Eelgrass Mitigation for the Massachusetts Port Authority

Through Habitat Restoration and Conservation Moorings

2019 Final Report

Submitted to:

Massachusetts Port Authority

Prepared By:

Massachusetts Division of Marine Fisheries

T. Evans, K. Frew, F. Schenck, K. Schmicker, I. Seto

MarineFisheries
Commonwealth of Massachusetts

Daniel J. McKiernan, Acting Director

Introduction

In 2019, in accordance with our agreement with the Massachusetts Port Authority (Massport) to support its Conservation Mooring Program, the Massachusetts Division of Marine Fisheries (MA DMF) conducted qualitative site checks (SC) via snorkel in at selected moorings Wareham and Boston and full-scale monitoring (F) at selected moorings using SCUBA at Gloucester, Manchester-by-the-Sea, and Falmouth (see Appendix B for full site maps). The monitoring schedule is outlined below in Table 1. A detailed monitoring methodology was provided in the 2014 report and is reproduced herein as Appendix D.

Table 1: Monitoring Schedule

SITE	2014	2015	2016	2017	2018	2019
Gloucester	N/A moorings installed after growing season	F (Baseline)	SC	F	SC	F (Final)
Manchester-by-the-Sea	F(Baseline)	F	SC	F	SC	F (Final)
Boston	N/A moorings not yet installed	F (Baseline)	F	F	SC	F (Final)
Falmouth	F (Baseline)	F	F	SC	F	F (Final)
Wareham	N/A moorings not yet installed	F (Baseline)	F	SC	F	SC (Final)

Note: Massport/DMF agreement terminates 12/31/19). F = Full monitoring, SC = Site check.

Observations

Hodgkins Cove and Davis Cove – Gloucester

Site Summary: On August 7, 2019 MA DMF staff completed full-scale monitoring at two conservation moorings in Hodgkins Cove and one conservation mooring in Davis Cove. At the time of monitoring, only three of the six originally monitored moorings were still conservation moorings that could be found and one of the three conservation moorings was dragging on the ground. The mean scar area around conservation moorings in Hodgekins and Davis cove decreased 55% from 2015 (mean ± se m^2 = 7.06 ± 6.29) to 2019 (mean ± se m^2 = 3.12 ± 2.47). Due to time constraints, the density of eelgrass in recovered scars was not assessed at this site. Eelgrass density in scars (mean ± se shoot/m^2 = 14 ± 4) was about a quarter of shoot density in reference areas (mean ± se shoot/m^2 = 63 ± 11). Overall, it is difficult to draw many conclusions from the Gloucester conservation moorings because only half of the conservation moorings remained throughout the duration of the study.

Field Notes: Both coves have patchy areas of dense eelgrass over sandy substrate. Hodgkins Cove moorings H-14/H-11 and H-15 each consisted of a bow mooring from a bow and stern moored vessel. At the H-14/H11 mooring, no subsurface buoy was observed, and the rode was on the ground, however, there was eelgrass growing up to the helix (*Fig 1; Appendix C*). The H-15 bow mooring was fouled and floating low, but not grounding at the time of monitoring, and looked similarly to observations from 2018 with a large and persistent scar (*Fig. 2*). In Davis Cove, full monitoring was only conducted at mooring DC 13-19. Mooring DC 13-19 had a subsurface buoy present, looked to have been recently cleaned, and was floating with a small amount of chain wrapped around the helix. There was tall eelgrass nearby the mooring and patchy grass near the helix (*Fig.3*). Moorings DC 10-21 and DC-02 were not at the previously recorded coordinates and a swim-over at mooring DC 14-19 confirmed that it was a conventional chain mooring (converted from an eco-rode back to chain in 2018) with about 50 feet of chain dragging through nearby eelgrass (*Fig. 4; Appendix C*). See Appendix A for data collected at each mooring and Appendix C for a graph of scar changes over time at each mooring.

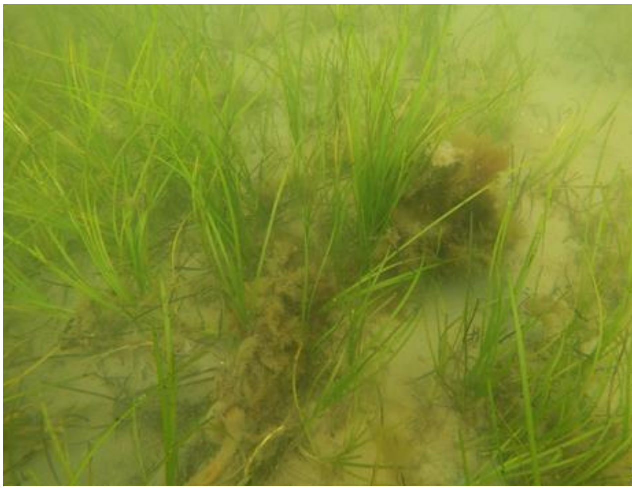



Figure 1.(left) H-11 mooring rode on ground with grass growing up to helix; Figure 2.(right) H-15 moorings rode floating with scar around helix

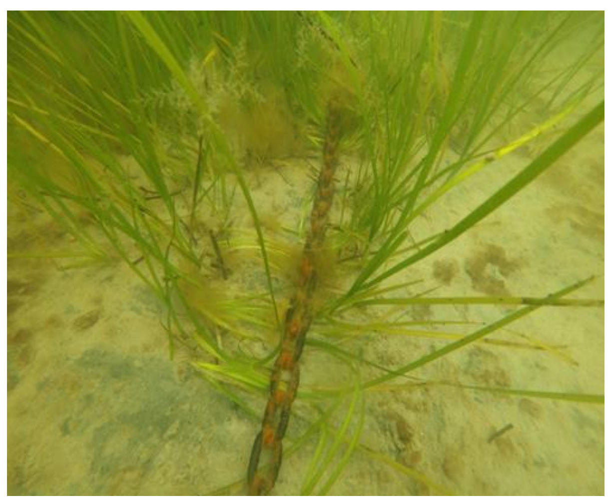



Figure 3. (left) Rode floating above eelgrass at DC 13-19; Figure 4. (right) Chain dragging through eelgrass at DC 14-19

Manchester Outer Harbor – Manchester-by-the-Sea

Site Summary: On August 9th and 20th 2019 DMF staff completed full-scale monitoring surveys at eight moorings in outer Manchester Harbor (745, 747, 749, 717, 700/G100, 775/G101, 712, and 778). At the time of monitoring, only six of the eight moorings originally monitored were still conservation moorings and four of the six conservation moorings were dragging on the bottom. The mean scar area around conservation moorings in Manchester decreased by 17% from 2014 (mean ± se m^2 = 38.48 ± 20.57) to 2019 (mean ± se m^2 = 31.66 ± 10.10). Shoot density in areas of recovered eelgrass within the original scar (mean ± se shoot/m^2 = 68 ± 6) was about a third of shoot density in references areas outside of the original scar (shoot/m^2 = 177 ± 56). Eelgrass shoot density in scars (mean ± se shoot/m^2 = 14 ± 7) was about one tenth of shoot density at reference areas. Overall, the eelgrass showed some growth back into mooring scars after the installation of conservation moorings in Manchester Outer Harbor, but there is considerable variability in the extent of this regrowth from mooring to mooring and the regrowth that has occurred does has a lower shoot density than reference areas.

Field Notes: Manchester outer harbor is characterized by dense continuous eelgrass over sandy substrate. Mooring 747, a Stormsoft mooring, had a section of chain dragging on the ground, but most of the gear was floating (*Fig. 5*). As in previous years, lobster gear was noted nearby. Mooring 717, also Stormsoft, was functioning properly (*Fig. 6*). This is an improvement from last year when the subsurface buoy and the eco-mooring rode were not buoyant. Moorings 700/G100 and 775/G101 were heavily fouled causing a portion of the rode to drag on the bottom (*Fig. 7a-b*). Mooring 712 was converted to a Dyneema line and all other previous eco-mooring parts were removed from the water (*Fig. 8a*). Divers noted that there was grass growing up to the helix from the northeast and the scar was mostly located to the southwest (*Fig. 8b*). Mooring 778, another Stormsoft, was minimally fouled, but was missing the subsurface buoy and dragging on the bottom within a ~4 m diameter scar surrounding the helix (Fig. 9). Mooring 745 was a chain mooring (converted from an eco-mooring in 2018). There was ~ 2m of chain dragging on the bottom (*Fig. 10*). Mooring 749/G49 could not be found in 2019. See Appendix A for the data collected at each mooring and Appendix C for a graph of scar changes over time at each mooring.


Figure 5. (left) Mooring 747 chain partially dragging through eelgrass; Figure 6. (right) Mooring 717 subsurface buoy floating gear and functioning properly

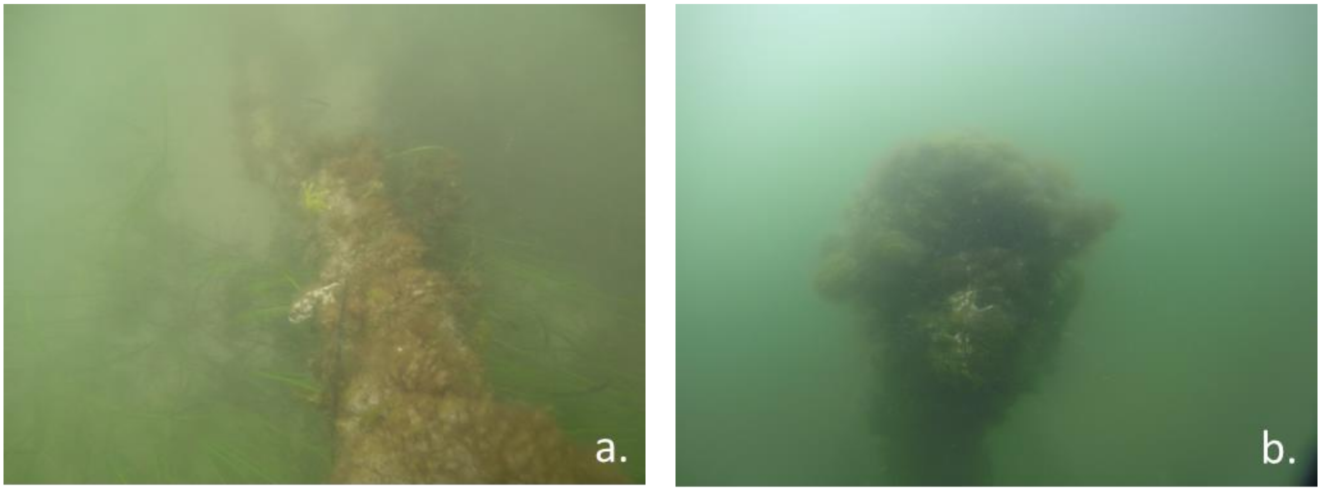


Figure 7. Mooring 700/G100 (a.) heavily fouled rode partially on ground (b.) heavily fouled subsurface buoy

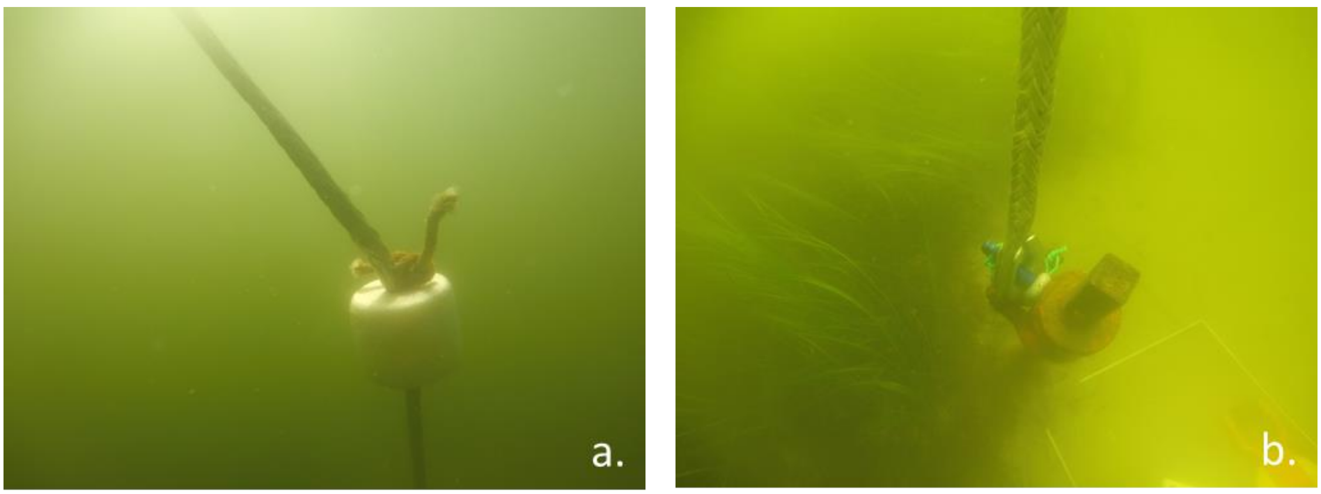


Figure 8. Mooring 712 (a.) newly installed dyneema line mooring system with subsurface buoy (b.) helix with eelgrass to the northeast and scar to southwest

