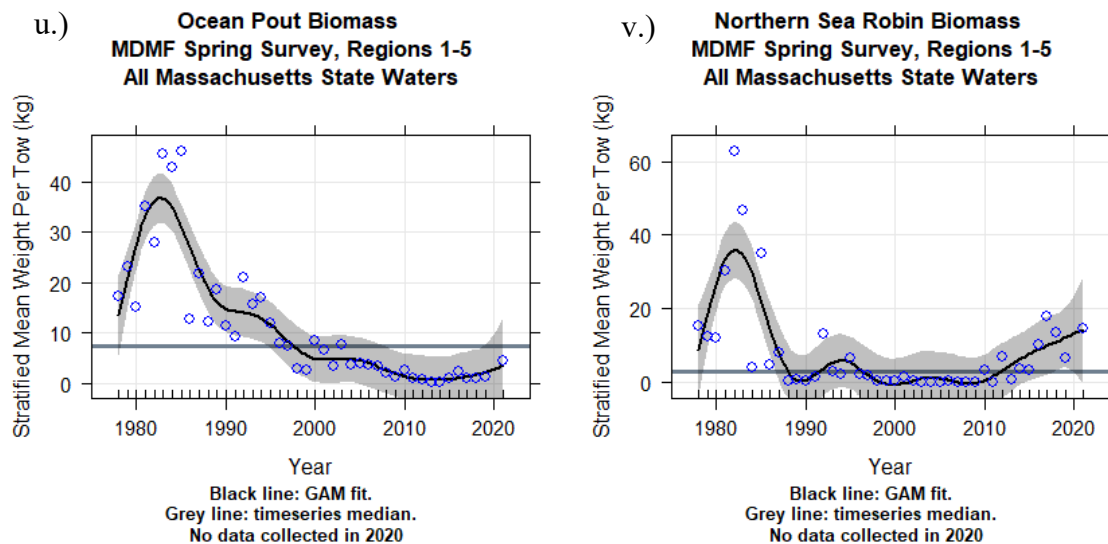


Figure 2. (w & x). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

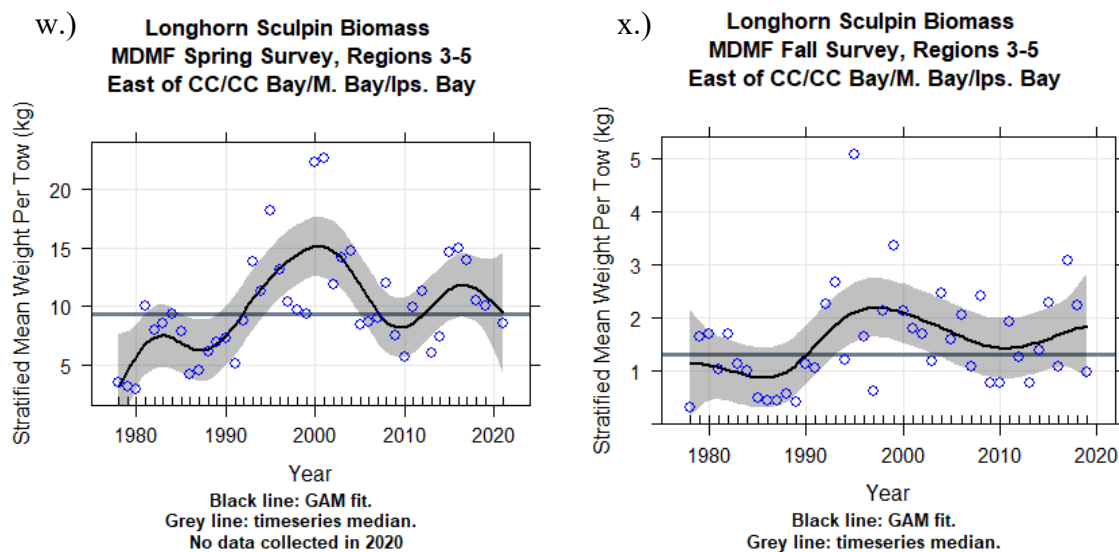


Figure 2. (y & z). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

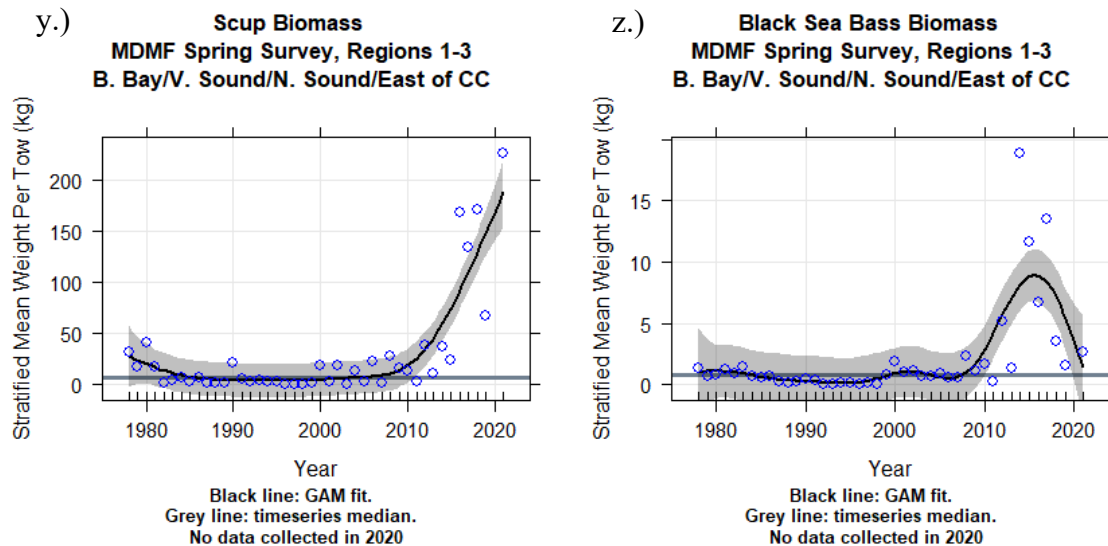


Figure 2. (aa & bb). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

