

Massachusetts Department of Fish and Game
In-Lieu Fee Program

Eelgrass Restoration Project 2018 Annual Report

Implemented by the Division of Marine Fisheries

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Submitted to

The Massachusetts In Lieu Fee Program

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Project Overview

The Massachusetts In-Lieu Fee Program (ILFP) funded The Division of Marine Fisheries (DMF) to restore and monitor ½ acre (2,023.4 m²) of eelgrass in the North Coastal Service Area beginning in 2017, for a duration of five years. The eelgrass restoration was permitted in 2017 under the Corps General Permit number NAE-2017-00754. This report is for the second year of this project; the calendar year 2018.

Based on site selection results, DMF chose Middle Ground in Salem Sound to plant two ¼ acre (1,011.7 m²) sites in 2017 (Figure 1). The restoration effort was split over two seasons, the West ¼ acre site (MGW) was planted in April and May 2017, while the East ¼ acre site (MGE) was planted in the end of August and September 2017 (Table 1). Monitoring was performed one year post-planting at both sites as scheduled in July 2018, and due to a series of three consecutive nor'easter storm events in February and March, additional post-storm monitoring was conducted in April (Table 2). Storm impacts were clearly evident at both sites and most severe at MGE where six of 18 plots were completely missing and many more were partially damaged. At the time of this post-storm monitoring, 43% of the planting units had survived at MGW, while 16% of the planting units had survived at MGE.

Because of these impacts, a new, identical ¼ acre site (MGS) was planted directly South of MGW in May of 2018. One-month monitoring of MGS was completed in June, showing survival of 99% of the planting units, which is an even better survival rate than that observed at both Middle Ground restoration sites in 2017 (Frew et al. 2017). Additionally, 5 plots missing from MGW were replaced in May 2018. Further planting at MGE was not conducted due to low survival, however the remaining plots may expand unassisted and we will continue to monitor them.

Methods

Transplanting

Plants were collected from donor meadows (Figure 2) using a low impact collection method detailed in our project proposal and 2017 final report. Harvested plants were stored in seawater for no more than 48 hours before being woven into the planting units (PUs). The method involved weaving ten eelgrass shoots by their rhizomes into a 20 cm diameter, circular burlap disc PU (Pickerell, pers. Com), dubbed the Pickerell Burlap Disc Method.

Each site consisted of three transects, with six evenly spaced plots. A plot had 6, 1m² squares, each planted with five PUs for a total density of 50 shoots/m² (Figures 3 and 4). Each PU is buried in an approximately 3-5 cm deep hole backfilled with sediment. To mitigate for seasonal effects (storms, algae blooms, crabs), the restoration effort was split over spring and fall seasons. The West ¼ acre site (MGW) was planted in April and May 2017, and the East ¼ acre (MGE) was planted in the end of August and September 2017.

To supplement the restoration, In 2018 approximately 5,400 shoots were collected from the three most promising donor beds, Nahant (Nahant Cove), Salem (Aquavitae), and Gloucester (Niles Beach) using the low impact collection method detailed in the 2017 annual report and project proposal. Plants from these three donor beds were associated with the more successful plots monitored in 2018 after the storm impact. The burlap disc PUs were planted in the new ¼ acre supplemental site (MGS) at Middle Ground in Salem on May 2, 2018 (Figure 2). An additional 1,500 shoots were collected from the donor

bed in Salem (Aquavita) to complete supplemental replacement plots at MGW for five plots that had been destroyed due to winter storm damage.

All adult-plant transplanting utilized the same methods from 2017, i.e. the Pikerell Burlap Disc Method. A final plot was planted at MGW using a new method, seeding. To test the use of seeds for restoration, we collected approximately 950 reproductive shoots from the West Beach and Manchester meadows in July and August 2018 and stored them in flow-through seawater tanks until they dropped their negatively buoyant seeds. Seeds were siphoned from the tank and planted in mid-October, 2018. Divers planted six, 1m² quadrats, each containing approximately 1,000 seeds, off the Southwest corner of MGW. At each quadrat approximately 1,000 seeds were smoothed into furrows in the sand. The seeded quadrats alternated along a transect and were then surrounded by a single row of adult shoots woven into discs. The adult shoots were planted to protect the seeds from current and sediment movement.

