Eel Grass

Restoration

Outreach Materials

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UMass Boston

School to Sea Boat Trip Eelgrass Lesson

Salem Sound Coastwatch

Abstract

This interactive lesson is meant to explain what eelgrass is, what threats it faces, and why it's important to the health of Salem Sound. It introduces how scientists collect data to monitor the abundance of eelgrass. Students will learn to estimate the percent coverage of vegetation within a quadrat. This lesson is intended for an audience of roughly 20-25 students and designed for a boat equipped with an underwater camera in Salem Harbor. It's flexible, so please tailor it to your needs; feel free to include as much or as little of the information below as you'd like, based on the age of the students.

Materials

- ☐ SplashCam underwater camera
- ☐ PVC 0.25 m^2 quadrat camera frame (with 30 ft. line)
- ☐ Laminated data sheets with reference charts (x2)
- ☐ Clipboards for data sheets (x2)
- ☐ Dry-erase markers for data sheets
- ☐ Laminated map of eelgrass beds in Salem Sound

Lesson Outline

What is Eelgrass?

- First, move to a location with fairly shallow water (roughly 15 to 25 ft.) before lowering the camera, which should be attached to the quadrat frame facing down toward the seafloor. The camera should project onto a monitor.
- Gently lower the drop-frame and camera to the bottom and wait 10 seconds for the sediment to settle. Make sure the quadrat lands upright and there is some amount of eelgrass within the quadrat.
- Ask the students what they see in the square: Do they know what's growing on the bottom?
- **Explain what they're seeing:** This is an eelgrass bed! Eelgrass (*Zostera marina*) is a native sea grass that lives in shallow waters with plenty of sunlight. It roots in the substrate and sprouts from rhizomes. It's a kind of flowering plant (unlike seaweed and other algae), which means it produces seeds.
    - Eelgrass is unique because it's one of very few plants that can survive entirely underwater! Its leaves have small air pockets to keep them buoyant, and its roots can grow in substrates where oxygen is unavailable.
- **Explain why it's important:** Eelgrass provides food and shelter to marine life and protects our coastlines from erosion.
    - Eelgrass is a nursery habitat for animals like young lobsters, flounder, mussels, and scallops, all of which are important to our fisheries.

    - The leaves (which grow up to 3 ft. tall) reduce incoming wave energy, and their roots secure the soil and trap sediment, which builds the shoreline and prevents coastal erosion.
    - It's a food source for sea turtles, ducks, geese, sea urchins, and snails.
    - It filters out pollutants / runoff and sequesters carbon dioxide as it grows, which keeps our water clean and reduces the impacts of climate change.
        - It's known as a "blue carbon" habitat because it combats ocean acidification and global warming by storing CO_2 underwater.

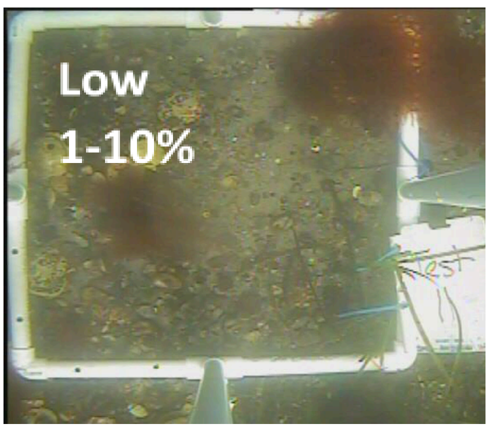
Quadrat Exercise

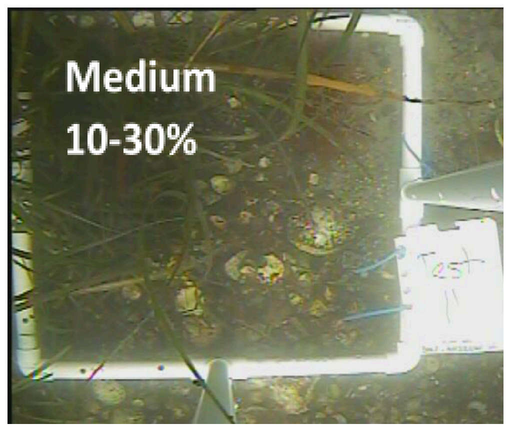
- Next, the students get to make their own observations. Move the frame and camera to a slightly different spot so the camera is looking at a new location on the seafloor.
- Split the students into two teams, and provide each team with a data sheet.
    - One team will observe the sediment and decide what types of substrate are present in the quadrat (sand, gravel, and shell hash).
    - One team will observe the eelgrass and estimate the percent coverage of grass in the quadrat using the chart below.
        - Older students can estimate the percent coverage numerically using four bins (1-10%, 10-30%, 30-75%, 75-100%).
        - Younger students can estimate the coverage qualitatively using three categories (low, medium, high).