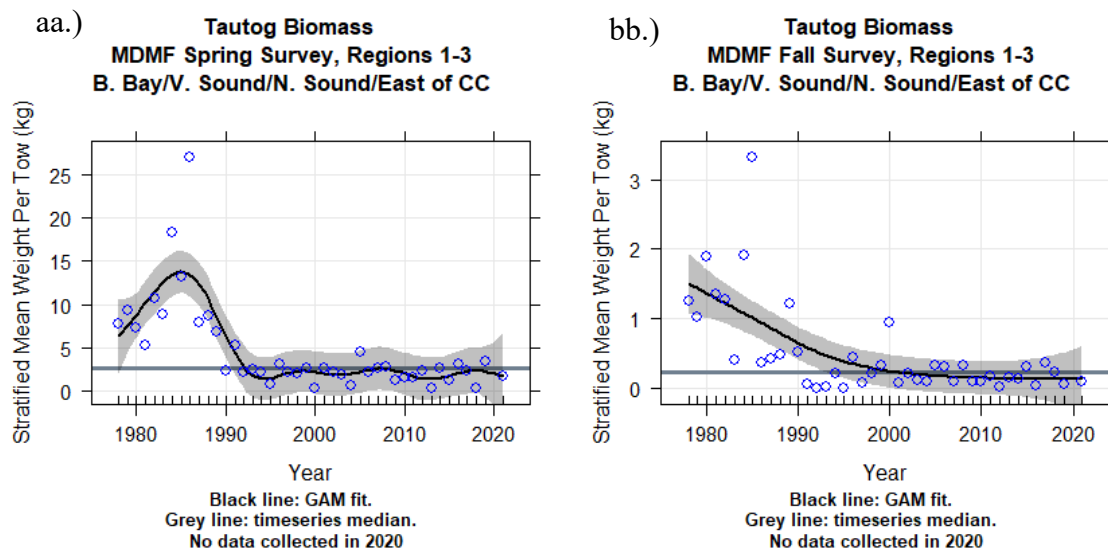


Figure 2. (cc & dd). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

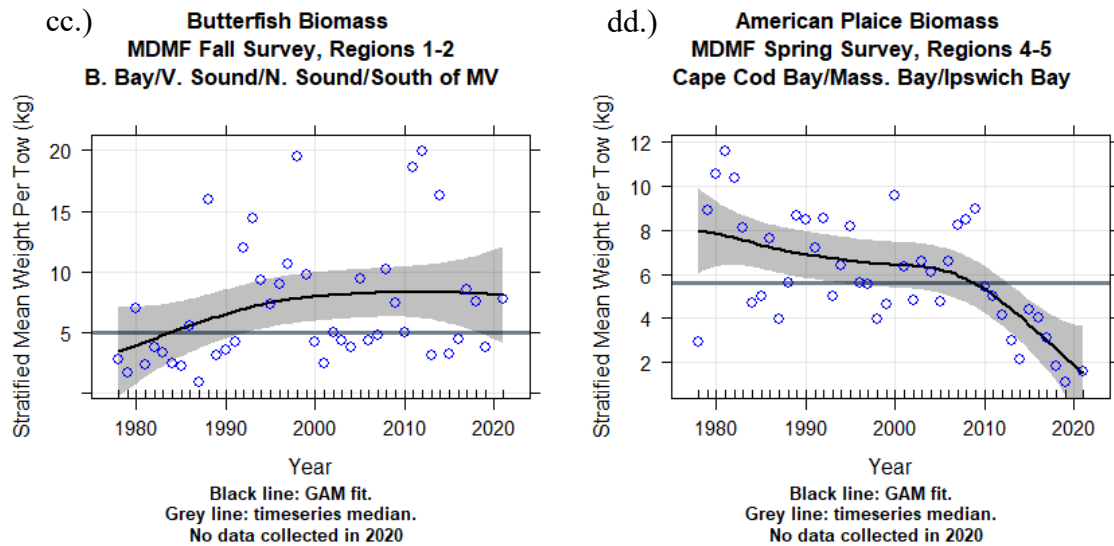


Figure 2. (ee & ff). Stratified mean weight per tow (kg) with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