Monitoring

Divers monitored MGE six months after planting in April (post-storm monitoring was also completed at MGW in April to see the impacts of major winter storm events) (Table 2). Additionally, monitoring was completed at both MGE and MGW for the first year of annual monitoring in July. One month monitoring was also completed for the newly planted MGS (planted in June). All monitoring in 2018 used the methods detailed in the 2017 annual report (Frew et al. 2017).

Divers monitored all three reference beds in July 2018 (West Beach, Peachs Point, and Aquavita) (Table 2) using methods detailed in the 2017 annual report. All reference sites were monitored for shoot density, canopy height, and percent cover. Observations included prevalence of wasting disease (on a scale of none, trace >0-1% , low 2-10%, moderate 11-30% and high 31-100%). All three reference sites will continue to be monitored once annually during the peak growing season (July) for comparison with restored sites.

Acoustic mapping was completed at all three restoration sites at Middle Ground on August 10, 2018. Additionally, reference sites (Aquavita and Peachs Point) were mapped on August 10 and October 12, 2018 respectively, to detect any changes in size and/or density of these beds. West Beach was not acoustically mapped due to weather constraints, but will be mapped in 2019. Acoustic surveys were conducted with a Humminbird HELIX 9 CHIRP MEGA SI GPS G2N, each with an 800 kHz high resolution transducer, following overlapping lines for 150% sonar coverage for the restoration sites, and less or no overlap for the reference sites. The resulting sonar files have the water column removed and then are slant range and beam angle corrected in SonarTRX Pro release 15, and the mosaicked tracks are imported into ArcGIS 10.4. In ArcGIS, areas within the mosaic that have the signature appearance of eelgrass are delineated. The area of the meadow is then quantified and compared to the mapped area from previous years. Restored and reference meadows were mapped in planting years and will be mapped again at the conclusion of the five year monitoring period.

Results

Middle Ground West (MGW)

Post-storm monitoring revealed losses at MGW. In some cases entire plots were eroded or buried and shoots were gone and in other cases some PUs were missing but the plots were still identifiable. The Five plots at MGW impacted by winter storms were re-planted in place in April 2018. The remaining 13 plots had a PU survival of 58.7% with mean shoot density of 72.1 shoots/m² within planted squares at

the annual monitoring on July 11, 2018 (Table 3). Despite losses of planting units believed to be from winter storm impacts, mean shoot density in the remaining plots increased by 40.6%. Canopy height at MGW averaged 41.8 cm, while the mean percent cover observed was 32.9%. Divers noted encrusting epiphytes, *Bugula* sp. and *Membranipora* sp. growing on eelgrass shoots. Bottom characteristics appeared to have changed since 6 month monitoring, as sand waves were no longer observed and gravel was present. Algae (*Laminaria* sp., green and red drift species) was also present in small patches.

The five replacement plots re-planted in April 2018 were monitored on July 11, 2018 (Table 4). Mean Planting unit survival was 99.3%, and four of the five plots had 100% PU survival. Mean shoot density was 61.7 shoots/m² an increase from the 50 shoots/m² planted one month before. Mean canopy height was 35.0 cm, and percent cover was 25.5%.

The increase in shoot density at the plots not impacted by storm driven erosion and burial, indicates that eelgrass is growing and expanding and the site is conducive to restoration. Several of the plots contained quadrats that had begun to coalesce and could no longer be distinguished from one another.

Middle Ground East (MGE)

Six month annual monitoring at MGE revealed that seven plots no longer contained any eelgrass/planting units (Table 5). The mean planting unit survival was 15.7% site-wide, with the middle and south transects at 22.8% and 21.7% respectively. The north transect was the most impacted with 2.8% planting unit survival. Mean shoot density was 6.1 shoots/m², mean canopy height was 18.9 cm, and the mean percent cover was 1.9% (Table 5).