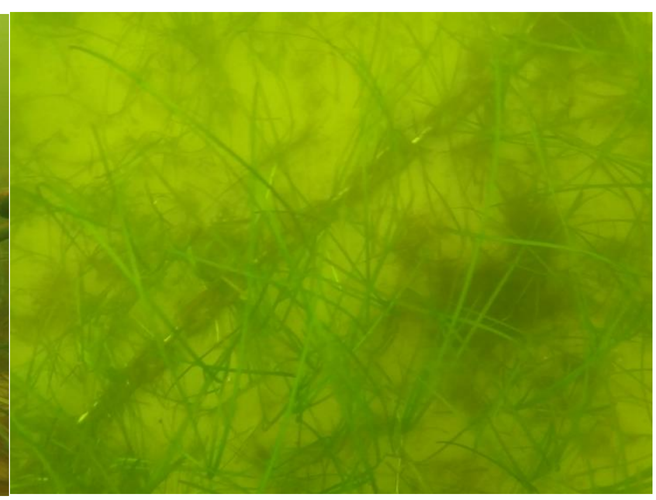



Figure 9. (left) Mooring 778, missing subsurface buoy, rode laying looped on the ground; Figure 10. (right) Chain mooring 745 dragging through eelgrass

Camp Harborview – Boston

Site Summary: On September 11, 2019, DMF staff completed full-scale monitoring at two moorings at Camp Harborview off Long Island. At the time of monitoring, none of the moorings originally monitored were conservation moorings and one of the moorings could not be found. The current Camp Harborview staff were contacted shortly after this site visit, and they stated that they were unaware of the mooring project and requirements to maintain the conservation moorings, stating that all moorings were replaced with chain systems based on recommendations by their mooring maintainer Aquamarine Services (Jenny Callahan, CHV, pers. Com. 9.13.19).

Field Notes: Moorings 1 and 3 were conventional chain moorings (converted 2018; *Fig. 11 & 12*). The swim float mooring could not be found in 2019. Scars were evident around each chain mooring where grass was observed previously.

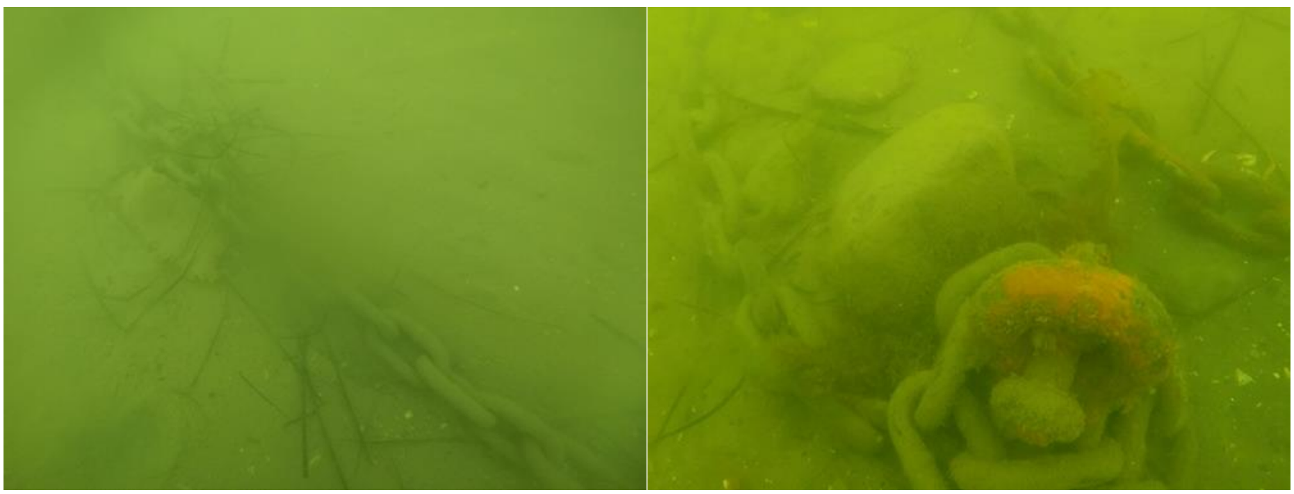


Figure 11. (left) Dragging chain at mooring 1; Figure 12. (right) chain wrapped around helix and dragging at mooring 3.

Quissett Harbor – Falmouth

Site Summary: On July 30, 2019, DMF staff completed full-scale monitoring at eight conservation moorings in Quissett Harbor (256, 264, 272, 274, 275, 276, 268, and 265). At the time of monitoring, all eight moorings were conservation moorings and only one of the eight conservation moorings was dragging on the bottom. The mean scar area in Quissett Harbor decreased by 54% from 2014 (mean ± se m^2 = 37.62 ± 13.95) to 2019 (mean ± se m^2 = 17.20 ± 5.96). Shoot density in areas of recovered eelgrass around these moorings (mean ± se shoot/m^2 = 25 ± 10) was only a little more than half that of shoot density in references areas outside of the original scar (mean ± se shoot/m^2 = 42 ± 9). Eelgrass shoot density in scars (mean ± se shoot/m^2 = 9 ± 3) was about one fifth of shoot density at reference areas. Overall, eelgrass has partially regrown back into mooring scars after the installation of conservation moorings in Quissett Harbor, but the regrowth that has occurred does not have the same shoot density as reference areas.

Field Notes: The Quissett Harbor site has continuous and moderately dense eelgrass over silty substrate. In Quissett Harbor, the rode and subsurface buoys of eco-moorings 256, 264, 272, 274, 275, 276, and 265 were heavily fouled, but still functioning correctly (*Figs. 13, 14, 15, 16 and 17*). Encouragingly, eelgrass was seen growing right up to the helices of moorings 272, 274 and 265. In contrast, mooring 275 had a large scar. At mooring 268 the chain connected to the subsurface buoy was dragging on the bottom (*Fig. 18*).


Figure 13. (left) Heavily fouled subsurface buoy at mooring 264; Figure 14 (right). Mooring 272 floating rode over eelgrass

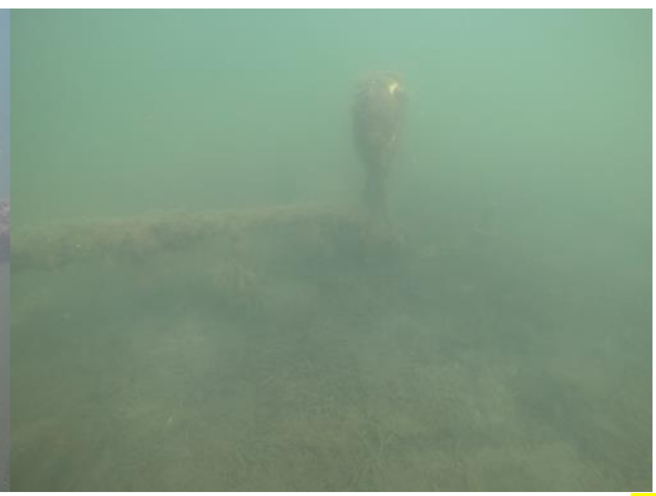



Figure 15.(left) Floating subsurface buoy and rode at mooring 274; Figure 16.(right) Mooring 276 subsurface buoy and floating rode

Figure 17. Floating, fouled rode at mooring 265

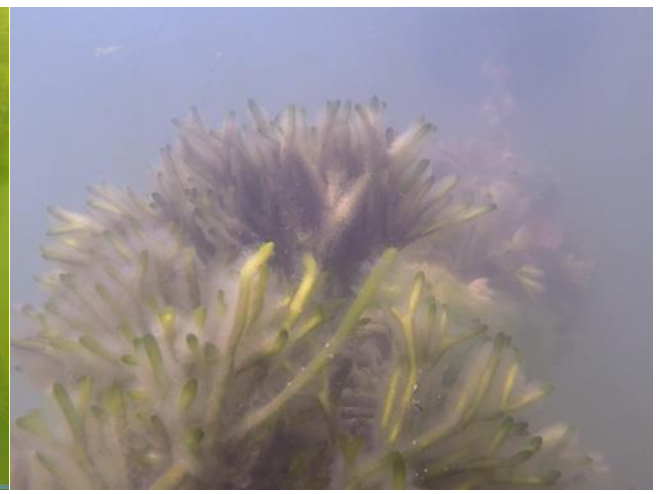


Figure 18. Chain dragging around helix of mooring 268; Figure 19. Rode of mooring 156 heavily fouled with *Codium*

West Falmouth Harbor – Falmouth

Site Summary: On July 29, 2019, DMF staff completed full-scale monitoring at eight conservation moorings in West Falmouth Harbor (156, 134, 262, 125, 151, 142, 29, and 107). At the time of monitoring, all eight moorings were conservation moorings and only two out of the eight conservation moorings were dragging on the bottom. The mean scar area in West Falmouth Harbor decreased by 80% from 2014 (mean ± se m^2 = 68.91 ± 26.88) to 2019 (mean ± se m^2 = 13.97 ± 7.16). Eelgrass shoot density in areas of recovered eelgrass around these moorings (mean ± se shoot/m^2 = 115 ± 19) was nearly equivalent to shoot density in references areas outside of the original scar (mean ± se shoot/m^2 = 136 ± 14). Eelgrass shoot density in scars (mean ± se shoot/m^2 = 65 ± 14) was half shoot density in reference areas. Overall, eelgrass has mostly grown back into mooring scars after the installation of conservation moorings in West Falmouth Harbor and the regrown eelgrass bed has similar shoot density to reference areas. In terms of eelgrass recovery, the conservation mooring installations at West Falmouth Harbor were the most successful.

Field Notes: West Falmouth Harbor has continuous and dense eelgrass over sandy and silty substrate. At all moorings, the rode and subsurface buoys were heavily fouled with *Codium, Didemnun sp., Botrylloides sp.,* and yellow sponge. Moorings 156, 134, 125, 262, 142, and 29 were floating off the bottom and functioning correctly (*Fig. 19, 20, 21, 22, 23, 24*). The rode of moorings 151 and 107 were dragging on the bottom (Fig. 25).

Figure 20. Subsurface buoy and rode of mooring 134 fouled with *Codium*


Figure 21. Rode of mooring 125 fouled with *Codium;* Figure 22. Rode of mooring 107 fouled with *Codium*

Figure 23. Eelgrass growing up to helix of mooring 142; Figure 24. Eelgrass growing up to helix of mooring 29. Note Atlantic silversides in the picture.

Figure 25. Rode of Mooring 151 fouled and dragging on eelgrass

Onset Harbor – Wareham

Site Summary: On July 30, 2019, MA DMF staff completed Site Checks at six conservation moorings in Onset Harbor (Town 1/Town 8, 1295, Town 6, 1410, 864, and 1307/525). At the time of monitoring, all of the moorings were conservation moorings, but four of the six conservation moorings were dragging on the bottom. No quantitative eelgrass data was collected on these moorings in 2019.