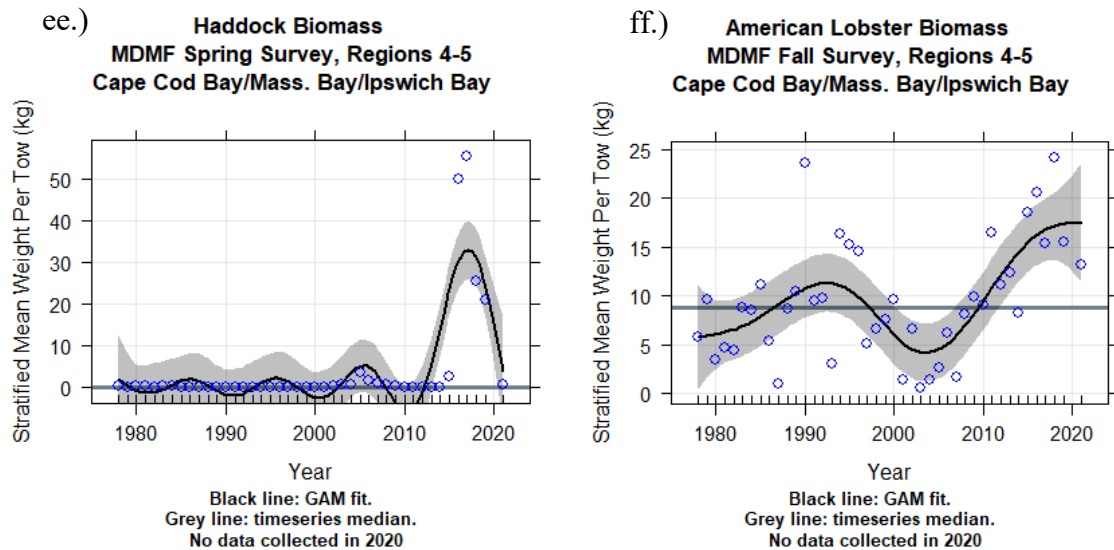


Figure 3. (a & b). Stratified mean number per tow with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

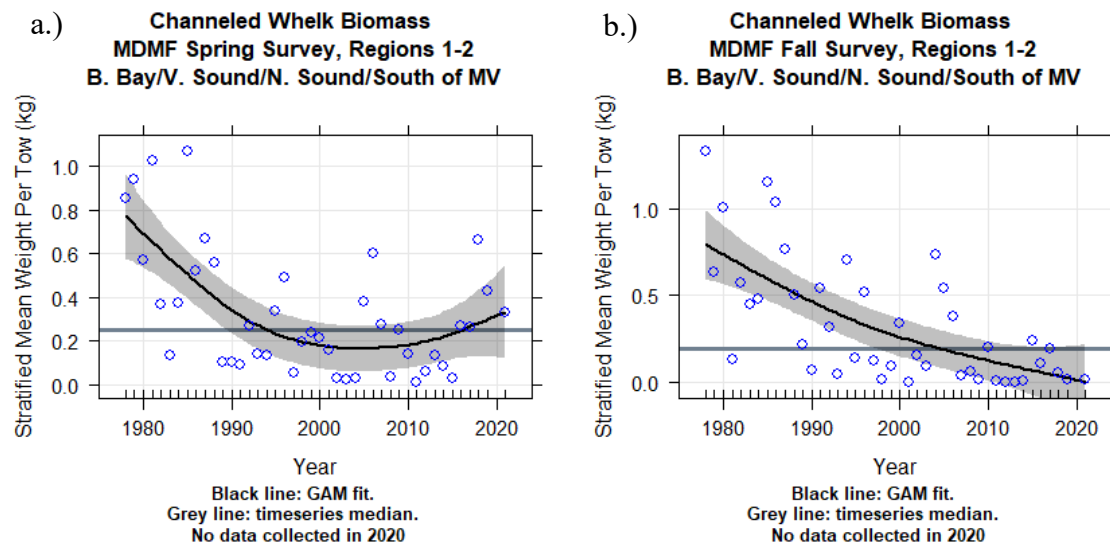


Figure 3. (c & d). Stratified mean number per tow with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.