Annual monitoring at MGE on July 11, 2018, showed further loss (Table 6); nine plots were completely gone and nine remained with only 20.7% PU survival, 17.1 shoots/m², 19.5 cm canopy height 10.3% cover .

In contrast to MGW, MGE had not recovered from the winter storms. The remaining eelgrass was not expanding. Because of the decrease in PU survival and the number of total plots lost, no supplemental planting was completed at MGE. We postulate that there may be two factors contributing to the substantial overall loss in eelgrass: planting in the fall did not allow the shoots enough time to root properly before winter storms impacted them, and the east location of the planting may have been more exposed to the winter storms than the west side (MGW).

Middle Ground South (MGS)

On June 14, 2018 divers completed 1 month monitoring at MGS. The mean planting unit survival was 99.4% and mean shoot density was 50.4 shoots/m² (Table 7). These numbers are similar to or better than those observed at MGW and MGE during 1 month monitoring in 2017. The mean canopy height at MGS was 43.3 cm and the average percent cover site wide was 30.9%.

Reference Sites

Peachs Point

Divers monitored Peachs Point reference site on July 3, 2018. The mean shoot density was 366.7 shoots/m², the mean canopy height was 106.3 cm, and the average percent cover was 67.1% (Table 8). Overall these results are similar to what was found at Peachs Point in 2017.

West Beach

On July 24, 2018 divers monitored the West Beach reference site in Beverly as part of the quarterly SeagrassNet monitoring. The mean shoot density was 206.3 shoots/m². The mean canopy height was 84.1 cm and the average percent cover was 43.8% (Table 8). This bed has been monitored by DMF since 2008, and the results found in 2018 are in line with normal observations at that site.

Aquavitae

In 2018, Aquavitae was established as a reference site for this restoration project due to its proximity to the restoration site and characteristic similarities. Divers monitored Aquavitae on July 3, 2017. The mean shoot density was 139.3 shoots/m² with density values ranging between 0 and 352 shoots/m². The mean canopy height was 25.9 cm, while the mean percent cover was 28.8% (Table 8).

Acoustic Mapping

Acoustic mapping of MGW and MGE (as well as post-planting at MGS) was completed on August 10, 2018. Individual plots could be detected at densities as low as the planting density of 50 shoots/m² (Fig 5).

Peachs Point and Aquavitae reference beds were mapped in August and October 2018. West Beach reference bed was not mapped in 2018 due to weather constraints, but will be mapped in 2019. Each of these sites will be mapped again in the fifth year of the project in accordance with the project proposal.

Requirements/Performance Standards

Success Criteria (performance standards):

The goal of the project is the restoration of ½ acre of eelgrass. Success is determined by the persistence and expansion of the planted eelgrass over five years, from 2017 to 2021. The initial transplants had successful survival rates, and where they did not, they have been replanted. Current plant metrics are on the expected restoration trajectory. That is, they have shown initial PU survival greater than 50% and an annual increase in density and plot expansion overall.

Summary and Conclusions

MA DMF has successfully completed the second year of the 5-year ILF eelgrass restoration project. We planted ½ acre of eelgrass at Middle Ground in Salem Sound over two seasons in 2017. After losses due to storms we augmented the plantings at Middleground in the spring of 2018 by filling in lost planting units at MGW and planting a new ¼ acre site, called MGS. We did not re-plant the MGE site because there was a >50% loss. Site characteristics, in addition to storm impacts and planting season, may have driven the decline. Therefore, the best course of adaptive management was to establish a new site on the same depth contour as the successful MGW site. We chose to plant the new site in the spring of 2018 because we have found spring to be the most successful planting season. We will continue to monitor MGE as plants could rebound in the future at that site. We plan to do a site check in early spring 2019 to determine if additional planting will be needed in April or May of 2019.

Three more seasons of monitoring are planned in July of 2019, 2020 and 2021.