Field Notes: The rodes of moorings Town 1/Town 8, 1410, and 1307/525 were fouled and dragging on the bottom over bare substrate (*Fig. 26*). The rode of mooring 1295 was dragging over low density eelgrass. The rode and subsurface buoy of mooring Town 6 was fouled, but not dragging; however, no eelgrass was observed in the area. Eelgrass was observed around mooring 864 in low density with a denser meadow to the west of the scar area.

Figure 26. Heavily fouled subsurface buoy at mooring 1307/525

See Appendix A for the raw data collected at each mooring and Appendix C for a graph of scar changes over time at each mooring.

Discussion

There are two primary criteria to consider when determining the degree to which conservation moorings minimize or eliminate impacts to eelgrass in a harbor, 1) reduction or elimination of the unvegetated area around the mooring (i.e. the scar), and 2) parity of eelgrass characteristics (e.g. shoot density, % cover and canopy height) within the original scar area with that measured in the reference location. Based on these criteria, the conservation moorings at West Falmouth Harbor were the most successful- a net of 440 m^2 of eelgrass habitat has recovered to equivalent shoot densities as reference sites around the monitored conservation moorings. Installation of conservation moorings in Quissett Outer Harbor, Manchester Outer Harbor, Gloucester, and Onset Harbor (2018 data) also led to positive net recoveries though considerably less than West Falmouth (Table 2), and with shoot densities considerably below reference shoot densities. Finally, all conservation moorings were removed from Camp Harborview in Boston Harbor during the study and thus any benefits from eelgrass recovery observed in the early years was short-lived and we were unable to quantify the benefits to eelgrass from installation of conservation moorings at this site.

Site	Moorings installed (monitored) %	Net area restored (m^2)	Total area restored (m^2)
West Falmouth	8 (8) 100%	440	440
Quissett	8 (8) 100%	160	160
Manchester	76 (8) 10.5%	40	380
Gloucester	60 (6) 10%	12	120
Onset	118 (6) 5%	2	40
Boston	15 (3) 20%	0	0
Total			**1,140m^2 (0.3 acres)**

The Massport conservation mooring project resulted in a total estimated gain of 1,140m^2 (0.3 acres) of eelgrass recovery (Table 2). Overall, conservation moorings appear to be encouraging eelgrass recovery in many harbors, when they are functioning correctly. However, obstacles to success remain a concern.

A major challenge to eelgrass recovery in MA harbors is the partial or complete conversion of conservation moorings back to a conventional chain system. All three conservation moorings monitored in Boston, one conservation mooring monitored at Davis Cove in Gloucester, and two conservation moorings in Manchester Harbor were converted back to chain systems. MA DMF reached out to the harbormasters and mooring owners to ask why this was happening. While each case was different, generally the respondents indicated that the eco-moorings had outlived their utility after a few years and for boat security reasons the owners installed the most commonly used mooring gear recommended by mooring installers; i.e. chain. In general, the mooring owners were not aware that they were required to maintain conservation moorings at the site. Mooring owners are obligated to maintain their mooring and federal regulations require a floating flexible rode on moorings in eelgrass otherwise a Pre-Construction Notification (PCN) review by the Army Corps of Engineers is required.

In addition, conservation moorings do not minimize impacts to eelgrass if they are dragging on the bottom. In over a third of the conservation moorings monitored in 2019, the rode and subsurface buoys were observed dragging over the bottom. Dragging was most often caused by excessive rode length, but also resulted from extra top chain, missing floats, or heavy fouling. Harbors with a greater proportion of conservation moorings that were observed dragging on the bottom (Gloucester, Manchester, and Onset) had less recovery of eelgrass than harbors where a lower proportion of conservation moorings were observed dragging on the bottom (West Falmouth and Quissett). Incorrect size of the rodes for the site resulted in dragging in West Falmouth, Onset, and Boston. Rodes were shortened in West Falmouth correcting the problem. In Gloucester, rodes were modified by tying two rodes together, forming a much longer double rode that also dragged along the seafloor. In Manchester, rode length seemed appropriate for the depth, but fouling and missing gear components still led to dragging.

In sum, to maximize eelgrass recovery in MA harbors, we recommend mooring owners, harbormasters, and mooring installers (1) consider site characteristics (i.e. depth and tidal range) during mooring installation, (2) de-foul conservation moorings regularly (~monthly) over the course of the boating season, (3) remove mooring gear during winter, and (4), once a mooring has been converted to a conservation mooring, do not change it back to a chain mooring or all eelgrass gains will be lost. Finally, we recommend that all moorings that were changed back to chain in Boston, Gloucester and Manchester be re-installed as conservation moorings, utilizing one of the several mooring options that are now available including stormsoft, Dyneema line systems, or EOM mooring systems.

Appendix A: Mooring Monitoring Raw Data

location	harbor	mooring. id	latitude	longitude	final. mooring. type	year	month	day	N.m	NE.m	E.m	SE.m	S.m	SW.m	W.m	NW.m	Area. m²	scar. shoot. count	ref. shoot. count	recovered. shoot. count
Gloucester	AN	DC2	42 40.081	70 40.500	CO	2014	9	15	NA	6.2	NA	8	NA	NA	NA	NA	NA	2.1	7.9	NA
Gloucester	AN	DC10	42 40.050	70 40.531	CO	2014	9	15	NA	NA	9.2	4.7	NA	5.9	4.4	NA	NA	12.3	18.6	NA
Gloucester	AN	DC13	42 40.111	70 40.454	CO	2014	9	15	0	0	0	0	0	0	0	0	0	40	29.9	NA
Gloucester	AN	DC14	42 40.081	70 40.443	CH	2014	9	15	6.7	NA	NA	NA	NA	NA	NA	NA	NA	12.5	22	NA
Gloucester	AN	H14	NA	NA	CO	2014	9	23	1.4	1.5	1.5	NA	0.3	1.7	0.1	0.5	2.66	19.4	21.5	NA
Gloucester	AN	H15	42 40.153	70 40.201	CO	2014	9	23	0	0	0	0	0	0.6	0.1	0.2	0.03	25.4	26.8	NA
Manchester	OM	G12	42 33.815	70 47.115	CO	2014	9	4	0	0	0	0	0	0	0	0	0	55.6	60.8	NA
Manchester	OM	G17	42 33.652	70 47.248	CO	2014	9	4	3.8	3.6	4.9	3.8	3.7	4.2	6.3	4.4	64	0	27.4	NA
Manchester	OM	G45	42 33.699	70 47.231	CH	2014	9	4	4.7	4.6	4.8	5.1	4.2	4.2	3.2	3.4	62.77	6.1	41.9	NA
Manchester	OM	G47	42 33.633	70 47.281	CO	2014	9	4	4.9	6.2	8.3	4.4	5.6	7.7	8.6	3.3	126.31	0.4	32.8	NA
Manchester	OM	G49	42 33.672	70 47.219	CO	2014	9	4	0	0	0	0	5.8	7	0	5.7	17.27	5	28	NA
Manchester	OM	G100	42 33.835	70 47.064	CO	2014	9	4	2.7	5.3	0.65	0.9	1	6	5.9	3.6	38.97	4.5	54.1	NA
Manchester	OM	G101	42 33.832	70 47.060	CO	2014	9	4	0	1.7	1.1	1.7	0	0	0	0	1.59	35.9	47.1	NA
Manchester	OM	G114	NA	NA	CO	2014	9	4	0	0	0	0	0	0	0	0	0	44.1	39.4	NA
Boston	CH	CH1	NA	NA	CH	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boston	CH	CH3	NA	NA	CH	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boston	CH	CHFloat	NA	NA	CO	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF29	41 36.358	-70 38.654	CO	2014	8	20	2.2	3.3	3.1	2.3	2.2	3	3.1	2.6	25.25	0.5	26.6	NA
Falmouth	WF	WF107	41 36.369	-7038.669	CO	2014	8	20	1.2	2.1	3.7	4.3	0.8	1	1.2	2.6	16.12	5.8	23.8	NA
Falmouth	WF	WF125	41 36.368	-70 38.741	CO	2014	8	19	5.5	4.9	10.4	6.7	2.8	6	6.1	6.3	124.59	0.3	29	NA
Falmouth	WF	WF134	41 36.380	-70 38.800	CO	2014	8	19	2.6	3.1	3.4	2.9	2.3	3.1	2	2	24.53	5	28.8	NA
Falmouth	WF	WF142	41 36.337	-70 38.673	CO	2014	8	19	3.6	3.3	2.7	0.1	0.1	0.1	0.1	1.8	11.81	20	38.1	NA
Falmouth	WF	WF151	41 36.394	-70 38.749	CO	2014	8	20	2.7	1.6	1.8	0	0.1	17	17.8	2.4	153.46	5.8	13.2	NA
Falmouth	WF	WF156	41 36.379	-70 38.812	CO	2014	8	19	0	0.6	3.2	0.1	0.4	0.3	0.4	1	1.24	16	27.3	NA
Falmouth	WF	WF262	41 36.364	-70 38.758	CO	2014	8	19	10.4	10.2	10.3	4	4.2	5.1	6.2	8.1	194.28	1	19.3	NA
Falmouth	QI	Q256	41 32.323	-70 39.844	CO	2014	8	19	1.2	3	5.6	NA	13.2	4.3	1	2.1	69.67	3.6	10.6	NA
Falmouth	QI	Q264	41 32.306	-70 39.843	CO	2014	8	19	0.2	0.4	0.4	0.4	0.3	0.3	0.2	0.3	0.34	11.3	22.6	NA
Falmouth	QI	Q265	41 32.276	-70 39.854	CO	2014	8	19	3.1	1.4	0.8	0.6	0.7	3.9	3.8	3.7	21.03	1.5	33.9	NA

Falmouth	QI	Q268	41 32.268	-70 39.797	CO	2014	8	19	5.1	6.7	5.1	6.1	7.7	5.6	5.4	3.7	110.03	1.5	22	NA
Falmouth	QI	Q272	41 32.276	-70 39.847	CO	2014	8	19	1.2	1.9	0.4	0.2	0	0.2	0.7	1.2	2.36	10.1	26.5	NA
Falmouth	QI	Q274	41 32.266	-70 39.868	CO	2014	8	19	0.4	0.3	0	0.2	0.2	0.4	0	0	0.1	22.1	31.4	NA
Falmouth	QI	Q275	41 32.258	-70 39.860	CO	2014	8	19	4.2	4.8	1.9	1.2	4.1	5.3	6.2	3.6	54.67	2.5	27.6	NA
Falmouth	QI	Q276	41 32.273	-70 39.839	CO	2014	8	19	6.1	5.3	1.3	1.1	2.6	3.6	3.7	3.5	42.75	1	27.8	NA
Wareham	OH	1410	NA	NA	CO	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	864	NA	NA	CO	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	12	NA	NA	CO	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	39	NA	NA	CO	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	37	NA	NA	CO	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	1307	NA	NA	CO	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC2	42 40.081	70 40.500	CO	2015	8	25	NA	14.2	15	NA	NA	NA	NA	NA	NA	1.5	15.5	NA
Gloucester	AN	DC10	42 40.050	70 40.531	CO	2015	8	25	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5	4.5	NA
Gloucester	AN	DC13	42 40.111	70 40.454	CO	2015	8	25	0.6	0.3	0.5	0.5	0.6	0.9	0.8	0.3	1.09	116.5	127	NA
Gloucester	AN	DC14	42 40.081	70 40.443	CH	2015	8	25	13.7	2.1	14.2	6.5	8	5	18.4	8.9	264.03	11.5	50	NA
Gloucester	AN	H14	NA	NA	CO	2015	8	25	1.6	6	2.1	3.2	1.5	1.3	2.1	2.1	19.64	53.5	132	NA
Gloucester	AN	H15	42 40.153	70 40.201	CO	2015	8	25	0.4	0.45	0.55	0.45	0.3	0.1	0.1	0.45	0.46	84.5	61.5	NA
Manchester	OM	G12	42 33.815	70 47.115	CO	2015	9	1	1	1.6	1.8	3.4	4.8	1.8	1.6	1.4	17.9	118.5	192	NA
Manchester	OM	G17	42 33.652	70 47.248	CO	2015	9	1	3.5	3.7	4.7	3.8	3.6	4	4.5	4.8	56.45	17	122.5	NA
Manchester	OM	G45	42 33.699	70 47.231	CH	2015	9	1	4.4	5.1	4	4.6	4.3	3.8	3.5	2.9	56.83	9	127	NA
Manchester	OM	G47	42 33.633	70 47.281	CO	2015	9	1	5.5	7.8	6.2	4.7	8.5	7.3	9.5	4.4	152.21	4.5	126	NA
Manchester	OM	G49	42 33.672	70 47.219	CO	2015	9	1	5.6	4.1	2.7	4.1	5.8	5.8	6.9	4.4	84.04	37	113.5	NA
Manchester	OM	G100	42 33.835	70 47.064	CO	2015	9	1	2.3	5	0.5	0.9	1	1	1.2	2	10.44	136.5	191	NA
Manchester	OM	G101	42 33.832	70 47.060	CO	2015	9	1	0.6	6	2	2.3	3.3	3	1.3	0.5	18.1	107.5	188	NA
Manchester	OM	G114	NA	NA	CO	2015	9	1	3.9	0.8	1.5	1.4	4	2.8	3.2	3.8	25.17	119	159	NA
Boston	CH	CH1	NA	NA	CH	2015	5	21	0.9	1.2	3.4	4.7	2.9	6.6	4.7	NA	38.02	15	93.5	NA
Boston	CH	CH3	NA	NA	CH	2015	5	21	NA	NA	1.3	4.3	5.2	7.1	NA	NA	NA	15.5	53	NA
Boston	CH	CHFloat	NA	NA	CO	2015	5	21	12.5	1.1	3.3	2.7	1	1.3	1	1.4	21.48	57.14	101	NA
Falmouth	WF	WF29	41 36.358	-70 38.654	CO	2015	9	9	2.3	2.3	2.5	2.3	2.6	3.2	2.2	3.1	22.16	12.5	114.5	NA
Falmouth	WF	WF107	41 36.369	-7038.669	CO	2015	9	9	0.8	2	1.7	3.6	3	1.4	0.8	0.7	12.07	42.5	164	NA
Falmouth	WF	WF125	41 36.368	-70 38.741	CO	2015	9	9	5.6	13.8	10.8	6.6	3.9	6.1	5.6	NA	176.24	10.29	64	NA
Falmouth	WF	WF134	41 36.380	-70 38.800	CO	2015	9	9	2.4	3.7	3.4	2.5	2.1	2.4	2.7	1.6	23.35	5.5	146.5	NA