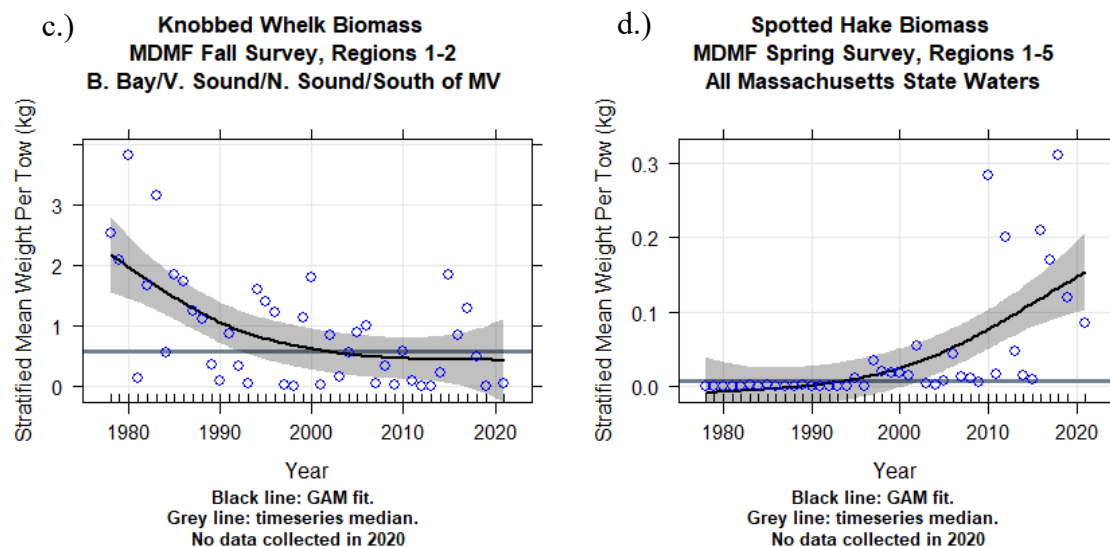
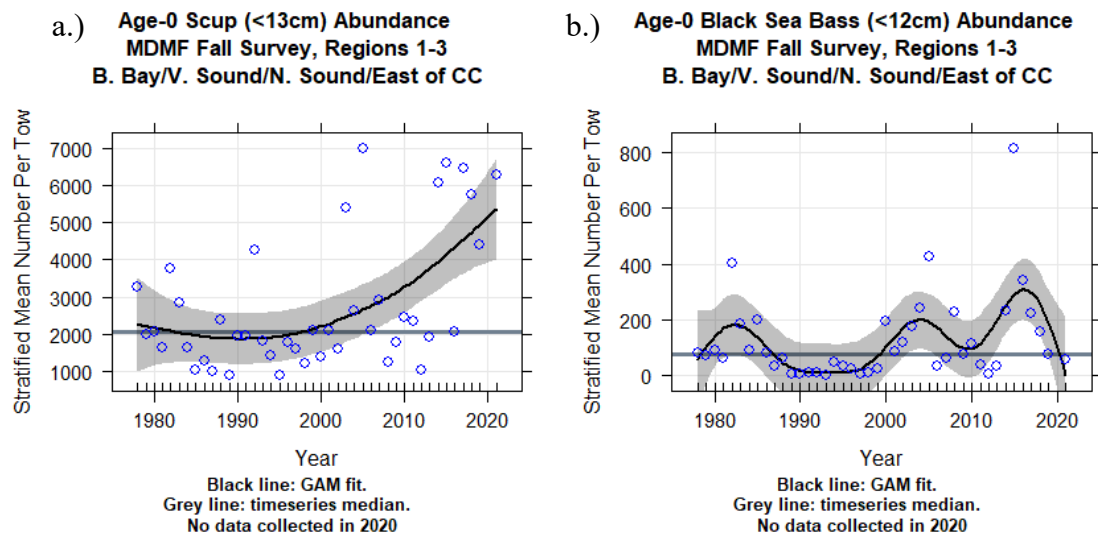


Figure 4. (a & b). Pre-recruit stratified mean number per tow with GAM smoothed trend line. 1978 – 2021 Massachusetts DMF Trawl survey.



Appendix B: Trends in Observed Bottom Temperatures Massachusetts Bottom Trawl Survey 1978 – 2021

A timeseries analysis of bottom temperatures recorded during spring and fall bottom trawl surveys is updated here to include 2021 observations. It should be noted that no data was collected in 2020, due to cancellations of both Spring and Fall Trawl Surveys due to the COVID-19 Pandemic. 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 1-2 for a listing of data gaps.