CY2018 Budget Update

In Calendar year 2018 the ILF eelgrass project charged a total of \$56,863 on all field, office and personnel expenses. Please see below for a breakdown of the expenses from CY2018 compared to our approved 5-year budget, and the CY2017 expenses. The total cumulative charges to the account for both CY2017 and CY2018 are also reported as is the remaining balance in each category and total remaining of \$156,536.

Line Item	Approved 5-Year Budget	CY2017 Expenses	CY2018 Expenses	Cumulative Charges	Remaining Balance
SCUBA Air fills	\$11,556	\$642	\$2,443	\$3,085	\$8,472
Field Supplies	\$3,200	\$553	\$476	\$1,029	\$2,171
Licor Sensors	\$560	\$913		\$913	-\$353
Boat Fuel & Maintenance	\$26,750	\$683	\$6,644	\$7,327	\$19,423
Dive Gear	\$5,000	\$31	\$1,085	\$1,115	\$3,885
Hummingbird Software	\$1,200	\$0		\$0	\$1,200
Lab Work	\$10,000	\$0	\$3,193	\$3,193	\$6,807
Permitting	\$880	\$657		\$657	\$223
Personnel Carr	\$18,121	\$5,193		\$5,193	\$12,928
Personnel Ostrikis	\$14,649	\$5,063		\$5,063	\$9,586
Dive Pay	\$48,150	\$4,605	\$2,220	\$6,825	\$41,325
Contract Employee	\$66,560	\$16,864	\$31,332	\$48,196	\$18,364
Travel	\$1,250	\$114		\$114	\$1,136
Indirect	\$40,798	\$7,752	\$8,173	\$15,925	\$24,873
Payroll tax	\$2,440	\$451	\$523	\$975	\$1,465
Fringe Benefits	\$10,978	\$5,173	\$774	\$5,947	\$5,031
TOTAL	\$262,092	\$48,692	\$56,863	\$105,556	\$156,536

Acknowledgements

We appreciate all those who assisted in this project by helping topside on the dive boat, weave burlap discs, or join us as divers; including Mark Rousseau, Kristen Schmicker, Wendy Mainard of DMF and , Forest Schenck, Randall Hughes and Torrie Hanley of Northeastern University Marine Science Center, Aisling O’Shea of DFG and Alyssa Novak of Boston University.

References

- Evans, T., W. Dukes and J. Carr (2012) Division of Marine Fisheries HubLine Eelgrass Restoration Mid-project Progress Report. Submitted to The Department of Environmental Protection, dated June 2012.
- Evans, T., J. Carr, K. Frew, M. Rousseau, K. Ford and A. Boeri (2018) Massachusetts Division of Marine Fisheries 2010 to 2016 HubLine Eelgrass Restoration Final Report. Submitted to the Department of Environmental Protection, dated March 2018.
- Frew, K., A. Boeri, J. Carr, and T. Evans (2017) Division of Marine Fisheries In-Lieu Fee Eelgrass Restoration Project 2017 Annual Report. Submitted to The Massachusetts In Lieu Fee Program.