Falmouth	WF	WF142	41 36.337	-70 38.673	CO	2015	9	9	0.7	0.8	1.5	1.8	1	1.4	1	1.5	4.94	40	121.5	NA
Falmouth	WF	WF151	41 36.394	-70 38.749	CO	2015	9	9	2.6	1.6	0.5	0.5	0.3	0.4	2.4	2.3	7.63	34	99	NA
Falmouth	WF	WF156	41 36.379	-70 38.812	CO	2015	9	9	0.7	0.8	0.8	0.9	0.1	0.4	0.2	0.8	1.21	124.5	198.5	NA
Falmouth	WF	WF262	41 36.364	-70 38.758	CO	2015	9	9	12.3	2	NA	18.3	7.1	6.6	6.1	NA	152.71	8.5	68	NA
Falmouth	QI	Q256	41 32.323	-70 39.844	CO	2015	9	8	0.8	1.3	0.7	NA	1.2	1.3	0.6	1.2	2.92	30	65	NA
Falmouth	QI	Q264	41 32.306	-70 39.843	CO	2015	9	8	0.3	0.3	0.6	0.2	0.4	0.3	0.8	0.7	0.68	59.5	64	NA
Falmouth	QI	Q265	41 32.276	-70 39.854	CO	2015	9	8	6.8	1.8	0.5	0.5	0.8	3.8	2.8	3.9	27.62	46.5	103.5	NA
Falmouth	QI	Q268	41 32.268	-70 39.797	CO	2015	9	8	4.8	7.1	5.4	6.1	7.7	5.9	2.7	3.9	103.36	6	119	NA
Falmouth	QI	Q272	41 32.276	-70 39.847	CO	2015	9	8	1.9	1.8	5	3.4	1	1.7	0.7	1.1	16.41	44	108	NA
Falmouth	QI	Q274	41 32.266	-70 39.868	CO	2015	9	8	0.2	0.3	0.3	0.5	0.7	0.7	1.2	1.2	1.56	62.5	117.5	NA
Falmouth	QI	Q275	41 32.258	-70 39.860	CO	2015	9	8	5.6	4.8	2.2	1.8	3.3	2.3	3.6	3.8	41.77	0.5	120	NA
Falmouth	QI	Q276	41 32.273	-70 39.839	CO	2015	9	8	6.7	6.7	2.1	3.5	1.7	4.1	3.3	3.6	54.78	23	107.5	NA
Wareham	OH	1410	NA	NA	CO	2015	11	3	1.1	1.4	1.1	1.3	3.1	0.8	1	1.2	6.1	8	56.5	NA
Wareham	OH	864	NA	NA	CO	2015	11	3	0.8	0.8	0.7	0.4	0.6	1	0.9	0.8	1.95	0	52	NA
Wareham	OH	12	NA	NA	CO	2015	11	3	2.5	0.5	0.5	0.4	0.3	NA	0.3	0.3	1.17	0	170	NA
Wareham	OH	39	NA	NA	CO	2015	11	3	0.7	0.8	0.8	1.2	1.5	1.3	0.7	1.2	3.62	42	74	NA
Wareham	OH	37	NA	NA	CO	2015	11	3	3.3	3.9	2.8	8.6	NA	1.9	NA	2	32.18	29.5	85	NA
Wareham	OH	1307	NA	NA	CO	2015	11	3	0.5	0.6	0.2	0.1	0.9	0.8	0.2	0.8	0.84	0	62.5	NA
Gloucester	AN	DC2	42 40.081	70 40.500	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC10	42 40.050	70 40.531	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC13	42 40.111	70 40.454	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC14	42 40.081	70 40.443	CH	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	H14	NA	NA	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	H15	42 40.153	70 40.201	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G12	42 33.815	70 47.115	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G17	42 33.652	70 47.248	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G45	42 33.699	70 47.231	CH	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G47	42 33.633	70 47.281	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G49	42 33.672	70 47.219	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G100	42 33.835	70 47.064	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G101	42 33.832	70 47.060	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G114	NA	NA	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Boston	CH	CH1	42 19.7273	-70 57.650	CH	2016	9	7	0.5	1.5	2.6	2.3	NA	0.95	0.45	0.5	5.88	12.5	148	NA
Boston	CH	CH3	42 19.7087	-70 57.676	CH	2016	9	7	NA	2.35	2.3	2.6	2.2	1	NA	1.25	10.09	16	139	NA
Boston	CH	CHFloat	42 19.6992	-70 57.651	CO	2016	9	7	1	1	9.7	7.1	1.3	NA	0.6	1	38.81	27	212	NA
Falmouth	WF	WF29	41 36.358	-70 38.654	CO	2016	7	20	1.7	2.6	2.2	1.7	0.9	1.6	1.8	2	11.37	37	165	NA
Falmouth	WF	WF107	41 36.369	-7038.669	CO	2016	7	20	0.6	0.4	0.5	0.9	0.95	0.73	0.65	1.8	2.2	54	225	NA
Falmouth	WF	WF125	41 36.368	-70 38.741	CO	2016	7	21	5.8	3.65	3.4	7.1	2.4	2.1	2.2	4.6	51.57	51	111	NA
Falmouth	WF	WF134	41 36.380	-70 38.800	CO	2016	7	21	1.52	2.65	1.55	1.9	1.52	1	1.1	1.4	8.62	63	198	NA
Falmouth	WF	WF142	41 36.337	-70 38.673	CO	2016	7	20	0.3	0.3	0.4	0.3	0.2	0.3	0.2	0.2	0.26	135.5	171	NA
Falmouth	WF	WF151	41 36.394	-70 38.749	CO	2016	7	21	2.4	1.1	1.5	0.9	NA	2	1.9	2.1	8.66	23	121	NA
Falmouth	WF	WF156	41 36.379	-70 38.812	CO	2016	7	20	0.6	0.1	0.6	0.4	0.5	0.6	0	0.7	0.54	55	147	NA
Falmouth	WF	WF262	41 36.364	-70 38.758	CO	2016	7	21	10.8	11.8	4.9	3.8	2.5	1.5	6	8.7	158.39	18.5	61.6	NA
Falmouth	QI	Q256	41 32.323	-70 39.844	CO	2016	7	21	0.6	0.7	6.2	4.1	0.5	0.4	0.6	0.5	14.15	6	66	NA
Falmouth	QI	Q264	41 32.306	-70 39.843	CO	2016	7	21	0.15	NA	0.45	NA	0.25	NA	0.3	NA	0.13	0	100	NA
Falmouth	QI	Q265	41 32.276	-70 39.854	CO	2016	7	21	2.2	5.2	1	0.5	0.8	3.4	3.2	2.2	18.3	4	100	NA
Falmouth	QI	Q268	41 32.268	-70 39.797	CO	2016	7	21	4.5	7.2	4.3	5.35	2	5.2	2.5	4.4	64.36	5.5	121	NA
Falmouth	QI	Q272	41 32.276	-70 39.847	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q274	41 32.266	-70 39.868	CO	2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q275	41 32.258	-70 39.860	CO	2016	7	21	5.2	5.8	2	1.2	4.6	2.8	3.1	5.3	49.02	2.5	96.8	NA
Falmouth	QI	Q276	41 32.273	-70 39.839	CO	2016	7	21	6.2	6.3	1	0.9	2.5	3.25	2.9	2.45	37.59	11.5	173	NA
Wareham	OH	1410	41 44.449	-70 39.334	CO	2016	8	31	0.5	0.6	0.9	0.7	0.6	0.4	0.6	0.5	1.24	36	102	NA
Wareham	OH	864	41 44.433	-70 39.353	CO	2016	8	31	0.3	0.3	1	0.7	0.7	0.5	0.6	0.6	1.18	34	68	NA
Wareham	OH	12	41 44.464	-70 39.289	CO	2016	8	31	0.45	0.45	0.7	0.65	0.5	0.35	0.4	0.4	0.83	139.5	271	NA
Wareham	OH	39	41 44.442	-70 39.319	CO	2016	8	31	0.6	0.7	0.6	0.55	0.5	0.5	0.45	0.45	1.02	93.5	129	NA
Wareham	OH	37	41 44.438	-70 39.345	CO	2016	8	31	0.7	0.7	0.5	0.6	0.3	NA	0.3	0.6	0.86	62.29	130	NA
Wareham	OH	1307	41 44.452	-70 39.301	CO	2016	8	31	0.1	0.6	0.5	0.4	0.4	0.4	0.4	0.3	0.51	96	107	NA
Gloucester	AN	DC2	42 40.081	70 40.500	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC10	42 40.050	70 40.531	CO	2017	7	19	4.8	5.8	7	1.8	NA	NA	NA	NA	NA	0	100	NA
Gloucester	AN	DC13	42 40.111	70 40.454	CO	2017	7	19	0.6	0.6	0.4	0.6	0.55	0.6	0.3	0.4	7.99	83.5	179	NA
Gloucester	AN	DC14	42 40.081	70 40.443	CH	2017	7	19	NA	3.3	NA	6	7.1	5	NA	10	79.18	0.5	106	NA
Gloucester	AN	H14	NA	NA	CO	2017	7	19	1.5	1.6	1.4	0.2	0.1	0.3	2.7	4.9	11.21	18.29	88	NA
Gloucester	AN	H15	42 40.153	70 40.201	CO	2017	7	19	0.1	0.01	0.15	0.05	0.04	0.1	0.1	0.1	0.02	97	104	NA
Manchester	OM	G12	42 33.815	70 47.115	CO	2017	8	15	2.4	2.3	0.9	1	NA	1.6	2.1	3	13.97	3	188	NA