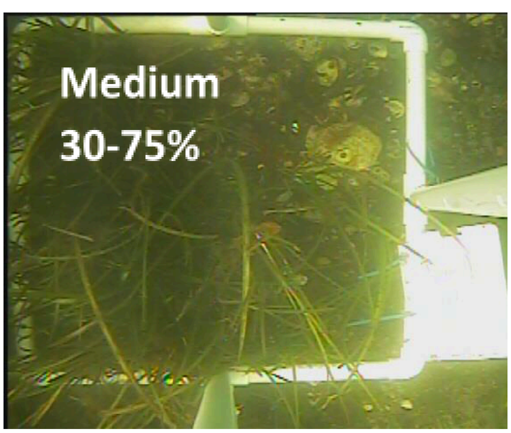
Sea Grass Field Sampling (Winter Island)				
	Coverage	**Sediment**		
	Eelgrass	Sand	Gravel	Shell Hash
Team A		Y / N	Y / N	Y / N
Team B		Y / N	Y / N	Y / N

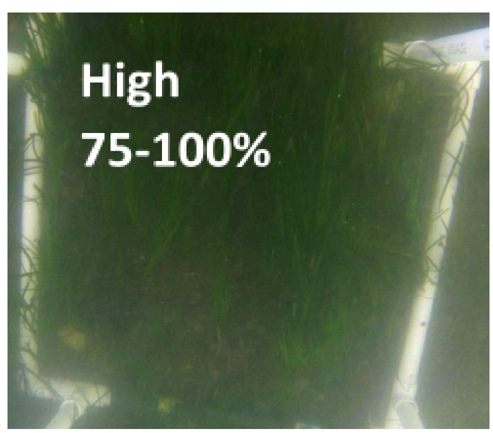
Substrates:

Percent Cover:









- Allow the teams to discuss and work on their data sheets for about 3-5 minutes, then change roles and repeat so that each team observes both the eelgrass and substrate.
    - If multiple chaperones are present, it may be helpful to have one adult act as a scribe for each team.
- After both teams have finished, reconvene the students as a group. Ask them to **share what they noticed**: were there any differences between the two teams' results? What might their observations mean about where eelgrass grows?
    - For instance, if there was dense eelgrass coverage and lots of sand, does eelgrass prefer to grow in sandy substrates?
- Finally, collect the data sheets and erase them to be reused next time.

Conclusion & Takeaways

- Use this exercise to **explain scientific monitoring efforts.** The students just used a quadrat to take a random sample of the harbor; scientists do the same thing to monitor the health of eelgrass beds. By doing lots of quadrat surveys in different places, we can get an idea of where eelgrass is growing and how its distribution is changing over time!
    - Salem Sound Coastwatch is doing exactly this – we're using an underwater camera to map changes in eelgrass habitat all along the coast of Massachusetts.
    - While explaining this, feel free to pass around a map of eelgrass beds in Salem Sound.
- **Explain what scientists have discovered this way:** it turns out, eelgrass has been disappearing from the harbor for a number of reasons.
    - Sediment runoff increases the turbidity (murkiness) of the water, as do algal blooms caused by excess nutrients. This reduces the amount of sunlight that

eelgrass receives, causing it to die off. Even shade from small docks can have the same effect!

    - Boating activities can harm eelgrass in a number of ways. Propellers and anchors tear up the leaves, and moorings can rip through the roots and rhizomes as they're dragged by the current, known as "scarring."
    - Severe storms and dredging projects can directly uproot eelgrass beds.
    - Higher temperatures, disease, and predation from invasive species also damage eelgrass populations.

- **Explain what people are doing to protect eelgrass:** Lots of people are trying to help eelgrass by improving our water quality and replanting eelgrass beds in Salem, Beverly, and Marblehead.
    - Salem Sound Coastwatch is currently working on a project funded by WHOI SeaGrant with MassBays and MA DMF to study the use of eelgrass seeds in eelgrass restoration at Winter Island. This is unusual in Massachusetts, because restoration projects usually involve transplanting entire eelgrass shoots (or "plugs"). If it proves to be successful, a seed-based approach could allow restoration projects to cover a much greater area.
    - Scientists are also investigating whether heat-tolerant eelgrass from southern regions could be brought further north in order to protect eelgrass beds from global warming in the future.
- Don't forget to pull up the camera and frame again before leaving!

Oceans & Climate
Fall Research

Name: ______________________
Partner(s): ____________________

Eelgrass Seed Viability Testing

Eelgrass (*Zostera marina*) is a critical marine habitat that provides a myriad of ecosystem services, yet its extent continues to decline across the Massachusetts coastline and beyond. Restoration efforts to date have largely focused on the transplantation of adult shoots, the effectiveness of which is limited by the high implementation cost and low potential for scaling up to the extent needed to reverse recent declines. Seed-based restoration offers an alternative that can be implemented at greater scales and at a lower per-area cost. The Massachusetts Bays National Estuary Partnership (MassBays), the Massachusetts Division of Marine Fisheries (MA DMF), and Salem Sound Coastwatch (SSCW) were funded by the Woods Hole Oceanographic Institution (WHOI) SeaGrant to determine if seed-based restoration can be an effective method for eelgrass restoration.

Viable seeds are the foundation of this work. We'll be contributing to this study by testing the viability of seeds from a local and a non-local source to measure their fall velocity, shell hardness, and color. Marion and Orth (2010) found that viable ("good") seeds had an intact coat, resisted compression, and had a fall velocity of 5.5cm/sec or higher, with 89% of those seeds producing seedlings.