Appendix

Figures

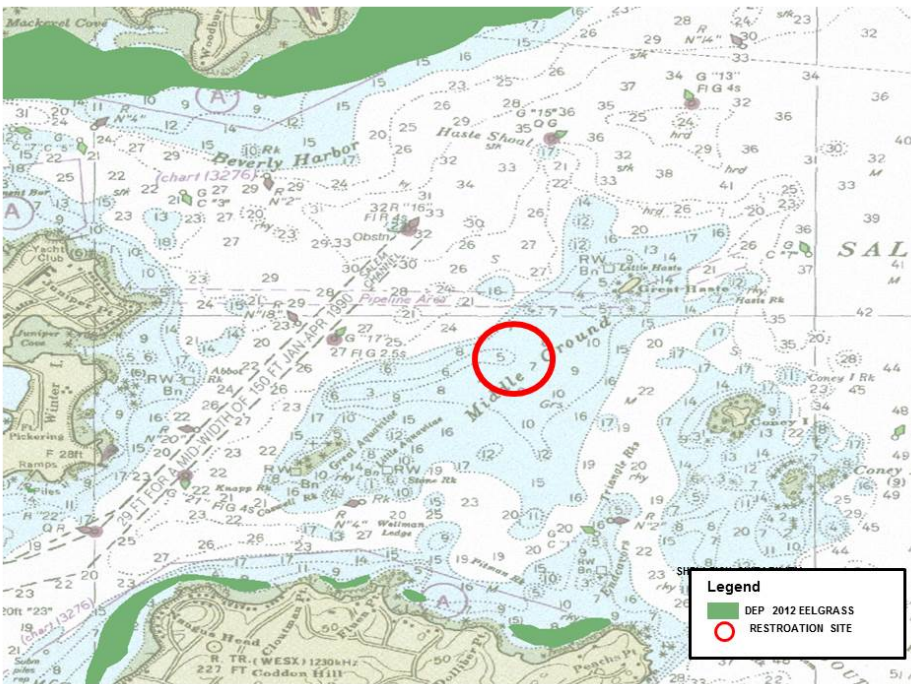


Figure 1: ½ acre restoration site at Middle Ground, Salem Sound.

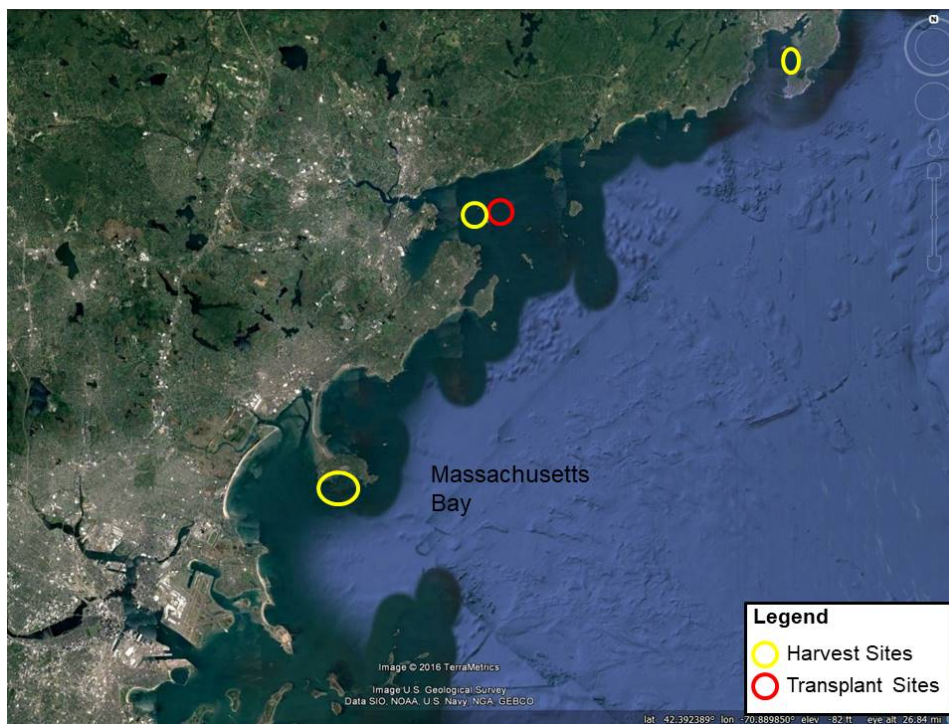


Figure 2: 2018 eelgrass donor sites.