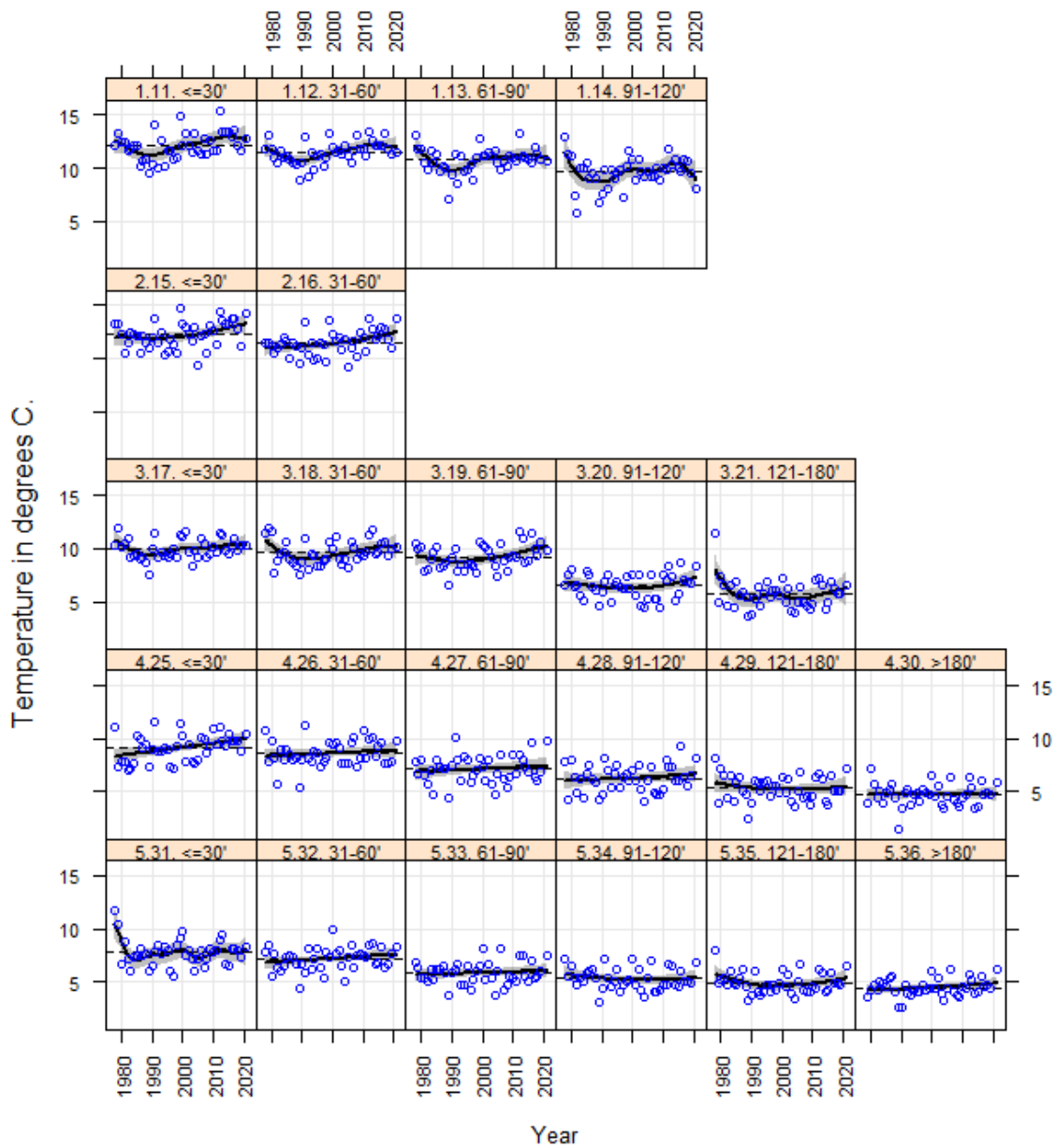
Year	Region 1				Region 2		Region 3					Region 4						Region 5					
	11	12	13	14	15	16	17	18	19	20	21	25	26	27	28	29	30	31	32	33	34	35	36
1978	12.1	11.8	13.1	13.0	13.2	11.5	10.3	11.5	10.5	6.5	11.5	11.1	10.7	7.8	7.8	8.2	N/A	11.7	7.8	6.8	7.2	7.9	N/A
1979	13.3	13.1	11.8	11.3	13.3	11.5	12.0	11.9	9.9	7.5	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
2019	11.7	11.3	10.8	9.5	11.2	11.0	10.2	10.0	10.7	6.7	5.8	8.9	7.9	6.9	6.5	5.0	4.7	7.3	7.6	6.0	4.9	4.6	4.5
2020	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2021	12.7	11.5	10.7	8.0	14.3	13.7	10.3	10.2	9.8	8.4	6.5	10.5	9.8	9.8	8.2	7.2	5.9	8.2	8.3	7.4	6.8	6.4	6.2
Median	12.1	11.5	10.8	9.8	12.2	11.5	9.9	9.5	9.2	6.5	5.7	9.2	8.2	7.0	6.2	5.1	4.8	7.8	7.3	5.8	5.1	4.7	4.4
Mean	12.1	11.5	10.8	9.6	12.2	11.4	9.9	9.6	9.2	6.5	5.7	9.1	8.6	7.1	6.3	5.3	4.7	7.7	7.2	5.8	5.3	4.9	4.5
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	7.2	11.7	10.0	8.1	7.2	7.9	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 1. Stratum mean bottom temperatures recorded on the MDMF spring survey, 1978 – 2021.