"Good" seed checklist:
☑ Intact coat
☑ Firm seed
☑ Fast fall velocity

Materials:

- 2 white ice cube trays (drop test)
- 1 gray ice cube tray (tetrazolium)
- Forceps
- Drop tank
- Ruler
- Seawater (20ppt)
- Stopwatch
- Tetrazolium solution (1%)
- Scalpel
- Dissecting microscope

Drop-test Procedure:
Each group will be testing a subset of seeds from either the LOCAL (West Beach, Beverly) or the NONLOCAL (Provincetown) seed source.

1. Fill your tank with 22cm of seawater (20 ppt). Be sure to measure the water level from the inside of the tank.
2. Obtain a sample of seeds from either the Local or the Nonlocal study site.
3. With forceps, randomly select a single seed from your sample. Inspect the seed. Note its color (<u>light, medium, dark</u>), hardness (<u>soft/firm</u>), and whether or not the seed coat is <u>intact</u> or <u>damaged</u>. Record this on the data sheet.

4. While one partner waits ready with the stopwatch, the other partner should hold the seed just below the water's surface with the forceps. Count down (3, 2, 1) and then simultaneously release the seed and start the timer. Stop the timer when the seed hits the bottom of the tank. Record the drop time on your data sheet.
5. Repeat until you have tested a total of 32 seeds.

DROP TEST DATA SHEET

Circle Seed Location: LOCAL // NONLOCAL

Seed #	**Color**	**Hardness**	**Seed Coat**	**Drop Time (sec)**
	Light / Medium / Dark	*Soft / Firm*	*Intact / Damaged*	

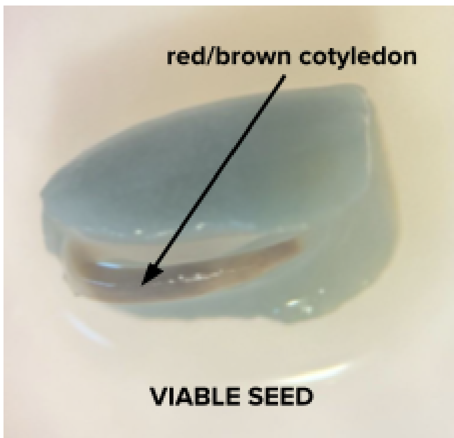
Seed #	Color	Hardness	Seed Coat	Drop Time (sec)

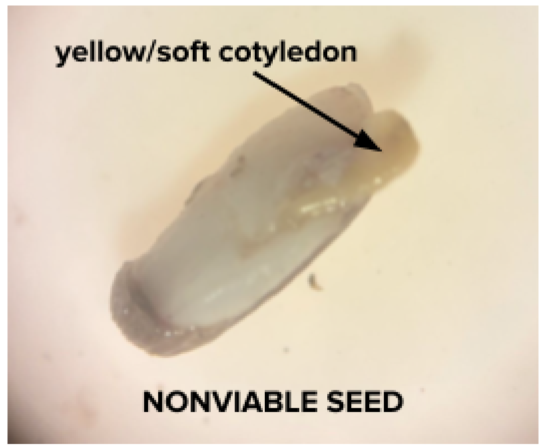
Tetrazolium Staining Procedure:
Viability is determined via tetrazolium staining. A seed's cotyledon will be stained brown/red if viable and will remain yellow if nonviable. Each group will test half of the seeds from the drop test to determine if there is a correlation between drop velocity and viability.

1. Put on gloves and safety goggles. Obtain the gray tetrazolium ice cube tray, forceps, and a scalpel (CAUTION: SCALPEL BLADES ARE EXTREMELY SHARP).
2. Using a pipette, fill each ice cube tray compartment with enough tetrazolium solution to cover the bottom (about 1ml).
3. Select 16 seeds to test in the following categories:
    a. 4 of the fastest seeds.
    b. 4 of the slowest seeds.
    c. 4 medium-fast seeds.
    d. 4 medium-slow seeds.
4. One at a time, remove a selected seed from the drop test ice cube tray and, using the scalpel, CAREFULLY cut away the seed coat, ensuring the inside embryo is not damaged.
5. Place the unsheathed seed in the tetrazolium solution, ensuring you've noted which seed # corresponds to the tetrazolium bin #.
6. Repeat these steps for the remaining seeds. Seeds will be inspected after 24 hours.

Day 2 Tetrazolium Procedure:

1. Put on gloves and goggles. Obtain forceps, a class petri dish, and dissecting microscope.
2. Remove the first seed from the tetrazolium solution with forceps and place in the glass dish.
3. Observe the seed through the dissecting microscope. Specifically, you're looking for the cotyledon (the first shoot during germination) is stained. If it is stained red/brown, consider the seed <u>viable</u>. If yellow or soft/mushy, consider the seed <u>nonviable</u>. See photos below.
4. Record your findings for all 16 seeds on the data sheet provided.