Manchester	OM	G17	42 33.652	70 47.248	CO	2017	8	15	4	3.6	3.6	3.5	2.7	2.9	2.8	4.2	39.96	7	138	NA
Manchester	OM	G45	42 33.699	70 47.231	CH	2017	8	15	3.4	4.4	3.9	2	2.3	1.85	2.8	3.2	31.4	2.5	111	NA
Manchester	OM	G47	42 33.633	70 47.281	CO	2017	8	15	4.4	5.9	6.2	4.7	3.6	7.2	8.8	4	106.65	3	73	NA
Manchester	OM	G49	42 33.672	70 47.219	CO	2017	8	15	2.5	3.8	2.5	3.1	5.5	3.9	3.4	3.6	42.44	3.43	117	NA
Manchester	OM	G100	42 33.835	70 47.064	CO	2017	8	15	3.5	4.6	0.3	0.15	0.2	0.6	0.8	1.7	10.83	45.33	236	NA
Manchester	OM	G101	42 33.832	70 47.060	CO	2017	8	15	3.8	4	0.8	0.7	4.5	5.3	3.4	4.8	41.92	8.5	121	NA
Manchester	OM	G114	NA	NA	CO	2017	8	15	1.9	2.2	1.9	0.8	0.95	0.7	0.6	3.2	8.39	18.29	176	NA
Boston	CH	CH1	42 19.7273	-70 57.650	CH	2017	7	18	0.55	1.7	2.65	2.65	1.1	1.6	0.5	0.55	7.88	21.5	203	NA
Boston	CH	CH3	42 19.7087	-70 57.676	CH	2017	7	18	1.5	2.1	2.4	2.4	2.1	2.4	0.9	1.4	12.57	31.5	96	NA
Boston	CH	CHFloat	42 19.6992	-70 57.651	CO	2017	7	18	0.8	0.7	11	3	1.4	0.5	0.8	0.65	20.25	22.5	285	NA
Falmouth	WF	WF29	41 36.358	-70 38.654	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF107	41 36.369	-7038.669	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF125	41 36.368	-70 38.741	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF134	41 36.380	-70 38.800	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF142	41 36.337	-70 38.673	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF151	41 36.394	-70 38.749	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF156	41 36.379	-70 38.812	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF262	41 36.364	-70 38.758	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q256	41 32.323	-70 39.844	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q264	41 32.306	-70 39.843	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q265	41 32.276	-70 39.854	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q268	41 32.268	-70 39.797	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q272	41 32.276	-70 39.847	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q274	41 32.266	-70 39.868	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q275	41 32.258	-70 39.860	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q276	41 32.273	-70 39.839	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	1410	41 44.449	-70 39.334	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	864	41 44.433	-70 39.353	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	12	41 44.464	-70 39.289	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	39	41 44.442	-70 39.319	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	37	41 44.438	-70 39.345	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	1307	41 44.452	-70 39.301	CO	2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Gloucester	AN	DC2	42 40.081	70 40.500	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC10	42 40.050	70 40.531	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC13	42 40.111	70 40.454	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC14	42 40.081	70 40.443	CH	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	H14	NA	NA	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	H15	42 40.153	70 40.201	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G12	42 33.815	70 47.115	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G17	42 33.652	70 47.248	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G45	42 33.699	70 47.231	CH	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G47	42 33.633	70 47.281	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G49	42 33.672	70 47.219	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G100	42 33.835	70 47.064	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G101	42 33.832	70 47.060	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G114	NA	NA	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boston	CH	CH1	42 19.7273	-70 57.650	CH	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boston	CH	CH3	42 19.7087	-70 57.676	CH	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boston	CH	CHFloat	42 19.6992	-70 57.651	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF29	41 36.358	-70 38.654	CO	2018	7	18	0.5	0.3	0.6	0.3	0.2	0.5	0.3	0.4	0.49	109	155	NA
Falmouth	WF	WF107	41 36.369	-7038.669	CO	2018	7	18	0.2	0.4	0.3	0.3	0.8	0.2	0.2	0.6	0.41	110	137.5	NA
Falmouth	WF	WF125	41 36.368	-70 38.741	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF134	41 36.380	-70 38.800	CO	2018	7	18	0.6	0.7	0.7	0.65	1.5	1.7	3.1	2.4	8.1	30	172	NA
Falmouth	WF	WF142	41 36.337	-70 38.673	CO	2018	7	18	0.35	0.35	0.35	0.3	0.5	0.45	0.44	0.25	0.48	188	184	NA
Falmouth	WF	WF151	41 36.394	-70 38.749	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF156	41 36.379	-70 38.812	CO	2018	7	18	0.3	0.5	0.46	0.5	0.4	3.5	0.3	0.4	1.49	141.33	217	NA
Falmouth	WF	WF262	41 36.364	-70 38.758	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q256	41 32.323	-70 39.844	CO	2018	7	19	0.75	1.5	0.9	0.75	0.8	0.7	0.8	0.75	2.57	15	23	NA
Falmouth	QI	Q264	41 32.306	-70 39.843	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q265	41 32.276	-70 39.854	CO	2018	7	19	0.4	0.5	0.4	0.5	1.4	1.6	1.7	0.5	3.11	57	101	NA
Falmouth	QI	Q268	41 32.268	-70 39.797	CO	2018	7	19	4.4	5.5	4.3	5.3	6.8	4.2	2.3	4.2	73.62	10	107.33	NA
Falmouth	QI	Q272	41 32.276	-70 39.847	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q274	41 32.266	-70 39.868	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	QI	Q275	41 32.258	-70 39.860	CO	2018	7	19	4.2	5.5	1.5	1.7	1.3	4.3	2.1	4.2	32.84	15.5	87	NA

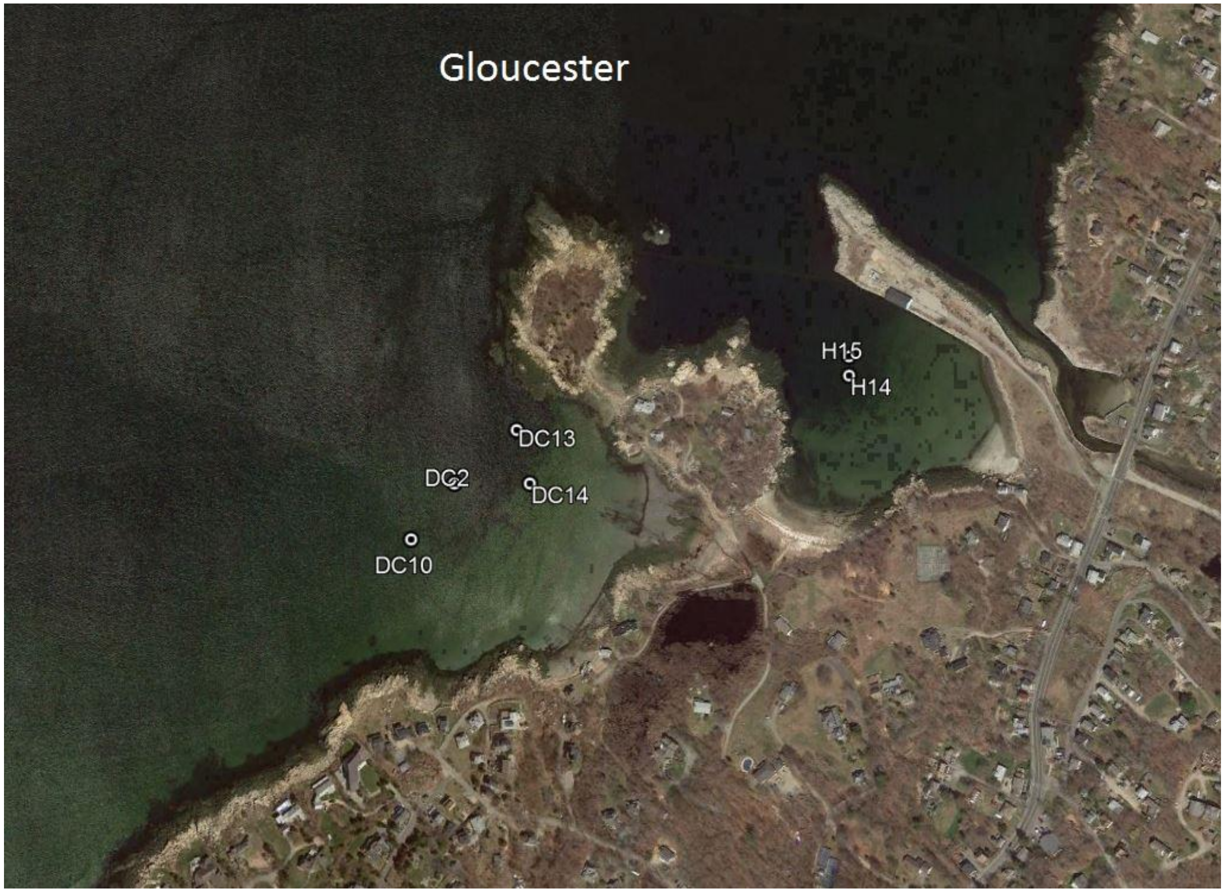
Falmouth	QI	Q276	41 32.273	-70 39.839	CO	2018	7	19	2.1	0.9	1	0.7	0.6	2.9	2	1.8	8.01	37	131.5	NA
Wareham	OH	1410	41 44.449	-70 39.334	CO	2018	7	17	0.2	0	0.2	NA	0	NA	0.3	NA	0.03	132	159	NA
Wareham	OH	864	41 44.433	-70 39.353	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	12	41 44.464	-70 39.289	CO	2018	7	17	0.95	0.85	0.65	0.6	0.5	0.55	0.75	0.55	1.56	124	184	NA
Wareham	OH	39	41 44.442	-70 39.319	CO	2018	7	17	1.3	0.7	0.3	0.2	0.3	0.35	0.25	0.2	0.74	154.5	115	NA
Wareham	OH	37	41 44.438	-70 39.345	CO	2018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	1307	41 44.452	-70 39.301	CO	2018	7	17	0.35	0.9	1	1	0.55	0.45	0.35	0.45	1.48	78.5	173	NA
Gloucester	AN	DC2	42 40.081	70 40.500	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC10	42 40.050	70 40.531	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	DC13	42 40.111	70 40.454	CO	2019	8	7	0.3	0.4	0.7	0.5	0.4	0.3	0.4	1.2	0.86	21.33	54	NA
Gloucester	AN	DC14	42 40.081	70 40.443	CH	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gloucester	AN	H14	NA	NA	CO	2019	8	7	0.4	0.8	0.3	0.3	0.4	0.2	0.3	0.2	0.45	16	51	NA
Gloucester	AN	H15	42 40.153	70 40.201	CO	2019	8	7	1.5	2.8	1.5	1	1.5	1	1	2	8.04	7.2	84	NA
Manchester	OM	G12	42 33.815	70 47.115	CO	2019	8	20	0.6	0.5	0.3	0.5	2.5	4.3	2.4	1.8	12.05	45.6	369.33	NA
Manchester	OM	G17	42 33.652	70 47.248	CO	2019	8	9	4	5.9	4.7	3	2.1	2	3.3	3.1	44.74	3	80	56
Manchester	OM	G45	42 33.699	70 47.231	CH	2019	8	9	5.2	5.4	5.2	5.8	5.2	6.3	3.7	3.7	87.42	NA	NA	NA
Manchester	OM	G47	42 33.633	70 47.281	CO	2019	8	9	5.1	5.4	4.6	3.4	5.1	5.1	3.9	4.3	72.31	6	65	62.66
Manchester	OM	G49	42 33.672	70 47.219	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manchester	OM	G100	42 33.835	70 47.064	CO	2019	8	9	1.6	1.8	3.2	0.5	0.8	1	1	1.2	6.62	0	335	86
Manchester	OM	G101	42 33.832	70 47.060	CO	2019	8	9	7.1	3.1	1.2	0.8	0.7	1.2	4.4	4.6	36.7	20.5	86.67	NA
Manchester	OM	G114	42 33.777	-70 47.164	CO	2019	8	20	3	2.5	3.6	1.5	1	1	3	2.3	17.53	8	127	NA
Boston	CH	CH1	42 19.7273	-70 57.650	CH	2019	9	11	1.3	NA	3.4	2.7	3	2.4	0.6	0.9	13.73	NA	NA	NA
Boston	CH	CH3	42 19.7087	-70 57.676	CH	2019	9	11	2	2.5	3.6	4.2	3	2.8	2.7	2.1	28.74	NA	NA	NA
Boston	CH	CHFloat	42 19.6992	-70 57.651	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Falmouth	WF	WF29	41 36.358	-70 38.654	CO	2019	7	29	0.3	0.4	0.4	0.3	0.4	0.3	0.3	0.3	0.39	NA	151	121
Falmouth	WF	WF107	41 36.369	-7038.669	CO	2019	7	29	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.33	NA	137	122
Falmouth	WF	WF125	41 36.368	-70 38.741	CO	2019	7	29	1.3	1.9	1.5	2.7	1.2	1.5	NA	2.1	8.7	NA	128	52
Falmouth	WF	WF134	41 36.380	-70 38.800	CO	2019	7	29	2.7	3.3	1	0.5	0.5	3	3.4	2.9	18.02	49.5	188	152
Falmouth	WF	WF142	41 36.337	-70 38.673	CO	2019	7	29	0	0	0	0	0	0	0	0	0	119	159	116
Falmouth	WF	WF151	41 36.394	-70 38.749	CO	2019	7	29	3.7	2.8	2.3	2.1	1	4.5	9.1	5.7	60.47	42.5	46.67	216
Falmouth	WF	WF156	41 36.379	-70 38.812	CO	2019	7	29	0.4	0.2	0.2	0.3	1.8	1.3	2.7	1.8	5.17	89	145	48
Falmouth	WF	WF262	41 36.364	-70 38.758	CO	2019	7	29	1.9	2.4	3.7	2.7	3.3	2	1.2	0.8	18.64	25	139	100