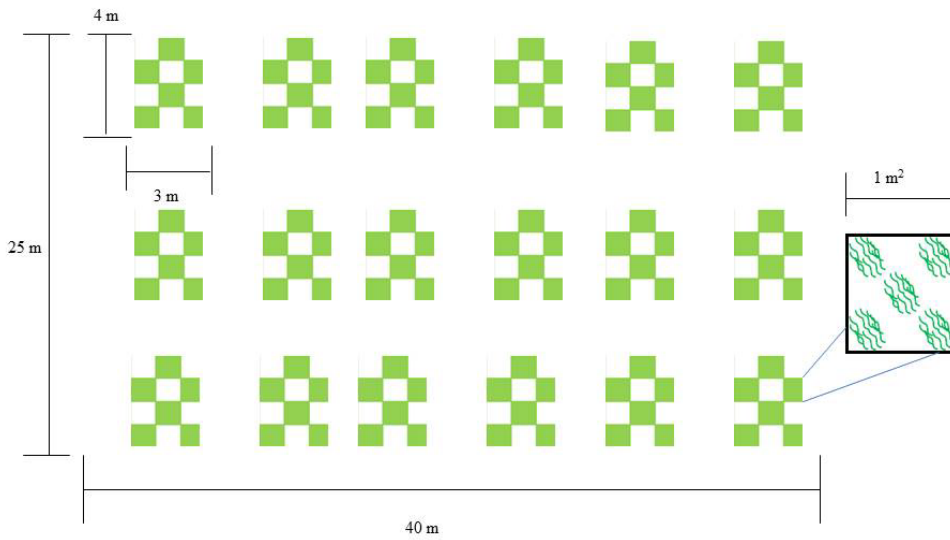


Figure 3: Layout for each site, approximately ¼ acre area. 18 plots each in a checkerboard pattern of 6 planted and unplanted 1 m² squares for a total of 5,400 shoots. Three sites planted adjacent to each other at Middle Ground.

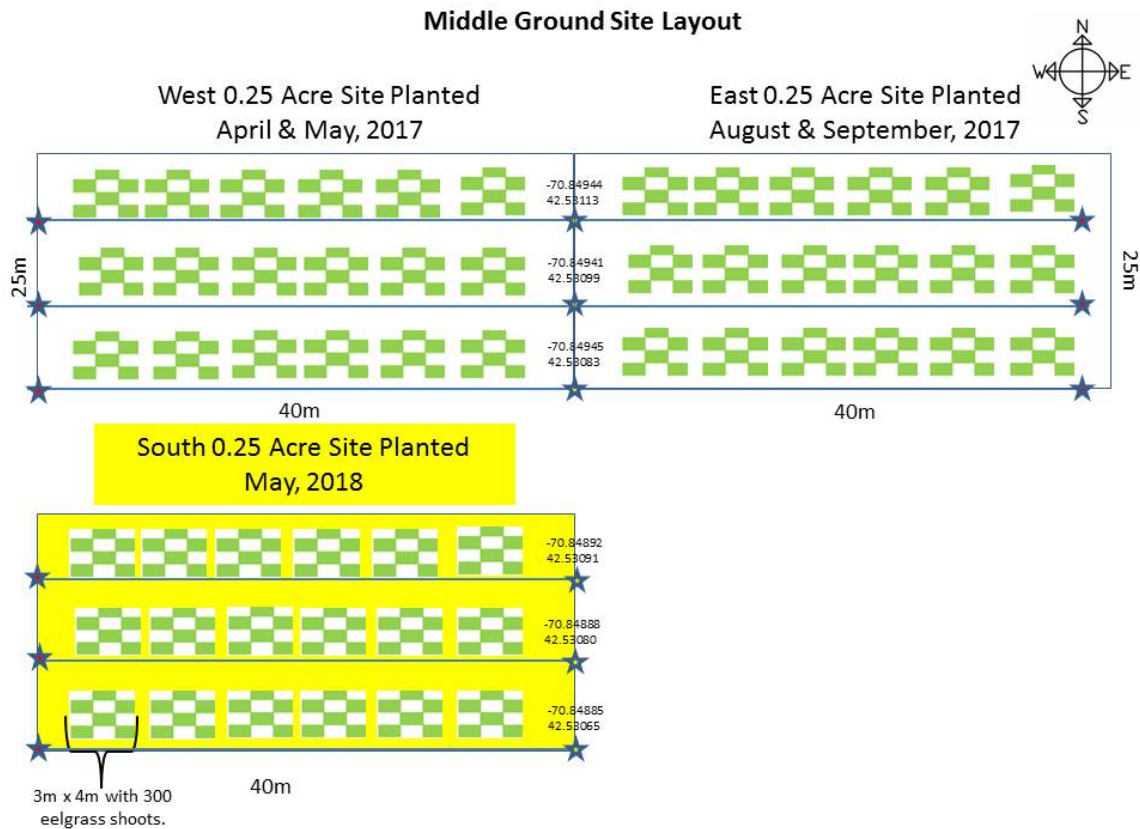


Figure 4: Middle Ground transplant site layout.