Year	Region 1				Region 2		Region 3					Region 4						Region 5					
	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	N/A	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
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	N/A	8.6	6.4	6.2	5.6	4.9
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	N/A	10.7	10.1	8.5	6.9	6.4
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	N/A	12.1	10.2	8.9	8.5
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	N/A	N/A	N/A	N/A	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
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
2019	20.5	19.9	18.0	17.0	18.7	19.5	18.1	18.4	16.8	11.3	10.0	17.3	14.0	9.6	8.8	8.1	8.1	15.7	15.6	12.9	10.2	8.3	N/A
2020	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2021	21.6	21.4	20.5	19.3	22.6	22.1	18.8	18.6	16.3	10.7	10.3	18.7	18.9	13.0	11.8	10.5	9.6	14.7	12.3	11.6	11.0	10.0	9.8
Median	19.0	18.8	17.6	16.5	19.6	19.5	16.4	16.3	14.9	9.6	8.5	16.2	13.1	10.2	9.3	8.6	7.9	14.3	12.2	10.5	9.5	8.4	7.8
Mean	19.0	18.8	17.7	16.6	19.5	19.5	16.3	15.8	14.9	9.9	8.5	15.9	13.6	10.7	9.6	8.4	7.7	14.3	12.6	10.8	9.4	8.4	7.8
Maximum	21.6	21.4	20.5	19.3	22.6	22.1	18.8	18.6	19.4	14.6	12.6	19.8	19.2	16.0	14.8	11.9	10.0	18.3	17.7	16.2	12.4	11.8	13.4
Minimum	16.0	16.2	14.7	14.3	16.1	16.1	13.0	11.7	10.7	5.6	4.5	11.3	7.8	6.4	5.4	5.0	5.1	10.0	8.6	6.4	6.2	5.6	4.9

Table 2. Stratum mean bottom temperatures recorded on the MDMF fall survey, 1978 – 2021.

Stratum Mean Bottom Water Temperature Observations **MDMF Spring Survey, 1978-2021**



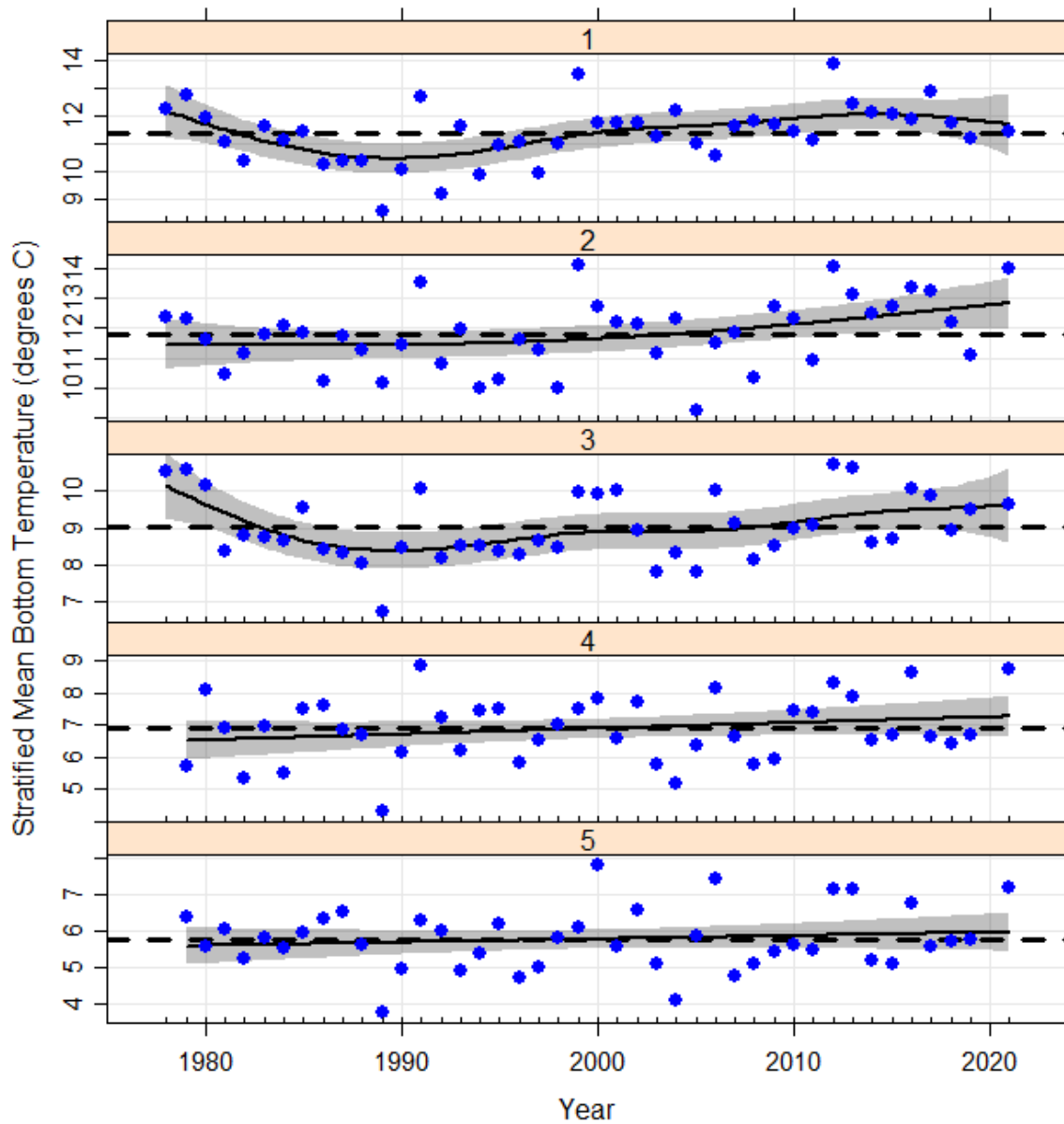
Panel label: Region, stratum, depth (ft).