Falmouth	QI	Q256	41 32.323	-70 39.844	CO	2019	7	30	1.05	5.1	NA	1	1	1.4	3	3	12.54	8	13	2
Falmouth	QI	Q264	41 32.306	-70 39.843	CO	2019	7	30	1.8	0.6	1.3	1.4	2.3	2.8	NA	2.2	10.11	16	26	NA
Falmouth	QI	Q265	41 32.276	-70 39.854	CO	2019	7	30	1.4	0.4	0.4	0.2	0.3	0.2	2	2.1	3.6	6	76	58
Falmouth	QI	Q268	41 32.268	-70 39.797	CO	2019	7	30	4.6	3.4	2.5	2.8	5.7	2.9	2.1	2.4	36.5	9	38	40
Falmouth	QI	Q272	41 32.276	-70 39.847	CO	2019	7	30	0.7	0.8	0.3	0.3	0.8	0.9	0.7	0.6	1.41	6	37	NA
Falmouth	QI	Q274	41 32.266	-70 39.868	CO	2019	7	30	0.6	0.4	0.3	0.3	0.35	0.4	0.3	0.5	0.54	24	71	NA
Falmouth	QI	Q275	41 32.258	-70 39.860	CO	2019	7	30	4.9	5.2	1.4	1.3	2.4	1.8	2.2	3.4	29.83	4.5	59	NA
Falmouth	QI	Q276	41 32.273	-70 39.839	CO	2019	7	30	10.5	3.3	1.3	4.5	3.8	2.7	2	1.9	43.1	0.57	13	0
Wareham	OH	1410	41 44.449	-70 39.334	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	864	41 44.433	-70 39.353	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	12	41 44.464	-70 39.289	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	39	41 44.442	-70 39.319	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	37	41 44.438	-70 39.345	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wareham	OH	1307	41 44.452	-70 39.301	CO	2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Appendix A Cont.: Mooring Monitoring Metadata

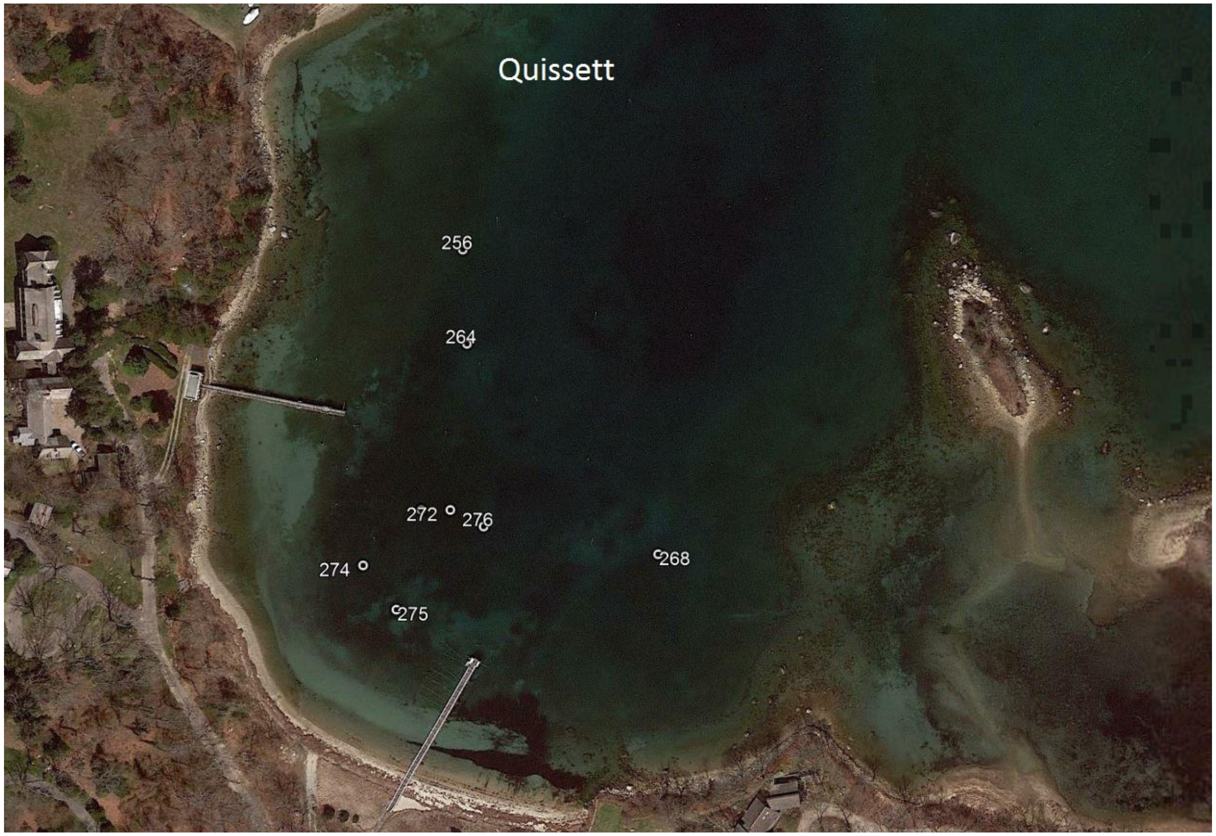
Column Name	Description
location	Name of town where site is located
Harbor	Acronym of name of harbor where site is located
	AN = Hodgekins Cove/Davis Cove, OM = Outer Manchester Harbor, CH = Camp Harborview, WF = West Falmouth Harbor, QI = Quissett Harbor, OH = Onset Harbor
mooring.id	Site level unique identifier for each mooring
longitude	Latitude in decimal degrees
longitude	longitude in decimal degrees
final.mooring.type	Mooring type in 2019
	CO = Conservation mooring, CH = Chain
Year	
MonthYear	
DayMonth	
N.mDay	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the North (0º)
N.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the North (0º)
NE.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the Northeast (45º)
NE.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the Northeast (45º)
E.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the East (90º)
E.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the East (90º)
SE.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the Southeast (135º)
SE.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the Southeast (135º)
S.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the South (180º)
S.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the South (180º)
SW.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the Southwest (225º)
SW.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the Southwest (225º)
W.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the West (270º)
W.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the West (270º)
NW.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the Northwest (315º)
NW.m	Distance from mooring helix to edge of bed (area of greater than 25% eelgrass cover) to the Northwest (315º)
Area.m2	Scar area in m2 calculated by using the sin(angle) * Length of product of the adjacent distances from helix to edge of bed
Area.m2	Scar area was not measured when adjactent transects were greater than 90ºScar area in m2 calculated by using the sin(angle) * Length of product of the adjacent distances from helix to edge of bed
	Scar area was not measured when adjactent transects were greater than 90º
scar.shoot.count	Mean shoot count from quadrats (typically 8) within the mooring scar along the 8 transects (N-NW)
scar.shoot.count	Mean shoot count from quadrats (typically 8) within the mooring scar along the 8 transects (N-NW)
ref.shoot.count	Mean shoot count from quadrats (typically 8) at least 1m outside of the original mooring scar along the 8 transects (N-NW)
ref.shoot.count	Mean shoot count from quadrats (typically 8) at least 1m outside of the original mooring scar along the 8 transects (N-NW)
recovered.shoot.count	Mean shoot count from quadrats (typically 8) located in areas of eelgrass regrowth into the mooring scar since baseline data along the 8 transects (N-NW)
recovered.shoot.count	Only collected in2019Mean shoot count from quadrats (typically 8) located in areas of eelgrass regrowth into the mooring scar since baseline data along the 8 transects (N-NW)
	Only collected in2019