TETRAZOLIUM VIABILITY DATA SHEET

Seed #	**Viability** (*viable / nonviable*)	**Observation Notes**

GRAPHS

Calculate the seeds' velocity (cm/sec) in Google sheets. Compile the results of the class data on a Google sheet. Calculate the average seed velocity per site. Calculate the average number of viable seeds per site. Make two bar graphs to visualize these data.

CONCLUSION

Write a conclusion summarizing your results.

- Brief overview of eelgrass restoration, our study, and why this is important.
- An analysis of the results of our (the class') study
- A comparison of our results to Marion and Orth's (2010)
- Concluding thoughts about the big picture of eelgrass restoration.

Seagrass Field Sampling (Winter Island)

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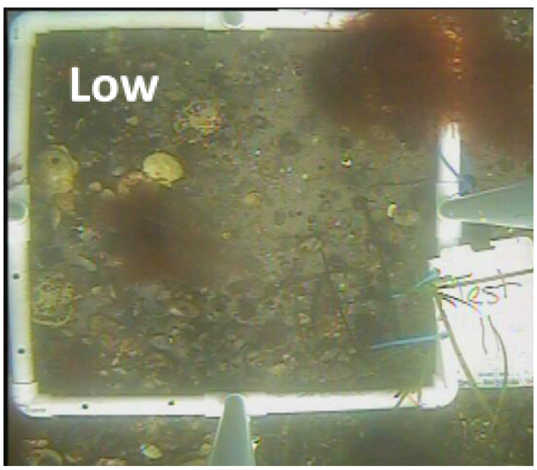
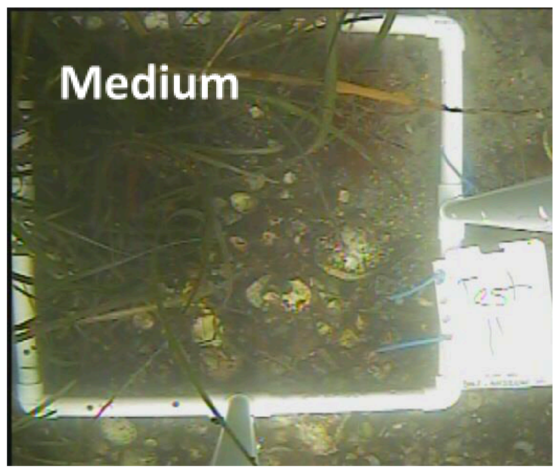
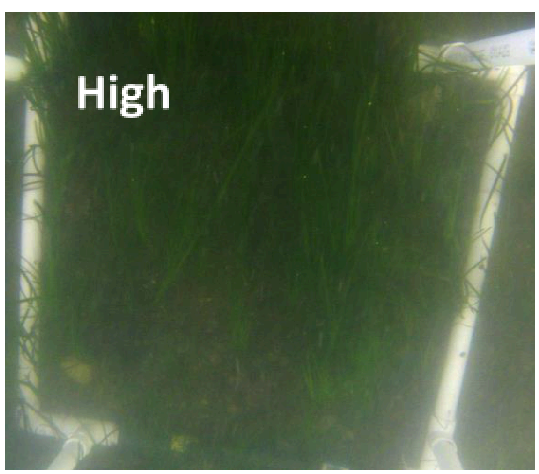






Moving toward seed-based approaches to eelgrass restoration and resiliency

MassBays
NATIONAL ESTUARY PARTNERSHIP
Jill Carr
NEP Tech Transfer 2024

Continued losses & attempts to restore

- Losing 2 football fields per hour globally
- Historic declines across most of Massachusetts, ~50% loss since 90's
- Traditional "adult shoot" restoration methods not scalable



Working Regionally

Working Regionally

- 2022: started convening New England NEPs to assess needs and resources

Intent: This spreadsheet will be shared with New England NEPs to assess resources and needs related to seed-based eelgrass restoration and monitoring; with the ultimate goal of developing region-wide project ideas that fill knowledge gaps and result in eelgrass restoration.

Instructions: Review the Components listed in columns A-C. In two blank columns to the right, work down the rows listing your resources and needs for each Component. Columns D and E can be used as an example (MassBays entry). Resources you list need not be in-house: in fact, it will be helpful to know who might be potential partners with resources (e.g., aquarium has seawater tanks, agency has boats, etc)

Data, Infrastructure, and Process Components to Support a Regional Large Scale Eelgrass Seeding Restorations