Solid line: GAM fit.

Dashed line: timeseries mean.

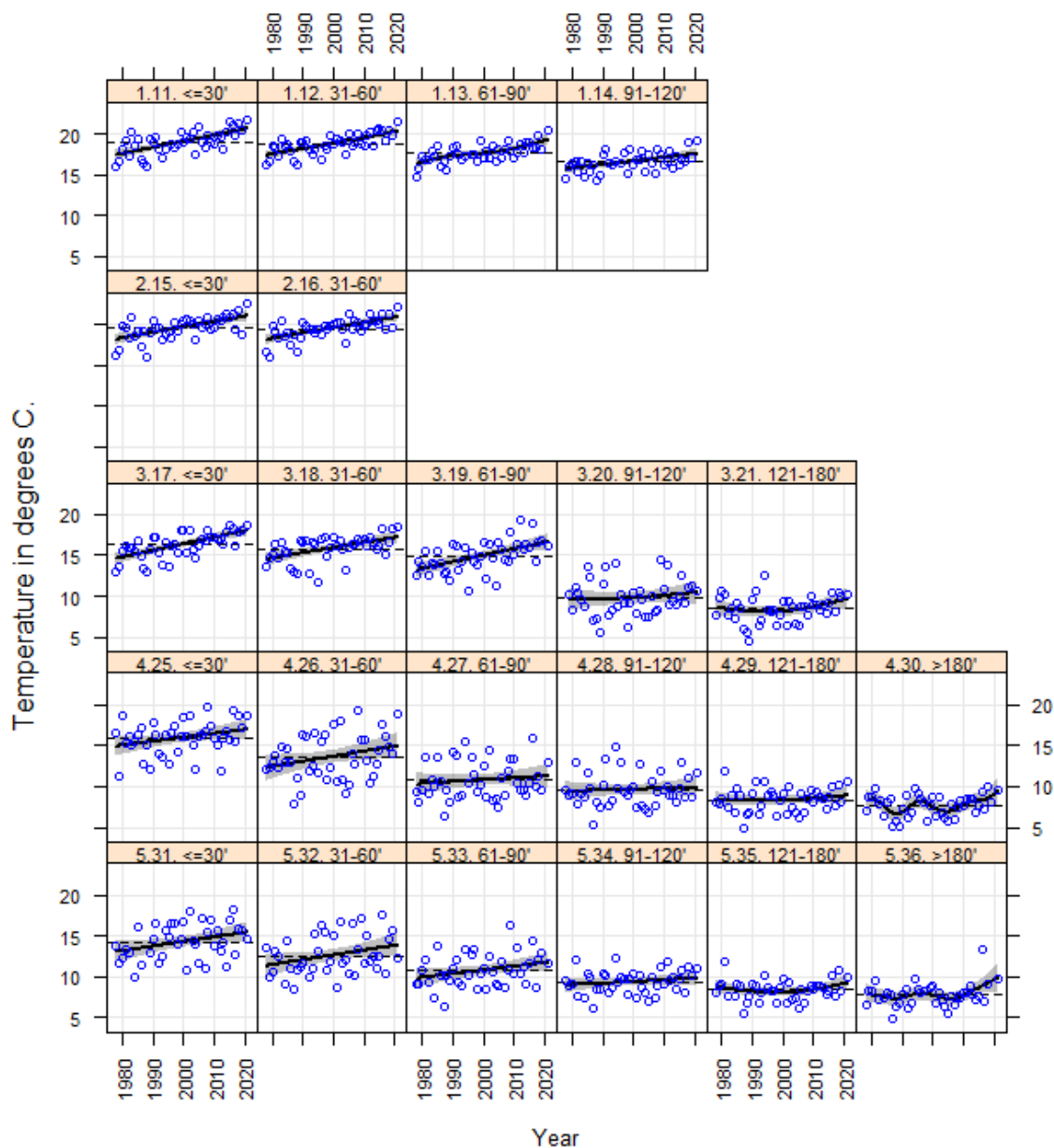
Note: No data collected in 2020

**Stratified Mean Bottom Temperature by Region.
MDMF Spring Trawl Survey, 1978 - 2021.**



Region label at top of each panel.
Solid line: GAM fit.
Dashed line: timeseries mean.
Note: No data collected in 2020