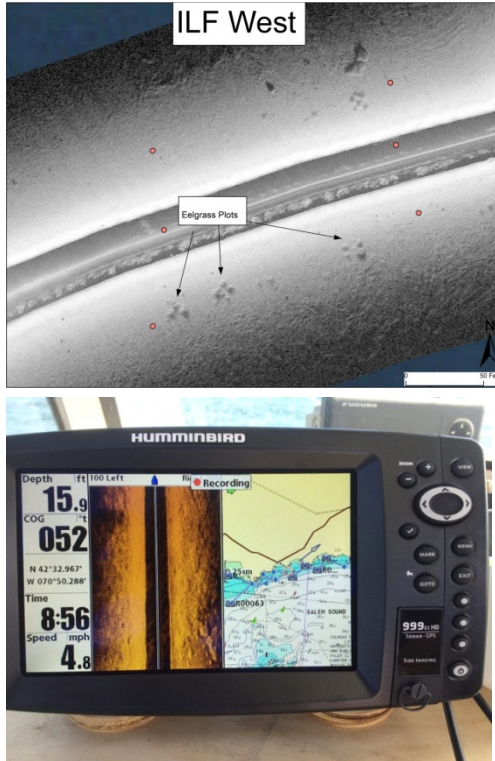
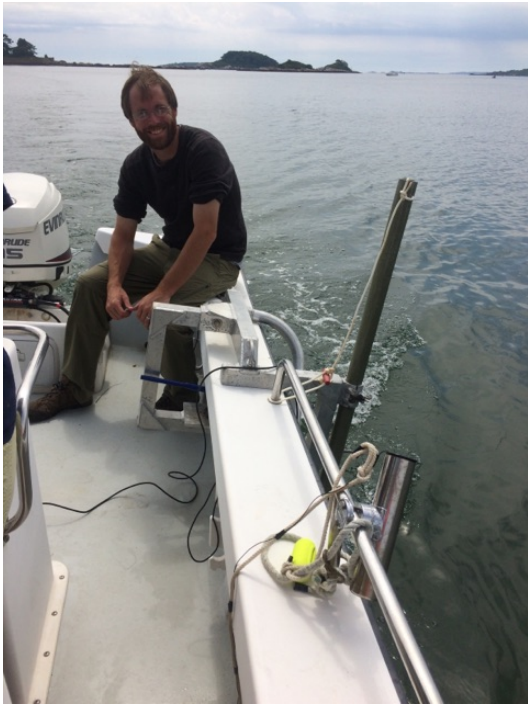


Figure 5: (clockwisw from left): Humminbird acoustic transponder mounted to the side of DMF's Maritime skiff; Planted eelgrass plots visible on acoustic survey at ILF West (red dots mark the boundaries of the site, the track in the middle is the disturbance from the boat and does not include useable acoustic data); the Humminbird display screen showing the acoustic return on the left (note light puffy looking areas are eelgrass) and location on a chart on the right.