			NEP (State): MassBays (Massachusetts) *Completed by*: Jill Carr	
			Resources Available	Needs
Data & Modeling	*Data: eelgrass meadow locations and extents*	Maps showing where eelgrass currently and/or historically exists. These data will inform all other modeling and groundtruthing efforts. Routine mapping programs may also be able to document restoration success or failure post-seeding.	MassDEP has run a nearly statewide mapping program since 1995. They fly and groundtruth one region per year on a 4 year cycle	An eelgrass condition assessment program
	Data: eelgrass meadow flowering shoots	We don't have a great sense for which meadows have the highest proportion of flowering shoots. Collecting from meadows with a greater proportion of flowering shoots will result in more	We have limited flowering shoot density data from three SeaGrassNet sites in MA, monitored for 10+	Need data from a larger sample of meadows. Included some of this work in WHOI pre-proposal for
	Data: optimal seed collection time	To optimize the viability of the seeds collected, collection timing should target ripened seeds that are beginning to dehisce (about to fall off). The timing of seed maturity will vary between states	No real dataset in MA, but could gather anecdotes from folks currently doing seed experiments (BU,	MassBays wrote this monitoring into a WHOI pre-proposal for 2024-2025 for field sampling. However,
	Data: traits and genetics of eelgrass populations	Eventually, a regional collaboration might include intentional selection of donor plants based on favorable genetic traits to acheive climate change resilience, e.g. moving plants from south to north	Limited genetics analysis performed on north shore by DMF and NEU as part of a restoration project (adult	Better coastwide coverage of genetics info; better understanding about what genetic similarities mean in
	Model: Donor bed site selection	Combine information about eelgrass extent, meadow persistence over time, density of flowering shoots, and access/safety to determine which meadows could be donors. Eventually,	No model in MA. We do have GIS and GIS skills in house.	MassBays wrote this monitoring in WHOI pre-proposal for 2024-2025.
	Model: Restoration site selection	To assess restoration suitability, assess historic and current eelgrass distribution, sediment type and potential human use conflicts, water temperature, water clarity/light, exposure/fetch	DMF has a restoration site selection model	DMF model needs enhancement; DMF and MassBays plan to work together in summer 2023 to
People	*Staff personnel for project management, plan*	A region-wide program would require a point-person in each state to lead the charge there. This person would directly manage that state's efforts (grant writing, reporting, planning,	I could take this on for MassBays' portion, and/or co-lead with agency partners.	--
	Staff or partner scientist for experimental design e.g. common gardens, genetics assessments	Ideally, each state would have an eelgrass practioner, either on staff or in a partner/subcontractor role (academic or NGO partner?) to develop research plans.	I could take this on and/or co-lead with agency (DMF) or academic partners (NEU? UMB? BU?)	Would need to lean on partners for experimental design assistance to ensure statistical strength.
	Field Personnel to collect reproductive shoots and distribute seeds	Depending on the location and tidal range, reproductive shoots can be collected via scuba, snorkeling or wading. They are easily recognizable in the field. Brad Peterson's lab	I could do some field work, and could train and manage field team. There would be a great deal of interest in	Funds to pay for external field team / partners.
	Lab Personnel to manage intake, storage and processing workflow	After collection, seed shoots must be promptly transported to seawater tanks. There is a spectrum of processing activities - but excess plant material should be removed to reduce tank	MassBays using BIL funds (2023-2025) to set up tanks and hire a university work-study student for tank	need funds after 2025 to sustain.
Infrastructure	*Boats and/or shore-based access for harvest activities*	Small skiffs are the ideal platform but shore entry can work if safety, swim distance, and beach access permission are addressed. Due to the high cost and skill required for boat ownership,	MassBays securing boat MOU with state university. Will have access to small center console and pontoon	need funds to sustain.
	Flow-through seawater tanks to hold the shoots until the seeds drop	Flow-through sea water systems are ideal (e.g. StonyBrook, VIMS) and there are a variety of setups and specs (e.g. aeration bubblers, drainable tanks for collecting seeds off bottom).	MassBays using BIL funds (2023-2025) to set up seed storage, processing, and experimental tanks at	need funds after 2025 to sustain.
	Materials to monitor germination success	The exact materials you need to monitor a seeding effort really depend on the specific	DMF has all sorts of field monitoring and lab	