Appendix B: Site Maps



Manchester
775
700
712
778
745
G49(7)
717
747

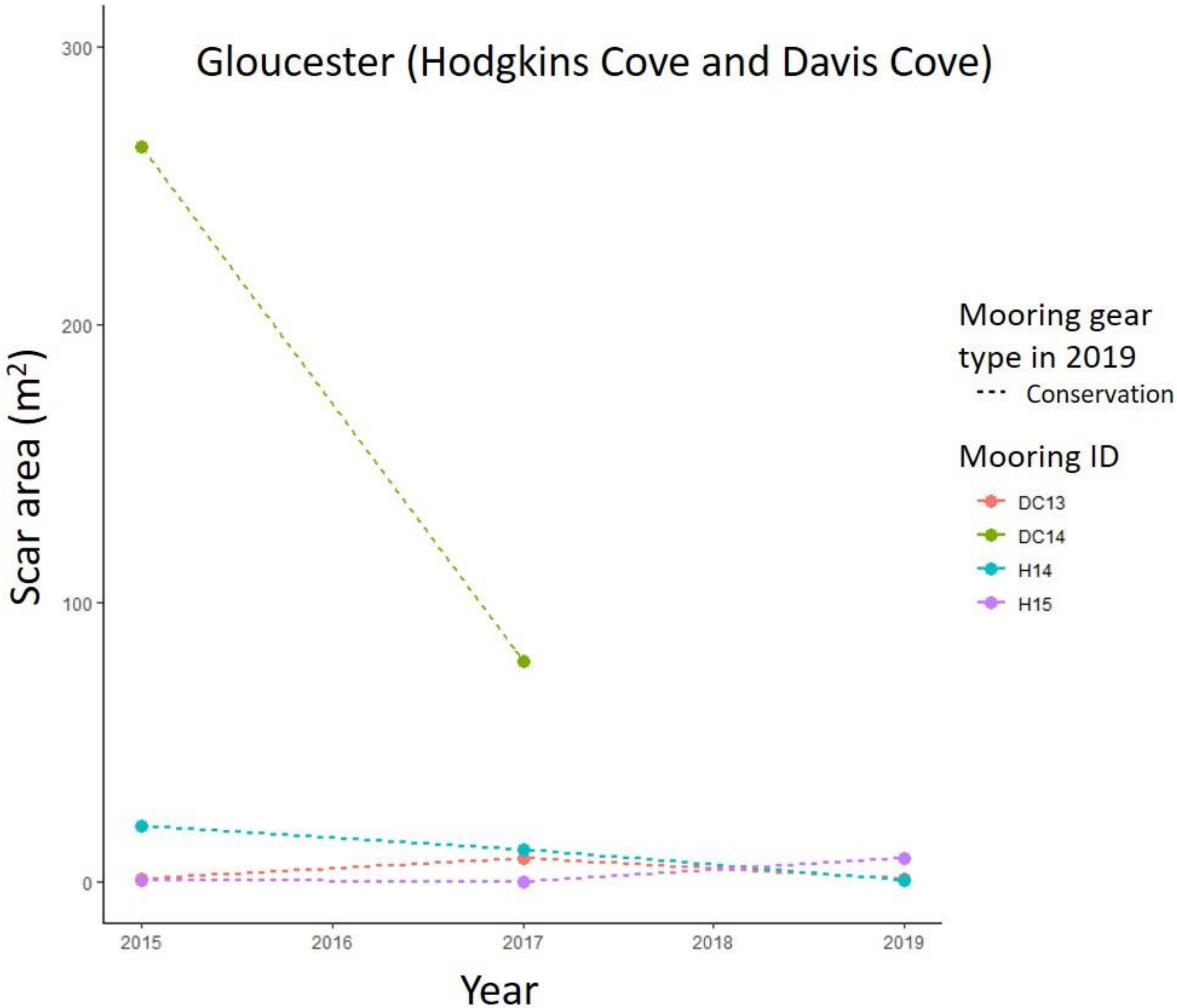

Boston
CHV1
CHV2
CHV Float

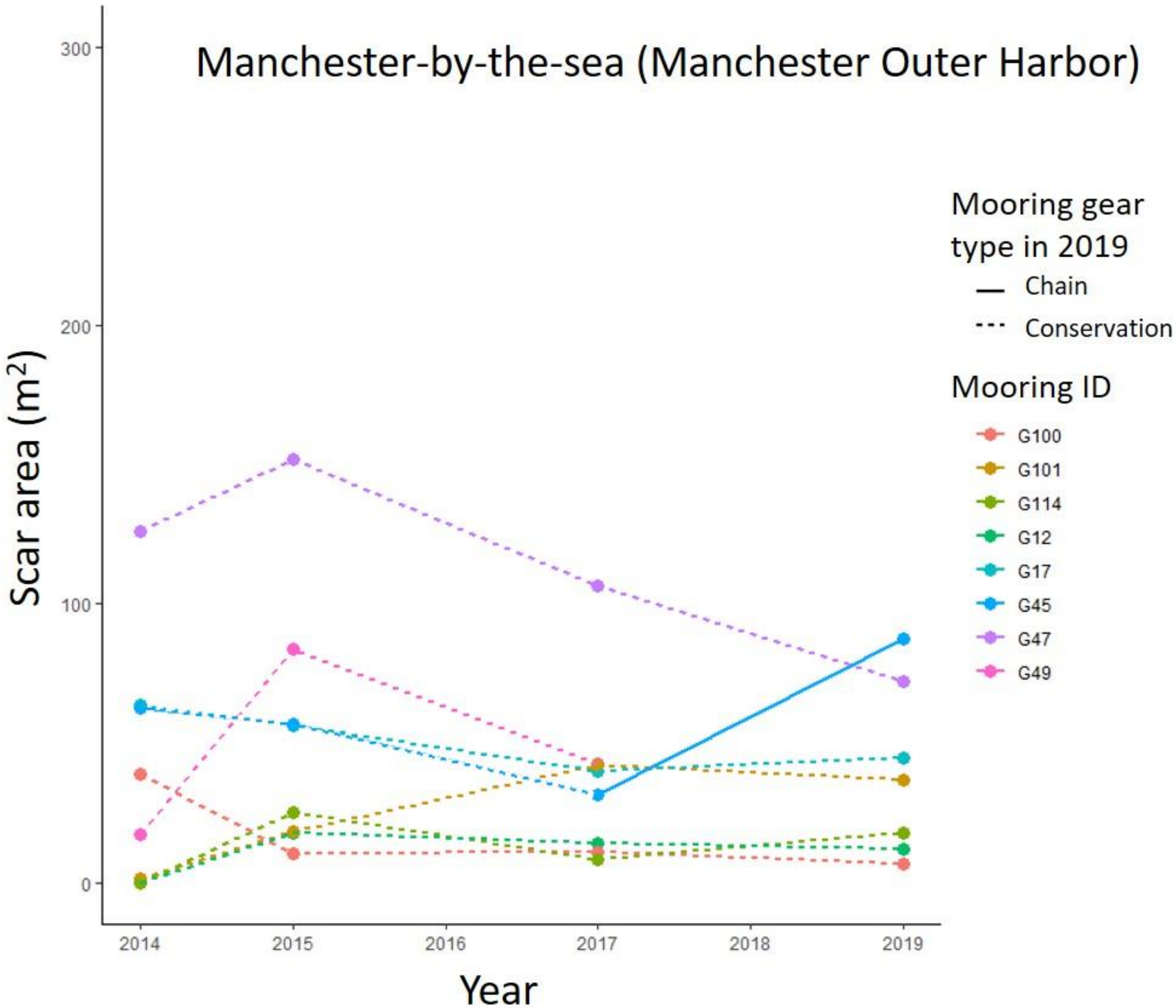

Quissett
256
264
272
276
268
274
275

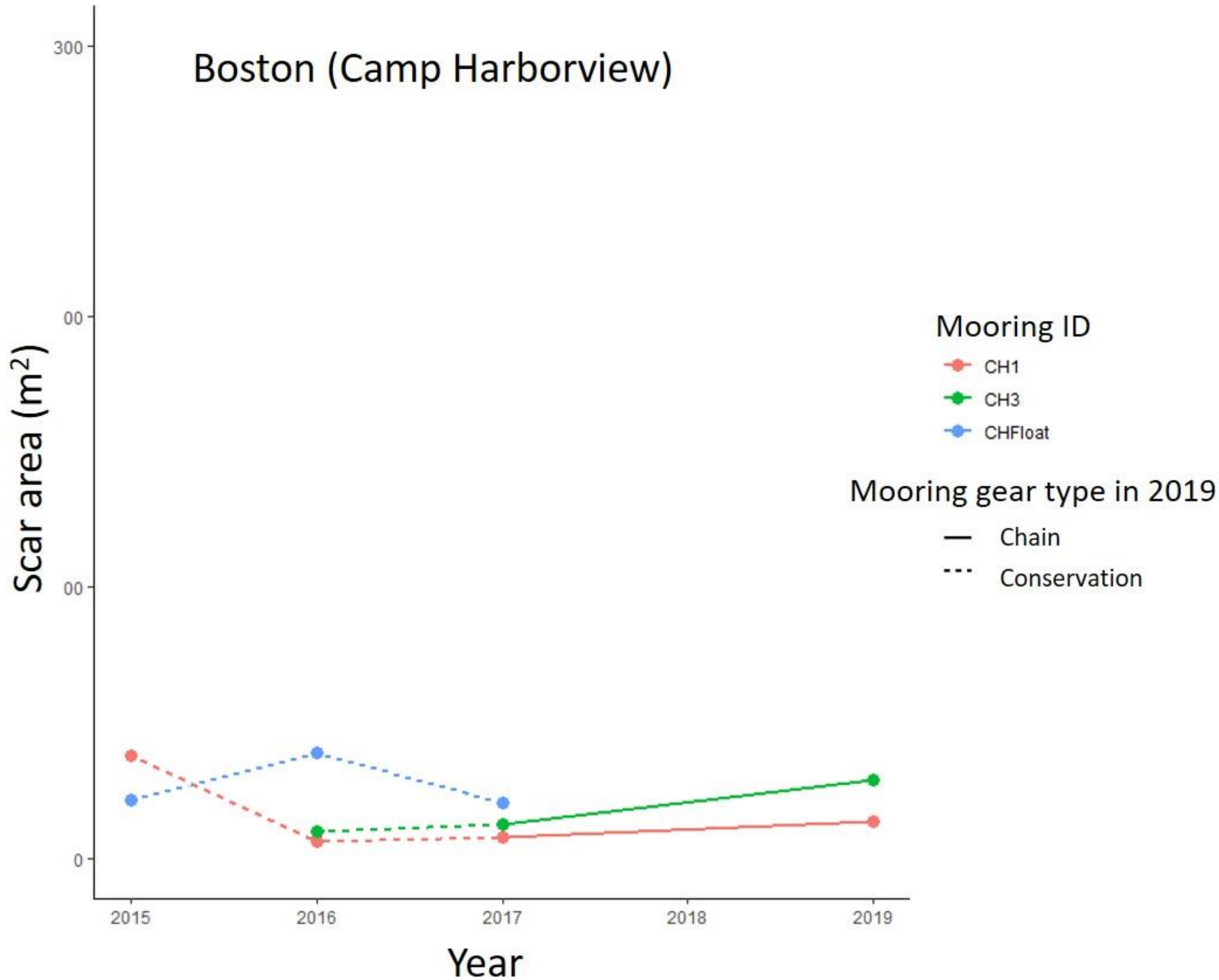

West Falmouth
151
156
134
262
125
107
29
142


Onset
12
1307
1410
39
37
864

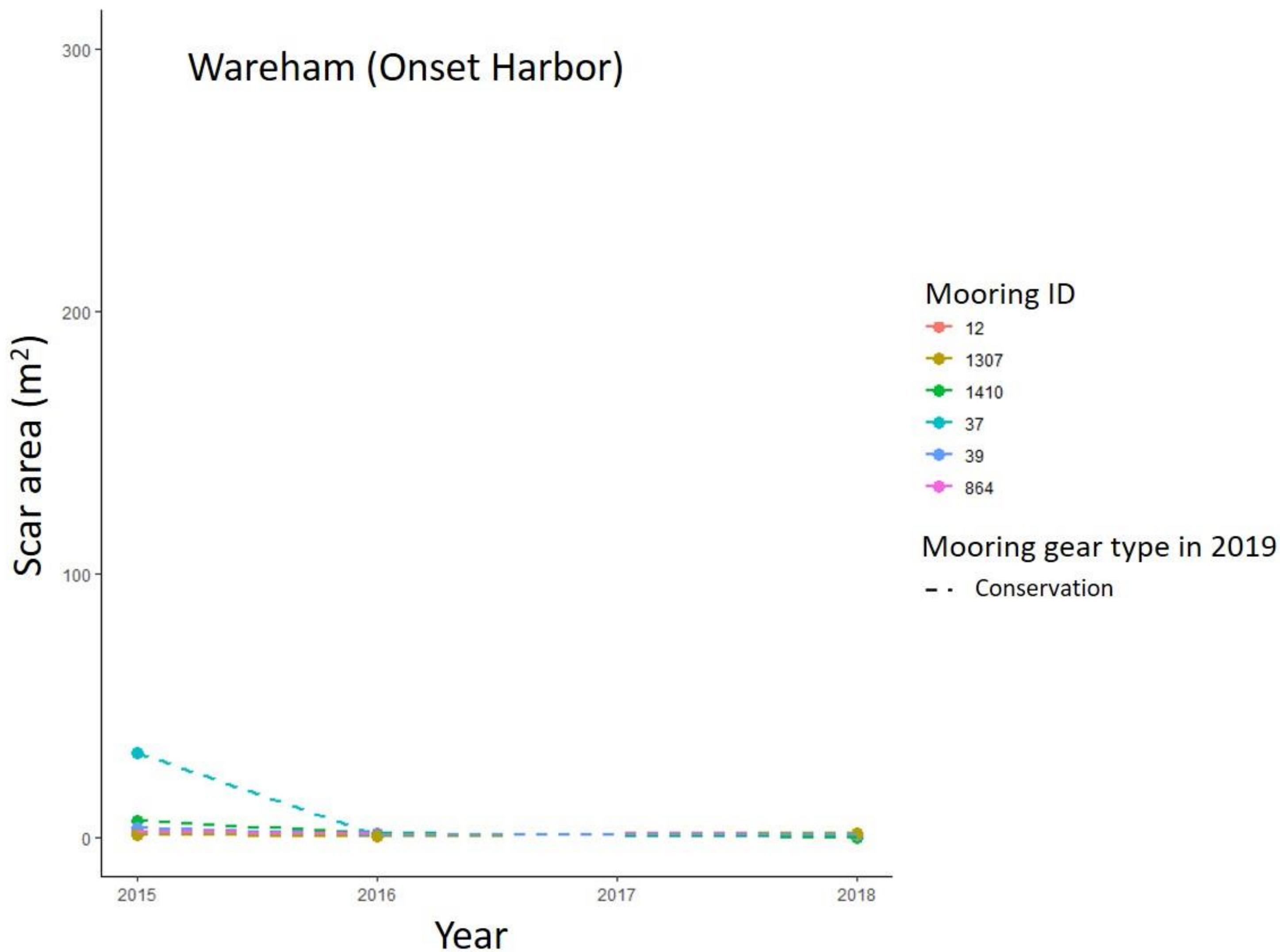
Appendix C: 2017/2018 Results (only data from full monitoring is included. No scar measurement data was collected during qualitative site checks)