Stratum Mean Bottom Water Temperature Observations **MDMF Fall Survey, 1978-2021**



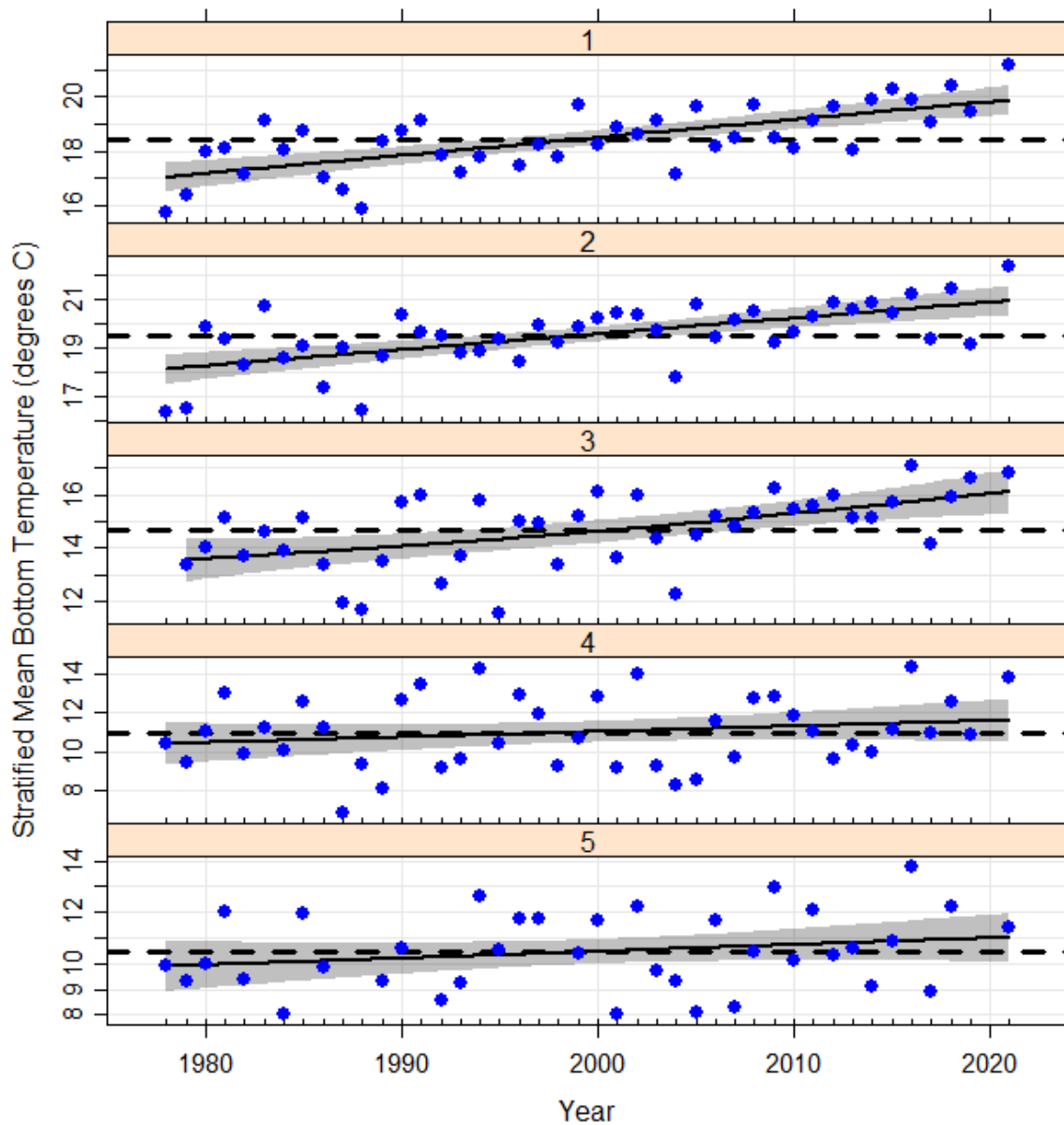
Panel label: Region, stratum, depth (ft).

Solid line: GAM fit.

Dashed line: timeseries mean.

Note: No data collected in 2020

Stratified Mean Bottom Temperature by Region. MDMF FALL Trawl Survey, 1978 - 2021.



Region label at top of each panel.

Solid line: GAM fit.

Dashed line: timeseries mean.

Note: No data collected in 2020

Appendix C. Corrections to the trawl survey database in 2021

No database corrections were made in 2021.