	NEP Casco Bay Estuary Partnership (Maine): *Completed by*: Curtis Bohlen, Matt Craig		*NEP (State)*: Long Island Sound Study *Completed by*: Cayla Sullivan	
Component	Resources Available	Needs	Resources Available	Needs
Data: eelgrass meadow locations and extents	Maine DEP collected data in Casco Bay last year. Will be flying whole coast of Maine on 5 year schedule.	Finer-resolution data and surveys looking for seedlings may be needed. Daat outside of Casco BAy will help define regional	Since 2002, eelgrass have been intermittently monitored through USFWS aerial surveys. The most recent survey was	A defined monitoring approach to produce maps annually to better understand interannual and seasonal variability.
Data: eelgrass meadow flowering shoots	Limited diver surveys, expanding interest from volunteers, but I don't think this is an explicit focus of	Start collecting data. Consider ways to mobilize volunteers.	No information available. CT NERR, in collaboration with EPA, will be setting up SeagrassNet sites so there	Start collecting data.
Data: optimal seed collection time	I'm unaware of any relevant data.	Need protocols and methods., especially ones that can be implemented in part by volunteers.	No information available. If this information can be pulled from satellite imagery, we are looking to	Start collecting data in meadows with HOBO loggers
Data: traits and genetics of eelgrass populations	Very limited genetic data	Gather info that already exists from Maine, assess gaps & needs.	One study has conducted genetic work in LIS (Short et al. 2012).	Conduct another study to identify populations in Long Island Sound specifically resilient to temperature
Model: Donor bed site selection	I'll bet some of our colleagues have recommendations. No formal data or model	Need more info on criteria. Suspect we can find donor beds relatively easily once criteria are defined.	Working on a proposal to update the Eelgrass Habitat Suitability Index Model (originally developed by	Data collection on all parameters noted.
Model: Restoration site selection	Data is available, but no validated local model, little prior analysis. Analysis complicated by highly	Determine primary eelgrass stressors in Maine waters. Test regional habitat models in Maine and/or develop	We have a model, but we need to update it (working on developing a proposal now that will be competed).	Update to our current model
Staff personnel for project management, plan	Maine DEP, Maine TNC and CBEP all have staff with related responsibilities. Not yet clear who has capacity	Once project scope is better defined, reconvene Maine organizations and evaluate available capacity.	TBD - NYS is hiring a seagrass coordinator. Additionally, CT NERR is looking to lead eelgrass	
Staff or partner scientist for experimental design	Few active eelgrass scientists in Maine. Some CBEP capacity to assist. May have to lean on		TBD - LISS has academics that could potentially play a role here	
Field Personnel to collect reproductive shoots and distribute seeds	Limited staff capacity. Very likely that we could recruit volunteers.	We'll need a lot more information on tasks and time involved to discuss who can contribute capacity	I can help out with this (pending joining EPA's dive team/management approval). Could potentially	
Lab Personnel to manage intake, storage and processing workflow	Limited capacity, given competing priorities. Prior (2015) eelgrass transplant collaboration with So. Maine	Initial outreach to existing labs (SMCC, GMRI, Bowdoin) to explore interest & fit. We don't have many	Could partner with UConn or Stony Brook. We have funding available to do this through Research Grant	
Boats and/or shore-based access for harvest activities	Several CBEP partners have boats. Boat time is in short supply. MUltiple suitable launch sites near	Check with Partners to determine available boat time, and/or raise funds to purchase boat time and	USFWS has offered up boat and captain in the past to LISS. Potentially NRCS?	
Flow-through seawater tanks to hold the shoots until the seeds drop	So. Maine Community College and other institutions have limited capacity in Casco Bay.	We need more details on requirements so we can begin conversations with Bowdoin, SMCC.	Could partner with UConn or Stony Brook. We have funding available to do this through Research Grant	
Materials to monitor germination success			Depending who would lead this effort for LISS, we have	

	NEP (State): Piscataqua Region Estuaries Partnership (NH/Southern ME) *Completed by*: Trevor Mattera		*NEP (State)*: Buzzards Bay NEP (MA) *Completed by*: Joe Costa	
Component	Resources Available	Needs	Resources Available	Needs
Data: eelgrass meadow locations and extents	PREP runs an annual "tier-1" aerial eelgrass monitoring program in the Great Bay Estuary that continues assessments		Same as MassBays; DEP now conducting assessments about every 5 years. The Buzzards Bay NEP may conduct	Worthwhile to bring in survey information from Chapter 91 licenses and NOIs for historic assessments. Baywide
Data: eelgrass meadow flowering shoots	NH has spatially limited flowering shoot density data from two SeagrassNet sites (one in Great Bay with	More monitoring. We don't have a good idea of when the flowering happens - it varies quite a bit spatially	Perhaps a few old site-specific assessments can be mined, but information on flowering	Characterizations of flowering may be variable from year to year among beds, but timing likely to be
Data: optimal seed collection time	No formal dataset currently exists in NH.	Protocols & methods to build this into current monitoring programs	Nil.	Seed collection will generally focus on shallow beds, so a seasonal collection time range for
Data: traits and genetics of eelgrass populations	Limited genetic data available, which includes an ongoing study by Cynthia Hays from Keene State and	Additional studies as well as knowing how specific traits affect resilience	?	
Model: Donor bed site selection	This type of model does not currently exist for Great Bay.	While we have a few donor beds commonly used for transplanting, this specific analysis for seed donors	Nil.	Because local permitting is also a factor, there will be a tendency for municipalities to want harvested seeds to
Model: Restoration site selection	NH has a model - Alyssa Novak (BU) and other updated the model originally developed in Short et al.	Additional data collection and possibly enhancing the 2021 updated model with additional parameters and	Site selection models have been developed.	Site selection models require logic model validation of common-sense principals to avoid GIGO.
Staff personnel for project management, plan	I could head this for PREP with the assistance of UNH JEL		None at the BBNEP; Mass DEP (Tay Evans?) should be heavily involved.	Agency staff can guide state0wide goals and help direct funding. for getting things done. I tend to favor
Staff or partner scientist for experimental design	I can take this on. PREP is currently leading a multi-org/agency eelgrass restoration group that has	Coodination with other programs here to align experimental design	potential grad students, WHOI and MBL, possible Buzzards Bay Coalition participation	best driven by partner group or research lab that are the lead for site-specific projects
Field Personnel to collect reproductive shoots and distribute seeds	I can lead most annual fieldwork for a short window like this. A volunteer program is certainly not out	Potentially funding after 2025 depending on harvesting program that is established	potential grad students, WHOI and MBL, possible Buzzards Bay Coalition participation	best driven by partner group or research lab that are the lead for site-specific projects
Lab Personnel to manage intake, storage and processing workflow	PREP would likely use BIL finding through 2025 to pay for equipment and student/intern time for	Funding after 2025	potential grad students, WHOI and MBL, possible Buzzards Bay Coalition participation	best driven by partner group or research lab that are the lead for site-specific projects
Boats and/or shore-based access for harvest activities	PREP has access to boats and the boat launch at UNH JEL. Costs could be funded w/ BIL.	Funding after 2025	WHOI and MBL facilities	
Flow-through seawater tanks to hold the shoots until the seeds drop	UNH JEL has some flow-through tanks available, depending on the scale required.	Funding after 2025	WHOI and MBL facilities	
Materials to monitor germination success	PREP has access to the majority of the field supplies		best driven by partner group or research lab that are the	