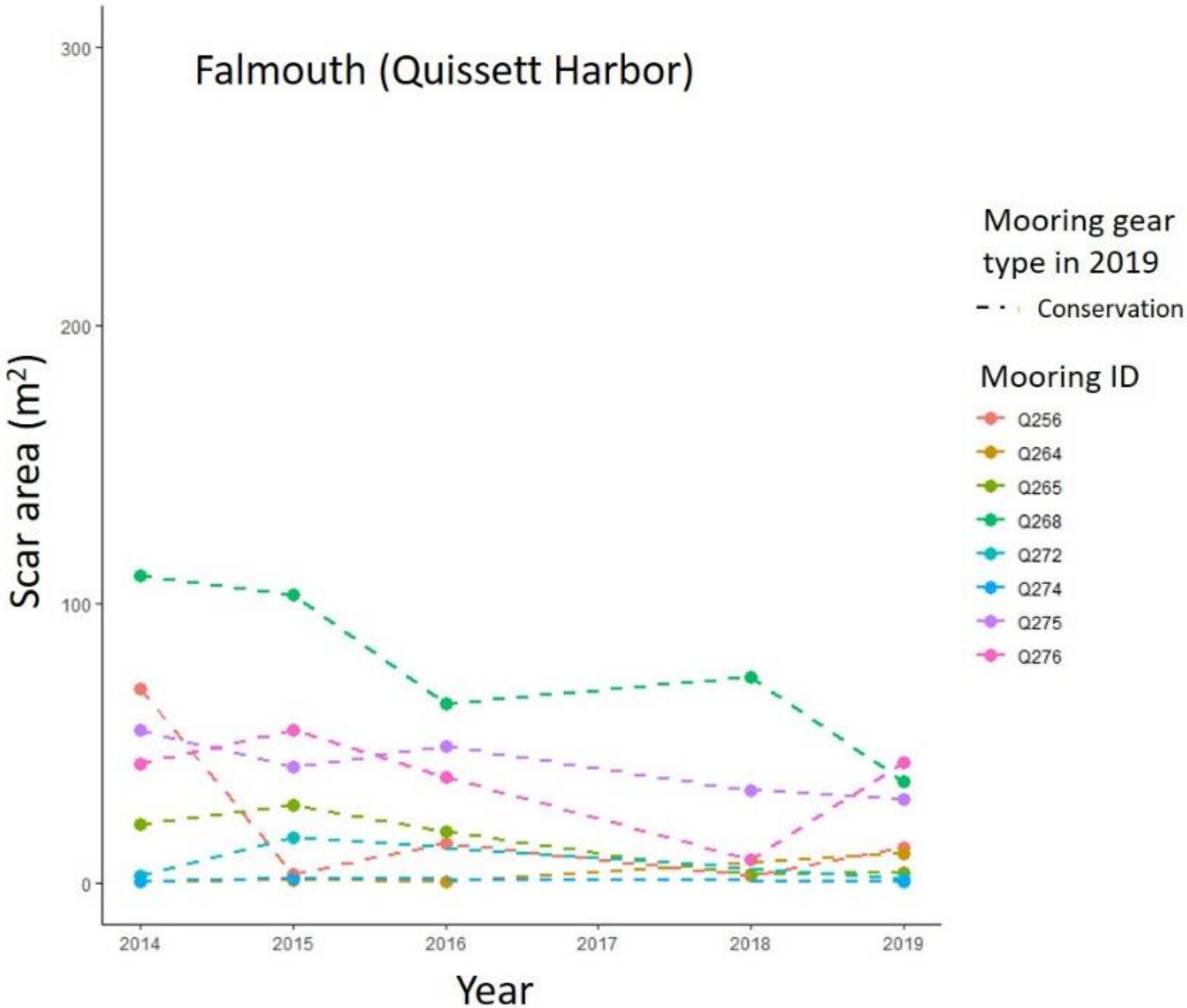



Manchester-by-the-sea (Manchester Outer Harbor)
Scar area (m²)
300
200
100
0
2014
2015
2016
2017
2018
2019
Year
Mooring gear type in 2019
Chain
Conservation
Mooring ID
G100
G101
G114
G12
G17
G45
G47
G49



Boston (Camp Harborview)
300
00
00
0
Scar area (m2)
2015
2016
2017
2018
2019
Year
Mooring ID
CH1
CH3
CHFloat
Mooring gear type in 2019
Chain
Conservation


Wareham (Onset Harbor)
Scar area (m²)
300
200
100
0
2015
2016
2017
2018
Year
Mooring ID
12
1307
1410
37
39
864
Mooring gear type in 2019
Conservation

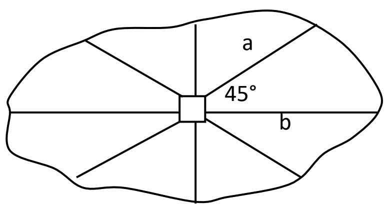

Falmouth (Quissett Harbor)
Scar area (m²)
300
200
100
0
2014
2015
2016
2017
2018
2019
Year
Mooring gear
type in 2019
Conservation
Mooring ID
Q256
Q264
Q265
Q268
Q272
Q274
Q275
Q276


Falmouth (West Falmouth Harbor)
Scar area (m²)
300
200
100
0
2014
2015
2016
2017
2018
2019
Year
Mooring ID
WF107
WF125
WF134
WF142
WF151
WF156
WF262
WF29
Mooring gear type in 2019
Conservation

Appendix D: Detailed Methodology

Field monitoring: Conservation moorings were chosen for monitoring by MA DMF based on water depth, presence of eelgrass, and evidence of a measurable scar, except in Falmouth where all moorings were monitored. MA DMF chose to monitor all moorings in Falmouth in order to extend a study initiated with a grant from the Atlantic Coastal Fish Habitat Partnership and US Fish and Wildlife, that funded the installation of 8 additional moorings in 2013.

Full monitoring of each mooring included measurements in (m) from the base of the conservation mooring (mooring shackle) to the first shoot and scar edge along transects in all cardinal and ordinal directions. The scar edge was defined as the point at which the percent cover of eelgrass transitioned to 20% or greater. Additionally, shoot counts were taken in eight ¼ m^2 quadrats within the scar as well as eight ¼ m^2 quadrats outside of the scar, the latter to be used as reference measurements. The quadrat locations were selected using a random number table to select points along each transect. The reference quadrats were at least 1m beyond the original scar edge. Additionally, moorings were visually inspected to note any fouling or maintenance concerns.



Area of sector = ½(a*b) sin(45°)

Figure SD1. Scar diagram with 8 cardinal and ordinal directions marking sectors to calculate the scar area.

For the last year of full monitoring (2019), additional shoots counts were taken in ¼ m2 quadrats placed in the area of the scar that had grown in since the baseline survey to compare the density of the recovered eelgrass to the reference bed.

In years where diver-based surveys were not required, MA DMF biologists visited the moorings and documented their status either via snorkel or using underwater cameras (SnakeMate or SplashCam Pro). Data collected included presence and condition of mooring equipment, fouling, appearance of eelgrass in the scar, and any observable qualitative changes since the previous year. Both diver and camera monitoring are completed during the peak growing season, between June and September.

Statistical analyses: The proportion of targeted moorings that remained conservation moorings throughout the duration of the study was calculated for the entire study and separately for each site. Moorings that did not remain conservation moorings for the duration of the study were excluded from the following analyses. When collected, the data from conservation moorings converted to chain moorings is included in figures for anecdotal purposes.

The proportion of conservation moorings that were observed dragging on the sediment in 2019 was calculated for the entire study and separately for each site. Mean shoot counts for each mooring were calculated for quadrats collected inside the scar, outside the scar, and in the recovered area of the scar. Means and standard errors for shoot counts inside, outside, and in the recovered area (when applicable) of the scar are reported for each site. The area of each scar was calculated by adding the area of each triangular sector defined by points at the mooring base and scar edges (Fig SD1). When missing data led to a greater than 90° angle between scar point scars were excluded from analyses. Means and standard errors for scar area are reported for each site. The total scar area was calculated as the sum of scar area for each conservation mooring.

Gloucester

A total of 60 conservation moorings were installed in Gloucester waters under this program in 2014. The moorings were installed by Eco-Moorings installers. MA DMF monitored 10% of these moorings (six moorings) annually. MA DMF conducted the full monitoring protocol in 2014, 2015, 2017, and 2019 and site checks in 2016 and 2018. The monitoring sites were in eelgrass beds in Davis Cove (four moorings) and Hodgkins Cove (two moorings). Due to the small size of Hodgkins Cove, the lack of sufficient protection from the north and the density of boats in the cove, most vessels are moored from the bow and stern and use two moorings per boat in order to eliminate the usual swing on the moorings. In this case, divers monitored the bow mooring only.

Manchester-by-the-Sea

A total of 76 Eco-Moorings were installed in Manchester-by-the-Sea waters under this program in 2014. Of those, 70 were boat moorings and six were navigation aid moorings. MA DMF monitored 10.5% of these moorings (eight moorings) annually. MA DMF conducted the full monitoing protocol in 2014, 2015, 2017, and 2019 and site checks in 2016 and 2018. The monitoring site was in an eelgrass bed in outer Manchester Harbor. During installation of the conservation moorings some of the original anchors were left in place.

Boston

Conservation moorings were installed in Boston waters under this program in 2014. MA DMF monitored three of these moorings annually. MA DMF conducted the full monitoring protocol in 2015, 2016, 2017, and 2019 and site checks in 2014 and 2018. MA DMF did not conduct a full monitoring until May, 2015 because the conservation moorings were installed after the peak growing season of eelgrass in 2014. The monitoring site was in an eelgrass bed in Camp Harborview off of Long Island. The moorings at this site were installed after 2006 in an eelgrass restoration area that MA DMF planted in 2005. In the summer of 2014, prior to conservation mooring installations, MA DMF noted that, in contrast to the other monitoring sites, the eelgrass was patchy right up to the mooring chain at most of the moorings and it did not appear that the conventional chain moorings were having a measureable impact on the grass. This may be because the boats using the moorings were small and light weight or not in the water for much of the year.

Wareham

Conservation moorings were installed in Wareham waters under this program in 2015. MA DMF monitored six of these moorings annually. MA DMF conducted the full monitoring protocol in 2015, 2016, and 2018 and site checks in 2017 and 2019. MA DMF did not conduct monitoring until September, 2015 because the conservation moorings were not installed until 2015. The monitoring sites were in an eelgrass bed in Onset Harbor.

Falmouth

A total of 16 Eco-Mooring System conservation moorings were installed in Falmouth waters under this program in 2014. The moorings were installed by local mooring maintainers with guidance from Dave Merrill at Eco-Mooring. MA DMF monitored 100% of these moorings annually. MA DMF conducted the full monitoring protocol in 2014, 2015, 2016, 2018, and 2019 and a site check in 2017. The monitoring sites were in eelgrass beds in Quissett Harbor and West Falmouth Harbor. The moorings in Quissett Harbor anchored five small sailboats (12' to 18'), two powerboats (32'), and one swim platform. Most of the original moorings were 100lb to 200lb mushroom anchors and were removed upon installation of the Eco-Moorings. The original anchor for the swim platform was a 1,000lb cement drum and was left in place. The moorings in West Falmouth Harbor included two small sail boats (12'), three power boats (13', 19', and 25'), and three larger sailboats (22', 35', and 35'). Original anchors range from 100lb to 300lb mushroom anchors up to 1000lb dormor anchors for the large sailboats. All original anchors were removed at the time of Eco-Mooring installation.