

Preparing for Climate-adapted eelgrass restoration in Pleasant Bay, Cape Cod, MA

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Introduction

Eelgrass (*Zostera marina* L.) is the dominant seagrass species found in the shallow coastal waters of the Northern Hemisphere. The value of eelgrass to coastal environments is well documented and includes stabilizing sediments, protecting shorelines by attenuating wave energy, improving water quality and clarity, mitigating CO₂ emissions through carbon sequestration, and provisioning food and habitat to a variety of commercially important and endangered species. Since 1951, Pleasant Bay, Cape Cod, MA has lost hundreds of acres of eelgrass due to watershed development and losses are expected to continue with rising sea surface temperatures. As part of the MVP Action Grant for Pleasant Bay in 2023, we developed an Eelgrass Habitat Suitability Model in ArcGIS model builder to identify potential areas for restoration and enhancement (rehabilitation) activities. The model uses newly available data on eelgrass distribution and abundance, water quality and physical characteristics of the estuary and considers worse-case scenarios for sea-surface temperature (SST) increases. The first scenario identified sites for future restoration activities assuming an SST increase of 1.95°C. The second scenario identified sites for rehabilitation that receive > 20% SI and have low percent cover (<25%). Between June and October of 2023, we visited multiple sites rated as Most or Very Suitable by the model to confirm their suitability and to collect additional information on factors that may adversely impact eelgrass restoration success such as bioturbation potential (numbers of green crabs, clam worms, spider crabs, horseshoe crabs, etc.) and conflicting uses (aquaculture areas, moorings, anchor scars, lobster pots, etc.). We also conducted a small-scale pilot study at one location to test the feasibility of using seeds for future restoration efforts. Below are the methods and results of our pilot study.

Methods

Harvesting

In July 2023, 1,000 reproductive shoots from locations within Pleasant Bay and Cape Cod Bay (Wellfleet) were collected via snorkeling. Healthy, green reproductive shoots were

broken off 1-2 cm above the sediment. If shoots appeared black (indicating their seeds had been dropped), they were not harvested. Collectors were spatially dispersed and remained in one location for up to a minute before they moved a few meters to a new location to prevent over-collection in one area. Harvested shoots were placed in handheld spat bags and transferred to the Pleasant Bay Community Boating Center (PBCB) for processing (Figure 1).

Storing shoots

One seawater flow-through tank was used to hold the seeds until they could be re-deployed into experimental plots. The tank was first scrubbed clean with a sponge and scraped free of barnacles and other organisms. Once clean, the tank was filled and adjusted for a moderate flow rate. Collected reproductive shoots were held in spat bags and hung from PVC pipes running perpendicular across the tank. Airlines from an air compressor were added to the bottom of the tank to prevent anoxic conditions inside the bags (Figure 1).

Trimming and Maintenance of the Reproductive Shoots

Excess biomass was trimmed from reproductive shoots by removing all parts of the plant except spathes containing seeds. The tank was cleaned with seawater multiple times during the summer to prevent overgrowth of epibiont. In mid-August, the bags were emptied and sieved to remove excess plant material (Figure 1).

Pilot site selection:

One thousand seeds were transplanted into three plots at a site located off the shoreline of Paw Wah Point Conservation Area, Orleans. At each plot a small hole was dug and three hundred seeds were dispersed. The site was chosen as it historically supports *Z. marina*, had a high suitability rating, and was easy to access for monitoring. At low tide, the site is approximately 1.2m deep.

Monitoring

In March 2024, the site was monitored to determine success rates. It was determined that there was an over-winter survival rate of ~15% for the 1,000 seeds released.

Next Steps

We have acquired some funding to implement additional pilot restoration efforts in Pleasant Bay. Specifically, the project will move seeds from multiple populations in the region with higher water temperatures into four 1/8-acre pilot restoration sites in Pleasant Bay that we identified in Phase I of the MVP action grant. The success of these plots will be monitored for one year following transplantation using well-vetted pilot-restoration and genomic techniques. The methods used in this project will identify the best heat-tolerant donor populations for this system that can be used for future large-scale restorations, yielding the best chance to prevent temperature related eelgrass declines. More importantly, our methods will be transferable to other systems in Cape Cod to guide additional climate-adapted restorations while the eelgrass facility that we build to store seeds can be used by multiple towns interested in conducting restorations in their town's waters.



Figure 1. Top Left: Image showing reproductive shoot with seeds. Top Right: Image showing trimmed reproductive shoot with seeds in spathe. Bottom Left: Image showing reproductive shoots being stored in bags at PBCB. Bottom Right: Image showing seeds before deployment.