Tables

Event	Date	Notes
West Monoculture	4/20/2017	2 plots planted
West Monoculture	5/4/2017	2 plots planted
West Monoculture	5/10/2017	2 plots planted
West Monoculture	5/12/2017	2 plots planted
West Monoculture	5/19/2017	2 plots planted
West Polyculture	5/24/2017	8 plots planted
East Monoculture	8/31/2017	10 plots planted
East Polyculture	9/7/2017	8 plots planted
West Monoculture	5/2/2018	4 plots planted
South Mono/Polyculture	5/10/2018	6 plots planted
South Mono/Polyculture	5/17/2018	6 plots planted
West Monoculture	5/23/2018	1 plot planted
South Mono/Polyculture	5/23/2018	6 plots planted
Hingham Test plot	5/11/18	1 pot planted
PIS seeding test plot	10/10/2018	1 seed plot planted
MG seeding test plots	10/12/19	1 seed plot planted
Essex seeding test plot	10/23/18	1 seed plot planted

Site	1 month	6 month	1 year	2 year (anticipated)
West 2017 Planting*	6/12/2017	11/14/2017	7/11/2018	7/2019
West 2018 Supplemental Planting	7/11/2018	NA	7/2019	7/2020
East 2017 Planting	10/12/2017	4/2/2018	7/11/2018	7/2019
South 2018 Planting	6/14/2018	NA	7/2019	7/2020
West Beach Reference	NA	NA	7/18/2017, 7/24/2018	7/2019
Peachs Point Reference	NA	NA	8/9/2017, 7/3/2018	7/2019
Aquavitae Reference	NA	NA	7/3/2018	7/2019

*Additional post-storm monitoring conducted on April 9, 2018

Table 3: MGW 1-year Monitoring results (13 plots planted in 2017)

Transect	Mean Planting Unit Survival	Mean Density [shoots/m ²]	Mean Shoot Survival	Mean Canopy Height [cm]	Mean % Cover
North	42.3%	60.4	120.8%	41.4	27.7%
Mid	62.5%	61.6	123.2%	34.7	30.3%
South	68.5%	89.9	179.8%	47.9	39.3%
ENTIRE SITE	58.7%	72.1	144.2%	41.8	32.9%

Table 4: MGW 1-mo Monitoring results (5 plots planted in 2018)

Transect	Mean Planting Unit Survival	Mean Density [shoots/m ²]	Mean Shoot Survival	Mean Canopy Height [cm]	Mean % Cover
North	98.3%	66.5	133%	37.5	16.3%
Mid	100%	63.3	126.7%	32.8	32.5%
South	100%	49.0	98%	34.3	30.0%
ENTIRE SITE	99.3%	61.7	123.5%	35.0	25.5%

Table 5: MGE 6-mo Monitoring results (18 plots planted in 2017)

Transect	Mean Planting Unit Survival	Mean Density [shoots/m ²]	Mean Shoot Survival	Mean Canopy Height [cm]	Mean % Cover
North	2.8%	0.04	0.08%	8	0.04%
Mid	22.8%	10.1	20.2%	16.6	3%
South	21.7%	8.3	16.6%	22.9	2.8%
ENTIRE SITE	15.7%	6.1	12.2%	18.9	1.9%

Table 6: MGE 1-year Monitoring results (18 plots planted in 2017)

Transect	Mean Planting Unit Survival	Mean Density [shoots/m ²]	Mean Shoot Survival	Mean Canopy Height [cm]	Mean % Cover
North	8.9%	4.5	9%	34.0	3.8%
Mid	15%	13.9	27.8%	33.5	6.9%
South	7.2%	7.2	14.4%	63.3	4.7%
ENTIRE SITE	10.4%	8.5	17%	39.7	5.1%

Table 7: MGS 1-mo Monitoring results (18 plots planted in 2018)

Transect	Mean Planting Unit Survival	Mean Density [shoots/m ²]	Mean Shoot Survival	Mean Canopy Height [cm]	Mean % Cover
North	100%	50.3	100.6%	44.6	29.7%
Mid	98.9%	51.1	102.2%	39.0	30.6%
South	99.4%	49.8	99.6%	46.4	32.5%
ENTIRE SITE	99.4%	50.4	100.8%	43.3	30.9%

Table 8: 2018 Reference bed monitoring results

Site	Mean Density [shoots/m²]	Mean Canopy Height [cm]	Mean % Cover
Peachs Point	366.7	106.3	67.1%
West Beach	206.3	84.1	43.8%
Aquavitae	139.3	25.9	28.8%