	NEP (State): Peconic Estuary Partnership (NY) *Completed by*: Joyce Novak	
Component	Resources Available	Needs
Data: eelgrass meadow locations and extents	We have an existing aerial map of eelgrass from 2016. We are fully funded for a 2023 aerial survey and groundtruthing. We pay a	Need increased funds for better annual monitoring which may include high tech satellite imagery and trained staff to groundtruth. Funds
Data: eelgrass meadow flowering shoots	We have shoot density but not flowering shoots	
Data: optimal seed collection time	Seed collection is carried out by partners. WIth warming waters, we are looking to characterize	research funding
Data: traits and genetics of eelgrass populations	We are looking to begint his work this year with a CWG grant and target resistent seeds/plants	additional funding for targeting and transplant of seeds from resistent individuals
Model: Donor bed site selection	n/a	all
Model: Restoration site selection	We had a bio-optical model / site selection tool completed in 2019. We excluded embayments	Thermal dynamics in all embayments
Staff personnel for project management, plan	We need additional project management as this initiative grows - it has started to take up too much	Eelgrass coordinator
Staff or partner scientist for experimental design	Dr Brad Peterson and the Peterson Lab at Stony Brook University has been leding this effort here.	His lab can handle growing work but will likley require funding for even expanding work.
Field Personnel to collect reproductive shoots and distribute seeds	The Cornell COoperative Extension can be used for this	funding
Lab Personnel to manage intake, storage and processing workflow	Peterson Lab	funding
Boats and/or shore-based access for harvest activities	access to these at additonal cost	funding
Flow-through seawater tanks to hold the shoots until the seeds drop	unsure	
Materials to monitor germination success		

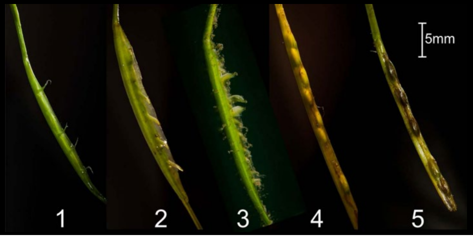
Working Regionally

- 2022: started convening New England NEPs to assess [needs and resources]
- 2023: Create and distribute flowering phenology protocol, based on NEP request

Standard Operating Procedure: Assessing Eelgrass Flowering Density and Seed Maturity

Version 1, 5/30/23
Contact: jillian.carr@umb.edu, colarusso.phil@epa.gov

Purpose: *There is great interest in using eelgrass (Zostera marina) seeds for restoration efforts, but little is known about the optimal location and timing of harvest activities. This field protocol was developed to address a regional data gap and provide a standardized approach to data col… Programs and NGO organizations located in New England. The proto… boat, and via snorkel, wading or scuba, by professional or trained vol…*



Data Collection

Beginning May 1 of any year and continuing until seed release has ended, visit each site and conduct the following assessments:

(A) Phase of seed maturation (seed scoring), *at least every-other week*, and/or

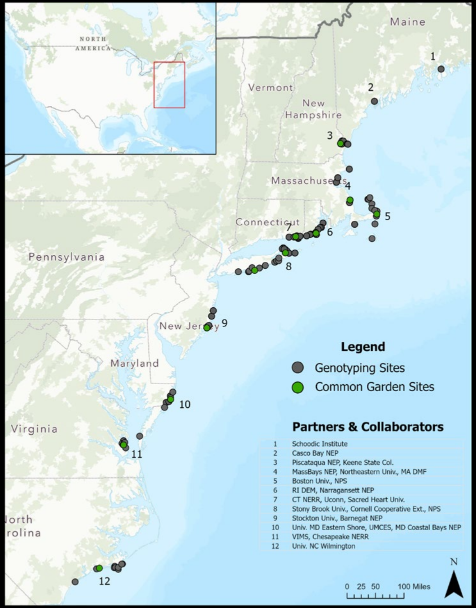
(B) Flowering shoot density, *every-other week, or at least once per year when at least 50% of spathes reach stage 4*, and/or

(C) Seed density, *at least once per year when at least 50% of spathes reach stage 4*.

Hoping to convene all partners this winter!

Working Regionally

- 2022: started convening New England NEPs to assess needs and resources
- 2023: Create and distribute flowering phenology protocol, based on NEP request
- 2023: connect with National Parks Service, with parallel interests
    - Giant $18M “HEAT” Proposal to NOAA → ☹ (still looking for $$!)
    - NPS able to continue with internal funding for subset of sites



- 2023 - ? : MassBays uses BIL funding to build and staff shared tank infrastructure

  (Cat Cove Marine Lab, Salem MA)

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- 2024: WHOI SG funds for seeding study across MassBays area,

  MADMF-RIDMF get funding for sister study in MA-RI

WHOI SeaGrant Study:

Fill data gaps for seed-based restoration

1) when and where reproductive eelgrass shoots should be harvested

2) the quantity, quality and germination rate of MA origin seeds

3) potential impacts of seed harvest on a donor meadow

4) the regulatory processes needed to permit large-scale routine harvest and seeding

Develop Best Practice Guide

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Photo: Forest Schenck

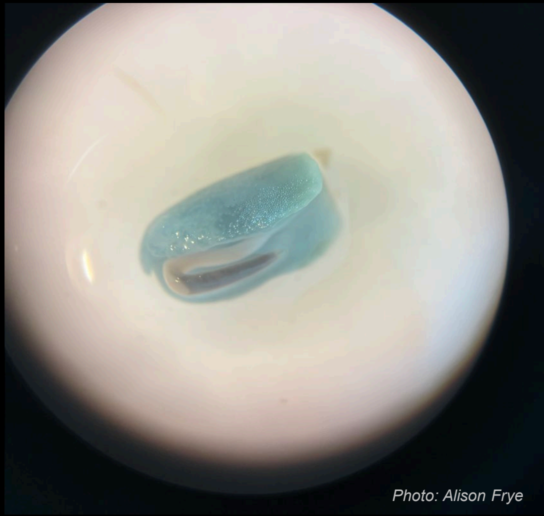

Photo: Alison Frye

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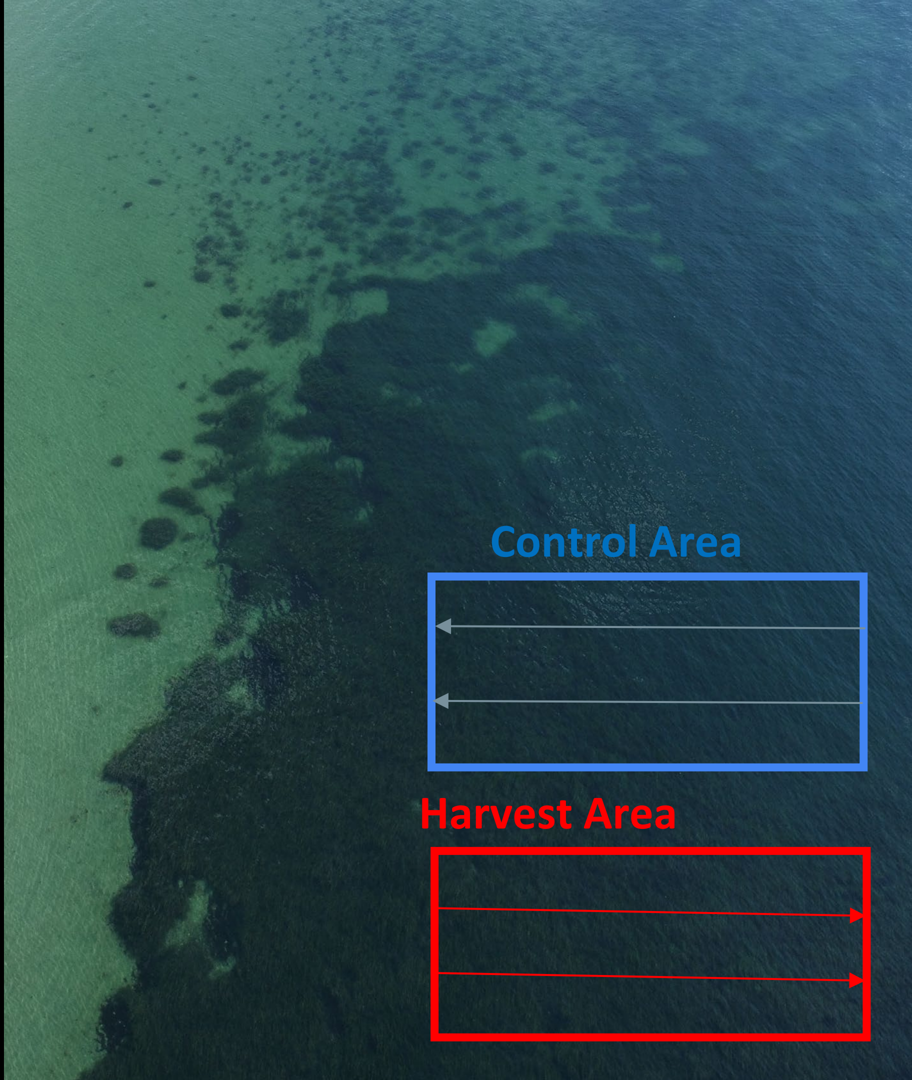

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EPA

US Army Corps of Engineers®

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

Massachusetts Environmental Policy Act Office (MEPA)

Massachusetts Office of Coastal Zone Management

Commonwealth of Massachusetts
Division of Marine Fisheries

CONSERVATION COMMISSION

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thank you!